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Survey Event No. **17**

Survey Name **N4 McNeads Bridge to Kinnegad Road Improvement Scheme, County Westmeath**

This Geophysical Report should be Referenced or Acknowledged as:

Bonsall, J. and Gimson, H., 2003. N4 McNeads Bridge to Kinnegad Road Improvement Scheme, County Westmeath: Archaeological Geophysical Survey. Earthsound Archaeological Geophysics. Unpublished Report No. 16. October 2003.

Detection Licence No. 03R080

Ministerial Directions No. Not Applicable

NRA Route No. N4

NRA Scheme Name McNeads Bridge/Kinnegad

NRA Scheme ID WH/00/100

Survey carried out for Westmeath County Council

Survey funded by the National Roads Authority

Known problems with this report

There are no known archive issues with this report

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This archive was last updated on 25/05/2009

N4 McNeads Bridge to Kinnegad

Road Improvement Scheme,

County Westmeath

Archaeological Geophysical Survey
VOLUME ONE: REPORT
Survey undertaken on behalf of

Westmeath County Council

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21 October 2003

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Summary of Results

Between the 30 June and 04 July 2003, a magnetic susceptibility survey funded by Westmeath County Council *was conducted within the 4.3km long common purchase order boundary of the proposed N4 McNeads Bridge to Kinnegad Road Improvement Scheme, County Westmeath. A Magnetic Susceptibility meter and Differential Global Positioning System formed an integrated hybrid instrument, collected northing, easting, volume specific magnetic susceptibility and altitude for each sampled data point at a sampling resolution of 5m x 5m, within national grid co-ordinates. Geophysical anomalies of potential archaeological origin were further investigated using a fluxgate gradiometer at a sampling resolution of 1m x 0.25m. Significant anomalies were also investigated with an earth resistance meter at a 1m x 1m sampling resolution.*

The survey was conducted upon a bedrock geology consisting of Lower to Middle Carboniferous Limestone, beneath grey-brown podzolics and some peats and peaty gleys. The majority of the survey area was covered in short grass. Portions of the land were comprised of marshland, and a small number of field contained spring barley, both of which were unsuitable for detailed investigations, but proved expectable for a reconnaissance survey.

A large number of unknown archaeological features were discovered, along with a significant number of geological trends. Of the archaeology, known and unknown relict field boundaries were common. A possible enclosure containing internal features appears to have been cut by the present N4, which suggests that it predates the known medieval road. An industrial complex and associated enclosures were found adjacent to the Royal Canal. These include a number of previously unknown kilns and possible structures. Domestic gardens and structures have also been successfully located via an integrated analysis of magnetic susceptibility data and 1st Edition Ordnance Survey maps. The reconnaissance survey was highly successful, providing a useful basemap of potential archaeological targets for future analysis.

Statement of Indemnity

The results and subsequent interpretation of the geophysical survey presented here should not be treated as an absolute representation of the underlying archaeological features. It is normally only possible to prove the nature of geophysical anomalies through intrusive means, such as trial trench excavations.

1. Introduction

Earthsound Archaeological Geophysics were commissioned by Mr. R. Swan, *National Roads Authority* Project Archaeologist for *Westmeath County Council*, to execute a magnetic susceptibility geophysical survey within the proposed 4.3km long common purchase order boundary of the N4 McNeads Bridge to Kinnegad Road Improvement Scheme, County Westmeath. Geophysical anomalies of potential archaeological origin were investigated further with a fluxgate gradiometer and earth resistance meter.

Permissions to undertake the survey were obtained from *Dúchas, The Heritage Service* (Licence Number 03R080, dated 24/06/2003) and the landowner's representative (Mr. R. Swan, *National Roads Authority*).

This Volume should be used in conjunction with Volume Two, which contains all relevant Figures.

1.1 Geography, Geology, Topography & Climate

The route of the proposed N4 road improvements crosses the townlands of Corralstwon, Crossantown, Knocksimon, Heathstown and Newdown. The northwest and southeast ends of the route (Figure 1) lie at *Ordnance Survey Ireland* National Grid (ING) Reference E251749 N249773, at 100m above Ordnance Datum and E255295 N247931, at 100.5m above Ordnance Datum, respectively.

The survey area encompassed the majority of the common purchase order boundary within available lands, not including existing roads or road verges. The majority of fields were of open grassland pasture which proved ideally suitable for a magnetic susceptibility survey, fluxgate gradiometer and earth resistance surveys. Some fields however contained very long grass, high silage and marsh reeds which hampered the speed of the magnetic susceptibility survey and effectively prevented fluxgate gradiometer and earth resistance surveys. Two fields contained crops of Spring Barley, again slowing the speed of the magnetic susceptibility survey and preventing further work at this time. A detailed breakdown of fields and vegetation can be found in Table 1, Appendix 1.

The bedrock geology consisted of a Lower to Middle Carboniferous Limestone, overlain by grey-brown podzolics and some peats and peaty gleys. Trial pits excavated along the proposed road take found that a strata of peat was comprised of silty sandy gravel, gravely silty clay and sand and gravel, each strata contained cobbles and boulders, assumed to have been derived from the limestone bedrock (WMCC 2000). Carboniferous Limestone is a magnetically quiet bedrock which can become strongly enhanced when exposed to cultural activity such as burning, fermentation, manuring etc. However, in-filled archaeological features containing weakly enhanced material can often be undetected by a fluxgate gradiometer survey. Potential archaeological geophysical anomalies were expected to contrast against a consistently weak magnetic background.

In the week preceding the geophysical survey, the climatic conditions consisted of mild warm weather following heavy showers, which continued during the fieldwork and are referenced in Table 1, Appendix 1. The earth resistance surveys were unaffected by the climate.

The topography of the site gently undulates with small pockets of low-lying marshy ground. Riverstown River and Corralstown Stream cross the site.

1.2 Archaeological Background

A series of road improvement schemes along the N4 has led to a large number of archaeological investigations over recent years. The archaeology is characterised by extensive occupation sites, isolated pit and hearth features, *fulachta fiadha* and industrial areas. Historical records indicate the potential of unrecorded or forgotten sites within the proposed road take.

A souterrain, possibly associated with Heathstown Castle (370m from the western edge of the site), is thought to have been located within the vicinity of the survey area. A sweathouse is also thought to be located 182m west of St. Agnes' Church, beyond the proposed route. A possible cillín site is likely to exist beyond the road take at Knocksimon hill, which may be associated with settlement within the vicinity. A demolished church lies close to the survey area of the site in Corralstown, where associated archaeology may be expected. Another church, in Crossantown, was partially examined during the construction of the present N4, an associated enclosure and ringfort, lie on the north side of the road.

Early Ordnance Survey maps, which have proved particularly effective for this project, have demonstrated a large number of relict field boundaries within the landscape lie in the survey area.

1.3 Aims & Objectives

The aim of the geophysical survey was to determine the nature of the archaeological resource in advance of the proposed N4 McNeads Bridge to Kinnegad Road Improvement Scheme. Specific objectives were to:

- Determine the presence or absence of potential archaeological occupation, burial or industrial areas within the proposed road take
- Establish a complete geophysical map of the route
- Assessment of the spatial extent and survival of archaeological features

A methodology was developed to allow a preliminary magnetic susceptibility reconnaissance survey to systematically investigate the site at a coarse sampling resolution of 5m x 5m. This technique has been an effective and proven method of identifying potential archaeological trends in European sites. Recent geophysical investigations along the proposed N25 Waterford Bypass and N7 Naas Road Improvement schemes have shown magnetic susceptibly to have demonstrable success as a reconnaissance prospection strategy, capable of indicating occupational, ritual and industrial archaeological sites for further investigation (Bonsall & Gimson 2003a, 2003b, 2003c).

Magnetic susceptibility anomalies of potential archaeological interest were subsequently investigated with a fluxgate gradiometer and earth resistance meter at a detailed sampling resolution. These techniques have been used in commercial and research archaeological projects for many years and are considered the most appropriate techniques for a detailed investigation of the underlying archaeology (Clarke 1996, Scollar *et al.* 1990).

2. Methodology

The fieldwork was carried out between 30 June and 04 July 2003 by J. Bonsall and H. Gimson of *Earthsound Archaeological Geophysics*. A *Bartington* MS2 Magnetic Susceptibility meter and an MS2D search loop were linked to a *Trimble* Pro-XRS Differential Global Positioning System, forming a hybrid instrument referred to in this report as an MS-DGPS. The MS-DGPS was used as a reconnaissance tool along the entire route of the proposed N4. A *Geoscan Research* FM36 Fluxgate Gradiometer was used to further investigate geophysical anomalies of potential archaeological origin. The gradiometer provided a basemap for targeted earth resistance surveys, which were executed using a *Geoscan Research* RM15 earth resistance meter.

The fields, which varied in vegetational cover, are described with additional survey metadata in Table 1, Appendix 1. Field numbers are based upon Ordnance Survey maps issued for the project by Westmeath County Council, in many cases, field boundaries have been removed in recent years to create larger fields, which are discussed in the text.

2.1 Preliminary Magnetic Susceptibility Reconnaissance Survey

The proposed road improvement scheme covered a total of 30 hectares, contained within a roughly linear route, aligned broadly northwest to southeast. In total, 34 individual fields were surveyed.

A geophysical grid baseline was not established for the Magnetic Susceptibility survey; the DGPS data logger, a *Trimble* TSC1, displayed a graphical representation of the Common Purchase Order (C.P.O.) boundary (as supplied by Westmeath County Council), as line data joined to points on the Irish National Grid. The graphical representation was used by the geophysicists to navigate along the C.P.O. boundary and collect data points at pre-determined intervals.

A topsoil volume magnetic susceptibility survey was undertaken along lines parallel to the C.P.O. boundary, walking approximately southeast to northwest across the length of the proposed road take. Subsequent lines were surveyed in alternate directions ('zigzag').

Data were recorded at a spatial resolution of 5m intervals between traverses and 5m intervals along those lines. The sample interval was increased to 2m along lines, dependent upon the ground cover, to increase the number of data points and enhance the survey resolution.

The MS2 was set to a recording sensitivity of 1 SI unit to obtain (infinite) volume specific magnetic susceptibility (Volume MS or κ). When measured in SI units, the data is expressed as 1 x 10^{-5} κ. The MS-DGPS recorded Easting and Northing data within the Irish National Grid to a minimum accuracy of ±0.5m, and altitude to an accuracy of ±2m.

The data collected by the MS2 are known to drift by 20% within the first twenty minutes of use, and by ± 1% after that time. The instrument was switched on 30 minutes prior to each days survey to compensate for this.

Prior to surveying each field, the MS2 was calibrated according to the manufacturers guidelines, by 'zeroing' whilst holding the sensor approximately 3m in the air. The positive and negative data presented in this report are κ values of the topsoil compared to the κ value of the air, being zero.

Data were collected and stored automatically in the TSC1 data logger by using a push button trigger on the MS2. The geophysicists walked at a constant pace along each traverse, pausing only briefly to obtain a measurement of magnetic susceptibility. The data were downloaded to a field computer using the *Trimble* Pathfinder Office 2.9 software.

2.1.1 *Data Processing*

2.1.1.1 Preliminary Data Treatment

The data were exported from Pathfinder Office 2.9 to *Microsoft* Excel. The data were analysed for temperature-induced drift, which was mostly removed by a linear equation. In some cases the drift removal was insufficient and this is noticed as artefacts are created in some data. These are further discussed in the relevant analysis text. The processed Excel data were gridded in x, y, z format as northing, easting and κ, using *Golden Software* Surfer 8.00.

2.1.1.2 Further Processing

A natural neighbour interpolation function was applied to the data using Surfer 8.00, to provide a smooth, aesthetically pleasing image for presentation.

No further processing functions were applied due to the high quality of the data collection.

2.1.2 *Graphical Display*

Data are displayed in contour plot format in Figures 43 - 48. Contour plots join data of equal value by a single line, allowing trends and isolated values to be seen.

Contour plots can also be shaded to emphasise particular regions between lines. Processed and interpreted data are shown in interpolated colourscale contour plots in Figures 7, 8, 14, 15, 19, 20, 23, 24, 29, 30, 34, 35, 40 and 41. The colourscale plot presents data as pixels on a linear colour shaded scale, increasing or decreasing dependent on the values of the maximum and minimum clip. The reconnaissance data in have been clipped to show data between -10×10^{-5} κ and 20×10^{-5} κ. The main advantage of this display option is that the data can be viewed as a base map and that each field or area of data are directly comparable to one another.

A series of archaeological maps, based upon the interpretation, are presented as Figures 13, 18, 22, 28, 33, 39 and 42.

The preliminary magnetic susceptibility reconnaissance survey provided a detailed base map of potential archaeological and geological targets. Representatives from *Earthsound Archaeological Geophysics*, *Westmeath County Council* and consulting geophysicist Kevin Barton, reviewed and discussed the preliminary results in detail. Eleven specific areas containing magnetic susceptibility anomalies that demonstrated archaeological potential were determined for further investigation using a fluxgate gradiometer. The areas were located in Fields 1, 2, 6, 18, 20, 25, 31A, 36, 37, 39A, 39B and 40. Two further areas (Field 35) were analysed as 'control' blocks to confirm the absence of geophysical anomalies, one of which was also subjected to an earth resistance survey. Control areas were used to confirm the operational stability of the magnetic susceptibility meter and the fluxgate gradiometer.

2.2 Detailed Fluxgate Gradiometer Survey

Geophysical baselines were established for each area (see Technical Appendix 2), using a DGPS to relocate areas of potential archaeology. The survey areas were divided into sub-grids of 20m x 20m (except for Field 25 and Filed 39 Area B, which comprised sub-grids of 30m x 30m). The surveys were undertaken along lines parallel to the sub-grid edges, walking approximately west to east, starting in the northwest corner of each grid. Subsequent lines were surveyed in alternate directions ('zigzag').

Data were recorded using an FM36, at a spatial resolution of 1m intervals between traverses and 0.25m intervals along those lines. The instrument was positioned facing north, parallel to the Earth's magnetic field, to allow increased geo-magnetic resolution.

The instrument was set to a recording sensitivity of 0.1nT. Prior to the beginning of the survey and after the completion of three 20m x 20m sub-grids (or two 30m x 30m sub-grids), the electronic and mechanical set-up of the instrument were examined and calibrated as necessary over a common reference point. The magnetic drift from zero was not logged.

Data were collected automatically using an ST1 sample trigger while the operator walked at a constant pace along the traverse. The data were stored in an internal data logger and downloaded to a field computer using the *Geoscan Research* Geoplot v.3.00a software.

2.2.1 *Data Processing*

2.2.1.1 Preliminary Data Treatment

The data were pre-processed in Geoplot 3.00.

The raw data contained some poorly matched sub-grids, caused by the internal drift of the fluxgate gradiometer. To compensate for this, the Geoplot Edge Match function was employed to create a 'smooth' image.

2.2.1.2 Further Processing

A low pass filter and zero mean traverse function were applied to improve the quality of the data. A sine wave interpolation function was applied to provide a smooth, aesthetically pleasing image for presentation. For a given point x, the contribution of adjacent readings to the interpolated point is given by the function sinc $(x) = \sin \pi x/\pi x$ (Scollar 1990.82,213). This function is used as a sliding window (similar to a 1D sliding box filter) along each transect, resulting in an interpolated image, expanding the resolution of the data from 1m x 0.25m to 0.5m x 0.125m. This function was chosen as giving a clearer interpolated image than linear interpolation (which assumes a direct linear change between each point) or bicubic interpolation (taking the surrounding sixteen values into account).

2.2.2 *Graphical Display*

Pre-processed, data are displayed in XY traceplot format from Figure 43, at a scale of 1:1000. An XY traceplot presents the data from each traverse as a single line, whilst each successive traverse is incremented on the Y-axis at equal intervals to produce a stacked plot. The data have not been clipped. The main advantage of this display option is that the full range of data can be viewed, so that the 'shape' of individual anomalies can be discerned and potential archaeological anomalies can be differentiated from geological or iron 'spikes'.

Processed data are shown in Greyscale format in Figures 9, 11, 12, 16, 17, 21, 25, 26, 31, 32, 36, 37 and 38. The greyscale plot presents data as pixels on a linear grey shaded scale, increasing or decreasing dependent on the values of the maximum and minimum clip. The clip varies between each survey area, as it is dependent upon the strength of the anomalies, which are not directly comparable. The clip is designed to highlight the geophysical anomalies rather than mask them in an all-encompassing clip. Data values beyond the clip limits are shown as 'pure' black or white. In some circumstances a greyscale proves useless depending on the variance of the geophysical data. Colourscales are used instead as an appropriate substitute. The main advantage of the greyscale or colourscale display option is that the data can be viewed as a base map.

2.3 Earth Resistance Survey

Earth Resistance surveys were undertaken in Field 1 in order to further enhance the fluxgate gradiometer data of a significant magnetic anomaly, and in a control area (Field 35).

The surveys were undertaken along lines parallel to the sub-grid edges, walking approximately west to east, starting in the northwest corner of each grid. Subsequent lines were surveyed in alternate directions ('zigzag').

Data were recorded using an RM15 PA5 Twin-probe array with a multiplexer, at a spatial resolution of 1m intervals between traverses and 1m intervals along those lines. The instrument was rotated between traverses and set to a recording sensitivity of 1Ω (Gain at x 1). The mobile probes were spaced 0.5m apart. The remote probes were located 15m away from the mobile probes (0.5m x 30) and were spaced 1.5m apart. The remote probes were relocated once during each of the two earth resistance surveys and calibrated as necessary to ensure consistency.

The data were stored in an automatic data logger and downloaded to a field computer, using Geoplot 3.00.

2.3.1 *Data Processing*

2.3.1.1 Preliminary Data Treatment

The data were pre-processed in Geoplot 3.00.

The raw data contained some poorly matched sub-grids, caused by the relocation of the remote probes. To compensate for this, the Geoplot Edge Match function was employed to create a 'smooth' image.

Spurious high intensity anomalies, commonly statistical outliers beyond ±2 standard deviations, are referred to as geophysical 'spikes'. In earth resistance data, spikes are caused by poor contact resistance, often with loose lying stones within the survey area. To compensate for this, the data were 'de-spiked' with an image processing algorithm threshold of 2, to remove the spurious data.

2.3.1.2 Further Processing

The data were smoothed by a sine wave interpolation sequence, as described above, expanding the resolution of the data from 1m x 1m to 0.5m x 0.5m.

2.3.2 *Graphical Display*

Pre-processed, data are displayed in XY traceplot format from Figure 49 at a scale of 1:1000. This display method has been chosen for the reasons stated above.

Processed data are displayed in greyscale or colourscale plot format in Figures 10 and 27.

2.4 Reporting, Mapping and Archiving

The geophysical survey and report follow the recommendations outlined in the *English Heritage Guidelines* (David 1995) as a minimum standard.

All figures reproduced from *Ordnance Survey Ireland* mapping are done so with permission from *OSI* copyright (Licence No. AR 0047303).

Geophysical data, figures and text are archived following the recommendations of the *Archaeology Data Service* (Schmidt 2001).

Technical information on the equipment used, data processing and methodology are given in Appendix 1. Appendix 2 details the survey geo-referencing information and Appendix 3 describes the composition and location of the archive.

3. Results & Discussion

*The interpretation figures should not be looked at in isolation but in conjunction with the relevant discussion section and with the information contained in the Appendices. Magnetic Susceptibility Reconnaissance anomalies (prefixed '***R***') are numbered in Figures 8, 15, 20, 24, 30, 35 and 41, and are described and interpreted within the text. Each field is discussed individually with appropriate comments regarding the use of further detailed investigations. Detailed area surveys, which identified anomalies, are numbered in additional figures (prefixed '***D***'). The results presented here are based entirely on the geophysical surveys and the known geological, topographical and morphological conditions.*

Figures 4 to 6 show the magnetic susceptibility survey along the entire route of the proposed N4, with increased detail in the western and eastern sides of the route. The background magnetic susceptibility (κ) is generally low, a statistical analysis of the data show that the average reading was 2 x 10^{-5} κ, although this has been skewed higher due to fields with very enhanced data, mostly caused by geological trends. Figures containing detailed magnetic susceptibility data immediately follow the individual text discussions per group of fields along a 750m stretch of the survey area. A non-technical summary may be found in Section 4.1

Field 1

The reconnaissance survey (Figure 7) revealed the presence of an enhanced linear anomaly (**R1**) of strength 11 x 10^{-5} κ originating in Field 1 and continuing in Field 2. R1 is aligned ENE-WSW in Field 2 and turns 90° in Field 1 to a NE-SW alignment. The strength of the anomaly falls off along its edges to 2 x 10^{-5} κ, before approaching a background level of ±1 x 10^{-5} κ. A curvilinear area of enhancement (**R2**) of strength 2 to 5 x 10^{-5} κ, is associated with R1 on its western side.

The distinctive curve of R2 warranted further investigation, therefore a 60m x 40m detailed gradiometer survey was carried out in the NE corner of Field 1. The results proved successful and a 40m x 40m area was also investigated with an earth resistance meter.

To the west of the survey area lies a private house, to the north the present N4 and to the east a laneway. The Royal Canal delimits the southern boundary of Field 1. The concrete and wire fences along the property boundary, and a significant proportion of traffic along the N4, created magnetic disturbance (**D1**) along the edges of the survey area. The resistance data was not effected by the magnetic properties of the field boundaries, but was disturbed by an increase in the resistance of the adjacent road and laneway.

D2 is a broken curvilinear anomaly of positive magnetism and low resistance, located in the NE corner of the survey area. The magnetic and resistance anomalies are slightly misaligned, which suggests that ploughing activity has disturbed and redistributed the enhanced soil The overall shape of D2 is difficult to determine as it is truncated to the north by the present N4 and to the east by a laneway. The neutral magnetic susceptibility data in the field on the opposite of the N4 (Field 5), suggests that the anomaly discontinues.

Given the geospatial and geophysical properties of anomaly D2, it may represent an enclosure ditch of length 62m and width 2-4m. A central gap in the possible ditch, of length 12m and open to the west may represent an entrance.

Several magnetic dipoles or 'iron spikes' - a response to buried ferrous objects, often in the topsoil - may be seen within the magnetic survey data. Iron spikes, although often modern in origin, can be indicative of archaeological material.

Within the possible entrance of the enclosure is a positive magnetic and low resistance anomaly (**D3**), circular in plan and approximately 6m - 7m in diameter. This may represent a large archaeological pit of unknown function or a geological anomaly.

Two weak low resistance anomalies (**D4**) may also be seen as extending talons from the two ends of the enclosure ditch. They do not appear in the magnetic data, which suggests that their in-filled properties are not greatly enhanced. The anomalies may have an archaeological origin such as small ditches or gullies, or a geological cause.

A curvilinear high resistance anomaly (**D5**) appears to originate from beyond the southern limits of the survey area, and extends in to the possible enclosure. It is possible that D5 represents a pathway or trackway of hardened ground, leading to the entrance of the enclosure, or a near surface geological anomaly. The possible trackway continues toward the present Royal Canal, presumably a notable water source and landscape feature prior to its canalisation.

A statistical analysis of the data reveals the mean resistance to be 84 Ohms within the possible enclosure D2, compared to 76 Ohms beyond it, possibly confirming the occupational nature of D2. This corresponds well with the magnetic analysis which also shows the mean inside D2 (0.1nT) to be higher than the mean outside it (-0.4nT), again suggesting occupational enhancement. Linear and curvilinear anomalies (**D6**) of higher resistance are visible within D2, which also coincide with negative magnetic data. It is possible that a structural feature of local unfired stone may be located in this area.

Broad trends of magnetic enhancement and low resistance values (**D7**) in the northeast corner of the survey area may be indicative of further occupational activity, however it may be associated with the disturbance created during the construction of the two field boundaries in this area.

A curvilinear anomaly (**D8**) of weak positive magnetism appears to traverse the survey area from northwest to southeast. The anomaly is 50m in length and broadly follows the alignment of anomaly D2. It also coincides with a narrow linear trend of low resistance, best observed in the raw XY traceplot. This could again be a small ditch or gully associated with the enclosure, or a possible geological anomaly.

D9 is a weakly magnetic circular anomaly, almost all of which can be seen in the gradiometer data. Its northern extent is masked by magnetic disturbance D1. D9 is also visible on the edge of the earth resistance data as low resistance feature. D9 appears to be associated with magnetic anomaly D8. D9 may represent a geological feature, however based upon the weakly magnetic quality of several anomalies discussed here, and the close proximity to enclosure D2, it is possible that D9 represents a ditched archaeological feature, possibly another enclosure. In the centre of D9 lie three dipole anomalies indicating near-surface ferrous debris. The mean magnetic response inside anomaly D9 (-0.1nT) is higher than the mean outside it (-0.4nT), which suggests a general trend of enhancement via occupational activity.

The earth resistance data indicates a broad trend of low resistance that coincides with magnetic susceptibility anomaly R1. This is likely to be a geological shift and suggests

that the enhanced band of magnetic susceptibility running between Fields 1 and 2 is in fact geological.

Field 2

Field 2 contains a known relict field boundary, aligned NE-SW, situated to the east of a quarry (site WM27:005) which had been backfilled during the early 1980's and was recently the subject of trial trenching (Egan 2003). The quarry appears on the 1st Edition Ordnance Survey Map and is marked on the 3rd Edition as a gravel pit, adding further credibility to the assertion that anomaly R1 is geological in origin, most likely fluvio-glacial sands and gravels associated with the pre-canalised Royal Canal. A very enhanced latticed shaped anomaly within R1, actually represents the recently backfilled trail trenches.

A detailed gradiometer survey of 40m x 40m, located 1m to the east of the trial trenching area, subsequently confirmed the geological origins of R1.

Geophysical anomaly **D10** is curvilinear in plan and of magnetism –0.4nT. Unfortunately, the feature occurs in close proximity to a fence line along the present N4, which has caused some magnetic disturbance along its length. D10 is approximately 18m in length and 0.5m – 1m in width. This is likely to represent a small ditch or gully, possibly filled with non-fired stone, or a geological feature. It appears to originate beyond the present N4 and terminates within the survey area, however it may be masked by the magnetic disturbance and continue beyond the road.

Fields 3 & 4

Fields 3 & 4 are presently one large field, now containing a relict field boundary aligned north-north-east to south-south-west, around which there is a slight increase in magnetic susceptibility to 2 x 10^{-5} κ. Fields 3 & 4 are in a low lying area of marshy ground. This is characterised by weak and negative background magnetic susceptibility data of diamagnetic strength, which further confirms its mostly organic wetland origins and strongly suggests an absence of archaeology in this area of C.P.O. Any archaeological features of enhanced magnetism (e.g. the aforementioned relict field boundary) would contrast starkly with the weak background.

Field 5

A small triangular enclosure containing a structure is present on the 1st Edition OS, neither of these features are visible today. The extinct structure lies approximately 20m to the west of the reconnaissance survey area, however the enclosure boundary partially crosses it. A single data point of 20 x 10^{-5} κ, and raised values of between 5 and 7 x 10^{-5} κ (**R3**) occur along the relict field boundary. The remaining area in Field 5 is characterised by a mean background of 3 x 10^{-5} κ which suggests a broadly low level of archaeological activity consistent with a garden soil that could be expected on the basis of the map evidence.

Fields 6, 6a, 6b

Field 6 has an average magnetic susceptibility of 2 x 10^{-5} κ. Two distinct broad linear bands of enhancement (**R4** & **R5**) of strength 2 to 5 x 10^{-5} κ can be seen within the data. **R6** is a small anomaly of enhanced magnetic susceptibility on the southern edge

of Field 6; it is most likely that R6 is the northern edge of the fluvio-glacial band of sands and gravels identified as R1 running through Fields 1 & 2.

On the eastern edge of Field 6a and the western edge of Field 6b, a dramatic rise in enhancement can be seen. This may be indicative of an area of intense burning, unfortunately centred on an existing field boundary and cannot be further clarified, although it may also have been caused by disturbance to the field boundary itself. On the eastern edge of Field 6b, three isolated areas of enhancement (of strength 4 to 6 x 10^{-5} κ) can be seen within a more widespread area of enhancement (of strength 2 x 10^{-5} κ).

Contained within anomaly R5 is a semi-circle of particularly enhanced data (7 to 17 x 10^{-5} κ), focused upon an oval topographic anomaly, which was chosen for further investigation. A 40m x 40m survey area (reduced to a 40m x 20m block due to field boundaries) was subjected to a detailed gradiometer investigation. The semi-circular anomaly could not be identified. The Ground Investigation (WMCC 2000) found that the centre of the topographic anomaly/R5 had a depth to bedrock of 2.9m, a roughly equivalent depth to the surrounding soil level, and that it was comprised of bands of alternating silty gravel and sandy gravel (TP100). The magnetic susceptibility enhancement of R5 is likely to represent fluvio-glacial bands of sands and gravels as seen elsewhere. The inherent High Pass Filter of the gradiometer instrument would have filtered out a broad geological trend such as this, over the size of detailed survey area (Walker 2000).

Broad criss-crossed anomalous trends of very weak positive and negative magnetism (**D11**) were found, and are best viewed as XY traceplots. The anomalies are parallel and perpendicular, aligned broadly east to west or north to south and of length up to 44m. These are likely to represent drainage ditches or ploughing furrows containing weakly magnetic material.

Two small areas of magnetic enhancement (**D12 & D13**) are also visible within the plot, possibly originating from burning.

Based on the gradiometer survey of R5, it is likely that R4 is also a geological feature. However, cartographic evidence from the 1st Edition OS indicates that Field 6 was separated by a - now relict - field boundary that appears to continue northwest as the present northern field boundary of Field 5. This is particularly significant as the relict boundary ran broadly parallel to R4, therefore the enhancement may be associated with its ploughed out remains. This can only be clarified by intrusive investigation.

2.9m.

Field 7

Field 7 has a mean magnetic susceptibility of 0.2 x 10^{-5} κ, which falls within the general background levels of the investigation. Two anomalies may be seen on the western edge of Field 7 (**R7** & **R8**). These may be associated with the northern edge of geological anomaly R1 and R6 (of Fields 1, 2 & 6), however the 1st Edition OS illustrates a small enclosure and structure in the vicinity of these anomalies, which are no longer visible in the landscape. R7 is comprised of a single data point higher than the surrounding background levels, which has been exaggerated graphically by an interpolation sequence; it may represent a small feature of enhancement such as a pit

or an example of exotic geology. An intrusive investigation of the R7 & R8 anomalies would clarify this.

R9 is a small area of enhancement in the northeast corner of the Common Purchase Order Boundary of Field 7. This may be associated with the field boundary dividing Fields 7 & 8 and again is suitable for small-scale intrusive investigation.

Field 8

Field 8 has a mean magnetic susceptibility of -2×10^{-5} κ, with no apparent internal variations. The field is a low-lying flat and boggy area; the magnetic susceptibility survey confirms the field's weak and negative diamagnetic organic properties.

Field 9

Field 9 contains two relict enclosures in its SW corner. The southern enclosure once contained a structure, possibly a barn. The northern enclosure lies just within the C.P.O. boundary. A number of fieldstones and boulders, possibly associated with the enclosures were noted along the southern edge of the field. The magnetic susceptibility survey found widespread enhancement within the enclosure, which suggests that the structure and associated archaeological material may survive beneath the soil. Two specific anomalies can be determined within the area of enhancement. Anomaly **R10**, a rectangular area of enhancement 2 to 3 x 10^{-5} κ in the SW corner, corresponds broadly to the location of the structure.

Anomaly **R11**, located to the east of R10, is a linear area of enhancement that runs parallel and perpendicular to both the relict and present field boundaries. This may indicate a further division within the enclosure that predates the 1st Edition OS.

Anomaly **R12** occurs along the SE corner of Field 9. This may represent dumping material coinciding with the field boundaries, however it may also be associated with geological anomalies R1 and R8.

No further geophysical investigation occurred in Field 9 due to the boggy land and thick vegetation cover. A programme of intrusive investigations targeted on the above anomalies and the known relict field boundaries will elucidate further information.

Fields 10, 11 & 12

Fields 10, 11 & 12 presently comprise one large field, containing two relict field boundaries, aligned NE-SW. A distinctive band of increased susceptibility, anomaly **R13**, coincides with a topographical ridge running across the length of the field. Along the western side of R13, the enhancement rises to 20 x 10^{-5} κ, which may be associated with disturbance from the relict boundary between Fields 10 and 11.

Anomaly **R14** is a small area of enhancement, 0 to 4 x 10^{-5} κ, in the centre of Fields 10-12. This may be associated with disturbance from the roadside field boundary.

Further geophysical investigations were not carried out due to the dense vegetation cover within Fields 10-12. A small intrusive investigation would clarify the nature of the anomaly.

Fields 13, 14 & 15

Fields 13, 14 & 15 presently comprise one large field, containing two relict field boundaries. The 13-14 relict boundary was aligned NE-SW, the 14-15 relict boundary

was aligned NNE-SSW. The field is extremely 'noisy' in that the magnetic susceptibility varies considerably within the narrow C.P.O. corridor, and that the background susceptibility (5 x 10^{-5} κ) appears stronger than the 'enhanced' anomalies discussed (between –2 and 1 x 10^{-5} κ). This may be a geological phenomenon and/or related to the substantial crop on the field, however discernable patterns in the data may reflect archaeological deposits.

Anomaly **R15** is a rectilinear shaped area, which has a well-defined 'arm' of enhancement along its western side. This may represent an area of archaeological activity or occupation such as a field system or enclosure. It is broadly bounded by the relict field boundary between Fields 13 and 14.

An area of very strong enhancement, **R16** - between 8 and 93 x 10^{-5} κ - is located to the west of R15. It too coincides with the former field boundary of Fields 13 and 14, which suggests that this may represent dumping material deposited in or around the relict ditch which has since been ploughed out and distributed. However, the anomaly is concentrated in a specific area and may well be associated with industrial activity adjacent to the proposed occupation area.

R17 also lies adjacent to the relict boundary of Fields 13 and 14, and represents a small area of magnetic enhancement possibly associated with archaeological activity.

Anomalies **R18** and **R19** are widespread areas of largely ambiguous enhancement, roughly rectangular in plan. It is suggested that R18 may represent the ploughed out remains of the relict field boundary between Fields 14 and 15.

R20 is an area of enhancement which does not vary substantially, with the exception of a slight increase in susceptibility in its centre. It has a very well defined northern and western edge, and may represent a geological change. This partially explains the variance in susceptibility between Fields 13, 14 & 15, Fields 16 & 17, immediately to the east and Fields 10, 11 & 12 immediately to the west, which are by comparison very quiet.

Anomaly **R21** is comprised of several data points of high magnetic susceptibility similar in strength to R16. R21 may also represent an industrial area or burnt material.

The presence of a crop on the field prevented further geophysical investigation at the time of writing.

Fields 16 & 17

Fields 16 & 17 presently comprise one large field, with a trackway running NE-SW along its eastern edge. Field 17 was previously a smaller enclosure in the northeast corner of Field 16. The variable magnetic susceptibility seen in Fields 13, 14 & 15 has returned to the 'normal' background levels (1 x 10^{-5} κ) seen elsewhere.

Anomaly **R22** is a linear spread of enhanced material (between 1 and 2 x 10^{-5} κ) with occasional areas of stronger enhancement (up to 16 x 10^{-5} κ). It coincides exactly with the relict WNW-ESE boundary between Fields 16 & 17. A particular concentration of enhanced material occurs to the SW of the enclosure boundary's right-angled corner, which may represent dumping material.

Using R22 as a geophysical model, it is possible to suggest that **R23** and R24 also represent former field boundaries. R23 is a linear spread of enhanced material, perpendicular to, and terminates intercepting, R21. R23 is also parallel to the relict NE-SW field boundary.

R24 is less convincing as a field boundary, although it does run parallel to R22 and terminates at the same point.

Anomalies R22 – R24 suggest a pre-cursor to the present field system that also predates the 1st Edition OS. Unfortunately the vegetation in fields 16 & 17 was dense, preventing further geophysical investigation. A series of intrusive investigations such as trial trenches aligned parallel and perpendicular to the above anomalies and known field systems would determine the exact nature of the suspected archaeology.

Fields 18 & 19

Fields 18 & 19 presently comprise one field. Ordnance Survey maps indicate that Field 18 was previously two fields, separated by a NE-SW boundary. The relict 18-19 field boundary was aligned NW-SE, on the same alignment as the relict boundary of Field 17. Anomaly **R25** coincides with both relict field boundaries and is represented by three isolated data points of enhancement. These may represent large pits or deeply buried burnt material, and may be associated with the relict field boundaries as ploughed out material in the topsoil.

R26 represents two small areas of negative enhancement (-20 to –21 x 10^{-5} κ). A third example, anomaly **R27** can be seen in the NW corner of the field. These negative areas are derived from a single data point at the centre of each anomaly and are likely to represent near-surface examples of exotic geology. It is extremely unlikely that they represent archaeological material.

Anomalies **R28 – 30** also represent isolated data points of magnetic enhancement which are likely to represent unique near-surface magnetic events such as burning or metalwork.

Fields 18 & 19 were used as a control area for the fluxgate gradiometer survey, to confirm that no archaeological features were present within a central 40m x 40m survey block, other than the known relict field boundary. The gradiometer data contains two linear anomalies (unnumbered) aligned northeast to southwest parallel to the existing field boundaries, spaced 25m apart. The anomalies are comprised of strongly alternating positive and negative data, which suggests that these are drainage ditches, in-filled with gravel and possible exotic geological specimens. The drainage ditches are bounded to the south by a very weak negative anomaly that corresponds to the known relict boundary. The drainage ditches are therefore part of a relict palimpsest of Field 19, and are likely to continue further NE to the northern boundary of Field 19, and that additional series of drainage ditches can be expected within a regularly spaced pattern across the field.

A dipole anomaly in the SE corner of the survey block is likely to represent a near-surface example of ferrous debris. A number of smaller dipoles may also be seen across the survey block and are likely to represent further isolated examples of ferrous debris or iron-pan.

The control survey was successful in that the unknown archaeological features – the drainage ditches - were too weak in terms of geospatial and geophysical qualities, to be located by a magnetic susceptibility prospection survey. Additionally the magnetic susceptibility surveying stations were much greater 5m x 5m, than the gradiometer data, 1m x 0.25m. The magnetic susceptibility data did not indicate any areas of notable enhancement and this was subsequently confirmed by the gradiometer data.

Fields 20 & 21

Fields 20 & 21 presently comprise one field. The remains of a relict field boundary, aligned WNW-ESE, are presently marked by a single tree in the centre of the field. To the east of Fields 20 & 21 is the Royal Canal. A topographic ridge, almost certainly associated with the pre-canalised river was noted on the eastern side of the field, parallel to the canal.

Anomaly **R31** is a single data point of increased magnetic susceptibility that may represent near-surface ferrous debris or burning, and is unlikely to be associated with further archaeological deposits.

Anomaly **R32** may be associated with the northern field boundary of Field 20, possibly representing some dumping or a disturbed soil. Its close proximity to anomaly R33 may be significant.

R33 is a widespread area of enhancement (1 x 10^{-5} κ) containing specific features of further enhanced material. **R34** is a rectilinear area, **R35** is a high susceptibility feature and **R36** is a lozenge shaped area. R33 and its associated anomalies were further investigated with a fluxgate gradiometer survey over a 60m x 60m area.

The detailed gradiometer survey found a number of archaeological features that correlated extremely well with the magnetic susceptibility survey.

D14 is a small rectangular area of magnetic enhancement that might be indicative of a small structure. Adjacent to it is **D15**, three separate circular magnetic anomalies, with a fourth example further east (D16). These are approximately 2.5m in diameter and may represent kilns, other industrial activity or strong geological anomalies. These may be associated with the nearby relict river channel and the extant Royal Canal.

D16 also appears to be in the vicinity of a generally enhanced linear area, which may also be associated with the D15 anomalies.

D17 is a very weak linear anomaly approximately 29m in length. It leads from the possible structure, D14, and through the southern most of the D15 circular anomalies. D17 may represent a gully or ditch associated with D15, possibly acting as a flu, water supply or drainage system.

The structure, D14, is surrounded on its SE side by a curvilinear anomaly of positive magnetism (**D18**). This is likely to represent a ditch of length 18m, which may continue beyond the limits of the survey area to the west. The ditch is probably filled with magnetic debris derived from the possible industrial complex, and may represent a functional element such as the gully D17, or a defining boundary.

D19 is a curvilinear anomaly of weak positive magnetism. It is situated on the top of the topographic ridge thought to be the edge of the palaeochannel associated with the Royal Canal. The palaeochannel ridge itself has a negative magnetism which further emphasises it's topographic origins. It is possible that D19 represents a small enclosure, possibly an animal pen or storage area. Its NW facing 'entrance' – a gap in the anomaly - suggests that it may be associated with the industrial complex. The enclosure is approximately 16m in length, and 8m in width. The entrance is 4m in width.

The industrial complex, structure and enclosure are encompassed by broad widespread area of positive magnetism (**D20**), which has an apparent right angle to it, suggesting a formal boundary, although no ditches, gullies, pits or walls can be discerned in this area. The area, which continues beyond the limits of the survey block, broadly relates to the enhancement of magnetic susceptibility anomaly R33.

Anomaly **D21** is a weakly positive magnetic curvilinear anomaly aligned NNW-SSE. It is characterised by stronger positive and negative extremes in its southern corner, which lies at the base of the topographic ridge and may include redistributed material derived from river erratics and dumping from the above enclosure (D19). D21 extends outwards into a rectilinear form approximately half way through the survey block, and then returns along a linear course. The rectilinear shape appears geological in plan however it displays a magnetic enhancement consistent with the archaeological enclosure anomaly D19. D21 possibly represents an in-filled ditched feature, which continues beyond the survey limits in both directions and incorporates a rectilinear enclosure. In the NW corner of the gradiometer survey block, four weakly magnetic linear anomalies can be seen. These are likely to be plough furrows, which are aligned parallel to the eastern boundary of Fields 20 & 21, and occur at 5m intervals. They appear to be bounded by anomaly D21, which suggests that D21 is a field boundary, possibly encompassing an enclosure.

Magnetic susceptibility anomaly **R37** may be associated with the anomalies investigated during the gradiometer survey. It is located on and adjacent to the southern end of the topographic ridge / palaeochannel. A program of trial trenching may be suitable in this vicinity.

It is suggested that trial trenching occur to confirm the nature of anomalies D15 – D20.

Field 22 and Field 25

Field 22 lies between the Royal Canal, to the west, and the Midland Great Western Railway, to the east. A canal towpath runs parallel to the western field boundary. Field 25 lies on the eastern side of the railway line.

A recent bonfire and other debris were noted in the SW corner of Field 22, which was responsible for the magnetic enhancement (**R38**) seen in that area.

Anomaly **R39** can be seen carrying through Field 22 and into Field 25. It is similar in strength and geospatial properties to the band of geology seen in Fields 1 and 2 (R1). This anomaly is geological in origin, most likely formed by the sands and gravels associated with the former river (Royal Canal). A fluxgate gradiometer survey of 60m x 60m was targeted over the mid section of the geological anomaly in order to further appreciate why its magnetic susceptibility values fall off on its northern side.

The gradiometer data can be neatly split into two areas, NE and SW (**D22** and **D23**, respectively). D22 is a broad negative area of mean magnetic value –0.3nT, whilst D23 is a broad positive area with a mean magnetic value of 0.2nT. A slight overlap between the two areas can be seen and is the result of agricultural activity disturbing and distributing the varying soil properties.

Area D22 is characterised by a large number of dipole like anomalies, which although potentially ferrous in origin are likely to have been derived from the magnetic gravels

or even iron pan. Two particular alignments of dipoles, perpendicular to one another, indicate that a series of linear drainage ditches are present, neither of which are aligned to the present OS field boundaries. The drainage ditches are likely to contain the discussed magnetic clasts.

D22 and D23 are separated along a curvilinear plane, which probably represents a geological boundary. This boundary broadly resembles that seen in the reconnaissance data, although the magnetic susceptibility survey indicates a greater level of enhancement in the topsoil which are likely to include near surface gravels, possibly represented by the iron-pan generating dipole responses discussed above.

D24 is a linear anomaly of weak magnetic strength, which continues beyond the limits of the survey area. This may be an archaeological anomaly however an electrical pylon at low height may be responsible for generating this anomaly.

Anomalies labelled **R40** in Field 22 are two isolated data points of enhanced magnetic susceptibility. These represent near-surface deposits such as ferrous debris or burning and are unlikely to be associated with further archaeological deposits.

Fields 26 & 26A

Fields 26 and 26A are small triangular strips forming an edge of the C.P.O. boundary. The geological anomaly R39, seen in Fields 22 and 25 clearly discontinues, which suggests that the field boundary between 25 and 26 may have been thoughtfully constructed to avoid the ridge of gravels. The contour plots indicate a slight degree of enhancement within the centre of 26, which may be associated with disturbance from the adjacent field boundary. No distinctive anomalies were found in either of the fields, 26 has a mean magnetic susceptibility of -2×10^{-5} κ, and 26A has a mean of 0×10^{-5} κ.

Field 27

Field 27 contains shallow depressions running across the field parallel to the east and west field boundaries, most likely representing drainage ditches. A trackway runs along the eastern field boundary. Field 27 has a mean magnetic susceptibility of 2×10^{-5} κ. Anomaly **R41**, is a widespread area of 1 to 3×10^{-5} κ, with a particular line of enhancement (**R42**) adjacent to the raised (banked) trackway. A single isolated point of enhancement (**R43**) lies along the northern field boundary, and may be associated with the general enhancement of R41, or disturbance along the field boundary. A small trial trench between anomalies R42 and R43 would also determine the nature of R41.

Field 28

Field 28 has a mean magnetic susceptibility of -1×10^{-5} κ. Two isolated data points of enhancement, **R44** and **R45**, can be seen along the northern field boundary and are associated with dumping or soil disturbance. It is highly unlikely that an archaeological deposit will be found in the vicinity of these anomalies.

Fields 29, 30, 31 & 32

Fields 29, 30, 31 & 32 presently comprise one very large field, containing a crop of spring barley. In order to preserve the crop, the magnetic susceptibility survey was conducted along and between the tractor lines, varying the traverse separation from 4m to 7m, rather than the standard 5m. A number of relict field boundaries were present in

the field, a NE-SW boundary between 29 and 31, a triangular shaped boundary between 29/31 and 30, and a NW-SE boundary between 31 and 32.

R46 is a very enhanced anomaly, of magnetic susceptibility between 2 and 192 x 10^{-5} κ. It is triangular in shape and accurately reflects the relict boundaries of Field 30. The high amount of enhancement within the field may be attributed to the presence of a relict structure marked on the 1st Edition OS, in the western corner of Field 30, this area, **R47**, is marked by a uniformly quieter enhancement than the rest of R46. It is likely that R46 represents a garden soil containing burnt debris and dumping material.

R48 is a linear anomaly of the similar enhancement to R46, located in Field 31. R48 is almost certainly the ploughed out debris from Field 30. The first ploughing event after Fields 30 and 31 were consolidated as a single piece of land would have disturbed the soil from Field 30 and distributed it along the length of Field 31. Based upon cartographic evidence of the most recent OS map, this ploughing event would have occurred within living memory. Anomaly R48 also gives us an insight into the direction of the ploughing event, from NW-SE along the northern field boundary.

R49 and **R50** may also be associated with the above ploughing event, although the enhancement falls off significantly in these areas, which may indicate that they are associated with disturbance from the field boundaries.

Anomalies **R51**, **R52** & **R53** are areas of increased enhancement above the background magnetic susceptibility. These again are aligned along the direction of the plough and may be associated with the destruction of the boundary between Fields 29 and 31, again, a relatively modern event. The concentration of material along the eastern side of Field 31 indicates that a substantial archaeological feature is located in this area. R53 has a particularly clear curve on its southern edges, which may be indicative of an enclosure. The remains of Heathstown Castle and a ringfort are located to the SW of Fields 29 – 31 and may be associated with the crossroads to the NE of the field.

Anomalies R51 and **R54** have a general northwest to southeast trend that may even suggest a relict boundary that predates the 1st Edition OS.

Anomalies **R55** and **R56** are short enhanced areas, most likely associated with the destruction of the field boundaries in those areas.

A combination of anomalies R46 and R48 have skewed the mean magnetic susceptibility to 2 x 10^{-5} κ.

Field 31a

Field 31a contains a distinct anomaly of high enhancement (**R57**) in its southern extremity. Anomalies **R58** and **R59** are isolated data points of high magnetic susceptibility caused by near-surface debris or burning and are unlikely to yield further archaeological deposits. Anomaly **R60** is an area of disturbance caused by modern debris scattered around the base of a pylon.

A fluxgate gradiometer survey of a 40m x 40m area was employed to further investigate anomaly R57 that appears to be a geological feature. A number of weak positive and negative anomalies can be seen within the data, all of which are likely to be geological in origin. A semi-circular anomaly, **D25**, may be of archaeological significance, although it is weakly negative. A trial trench in this area would determine

its true nature. Anomaly **D26** has been caused by disturbance from the adjacent field boundary and a nearby pylon base.

Field 33, 33B & 33C

Field 33 contains a small enclosure marked by a post and wire fence in the NW corner of the field, which does not appear on the most recent OS, and is therefore, a very modern enclosure. Inside the enclosure an area of enhancement, **R61**, can be seen. This may be associated with a concentrated animal occupation of the enclosure and/or the close proximity to the main road. A small trial trench would determine the exact nature of the anomaly.

Field 33B is a small area immediately SE of the present cross roads. **R62**, an area of high enhancement has been created by modern disturbance, including visible service drains and fire hydrant stations.

R63 is an enhanced anomaly that appears alongside the boundary between Fields 33 and 33C, suggesting either boundary disturbance or possibly a feature that predates the boundary itself. A large number of trees on all four sides of Field 33C, prevented the MS-DGPS instrument from functioning near the boundaries, resulting in a very small survey area. A trial trench across the field boundary in the vicinity of R63 would determine the nature of the anomaly.

R64 is an isolated point of moderate enhancement that is unlikely to yield further archaeological deposits, but may be associated with R63. It may be appropriate to ground truth this anomaly if R63 is to be investigated via intrusive means.

Field 34

Field 34 appears as an oddity in that a major change in the background magnetic susceptibility occurs; Field 33, to the west has a mean of 1 x 10^{-5} κ; Field 35 to the east has a mean of 2 x 10^{-5} κ; whilst Field 34 has a mean of 4 x 10^{-5} κ. The 'background' enhancement, **R65**, is almost certainly geological in origin, again representative of the fluvio-glacial gravels commonly seen in the area. It is again possible that this geological area has been purposefully cordoned off as a specific site, given its geospatial qualities within the field systems. The presence of the Parish boundary on the western side of the field adds further plausibility to this suggestion.

Field 35

A strong band of enhancement, **R66**, may be seen along the eastern and NW boundaries of Field 35. This can be attributed to disturbance and possible dumping of material along the field boundaries.

Anomalies **R67** and **R68** are small areas of enhancement, between 2 and 4 x 10^{-5} κ.

Field 35 was mostly absent of geophysical anomalies, with a background magnetic susceptibility of 2 x 10^{-5} κ; for that reason it was chosen as a control area for both a fluxgate gradiometer survey and an earth resistance survey, within a 40m x 40m area. The background magnetism is actually a very weak value (0nT) which suggests that animal occupation and/or ploughing has contributed significantly to the topsoil magnetic susceptibility, which has little relation to the underlying archaeological material in this area.

Within the detailed gradiometer survey, a weak negative linear anomaly, **D27**, can be seen. The earth resistance survey has also found D27, which classifies it as a low resistance anomaly (between 87ohm and 99ohm, compared to a background resistance of 101ohm). D27 is a ditched feature of length 50m; the negative response created by the ditch suggests that its soil matrix is predominantly composed of back-filled natural material. D27 continues beyond the limits of the survey area in both north and south directions; by following its course we can see that it intercepts magnetic susceptibility anomalies R67 and R68, which are likely to represent specific concentrations of enhanced material such as burnt debris dumped within the ditch. By extrapolating its course further, we can see that the feature would intercept the NE corner of the boundary separating Fields 34 and 35. It is extremely likely therefore that the ditched feature is in fact a relict field boundary, which pre-dates the 1st Edition OS. Fundamentally, the boundary also corresponds with a slight kink in the boundary between Fields 34 and 35, which belies a past palimpsest.

D28 is a 6m diameter semi-circle of magnetic enhancement, lying on the edge of the survey area. This coincides with an area of low resistance, of similar dimensions. This is likely to represent an excavated feature e.g. a large pit, possibly containing some very enhanced debris such as burnt material; it's magnetic component is 1.5nT (approximately 18 times greater than the enhancement of the ditched feature D27). D28 occurs adjacent to D27; therefore a trial trench across the two features may be useful for gaining dating material for each.

D29 represents two (magnetic) and five (resistive) small anomalies. These represent field stones; three of which were not detected by the magnetometer, which suggests that they are deeply buried. It is probable that these are of an exotic geology, i.e. purposefully imported or naturally transported to the site by palaeo-glaciation etc.

D30 and **D31** are thin linear anomalies of low resistance and slight magnetic enhancement. They are aligned broadly parallel to D27, and may represent plough furrows, several of which were noted on the surface during the survey, or small gullies. These are also visible within the magnetic data as weak negative anomalies.

D32 is a small sub-rectangular low resistance anomaly, which has no discernable magnetic signature. This may represent a large pit of 4m – 5m diameter. It is unlikely to contain magnetically enhanced material such as burnt debris.

A number of small circular anomalies (unnumbered) of substantial magnetic enhancement are spread across the survey area. These may represent pits containing burnt material, of diameter less than 1.5m.

A trial trench across D27, D30, D31 and D32 would elucidate further information, concerning the nature of the anomalies.

It is worthy of note that a large archaeological feature, D27, located successfully by the earth resistance survey appears only as a weak magnetic anomaly in the gradiometer data. The contribution of magnetically enhanced material within the ditched feature is not large, due to the magnetically quiet nature of the underlying Carboniferous Limestone geology. This implies that potentially weak anomalies discussed within this report may in fact be quite substantial. Importantly, some archaeological features may be so magnetically weak, that they have not been located at all with the fluxgate gradiometer.

Field 36 and Fields 37 & 38

Field 36 has a variable background magnetic susceptibility with an average of 4 x 10^{-5} κ. A specific area of enhancement comprised of three linear 'arms' of 4 to 5 x 10^{-5} κ, **R69**, can be seen in the centre of the field.

R70, a linear area of high enhancement on the eastern edge of Field 36 may be associated with the field boundary, although it can most likely be attributed to the same anomaly that runs through Fields 37 & 38, and terminates in Field 39; a probable geological trend. R70 occupies almost all of Fields 37 & 38, which are now a single field containing a relict boundary. A barn and farm complex lie at the eastern end of Field 38 which also contains visible surface dumping material which was not surveyed. Fields 37 & 38 have a skewed mean magnetic susceptibility of 6.2 x 10^{-5} κ, mostly caused by anomaly R70. Further, Test Pit TPB2 (E254353, N248503) is capped by made up ground, possibly associated with the eastern structure and no doubt at least one cause for an increase in the magnetic susceptibility of this area.

R71 is a 'Y' shaped area of enhancement within R70, of magnetic susceptibility between 9 and 20 x 10^{-5} κ. **R72** is a sub-rectangular anomaly of similar strength to R71. **R73** may represent the fall off from the suspected geological trend R70.

Two fluxgate gradiometer surveys were used to further investigate anomalies R69 (Field 36) and R70 & R71 (Field 37). The gradiometer survey of Field 36 covered an area of 40m x 40m, which was slightly reduced to account for the triangular shape of the field. In general terms the gradiometer data is magnetically quiet with a mean of 0nT which contrasts sharply with the topsoil magnetic susceptibility data which was shown as variable and higher than average compared to other fields surveyed along the route. The western arm of anomaly R69 corresponds broadly to an alignment of dipole anomalies in the gradiometer data, **D33**. The trend of the dipoles suggests a possible access route, a path or track beginning from the NW corner of the field along the western boundary and continuing toward the southern corner.

D34 is a curvilinear weakly positive magnetic anomaly originating from beyond the survey limits to the NW and continuing further SE. It is approximately 49m in length, and is likely to represent an agricultural furrow or gully. It is broadly parallel to the existing western field boundary and is associated with similar weak curvilinear anomalies to the east.

D35 is a stronger magnetic anomaly of consistent strength 0.6nT to 1.1nT. Like anomaly D34, it too continues beyond the survey area in both a NW and SE direction. The anomaly represents an in-filled feature such as a gully or narrow ditch.

The variability of the topsoil magnetic susceptibility survey may be attributed to an agricultural regime such as manuring which has not been detected by the gradiometer survey.

The gradiometer survey of Field 37 was carried out over a 40m x 40m area to investigate the nature of the anomalies R70 and R71. The eastern side of the distinctive 'Y' shape anomaly R71 has been partially determined as a strong linear positive magnetic anomaly, **D36**. D36 is 41m in length and continues beyond the survey area in both a NE and SW direction. It represents a ditched feature, possibly a field boundary pre-dating the 1st Edition OS. This may have further implications within the landscape as a known relict field boundary from the 1930 OS is shown to have existed less than 20m to the east of D36, and may represent the reuse of an important boundary feature.

Crossing D36 in an almost perpendicular fashion is **D37**, a curvilinear anomaly of positive magnetism that appears to terminate within the survey area. It is approximately 19m in length, aligned NW-SE and curves NE-SW at its terminus, its eastern end continues beyond the limits of the survey area. D36 may relate to the western side of the 'Y' shaped anomaly R71.

A number of small circular anomalies (unnumbered) of positive magnetic enhancement may represent pits of diameter less than 1.5m, which may be suitable for a small open excavation. A small curvilinear feature (unnumbered) appears to be of geological origins.

Magnetic susceptibility anomaly R70 appears to be a geological trend as very little variation occurs within the gradiometer data, which completely encompasses the said anomaly. The geological feature appears, as others have within this survey, to be almost completely isolated by the field boundaries. This suggests that past inhabitants held an in-depth knowledge of these soils and their positive and negative effects upon agricultural practices.

The magnetic susceptibility response to anomaly R71/D36 was very strong and correlated well with the gradiometer data. Based on this, it would be wise to further investigate anomaly R72 via intrusive means, which is very likely to yield an archaeological feature such as a large pit or area of burning. A trial trench across anomaly R70 in the SW corner of Field 37 would also be useful to confirm the probable end of the geological anomaly R70 in this area.

Fields 39, 39A & 39B

Fields 39, 39A & 39B presently comprise one field. Relict boundaries between the fields were aligned NE-SW. 39B is in close proximity to a known ringfort on the opposite side of the present N4 road. The field is characterised by an enhanced 'strip' in the magnetic susceptibility data. These have originated mostly because of temperature drift from the MS2, however some of the enhancement represents true anomalies in the topsoil. The instrument drift was not removed in this case as the true anomalies would also have been masked.

R74 comprises two 'strips' of enhancement; the majority of the strips are caused by instrument drift. **R75** is a comparatively small rectangular area of enhancement on the eastern side of Field 39. **R76** is an area of slight enhancement in the northern area of Field 39, adjacent to Field 40, which is characterised by extremely high values (see below).

Two areas were examined in further detail with a fluxgate gradiometer; Area A and Area B. **Area A** was a 40m x 40m survey block designed to confirm the instrument drift and elucidate further geophysical information that may have been masked by R74. A large number of linear anomalies of weak positive magnetism may be seen, however it is almost certain that these are geological in origin given their geospatial and geophysical qualities. One possible exception to this is **D38**, a particularly strong anomaly of length 20m. This may represent a ditched feature. A relict field boundary lies less than 10m from D38, to the west of the survey area; it may be useful to place a trial trench across the known relict boundary and investigate D38 with the same trench. Two dipole anomalies representing near-surface ferrous iron debris can be seen in the southern portion of the survey area. The gradiometer survey confirmed that R74 is most likely a phenomenon of instrument drift.

Area B was a 100m x 60m survey block, designed to investigate the magnetic susceptibility anomalies R75 and R76. Emphasis had been placed on this area as the very enhanced values of Field 40 lie between Area B and a known ringfort, just 50m to the north.

Characteristic across the survey area are a series of parallel linear anomalies (unnumbered) of positive magnetism aligned NE-SW, and a series of the same type of anomalies, located further north, aligned perpendicular to the first, *viz.* NW-SE. These represent plough furrows, which appear in an area of Field 39 where the topography rises, i.e. where the soil horizon is thin. The northern furrows also coincide with magnetic susceptibility anomaly R76, which explains the origins of its enhancement via soil disturbance. A curvilinear anomaly (unnumbered) amongst the northern furrows can also be seen and is likely to represent a ditched archaeological feature.

By examining the map evidence, the mismatched ploughing regime can be understood; the NE corner of Field 39 contains a field boundary aligned NW-SE - the same alignment as the northern plough furrows - whilst the southern plough furrows are aligned NE-SW - the same alignment as the relict boundaries in Field 39.

D39 is broadly parallel to the northern plough regime, aligned NW-SE, but has a much stronger magnetic response which suggests that it might contain more enhanced material than the other furrows. It also lies at the base of the topographical rise and may contain a certain amount of hill washed soil.

D40 is a curvilinear anomaly of length 47m, which may represent a ditched feature. Its southern end continues beyond the survey area whilst its northern end terminates against anomaly D41.

D41 is a very broad anomaly of weak positive and negative magnetism, traversing the survey area from west to east and continuing in both directions. D41 may represent a geological fault, although it may also be a narrow ditch or gully that has been substantially ploughed out. The terminus end of anomaly D40 adds further weight to it being an archaeological feature. A test trench across the feature would further clarify its origins.

D42 is an enhanced circular anomaly that may represent a large pit of diameter less than 4m. The interpolation method has created a 'dipole-like' appearance. A number of smaller circular enhanced anomalies (unnumbered) are also likely to represent pits.

D43 represents an anomaly of alternating high and low values caused by a fenceline separating Fields 39 & 40.

Field 40

Field 40 is a long and short field, less than 20m south of the known ringfort on the opposite side of the present N4 road. The magnetic susceptibility survey has shown this area to be one of very high enhancement, with a background reading of 16 x 10^{-5} κ. Extremely high values can be seen along the NE and northern field boundaries as anomaly **R77**. A fluxgate gradiometer survey was used to investigate this area, with an extension beyond the C.P.O. boundary to form a 60m x 20m survey block.

The gradiometer survey illustrated that the enhancement is in general derived from a disturbed soil. A sharp rise in height between Field 39 and Field 40 was noted during survey, allowing speculation that Field 40 may comprise made-up ground. The survey of Field 40 was hampered by the narrow width of the survey area, a maximum of 20m. The presence of wire mesh fences on either side of the field reduced the viable geophysical data to a width of 12m and created anomalies **D44** and **D45**. A steel pylon support wire also created anomaly **D46**. The mean magnetic response was –5.2nT, rising to 1.5nT when ferrous derived anomalies D44 – D46 are omitted from the data.

D47 is a linear positive magnetic anomaly continuing NW and SE beyond the survey area. It is approximately 50m in length and 3m - 5m in width, following the alignment of the present N4 and northern field boundary. This may represent a metalled trackway or roadside ditch, almost certainly associated with the N4's pre-cursor and possibly even the adjacent ringfort. A trial trench across the width of Field 40 will help determine the exact nature of the access feature.

Field 41

Field 41 is a small area of background magnetic susceptibility with enhancement along the edges of the field boundaries, which are likely to have been caused by soil disturbance. No further investigation is necessary here.

Field 42 and Field 43

Field 42 and Field 43 are both areas of low background magnetic susceptibility with very little variation. Field 42 has a mean magnetic susceptibility of 0 x 10^{-5} κ, Field 43 has a mean of –3 x 10^{-5} κ. Field 42 contains an area of slight enhancement, **R78**, that could be tested via intrusive methods.

Field 46

Field 46 is characterised by very enhanced magnetic susceptibility values with a mean of 6 x 10^{-5} κ. Based upon similar data collected here, it is highly probable that this indicates a geological origin. Field 46 is a very small area, and may be suitable for a small keyhole intrusive investigation to confirm its geological origins.

4. Conclusions

4.1 Achievement of Objectives

The presence of several known and unknown archaeological features has been established. The objectives have been clearly achieved, with generally positive results forming a cohesive and tangible geophysical basemap that can be used to inform further work in advance of the proposed N4 Road Improvement Scheme.**Summary of Results**

The volume magnetic susceptibility survey carried out at a spatial resolution of 5m x 5m has indicated the presence of a number of unknown areas of enhancement, indicative of archaeological material. Further geophysical investigations have revealed a range of archaeological features.

A large number of drainage ditches, plough furrows, relict field boundaries and associated agricultural features were found across the length of the survey area.

Several structures known from the 1st Edition Ordnance Survey map were also located during the magnetic susceptibility survey.

It has also been noted that geological ridges of gravel's determined by the magnetic susceptibility survey have been effectively fenced off. They appear to occur entirely within large fields demonstrating a past attempt wish to parcel the resource in order to utilise or avoid its drainage and agricultural qualities.

4.3 Implications

The rapid identification of a large number of interpreted archaeological features in a large area is a substantial confirmation for the use of a magnetic susceptibility survey. Given the size of the corridor, only a small number of substantial features have been found, however the marshland topography found throughout the project dictates by default that occupation and industrial sites would be absent from those areas. The higher ground has proved fruitful however and demonstrated an emphasis on agricultural practices.

4.4 Recommendations

A number of trial trenches may be located over known and suspected archaeological features throughout the survey area. A number of possible archaeological and geological features also require ground proofing, which have been discussed in the text.

4.5 Dissemination

The results of this survey (digital data and paper report) were handed to the *Client*. *Earthsound Archaeological Geophysics* will ensure that copies will be forwarded to *Department of the Environment, Heritage and Local Government* and the National Museum.

5. Acknowledgements

Project Management: James Bonsall BA (Hons) MSc PIFA

Fieldwork: James Bonsall
Heather Gimson BA (Hons) MSc

Report: James Bonsall
Graphics: Heather Gimson

Landowner: National Roads Authority Design Office,
County Buildings, Mullingar, County Westmeath

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Technical Appendix

Appendix 1

1. Magnetic Survey: Technical Information

1.1 Magnetic Susceptibility and Soil Magnetism

The Earth is comprised of approximately 6% iron. Via geological and pedological processes iron is present in soils and rocks as three main minerals; haematite, magnetite and maghaemite. Haematite is a very common mineral in archaeological soils and is largely responsible for most of the red colouration in the environment. Magnetite is a common mineral found in all igneous rocks, most sedimentary rocks and nearly all soils. These minerals have a weak, measurable magnetic property termed magnetic susceptibility. Susceptibility measures how susceptible a material is to becoming magnetized. A magnetic susceptibility survey can identify and classify different types of iron bearing materials in a safe, fast and non-destructive manner either in a laboratory or as a fieldwork component, complementing other archaeological analyses.

Anthropogenic activities can redistribute these minerals and alter others into more magnetic forms by a process of enhancement, such as burning, industrial activity, fermentation and manuring. Magnetic susceptibility enhancement of antiferromagnetic haematite in the topsoil is caused by the Le Borgne effect of domestic fires on soils and vegetational matter:

> *The burning of organic matter and the heating of non-organic matter above 200°C, allows electrons to be gained through a process of reduction, creating ferrimagnetic magnetite. As the matter cools, or in the case of organic matter, is combusted, electrons are lost through a process of re-oxidation, creating ferrimagnetic maghaemite.*

The decay of organic material associated with areas of human occupation or settlement can be identified by measuring the magnetic susceptibility of the topsoil and noting the degree of enhancement. If the enhanced material subsequently comes to fill features, such as ditches or pits, localised isolated and linear magnetic anomalies can result whose presence can be detected by a magnetometer (fluxgate gradiometer).

There are five different types of magnetic behaviour found in Magnetic Susceptibility surveys, dependent upon the sub-atomic properties of the samples:

- *Ferromagnetism* — Strongest
- *Ferrimagnetism*
- *Antiferromagnetism*
- *Antiferromagnetism*
- *Paramagnetism*
- *Diamagnetism* — Weakest

Magnetic susceptibility is a value defined by a combination of all of the above types of magnetic behaviour, so that weaker paramagnetism and diamagnetism will be masked if other, *stronger*, magnetic properties are present. For example, a topsoil magnetic susceptibility survey will introduce additional contributions from colluvial/alluvial covering or a disturbed Ap horizon (cultivation/pasturing disturbance *etc*.), that may mask an archaeologically derived response.

Field Number	Vegetation	Date Surveyed	Climate during survey
1	Loose silage	04 July 2003	Dry, constantly mild temperature
2	Short Grass	30 June 2003	Light and Heavy rain, mild temperature
3 & 4	Tall Reeds	30 June 2003	Light rain, mild temperature
5	Silage	30 June 2003	Light rain, mild temperature
6	Silage	30 June 2003	Light rain, mild temperature
7	Silage	30 June 2003	Dry, mild temperature
8	Long grass	30 June 2003	Dry, mild temperature
9	Long reeds	01 July 2003	Dry, mild temperature
10, 11 & 12	Reeds, nettles, thistles, long grass	01 July 2003	Dry, mild temperature
13, 14 & 15	Corn	01 July 2003	Dry, mild temperature rising as the survey progressed.
16 & 17	Long Grass	01 July 2003	Dry and hot.
18 & 19	Short Grass	02 July 2003	Dry, mild temperature rising as the survey progressed.
20 & 21	Short Grass	02 July 2003	Dry, mild temperature rising as the survey progressed
22	Short Grass	02 July 2003	Dry, mild temperature rising as the survey progressed
25	Short Grass	02 July 2003	Dry, mild temperature
26	Short Grass	02 July 2003	Dry, mild temperature
26a	Short Grass	02 July 2003	Dry, mild temperature
27	Short Grass	02 July 2003	Dry, hot temperature
28	Short Grass and few reeds	02 July 2003	Dry, hot temperature
31a	Short Grass	02 July 2003	Dry, decrease in temperature
33b	Tall Grass	03 July 2003	Dry, mild temperature
33c	Tall Grass and thistles	03 July 2003	Dry, mild temperature
33	Short Grass	03 July 2003	Dry, mild temperature
34	Short Grass	03 July 2003	Cool and dry, following showers
35	Short Grass	03 July 2003	Cool and dry, following showers
36	Short Grass	03 July 2003	Cool and dry, following showers
37 & 38	Short Grass, nettles and thistles	03 July 2003	Cool and dry, following showers
39, 39a & 39b	Short Grass	03 July 2003	Cool and dry, following showers
40	Short Grass	04 July 2003	Dry, mild temperature
41	Short Grass, tall reeds along field boundary	04 July 2003	Dry and overcast, mild temperature
42	Short Grass, occasional reeds and thistles	04 July 2003	Dry and overcast, mild temperature
43	Short Grass, occasional reeds	04 July 2003	Dry and overcast, mild temperature
46	Tall reeds	04 July 2003	Dry, mild temperature

Table 1. Field conditions during the Magnetic Susceptibility Reconnaissance Survey

A graphical analysis of the functionality of the magnetic susceptibility and fluxgate gradiometer data indicates that both instruments recorded consistent data within optimum parameters (Volume 2: Figures 43 and 44). The magnetic susceptibility data varied only slightly when 100 sample readings were taken with the field coil placed over a single test spot. This procedure was repeated during the period of the preliminary reconnaissance on four separate occasions. The variability occurs in a mostly uniform manner and was unlikely to have created misleading artefacts in the data.

The fluxgate gradiometer data did not vary at all over 80 readings which was mostly expected. Diurnal variations and instrument drift usually require a period of a few minutes to become established within a data set and these were removed during the preliminary data processing steps.

Appendix 2

Survey Grid Re-location

1. The magnetic susceptibility survey comprised the total area available within the Common Purchase Order boundary (excluding existing roads and roadside verges). A baseline was not established as the *Trimble* Pro-XRS Differential Global Positioning System (DGPS), was used to map each sample point to an accuracy of ±0.5m. Each survey data point is available in the relevant accompanying MS Excel file.

2. There was a good correlation between the geophysical survey data and the digital map base and it is estimated that the average 'best fit' error is lower than ±0.25m. It is important to note that local grid north (06/06/03) varies slightly from *Ordnance Survey* north, with an annual decrease of 0.9°3'. It was found that the digitised basemaps provided by the Client displayed inaccuracies up to 5m in some cases. A likely cause for this was the digitisation of field boundaries from aerial photographs. The geophysical data may appear 'misplaced' along field boundaries, however these correspond to the correct Irish National Grid Co-ordinates.

3. The detailed fluxgate gradiometer and earth resistance surveys each had specific geophysical grid baselines established. The location of the grid pegs at either end of the baselines are given below in Irish National Grid (ING) co-ordinates, as determined by the DGPS.

Field	Grid Peg Corner	Length of baseline	ING Coordinate	
			Easting	Northing
1	SOUTHWEST	60m	251749.1129	249743.1368
	SOUTHEAST		251802.6164	249715.9821
2	SOUTHWEST	40m	251928.5254	249659.5400
	SOUTHEAST		251964.6713	249642.4089
6	NORTHWEST	40m	251918.6055	249816.5552
	NORTHEAST		251951.7379	249794.1443
18/19	NORTHWEST	40m	252842.9304	249426.9900
	NORTHEAST		252878.8650	249409.4200
20/21	NORTHWEST	60m	253014.7371	249409.0912
	NORTHEAST		253064.0199	249374.8683
25	NORTHWEST	60m	253212.2495	249227.8403
	NORTHEAST		253257.3342	249188.2502
31a	NORTHWEST	40m	253794.2806	248919.6062
	NORTHEAST		253826.6921	248896.1649
35	NORTHWEST	40m	254142.9113	248657.5722
	NORTHEAST		254178.9684	248640.2551
36	NORTHWEST	40m	254205.4528	248643.6630
	NORTHEAST		254241.5100	248626.3459
37	NORTHWEST	40m	254285.0528	248594.5805
	NORTHEAST		254318.2331	248572.2407
39 – Area A	NORTHWEST	40m	254537.6471	248424.2002
	NORTHEAST		254570.9019	248401.9714
39 – Area B	NORTHWEST	100m	254844.9949	248288.0314
	SOUTHWEST		254796.1113	248200.7939
40	NORTHWEST	20m	254847.9651	248313.4428
	SOUTHWEST		254838.0317	248296.1782

Appendix 3

Geophysical Archive

Earthsound Archaeological Geophysics takes its archiving responsibilities very seriously. Archiving is a necessary measure to maintain a complete record of past research, prevent unnecessary duplication and allow the re-use and re-interpretation of geophysical data as analytical techniques evolve.

The geophysical archive comprises:-

- an archive CD-ROM containing files of the raw data (Surfer 8.00, MS-Excel), report text (Word 2000 9.0), and graphics files (AutoCAD 2000). The CD-ROM also contains a text file of the names of all datasets presented in this report.
- a hard (paper) copy of the report

At present, two copies of the archive are held by *Earthsound Archaeological Geophysics*, at separate locations to ensure preservation against accidental damage or theft. The Client, *Westmeath County Council*, hold one further copy of the archive. Additional paper copies intended for ultimate deposition with *Department of the Environment, Heritage and Local Government*, and the National Museum, are in the guardianship, and are the responsibility of, *Earthsound Archaeological Geophysics*.

N4 McNeads Bridge to Kinnegad Road Improvement Scheme, County Westmeath

Archaeological Geophysical Survey

VOLUME TWO: FIGURES

Survey undertaken on behalf of

Westmeath County Council

J. Bonsall BA (Hons) MSc PIFA
H. Gimson BA (Hons) MSc

EAG 16

21 October 2003

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Figure List

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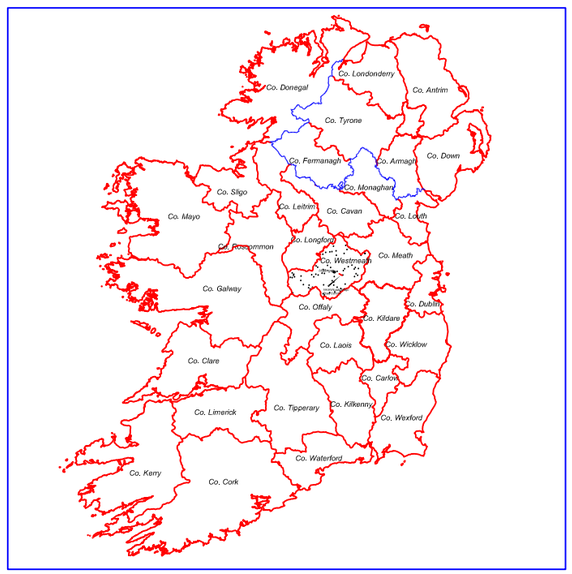

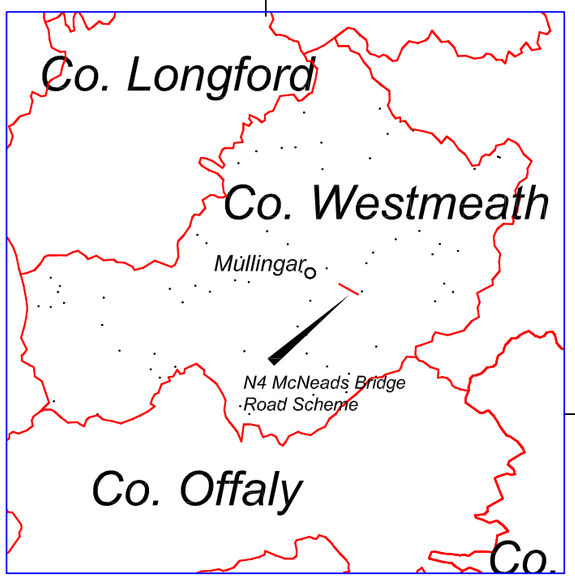

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- CPO line
- Present Land Boundaries

Site Location: N4 McNeads Bridge, County Westmeath.

Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/01

0m 500m 1000m

Figure No. 1 Location of McNeads Bridge Road Realignment

EARTHSOUND archaeological geophysics

Legend

- CPO line
- Present Land Boundaries
- Magnetic Susceptibility Survey Areas
- Detailed Investigation Areas
- Areas Unavailable
- No Survey Required

Site Location: N4 McNeads Bridge, County Westmeath.

Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/02

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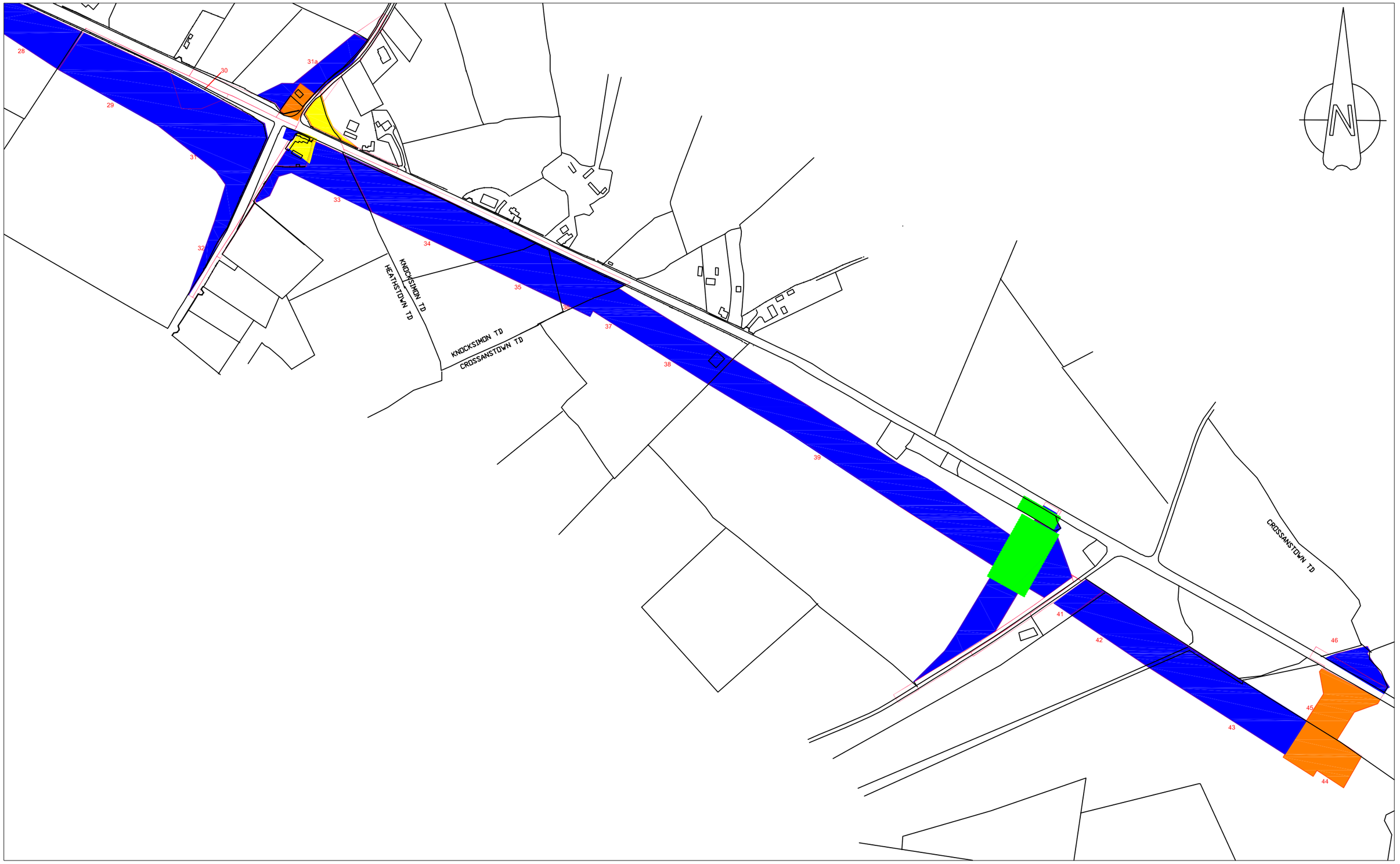
Figure No. 2 Geophysical Coverage of the Western Half of the Contract

EARTHSOUND archaeological geophysics



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- CPO line
- Present Land Boundaries
- Magnetic Susceptibility Survey Areas
- Detailed Investigation Areas
- Areas Unavailable
- No Survey Required

Site Location: N4 McNeads Bridge, County Westmeath.

Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/03

0m 200m 400m

Figure No. 3 Geophysical Coverage of the Eastern Half of the Contract

EARTHSOUND archaeological geophysics

Legend

CPO line

Hedgerows

Survey Stations

K

-10 0 x10 -5 14 20

Site Location: N4 McNeads Bridge, County Westmeath.

Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/04

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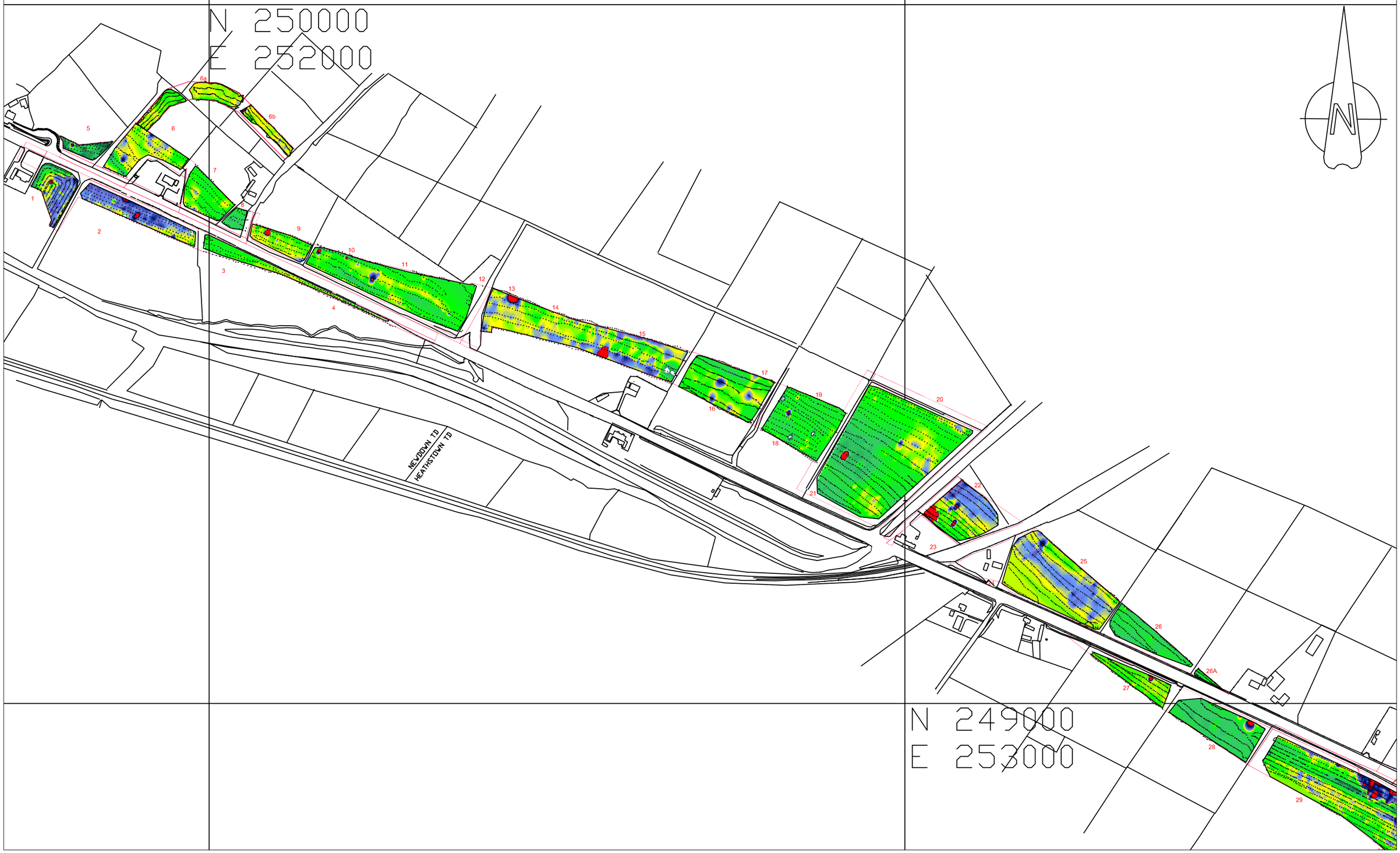
FIGURE No. 4 Magnetic Susceptibility data along the Entire Contract

EARTHSOUND archaeological geophysics



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CPO line

Hedgerows

Survey Stations

K

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Site Location: N4 McNeads Bridge, County Westmeath.

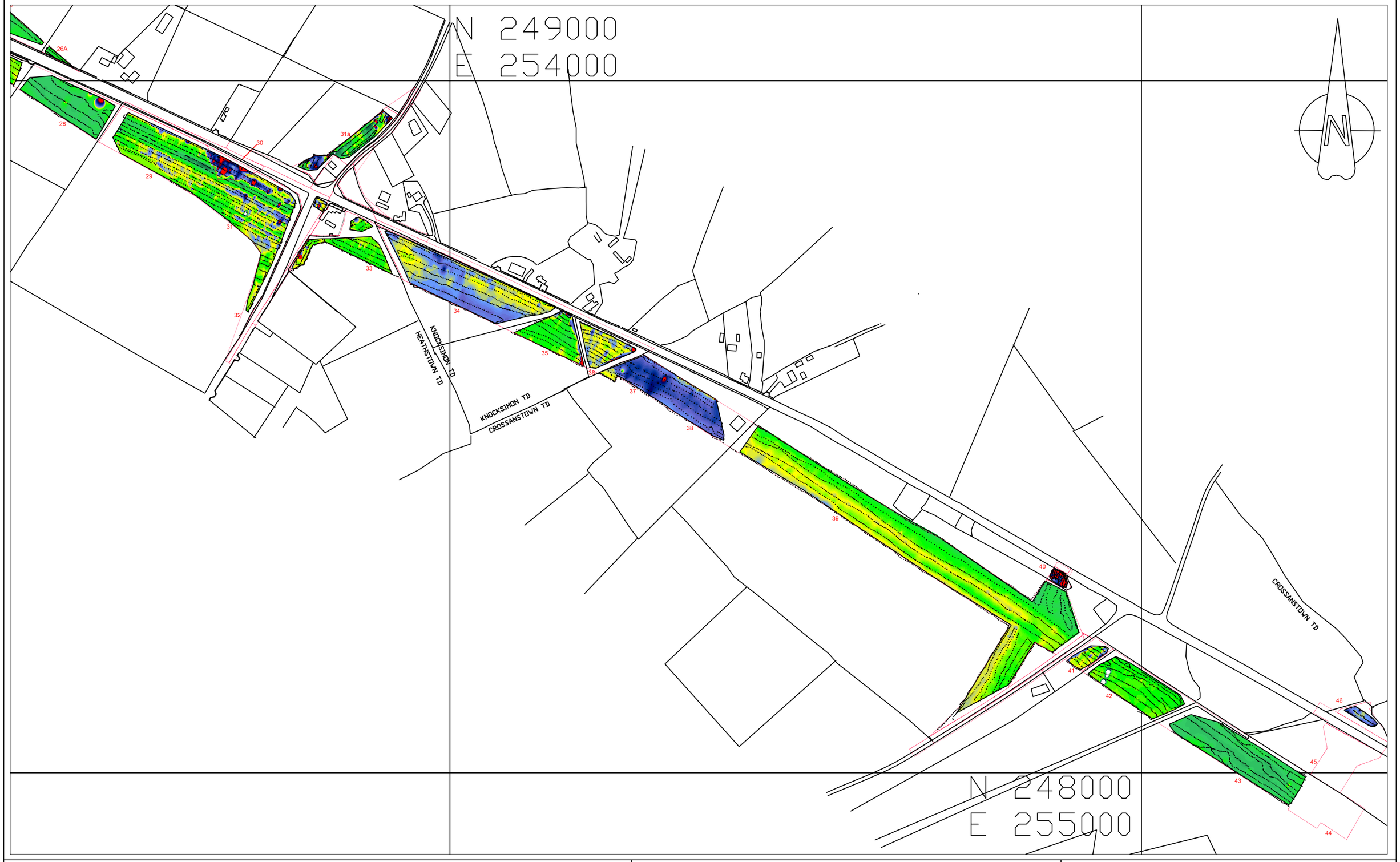
Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/05

0m 200m 400m

FIGURE No. 5 Magnetic Susceptibility data along the Western Half of the Contract

EARTHSOUND archaeological geophysics



Legend

- CPO line
- Hedgerows
- Survey Stations

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Site Location: N4 McNeads Bridge, County Westmeath.

Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/06

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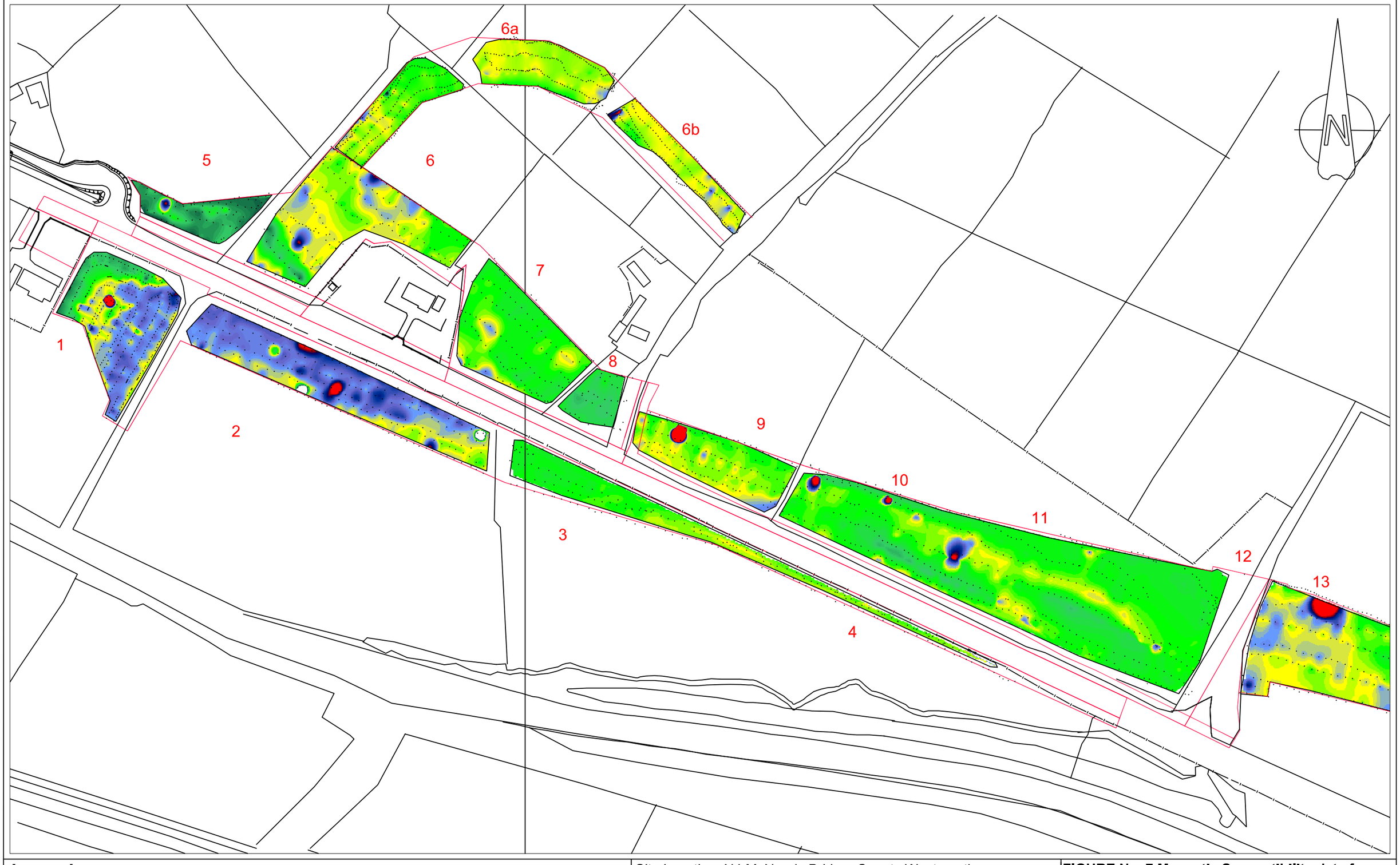
FIGURE No. 6 Magnetic Susceptibility data along the Eastern Half of the Contract

EARTHSOUND archaeological geophysics



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- CPO line
- Hedgerows
- Survey Stations

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Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/07

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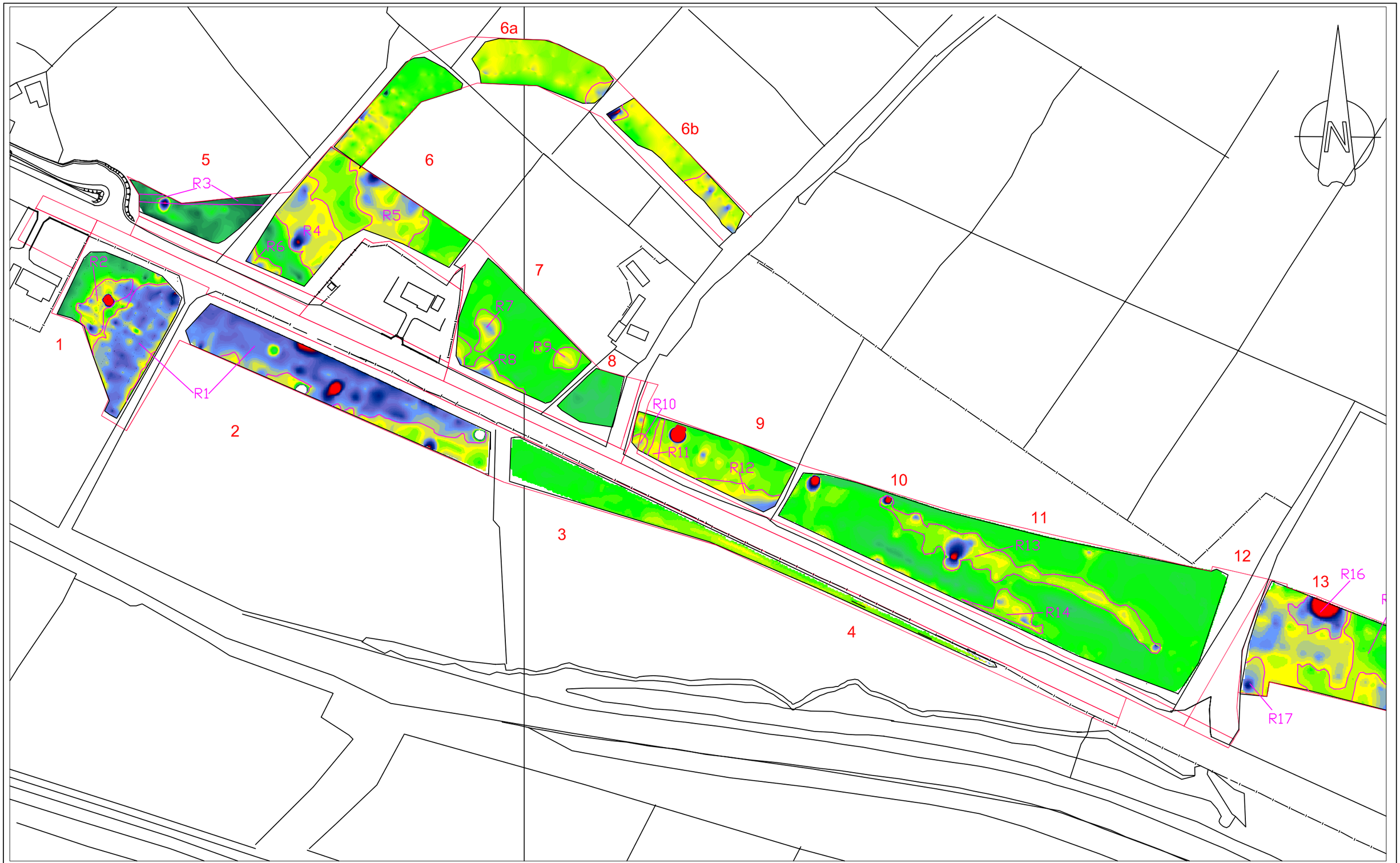
FIGURE No. 7 Magnetic Susceptibility data for Fields 1 - 12

EARTHSOUND archaeological geophysics



Legend

- Magnetic Susceptibility Anomalies
- CPO line
- Hedgerows

K

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Site Location: N4 McNeads Bridge, County Westmeath.

Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/08

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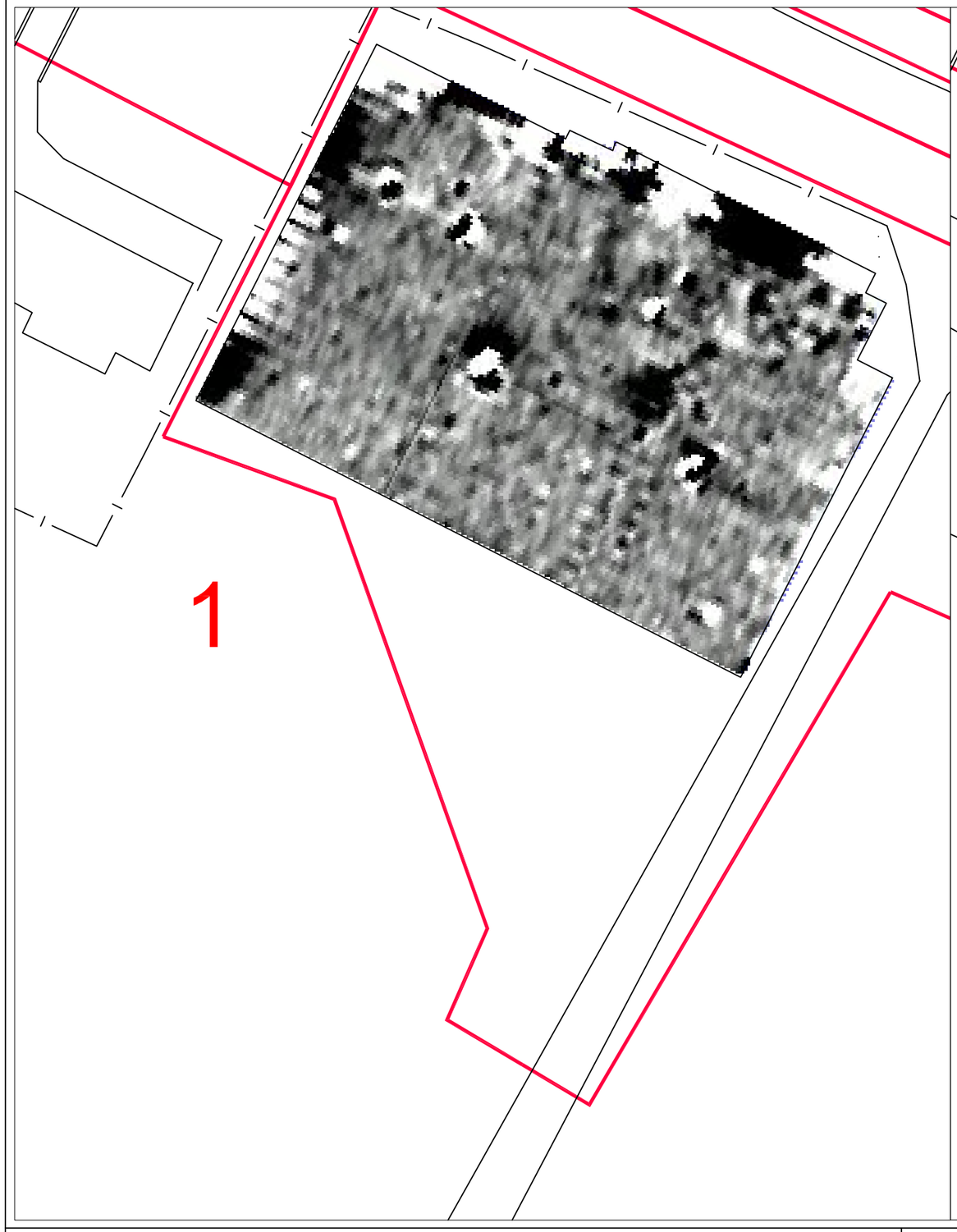
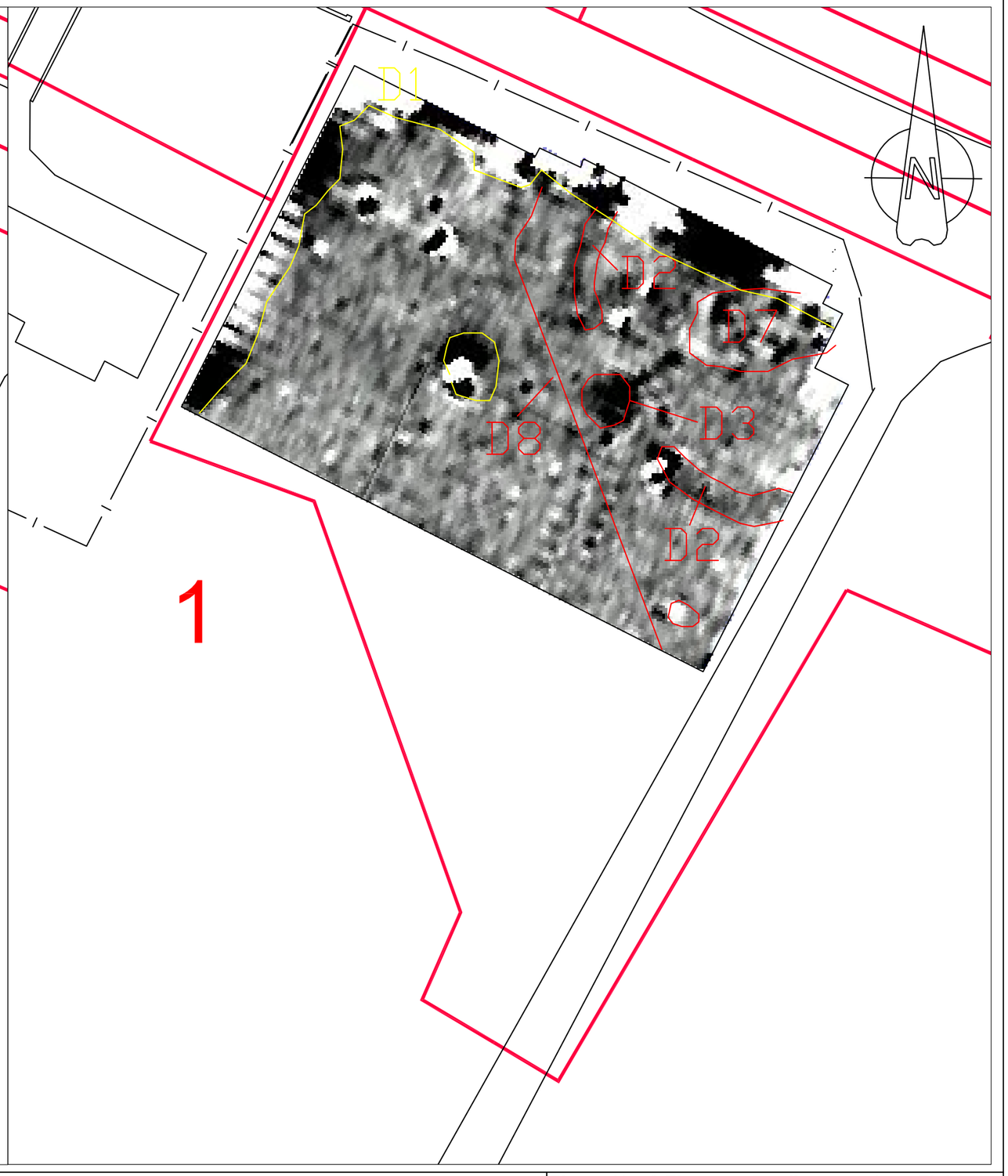
Figure No. 8 Magnetic Susceptibility Interpretation Fields 1 - 12

EARTHSOUND archaeological geophysics





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- CPO line
- Present Land Boundaries
- Discrete Negative Anomalies
- Discrete Positive Anomlies
- Magnetic Dipoles

nT

-1 0 1

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Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/09

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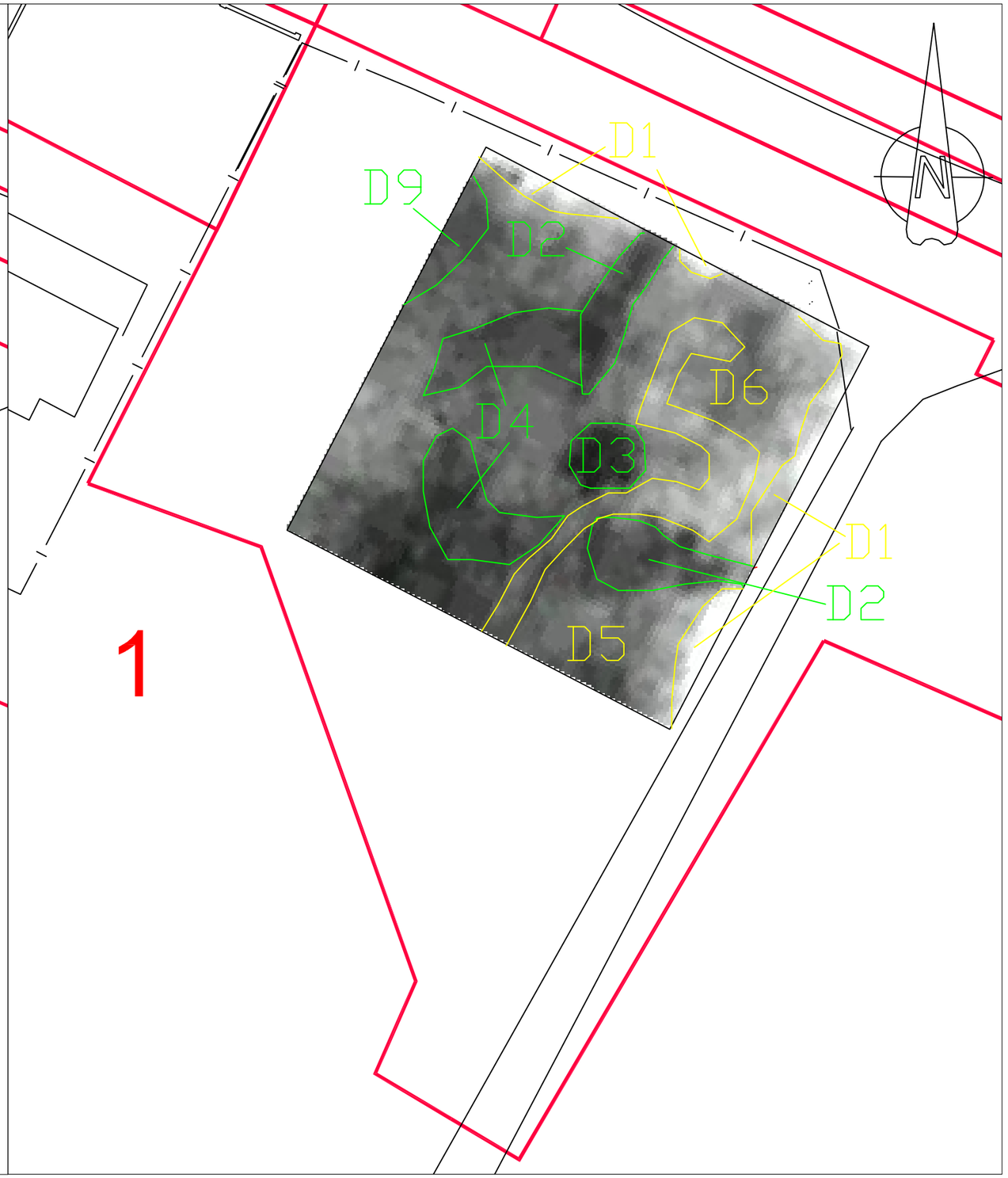
Figure No. 9 Fluxgate Gradiometer data, Field 1

EARTHSOUND archaeological geophysics



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CPO line

Present Land Boundaries

Discrete Low Resistance Anomalies

Discrete High Resistance Anomlies

Ohms

95 79 65

Site Location: N4 McNeads Bridge, County Westmeath.

Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/10

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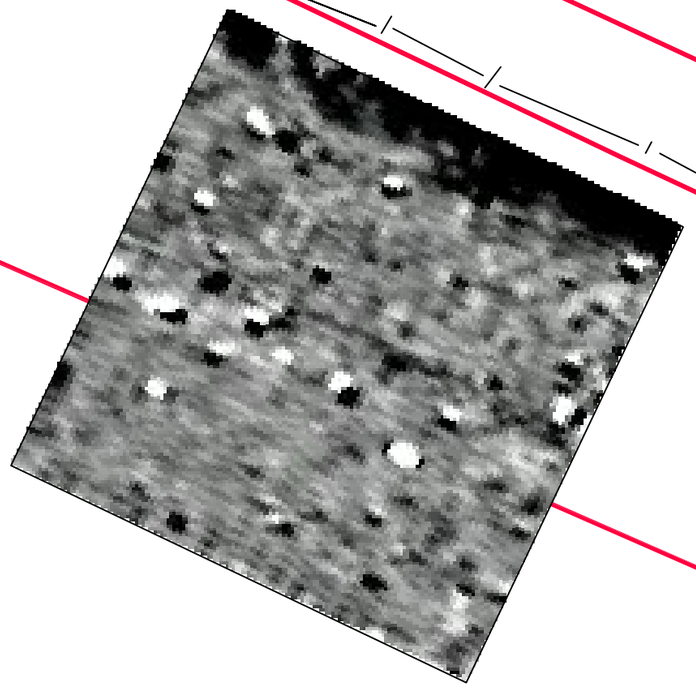
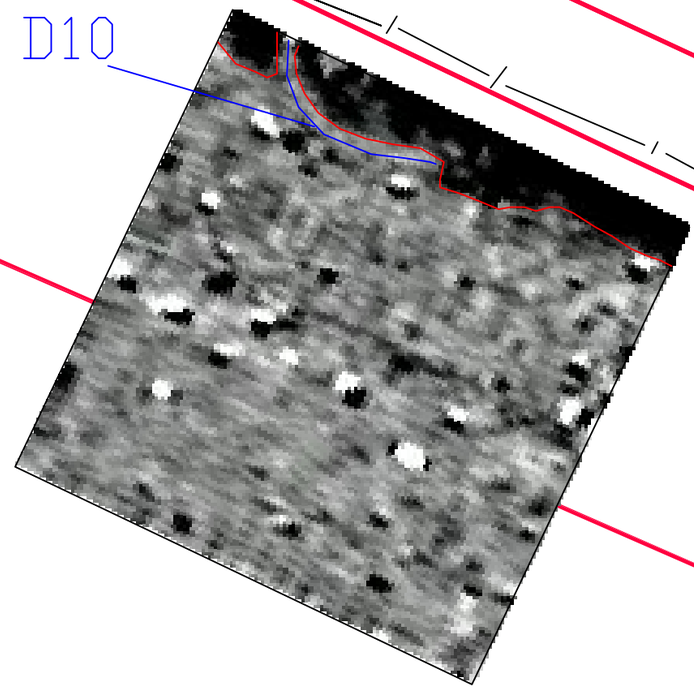
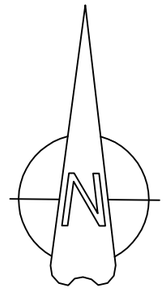
Figure No. 10 Earth Resistance data Field 1

EARTHSOUND archaeological geophysics







Legend

- CPO line
- Present Land Boundaries
- Discrete Negative Anomalies
- Discrete Positive Anomlies
- Magnetic Dipoles

nT

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Site Location: N4 McNeads Bridge, County Westmeath.

Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/11

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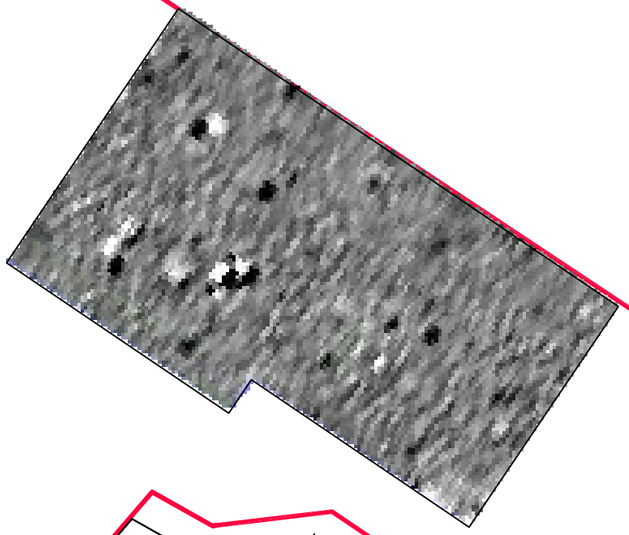
Figure No. 11 Fluxgate Gradiometer data Field 2

EARTHSOUND archaeological geophysics

6



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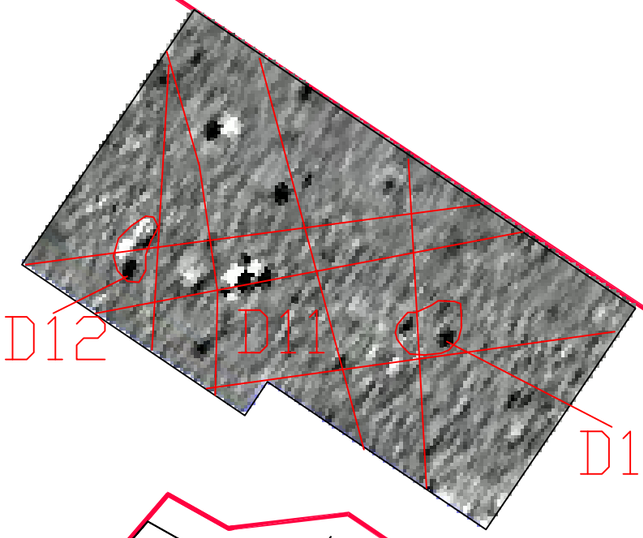

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- Discrete Negative Anomalies
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- Magnetic Dipoles

nT

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Site Location: N4 McNeads Bridge, County Westmeath.

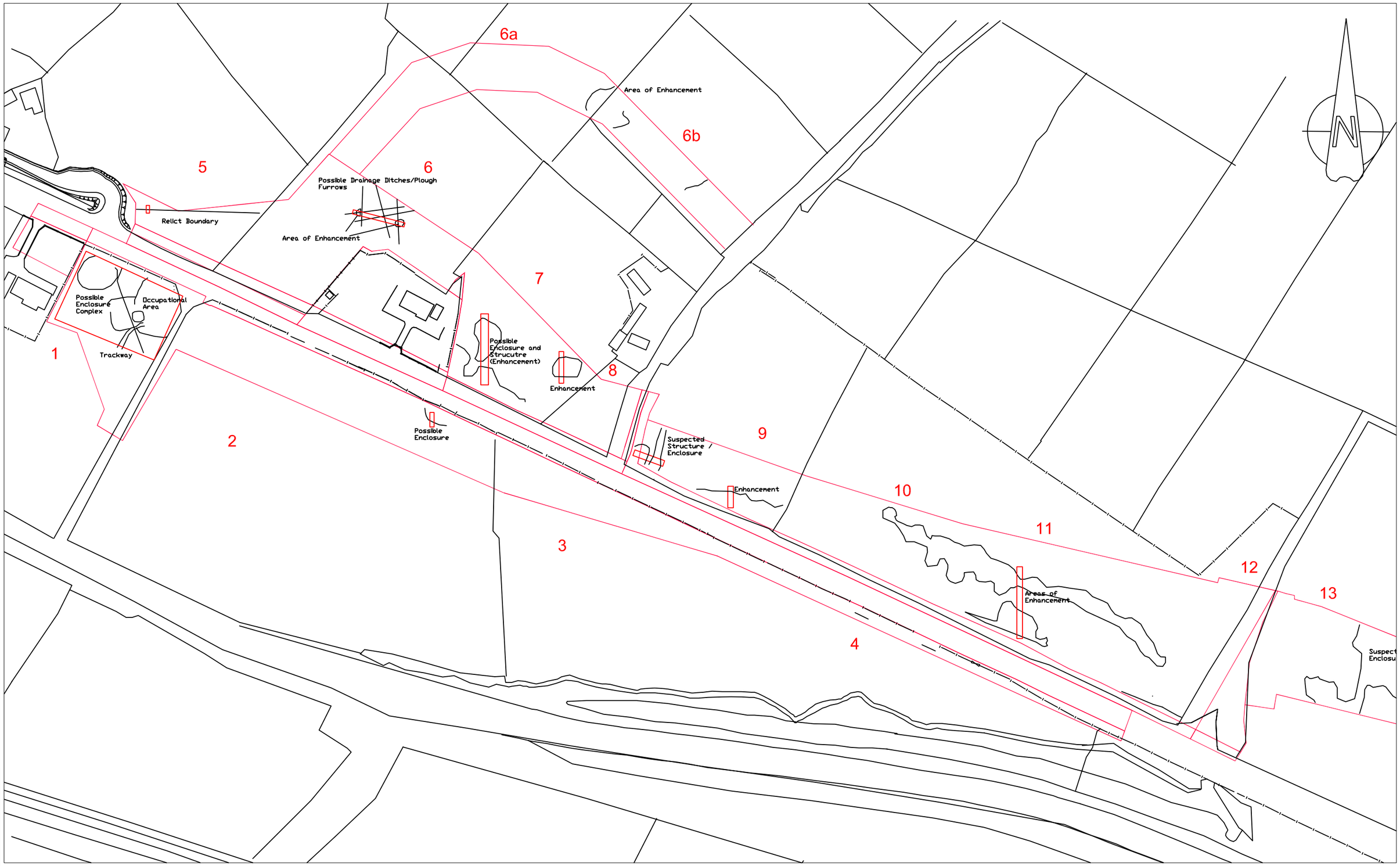
Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/12

0m 20m 40m

Figure No. 12 Fluxgate Gradiometer data Field 6

EARTHSOUND archaeological geophysics



Legend

- CPO line
- Present Land Boundaries
- Archaeological Features
- Suggested Locations of Trial Trenches

Site Location: N4 McNeads Bridge, County Westmeath.

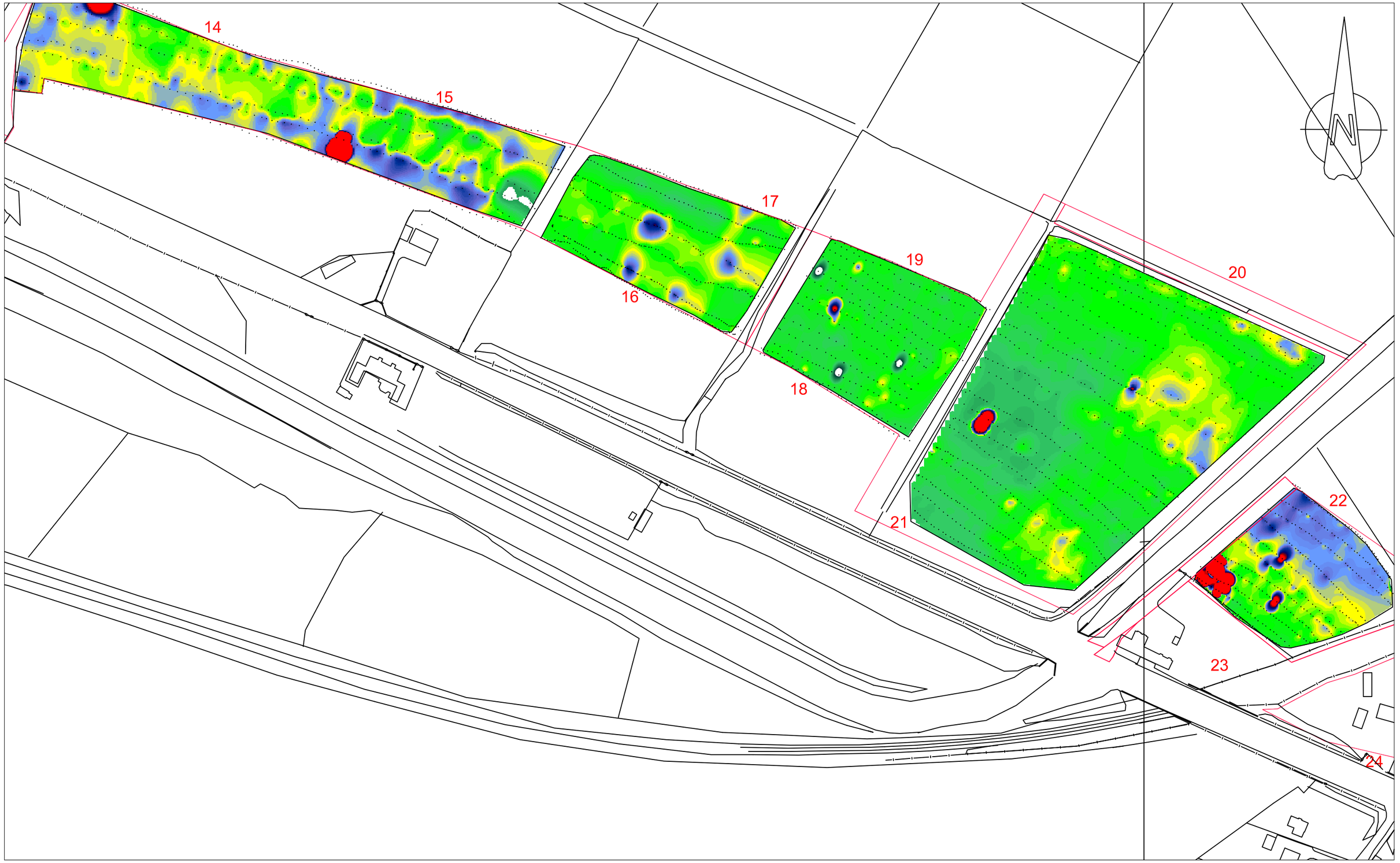
Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/13

0m 100m 200m

Figure No. 13 Archaeological Map Fields 1 - 12

EARTHSOUND archaeological geophysics



Legend

CPO line

Hedgerows

Survey Stations

K

-10 0 x10 -5 14 20

Site Location: N4 McNeads Bridge, County Westmeath.

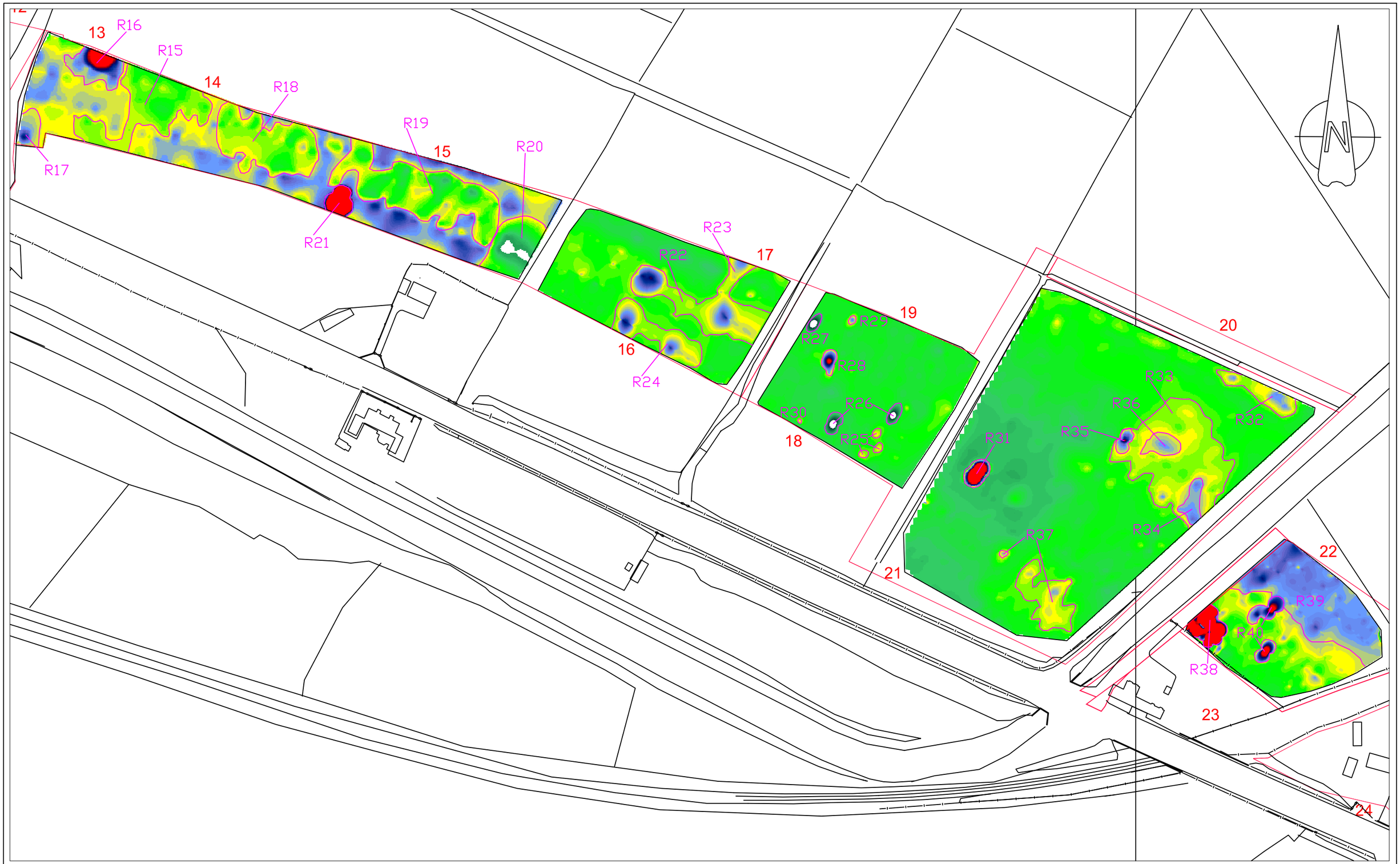
Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/14

0m 100m 200m

FIGURE No. 14 Magnetic Susceptibility Data for Fields 13 - 23

EARTHSOUND archaeological geophysics



Legend

- CPO line
- Hedgerows
- Magnetic Susceptibility Anomalies

K

-10 0 10 x10-5 20 40

Site Location: N4 McNeads Bridge, County Westmeath.

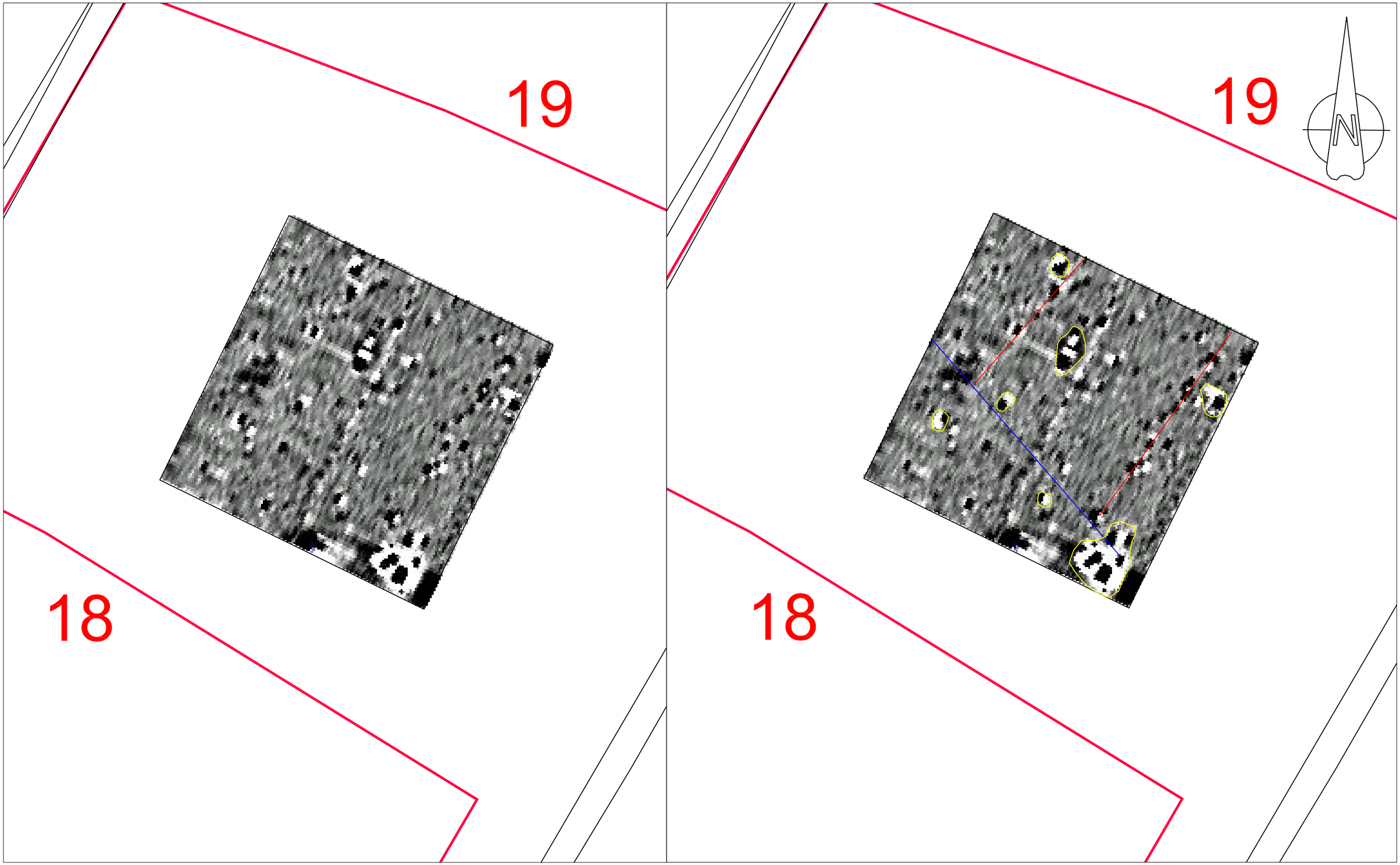
Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/15

0m 100m 200m

Figure No. 15 Magnetic Susceptibility Interpretation Fields 13 - 23

EARTHSOUND archaeological geophysics



Legend

- CPO line
- Present Land Boundaries
- Discrete Negative Anomalies
- Discrete Positive Anomlies
- Magnetic Dipole

nT

-1 0 1

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Site Location: N4 McNeads Bridge, County Westmeath.

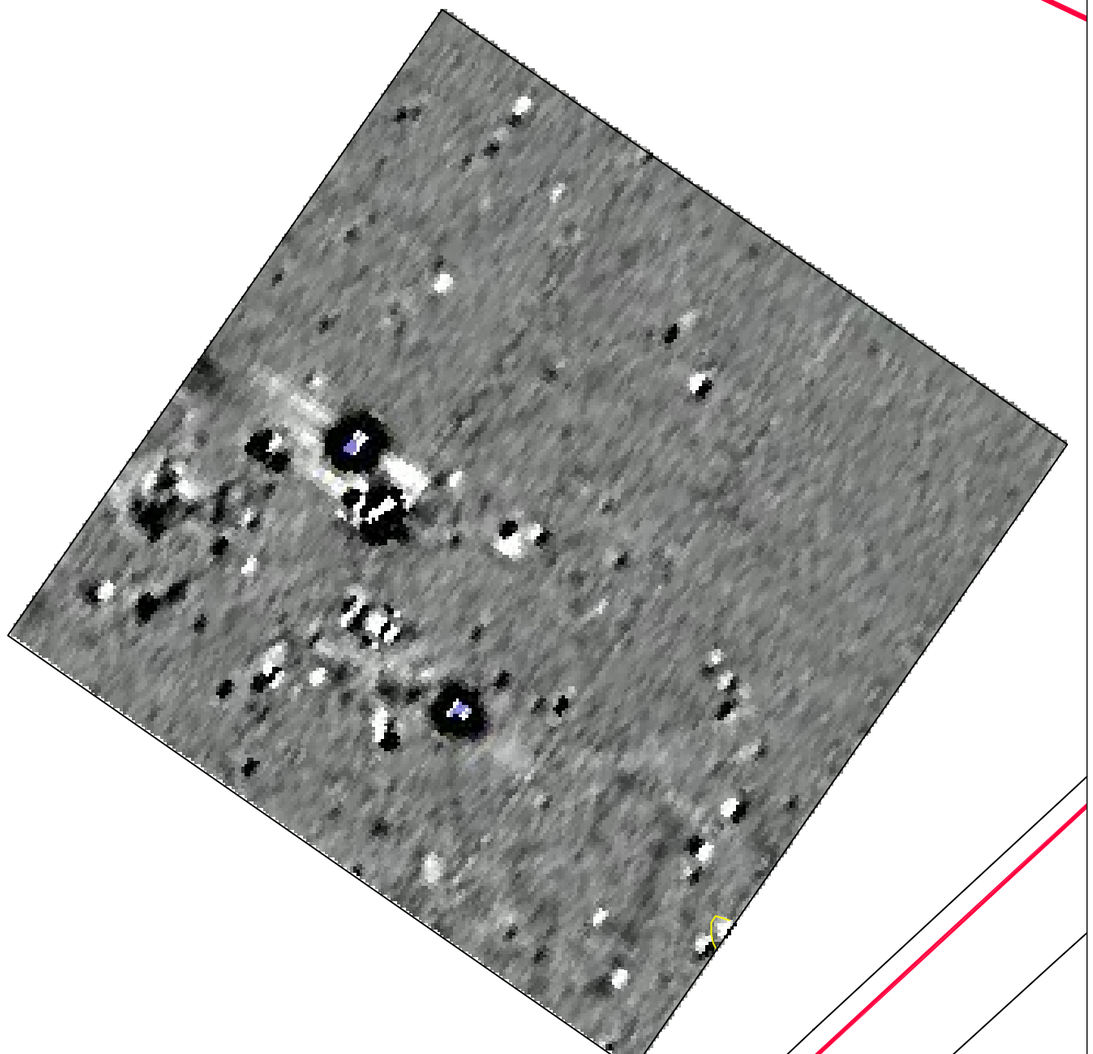
Client: Westmeath County Council.

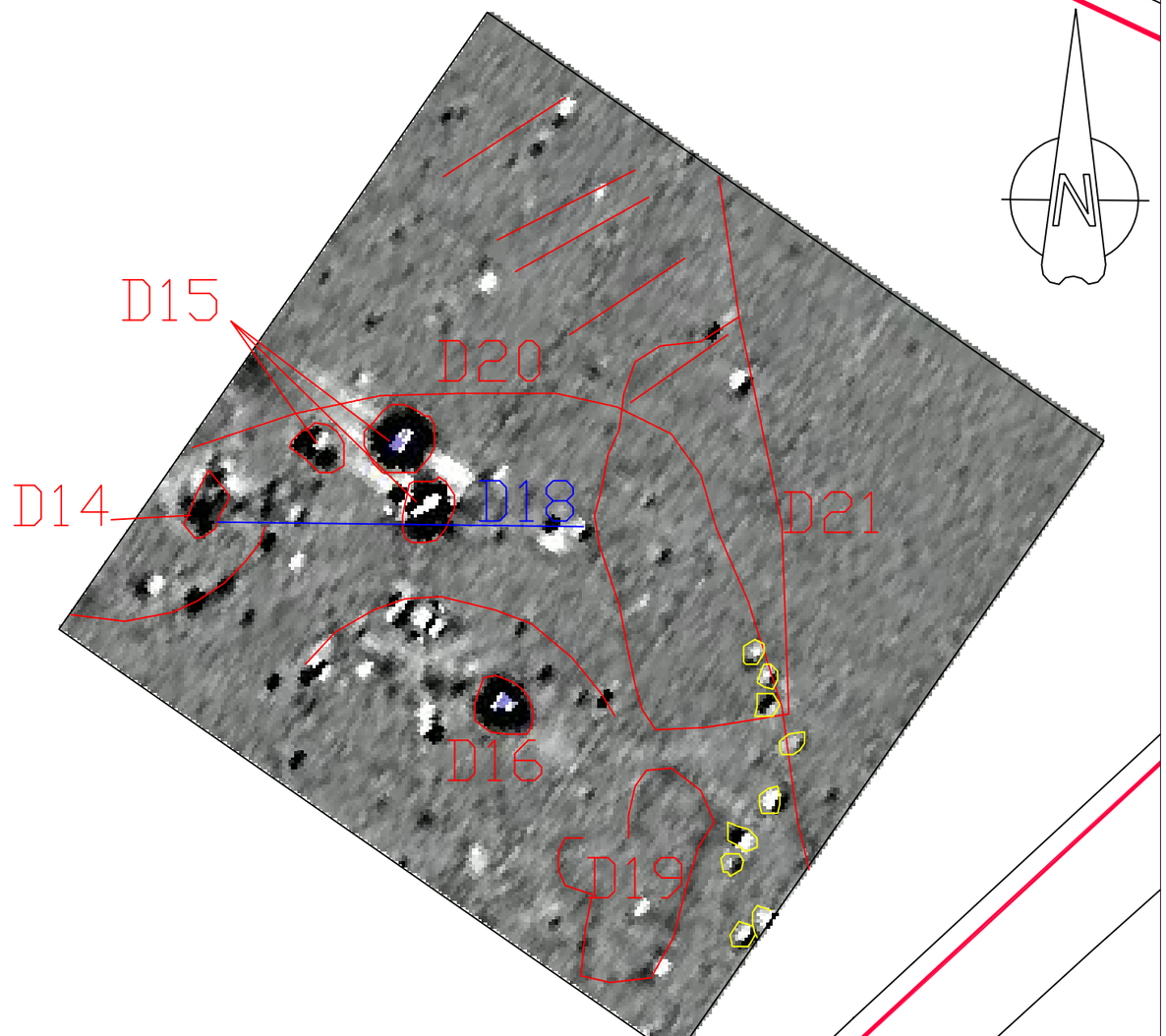
Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/16

0m 20m 40m

Figure No. 16 Fluxgate Gradiometer data
Field 18 - 19

EARTHSOUND archaeological geophysics





Legend

- CPO line
- Present Land Boundaries
- Discrete Negative Anomalies
- Discrete Positive Anomlies
- Magnetic Dipole

nT

-3 0 3

Site Location: N4 McNeads Bridge, County Westmeath.

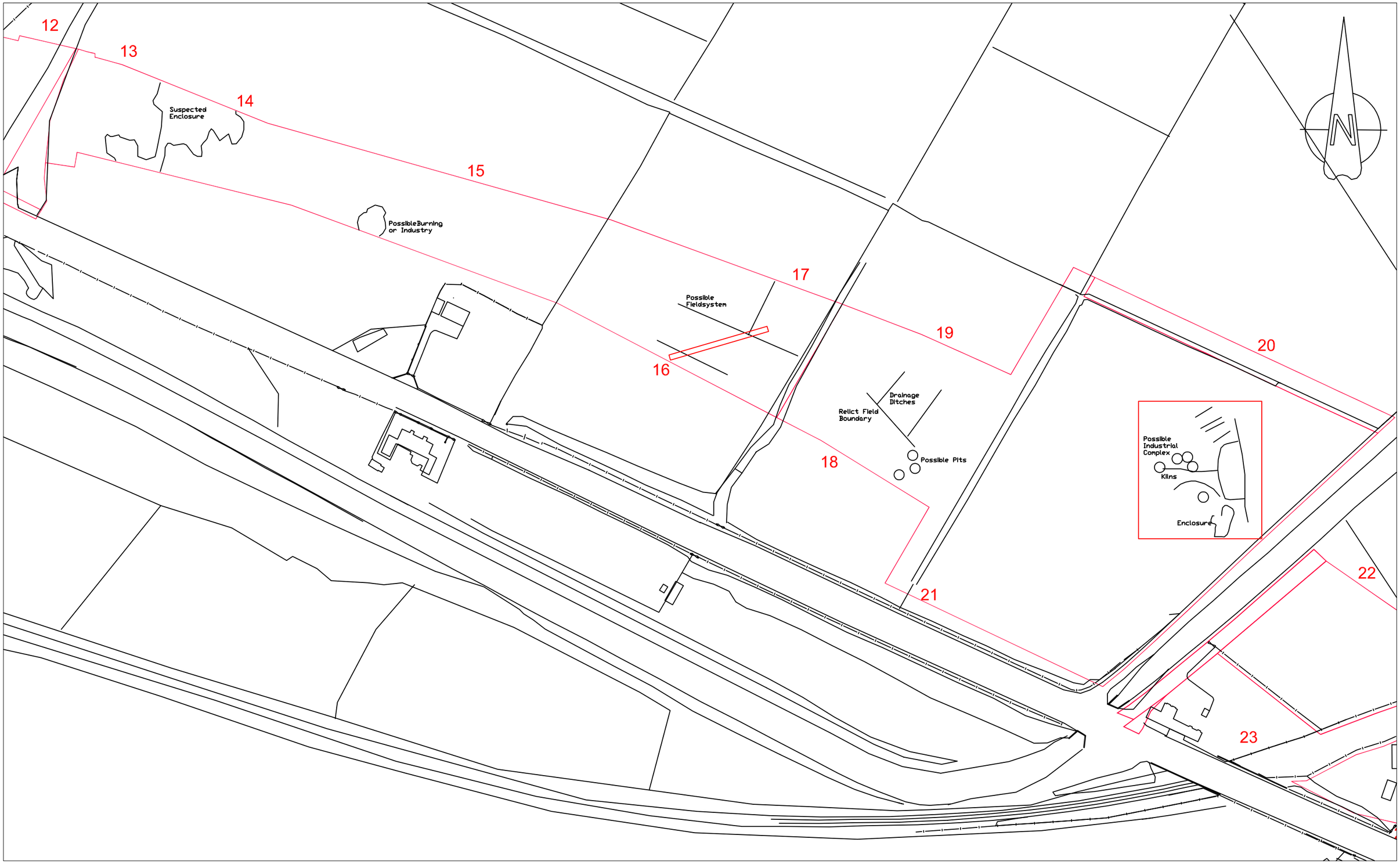
Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/17

0m 20m 40m

Figure No. 17 Fluxgate Gradiometer data
Field 20 - 21

EARTHSOUND archaeological geophysics



Legend

- CPO line
- Present Land Boundaries
- Archaeological Features
- Suggested Locations of Trial Trenches

Site Location: N4 McNeads Bridge, County Westmeath.

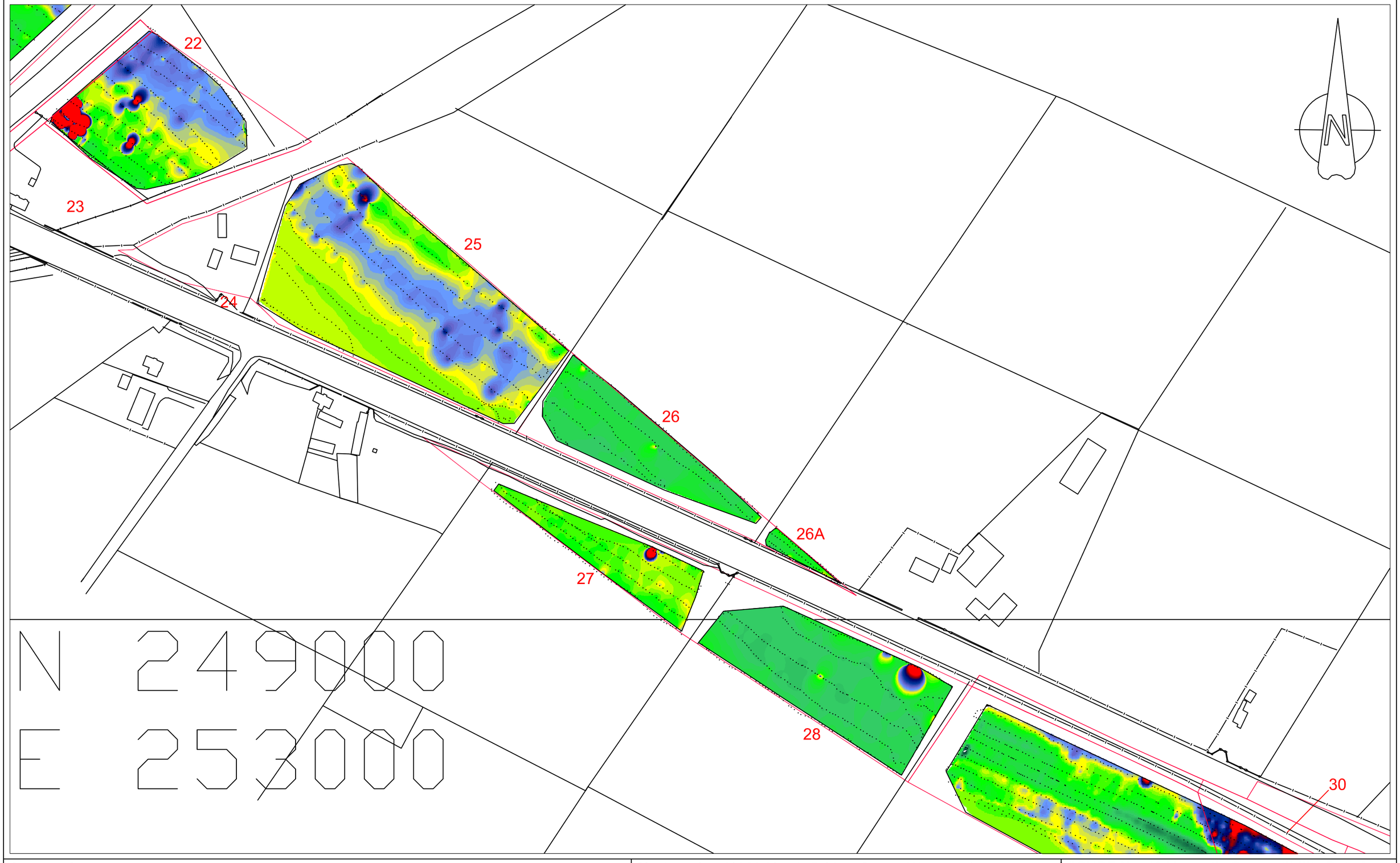
Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/18

0m 100m 200m

Figure No. 18 Archaeological Map Fields 13 - 23

EARTHSOUND archaeological geophysics



Legend

- CPO line
- Hedgerows
- Survey Stations

K

-10 0 x10 -5 14 20

Site Location: N4 McNeads Bridge, County Westmeath.

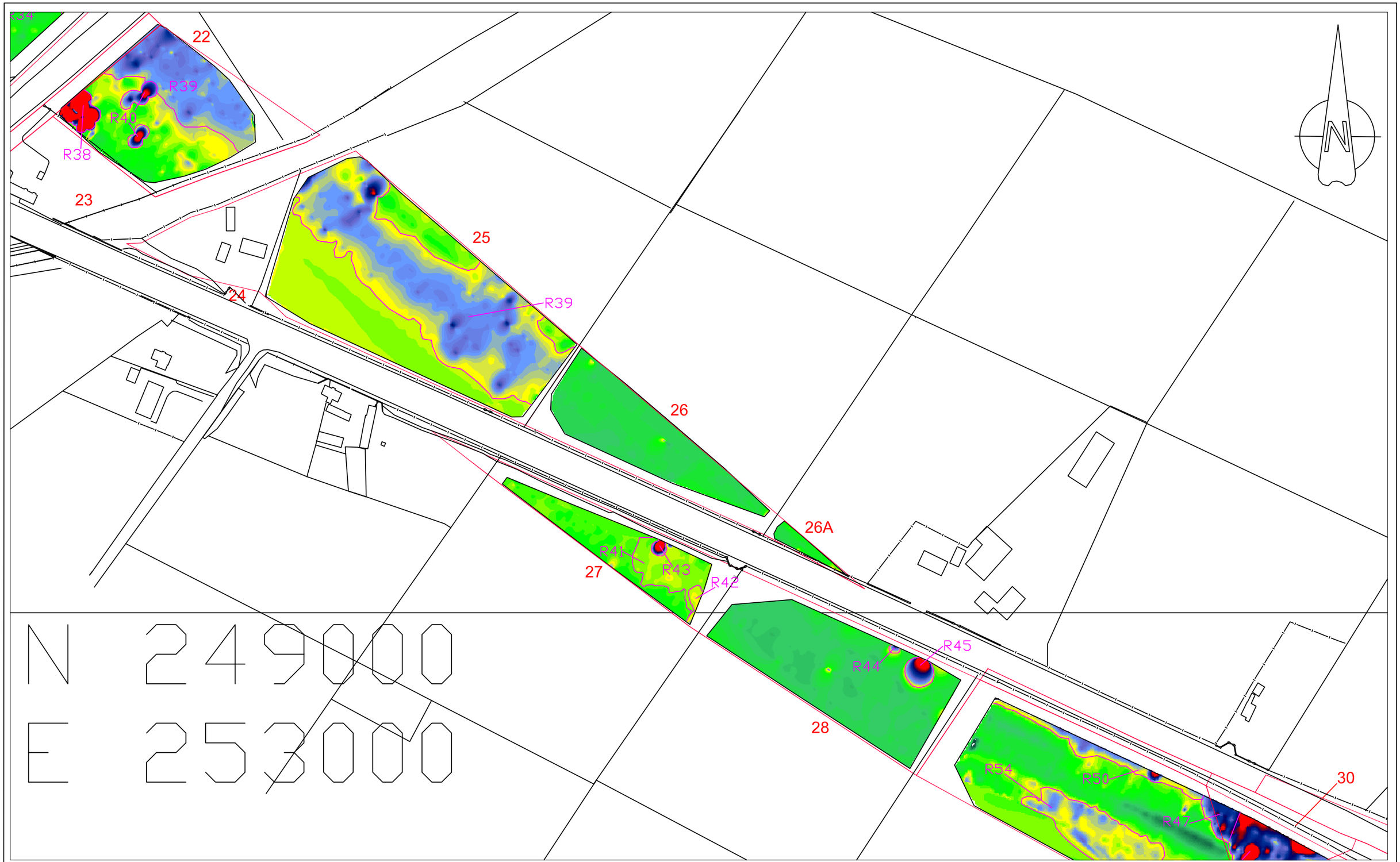
Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/19

0m 100m 200m

FIGURE No. 19 Magnetic Susceptibility Data for Fields 22 - 28

EARTHSOUND archaeological geophysics



Legend

CPO line

Hedgerows

Magnetic Susceptibility Anomalies

K

-10 0 10 x10^{-5} 20 40

Site Location: N4 McNeads Bridge, County Westmeath.

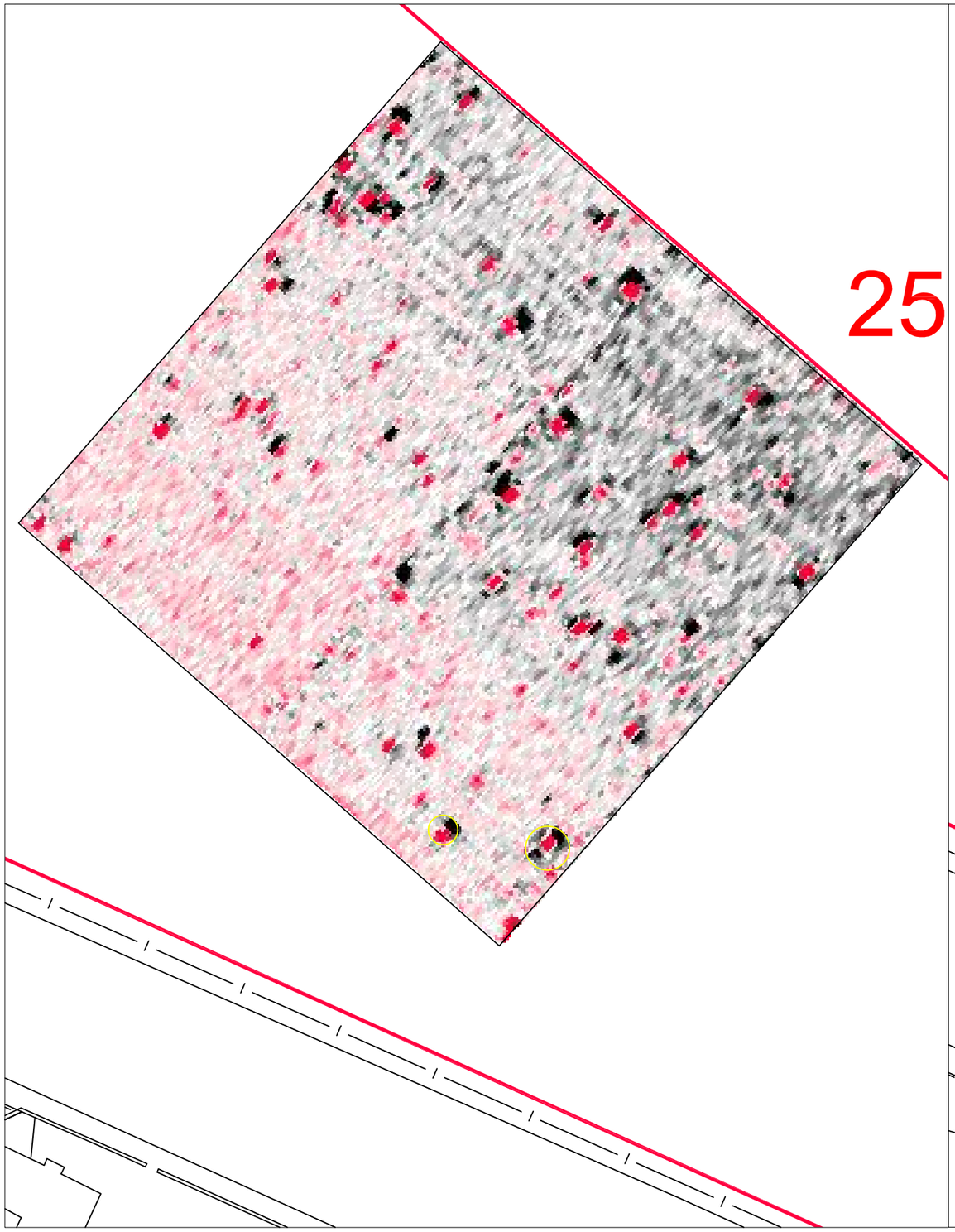
Client: Westmeath County Council.

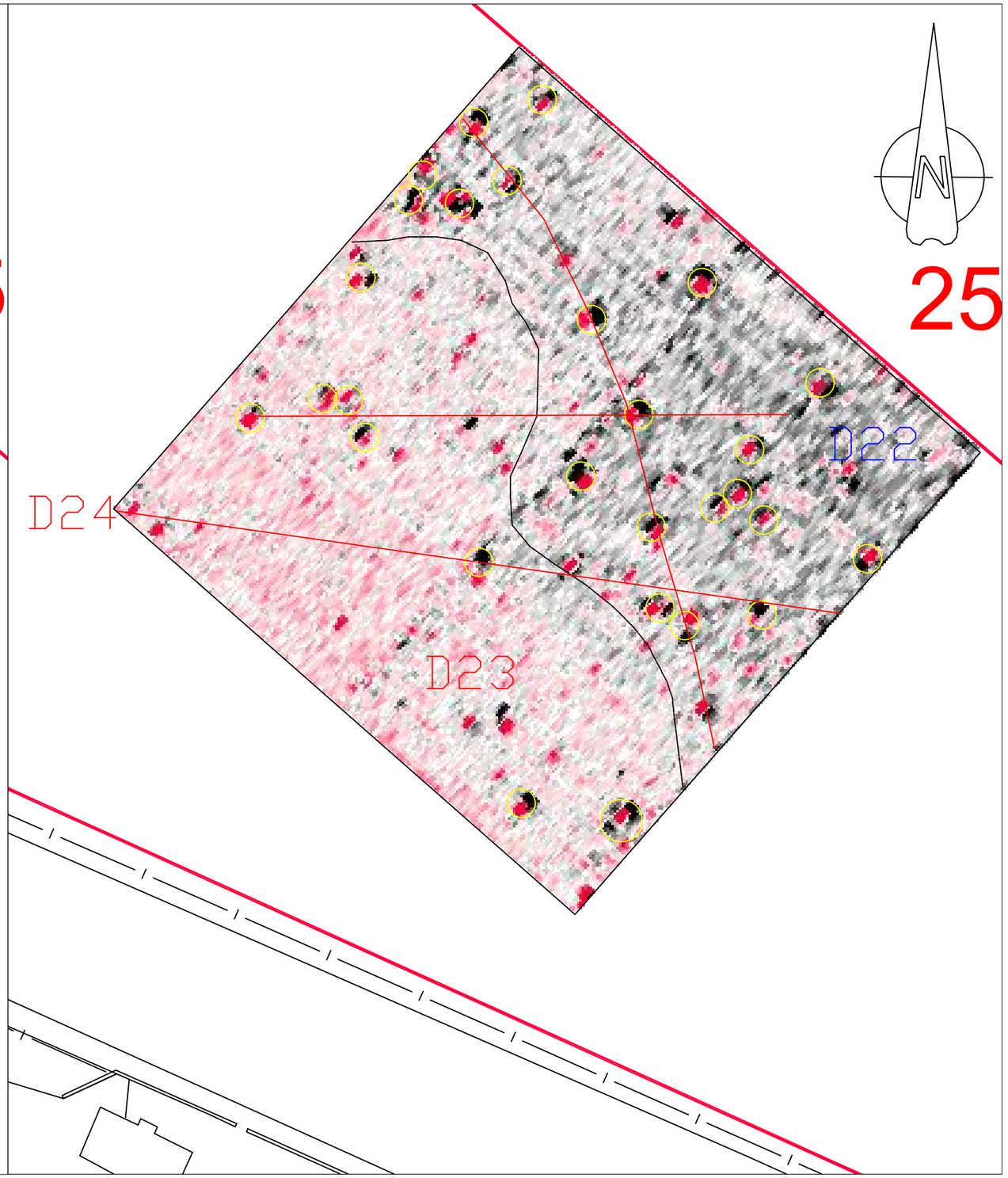
Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/20

0m 100m 200m

Figure No. 20 Magnetic Susceptibility Interpretation Fields 22 - 28

EARTHSOUND archaeological geophysics





Legend

- CPO line
- Present Land Boundaries
- Discrete Negative Anomalies
- Discrete Positive Anomlies
- Magnetic Dipoles

nT

-1 0 2

Site Location: N4 McNeads Bridge, County Westmeath.

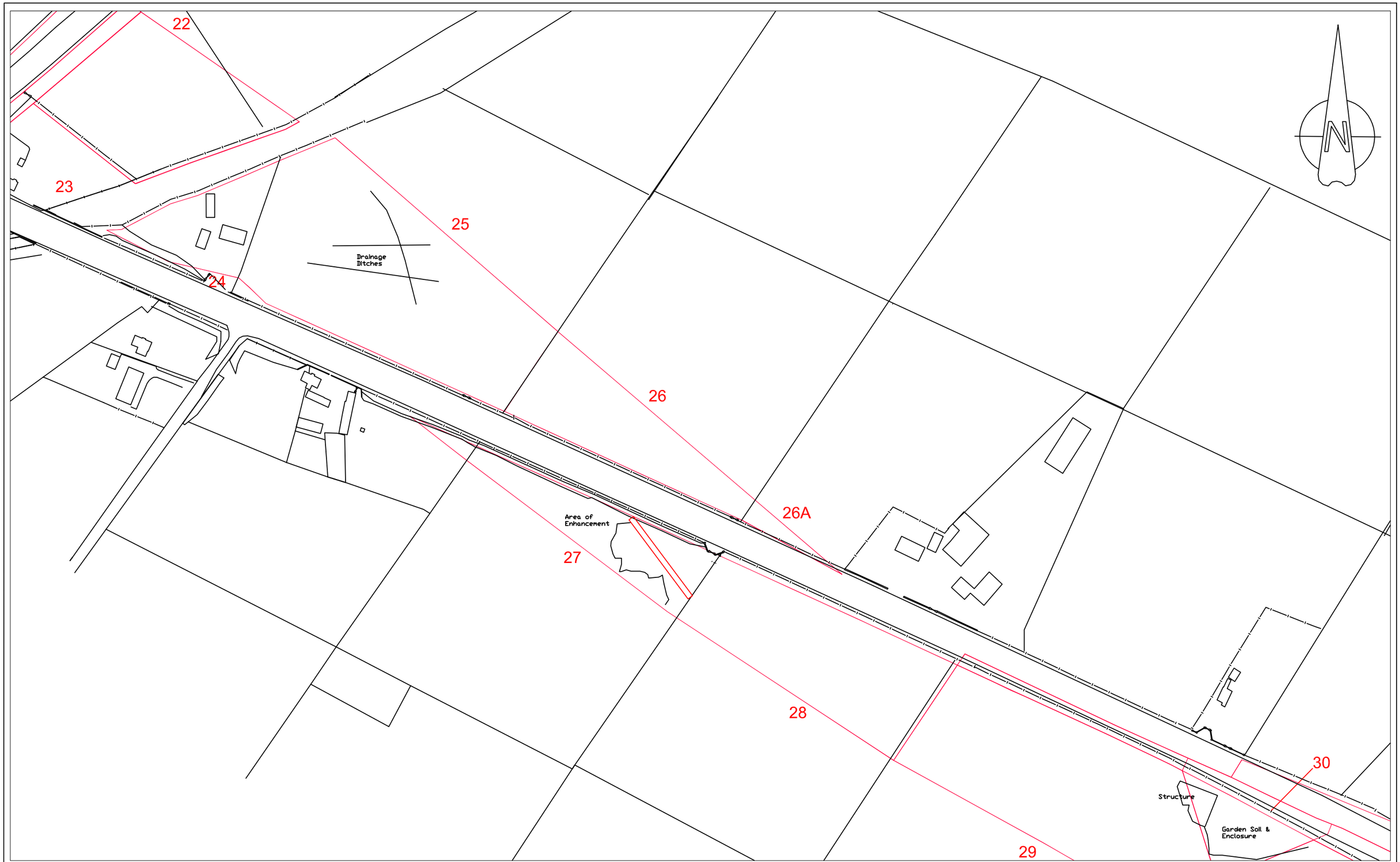
Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/21

0m 20m 40m

Figure No. 21 Fluxgate Gradiometer data Field 25

EARTHSOUND archaeological geophysics



Legend

- CPO line
- Present Land Boundaries
- Archaeological Features
- Suggested Locations of Trial Trenches

Site Location: N4 McNeads Bridge, County Westmeath.

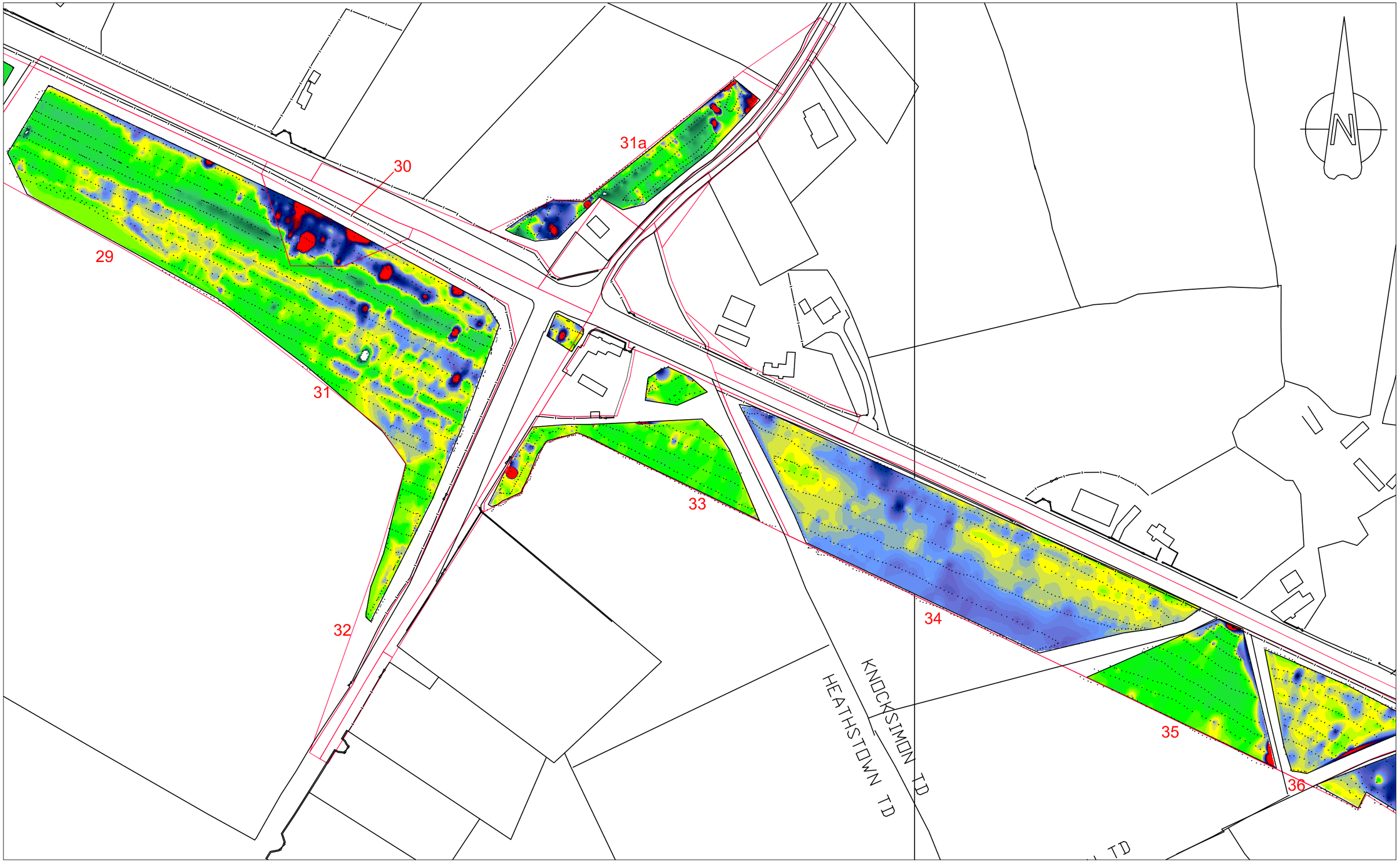
Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/22

0m 100m 200m

Figure No. 22 Archaeological Map Fields 22 - 28

EARTHSOUND archaeological geophysics



Legend

CPO line

Hedgerows

Survey Stations

K

-10 0 x10 -5 14 20

Site Location: N4 McNeads Bridge, County Westmeath.

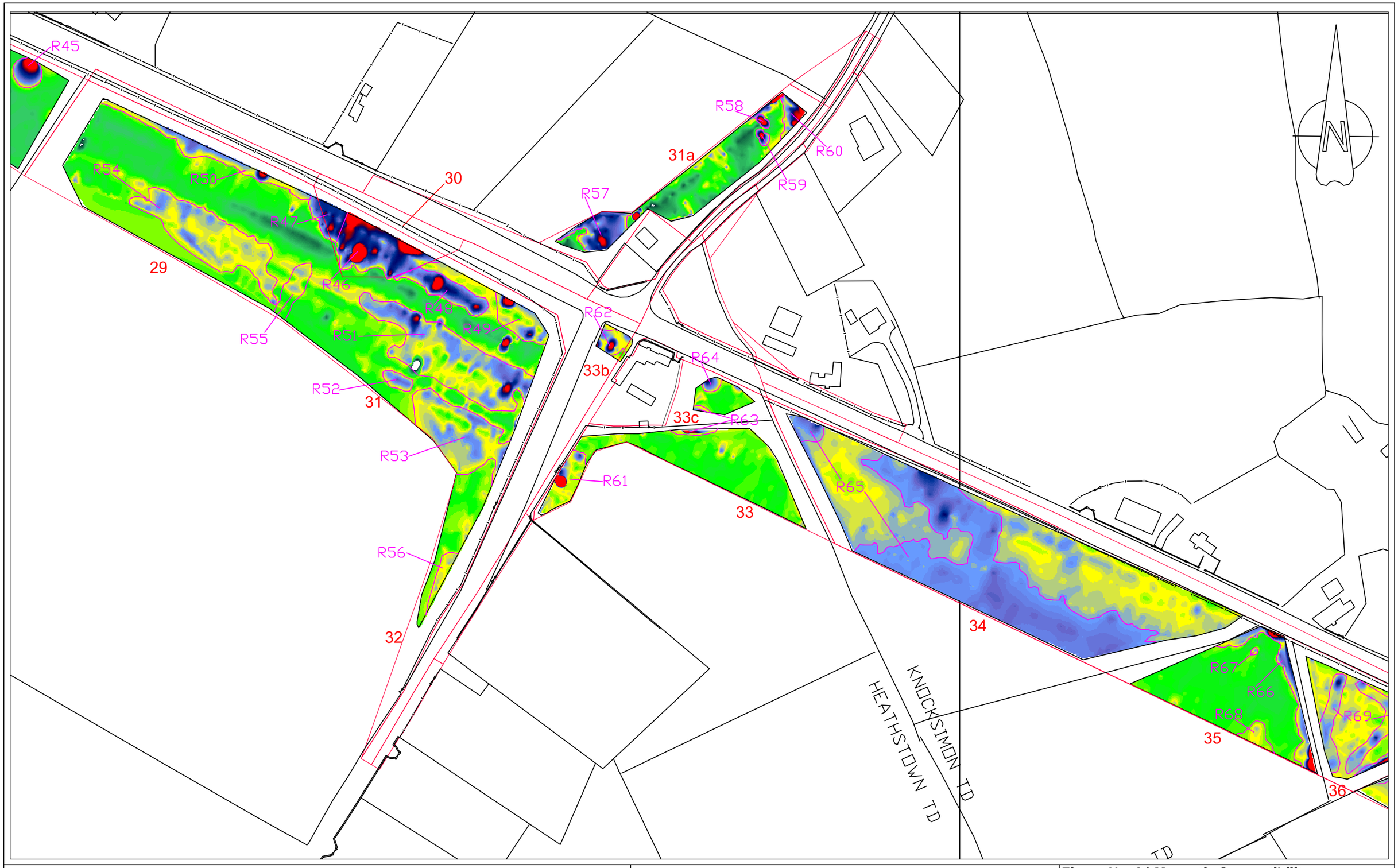
Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/23

0m 100m 200m

FIGURE No. 23 Magnetic Susceptibility Data for Fields 29 - 35

EARTHSOUND archaeological geophysics



Legend

CPO line

Hedgerows

Magnetic Susceptibility Anomalies

K

-10 0 10 x10⁻⁵ 20 40

Site Location: N4 McNeads Bridge, County Westmeath.

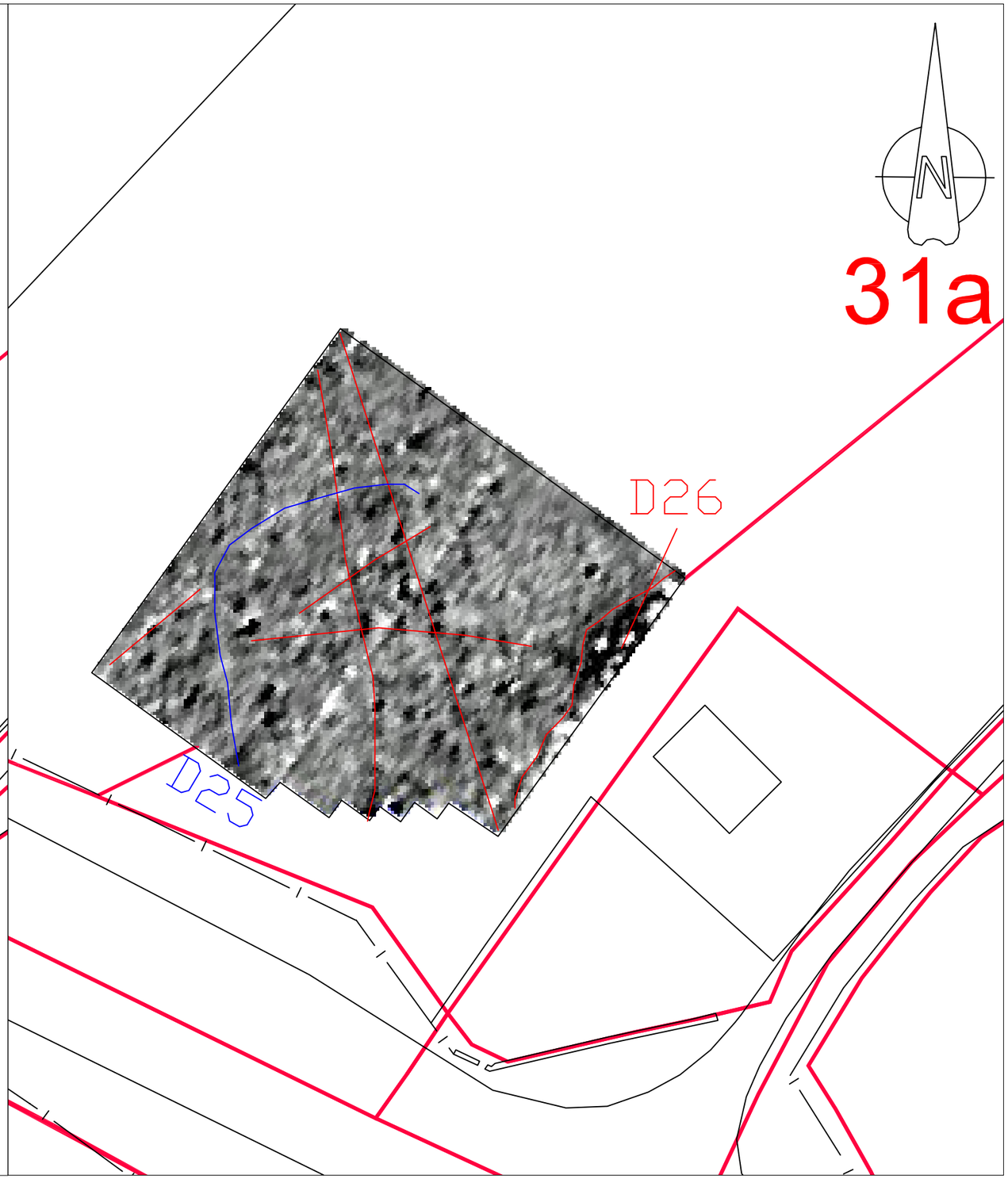
Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/24

0m 100m 200m

Figure No. 24 Magnetic Susceptibility Interpretation Fields 29 - 35

EARTHSOUND archaeological geophysics



Legend

- CPO line
- Present Land Boundaries
- Discrete Negative Anomalies
- Discrete Positive Anomlies
- Magnetic Dipoles

nT

-3 0 3

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Site Location: N4 McNeads Bridge, County Westmeath.

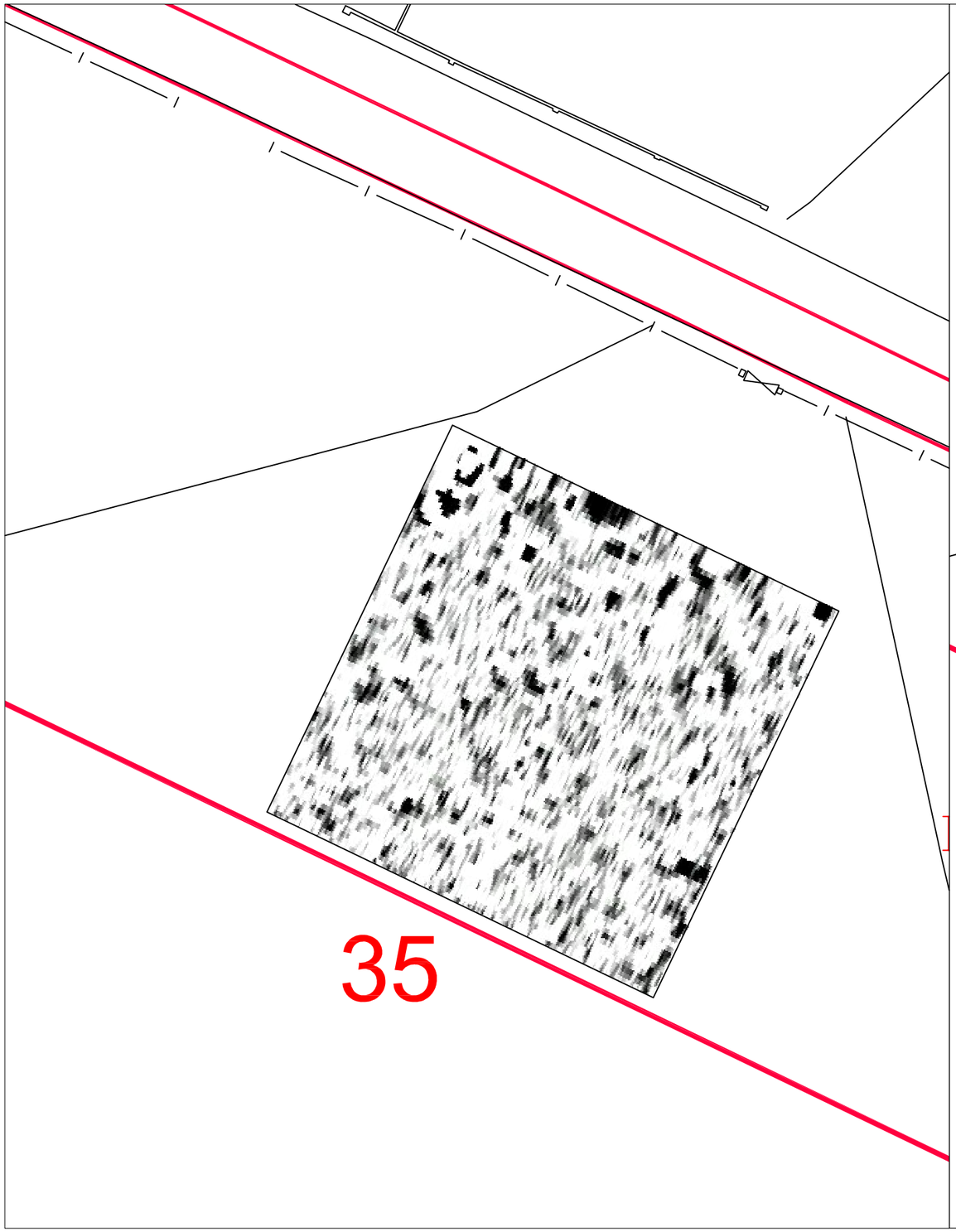
Client: Westmeath County Council.

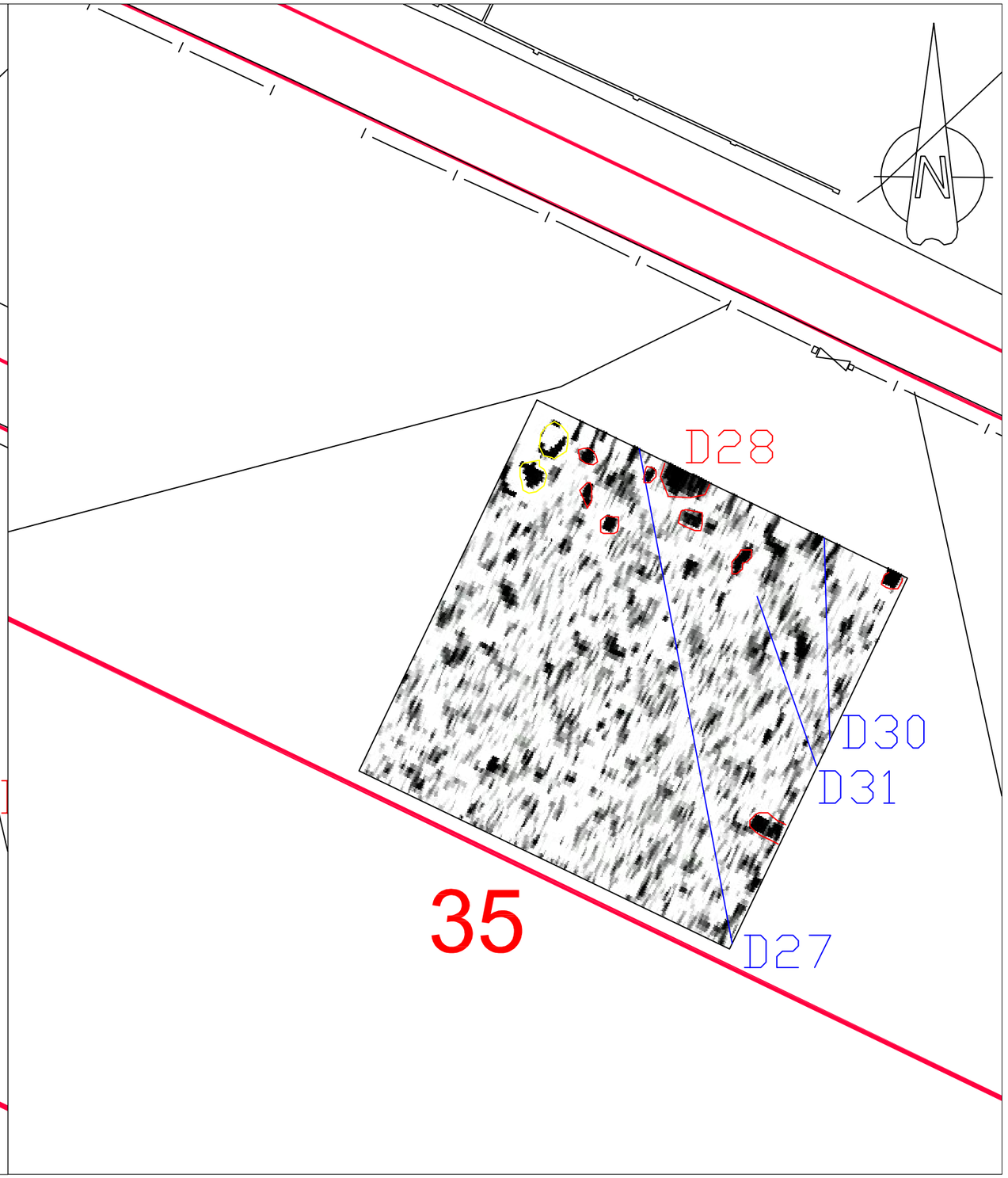
Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/25

0m 20m 40m

Figure No. 25 Fluxgate Gradiometer data
Field 31a

EARTHSOUND archaeological geophysics





Legend

- CPO line
- Present land Boundaries
- Discrete Negative Anomalies
- Discrete Positive Anomlies
- Magnetic Dipoles

nT

-3 0 3

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Site Location: N4 McNeads Bridge, County Westmeath.

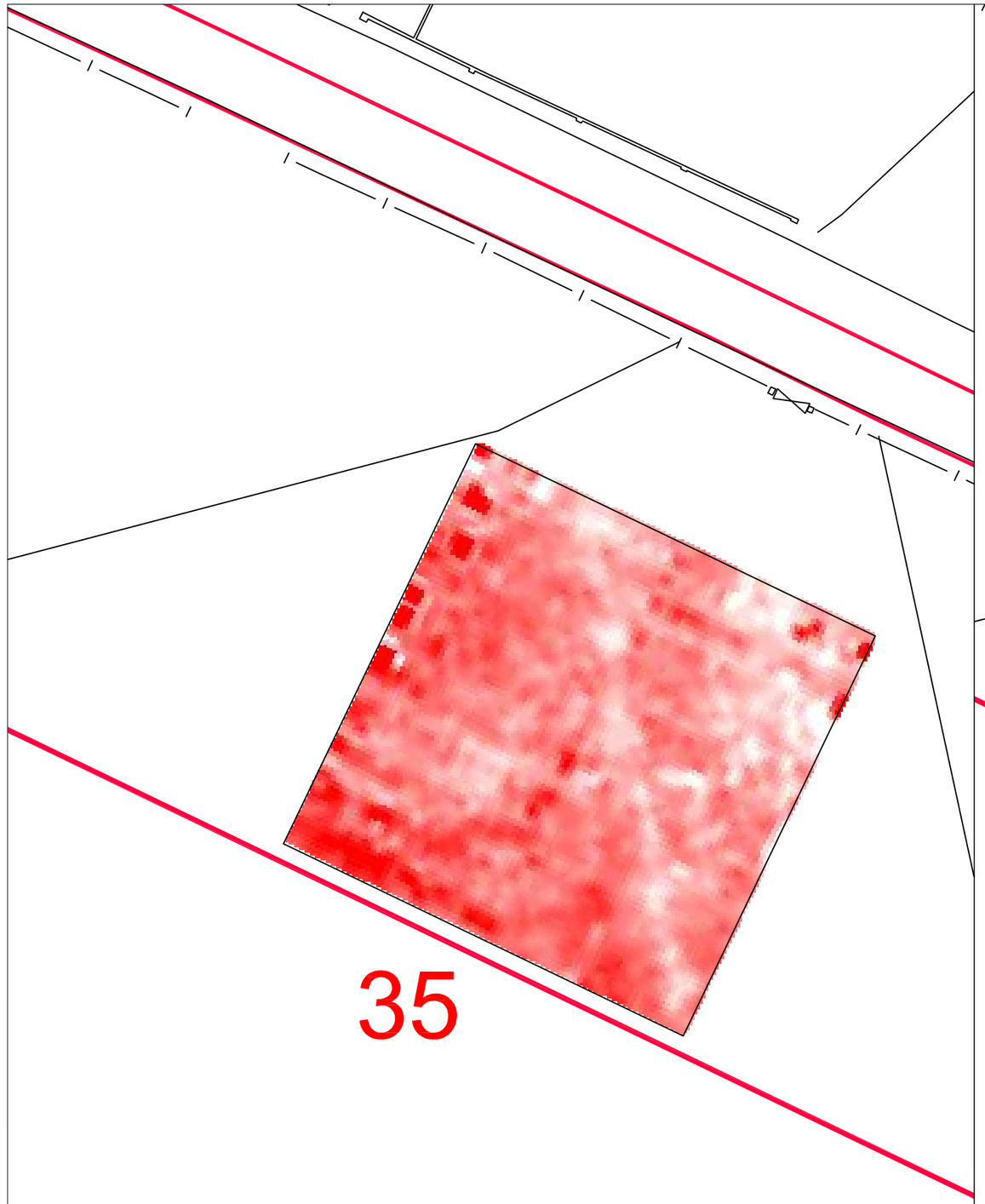
Client: Westmeath County Council.

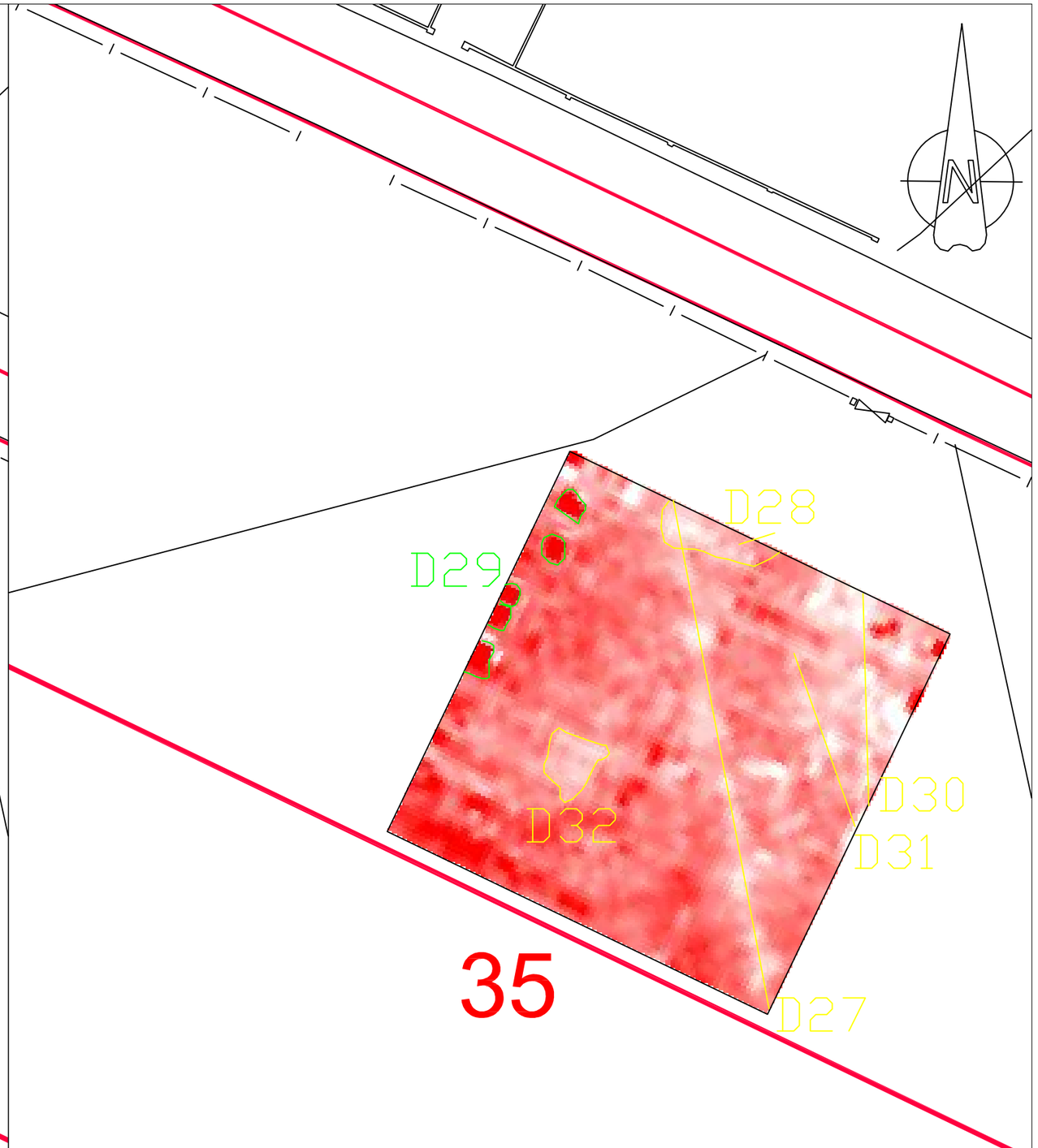
Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/26

0m 20m 40m

Figure No. 26 Fluxgate Gradiometer data Field 35

EARTHSOUND archaeological geophysics





Legend

CPO line

Present Land Boundaries

Discrete Low Resistance Anomalies

Discrete High Resistance Anomlies

Ohms

85 105 113

Site Location: N4 McNeads Bridge, County Westmeath.

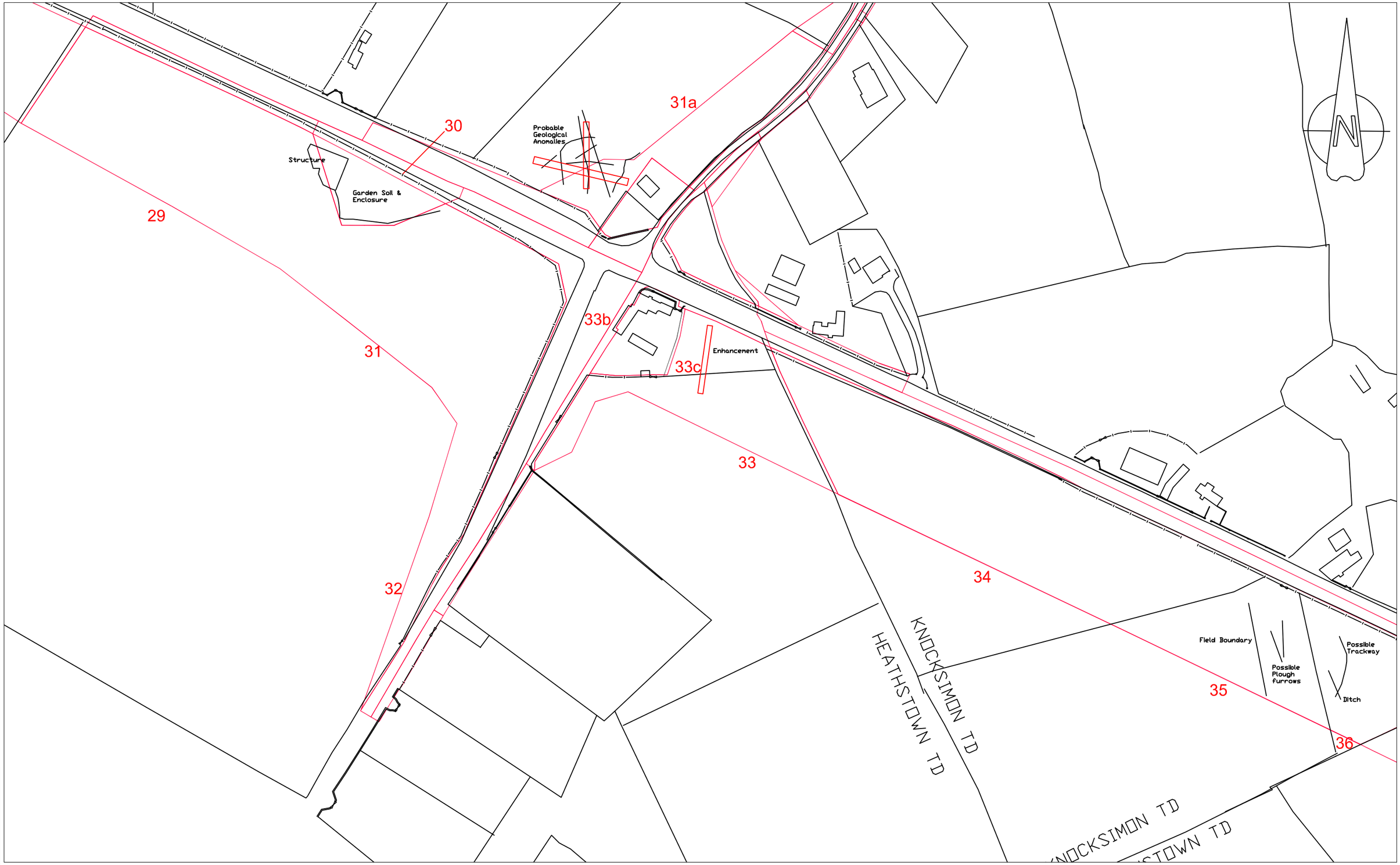
Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/27

0m 20m 40m

Figure No. 27 Earth Resistance data Field 35

EARTHSOUND archaeological geophysics



Legend

- CPO line
- Present Land Boundaries
- Archaeological Features
- Suggested Locations of Trial Trenches

Site Location: N4 McNeads Bridge, County Westmeath.

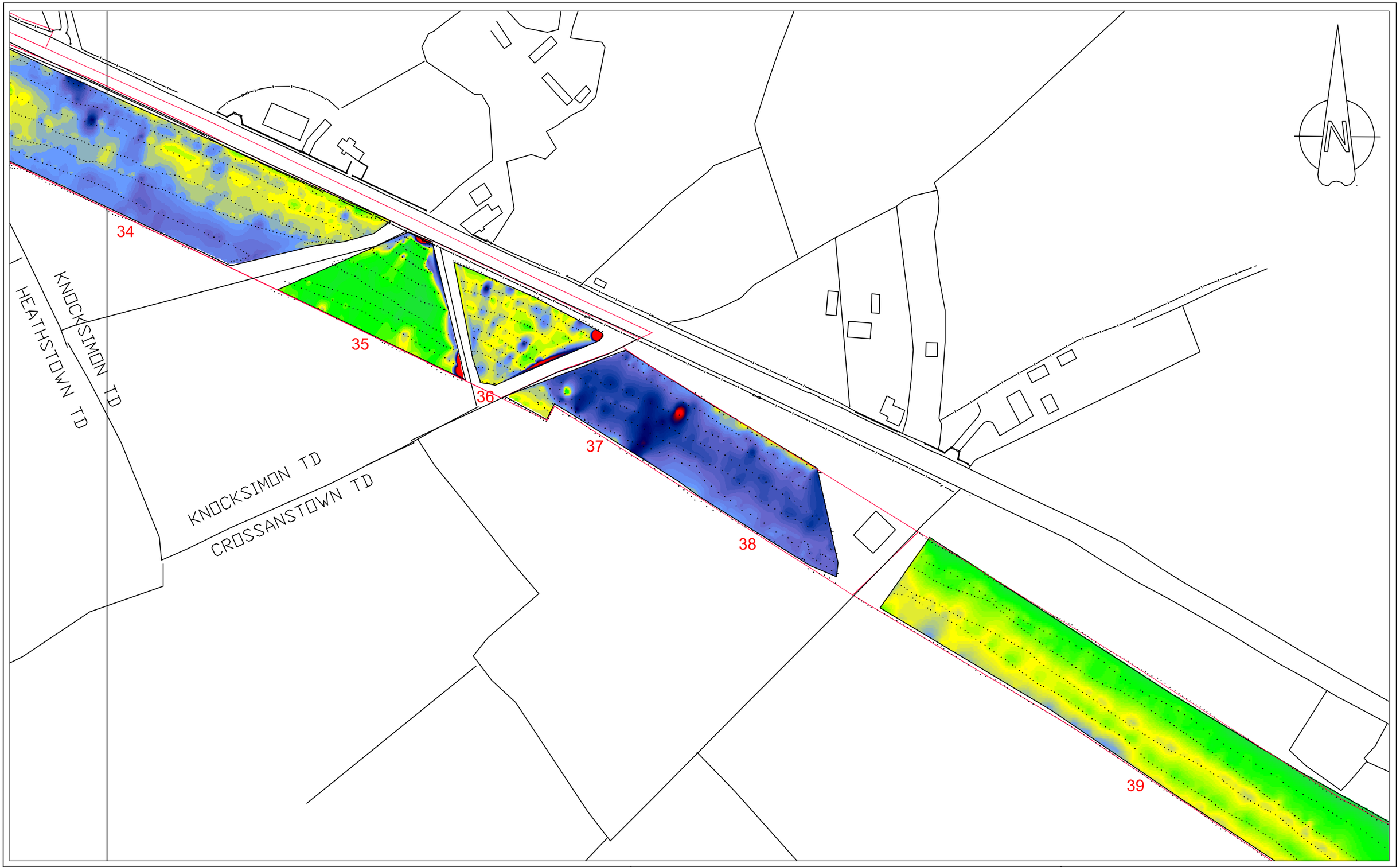
Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/28

0m 100m 200m

Figure No. 28 Archaeological Map Fields 29 - 35

EARTHSOUND archaeological geophysics



Legend

CPO line

Hedgerows

Survey Stations

K

-10 0 x10^{-5} 14 20

Site Location: N4 McNeads Bridge, County Westmeath.

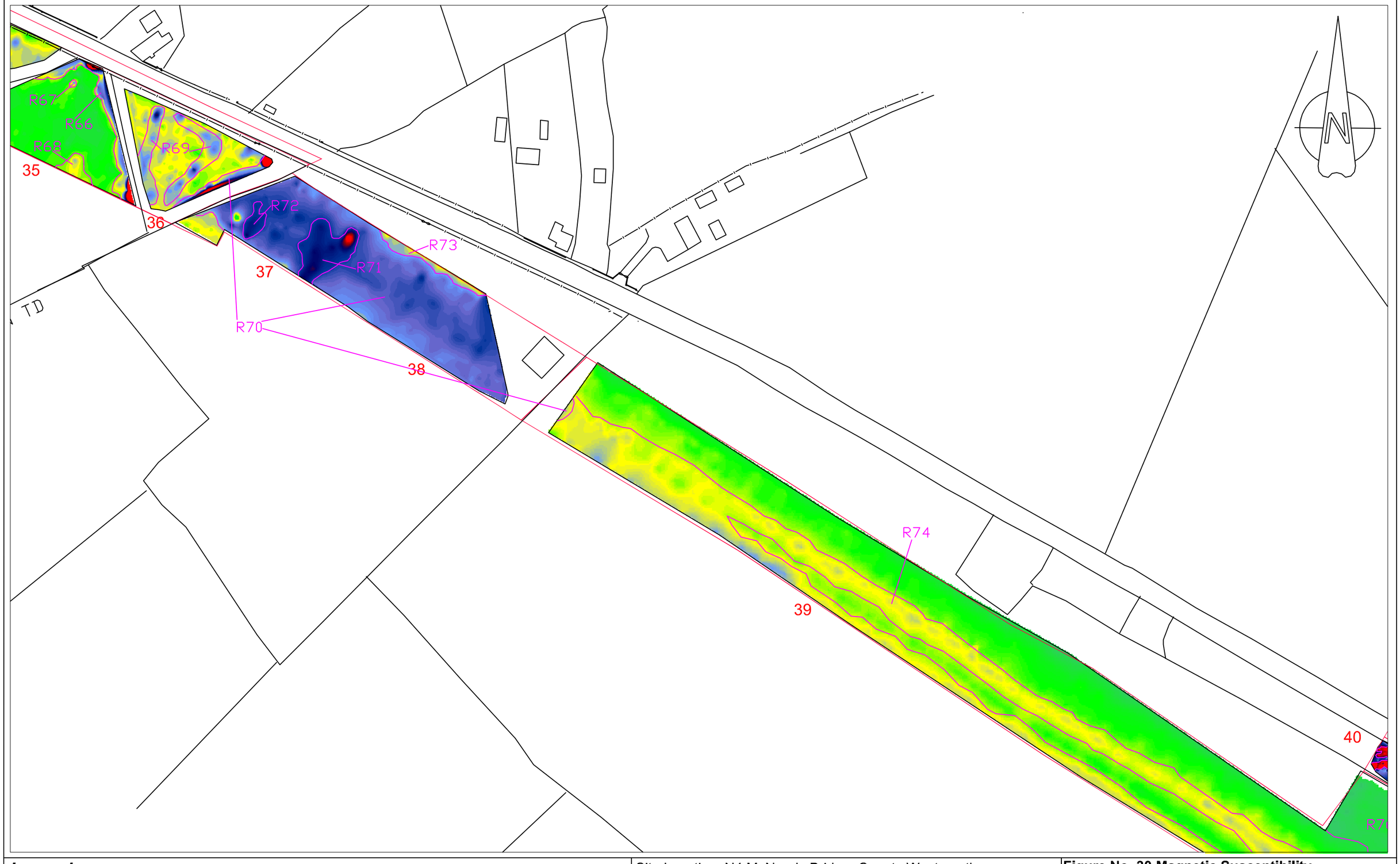
Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/29

0m 100m 200m

FIGURE No. 29 Magnetic Susceptibility Data for Fields 36 - 38

EARTHSOUND archaeological geophysics



Legend

CPO line

Hedgerows

Magnetic Susceptibility Anomalies

K

-10 0 10 x10 -5 20 40

Site Location: N4 McNeads Bridge, County Westmeath.

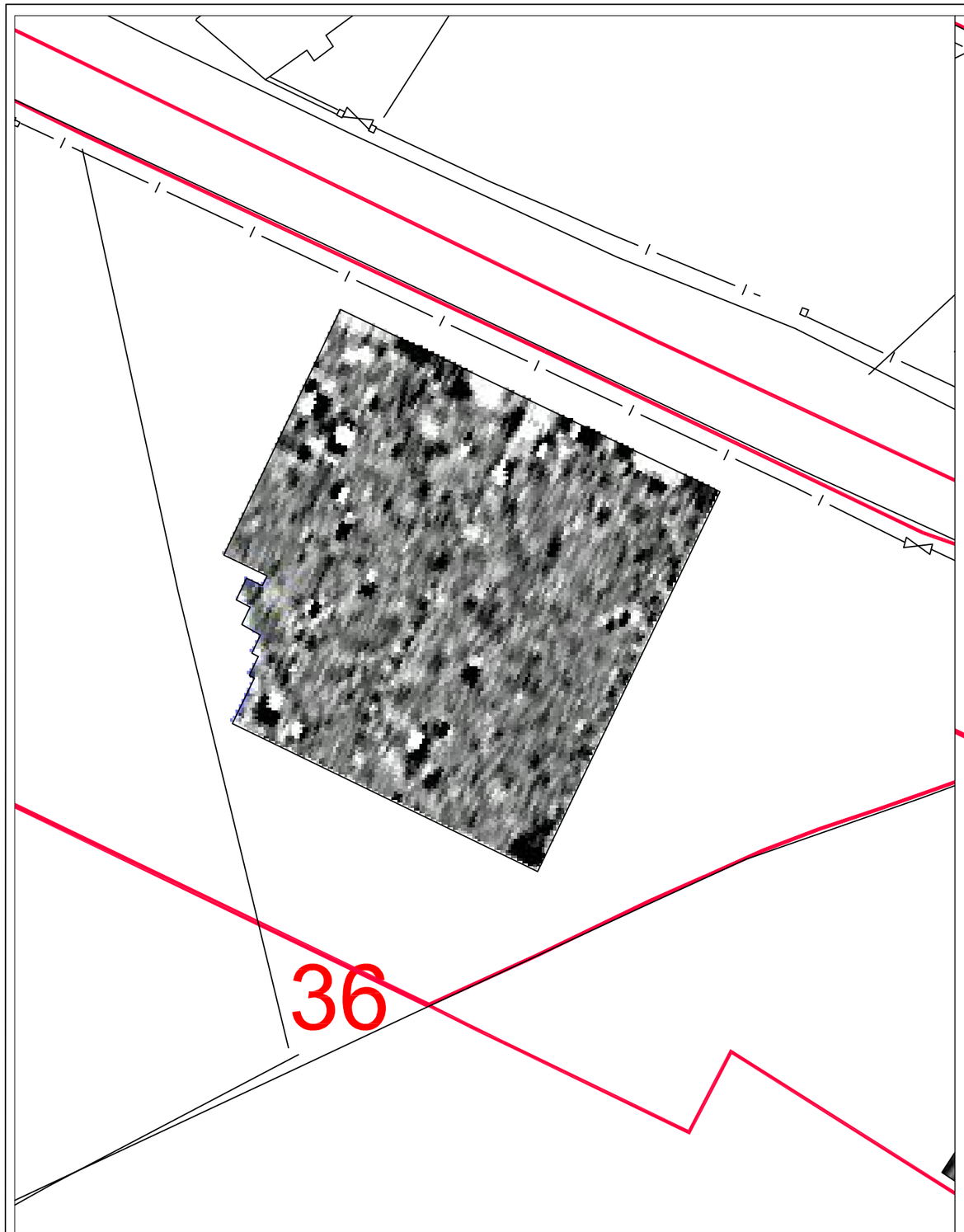
Client: Westmeath County Council.

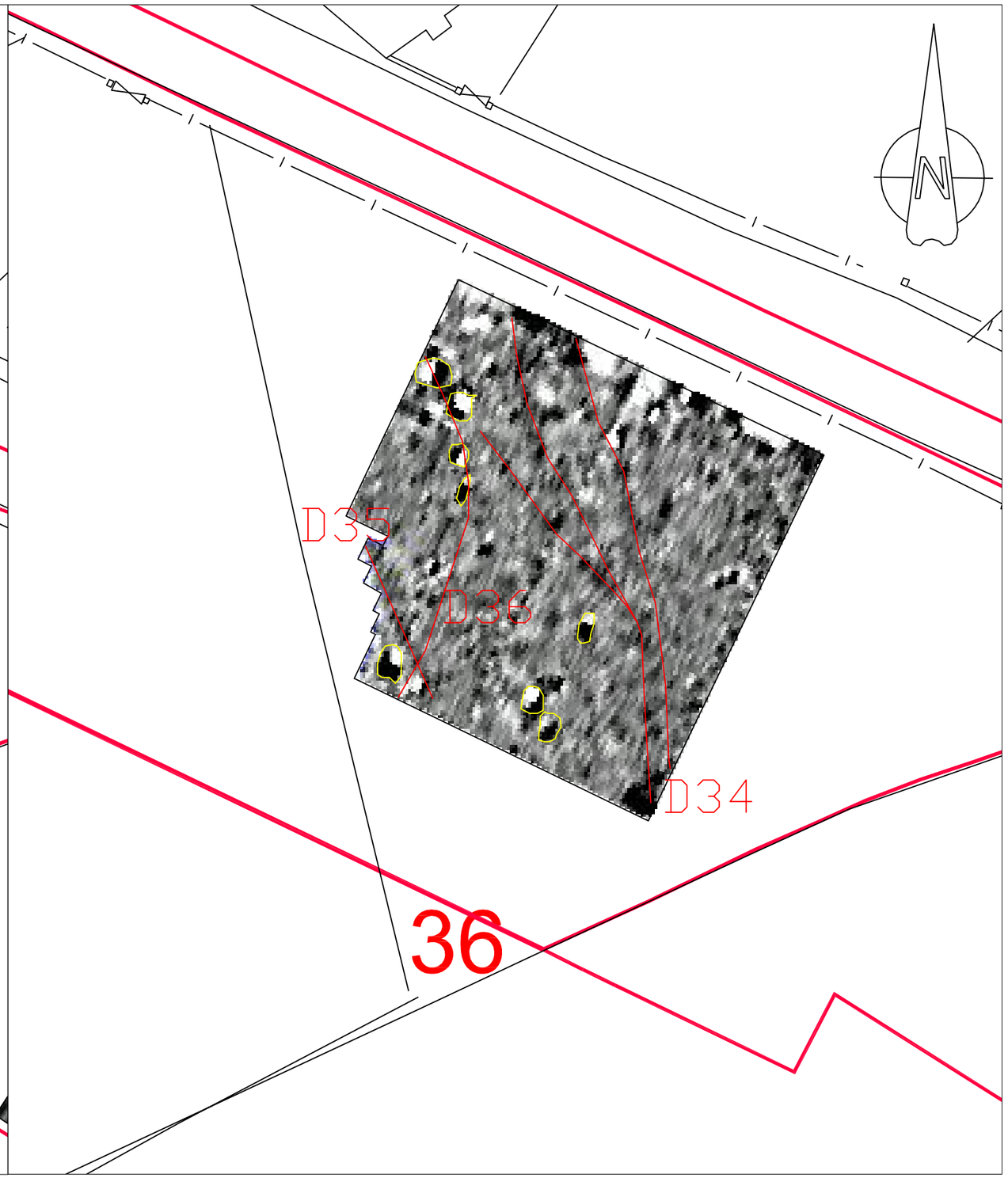
Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/30

0m 100m 200m

Figure No. 30 Magnetic Susceptibility Interpretation Fields 36 - 38

EARTHSOUND archaeological geophysics





Legend

- CPO line
- Present Land Boundaries
- Discrete Negative Anomalies
- Discrete Positive Anomlies
- Magnetic Dipoles

nT

-1 0 1

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Site Location: N4 McNeads Bridge, County Westmeath.

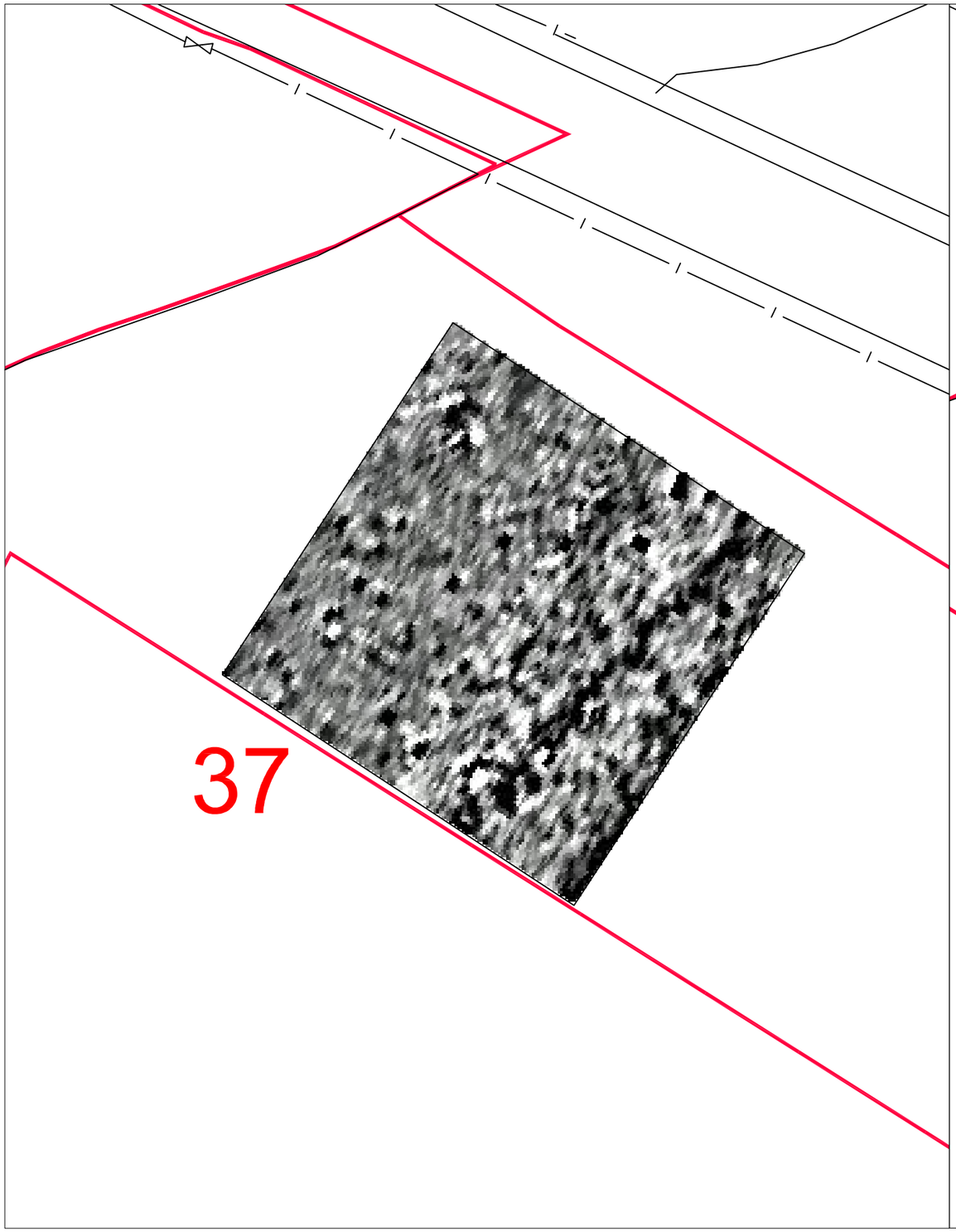
Client: Westmeath County Council.

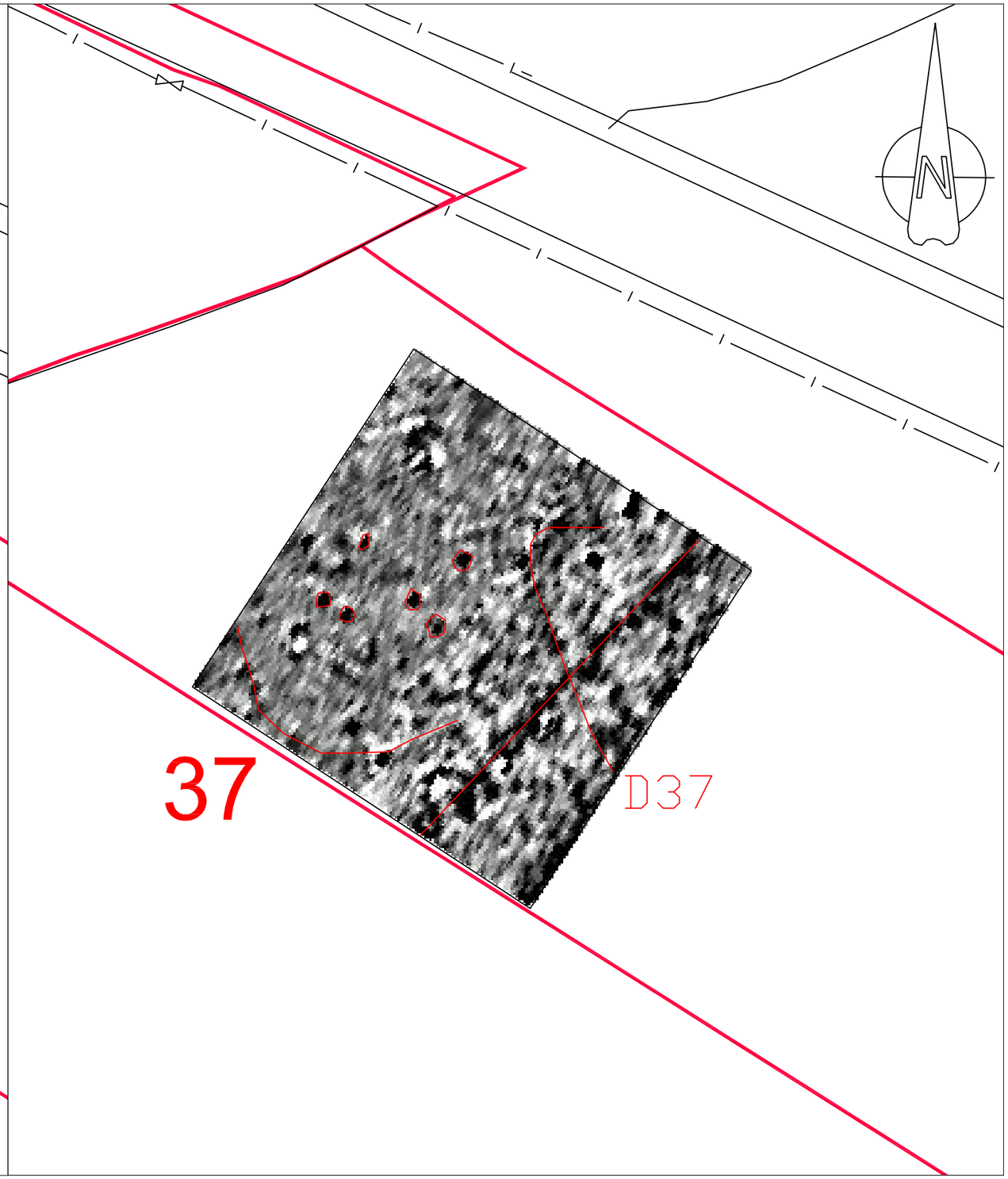
Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/31

0m 20m 40m

Figure No. 31 Fluxgate Gradiometer data Field 36

EARTHSOUND archaeological geophysics





Legend

- CPO line
- Present Land Boundaries
- Discrete Negative Anomalies
- Discrete Positive Anomlies
- Magnetic Dipoles

nT

-2 0 1

Site Location: N4 McNeads Bridge, County Westmeath.

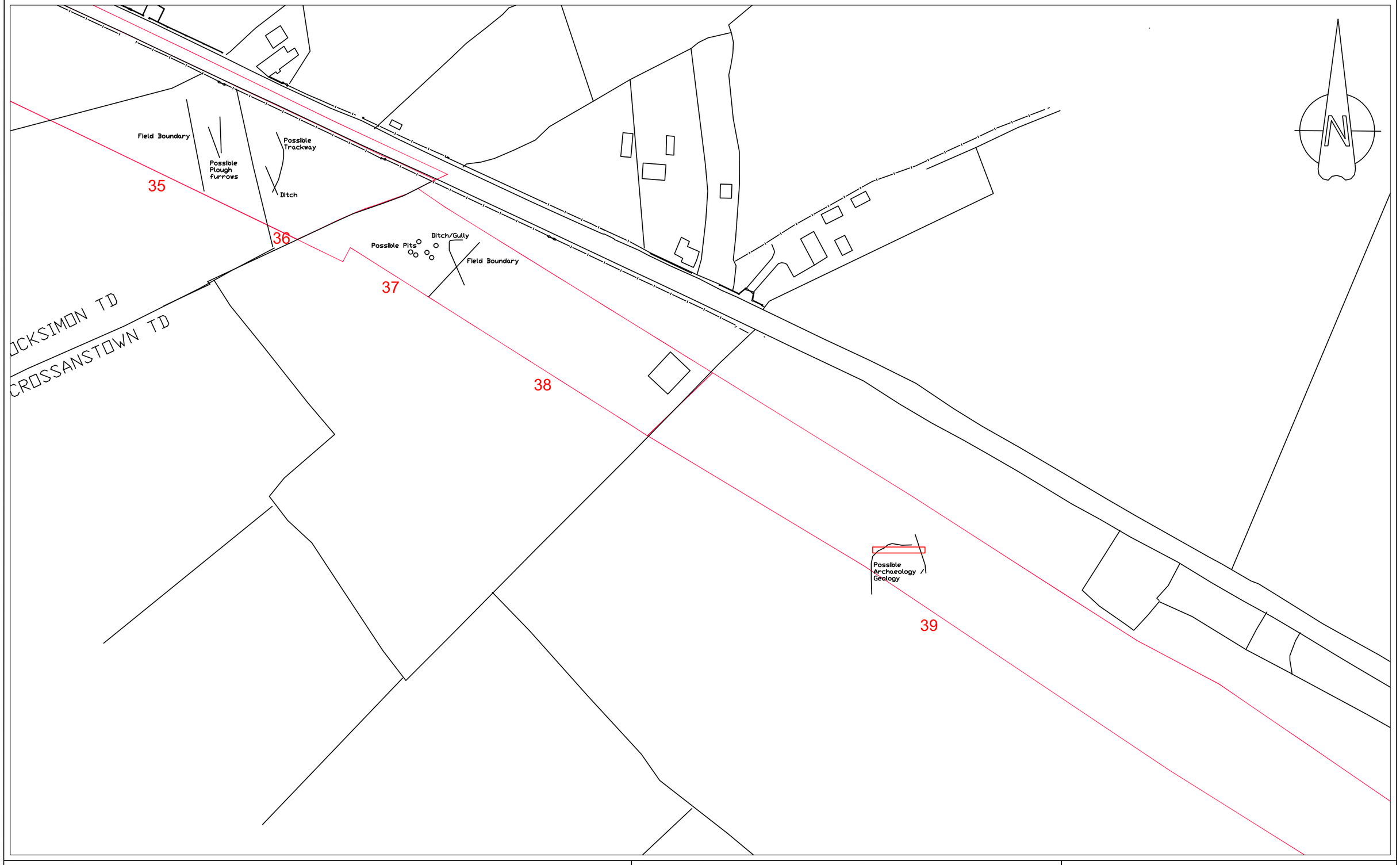
Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/32

0m 20m 40m

Figure No. 32 Fluxgate Gradiometer data
Field 37 - 38

EARTHSOUND archaeological geophysics



Legend

- CPO line
- Present Land Boundaries
- Archaeological Features
- Suggested Locations of Trial Trenches

Site Location: N4 McNeads Bridge, County Westmeath.

Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/33

0m 100m 200m

Figure No. 33 Archaeological Map Fields 36 - 38

EARTHSOUND archaeological geophysics

38

39

40

41

42

N

Legend

CPO line

Hedgerows

Survey Stations

K

-10 0 x10 -5 14 20

Site Location: N4 McNeads Bridge, County Westmeath.

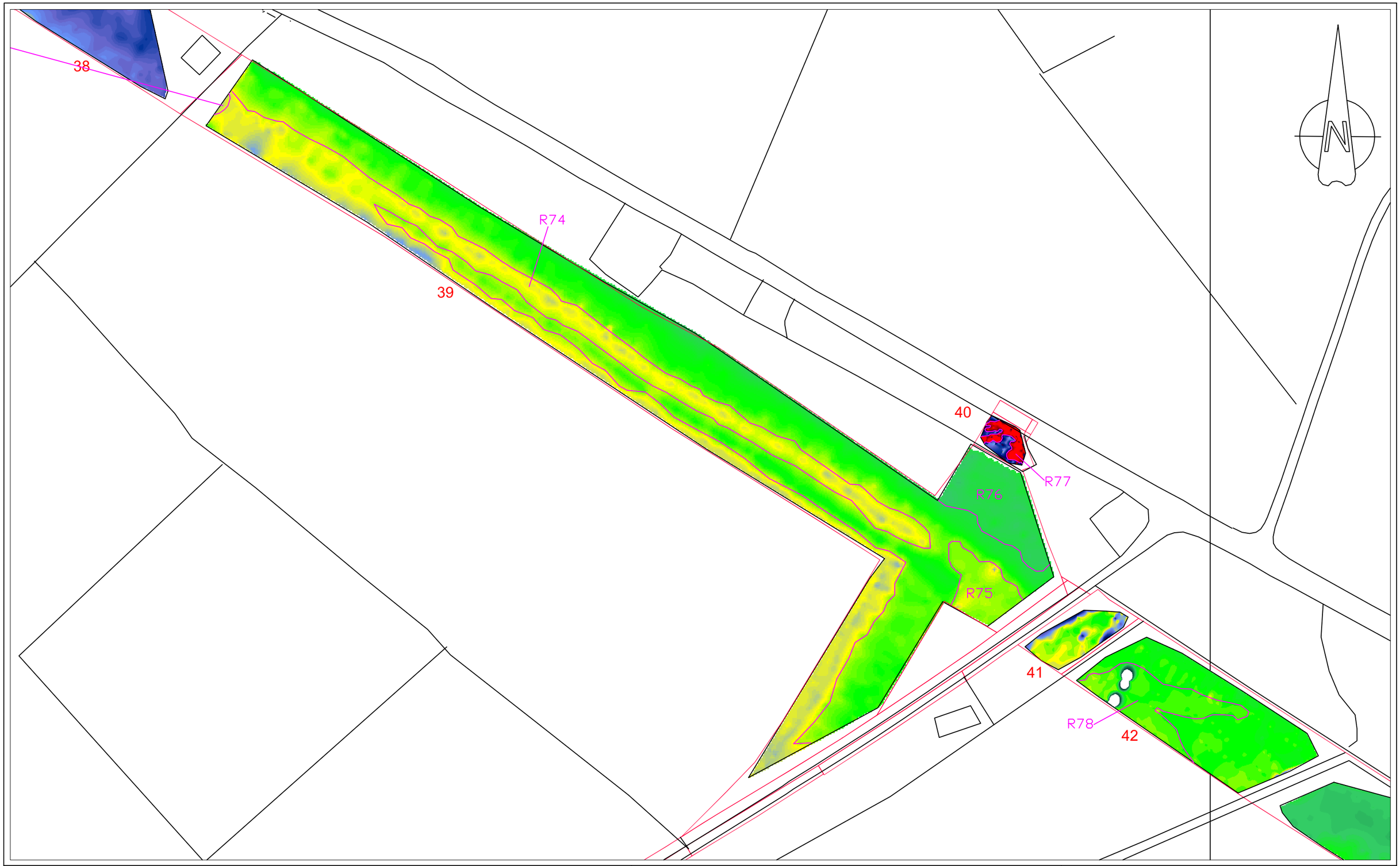
Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/34

0m 100m 200m

FIGURE No. 34 Magnetic Susceptibility Data for Fields 39 - 40

EARTHSOUND archaeological geophysics



Legend

CPO line

Hedgerows

Magnetic Susceptibility Anomalies

K

-10 0 10 x10⁻⁵ 20 40

Site Location: N4 McNeads Bridge, County Westmeath.

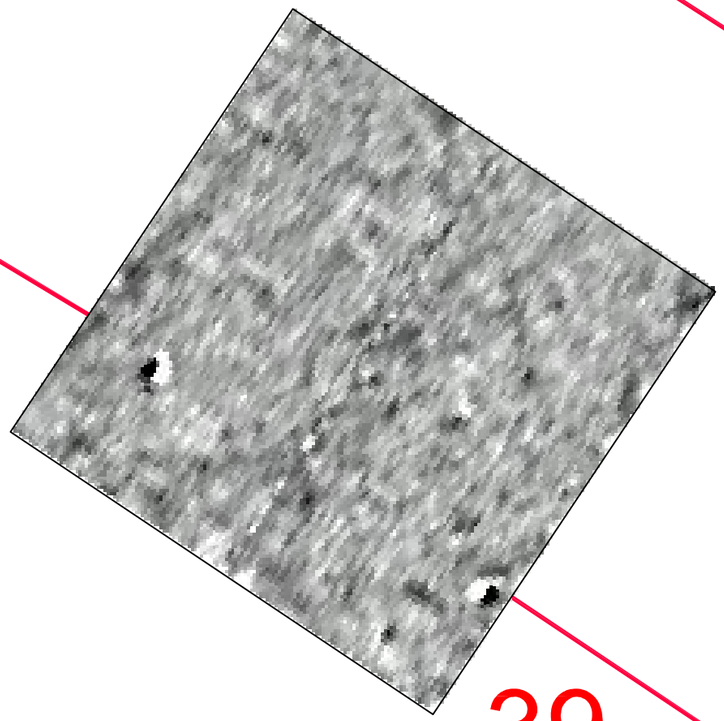
Client: Westmeath County Council.

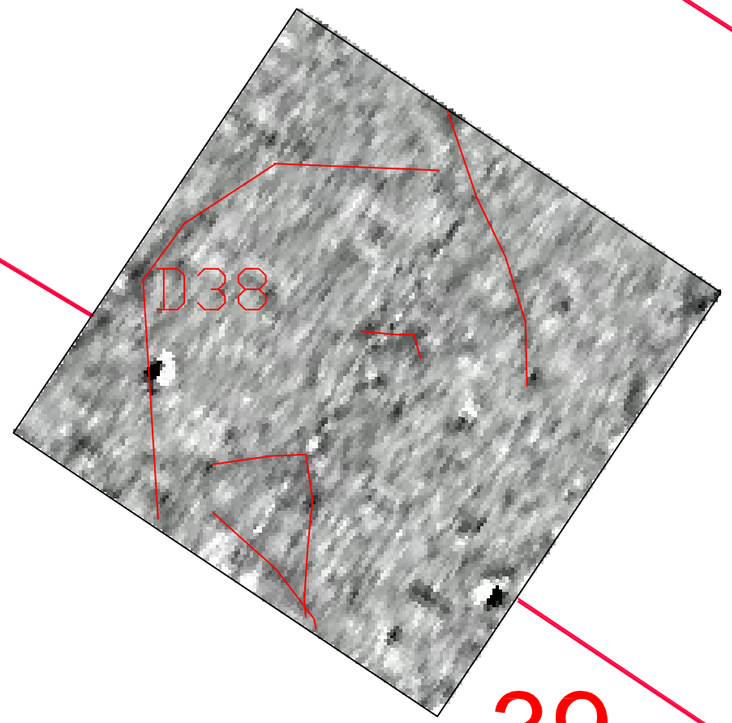
Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/35

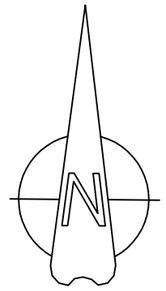
0m 100m 200m

Figure No. 35 Magnetic Susceptibility Interpretation Fields 39 - 40

EARTHSOUND archaeological geophysics







39

39

Legend

- CPO line
- Present Land Boundaries
- Discrete Negative Anomalies
- Discrete Positive Anomlies
- Magnetic Dipoles

nT

-1 0 2

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Site Location: N4 McNeads Bridge, County Westmeath.

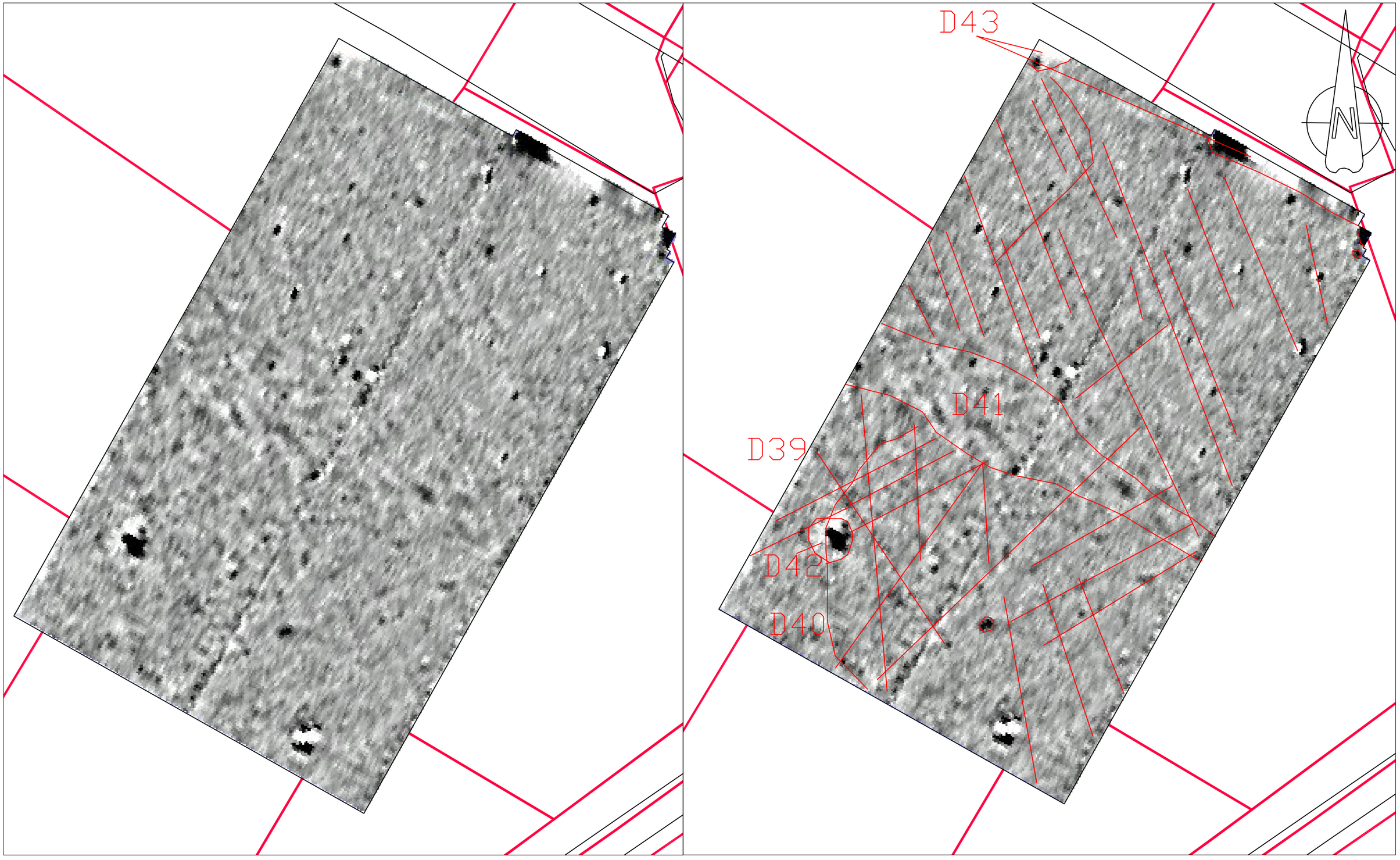
Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/36

0m 20m 40m

Figure No. 36 Fluxgate Gradiometer data
Field 39a

EARTHSOUND archaeological geophysics



Legend

- CPO line
- Present Land Boundaries
- Discrete Negative Anomalies
- Discrete Positive Anomlies
- Magnetic Dipoles

nT

-1 0 2

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Site Location: N4 McNeads Bridge, County Westmeath.

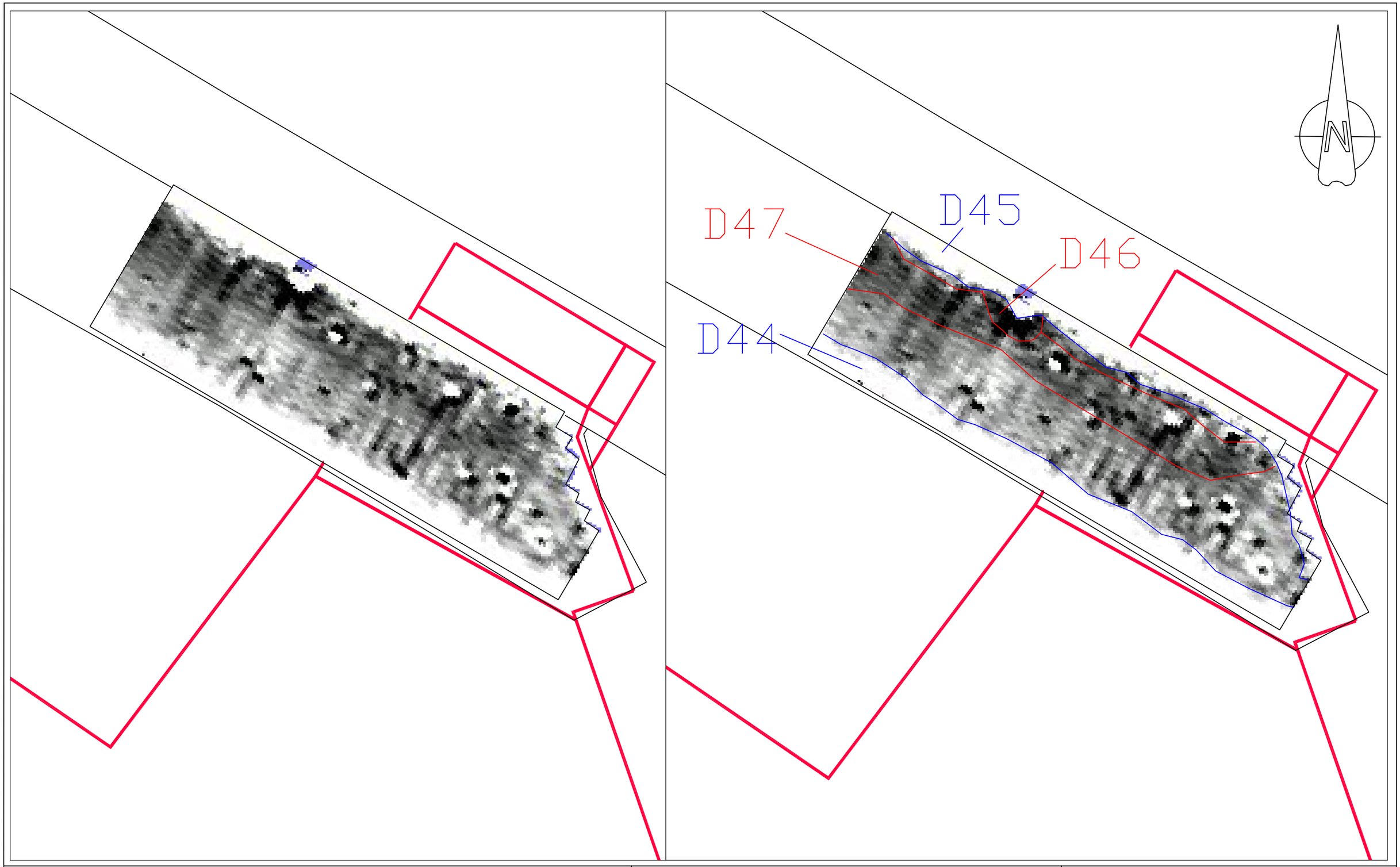
Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/37

0m 30m 60m

Figure No. 37 Fluxgate Gradiometer data
Field 39b

EARTHSOUND archaeological geophysics



Legend

- CPO line
- Present Land Boundaries
- Discrete Negative Anomalies
- Discrete Positive Anomlies
- Magnetic Dipoles

nT

-3 0 3

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Site Location: N4 McNeads Bridge, County Westmeath.

Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/38

0m 20m 40m

Figure No. 38 Fluxgate Gradiometer data Field 40

EARTHSOUND archaeological geophysics

38

39

40

41

42

Possible Archaeology / Geology

Trackway

Roadside Ditch

Plough furrows

Plough furrows

Ploughed out Field Boundary

Plough furrows

Large Pit

?Ditch

Plough furrows

Enhancement

N

Legend

- CPO line
- Present Land Boundaries
- Archaeological Features
- Suggested Locations of Trial Trenches

Site Location: N4 McNeads Bridge, County Westmeath.

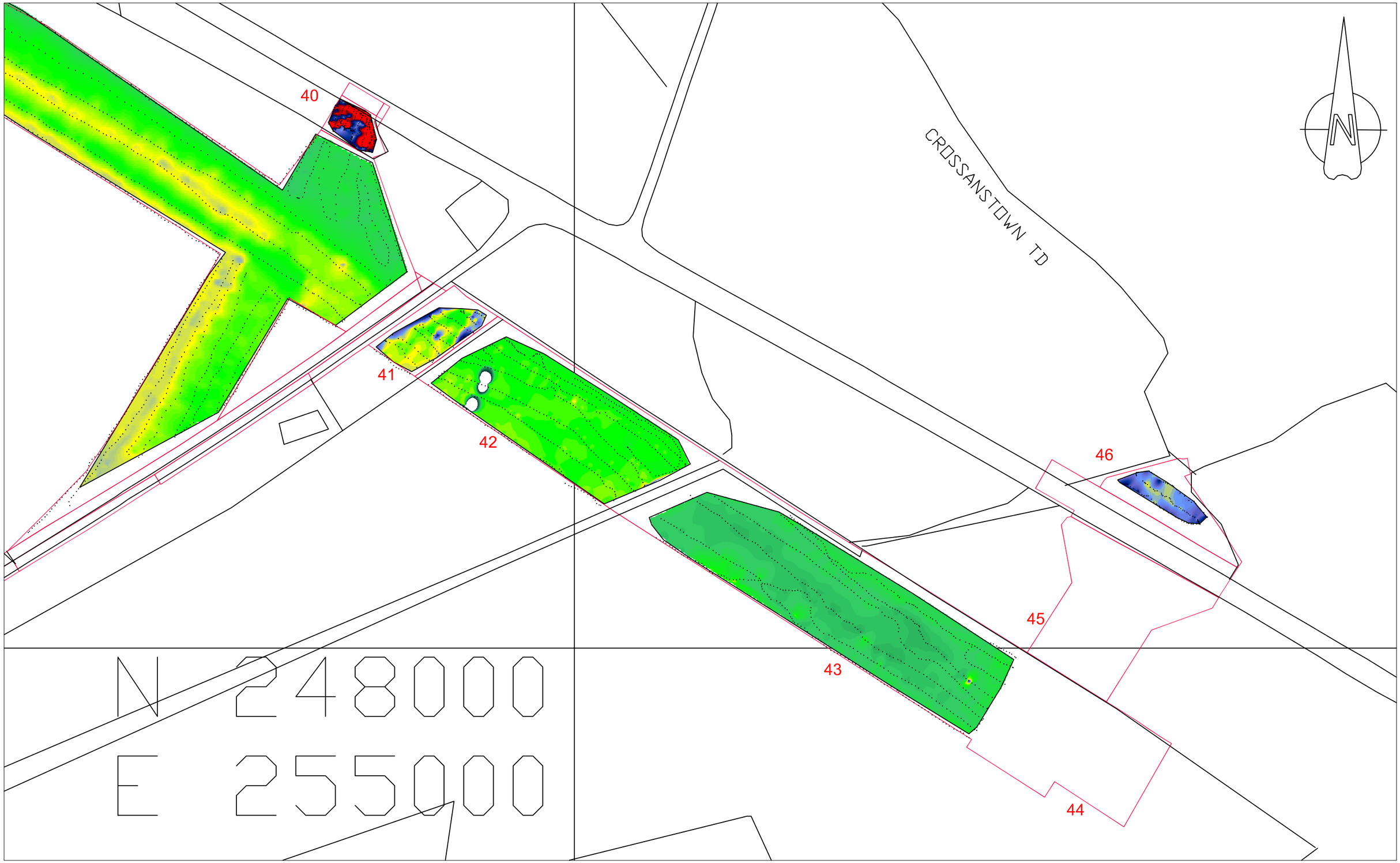
Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/39

0m 100m 200m

Figure No. 39 Archaeological Map Fields 39 - 40

EARTHSOUND archaeological geophysics



Legend

- CPO line
- Hedgerows
- Survey Stations

K

-10 0 x10 -5 14 20

Site Location: N4 McNeads Bridge, County Westmeath.

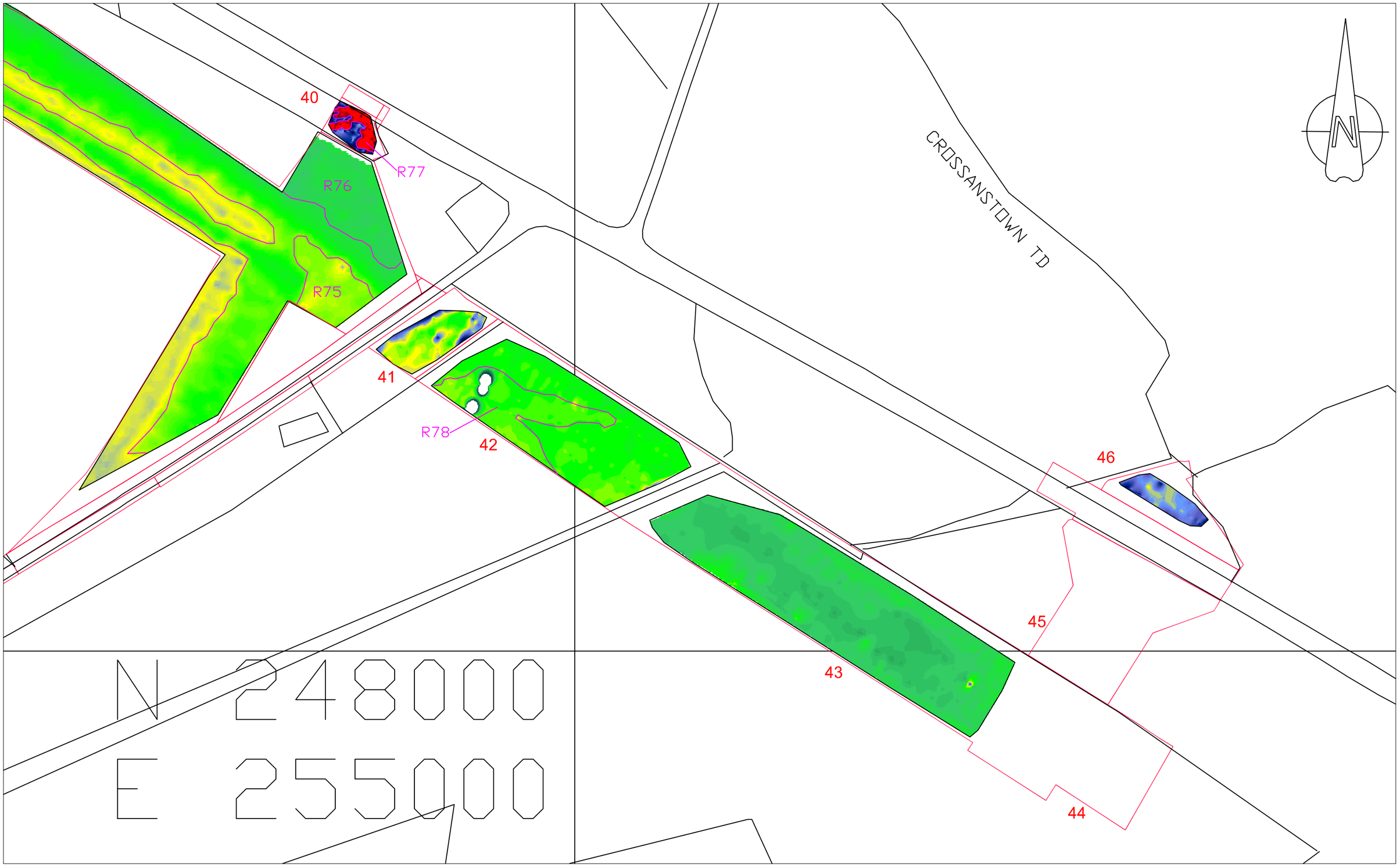
Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/40

0m 100m 200m

FIGURE No. 40 Magnetic Susceptibility Data for Fields 41 - 46

EARTHSOUND archaeological geophysics



Legend

CPO line

Hedgerows

Magnetic Susceptibility Anomalies

K

-10 0 10 x10-5 20 40

Site Location: N4 McNeads Bridge, County Westmeath.

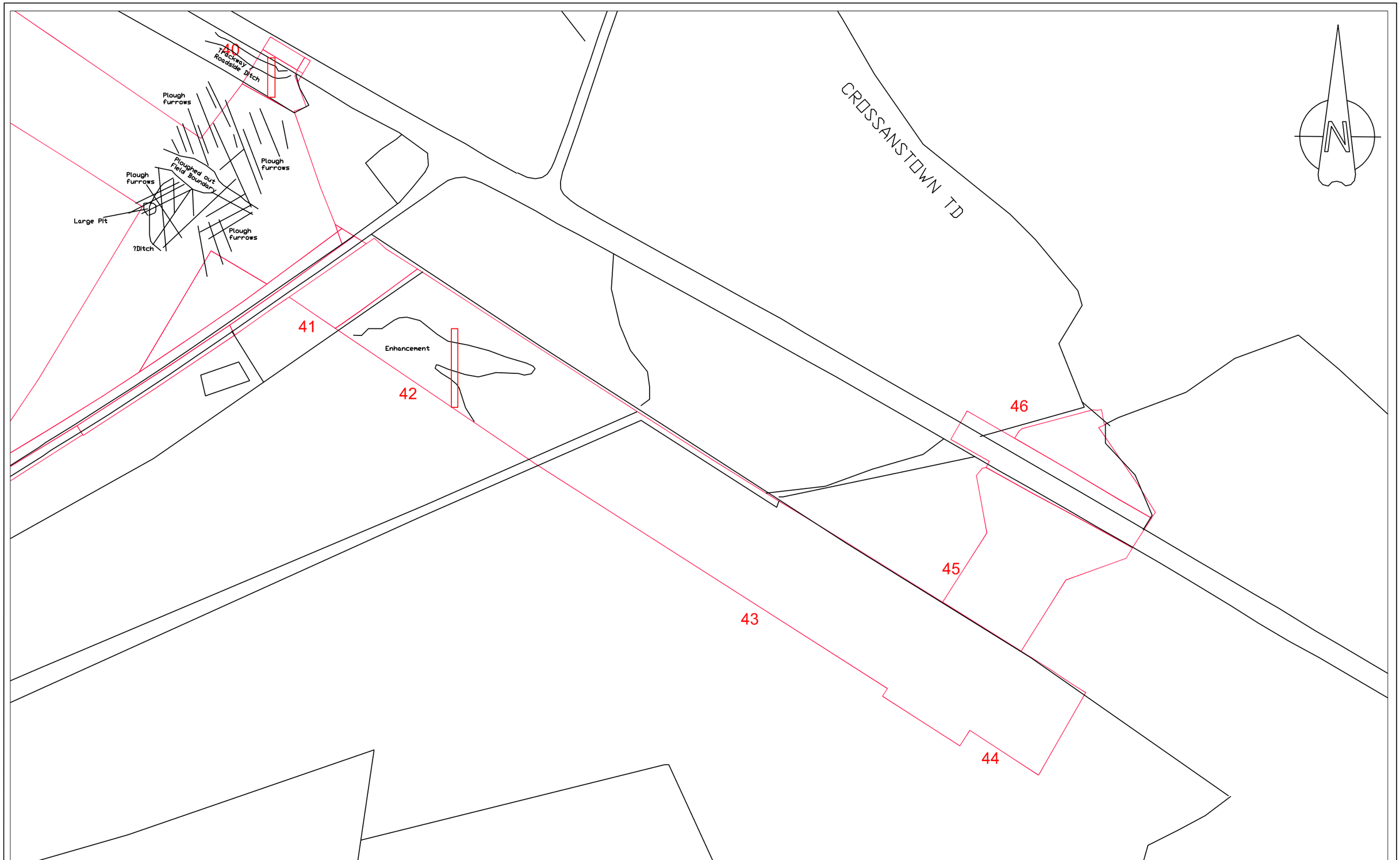
Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/41

0m 100m 200m

Figure No. 41 Magnetic Susceptibility Interpretation Fields 41 - 46

EARTHSOUND archaeological geophysics



Legend

- CPO line
- Present Land Boundaries
- Archaeological Features
- Suggested Locations of Trial Trenches

Site Location: N4 McNeads Bridge, County Westmeath.

Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/42

0m 100m 200m

Figure No. 42 Archaeological Map
Fields 41 - 46

EARTHSOUND archaeological geophysics

Figure 43: Sinusoidal wave variation of MS data over a fixed point
Samples taken 1 per second, MS2 not zeroed between samples.
Fixed points varied in location for each date

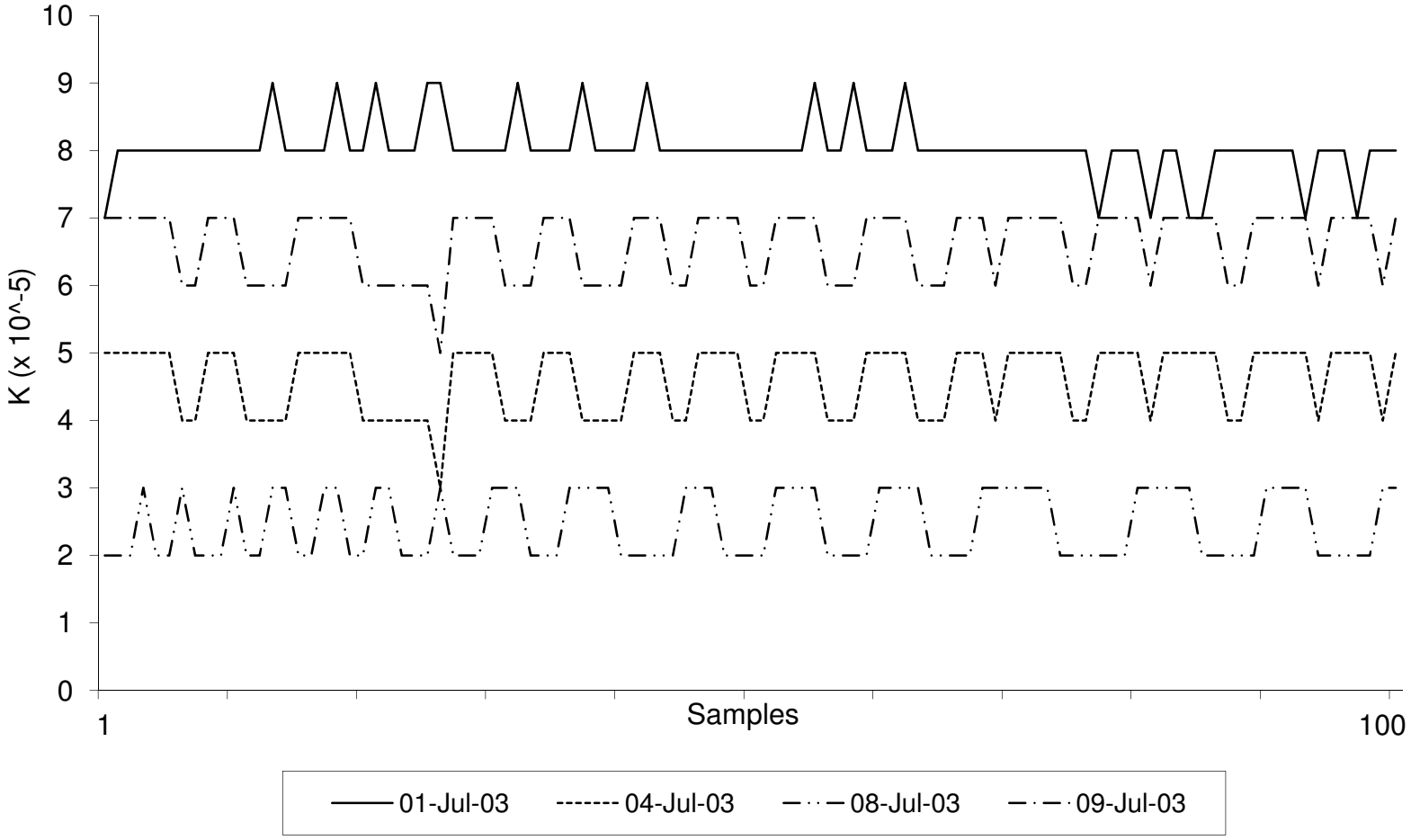
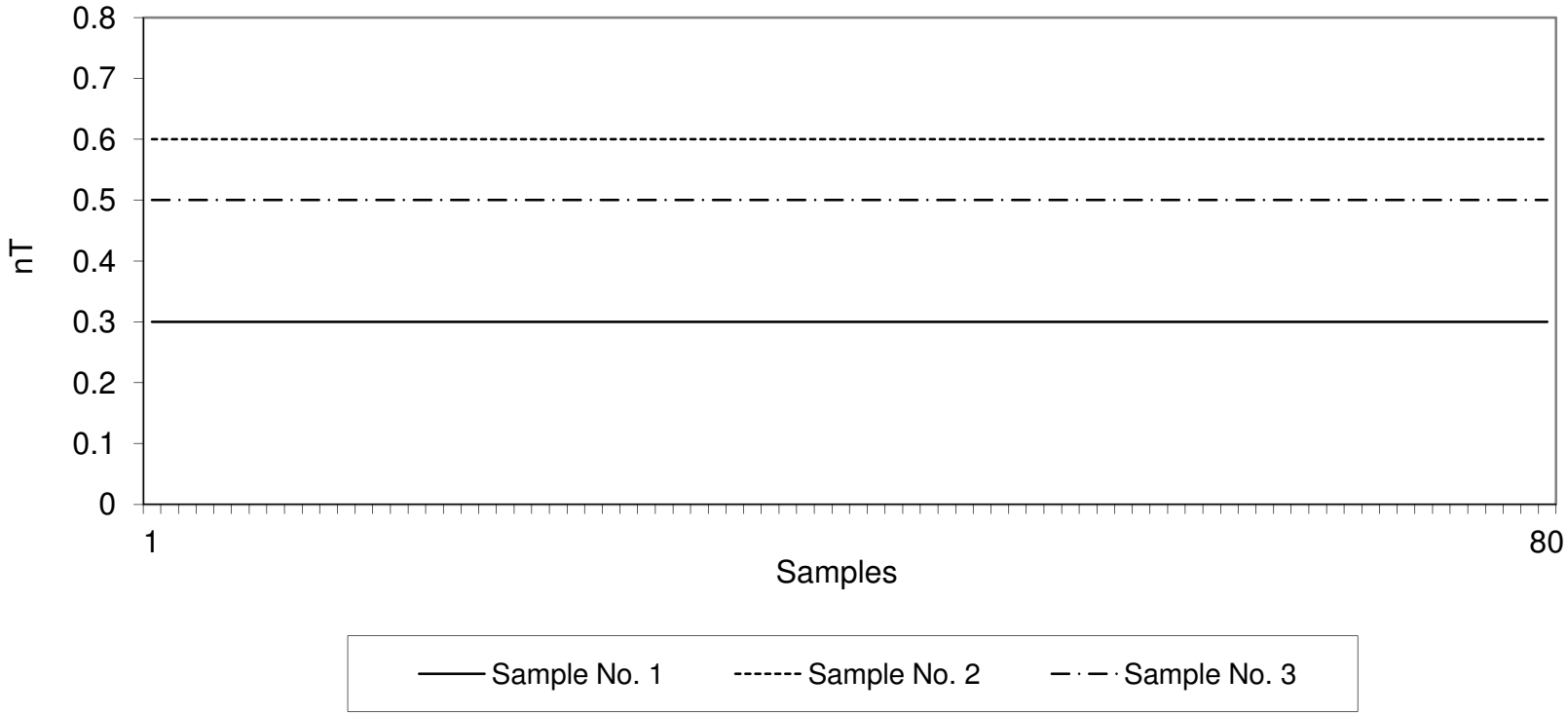


Figure 44: Fluxgate Gradiometer Samples
80 samples = 1 line of data along a 20m traverse @ 4/m
Each sample taken at a fixed point at three different sites,
using an ST1 Sample Trigger.
No internal dirft visible at 0.1nT resolution



Legend

- CPO line
- Hedgerows
- Contour Lines
- Survey Stations

Site Location: N4 McNeads Bridge, County Westmeath.

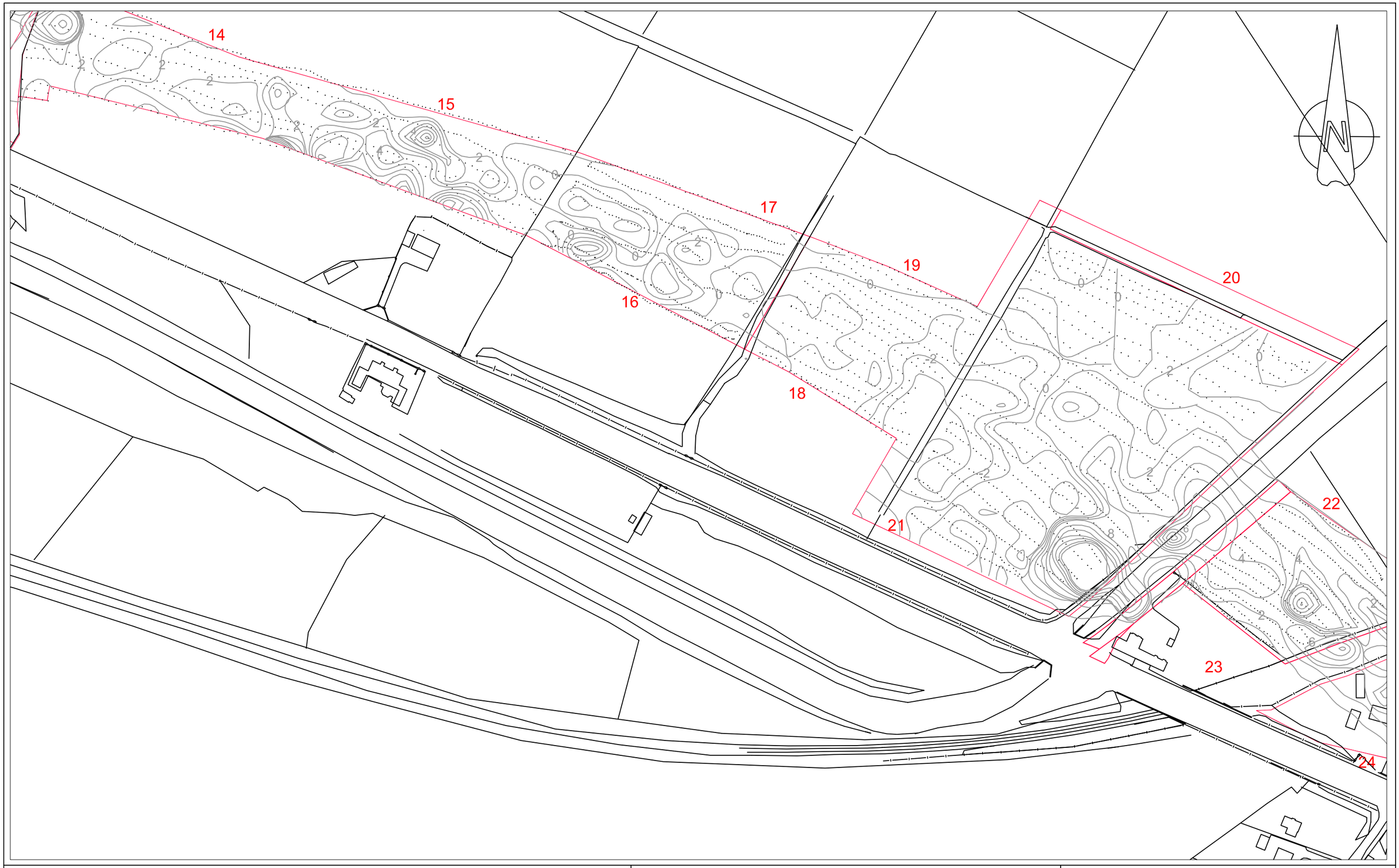
Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/45

0m 100m 200m

FIGURE No. 45 Pre-processed Magnetic Susceptibility Contour Plots for Fields 1 - 12

EARTHSOUND archaeological geophysics



Legend

- CPO line
- Hedgerows
- Contour Lines
- Survey Stations

Site Location: N4 McNeads Bridge, County Westmeath.

Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/46

0m 100m 200m

FIGURE No. 46 Pre-processed Magnetic Susceptibility Contour Plots for Fields 13 - 23

EARTHSOUND archaeological geophysics

22
23
24
25
26
26A
27
28
30

Legend

- CPO line
- Hedgerows
- Contour Lines
- Survey Stations

Site Location: N4 McNeads Bridge, County Westmeath.

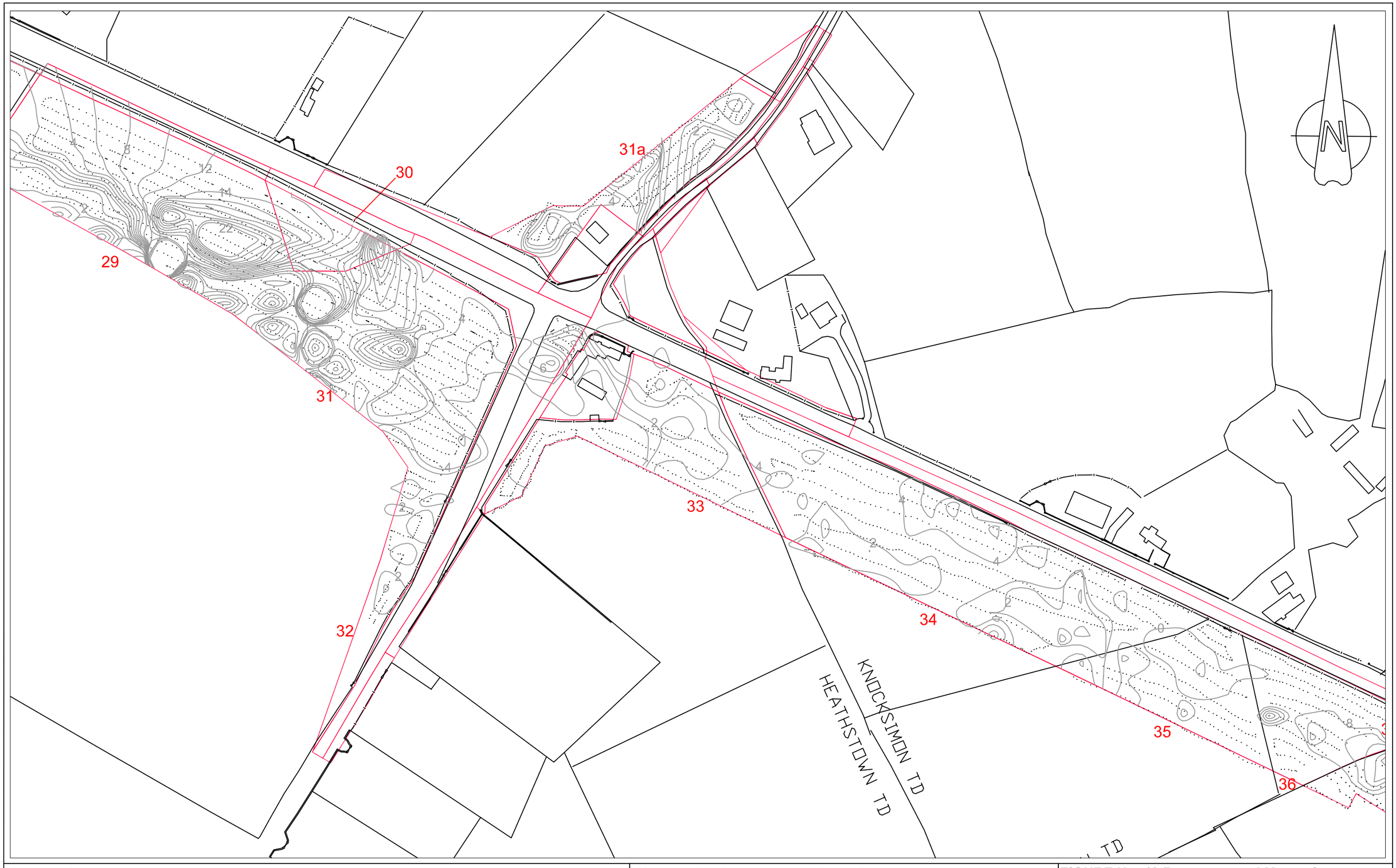
Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/47

0m 100m 200m

FIGURE No. 47 Pre-processed Magnetic Susceptibility Contour Plots for Fields 22 - 28

EARTHSOUND archaeological geophysics



Legend

- CPO line
- Hedgerows
- Contour Lines
- Survey Stations

Site Location: N4 McNeads Bridge, County Westmeath.

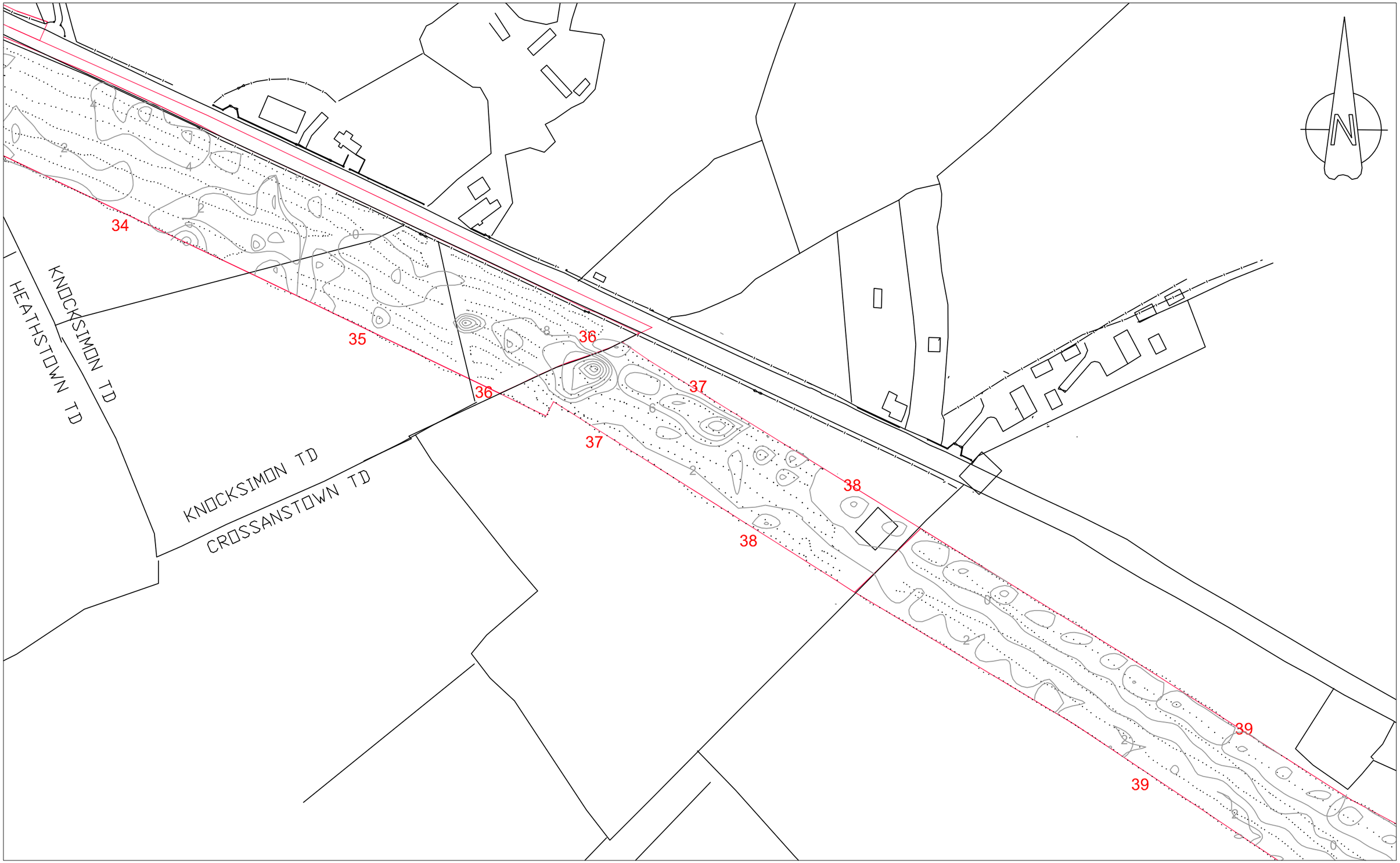
Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/48

0m 100m 200m

FIGURE No. 48 Pre-processed Magnetic Susceptibility Contour Plots for Fields 29 - 35

EARTHSOUND archaeological geophysics



Legend

- CPO line
- Hedgerows
- Contour Lines
- Survey Stations

Site Location: N4 McNeads Bridge, County Westmeath.

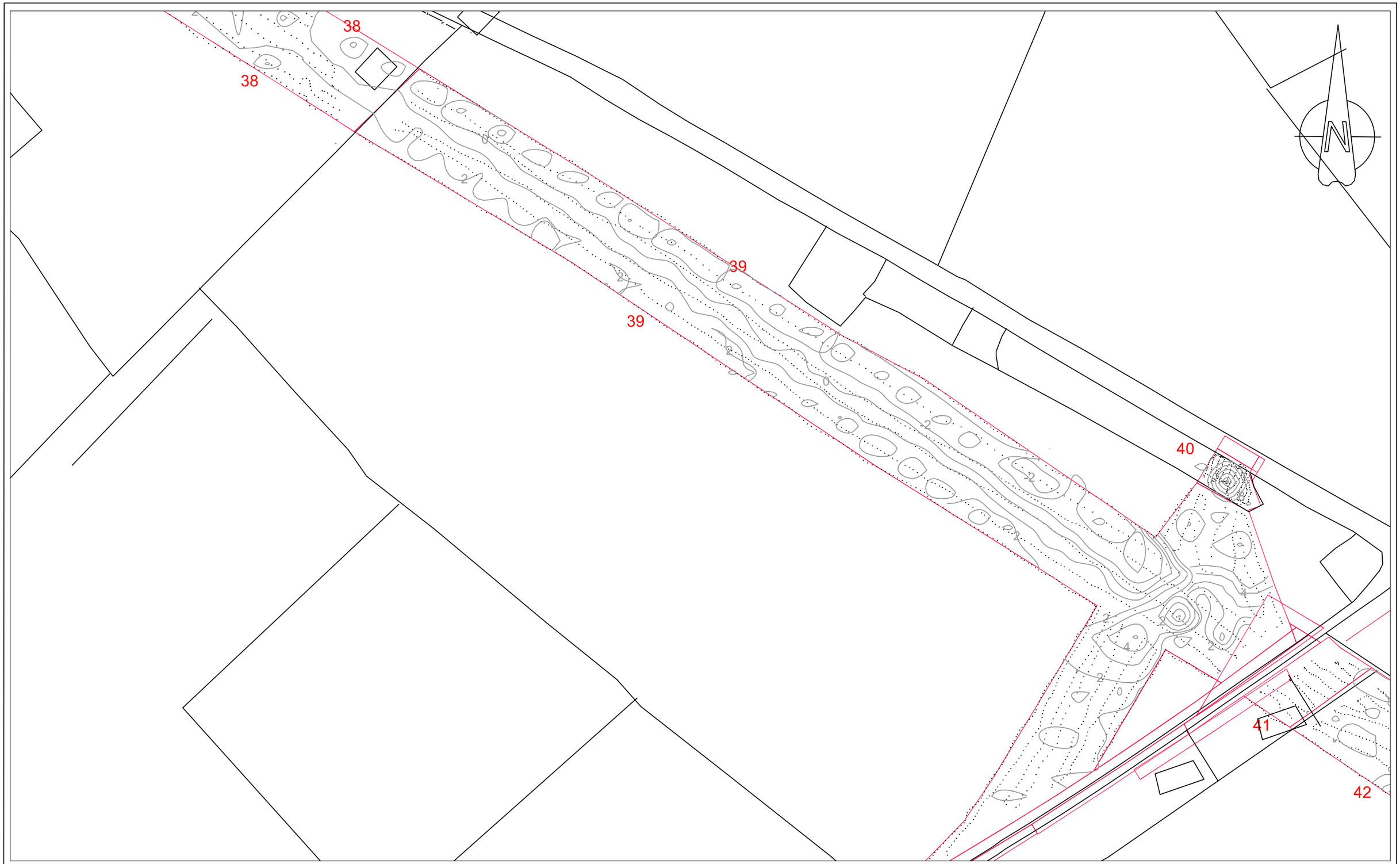
Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/49

0m 100m 200m

FIGURE No. 49 Pre-processed Magnetic Susceptibility Contour Plots for Fields 36 - 38

EARTHSOUND archaeological geophysics



Legend

- CPO line
- Hedgerows
- Contour Lines
- Survey Stations

Site Location: N4 McNeads Bridge, County Westmeath.

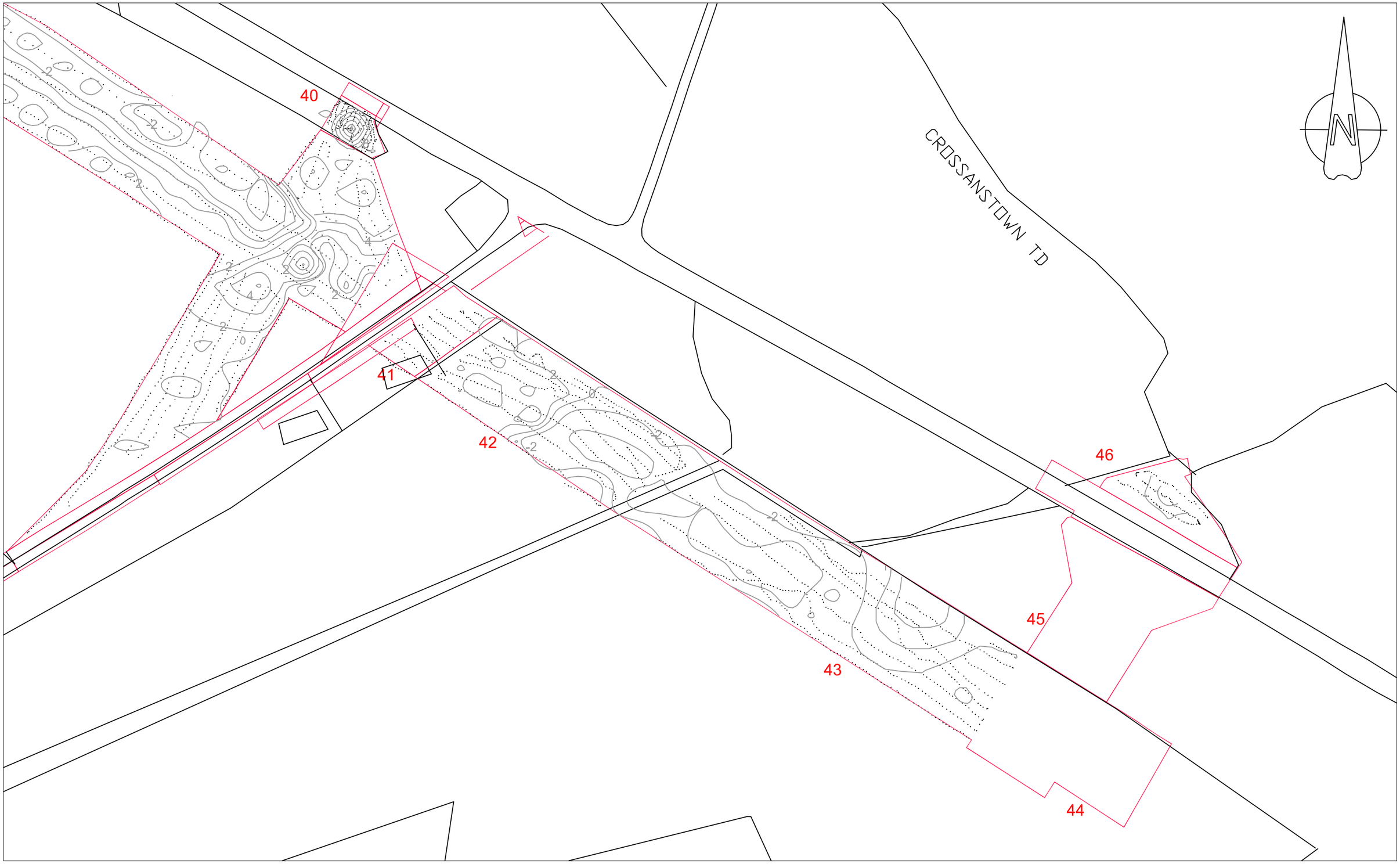
Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/50

0m 100m 200m

FIGURE No. 50 Pre-processed Magnetic Susceptibility Contour Plots for Fields 39 - 40

EARTHSOUND archaeological geophysics



Legend

- CPO line
- Hedgerows
- Contour Lines
- Survey Stations

Site Location: N4 McNeads Bridge, County Westmeath.

Client: Westmeath County Council.

Drawing Courtesy of: Westmeath RDO	Date 21/10/03	Drawing No.: 03-32/51

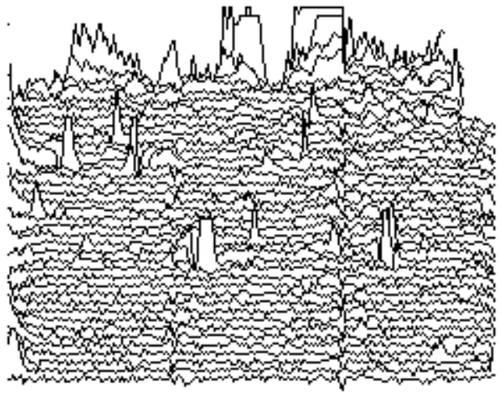
0m 100m 200m

FIGURE No. 51 Pre-processed Magnetic Susceptibility Contour Plots for Fields 41 - 46

EARTHSOUND archaeological geophysics

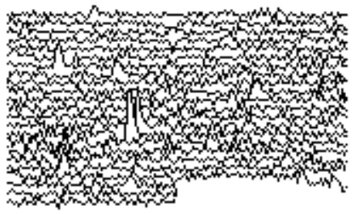
N4 McNeads Bridge, County Westmeath

Figure 52: Pre-processed Fluxgate Gradiometer XY Traceplots

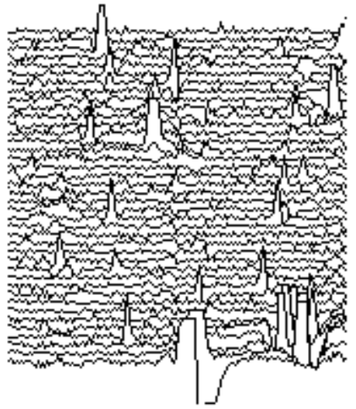


Field 1

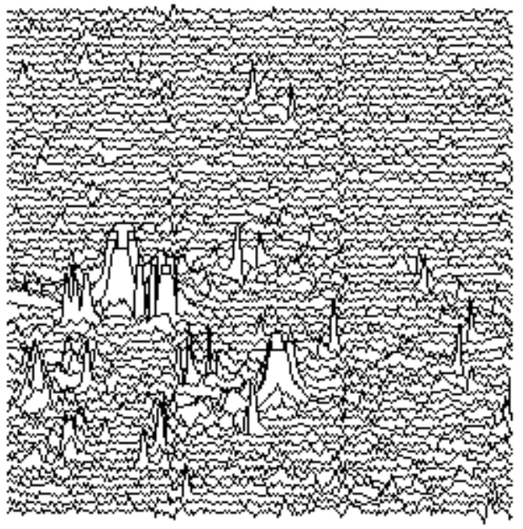
Field 2



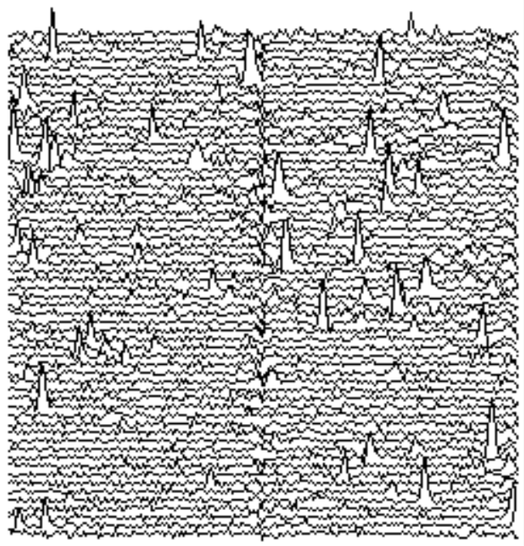
Field 6



Field 18 –19



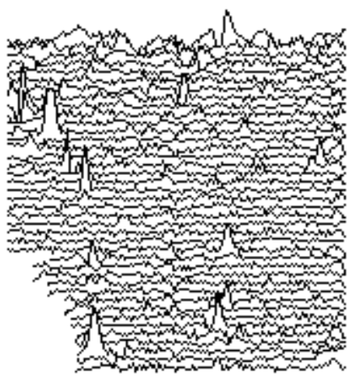
Field 20 - 21



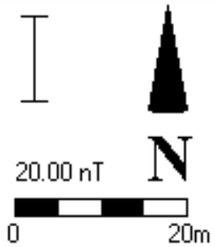
Field 25

Field 25

Field 31a



Field 35



Resolution 0.5nT,
Data Clipped to ± 10nT

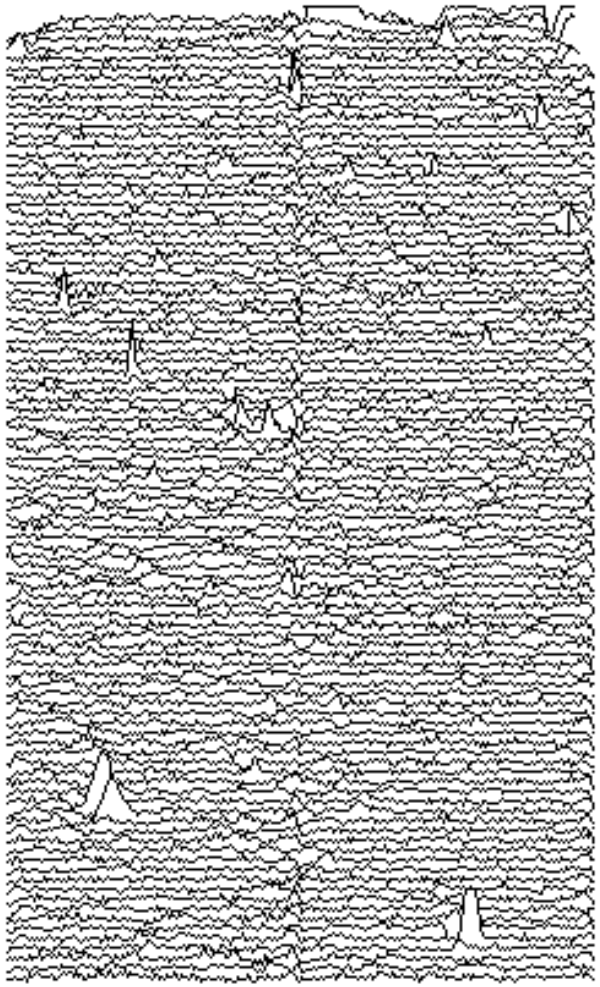
1m x 0.5m Sample Interval

EARTHSOUND archaeological geophysics

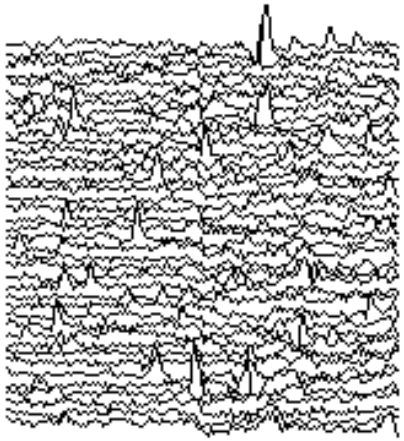
Drawing No.:03_39a/52

N4 McNeads Bridge, County Westmeath

Figure 53: Pre-processed Fluxgate Gradiometer XY Traceplots

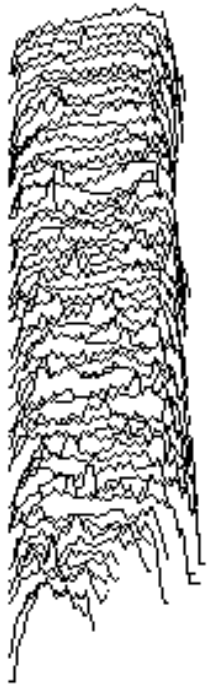


Site 39a

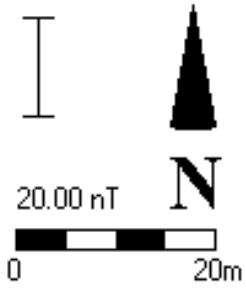


Site 37 - 38

Site 39b



Site 40



Resolution 0.5nT,
Data Clipped to ± 10nT

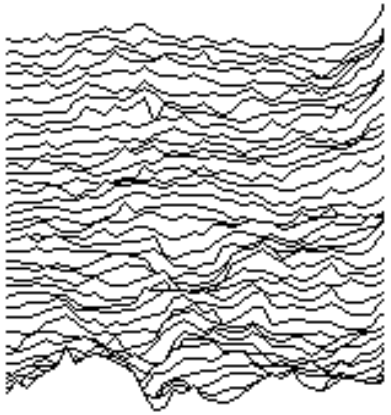
1m x 0.5m Sample Interval

EARTHSOUND archaeological geophysics

Drawing No.: 03_39a/53

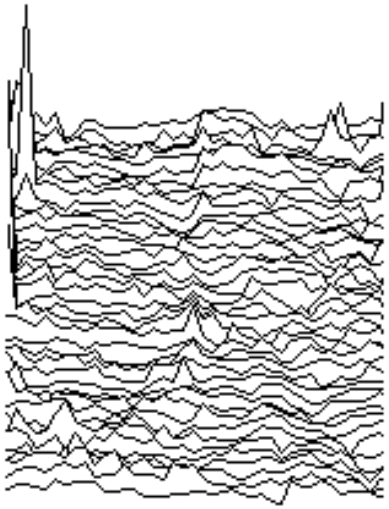
N4 McNeads Bridge, County Westmeath

Figure 54: Pre-processed Earth Resistance XY Traceplots



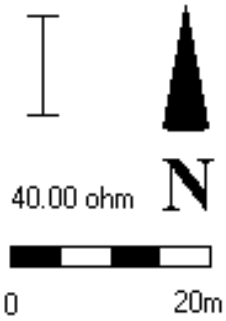
Site 1

Resolution 1 Ohm



Site 35

Resolution 2 Ohm



40m x 40m at 1m x 1m

EARTHSOUND archaeological geophysics

Drawing No.: 03_39a/54