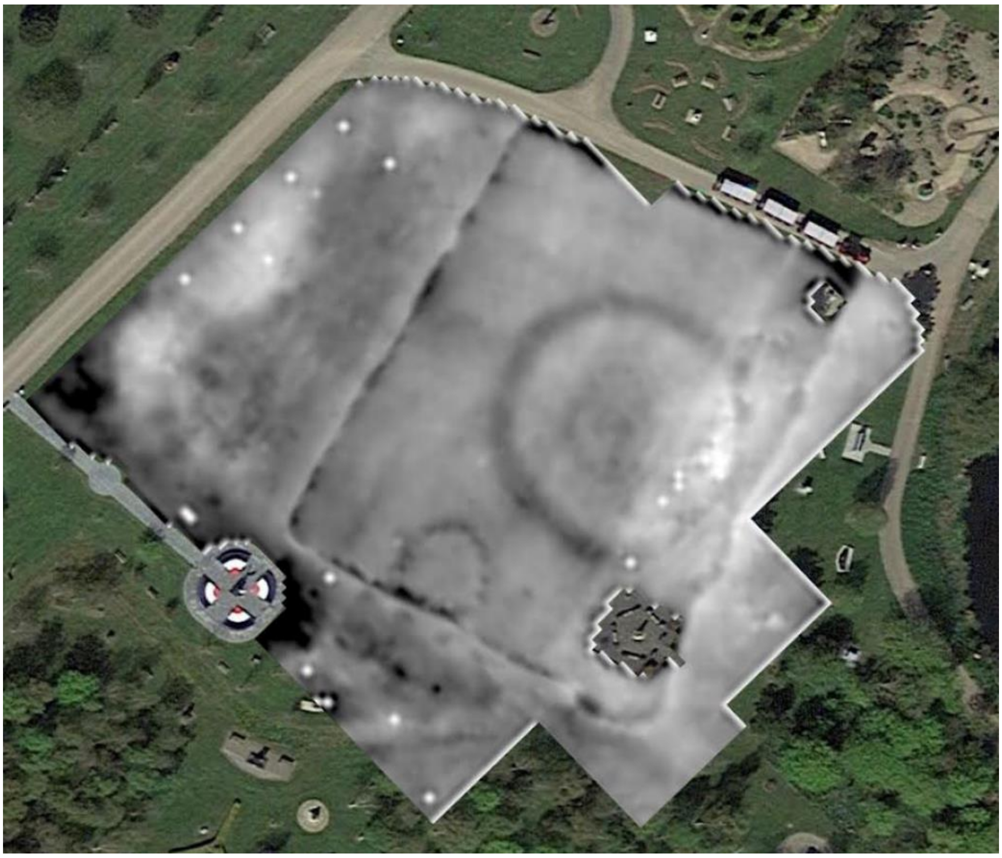
A Geophysical Survey of the Hengiform Monument (SM1006090) at The National Memorial Arboretum, Alrewas

Aug – Sep 2023



Non-technical summary

This document was prepared and written by Mark Knight, Keith Foster and Andy Austen, with additional contributions by Paula Whirrity and Adrian Farnsworth.

As part of Historic England's support for the Transforming the Trent Valley Partnership Scheme (TTTV), a number of designation reviews were requested. It had been observed that the map accompanying the listing of scheduled monument 1006090, now in the care of the National Memorial Arboretum (NMA), seemed to be misaligned with the aerial photography overlays onto satellite imagery, so TTTV undertook a series of geophysical surveys which would serve several functions:

- Accurately geolocate any physical remains of the monument.
- Provide information as to the survival rate and depth of any remains.
- Provide additional information to help categorise the monument type.
- Allow a designation review document to be created.
- Provide information to the NMA to enable the appropriate management regime, to correctly locate and position modern memorials away from the ancient monument, and to provide information for additional interpretation of the ancient monument.
- Provide training opportunities for TTTV volunteers in the use of geophysics for archaeology.

The official list entry is named *Site of round barrow near River Tame* but summarises the monument as *prehistoric multiple ring ditch, 310m north east of the National Memorial Arboretum Visitor Centre*.

The geophysics results indicate that the monument survives well where it was not truncated (presumed to have taken place in the mid-20th century). It was observed from LiDAR that the monument appears to be located centrally on an artificially raised circular mound approximately 84m diameter. The conclusion reached by the team is that this may be a Neolithic henge or hengiform monument later reused to locate a round barrow, presumably in the later Neolithic or early Bronze Age.

The linear boundaries mentioned in the listing document were also partially located, as was the quarry boundary, which destroyed the remaining linear and other features visible in the overlay transcriptions. It seems possible that these may have delineated a route way to the monument, perhaps processional in nature.

The proximity of the monument to the river and the river confluence would have been of primary significance and is the reason for the specific location of the hengiform monument.

Introductory statements

We are grateful to the following:

The National Memorial Arboretum for granting permission to undertake these geophysical

surveys within the grounds of the Arboretum; to Paul Johnson and other NMA staff during the surveys. (Ref 4)
Nick Carter of Historic England for licence No:SL00234493 on Monument no:1006090 under section 42 of the 1979 Ancient Monuments and Archaeological Areas Act (as amended by the National Heritage Act 1983, licence dated 8 June 2023.
Dr Ian Stimpson of Keele University and his support team for using their GPR and for his support.
Volunteers of Transforming the Trent Valley Partnership, who assisted during the surveys.

Background:

The National Memorial Arboretum is situated in Staffordshire at the confluence of the River Tame with the River Trent, close to the village of Alrewas and between the towns of Burton on Trent and Lichfield. The valley has been formed by the river in the bedrock of Triassic age Gunthorpe Member – a mudstone – sedimentary bedrock formed between 247.1 and 237 million years ago. The infill of the valley is composed of Alluvium – clay, silt, sand and gravel. The sedimentary superficial deposits were formed between 11.8 thousand years ago and present during the Quaternary period. Most of the area has been extensively quarried for sand and gravel which continues to this day. (BGS Geology Viewer 2023). Prior to the quarrying crop marks had been observed from aerial photography, it was realised that part of the area was historically significant and was partly protected under HER 199. The area surveyed is outside the quarried area. Reference to previous archaeological work can be seen in references 1 & 2.

Four geophysical surveys were undertaken by TTTV volunteers and Keele University between 7th August and 25th September 2023; a grid survey of the monument, two pseudo-sections and a partial ground penetrating radar survey.

Centre of crop circle SK18536 14600.

Aims and objectives

The purpose of the geophysics project was to establish the location and if possible the depth, width and general survival of the monument. It was hoped to be able to provide as much information about the monument as possible using remote sensing, non-intrusive methods. It also provided the opportunity to engage TTTV volunteers in a ‘real-world’ archaeology project with outcomes that would be useful for Historic England, the NMA and in enabling TTTV to add to the story and understanding of the prehistory of the Trent Valley, whilst training them in different methods and applications of geophysics for archaeology.

Providing accurate geolocation information would also allow TTTV to write a designation review document for Historic England, enabling that body to relocate its scheduling map, if necessary.

A series of concentric circles had been observed as crop marks from aerial photography and the site listed as a scheduled monument in January 1970. It was observed that the monument had been partially damaged and after examining the OS mapping this was presumed to have taken place in the 20th century, perhaps as a flood defence. The depth of the archaeology is apparent in the photograph (figure 1) as it survives, despite having been partially dug away to an approximate depth of 80-100cm. The small stream flowing into the River Tame from the centre bottom of the photograph was re-routed during the quarrying process in the 1990s. The truncated portion of the monument is observable as a lighter patch of ground within the circles.

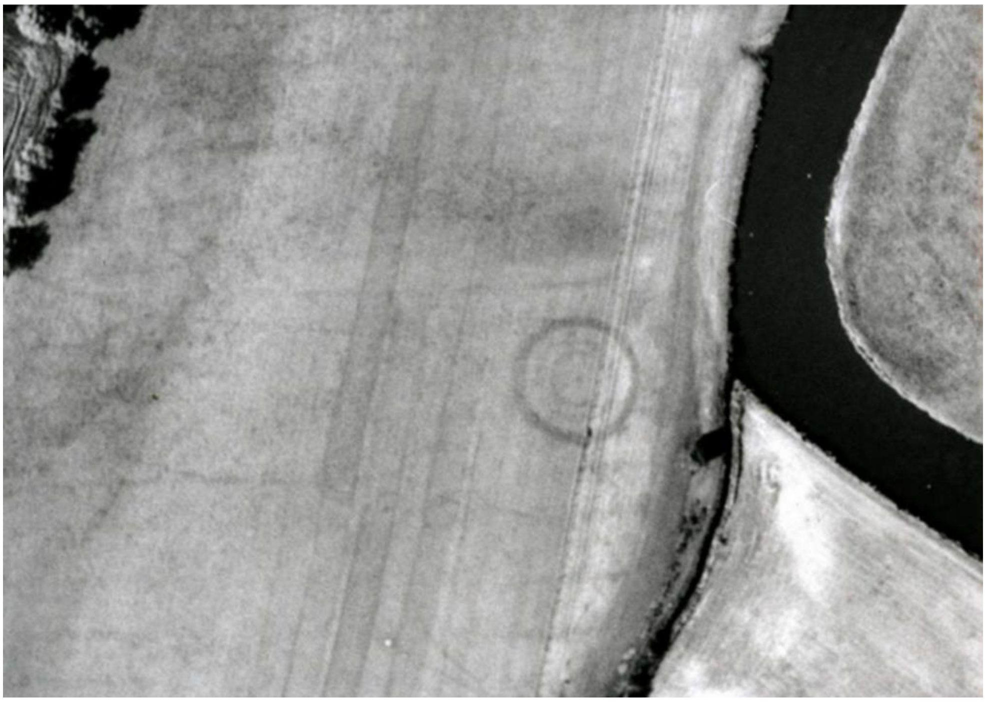


Figure 1. Crop marks apparent in aerial photograph NMR2167/1181. © Crown copyright. Copy of a photograph on display at the NMA.

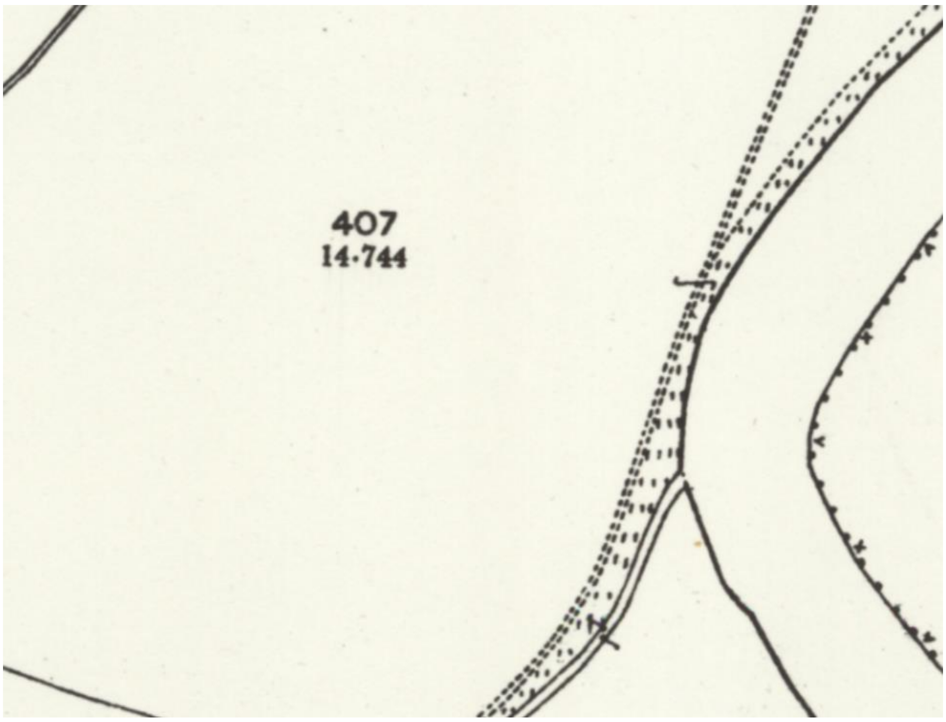


Figure 2. Detail from the OS six-inch map series, 1900. Source:

https://maps.nls.uk/geo/explore/#zoom=17.9&lat=52.72893&lon=-1.72567&layers=168&b=1

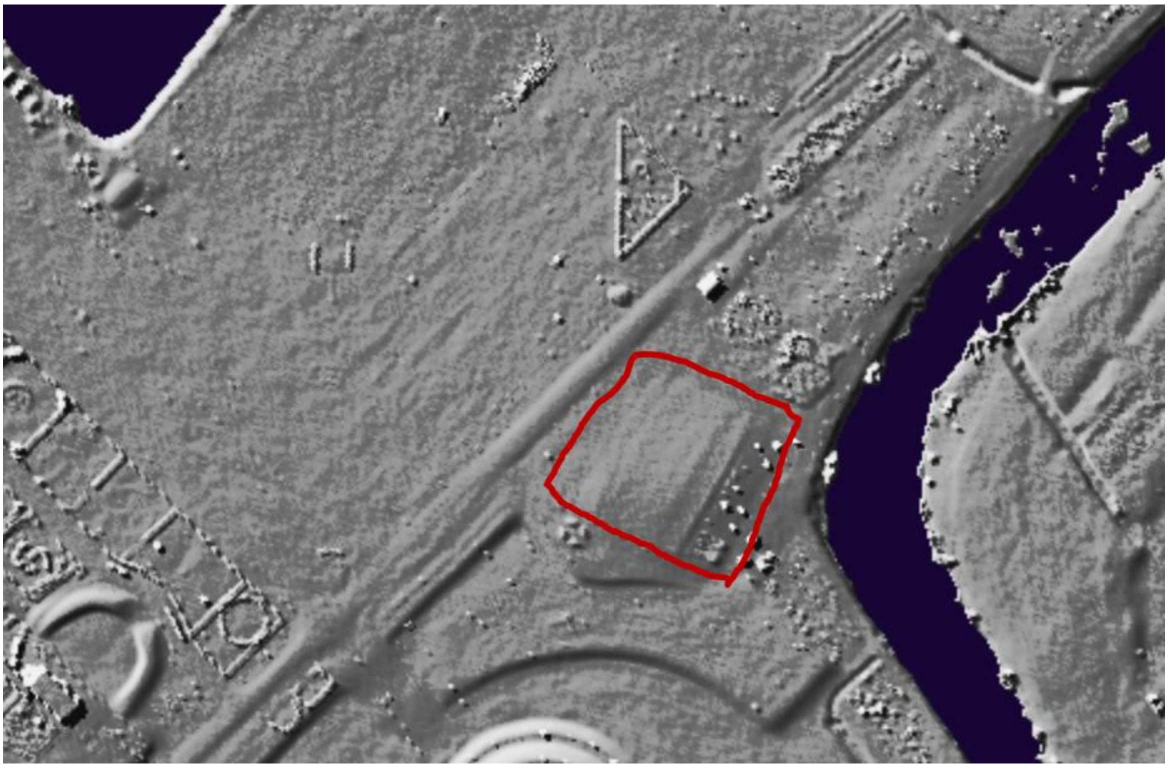


Figure 3. LiDAR image showing the approximate area containing the monument outlined in red.

Figure 4. Transcript of the National Forest aerial mapping project 1993, overlaid onto Google Earth satellite imagery. The red sub-rectangular polygon shows the area mapped in the listing schedule. The other lines show no other landscape features, including possible post rows, barrows and possible processional route. All have been lost to quarrying activities.

Methodology

It was considered that a standard twin probe electrical resistivity survey would be appropriate and adequate to delineate any structure. It was also hoped that further surveys to create a pseudosection across any feature and a GPR survey would assist to determine the depth of any feature.

The origin of the survey was 2m from the main roadway and 2m from the side path and ran parallel with the main pathway at 2m from the edge. The area under consideration approx. 100m by 100m was then mapped out into a number of 20m by 20m grids which were named and marked by temporary markers.

4a. Twin-Probe Resistivity.
An arrangement of electrodes for making earth resistance measurements that is particularly suited to archaeological geophysics. The two current electrodes are each paired with one of the two potential electrodes, one pair is set into the ground at a fixed reference position at least 15m from the area to be surveyed while the second pair with a separation of 0.5m is carried on a mobile frame and inserted into the ground and the earth resistance measured. Two sets of equipment – the Mk 1 TR/CIA Resistance Meter and the Mk 2 version were used. (Ref 3)
The 20m square grids were surveyed by the two sets in a conventional manner at 1m spacing ensuring that no part of the equipment was within 50m of the other set. The results of the survey were downloaded to a PC and processed using the supplied TR/CIA software and enhanced to display the final results

Figure 5. The resistivity results highly processed to highlight the mound. The circles in the lower half are recent flowerbeds. The white squares are null points where readings were not possible because of trees or modern monuments.

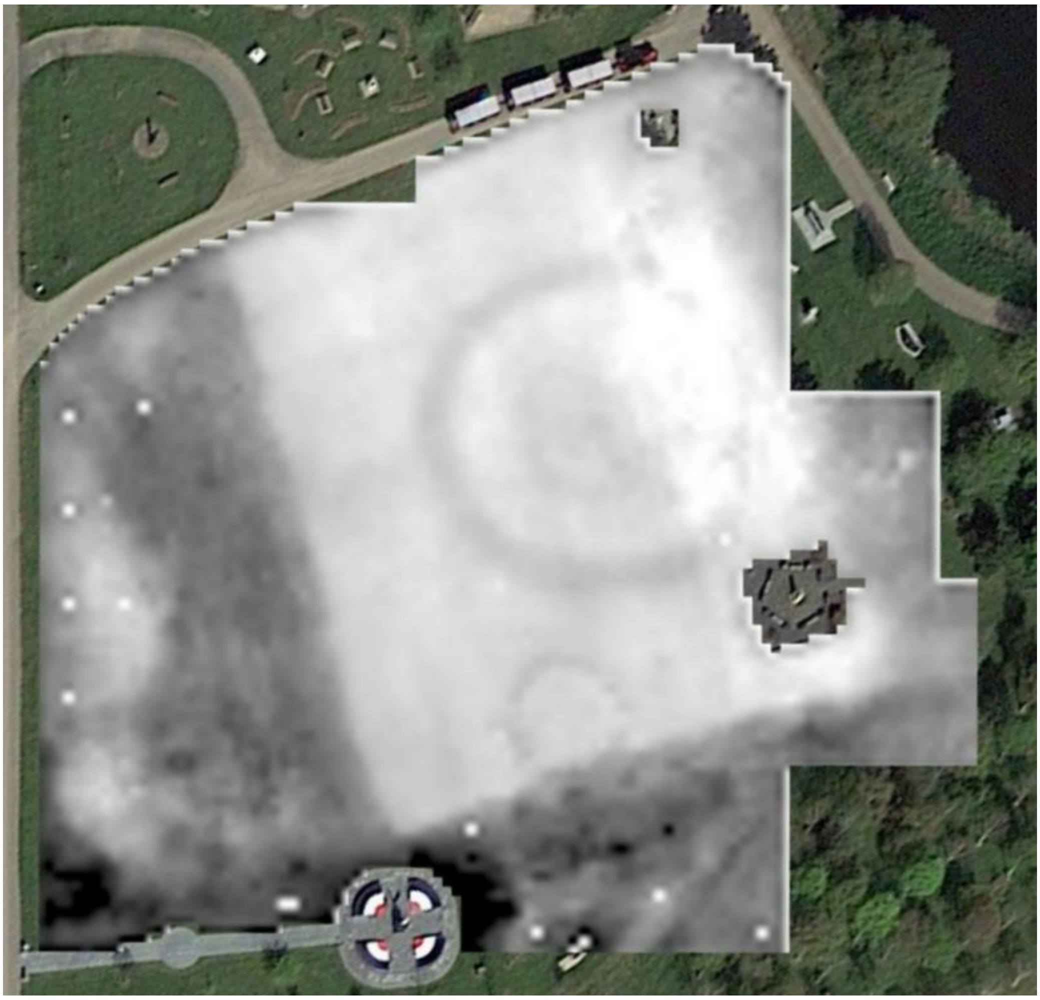


Figure 6. The same area as figure 5 with resistivity results having minimal processing, superimposed on Google Earth.

4b. Pseudosection (A VES Slice).

A pseudosection (Vertical Electrical Slice/tomography) is an electrical resistivity survey whereby the resistivity of the earth at different depths are measured by altering the distance between a line of fixed probes. The equipment used was a Mk 1 Resistivity Meter with appropriate cables. A fixed voltage and current is sent to the 2 outer probes and the corresponding voltage between the two inner probes is measured - hence resistance is calculated using ohms law. Starting with measuring the resistivity at 1m separation between all the probes along the line and repeating with 2m and increasing to a 6m spacing. The results are reformatted using the TR/CIA software into a format accepted by the RES2DVI inverse modelling program (Ref.5) which displays the reading as a section along the line. The equipment had a built-in limit of 60 readings so the 100m line was split into two sections with a 20m overlap. The results were merged.

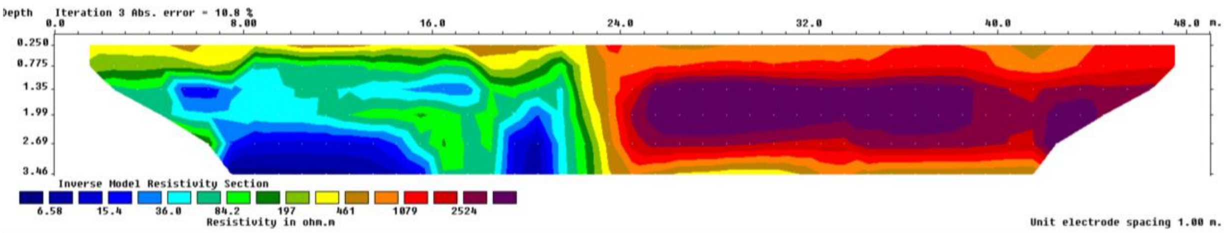


Figure 7.RES2DVI processing on full 100m section data across field (mound on right of section) and infilled area post gravel extraction (on left of section).

4c. Ground Penetrating Radar

GPR is a geophysical method that uses Radar pulses to image the subsurface. A source transmitter fires pulses of electromagnetic radiation (much like a kitchen microwave) into the earth and the radiation is reflected (& refracted) by objects that have different characteristics. The amplitude of the bounced waves is measured by a receiving antenna together with the time. The results are processed and displayed as a section along one line or as a time slice from many lines.

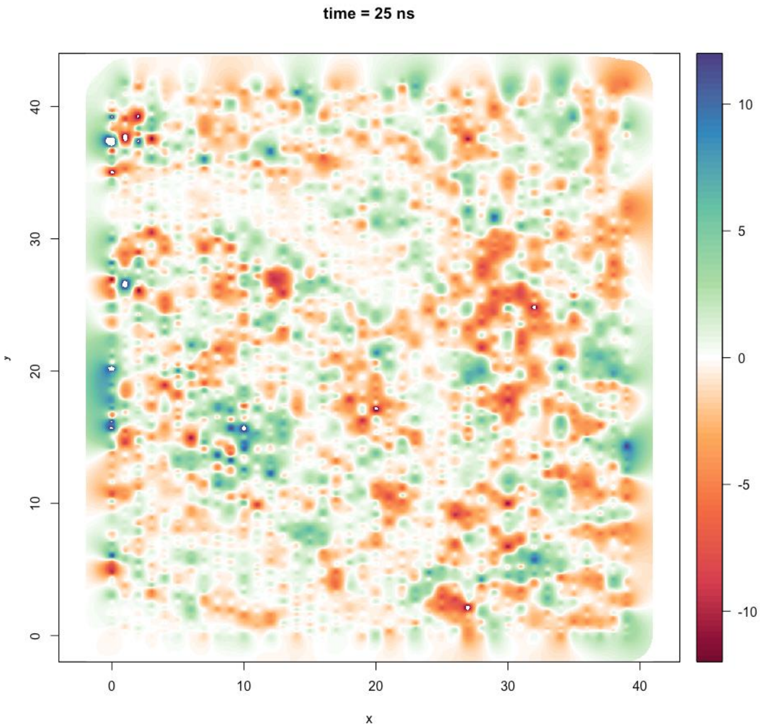


Figure 8. The results of the GPR survey. South is at the top.

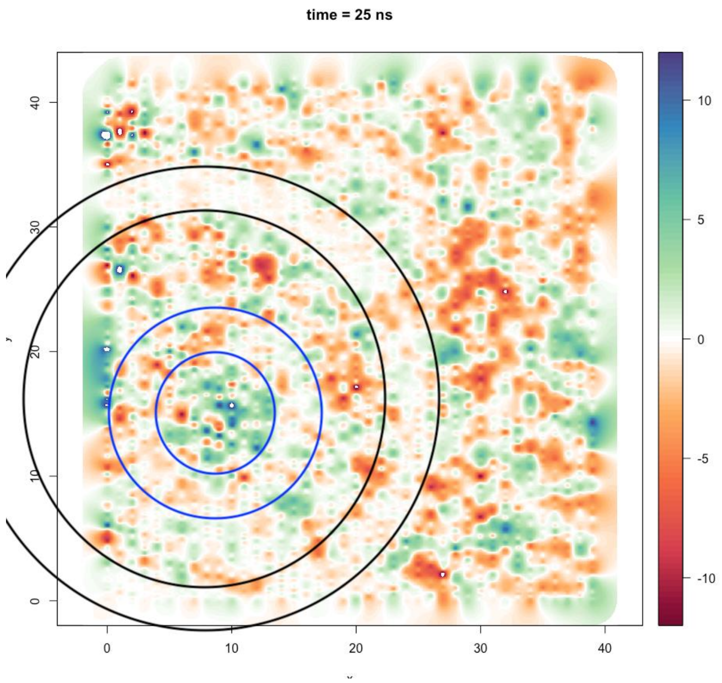


Figure 9. The same image, annotated to show the ditch rings clearly.

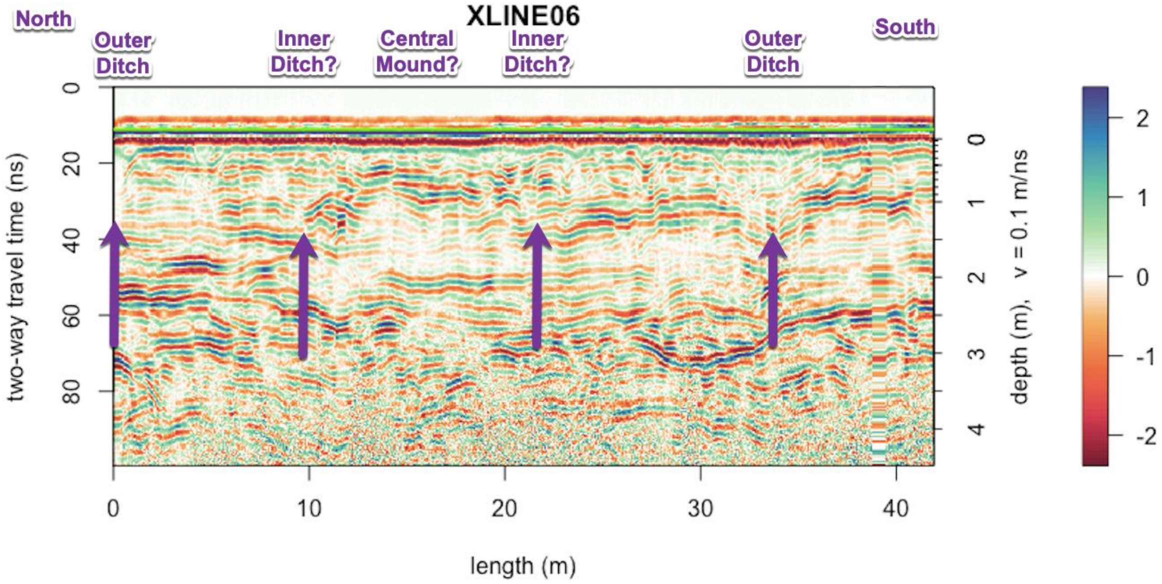


Figure 10. A GPR time slice across the monument. The purple arrows indicate the ditches.

Results

Grid survey

The area was set out with 20 grids each 20m square and the resistivity of each square metre within each grid was measured and logged. These were then plotted out using shades of grey to represent resistivity – lighter shades being high resistance and darker being lower. A ditch that has filled in over time will typically have a lower resistivity (darker shades) as it will usually have filled with topsoil. A wall foundation will typically have a higher resistivity and appear as lighter shades.

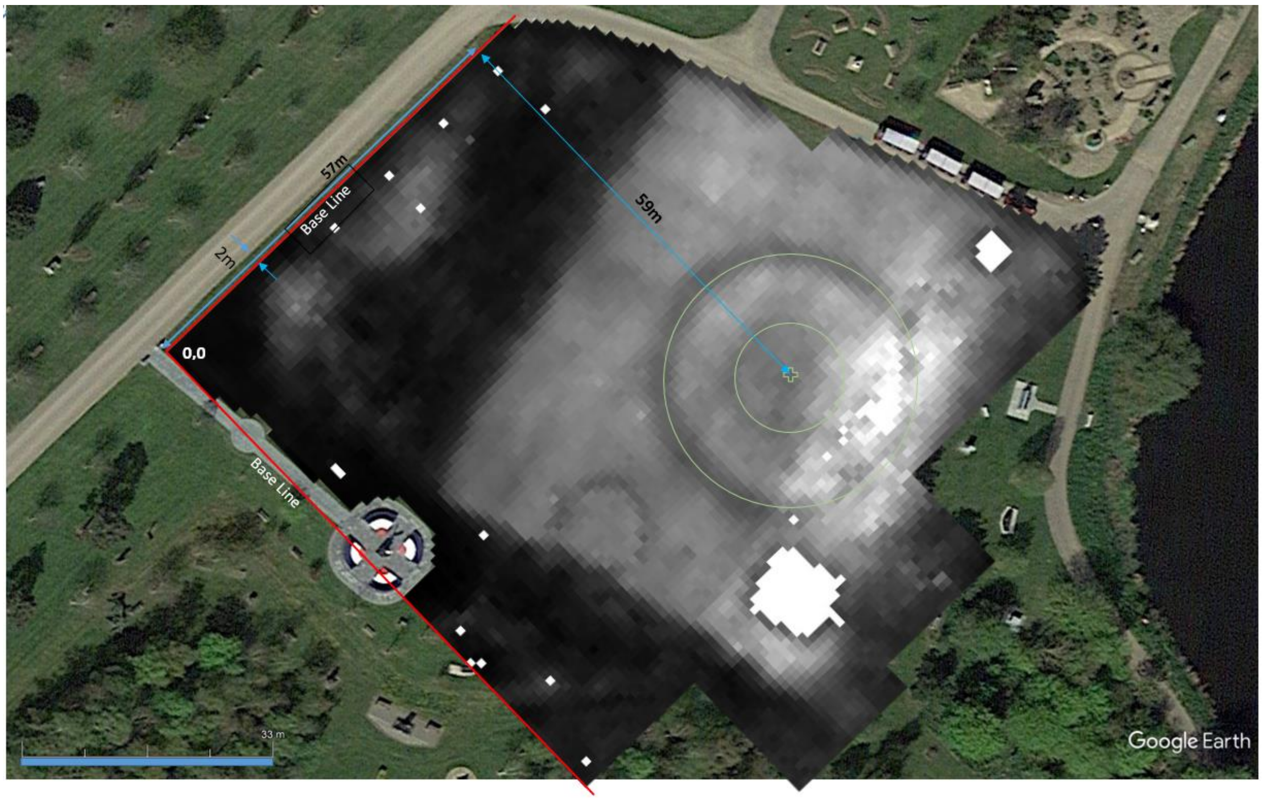


Figure 11. The results of the grid survey overlaid on Google Earth and annotated with base and centre lines.

The results of the grid survey are shown in Fig.11 above and clearly display a circular feature c.17m radius and c.4m wide and, less distinctly, a smaller, co-centred, circular feature c.7m radius and c.2m width. These low resistance features (darker grey) represent ditches centred, by eye, 57m along the base line and 59m normal to it. The 1m squares of the survey enable accurate measurement.
The indistinct low resistance feature in the centre may represent a pit. The eastern edge of the feature has been disturbed at some point and this is clearly visible on the ground.

The small circular feature to the south west is the result of a modern shrubbery planting.

Also clearly displayed is a rectangular, high resistance feature (lighter area) containing the circular ditches. The NW, SW and SE boundaries to this feature appear to match the fences shown in a test pit report (Project 504.1) by Birmingham University Field Archaeology Unit in August 1998 although there is insufficient information in the report to accurately geo-locate them (figure 12 below). It is understood that the fences were the markers for the limit of aggregate extraction. The lower resistance (darker areas) to the north-west, south-west and south-east of the fences (fig.11) strongly suggest that those areas were excavated and refilled.

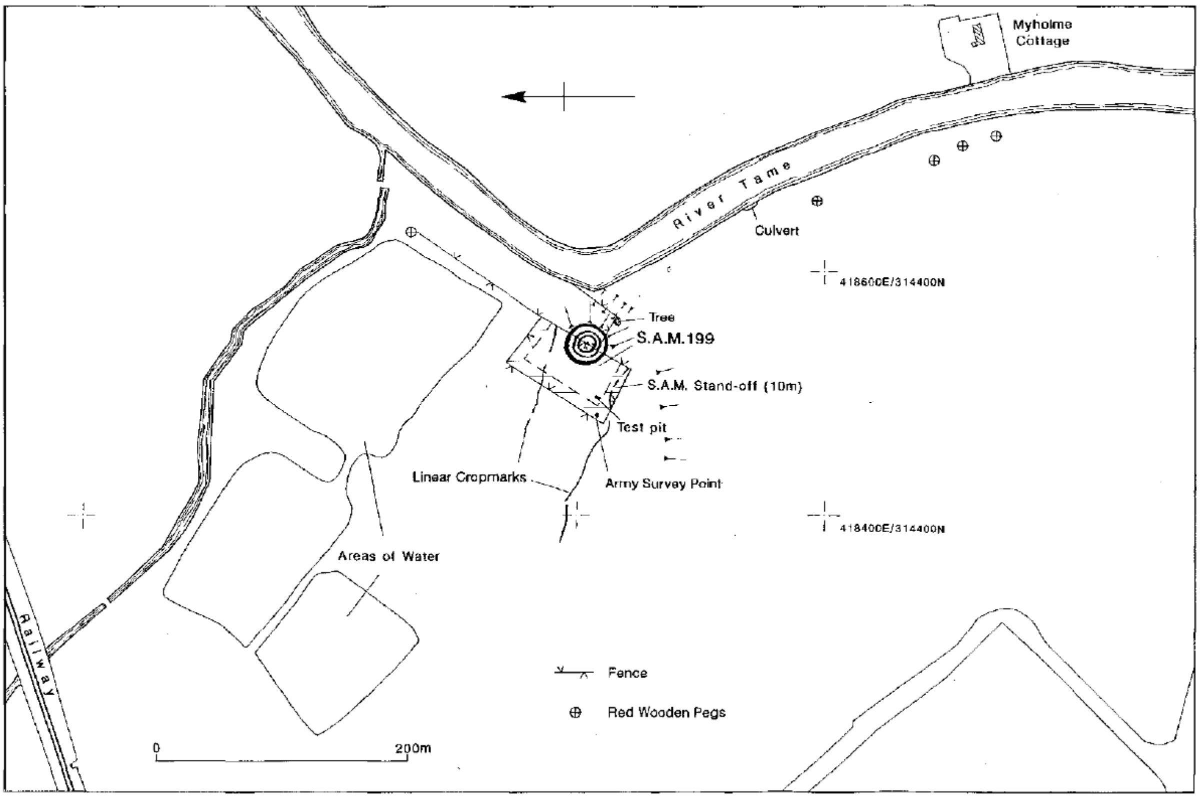


Figure 12. From test pit report (Project 505.1) by Birmingham Field Archaeology Unit.

Circular crop marks observed in an aerial photograph taken prior to gravel extraction, had been overlaid on a satellite view and made available to us. The crop marks were digitally traced and, using the edge of the main road and the path to the RAF Association memorial as markers, they were overlaid on the grid survey image revealing that the circular features were centred in a slightly different place. Assuming this to be an error due to visual rather than measured placement, they were relocated to be co-centred with the resistivity features. This demonstrated that they (yellow lines in fig. 13) are slightly larger in diameter than the ditches. Assuming they are parching marks, then they would represent the mounds surrounding the ditches and suggest 3 circular mounds and a central mound.

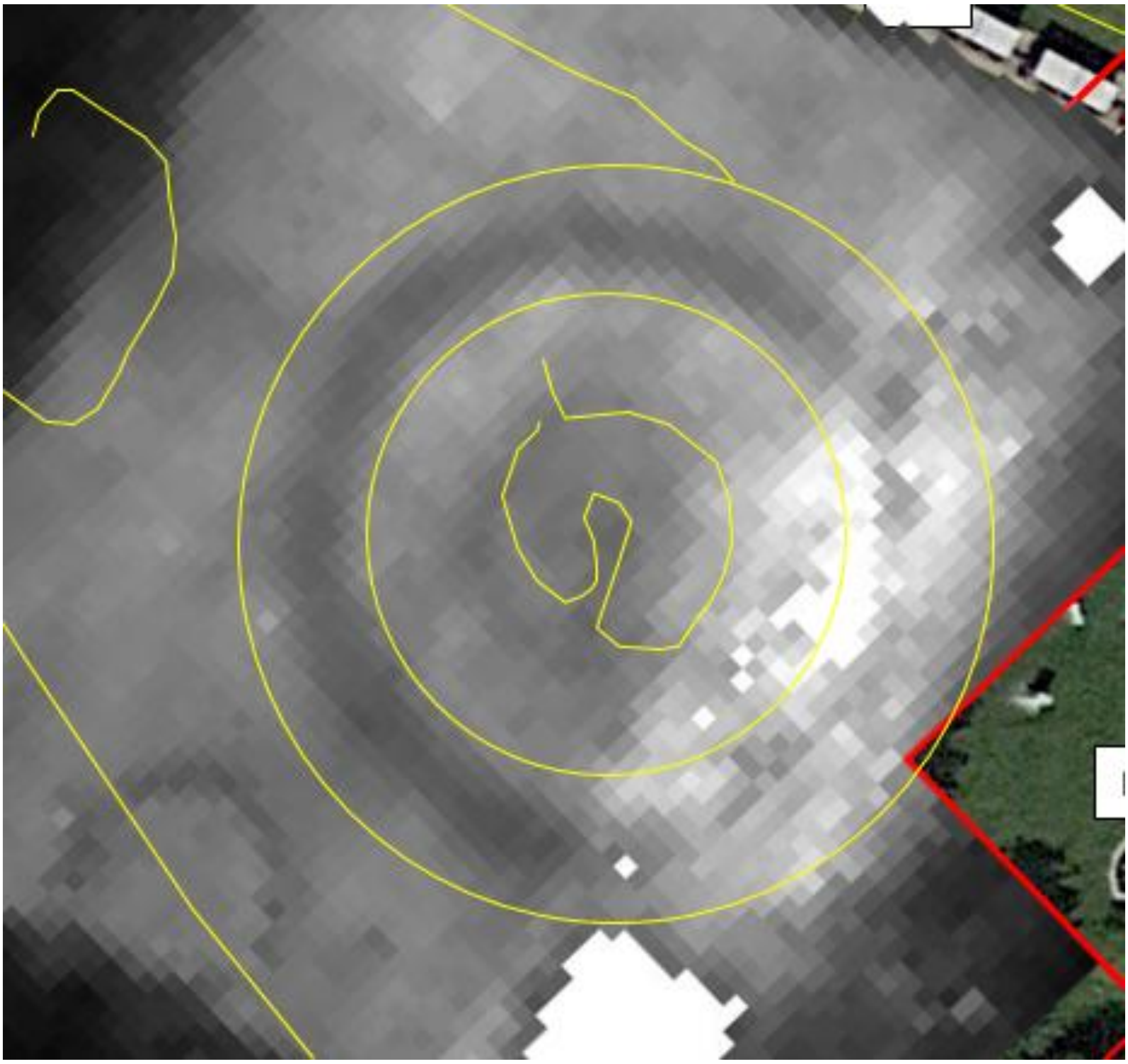


Figure 13. Traced crop marks in yellow.

There is little suggestion of the inner circular or central mounds in the grid survey results.

By ignoring very high or very low resistivity values and by adjusting contrast, faint traces of other low resistance features were revealed (figure 14).

There are two linear features to the north west of the circles which might be an extension of linear crop marks farther west (A & B). There is a linear feature running east-west towards the centre (C). In the south west corner of the high resistance rectangle is a low resistance feature that may be the test pit mentioned in the Birmingham University report (D).

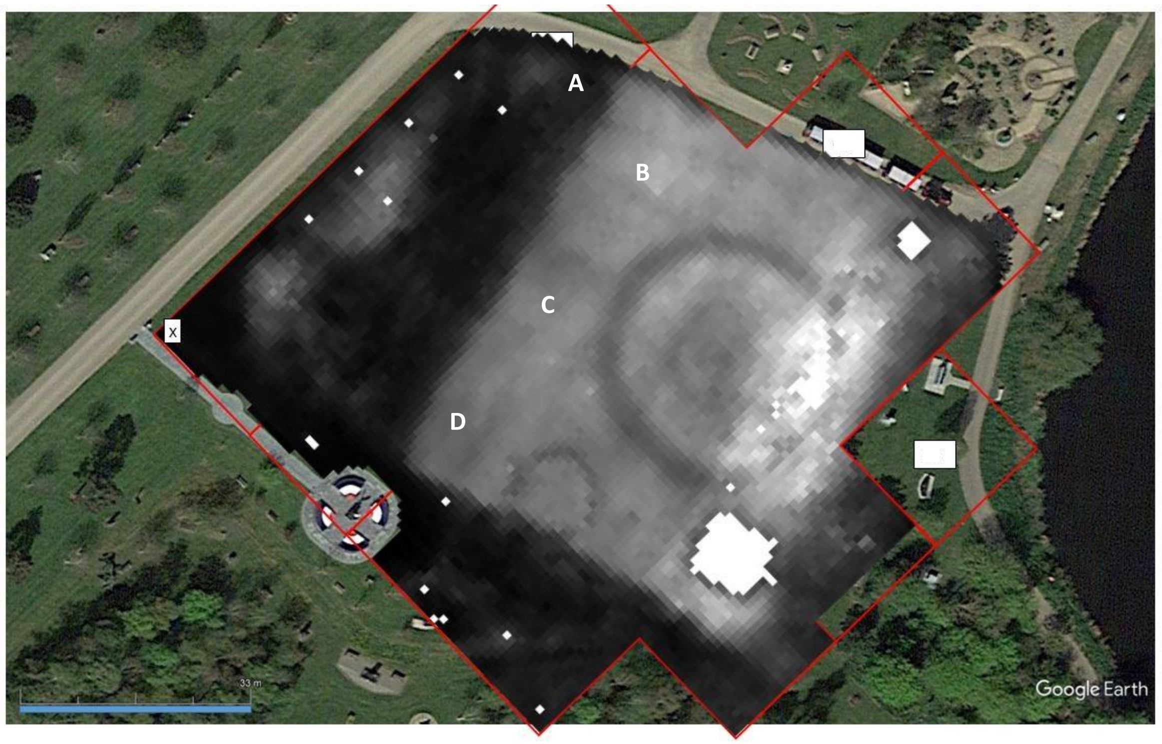


Figure 14. Contrast adjusted to show linear features clearly.

Survey results – Section survey

By measuring and logging the resistivity at varying depths along a line of probes, an indication of underground strata and features can be made. Such a pseudo-section was surveyed (figure 15). It was 60m long and centred on the observed centre of the low resistance circular features and running along the line from the 57m mark on the base line. The zero datum position is to the west of the observed centre.

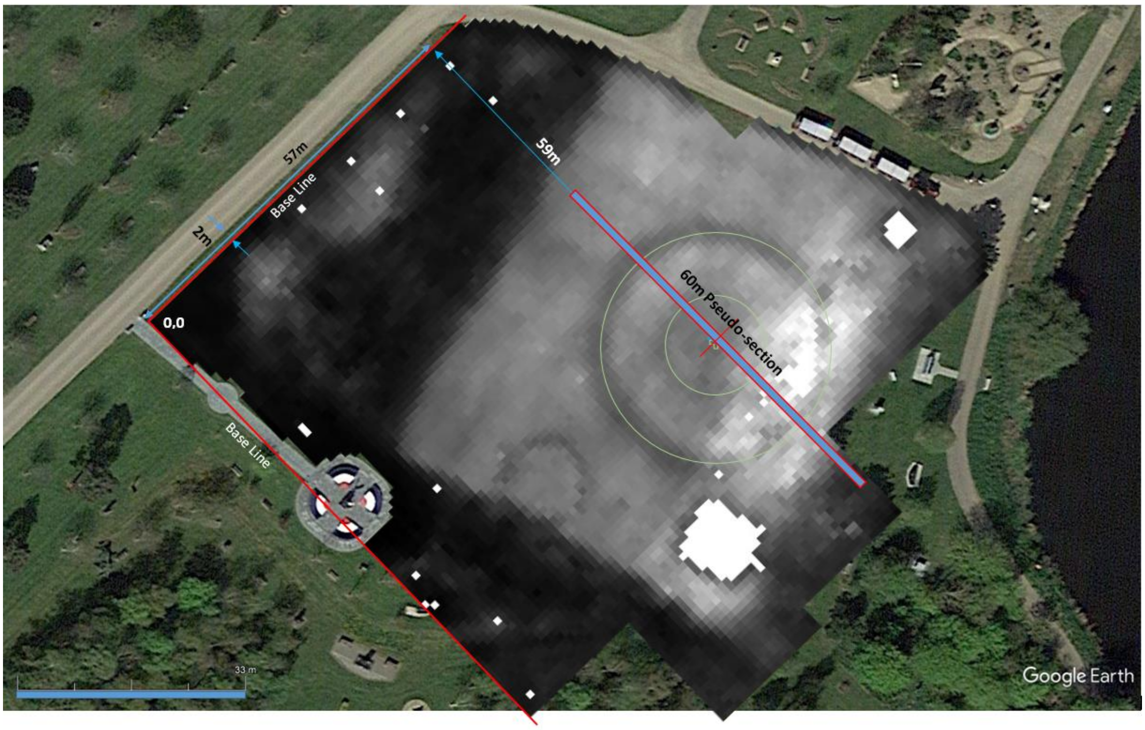


Figure 15. East-west pseudo section location.

The resulting section:

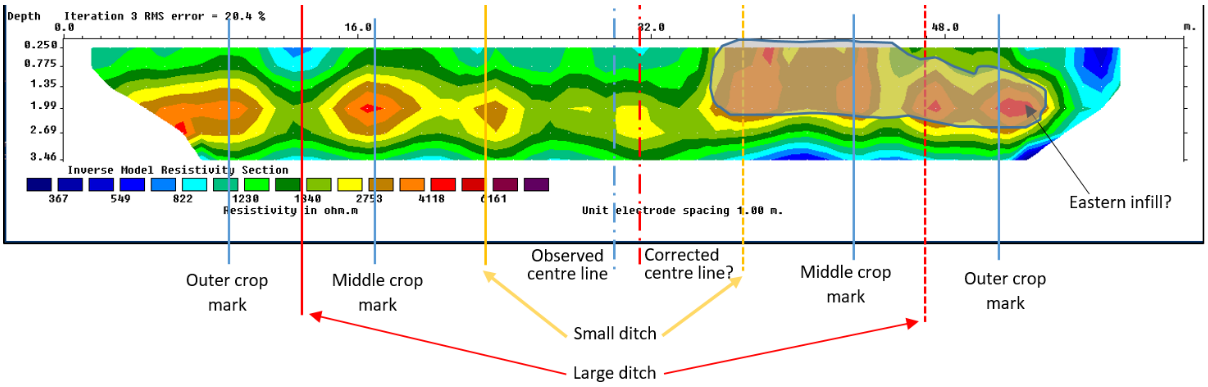


Figure 16. Annotated results of the east-west section.

The colours in the resulting image (figure 16) represent resistivity ranging from blues being low resistivity and reds and purples, high. Note that the vertical and horizontal scales are different. The chain dotted blue line is the observed centre. The right hand (eastern end) is the damaged part of the monument but to the left side, the large ditch coincides with low resistance at 13m from the origin (0.0) and the smaller ditch coincides with low resistance at 23m from the origin. The circular crop marks coincide with relatively high resistance features at 9m and 17m from the origin and represent the location of the mounds. The central area is unclear but an alternative centre location is at the lower resistance point at 31m from the origin.

A further 60m pseudo-section was surveyed running SSW to NNE (figure 17) in order to avoid the damaged section of the monument and pick up both sides of the circles. It confirms the larger circular ditch but did not find the smaller circular ditch or clarify the central features. The zero datum point was at the southern end.

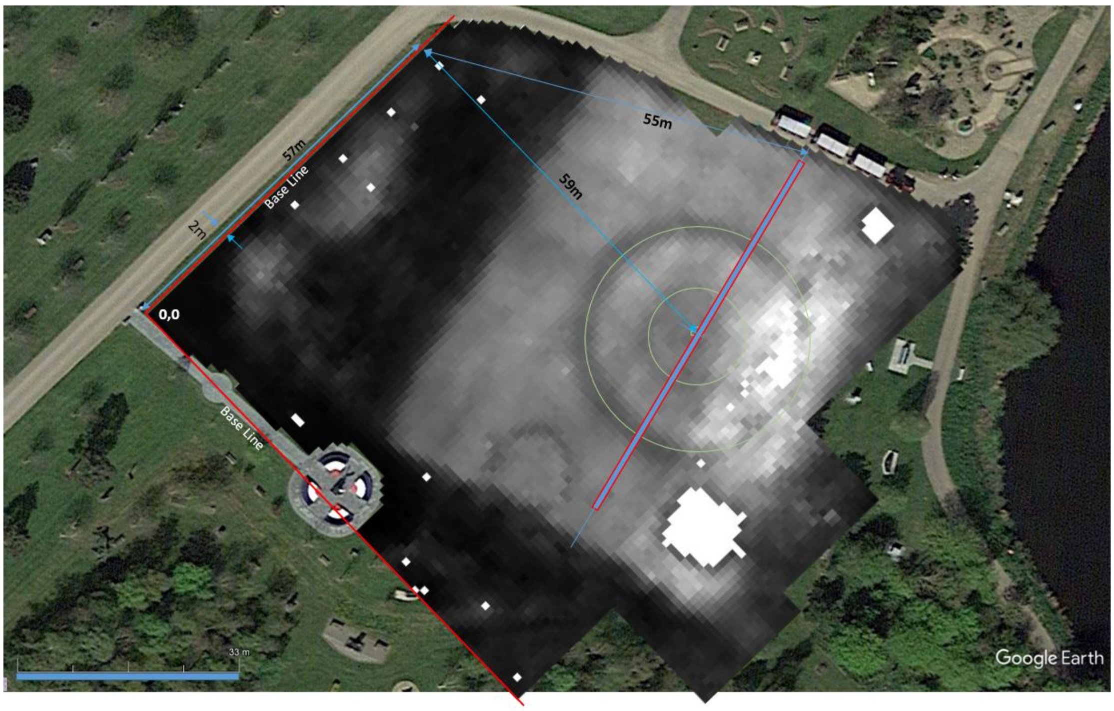


Figure 17. The NNE-SSW pseudo section position.

The resulting section:

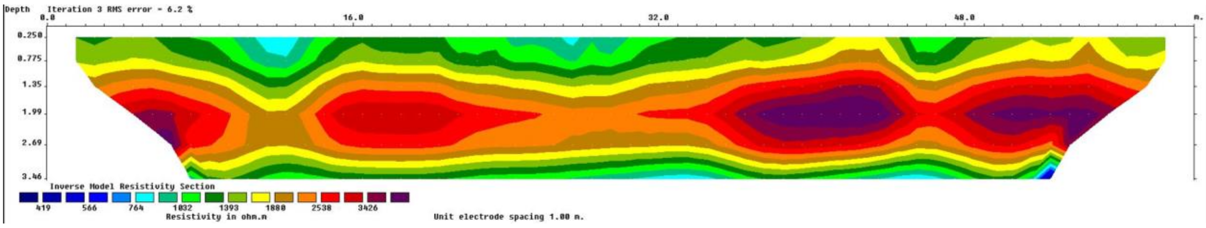


Figure 18. Pseudo section cut approximately NNE-SSW.

Survey Results

Whilst these surveys have not resolved the central feature, they have accurately located circular ditch features and enabled a depth of ~1.5m of those to be ascertained. These fit with the crop parch marks previously observed and which we have interpreted as representing the banks surrounding the ditches. The outer ring ditch is circa 34m in diameter and 4m wide, and the inner ring ditch circa 14m diameter and 2m wide.[1]

Conclusions

The team was able to accurately geolocate the remains of the monument, and ascertain the likely depth of the circular ditches. We were able to establish that the eastern part of the monument was damaged, likely in the middle part of the 20th century and that subsequently the location of the monument was assumed to be west of this line, which was represented by a fence. The team was also able to able to establish the remains of the linear features running roughly east-west towards the monument. Our researchers were able to establish that the monument sits centrally within a wider artificial mound, some 84m in diameter.

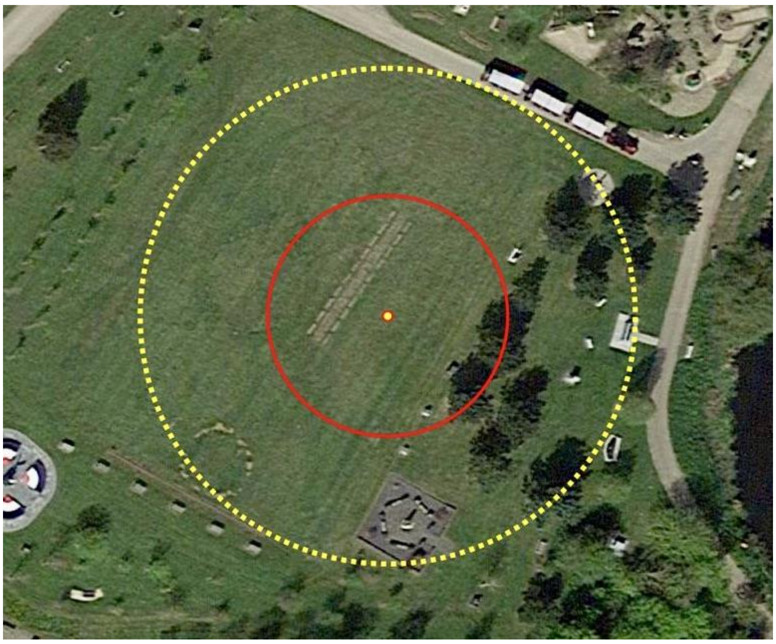


Figure 19. The red line indicates the outer ring ditch of the hengiform monument, the dashed yellow line the approximate diameter of the artificially raised platform.

[1] This would produce an estimated ~550m^3 of soil from the ditches. Assuming that compaction rate of the soil is unchanged this creates a 4m or 2m wide by 1.5m high bank around the outside of each ring ditch respectively.

Figure 20. The resistivity survey draped over the Lidar image, height exaggerated 10x to demonstrate the artificially raised platform.

Interpretation.
This has been the subject of considerable discussion within the team and although the general consensus is as follows, is still subject to debate and discussion:

A hengiform monument was created on an artificially raised earthen mound, probably in the later Neolithic period and which is focussed on the bend in the River Tame, and the confluence between that river and the River Trent. The River Mease also has its confluence with the River Trent close to this point and this triple convergence seems likely to have influenced the choice of location for this hengiform monument. The “dense archaeological record of monuments within the river valleys” referred to in list entry 1006090 is pertinent here, as is the reference to the development of a cultural landscape. The focus of ceremonial and ritual activity at Catholme may have influenced the siting of this hengiform monument, but equally – and importantly – it may be the case that this monument, closer in proximity to the confluence of the three rivers as it is, may have influenced the siting of the Catholme Ceremonial Complex. This monument may have been subject to annual flooding, perhaps causing a move to Catholme. Other interpretations are possible and without accurate dating evidence it will remain a moot point. Two final noteworthy points for consideration: Firstly, a line scribed from the monument south-east on the map (and therefore aligned on the midwinter sunrise) bisects the burial mound at Croxall. Whilst this is designated as a potential Anglo-Saxon or Viking mound, it may date to prehistory and was perhaps later enhanced in the early-medieval period (see appendix 2). Secondly, in figure 13 it may be seen that there are possible crossing points of the central ditch and bank located to the south west and northwest. If these are accurate observations, then the fact that they align on the setting points of the sun at the midwinter and midsummer sunsets respectively may be of significance.

Recommendations.

Based on the geophysics survey results, the team recommends that the listing schedule be modified so that the defined area on the map corresponds with the monument, including the area that was damaged in the 20th century.

Archive location

The final report will be archived with the Archaeological Date Service of York University. Copies will be given to Staffordshire Wildlife Trust (SWT), the National Memorial Arboretum, Historic England, Staffordshire County Archaeologist, Staffordshire Historic Environment Records Officer and Keele University, and all volunteers who helped during the surveys. The report will be published on the TTTV website: thetrentvalley.org

The original data, subsequent edits and pictures will be stored by SWT and the owners of the equipment used during the survey.

References and bibliography

1. A Cropmarked Ring Ditch at NMA Alrewas. Birmingham University Field Archaeology Unit. Project 504.1. August 1998.

2. Geophysical Survey at Alrewas, Staff. Ancient Monuments Laboratory Report 113/90. 1989

3. TR/CIA Archaeological Resistivity Meters. Randall 2002 & 2015

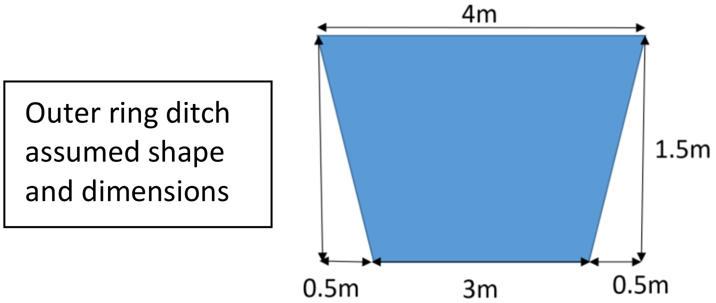
4. www.thenma.org.uk/about-us/who-we-are/our-story

5. en.wikipedia.org/wiki/Ground-penetrating_radar

6. Loke, M.H. Res2Dinv. Rapid 2-D Resistivity & IP Inversion Using the Least-Squares Method. Geotomo Software 2010, Malaysia.

Appendix 1. Volume calculation

The estimated volume of soil from the ring ditches was calculated as follows and is intended as a demonstration of the effort involved and is an indicative number only:



i) 17m Ø ring ditch circumference = 106.8m. Area of the ditch shape above: (4 x 1.5 = 6) – ((0.5 x 1.5 = 0.75) x 2 =1.5) = 4.5m^2. Volume of the outer ring ditch: 106.8 x 4.5 = 480m^3

ii) 7m Ø ring ditch circumference = 44m. Area of inner ring ditch = 1.5 m^2. Volume of the inner ring ditch: 44 x 1.5 = 66m^3

iii) Total soil volume of both ring ditches = 480 + 66 = 546m^3

If the ring ditches were semi-circular or torus-shaped in cross section, the total soil volume of both ditches would increase to ~ 810m^3 (calculate half the volume of a ring type torus for each).

Appendix 2. Midwinter sunrise calculation

The observation of the midwinter sunrise from the NMA monument possibly aligning with the burial mound at Croxall was made using the Suncalc website here:
https://www.suncalc.org/#/52.7288,-1.7269,19/2024.12.22/08:01/1/1
Which generated the image in figure 21 below. However, even the slightest change to the origin position creates a significant difference in the perceived sunrise location from the monument.

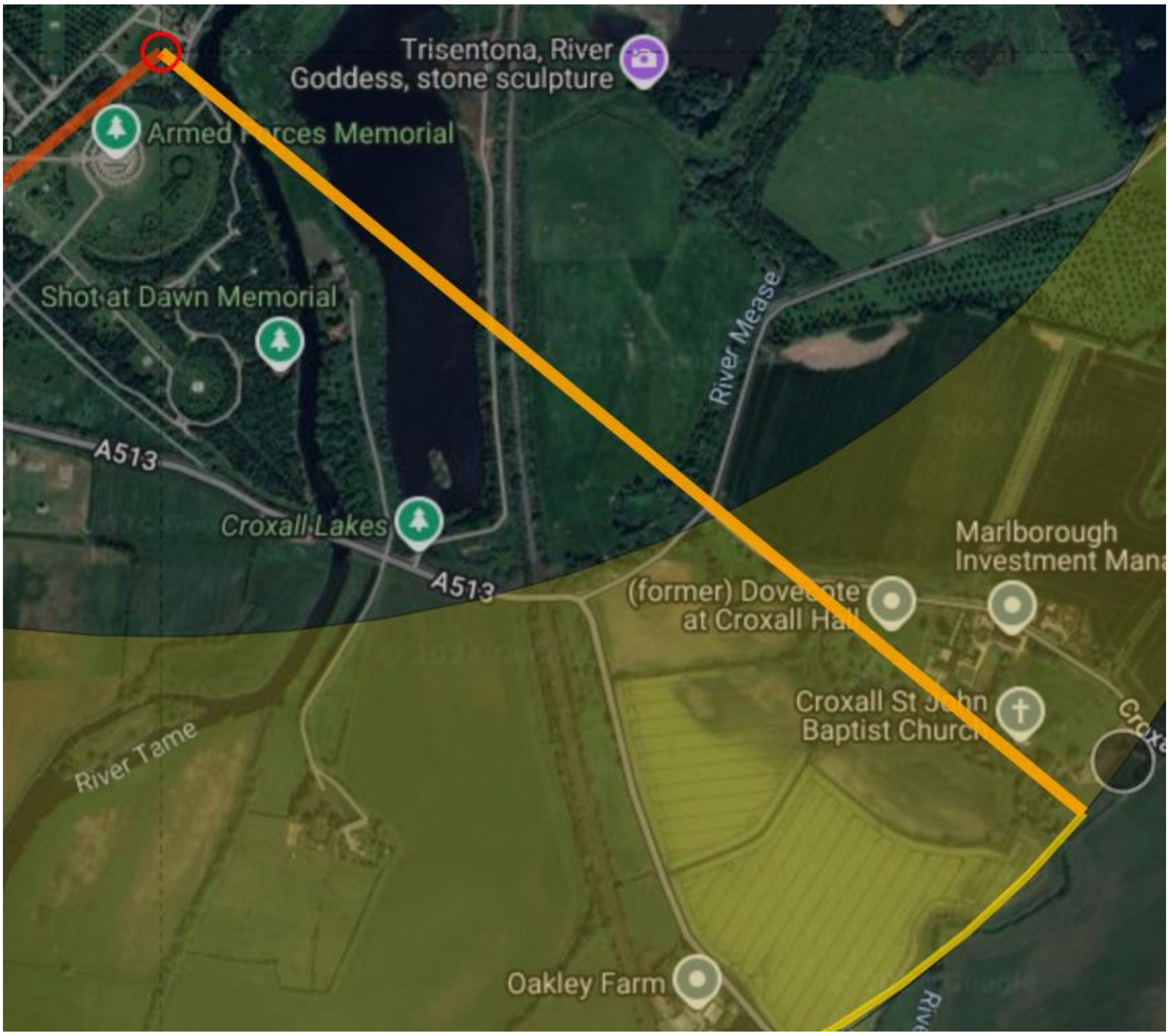


Figure 21. Midwinter sunrise from the NMA monument using suncalc.org

Thanks to the following people, who volunteered their time to survey this monument:

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Richard Fletcher	Mark Smith
Keith Foster	Ian Stimpson
Patrick Foster	Paula Whirrity

Disclaimer.

Whilst every effort has been made to ensure accurate data recording and interpretation of the results neither the authors or SWT will accept any liability for the readings or interpretations of the results.