NYCC HER	
SNY	9147
ENY	1580
CNY	2799
Parish	1092
Rec'd	30/08/2003

GEOPHYSICAL SURVEYS ON LAND ADJACENT TO SCOTS DYKE, RICHMOND, NORTH YORKSHIRE

A programme of research carried out
on behalf of

Randall Orchard Construction Ltd

by

GeoQuest Associates

1 INTRODUCTION

1 1 This report describes the results of detailed geophysical surveys of a parcel of land to the E of St Nicholas Drive, in Richmond North Yorkshire (Figure 1) The primary aim of the geophysical investigation was to map subsoil archaeological features, in particular remains associated with Scots Dyke, an important early medieval earthwork which is also a Scheduled Ancient Monument (No 26957) The research was carried out by GeoQuest Associates on behalf of Randall Orchard Construction (ROC) who propose to erect 5 detached houses on the site

1 2 The study area compnses a sub-rectangular block of land enclosed to the N, E and S by hedges and to the W by existing houses and gardens along St Nicholas Drive Informal pathways cross the area, leading E to a footpath along the crest of Scots Dyke Vegetation was cleared from much of the site immediately pnor to the survey, leaving several areas of dense undergrowth and a mound of debns in which geophysical investigation was impractical ROC provided drawing SW434/01/01A which was digitised and used as the basis of plans presented in this report

1 3 Scots Dyke is a linear earthwork, constructed dunng the 6th and 7th centunes AD which extends for 14km from the River Swale to the River Tees in North Yorkshire The structure comprised a substantial earth rampart flanked on the E side by a ditch and, in places, a counterscarp bank Although parts of the earthwork have been reduced by agricultural activity, archaeological remains will be preserved as buned features It is thought that Scots Dyke was constructed to act as a formal boundary, enclosing valuable arable and pastoral land in the eastern foothills of the Pennines between the Swale and the Tees, together with mineral resources Less than 50 post-Roman linear earthworks are recorded in England, highlighting the importance of this local example The eastern half of the application site lies within the Scheduled Area

1 4 In view of the landscape history the majority of buned remains in the study area are likely to exist as cut features (and possibly post holes), now infllled with topsoil, together with remains of ndge and furrow truncated by modern ploughing It was therefore decided that geophysical survey using a fluxgate gradiometer (magnetometer) would be the ideal pnmary technique to use in this instance This instrument will also be sensitive to the intense theremoremanent magnetisation associated with fired structures such as kilns and hearths The project design also allowed for additional survey using the resistivity method since these data might enhance the archaeological interpretation of subsoil targets Following an initial site visit on 24th May 2003, the geophysical survey took place on 19th June 2003

2 THE GEOPHYSICAL SURVEYS

2 1 Measurements of vertical geomagnetic field gradient were first recorded using a Geoscan FM36 fluxgate gradiometer within a senes of 20m x 20m 'gnds constructed from a baseline along the western boundary of the site Data were recorded at 0 5m intervals along zig-zag traverses spaced 1 0m apart Resistivity survey data were collected at 1 0x1 0m gridded intervals using a Geoscan RM15 resistance meter, operating in 'twin-electrode' configuration, with 0 5m spacing of the mobile electrodes With this arrangement, the instrument was sensitive to soil resistivity anomalies extending to a

maximum depth of about 1 0m Unfortunately, areas of remaining dense vegetation and the debns mound could not be mapped by the magnetometer or resistivity meter

2 2 Data logged in both geophysical instruments were penodically downloaded on-site into a portable graphics computer for initial processing and as a means of assessing the quality of results and forming a preliminary interpretation These data were subsequently transferred to a laboratory computer for final processing, interpretation and archiving

2 3 The GeoQuest InSite® software was used to process the geophysical data and thus convert the field readings into continuous tone grey-scale images (Figures 2 & 3) These drawings use a convention that displays positive magnetic and resistivity anomalies as dark grey, and negative anomalies as light grey Technical details of the data processing algorithms are given in Appendix A

2 4 An archaeological interpretation of the geophysical surveys is presented in Figures 4 and 5 A key defines the colours and fill styles used in these drawings, while feature codes f1, f2 etc, are included in Figure 5 for reference in the discussion below

3 INTERPRETATION

General

3 1 Both sets of geophysical data contain a wide range of anomaly amplitudes, the major source almost certainly being a spread of modern debns, together with gravel and subsoil matenals brought close to the surface by recent agricultural and landscaping activity (f1) Intense magnetic anomalies are also present near the steel lamp post (LP) iron inspection covers (IC) and field boundanes, preventing the detection of more subtle geophysical anomalies of possible archaeological interest

Possible Archaeological Feature

3 2 f2 A distinct positive magnetic anomaly, of linear form, has been detected close to the eastern boundary of the proposed development area, onented approximately parallel to the axis of Scots Dyke This anomaly can be traced for a distance of about 15m and is of a form consistent with a soil-filled ditch, about 3m in width A more detailed archaeological charactensation of this feature may require a programme of selective tnal trenching

3 3 No further anomalies of archaeological interest have been detected by the geophysical surveys Nevertheless, it should be stressed that the presence of modern surface contamination (and residual vegetation) has prevented the archaeological evaluation of low-level geophysical anomalies over much of the site

4 SUMMARY AND CONCLUSIONS

4 1 A fluxgate magnetometer and resistivity meter have been used to carry out geophysical surveys over part of an area of proposed residential development E of St Nicholas Dnve in Richmond, North Yorkshire The research was earned out by GeoQuest Associates on

behalf of Randall Orchard Construction Ltd, to comply with advice given by the Heritage Unit of North Yorkshire County Council

4 2 Archaeological interest in the proposed development area stems from its proximity to Scots Dyke, an early medieval earthwork of regional importance which is also a Scheduled Ancient Monument To maximise to the potential for detecting subsurface targets both geomagnetic (magnetometer) and soil resistivity survey techniques were used in this instance Unfortunately strongly magnetic surface debns, together with rubble and upcast subsoil matenals were found to be the major sources of geophysical anomalies over much of the site However one linear magnetic anomaly of archaeological interest has been detected this feature is consistent with a soil-filled ditch onented approximately parallel to Scots Dyke Further investigation of this target may therefore be warranted via a scheme of tnal trenching

5 CONFIDENCE LIMITS

5 1 The following are the levels of confidence which we assign to features inferred from the geophysical data

f1	Bnck, tile, iron & rubble	80%
f2	Ditch	60%

6 CREDITS

Survey & Report M J Noel PhD, FRAS
Date 20th June 2003

SCOTS DYKE, RICHMOND

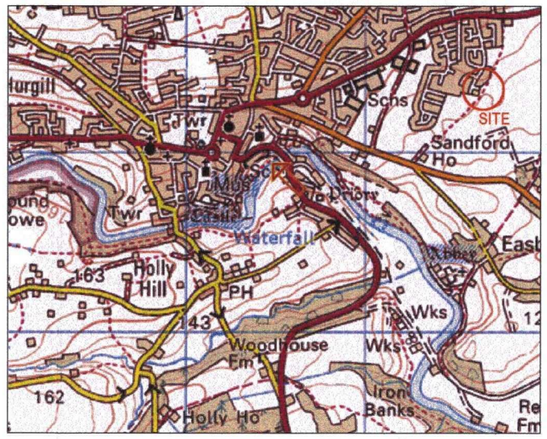
Location of Geophysical Survey Area

0 1:500 25

SURVEY BY GeoQuest Associates FOR Randall Orchard Construction Ltd

N
(indicative)

GENERAL LOCATION



1 km

FIGURE 1

SCOTS DYKE, RICHMOND
Results of Geomagnetic Survey

0 1:750 25

SURVEY BY GeoQuest FOR Randall Orchard Construction Ltd

ANOMALIES, nT/m

-12.4 -1.4 0.0 1.4 12.4

N
(indicative)

FIGURE 2

SCOTS DYKE, RICHMOND
Results of Resistivity Survey

0 1:750 25

SURVEY BY GeoQuest FOR Randall Orchard Construction Ltd

ANOMALIES, Ohms

-33.0 -3.6 0.1 3.8 33.0

N
(indicative)

FIGURE 3

SCOTS DYKE, RICHMOND
Archaeological Interpretation

0 1:750 25

SURVEY BY GeoQuest FOR Randall Orchard Construction Ltd

N
(indicative)

ANOMALIES, nT/m

-12.4 -1.4 0.0 1.4 12.4

KEY

Soil-filled ditch

Surface iron litter

FIGURE 4

SCOTS DYKE, RICHMOND
Archaeological Interpretation

0 1:750 25

SURVEY BY GeoQuest FOR Randall Orchard Construction Ltd

N
(indicative)

KEY

Soil-filled ditch

Surface iron litter

FIGURE 5

APPENDIX A

DATA PROCESSING

PROCESSING THE SURVEY DATA

The geophysical images contained in this report were prepared within Microsoft Windows® using the InSite® program published by GeoQuest Associates. Geophysical images were then placed onto a map which was digitised from the Ordnance Survey, edited and then plotted using a computer aided drafting (CAD) system and colour inkjet printer.

Data were downloaded from the meter to a portable computer in the field for storage, visualisation and quality control (QC) assessment. These data were then transferred to a laboratory computer for final processing, printing and archiving.

A number of process steps have been applied to the geophysical data obtained during the survey and those which have been used are linked to the main flow path by arrows. Steps were applied in the order shown and are designed to reduce artifacts in the data and enhance geophysical features of archaeological interest. The following sections describe each step in more detail.

REMOVE STRIPING

Reduces a data artifact comprising alternating changes in level in readings logged along zig-zag traverses. This artifact is common in fluxgate magnetometer data. InSite uses a proprietary algorithm to reduce this error.

INFILL SMALL BLANK AREAS

Fills isolated blank data cells with the mean of near-neighbours or a suitable approximation entered manually. Small blank areas will have been logged if it was not possible to obtain a geophysical reading over, for example, a manhole cover in the case of a resistivity survey.

REMOVE SPIKES

Replaces isolated, anomalously high or low values with the mean of near neighbours or a suitable approximation entered manually. 'Spike' readings are commonly associated with ferrous litter or poor electrical contact in the case of geomagnetic and resistivity data, respectively.

REDUCE WALK HARMONICS

Reduces a regular oscillation in traverse data caused by walking movements of the operator during a geomagnetic survey. InSite employs a fast Fourier transform to determine the optimum amplitude and phase of the walk-induced harmonic which is then subtracted from each traverse.

REDUCE SHEAR ARTIFACTS

Corrects for apparent shear in geomagnetic anomalies surveyed by zig-zag traversing in a geomagnetic survey. The shearing effect arises from the interaction of the operator+magnetometer with the geomagnetic field and also from the lag in the instrument response to changes in the field. InSite uses a proprietary algorithm to reduce this error.

CORRECT FOR METER DRIFT

Corrects for a linear drift in the meter calibration with time. Such drift is a common problem with fluxgate magnetometers, particularly during periods of rapid air temperature change. InSite uses least-squares regression on the mean of data along each traverse to estimate the change in calibration level across each grid. This gradient is then removed from the data.

ADJUST GRID MEAN LEVELS

Adjusts for differences in the mean level in data grids due to changes in instrument calibration (fluxgate magnetometer survey) or alteration in remote electrode spacing (resistivity survey).

INTERPOLATE AND COMBINE

Combines grids to form an array of regularly-spaced data on a square mesh. InSite uses bilinear interpolation to accomplish this.

LOW PASS FILTER

If this process task is indicated then a 3x3 or 5x5 boxcar filter has been used to smooth the data and reduce noise or 'speckle' seen in the original image.

HIGH PASS FILTER

If this process task is indicated then a 3x3 or 5x5 filter, with appropriate coefficients, has been used to pass short-wavelength information into the resulting image.

EDGE DETECT FILTER

Signifies that a Sobel, Laplace or other specialised filter has been applied to enhance significant lateral transitions in the geophysical image.

DIRECTIONAL FILTER

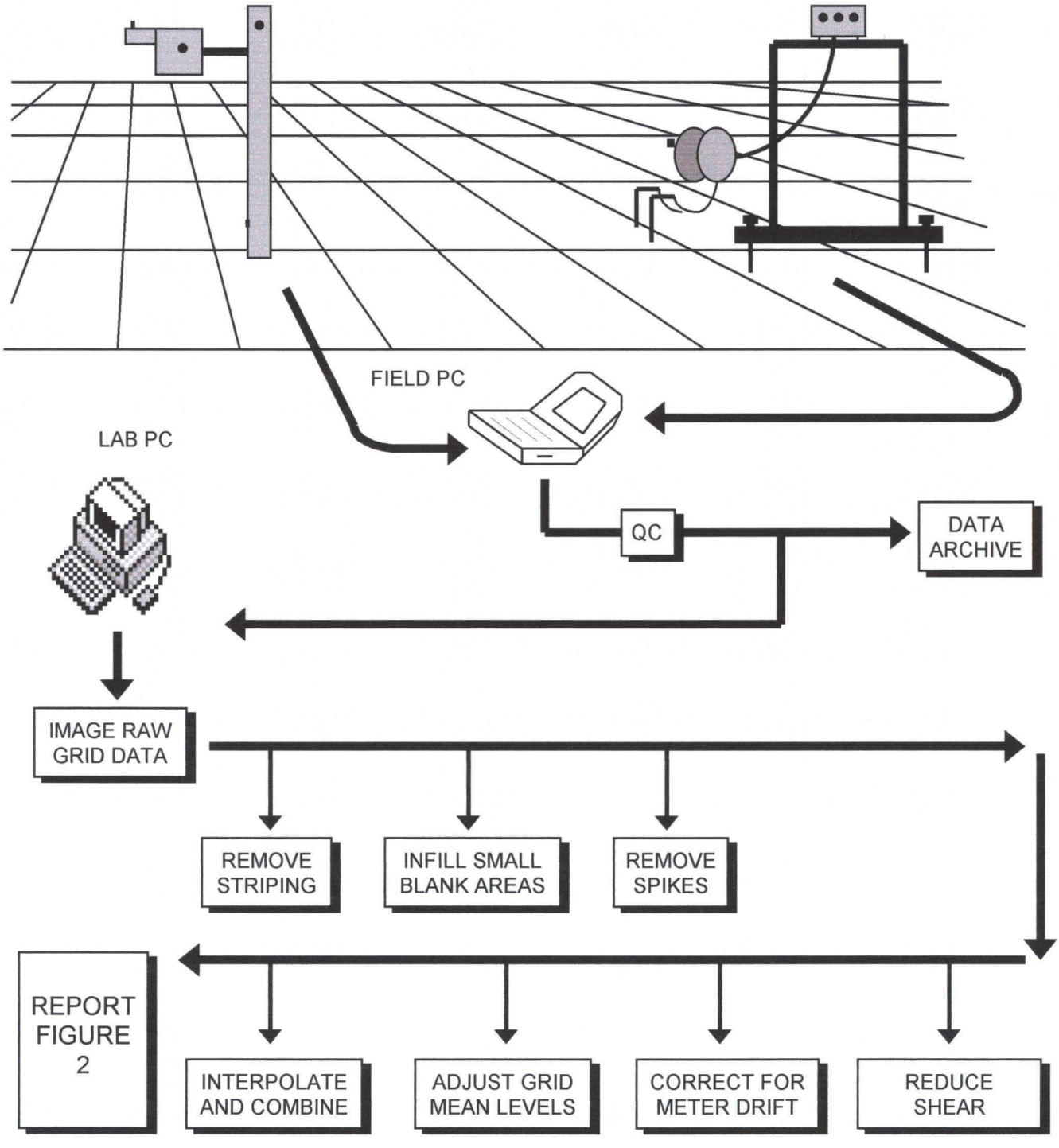
This filter is equivalent to illuminating the data from one direction to produce a pseudo-relief image. Directional filtering is usually employed to aid the identification of subtle anomalies in resistivity data. This filter highlights features trending at right angles to the direction of illumination.

NOTE

GeoQuest Associates can supply the geophysical images presented in this report in a variety of digital formats for visualisation on microcomputers running Microsoft Windows. These formats include the TIF, BMP and PCX standards. Please complete the request form at the rear of this report if you would like to receive such image files.

InSite

APPENDIX A
DATA PROCESSING



PROJECT: Scots Dyke

SITE: Development Area