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Land Adjacent to M1 Junction 24 Kegworth, Leicestershire

Detailed Gradiometer Survey Report



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geoservices



Land Adjacent to M1 Junction 24 Kegworth, Leicestershire

Detailed Gradiometer Survey Report

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Summary

Wessex Archaeology was commissioned by CgMs Consulting to undertake a detailed gradiometer survey of land adjacent to Junction 24 of the M1, Kegworth, over the area of a proposed development (centred on NGR 447850 327350). The aim of the work was to establish the presence, or otherwise, and nature of detectable archaeological features on the site as part of a programme of archaeological works, ahead of a proposed housing development.

The survey was undertaken between the 4th and 7th February 2014 and the site is located approximately 10km northwest of Loughborough and 15km southeast of the centre of Derby; on the northwest edge of Kegworth. The site comprises an area of arable agricultural land located directly to the east of the M1.

Detailed gradiometer survey was undertaken over all accessible parts of the site, a total of 21.3ha, and has demonstrated the presence of anomalies of likely, probable and possible archaeological interest in addition to two modern services.

The archaeology detected includes isolated ditch sections and several pit-like anomalies but nothing that suggests concentrated settlement activity. The majority of the features detected relates to agricultural activity. No archaeology detected in the neighbouring East Midlands Gateway project (Wessex Archaeology 2014b) area appears to extend into this area.

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Acknowledgements

The detailed gradiometer survey was commissioned by CgMs Consulting. The assistance of Sally Dicks is gratefully acknowledged in this regard.

The fieldwork was carried out by Philip Roberts, Michael Keech, Matthew Weightman, Jonathan Buttery and Laurence Savage. The geophysical data was processed and interpreted by Ross Lefort. This report was written by Ross Lefort and Ashley Tuck. The geophysical work was quality controlled by Dr. Paul Baggaley and Ben Urmston. Illustrations were prepared by Ross Lefort and Robert Goller. The project was managed on behalf of Wessex Archaeology by Andrew Norton.



Detailed Gradiometer Survey Report

1 INTRODUCTION

1.1 Project Background

- 1.1.1 Wessex Archaeology was commissioned by CgMs Consulting to carry out a programme of geophysical survey over land Adjacent to the M1 on the northwest side of Kegworth, Leicestershire (centred on NGR 447850 327350; **Figure 1**), hereafter "the Site".
- 1.1.2 The scheme comprised the redevelopment of land for a proposed housing development over an area of 36ha. Excluding areas already surveyed as part of previous works the total surveyable area was *c*.21.3ha. The western part of the Site was surveyed as part of the East Midlands Gateway Project (Wessex Archaeology 2014b) and the eastern area evaluated during the A453 widening (Wessex Archaeology 2012). No significant features were revealed in the east of the Site and the geophysical survey only identified agricultural features in the west of the Site. However, the proposed Site lies within an area of archaeological significance, and a programme of geophysical survey was proposed in order to evaluate the archaeological potential of the Site.
- 1.1.3 An archaeological Desk-Based Assessment (DBA) was carried out by CgMs Consulting (2013) for the East Midlands Gateway project and will be referred to in relation to the interpretation of certain geophysical anomalies.
- 1.1.4 A Written Scheme of Investigation (WSI) was prepared by Wessex Archaeology (2014a) that set out the following aims for the gradiometer survey:
 - Conduct a detailed gradiometer survey that covers as much of the specified area as possible, allowing for artificial obstructions.
 - Clarify the presence/absence and extent of any buried archaeological remains within the Site.
 - Clarify the general nature of the remains present.
 - Produce a report which will present the results of the geophysical survey in sufficient detail, to support an informed decision to be made concerning the Site's archaeological potential.
- 1.1.5 This report presents a brief description of the methodology followed, the detailed survey results and the archaeological interpretation of the geophysical data.

1.2 Site Location and Topography

1.2.1 The Site is located approximately 10km northwest of the centre of Loughborough and 15km southeast of the centre of Derby. The Site comprises three arable fields located to the east of Junction 24 of the M1 (**Figure 1**). The Site lies on the northwest edge of Kegworth with the village of Lockington located further to the northwest.



1.2.2 The land is roughly level lying at *c*. 35m aOD. The Site is located at the point where an area of higher ground slopes down towards the flood plain of the River Trent located further north; the River Soar is closest to the Site and is located running past the eastern side of Kegworth. The Site is defined by field boundaries to the east, north and south but is defined by the the limits of the previous geophysical survey carried out for the East Midlands Gateway project to the west.

1.3 Soils and Geology

- 1.3.1 The Site is spanned by three east to west aligned bands of solid geology with Bromsgrove sandstone formation across the southern edge, Edwalton member mudstone across the centre and Arden sandstone formation across the northern edge (BGS).
- 1.3.2 The superficial geologies recorded all date to the Quaternary period. The southern edge of the Site has no superficial deposits recorded and the areas further north are made up of a mix of Hemington member silt and gravel, Wanlip member sand and gravel, head deposits, Egginton Common sand and gravel member and Syston member sand and gravel (BGS).
- 1.3.3 The soils recorded are a mix of typical brown alluvial soils of the 561a (Wharfe) association, stagnogleyic argillic brown earths of the 572c (Hodnet) association and typical brown earths of the 541r (Wick 1) association (SSEW 1983).

1.4 Archaeological & Historic Background

1.4.1 The following information is summarized from the Heritage Gateway website (<u>www.heritagegateway.org.uk</u>). A search was performed for all heritage assets within 1km of the Site.

1.5 Prehistoric and Roman

- 1.5.1 A pair of parallel gullies discovered in 2008 at Lockington Quarry may be Neolithic or early Bronze Age, although the 1886 OS map shows a field boundary in this location.
- 1.5.2 A prehistoric flint core was identified by the museums service in 1990. It was found at NGR 4467 3273, to the northeast of M1 junction 24. Fieldwalking in the same field in spring 2000 recovered a light scattering of late Neolithic or early Bronze Age flint.
- 1.5.3 A possible Bronze Age barrow was identified from an aerial photo of 2006 in Lockington Park at NGR 4470 3283. This may be an outlier of a cemetery further north that lies over 1km from the present Site.
- 1.5.4 Geophysical survey in 2007 associated with the "Fulcrum" development identified a series of possible prehistoric and undated ditches, pit alignments and other features at several sites within 1km of the present Site.
- 1.5.5 A possible rectilinear enclosure, perhaps dating from the Iron Age, was identified by an archaeology evening class in 2004. This lies east of Lockington Hall and is cut by the A6.
- 1.5.6 A watching brief recovered a single sherd of Roman pottery, 11 sherds of medieval and 15 sherds of post-medieval pottery from northeast of Roughstones, Long Lane, Kegworth. An assemblage of Roman finds is reported to have been found to the south of the same farm.



1.6 Medieval

- 1.6.1 Kegworth is mentioned in the Domesday survey, and a market charter of 1290 survives. The oldest extant part of the Church of St. Andrew in Kegworth village in the 13th century base of the tower. 8-10 High Street, Kegworth are timber framed cruck buildings. Also in Kegworth village, 10 High Street and 7 Dragwell are reworked late medieval buildings of 15th-16th century origin.
- 1.6.2 Ridge and furrow ploughing is recorded from aerial photographs at SK4249 and at SK4245.
- 1.6.3 Ditches and postholes indicating a medieval burgage plot were excavated at 9 Market Place, Kegworth.

1.7 Post-medieval

- 1.7.1 Several listed buildings are recorded from the village of Kegworth, including Harrison House, The Old Rectory and its Stables and Coach House, The Great House on London Road, eleven further properties on the High Street, as well as two houses on Nottingham Road, two on Packington Hill, and one on Market Place. A milepost opposite the junction with Borough Street and a Lamp-Post near St. Andrews Church are also listed. Additional post-medieval properties in Kegworth are described on EH Pastscape.
- 1.7.2 A Second World War depot is visible on aerial photographs at NGR 447 328, although no evidence is visible on the ground. There is a Baptist chapel dating from 1815 on Kegworth High Street.
- 1.7.3 Tower Mill, Kegworth, was a former windmill at NGR 4477 3267 with a foundation stone dated 1790. A post mill of the supporting roundhouse type formerly existed at NGR 4484 3272.

1.8 Undated

1.8.1 A circular enclosure north of St. Andrew's Church, Kegworth, is visible on a map of 1779 and on aerial photographs.

1.9 Previous archaeological investigations

1.9.1 Several desk-based assessments have been undertaken nearby. A programme of geophysics and fieldwalking at the "Fulcrum" site by Leicestershire Archaeological Services in 2000 discovered prehistoric flint scatters and possible structures and settlement at NGR 44850 32650. Work was recently undertaken by Wessex Archaeology on the A453 widening project to the east of the Site (Wessex Archaeology 2012). Wessex Archaeology has recently completed a geophysical survey on the East Midland Gateway development west of the Site, which revealed pockets of evidence for Iron Age and/or Romano-British settlement.

2 METHODOLOGY

2.1 Introduction

2.1.1 The detailed magnetometer survey was conducted using Bartington Grad601-2 dual fluxgate gradiometer systems. The survey was conducted in accordance with English Heritage guidelines (2008).



2.1.2 The geophysical survey was undertaken by Wessex Archaeology's in-house geophysics team between the 4th and 7th February 2014. Field conditions at the time of the survey were good, with firm conditions under foot.

2.2 Method

- 2.2.1 Individual survey grid nodes were established at 30m x 30m intervals using a Leica Viva RTK GNSS instrument, which is precise to approximately 0.02m and therefore exceeds English Heritage recommendations (2008).
- 2.2.2 The magnetometer survey was conducted using a Bartington Grad601-2 fluxgate gradiometer instrument, which has a vertical separation of 1m between sensors. Data were collected at 0.25m intervals along transects spaced 1m apart with an effective sensitivity of 0.03nT, in accordance with EH guidelines (2008). Data were collected in the zigzag method.
- 2.2.3 Data from the survey was subject to minimal data correction processes. These comprise a zero mean traverse function (between ±5nT to ±10nT thresholds typically) applied to correct for any variation between the two Bartington sensors used, and a de-step function to account for variations in traverse position due to varying ground cover and topography. The deslope and multiply functions were used in certain instances to process out grid edge discontinuities and account for differences in sensor height between different operators. These four steps were applied to all survey areas, with no interpolation applied.
- 2.2.4 Further details of the geophysical and survey equipment, methods and processing are described in **Appendix 1**.

3 GEOPHYSICAL SURVEY RESULTS AND INTERPRETATION

3.1 Introduction

- 3.1.1 The gradiometer survey has been successful in identifying anomalies of likely, probable and possible archaeological interest across the Site, along with a number of modern services. Results are presented as a series of greyscale and XY plots, and archaeological interpretations, at a scale of 1:2000 (**Figures 2** to 7). The data are displayed at -2nT (white) to +3nT (black) for the greyscale image and ±25nT at 25nT per cm for the XY trace plots.
- 3.1.2 The interpretation of the datasets highlights the presence of potential archaeological anomalies, ferrous/burnt or fired objects, and magnetic trends (**Figure 4** and **7**). Full definitions of the interpretation terms used in this report are provided in **Appendix 2**.
- 3.1.3 Numerous ferrous anomalies are visible throughout the detailed survey dataset. These are presumed to be modern in provenance and are not referred to, unless considered relevant to the archaeological interpretation.

3.2 Gradiometer Survey Results and Interpretation

Southern field

3.2.1 The most interesting group of anomalies is located in the southern field at **4000** to **4002**, these include a pit-like anomaly and two ditch sections that possibly form an enclosure. The probable pit is located at **4000** and is sub-oval in shape measuring around 3.5m in length with magnetic values well over +5nT; this represents one of the clearest anomalies



identified and has been classed as archaeology. This pit is flanked by two clear northeastsouthwest aligned ditches at **4001** and **4002** with weaker ditches on a similar alignment visible in between. The strongest ditch sections have magnetic values around +2.5nT and the weakest sections measure around +1.5nT. It is not immediately apparent that these ditches form an enclosure and it is possible that they may have served an agricultural function. As a result of this uncertainty these ditch sections have been classed as probable archaeology and possible archaeology depending on their magnetic values.

- 3.2.2 There are two more ditch sections either side of a modern service in this field at **4003** and **4004**; both ditches have weak magnetic values around +1nT and both are aligned parallel to the northern field boundary. Given their alignment it is likely that they relate in some way to relatively recent agricultural activity and have therefore been classed as possible archaeology only.
- 3.2.3 There are two clearer pit-like anomalies located towards the western side of the field at **4005** and **4006**; they are both sub-oval in shape with magnetic values over +3nT and measure 3m and 2.5m in length respectively. These responses are clearly pit-like in form but have been classed as probable archaeology given their smaller size and weaker values compared to the pit at **4000**.
- 3.2.4 There are two much larger positive anomalies at **4007** and **4008**; they are elongated irregular shaped positive anomalies with values over +3nT and measure around 8m and 9.5m in length respectively. These anomalies could represent very large pits but their irregular form suggests that a geological explanation is more likely. They have both been classed as possible archaeology to reflect the uncertainty over their interpretation.
- 3.2.5 Areas of broad parallel weak positive and negative trends are visible around **4009** and **4010**; these look similar to the responses expected from former ridge and furrow and may be of archaeological significance.
- 3.2.6 A former field boundary is visible at **4011** as a clear ditch and at **4012** as a faint trend visible running through a wide concentration of ferrous responses. This boundary is visible on early OS maps dating to 1955 and earlier and is shown as a simple boundary to its western side at **4011** and as a boundary and track to its eastern side at **4012**. The presence of a track on the eastern end may account for the large amount of ferrous material detected here.
- 3.2.7 The remaining anomalies detected in this field include spreads of increased magnetic response around **4013** that may relate to concentrations of metallic/ceramic debris, numerous weak linear and curvilinear trends such as around **4014** and small positive anomalies of possible archaeological significance. These anomalies may prove to be archaeological but there is not enough regular form or patterning in their spatial distribution to allow any further interpretation. A modern service also runs through this field at **4015** but this will be discussed in more detail below.

Northern field

3.2.8 There are few anomalies of archaeological interest located in the northern field with only two short ditch sections observed at **4016** and **4017**. These anomalies have magnetic values over +3nT at their strongest with weaker regions around +1.5nT. These ditches do not appear to form an enclosure and they are not quite parallel to one another, the weaker regions have been classed as possible archaeology and the stronger as probable archaeology.

- 3.2.9 More ridge and furrow has been observed towards the southern end of this field around **4018** and **4019** that may prove to be of some significance. Numerous weak linear and curvilinear trends are observed throughout the data such as at **4020** and **4021** and some of these may prove to be of archaeological significance.
- 3.2.10 Another former field boundary is visible as weak ditch sections at **4022** and concentrations of ferrous responses to the eastern end at **4023**. This field boundary is visible on early OS maps up to 1955 with others shown to extend south from this boundary; none of these radiating boundaries were detected in this survey.
- 3.2.11 There are several spreads of increased magnetic response in this field such as at **4024**, these are likely to represent spreads of modern debris.
- 3.2.12 The remaining anomalies detected in this field are numerous small positive anomalies classed as possible archaeology. The shape of these anomalies in the XY traces suggests they could represent small cut features such as small pits and postholes but it is also possible they could represent unusual ferrous spikes from deeply buried iron objects, or may be geological in origin. As they have no significant patterning in their spatial distribution it is not possible to further interpret these anomalies.
- 3.2.13 A modern service is visible running through this field at **4025** but this will be discussed in more detail below.

3.3 Gradiometer Survey Results and Interpretation: Modern Services

- 3.3.1 Two services are visible running through the data at **4015** and **4025**; the former possibly represents a pipe and the latter possibly represents a cable. Both services appear to follow on from services already identified in the East Midlands Gateway project area.
- 3.3.2 It is not clear from the geophysical data whether any of the services identified are in active use. It should also be noted that gradiometer survey may not detect all services present on Site. This report and accompanying illustrations should not be used as the sole source for service locations and appropriate equipment (e.g. CAT and Genny) should be used to confirm the location of buried services before any trenches are opened on Site.

4 CONCLUSION

4.1 Summary

- 4.1.1 The detailed gradiometer survey has been successful in detecting anomalies of likely, probable and possible archaeological interest within the Site, in addition to regions of increased magnetic response and several modern services.
- 4.1.2 There are several isolated anomalies of likely and probable archaeological interest scattered throughout the data. It is not clear what these features represent but it seems as though none of it constitutes concentrated settlement activity. There is a possibility that the ditches at **4001** and **4002** join to form an enclosure but it is equally possible that they relate to agricultural activity. No archaeological features identified in the East Midlands Gateway project area were shown to extend into this Site.
- 4.1.3 Remnants of medieval and post-medieval use of this land were detected in the form of ridge and furrow. The fields identified from the data as containing these features roughly correspond to the recorded locations of known ridge and furrow in the area (CgMs, 2013).





- 4.1.4 The majority of the anomalies detected relate to the use of the land for agricultural purposes with former field boundaries, modern ploughing trends and ditches thought to relate to recent agricultural activity detected.
- 4.1.5 The relative dimensions of the modern services identified by the gradiometer survey are indicative of the strength of their magnetic response, which is dependent upon the materials used in their construction and the backfill of the service trenches. The physical dimensions of the services indicated may therefore differ from their magnetic extents in plan; however, it is assumed that the centreline of services is coincident with the centreline of their anomalies. Similarly, it is difficult to estimate the depth of burial of the services through gradiometer survey.
- 4.1.6 It should be noted that small, weakly magnetised features may produce responses that are below the detection threshold of magnetometers. It may therefore be the case that more archaeological features may be encountered than have been identified through geophysical survey.

5 **REFERENCES**

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Wessex Archaeology, 2012: A453 Widening M1 Junction 24 to A52, Kegworth, Leicestershire, Site 29, unpublished client report ref. 86082.04.

5.2 Cartographic Sources

British Geological Survey http://www.bgs.ac.uk/discoveringgeology/geologyofbritain/viewer.html

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APPENDIX 1: SURVEY EQUIPMENT AND DATA PROCESSING

Survey Methods and Equipment

The magnetic data for this project was acquired using a Bartington 601-2 dual magnetic gradiometer system. This instrument has two sensor assemblies fixed horizontally 1m apart allowing two traverses to be recorded simultaneously. Each sensor contains two fluxgate magnetometers arranged vertically with a 1m separation, and measures the difference between the vertical components of the total magnetic field within each sensor array. This arrangement of magnetometers suppresses any diurnal or low frequency effects.

The gradiometers have an effective resolution of 0.03nT over a $\pm 100nT$ range, and measurements from each sensor are logged at intervals of 0.25m. All of the data are stored on an integrated data logger for subsequent post-processing and analysis.

Wessex Archaeology undertakes two types of magnetic surveys: scanning and detail. Both types depend upon the establishment of an accurate 20m or 30m Site grid, which is achieved using a Leica Viva RTK GNSS instrument and then extended using tapes. The Leica Viva system receives corrections from a network of reference stations operated by the Ordnance Survey and Leica Geosystems, allowing positions to be determined with a precision of 0.02m in real-time and therefore exceed the level of accuracy recommended by English Heritage (2008) for geophysical surveys.

Scanning surveys consist of recording data at 0.25m intervals along transects spaced 10m apart, acquiring a minimum of 80 data points per transect. Due to the relatively coarse transect interval, scanning surveys should only be expected to detect extended regions of archaeological anomalies, when there is a greater likelihood of distinguishing such responses from the background magnetic field.

The detailed surveys consist of 20m x 20m or 30m x 30m grids, and data are collected at 0.25m intervals along traverses spaced 1m apart. These strategies give 1600 or 3600 measurements per 20m or 30m grid respectively, and are the recommended methodologies for archaeological surveys of this type (EH, 2008).

Data may be collected with a higher sample density where complex archaeological anomalies are encountered, to aid the detection and characterisation of small and ephemeral features. Data may be collected at up to 0.125m intervals along traverses spaced up to 0.25m apart, resulting in a maximum of 28800 readings per 30m grid, exceeding that recommended by English Heritage (2008) for characterisation surveys.





Post-Processing

The magnetic data collected during the detail survey are downloaded from the Bartington system for processing and analysis using both commercial and in-house software. This software allows for both the data and the images to be processed in order to enhance the results for analysis; however, it should be noted that minimal data processing is conducted so as not to distort the anomalies.

As the scanning data are not as closely distributed as with detailed survey, they are georeferenced using the GPS information and interpolated to highlight similar anomalies in adjacent transects. Directional trends may be removed before interpolation to produce more easily understood images.

Typical data and image processing steps may include:

- Destripe Applying a zero mean traverse in order to remove differences caused by directional effects inherent in the magnetometer;
- Destagger Shifting each traverse longitudinally by a number of readings. This corrects for operator errors and is used to enhance linear features;
- Despike Filtering isolated data points that exceed the mean by a specified amount to reduce the appearance of dominant anomalous readings (generally only used for earth resistance data)

Typical displays of the data used during processing and analysis:

- XY Plot Presents the data as a trace or graph line for each traverse. Each traverse is displaced down the image to produce a stacked profile effect. This type of image is useful as it shows the full range of individual anomalies.
- Greyscale Presents the data in plan view using a greyscale to indicate the relative strength of the signal at each measurement point. These plots can be produced in colour to highlight certain features but generally greyscale plots are used during analysis of the data.

APPENDIX 2: GEOPHYSICAL INTERPRETATION

The interpretation methodology used by Wessex Archaeology separates the anomalies into four main categories: archaeological, modern, agricultural and uncertain origin/geological.

The archaeological category is used for features when the form, nature and pattern of the anomaly are indicative of archaeological material. Further sources of information such as aerial photographs may also have been incorporated in providing the final interpretation. This category is further subdivided into three groups, implying a decreasing level of confidence:

- Archaeology used when there is a clear geophysical response and anthropogenic pattern.
- Probable archaeology used for features which give a clear response but which form incomplete patterns.
- Possible archaeology used for features which give a response but which form no discernible pattern or trend.

The modern category is used for anomalies that are presumed to be relatively modern in date:

- Ferrous used for responses caused by ferrous material. These anomalies are likely to be of modern origin.
- Modern service used for responses considered relating to cables and pipes; most are composed of ferrous/ceramic material although services made from non-magnetic material can sometimes be observed.

The agricultural category is used for the following:

- Former field boundaries used for ditch sections that correspond to the position of boundaries marked on earlier mapping.
- Agricultural ditches used for ditch sections that are aligned parallel to existing boundaries and former field boundaries that are not considered to be of archaeological significance.
- Ridge and furrow used for broad and diffuse linear anomalies that are considered to indicate areas of former ridge and furrow.
- Ploughing used for well-defined narrow linear responses, usually aligned parallel to existing field boundaries.
- Drainage used to define the course of ceramic field drains that are visible in the data as a series of repeating bipolar (black and white) responses.

The uncertain origin/geological category is used for features when the form, nature and pattern of the anomaly are not sufficient to warrant a classification as an archaeological feature. This category is further sub-divided into:

- Increased magnetic response used for areas dominated by indistinct anomalies which may have some archaeological potential.
- Trend used for low amplitude or indistinct linear anomalies.
- Superficial geology used for diffuse edged spreads considered to relate to shallow geological deposits. They can be distinguished as areas of positive, negative or broad bipolar (positive and negative) anomalies.



Site location map



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Greyscale, south



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XY trace, south



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Interpretation, south



Greyscale, north



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	Survey Extents Archaeology	Former Field Boundary	Ferrous Increased Magnetic Response		Contains Ordn	ance Survey data © Crown copyright and da s for client report only © Wessex Archaeolog	atabase right 2014. gy. No unauthorised reproduction.	
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Interpretation, north





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