Historic England

Research Report Series 69/2024

# Thornborough Northern Henge, West Tanfield, North Yorkshire

## Report on Geophysical Surveys, July 2024

Megan Clements, Neil Linford, Paul Linford and Andrew Payne

With Christine Clarke, Richard Deakin and Geoffery Nunn


Geophysics

# Thornborough Northern Henge, West Tanfield, North Yorkshire

## Report on Geophysical Surveys, July 2024

Megan Clements, Neil Linford, Paul Linford and Andrew Payne

With Christine Clarke, Richard Deakin and Geoffrey Nunn

Field North of Thornborough Northern Henge
West Tanfield
North Yorkshire

NGR: SE 28068 80255

Print: ISSN 2398-3841
Online: ISSN 2059-4453

The Research Report Series incorporates reports by Historic England's expert teams, their predecessors and other researchers. Many Research Reports are interim, to make available the results of specialist investigations in advance of full publication. Although subject to internal quality assurance, they are not usually refereed externally and their conclusions may sometimes have to be modified in the light of information not available at the time of the investigation. Where no final project report is available, readers should consult the author before citing these reports.

For more information email Res.reports@HistoricEngland.org.uk or write to:

Historic England
Fort Cumberland
Fort Cumberland Road
Eastney
Portsmouth PO4 9LD

Opinions expressed in Research Reports are those of the author(s) and are not necessarily those of Historic England.

# Summary

Earth resistance (0.54ha), caesium magnetometer (5ha) and Ground Penetrating Radar (GPR) (5.2ha) surveys were conducted in the field immediately to the north of the Thornborough northern henge to investigate the area for possible buried archaeology ahead of plans to improve visitor access to the site by the English Heritage Trust. The surrounding landscape contains an important prehistoric monument complex incorporating features of Neolithic and Bronze Age origins, including the three large Thornborough henge monuments. Anomalies detected by all three geophysical techniques suggest the northern henge extends into the survey area. The surveys have also identified a series of pits and possible pit alignments that may have archaeological significance, in addition to the former gravel haul road and anomalies related to recent agricultural activity. Field work for the survey was conducted in July 2024.


## Contributors

The fieldwork was completed by Megan Clements, Neil Linford, Paul Linford and Andrew Payne of the Historic England Geophysics Team, with help from English Heritage Trust volunteers Christine Clarke, Richard Deakin and Geoffrey Nunn.

## Acknowledgements

The authors are grateful for the help provided by colleagues from the English Heritage Trust in coordinating access for the survey to take place. The cover image shows the caesium magnetometer array along with the GNSS base station in the foreground (photo by Neil Linford).

## Archive location

Historic England, Fort Cumberland, Fort Cumberland Road, Portsmouth, PO4 9LD.

## Date of survey

The fieldwork was conducted between the 9 and 11 July 2024. The report was completed on 16 August 2024.

## Contact details

Dr Neil Linford, Geophysics Team, Historic England, Fort Cumberland, Fort Cumberland Road, Portsmouth, PO4 9LD.
Tel: 02392 856761. Email: Neil.Linford@HistoricEngland.org.uk.

# Contents

# Introduction

Earth resistance, caesium magnetometer and Ground Penetrating Radar (GPR) surveys were conducted during July 2024 in the field to the immediate north of the Thornborough northern henge, West Tanfield, North Yorkshire. Aerial photographs and cropmarks suggest possible buried archaeology is present within the field and geophysical surveys were undertaken to investigate the area ahead of plans to improve visitor access to the Thornborough northern henge. The survey was conducted in response to a request from the English Heritage Trust under the Shared Services Agreement and addressed Historic England corporate plan activity “5.2 Work with English Heritage Trust to support the National Collection”.

The three Neolithic henges at Thornborough (National Heritage List for England: 1004912) are aligned along a north-west to south-east axis, stretching out over a mile. Each henge is about 250m in diameter and surrounded by an earthen bank broken by two opposing entrances. The henges originally had a deep and wide ditch inside the bank, defining the circular central area. Outside the main bank was a shallower and more uneven outer ditch, with a corresponding small outer bank (English Heritage 2024). The northern henge is part of a large prehistoric monument complex, within a landscape that has been much modified by modern bulk gravel extraction (Harding et al. 2013). Previous research has included targeted geophysical survey, but not within the current survey area, although aerial photography identified cropmarks in the field immediately north-west of the northern henge, suggesting this is an area of archaeological sensitivity (Deegan 2005; Historic England 2024).

The bedrock geology consists of Permian Edlington Formation calcareous mudstone to the east and Cadeby Formation dolostone to the west. Superficial deposits of Devensian Glaciofluvial Terrace sand and gravel cover the entirety of the site with former aggregate extraction workings found in the immediate vicinity of the henges (Geological Survey of Great Britain 1992a, 1992b; British Geological Survey 2024). The freely draining, slightly acidic and loamy soils developed over the site are of the Wick 1 association (541r) (Soil Survey of England and Wales 1983; Soilscapes 2024).

The field was mostly flat with the grass recently cut for a hay crop and possibly grazed by sheep. The weather was mostly overcast with occasional light rain throughout the three days with heavy rain during the first half of the first day and overnight.

# Method

## Earth Resistance survey

Measurements were recorded over a series of 30m grids established with a Trimble R8s Global Navigation Satellite System (GNSS), Figure 1, using a Geoscan RM85 earth resistance meter, internal multiplexer, and a PA5 electrode frame in the Twin-Electrode configuration, to allow two separate surveys, with mobile electrode separations of 0.5m and 1.0m, to be collected simultaneously. The 0.5m mobile electrode separation coverage was designed to detect near-surface anomalies in the upper 0.5m of the subsurface whilst the 1.0m separation survey allowed anomalies to an approximate depth between 1 and 1.25m to be detected. For the 0.5m mobile electrode separation survey readings were taken at a density of 0.5m by 1.0m whilst for the 1.0m separation survey they were taken at a density of 1.0m by 1.0m.

The minimally processed data, after initial suppression of occasional extreme values caused by high contact resistance using an adaptive thresholding median filter with radius 1m, is presented as trace plots for both the 0.5m and 1.0m mobile electrode separation data sets in Figures 7(A) and (E) respectively. Linear and histogram equalised greyscale images of the minimally processed data, following slight noise reduction using Gaussian low-pass filter of 0.6m radius are shown in Figures 7(B) and (C) for the 0.5m mobile electrode separation data, and 1.0m radius in Figures 7(F) and (G) for the 1.0m mobile electrode separation data (Scollar et al. 1990). The minimally processed near-surface 0.5m mobile electrode separation data following the application of the same noise reduction are also depicted as a linear greyscale image in Figure 4 superimposed on the base Ordnance Survey (OS) mapping data.

To enhance localised low resistance responses to small pits in the near-surface, local contrast enhancement of the 0.5m mobile electrode separation dataset was performed by estimating the linear least-squares relationship between the 0.5m and 1.0m electrode separation measurement pairs at each station and plotting the residual after subtracting the estimated half 0.5m value from that actually measured in the field. This linear least-squares relationship was recalculated at each station using all measurement pairs within a 10m radius, thus accentuating near-surface anomalies of archaeological scale while suppressing the larger-scale geological background variations (Figure 7(D)). In addition, Figure 7 (H) shows the application of a 3m radius Gaussian high-pass filter to enhance linear anomalies in the 1.0m mobile electrode separation data set.

## Caesium Magnetometer survey

Magnetometer data were collected along the instrument swaths shown in Figure 2 using an array of six Geometrics G862 caesium vapour sensors mounted on a non-magnetic sledge (Linford et al. 2018). The sledge was towed behind a low-impact All-Terrain Vehicle (ATV) which housed the power supply and data logging electronics. Five sensors were mounted 0.5m apart in a linear array transverse to the direction of travel and, vertically at a height approximately 0.36m above the ground surface. The sixth was fixed 1.0m directly above the centre of this array to act as a gradient sensor. The sensors were sampled at a rate of 25Hz resulting in an along-line sample density of approximately 0.12m given typical ATV travel speeds of between 2.5 and 3.0m/s. As the five non-gradient sensors were 0.5m apart, successive survey swaths were separated by approximately 2.5m to maintain a consistent traverse separation of 0.5m. Navigation and positional control were achieved using a Trimble R8s (GNSS) receiver mounted on the sensor platform 1.65m in front of the central sensor and a second R8s base station receiver established using the Ordnance Survey VRS Now correction service. Sensor output and survey location were continuously monitored during acquisition to ensure data quality and minimise the risk of gaps in the coverage.

After data collection, the corresponding readings from the gradient sensor were subtracted from the measurements made by the other five magnetometers to remove any transient magnetic field effects caused by the towing ATV or other nearby vehicles. The median value of each instrument traverse was then adjusted to zero by subtracting a running median value calculated over a 50m 1D window (see for instance Mauring et al. 2002). This operation corrects for any remaining biases added to the measurements owing to the diurnal variation of the Earth's magnetic field.

A linear greyscale image of the minimally processed data between the limits of ±1.5nT/m is shown superimposed over the base Ordnance Survey (OS) mapping in Figure 5. Figure 8(A) shows a trace plot of the minimally processed data range truncated to limits of ±100nT/m, and as a histogram equalised greyscale image in Figure 8(B). In addition, the minimally processed data shown in both greyscale images, Figures 5 and 8(B), has been subject to directional and high-pass filtering in the Fourier domain to suppress the influence of the most recent cultivation pattern.

## Ground Penetrating Radar survey

A 3d-Radar (Kontur) MkIV GeoScope Continuous Wave Step Frequency (CWSF) Ground Penetrating Radar (GPR) system was used to conduct the survey collecting data with a multi-element DXG1820 vehicle towed, ground coupled antenna array (Linford et al. 2010; Eide et al. 2018). A roving Trimble R8s GNSS receiver was mounted on the GPR antenna array, that together with a second R8s base station was used to provide continuous positional control for the survey collected along the instrument swaths shown on Figure 3. The GNSS base station receiver was adjusted to the National Grid Transformation OSTN15 using the Trimble VRS Now Network RTK delivery service. This uses the Ordnance Survey GNSS correction network (OSNet) and gives a stated accuracy of between 0.01 and 0.015m per point with vertical accuracy being half as precise.

Data were acquired at a 0.075m by 0.075m sample interval across a continuous wave step frequency range from 40MHz to 2.99GHz in 4MHz increments using a dwell time of 2ms. A single antenna element was monitored continuously to ensure data quality during acquisition together with automated processing software to produce real time amplitude time slice representations of the data as each successive instrument swath was recorded in the field (Linford 2013).

Post-acquisition processing involved conversion of the raw data to time-domain profiles (through a time window of 0 to 75ns), adjustment of time-zero to coincide with the true ground surface, background and noise removal, and the application of a suitable gain function to enhance late arrivals. Representative profiles from the full GPR survey data set are shown on Figure 9. To aid visualisation amplitude time slices were created from the entire data set by averaging data within successive 2.5ns (two-way travel time) windows (e.g. Linford 2004). An average sub-surface velocity of 0.114m/ns was assumed following constant velocity tests on the data and was used as the velocity field for the time to estimated depth conversion. Each of the resulting time slices therefore represents the variation of reflection strength through successive approximately 0.14m intervals from the ground surface, shown as individual greyscale images in Figures 6, and 10 to 13. Further details of both the frequency and time domain algorithms developed for processing this data can be found in Sala and Linford (2012).

# Results

## Earth Resistance survey

A graphical summary of significant earth resistance anomalies [**r1**-**19**] discussed in the following text superimposed on the base OS mapping data is provided in Figure 13.

A low resistance semi-circular ditch anomaly has been detected at [**r1**] forming an arc that appears to block or screen access to the northern entrance to the henge.

Another series of ditch segments have been detected as low resistance anomalies at [**r2-4**] immediately to the south-west and at [**r5**] to the north-east, with [**r2-4**] forming a closely spaced group followed by a broad gap facing the northern entrance of the henge and [**r1**]. This series of segmented ditches [**r2-5**] appear to form elements of an interrupted ditch circuit concentric with the outer upstanding bank of the northern henge, that together with [**r1**] and existing aerial photography, suggest a considerable elaboration of the monument known from the standing remains largely located in the wooded area to the south.

An area of high resistance [**r6**] against the southern field boundary may represent stonier material spread from the outer bank of the main henge to the south-east or, perhaps, deposits of material excavated from the ditches at [**r1**] and [**r2-4**]. It would appear that [**r6**] stops at the north entrance of the henge which may also relate to the same entrance gap screened by [**r1**].

Four regularly spaced, small pit-type anomalies [**r7-10**] are just visible in the 0.5m mobile electrode separation data extending on a south-east to north-west alignment from the south-west side of the main henge entrance and [**r1**]. Anomalies [**r7-10**] are likely to represent a second pit alignment parallel to the pits known in this area from aerial photographs (cf [**m4**]). An additional anomaly, might be expected between [**r8**] and [**r9**] if these pits were regularly spaced but only a single larger more irregularly shaped pit-type response [**r11**] is present offset to the west within a broader area of lower resistance [**r12**]. Anomaly [**r11**] is again only really evident in the near-surface 0.5m mobile electrode separation data (Figures 7(B) and 7(D)).

Broader areas of low [**r12**] and high resistance [**r13**] may relate to variation in the near-surface gravel deposits or, perhaps, unrecorded areas of small-scale quarrying. A more significant interpretation of [**r12**] and [**r13**] cannot be entirely discounted as they follow an alignment not dissimilar to ditch-type anomalies [**r2-4**] to the south, although appear rather too large in area to be archaeological in origin.

A series of mixed linear high [**r14**] and [**r15**], and low [**r16-19**] resistance anomalies following a west-south-west to east-north-east orientation across the north of the survey coverage corresponds with the location of the former gravel haul road between the previous extraction pits.

## Caesium Magnetometer survey

A graphical summary of significant magnetic anomalies [**m1-13**] discussed in the following text superimposed on the base OS mapping data is provided in Figure 14.

A curved positive anomaly [**m1**] has been detected in the south of the survey area, appearing to largely contain the mapped entrance to the northern henge. The broader anomaly [**m2**] to the east of [**m1**] is likely to be a outer ditch associated with the northern henge and the smaller, less defined reponse [**m3**] to the west of [**m1**] may indicate the opposing end of the outer ditch.

To the north-west of [**m3**] are two parallel pit alignments [**m4**]. The two lines of pits are separated by between approximately 26.5m to 27.5m and the diameter of the magnetic anomaly of each pit is between approximately 1.5m to 2m. A further series of pit-type anomalies [**m5**] lie to the north-east and are much larger in size with magnetic responses between approximately 3m to 4m in diameter. It is not possible from the magnetometer data to ascertain the origin or relation of the pits to the henge. The pit alignment at [**m5**] also appears to respect the parallel linear low and high magnetic anomaly [**m6**], which is likely to be the continuation of a historic field boundary found immediately to the north and south of the survey area. Abutting [**m6**] and apparently passing through [**m5**], are a series of faint, negative anomalies [**m7**] which tentatively form a circular shape. While [**m7**] could have been produced from agricultural activity, given the proximity to anomalies of likely archaeological origin and the northern henge, [**m7**] may have some archaeological significance.

A former field boundary appears as a linear anomaly [**m8**] with a mixed polarity of response, which is known from historic mapping (Ordnance Survey, Historic County Mapping Series: Yorkshire 1943-1893 Epoch 1). Linear anomalies [**m9**] are possibly associated with a previous agricultural pattern although it is difficult to determine whether this is due to more recent activity of or, perhaps, relict ridge and furrow. A series of anomalies [**m10**] are found across the survey area, from the gate in the north-east to the west end of the field, of varying magnetic response following the course of the former gravel haul road. The road appears to be a short-lived landscape feature it was recorded on background mapping used for previous research of the Thornborough complex (eg Figure 3.7 in Harding et al. 2013). The high magnitude ferrous anomaly [**m11**], while located close to the west entrance, is offset to the current gate, suggesting the western entrance to the field may have been moved.

A group of disjointed linear and discrete anomalies [**m12**] are found between [**m6**] and [**m8**] that share a similar east to west-north-west alignment and mostly demonstrate a strong magnitude of response. The anomalies forming [**m12**] are likely to be associated with each other due to their similar orientation and response, however, given the discontinuous nature and dissimilarity from the surrounding magnetic activity, ascribing a definitive interpretation is difficult, but one of archaeological significance cannot be entirely ruled out.

Within the data set are a number of anomalies of known modern origin. These include [**m13**] which corresponds to telegraph poles located in the field. Other ferrous anomalies detected at the edge of the survey area have been produced from wire fencing. Numerous discrete ferrous anomalies have also been identified, which are likely to be of modern origin.

## Ground Penetrating Radar survey

A graphical summary of the significant anomalies, [**gpr1**-**22**] discussed in the following text, superimposed on the base OS map data, is provided in Figure 15.

Reflections have been recorded throughout the 75ns two-way travel time window, although there are few significant responses beyond a two-way travel time of approximately 35.0ns (2.0m) where the signal is more heavily attenuated. The very near-surface responses between 0.0 and 5.0ns (0.0 to 0.29m) contain anomalies [**gpr1**] related to vehicle tracks and the most recent cultivation pattern. The response is largely uniform throughout the 35ns two-way travel time with the dominant linear high and low amplitude anomaly [**gpr2**] corresponding with the response to the gravel haul road [**m10**]. The varying amplitude of response may have been produced from laying different material along the gravel haul road and its movement and change over time. The high-amplitude anomalies at either end of [**gpr2**] suggest compacted material where the haul road meets the public carriage-way.

A number of sub-annular high-amplitude anomalies [**gpr3**] appear between 0.0 and 5.0ns (0.0 to 0.29m) with diameters between 2.0 and 4.0m. While [**gpr3**] could represent animal burrows, the sub-annular morphology is more suggestive of fungal ‘fairy rings’ that have been noted on other sites and could be confused with more significant pit-type anomalies (Linford et al. 2020).

The former field boundary [**m8**] has produced a diffuse high-amplitude linear response [**gpr4**] between 7.5 and 15.0ns (0.43 to 0.85m) and the largely low-amplitude ditch-type anomaly [**gpr5**] corresponds with the probable unmapped historic field boundary [**m6**]. The series of pits [**m5**] have been detected in the GPR data set as low-amplitude anomalies [**gpr6**], most evident between 20.0 and 22.5ns (1.28 to 1.43m). While pits forming [**gpr6**] share an apparent alignment with the former field boundary [**gpr5**] to the east there is an additional high-amplitude anomaly [**gpr7**] found between 17.5 and 22.5ns (1.0 to 1.43m), immediately to the west on a differing orientation.

Only two of the series of pits [**m4**] in the south-west of the survey area have been detected as low-amplitude anomalies [**gpr8**] found between 10.0 and 30.0ns (0.57 to 1.71m). Two discrete low-amplitude anomalies [**gpr9**] identified in this area correspond with the previous locations of animal feeders noted on the surface. Other low-amplitude anomalies [**gpr10**] are located in the centre of the survey area, and appear more natural in origin, or are perhaps due to historic quarrying. Additional discrete responses [**gpr11**], are also possibly pits, found in the north of the field associated with [**gpr2**], and towards the south-west end of the field. However [**gpr11**] appear as high-amplitude responses, suggesting they potentially contain a greater proportion of possibly compacted gravel. The high-amplitude anomaly [**gpr12**] located along the south-western edge of the field has probably been produced from compacted material from agricultural machinery entering through the gate. The two areas of near-surface low-amplitude response [**gpr13**] in the north of the survey area and curvilinear anomalies extending from [**gpr2**], are likely to be of geomorphological origin.

A curvilinear diffuse low-amplitude anomaly [**gpr14**] is found between 7.5 and 22.5ns (0.43 to 1.28m) along the south-eastern edge of the field and corresponds with [**m2**], most likely the outer ditch to the henge with some evidence for segmented construction (cf [**r2-4**] and [**r5**]) in the deeper time slices (Dennison 1998; Deegan 2005). An area of low-amplitude response [**gpr15**] found between 7.5 and 22.5ns (0.43 to 1.28m) could indicate a surface layer associated with the entrance to the henge. A ditch-type anomaly [**gpr16**], corresponding with [**m1**], encircles [**gpr15**] and from between 20.0 and 32.5ns (1.14 to 1.85m) a high-amplitude response is evident, possibly associated with more compacted deposits towards the base of the ditch fill.

A wider area of low-amplitude response [**gpr17**] appears to contain [**gpr14-16**], possibly a surface layer surrounding the entrance to the henge. High-amplitude anomalies [**gpr18**] to the south correspond approximately with [**m3**]. While the magnetic data suggests [**m3**] may be part of the same outer ditch as [**m2**], anomalies [**gpr14**] and [**gpr18**] have a dissimilar response that could imply either unrelated causative features or, perhaps, different material in-filling the ditches. A series of subtle, mainly linear high-amplitude anomalies, [**gpr19**] are also found in the vicinity of the northern entrance to the henge between 22.5 and 47.5ns (1.28 to 2.71m). It is difficult to provide a definitive interpretation for [**gpr19**] and while a more significant archaeological origin should not be dismissed the depth of the anomalies may, perhaps, be more suggestive of a geomorphological response. It is difficult to determine if [**gpr20**], immediately to the west, is related to the northern henge, the gravel haul road [**gpr2**], or is geomorphological in origin. In addition, it is difficult to provide a confident interpretation for anomalies [**gpr21**] and [**gpr22**], as they could have been produced from either archaeological or more recent quarrying activity but might also be due to a geomorphological origin.

# Conclusions

The earth resistance, caesium magnetometer and Ground Penetrating Radar surveys have successfully identified anomalies that suggest the Thornborough northern henge extends into the survey area with possible outer ditches and evidence for other outer works. A number of pit-type anomalies and linear pit alignments of likely archaeological significance have been identified across the survey area. In comparison to the previous aerial photography the geophysical survey has revealed a second parallel pit-alignment immediately to the east of the pits identified from cropmarks. A further alignment of more substantial pit-type anomalies has also been identified possibly associated with a former field boundary in the north-east of the survey area. The cropmarks also appear to have indicated a pair of narrow arching ditches as the elaboration outside the north entrance to the northern henge, whereas the geophysical data suggests a single broader ditch-type response. In addition, the location of the former gravel haul road across the field has been confirmed, together with anomalies related to more recent agricultural activity.

# List of Enclosed Figures

# References

British Geological Survey 2024. "Thornborough, Hambleton, North Yorkshire." British Geology Viewer. Retrieved 04/07/2024, from https://geologyviewer.bgs.ac.uk/.

Deegan, A 2005 *'Aggregates Levy Sustainability Fund Thornborough Henges: Air Photo Mapping Project (3897). Summary of Resources and Results'*. West Yorkshire Archaeological Service report for English Heritage Research Report Series **82/2005**.

Dennison, E 1998 *'Thornborough North Henge, Tanfield Archaeological and Ecological Survey'*. Ed Dennison Archaeological Services Ltd.

Eide, E, Linford, N, Persico, R and Sala, J 2018 'Advanced SFCW GPR systems' *in* Persico, R, Piro, S and Linford, N (eds), *Innovation in Near-Surface Geophysics Instrumentation, Application, and Data Processing Methods* Amsterdam: Elsevier, 253-285.

English Heritage 2024. "History of Thornborough Henges." from https://www.english-heritage.org.uk/visit/places/thornborough-henges/history/?_gl=1*129z0p*_up*MQ..*_ga*MjA5ODUwMDMyOC4xNzIwMDg1MDg0*_ga_QK86RM1N34*MTcyMDA4NTA4My4xLjAuMTcyMDA4NTA4My4wLjAuMA..

Geological Survey of Great Britain 1992a Thirsk, Geological Survey of England and Wales, Sheet 52. Drift Edition Drift. Southampton, The Director General of the Ordnance Survey.

Geological Survey of Great Britain 1992b Thirsk, Geological Survey of England and Wales, Sheet 52. Solid Edition Solid Devensian. Southampton, The Director General of the Ordnance Survey.

Harding, J, Allason-Jones, L, Aspinall, A, Biggins, A, Dennison, E, Groves, S, Mays, S, Johnson, B, Laurie, E, Makey, P, Martlew, R, Schmidt, A, Strutt, K and Vyner, B 2013 *'Cult, Religion, and Pilgrimage: archaeological investigations at the Neolithic and Bronze Age monument complex of Thornborough, North Yorkshire '*. Council for British Archaeology **CBA research report 174**.

Historic England 2024. "Aerial Archaeology Mapping Explorer." from https://historicengland.org.uk/research/results/aerial-archaeology-mapping-explorer/

Linford, N 2004 'From Hypocaust to Hyperbola: Ground Penetrating Radar surveys over mainly Roman remains in the U.K.'. *Archaeological Prospection*, **11** (4), 237-246.

Linford, N 2013. *Rapid processing of GPR time slices for data visualisation during field acquisition*. In Neubauer, W, Trinks, I, Salisbury, R and Einwogerer, C (Editors), Archaeological Prospection, Proceedings of the 10th International Conference, May 29th - June 2nd 2013 2013 (Vienna: Austrian Academy of Sciences Press). 176-78

Linford, N, Linford, P, Martin, L and Payne, A 2010 'Stepped-frequency GPR survey with a multi-element array antenna: Results from field application on archaeological sites'. *Archaeological Prospection*, **17** (3), 187-198.

Linford, N, Linford, P and Payne, A 2020 *'Audley End, Littlebury and Saffron Walden,Essex, Report on Geophysical Surveys, June and November 2019'*. Historic England Research Report Series **188/2020**. [web page] https://historicengland.org.uk/research/results/reports/7946/AudleyEndLittleburyandSaffronWaldenEssex_ReportonGeophysicalsurveysJuneandNovember2019.

Ordnance Survey 1843-1893 Historic County Mapping Series: Yorkshire (1843-1893) Epoch 1.

Sala, J and Linford, N 2012 'Processing stepped frequency continuous wave GPR systems to obtain maximum value from archaeological data sets '. *Near Surface Geophysics*, **10** (1), 3-10.

Scollar, I, Tabbagh, A, Hesse, A and Herzog, I 1990 *Archaeological Prospecting and Remote Sensing*. Topics in Remote Sensing. Cambridge, Cambridge University Press.

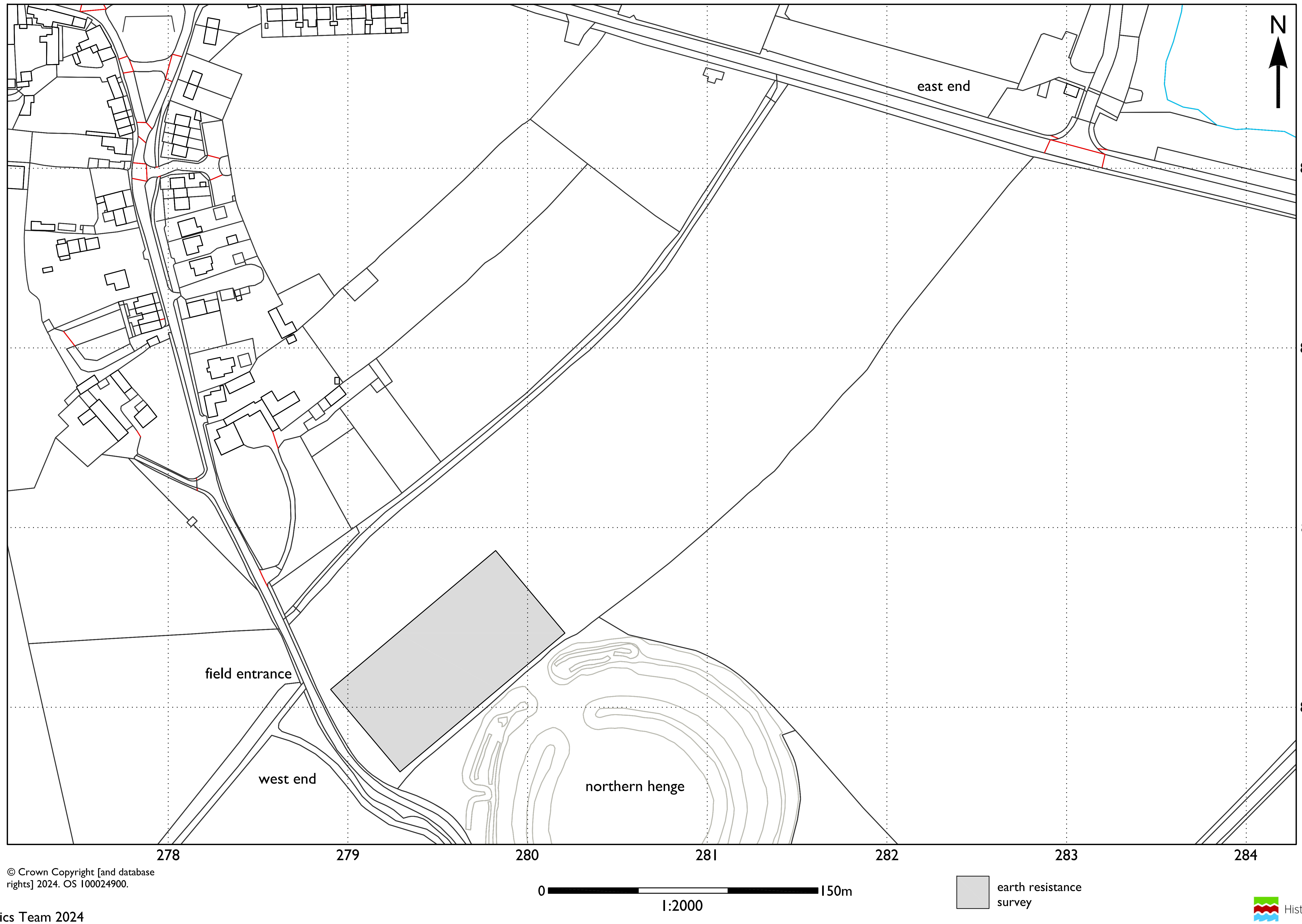
Soil Survey of England and Wales 1983 Soils of England and Wales, Sheet 1 - Northern England, 1:250,000 scale soil map, Lawes Agricultural Trust, Harpenden.

Soilscapes 2024. "Thornborough, DL8, North Yorkshire, Yorkshire and the Humber, England." Retrieved 04/07/2024, from https://www.landis.org.uk/soilscapes/.

Figure 1

# THORNBOROUGH NORTHERN HENGE, WEST TANFIELD, NORTH YORKSHIRE

## Location of earth resistance survey grids, July 2024






Geophysics Team 2024

Historic England

Figure 2

# THORNBOROUGH NORTHERN HENGE, WEST TANFIELD, NORTH YORKSHIRE

## Location of caesium magnetometer instrument swaths, July 2024

SE2880

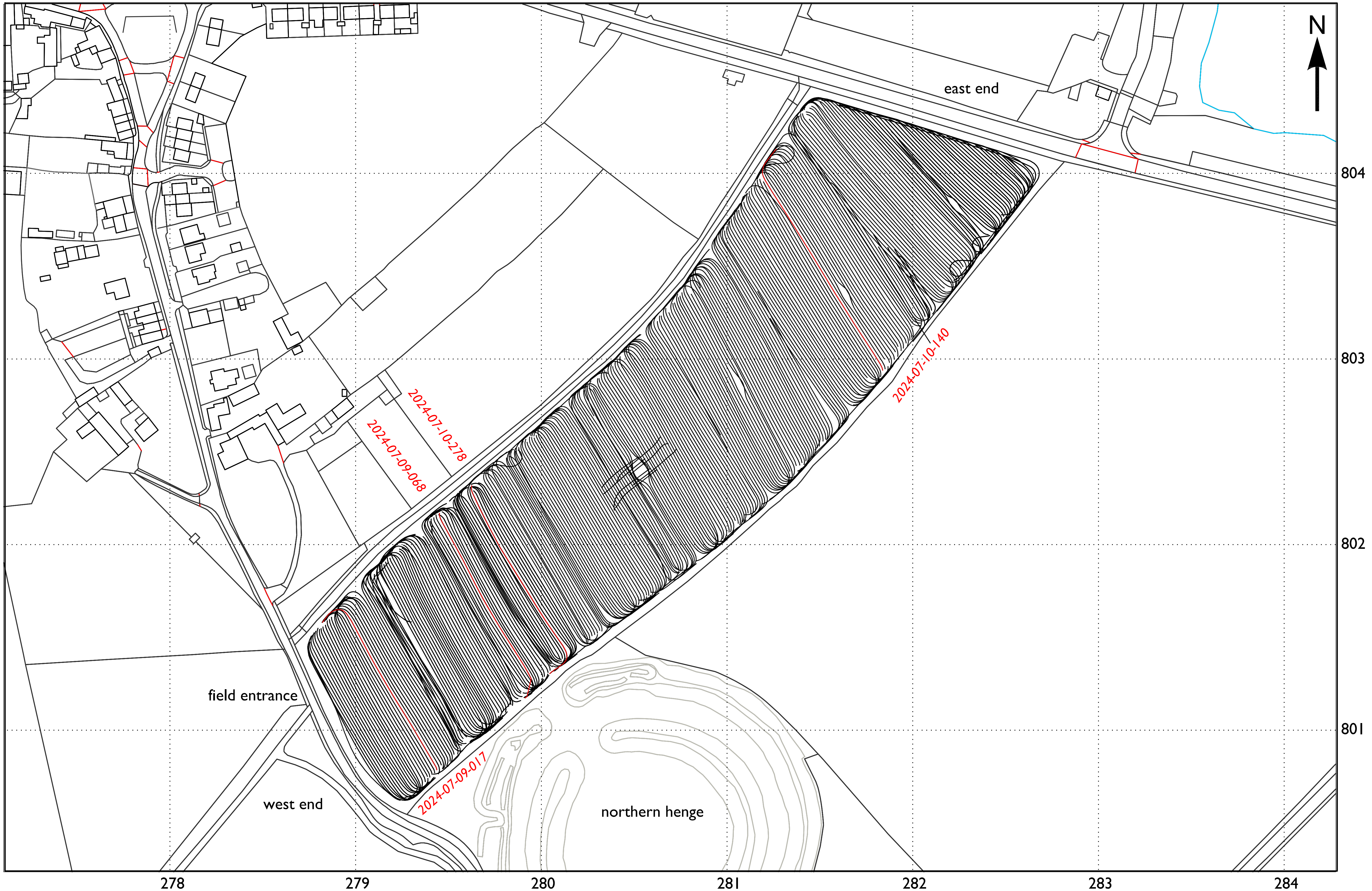



Geophysics Team 2024

Historic England

Figure 3

# THORNBOROUGH NORTHERN HENGE, WEST TANFIELD, NORTH YORKSHIRE
## Location of GPR instrument survey swaths, July 2024






0 150m
1:2000

GPR instrument survey swaths

*2024-04-30-001* Location of selected GPR profiles shown on Figure 9

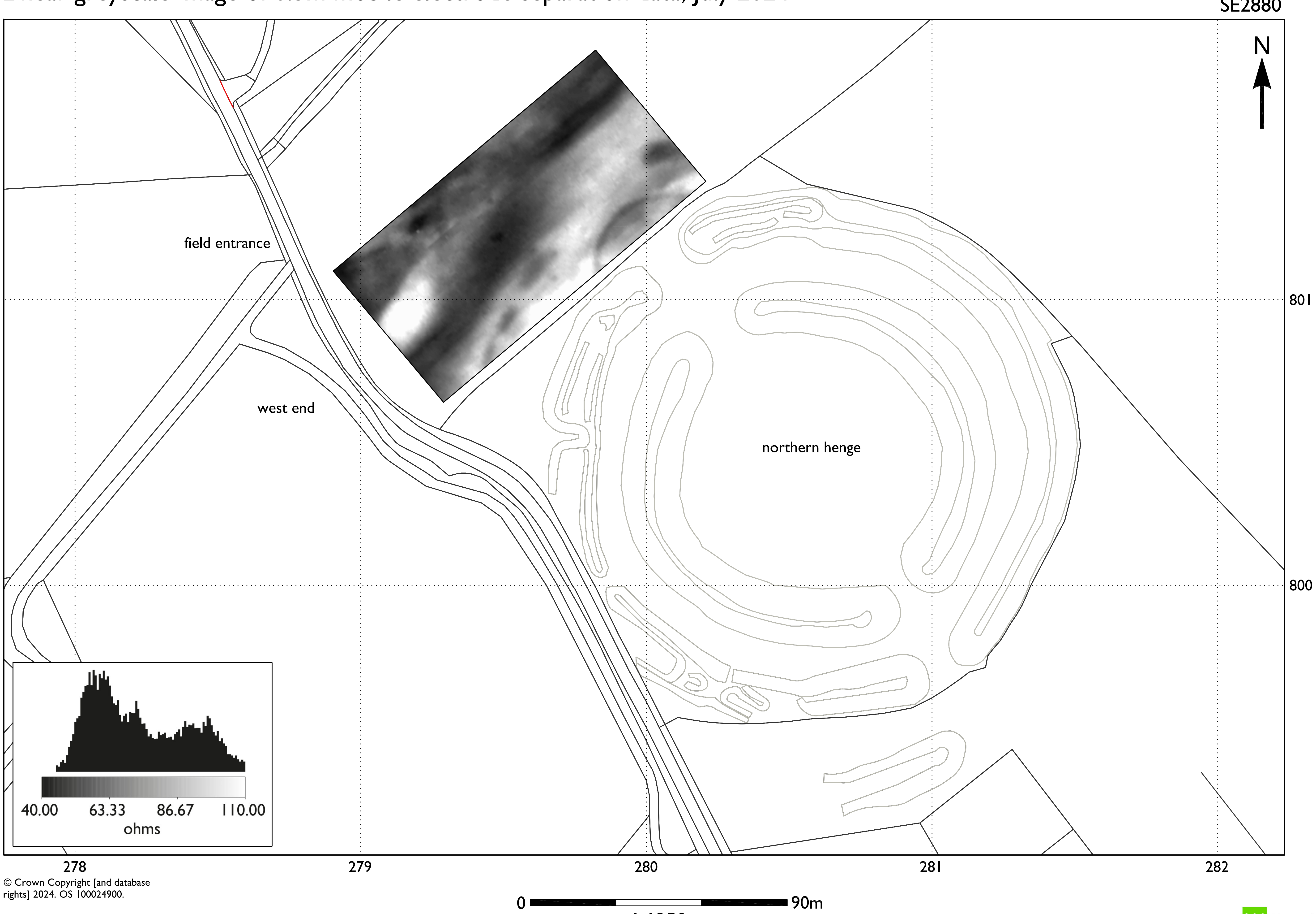
Historic England

Geophysics Team 2024

Figure 4

# THORNBOROUGH NORTHERN HENGE, WEST TANFIELD, NORTH YORKSHIRE

## Linear greyscale image of 0.5m mobile electrode separation data, July 2024






Geophysics Team 2024

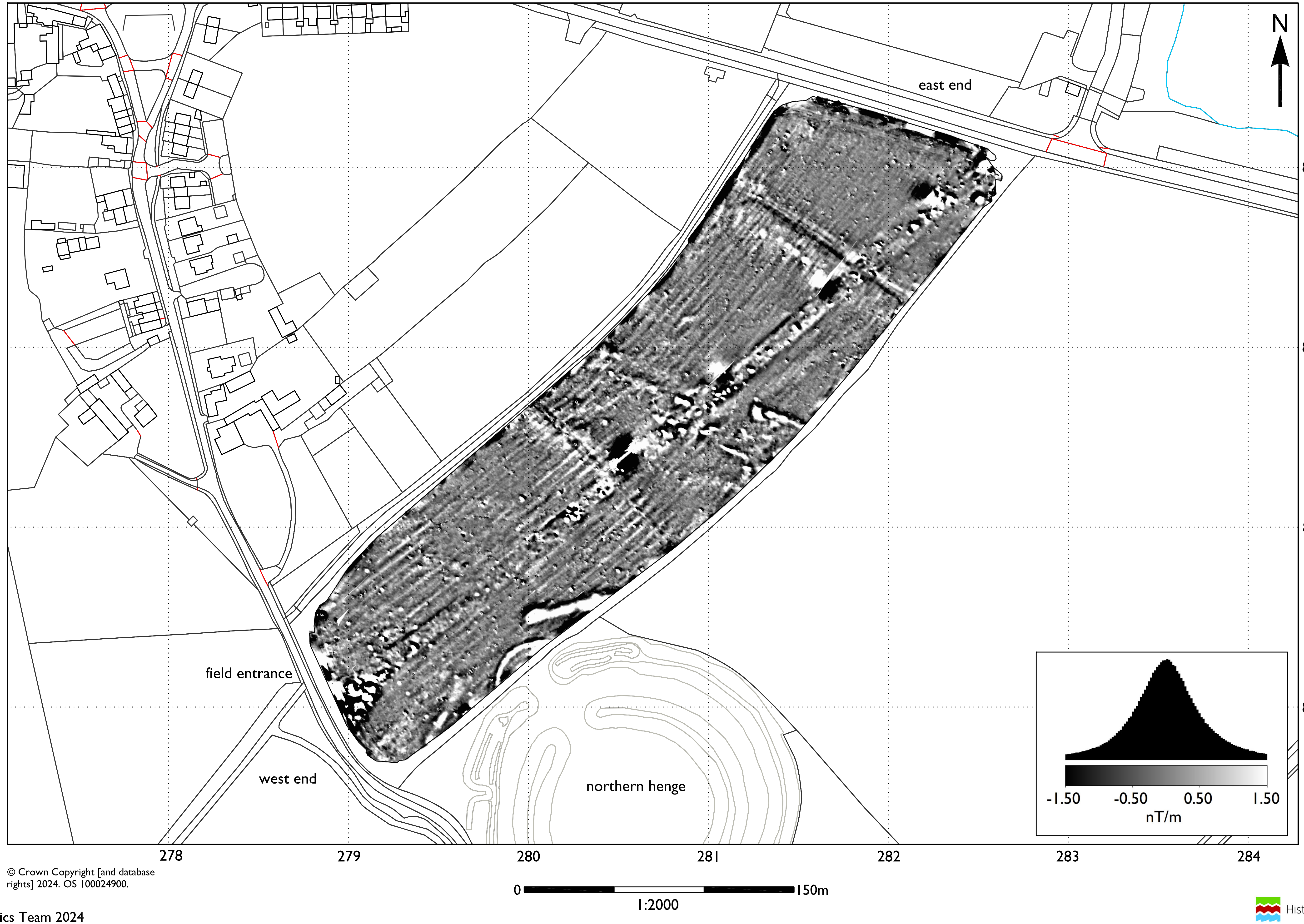
Historic England

Figure 5

# THORNBOROUGH NORTHERN HENGE, WEST TANFIELD, NORTH YORKSHIRE

## Linear greyscale image of caesium magnetometer data, July 2024

SE2880






Geophysics Team 2024

Historic England

Figure 6

# THORNBOROUGH NORTHERN HENGE, WEST TANFIELD, NORTH YORKSHIRE

## GPR amplitude time slice between 20.0 and 22.5ns (1.14 to 1.28m), July 2024



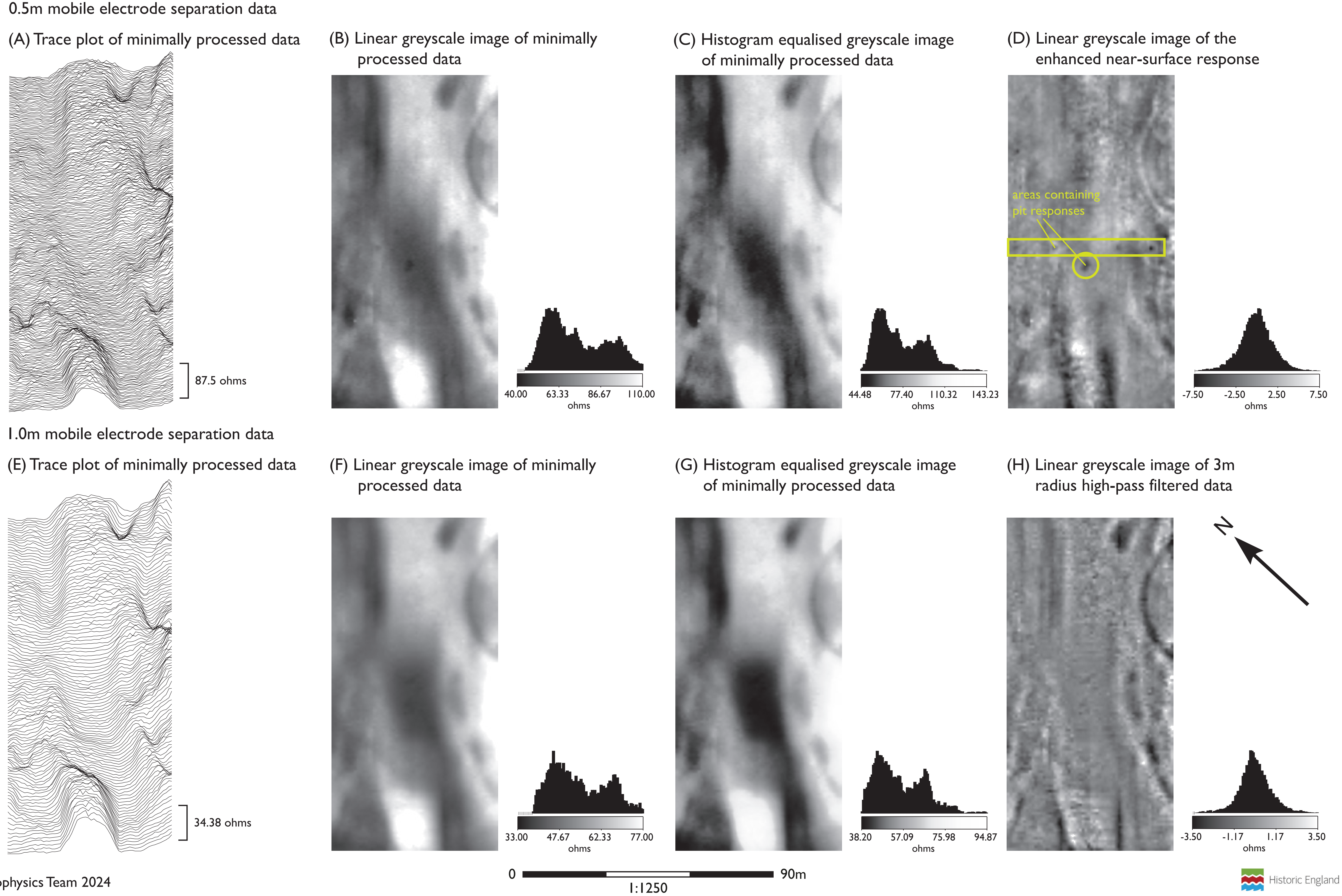

Geophysics Team 2024

Historic England

Figure 7

# THORNBOROUGH NORTHERN HENGE, WEST TANFIELD, NORTH YORKSHIRE

## Earth resistance survey, July 2024



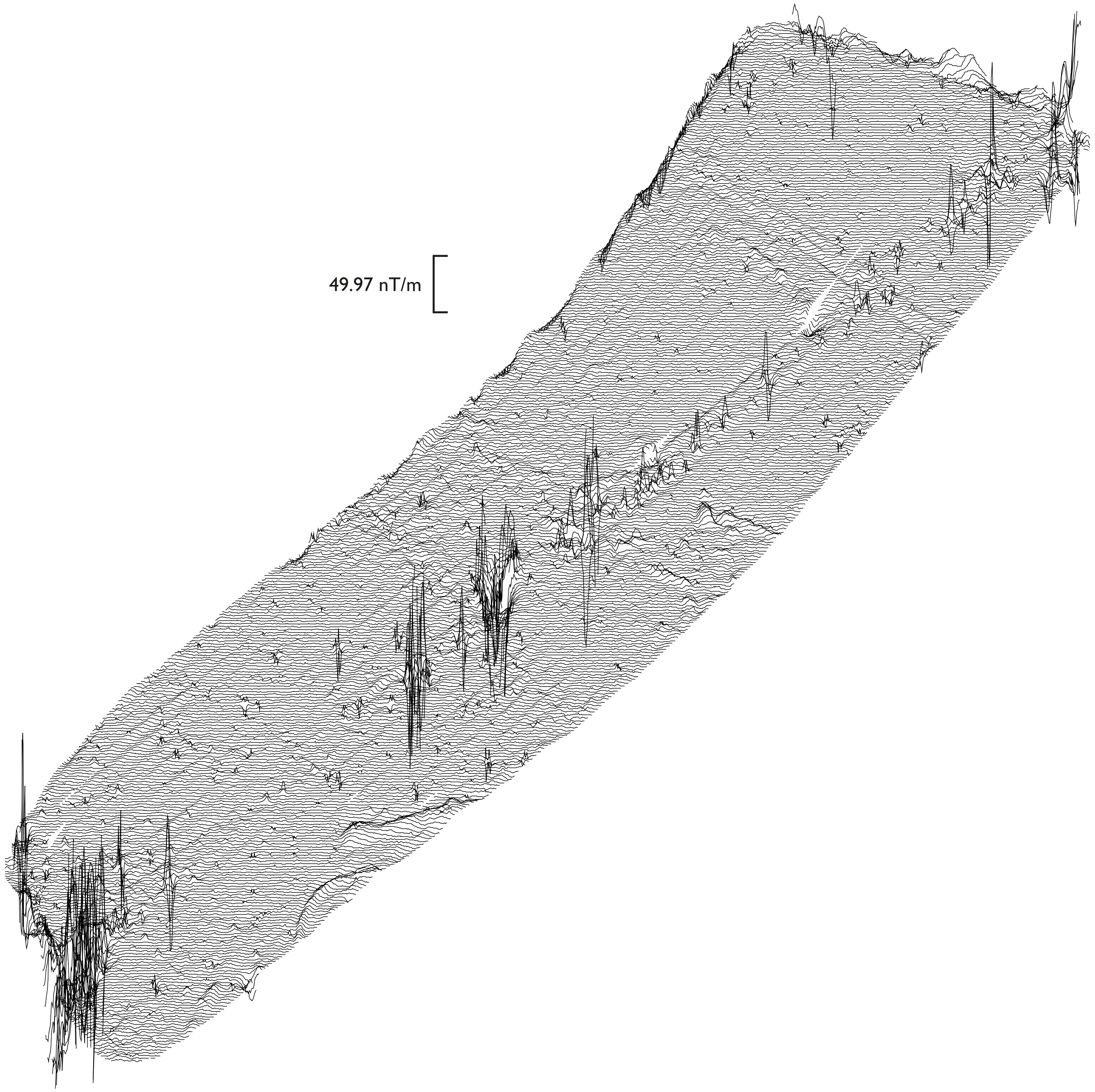

Geophysics Team 2024

Historic England

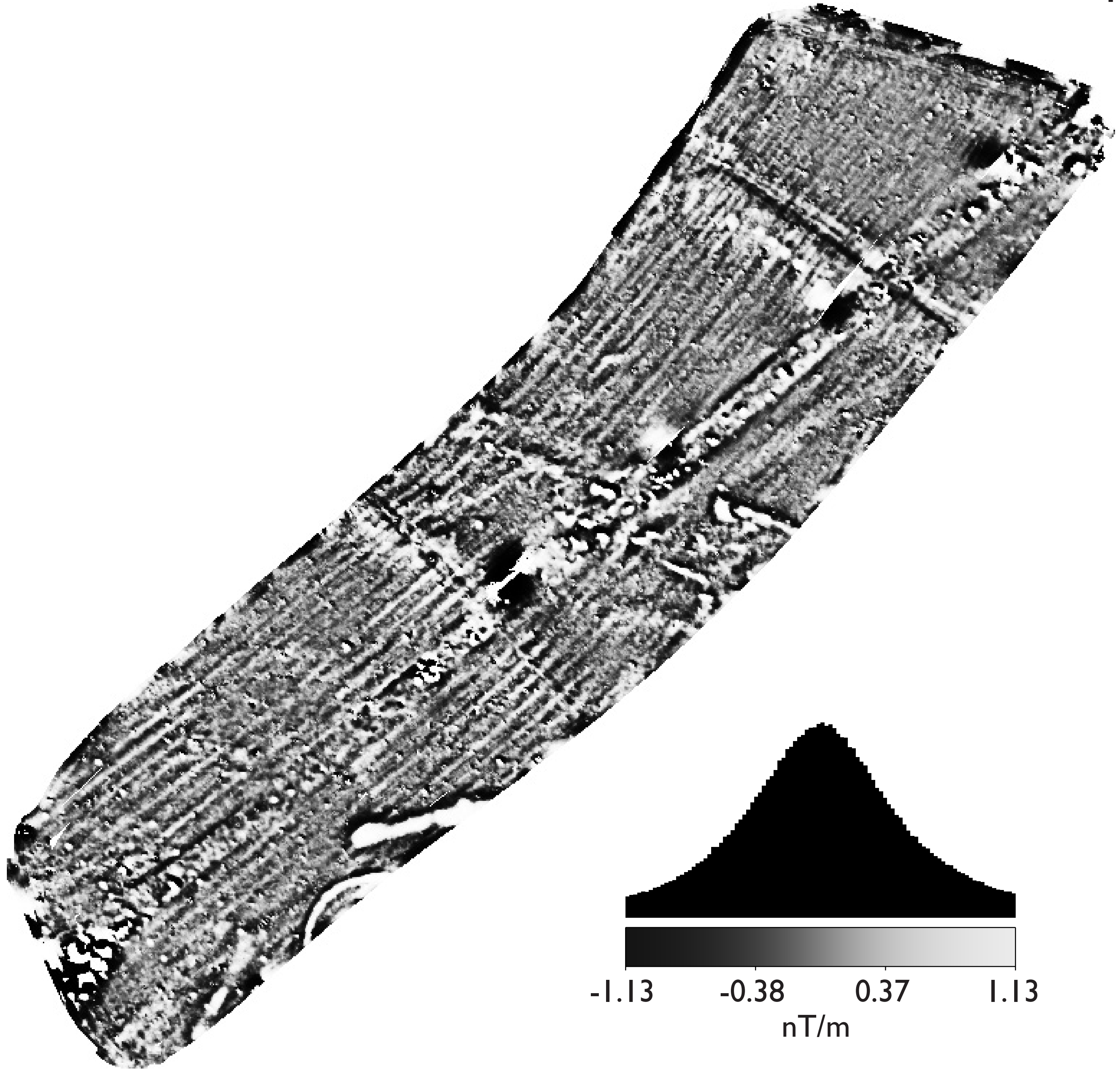
Figure 8

# THORNBOROUGH NORTHERN HENGE, WEST TANFIELD, NORTH YORKSHIRE
## Caesium magnetometer survey, July 2024

(A) Trace plot of minimally processed data after range (-/+100 nT/m) truncation

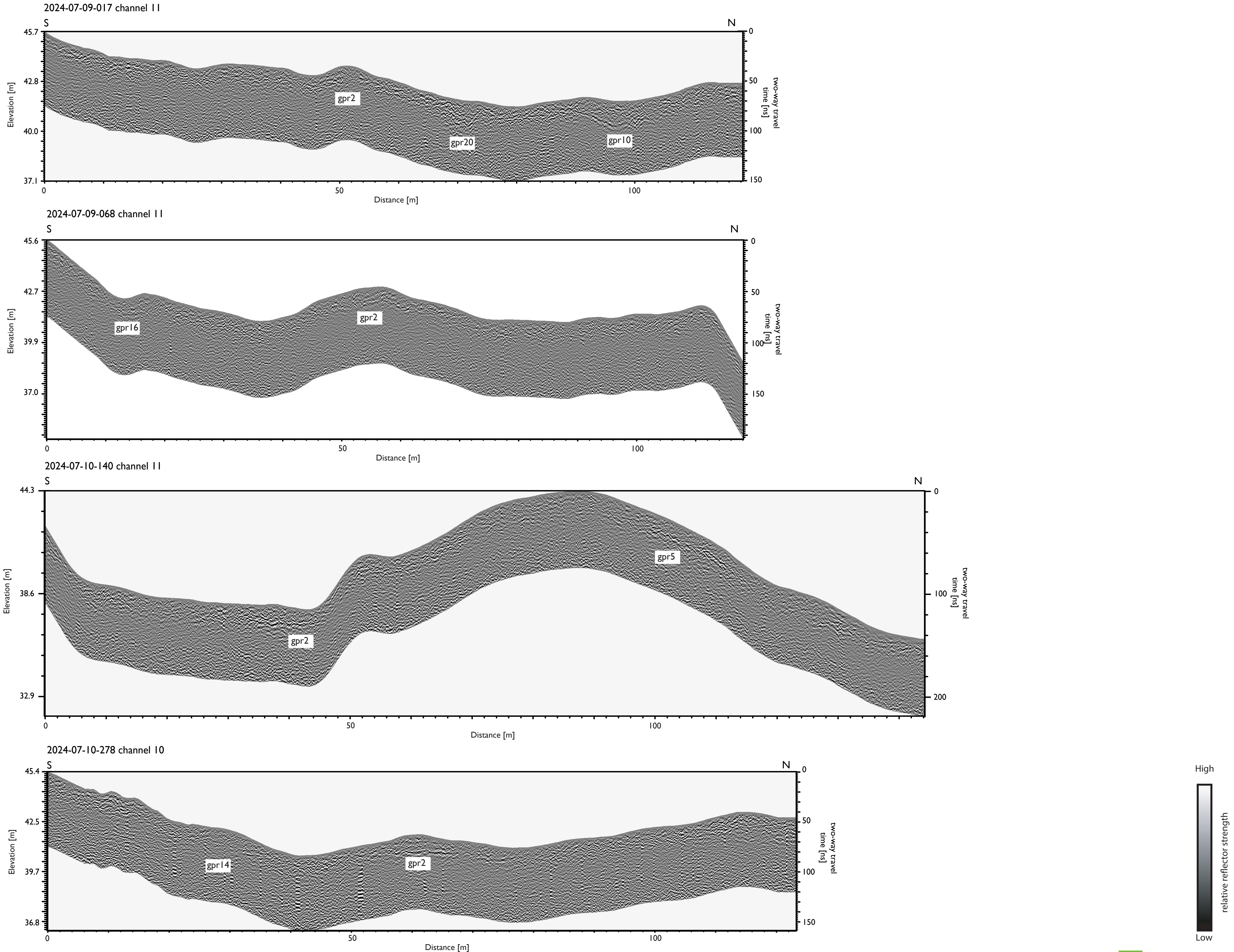



(B) Histogram equalised greyscale image of minimally processed data



NORTH THORNBOROUGH HENGE, WEST TANFIELD, NORTH YORKSHIRE
Representative topographically corrected GPR profiles, July 2024

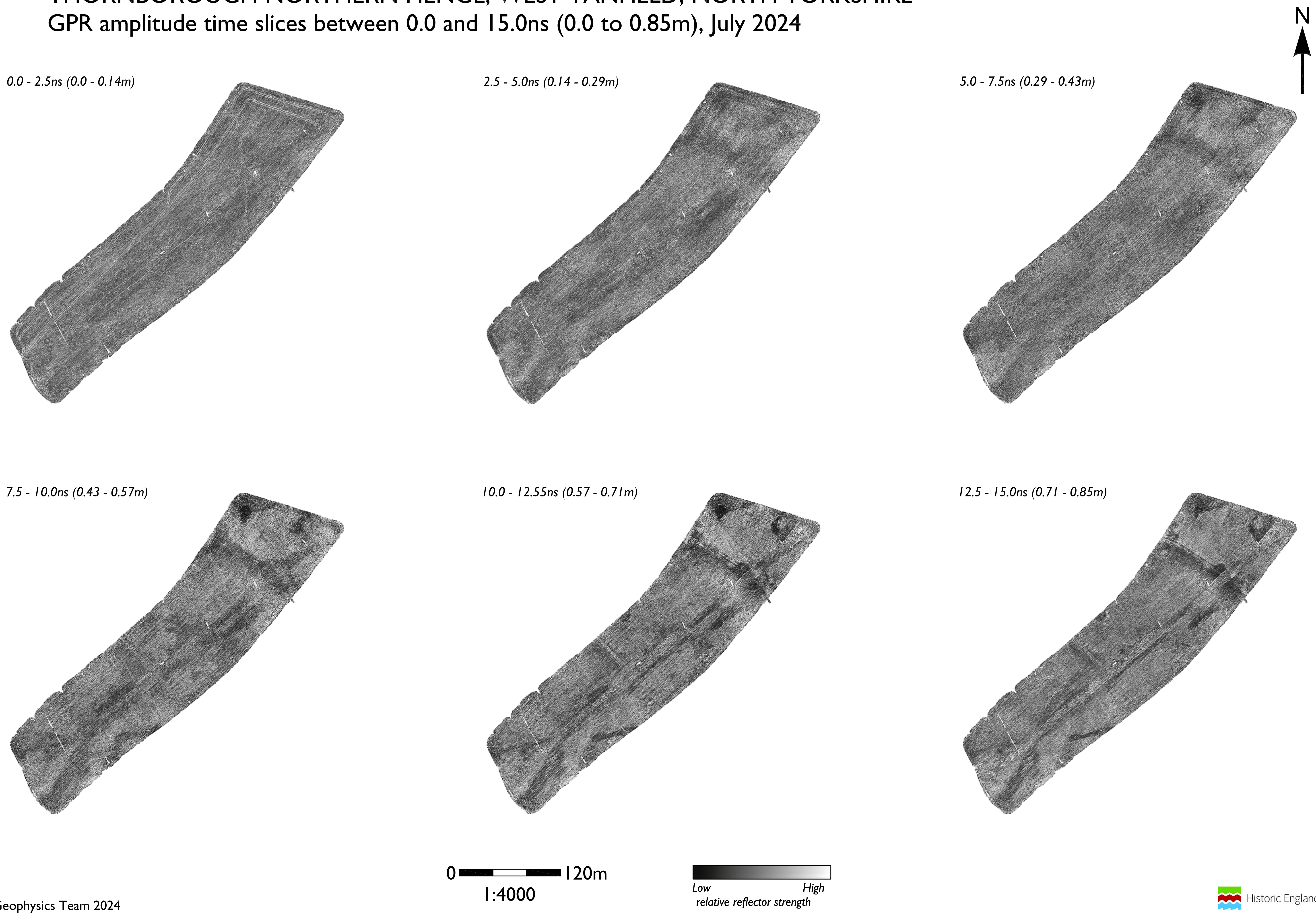
Figure 9




Geophysics Team 2024

Figure 10

# THORNBOROUGH NORTHERN HENGE, WEST TANFIELD, NORTH YORKSHIRE
## GPR amplitude time slices between 0.0 and 15.0ns (0.0 to 0.85m), July 2024

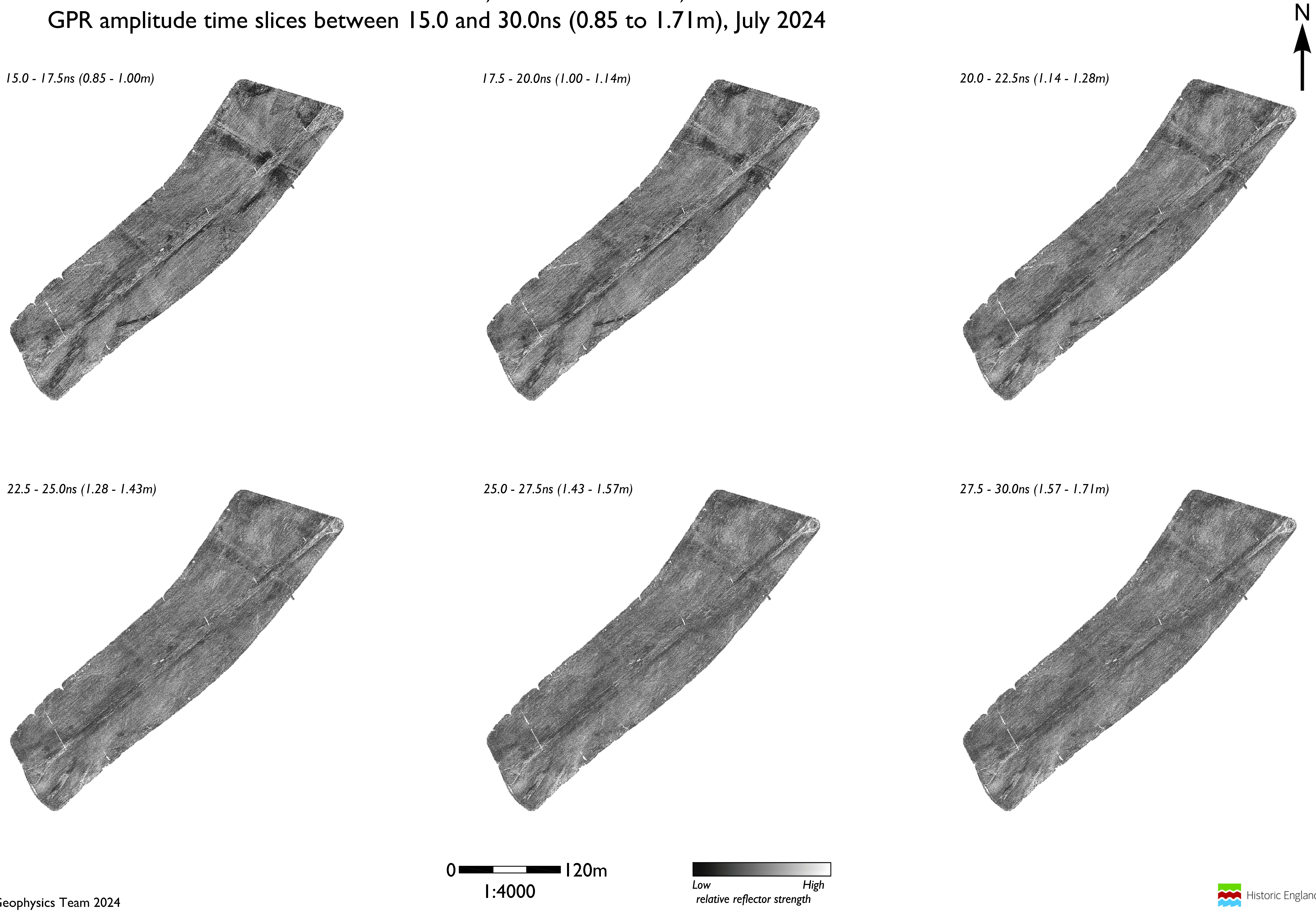



Geophysics Team 2024

Historic England

Figure 11

# THORNBOROUGH NORTHERN HENGE, WEST TANFIELD, NORTH YORKSHIRE
## GPR amplitude time slices between 15.0 and 30.0ns (0.85 to 1.71m), July 2024




Geophysics Team 2024

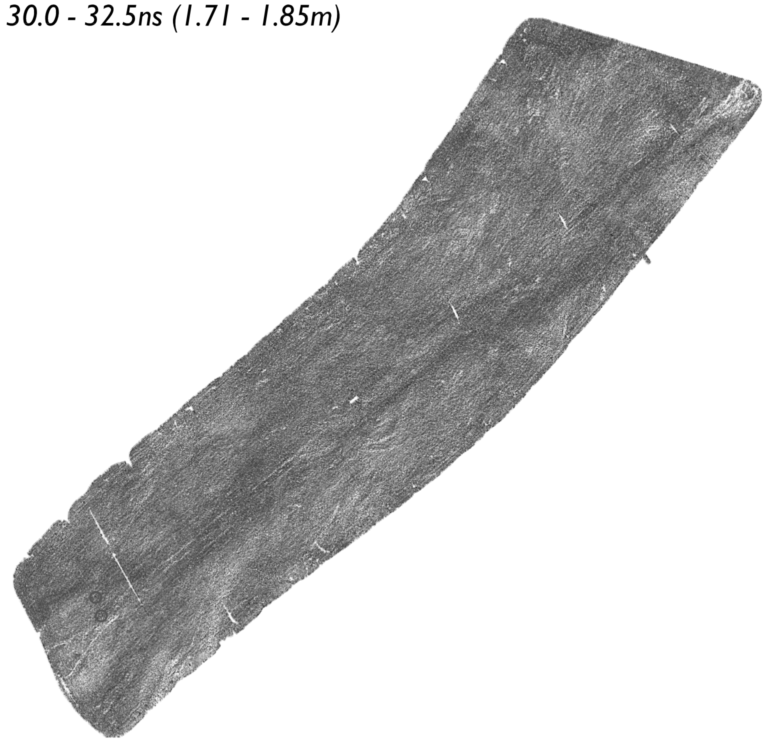
Historic England

Figure 12

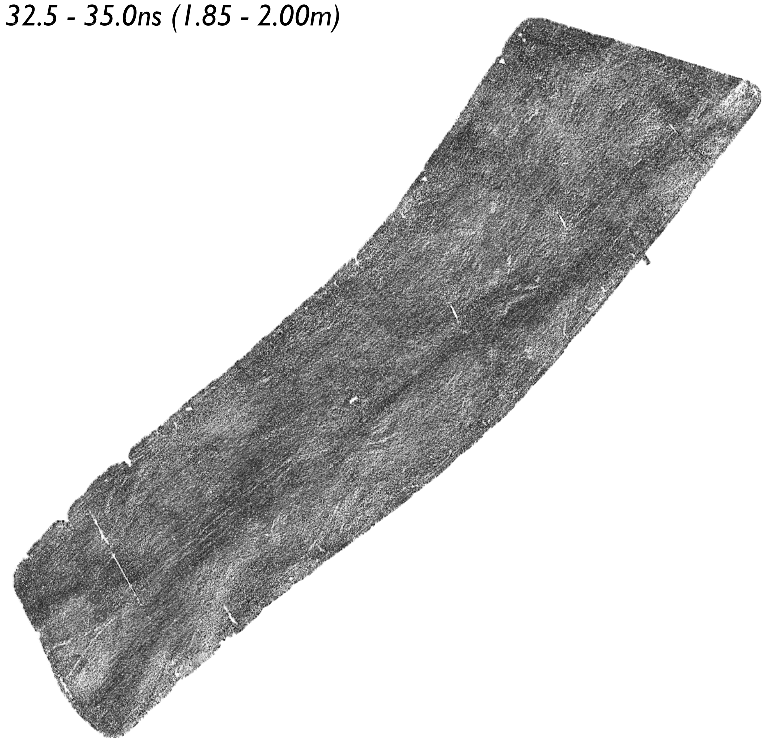
# THORNBOROUGH NORTHERN HENGE, WEST TANFIELD, NORTH YORKSHIRE
## GPR amplitude time slices between 30.0 and 45.0ns (1.71 to 2.56m), July 2024

N

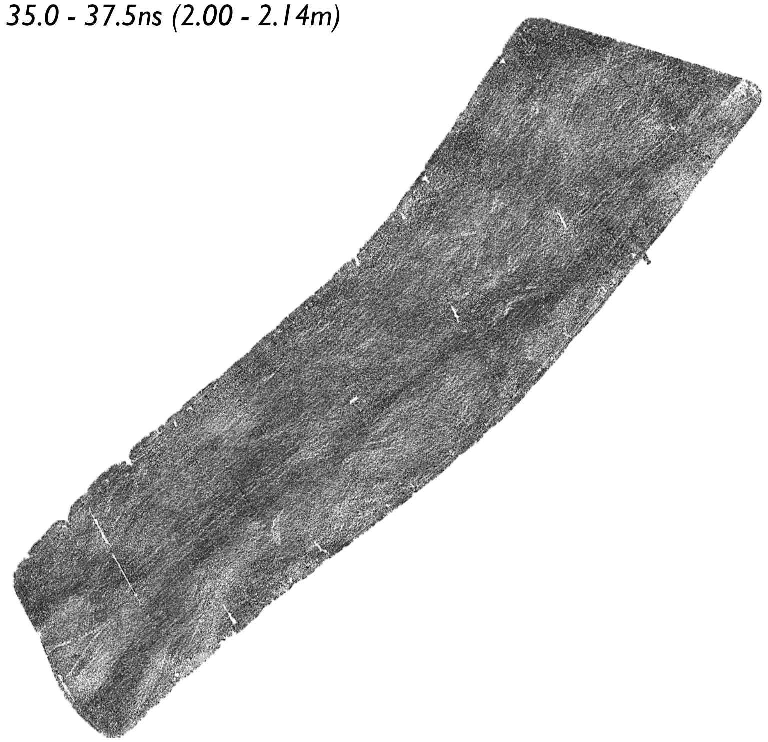
*30.0 - 32.5ns (1.71 - 1.85m)*



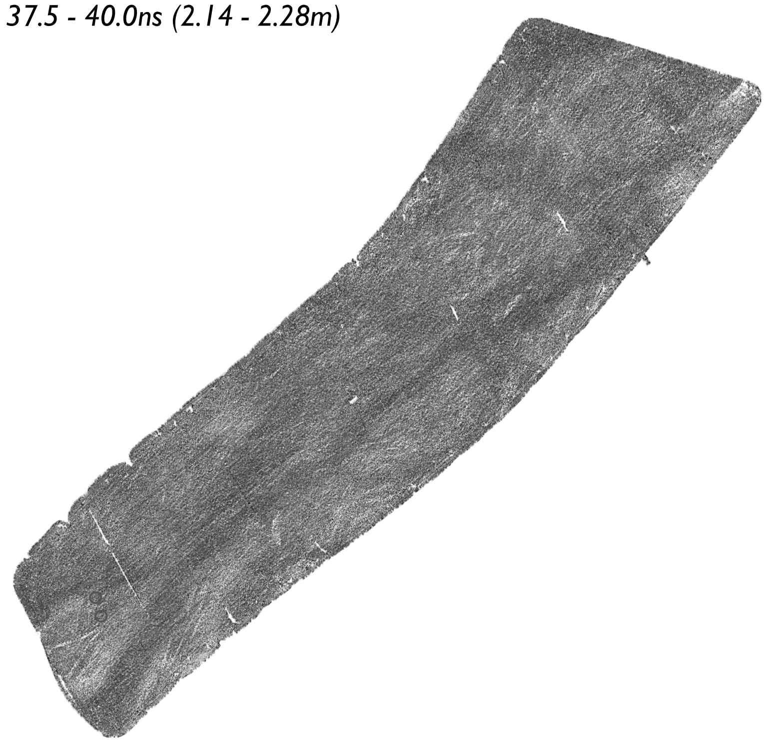
*32.5 - 35.0ns (1.85 - 2.00m)*



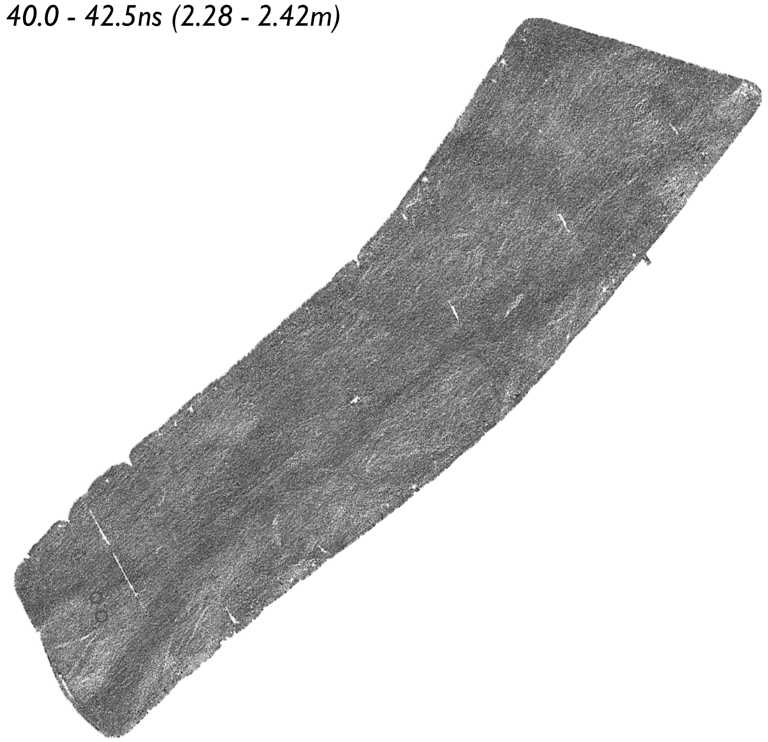
*35.0 - 37.5ns (2.00 - 2.14m)*



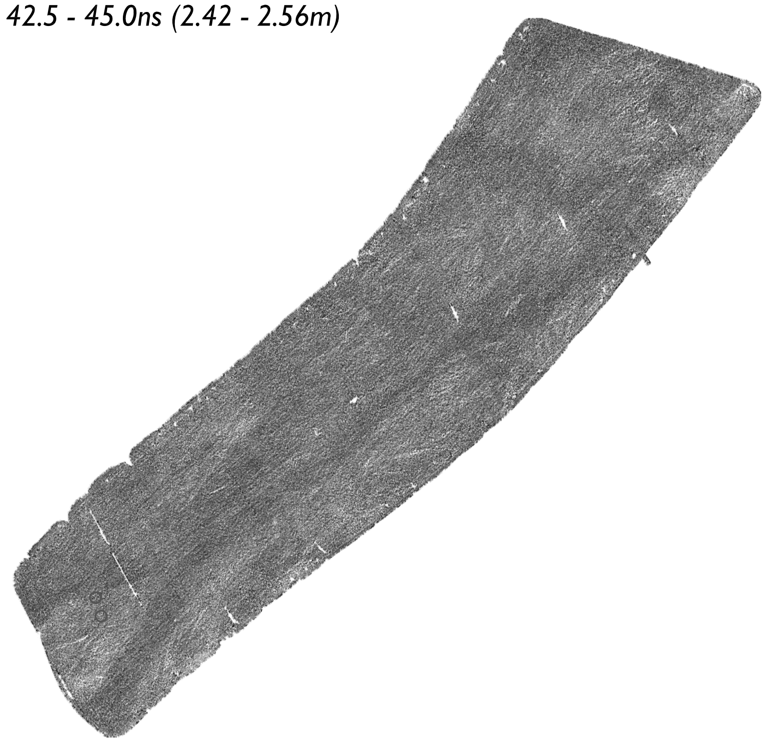
*37.5 - 40.0ns (2.14 - 2.28m)*



*40.0 - 42.5ns (2.28 - 2.42m)*



*42.5 - 45.0ns (2.42 - 2.56m)*



0 120m
1:4000

*Low* *High*
*relative reflector strength*

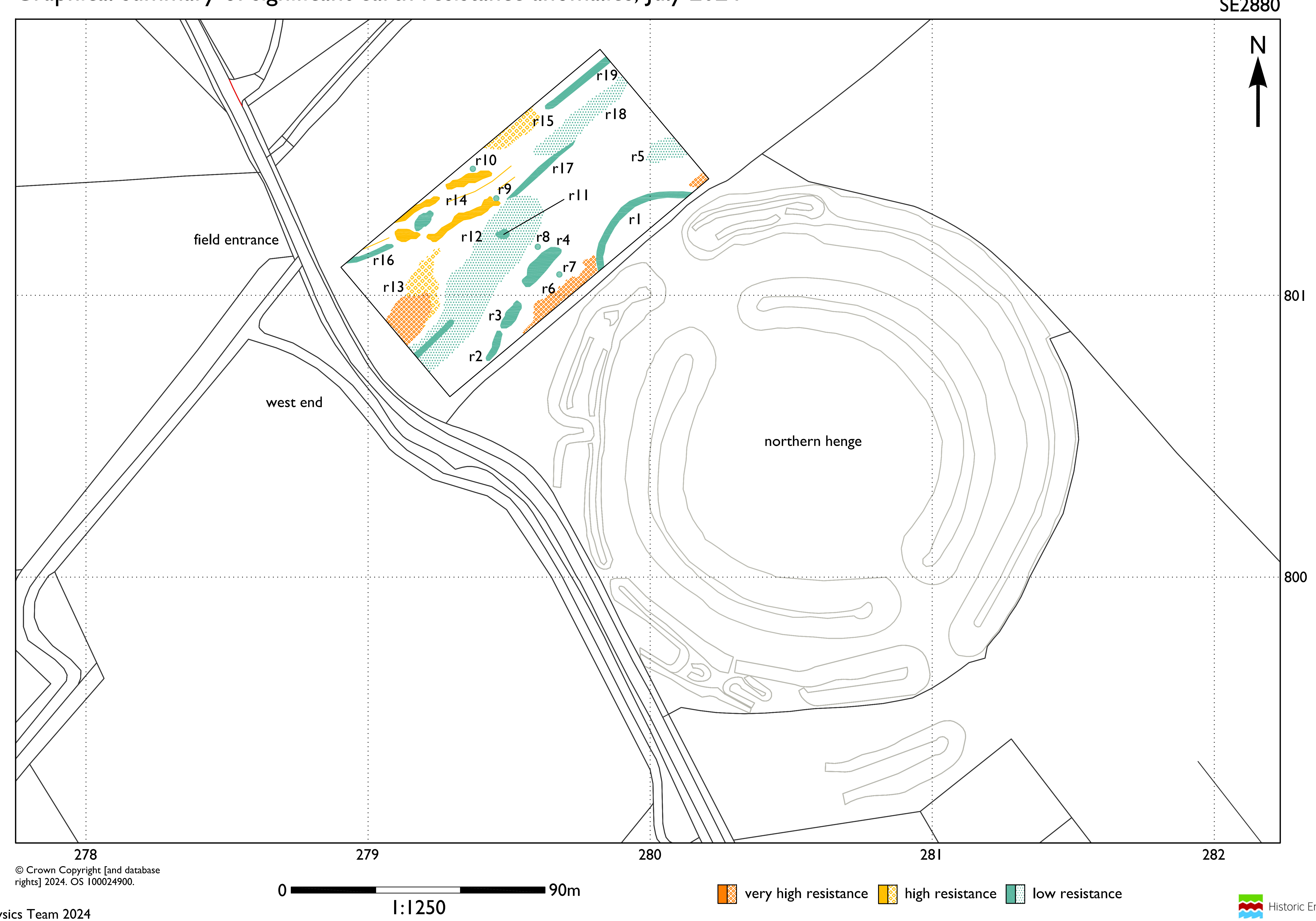
Geophysics Team 2024

Historic England

Figure 13

# THORNBOROUGH NORTHERN HENGE, WEST TANFIELD, NORTH YORKSHIRE

## Graphical summary of significant earth resistance anomalies, July 2024





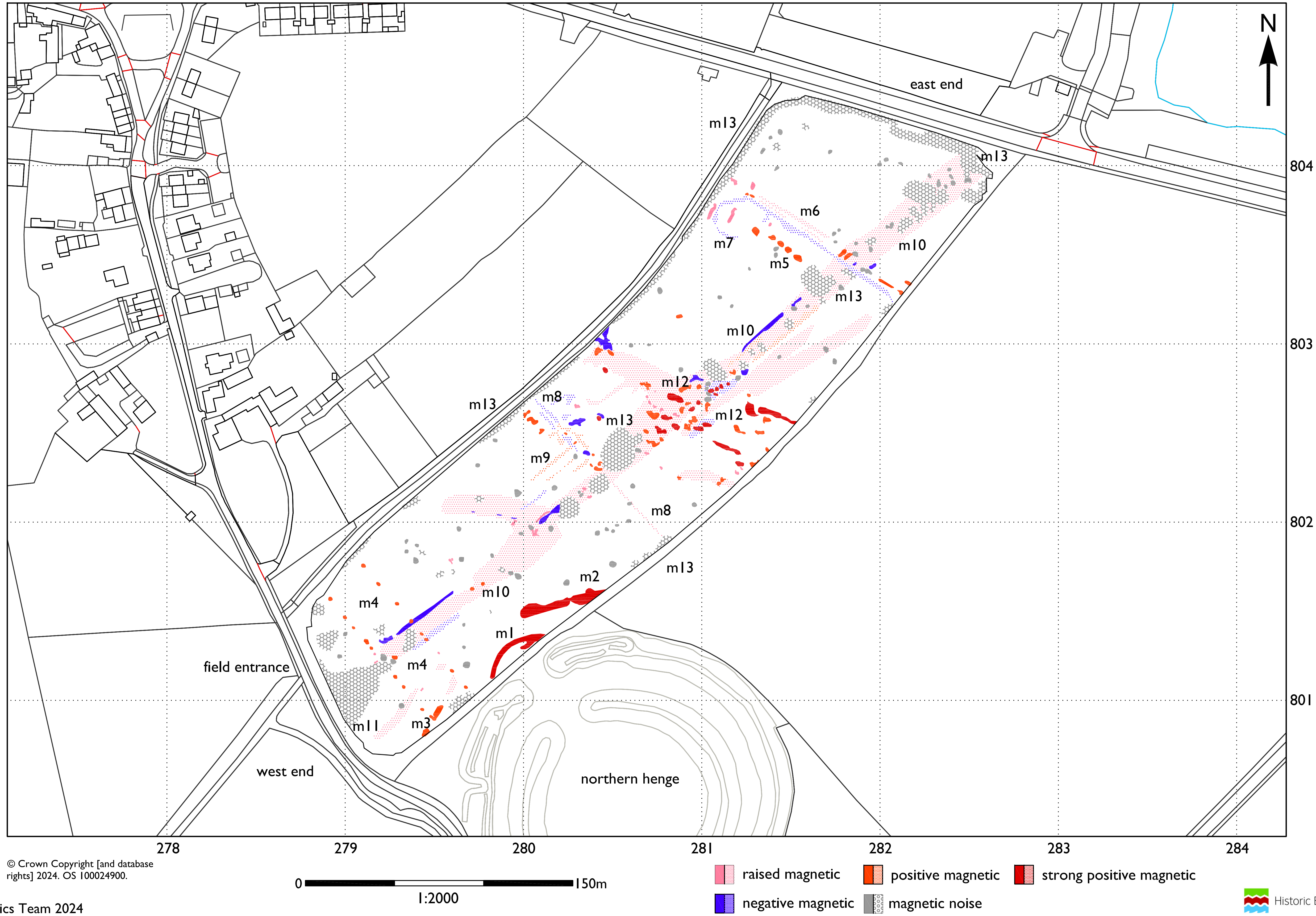

Geophysics Team 2024

Historic England

Figure 14

# THORNBOROUGH NORTHERN HENGE, WEST TANFIELD, NORTH YORKSHIRE

## Graphical summary of significant caesium magnetometer anomalies, July 2024





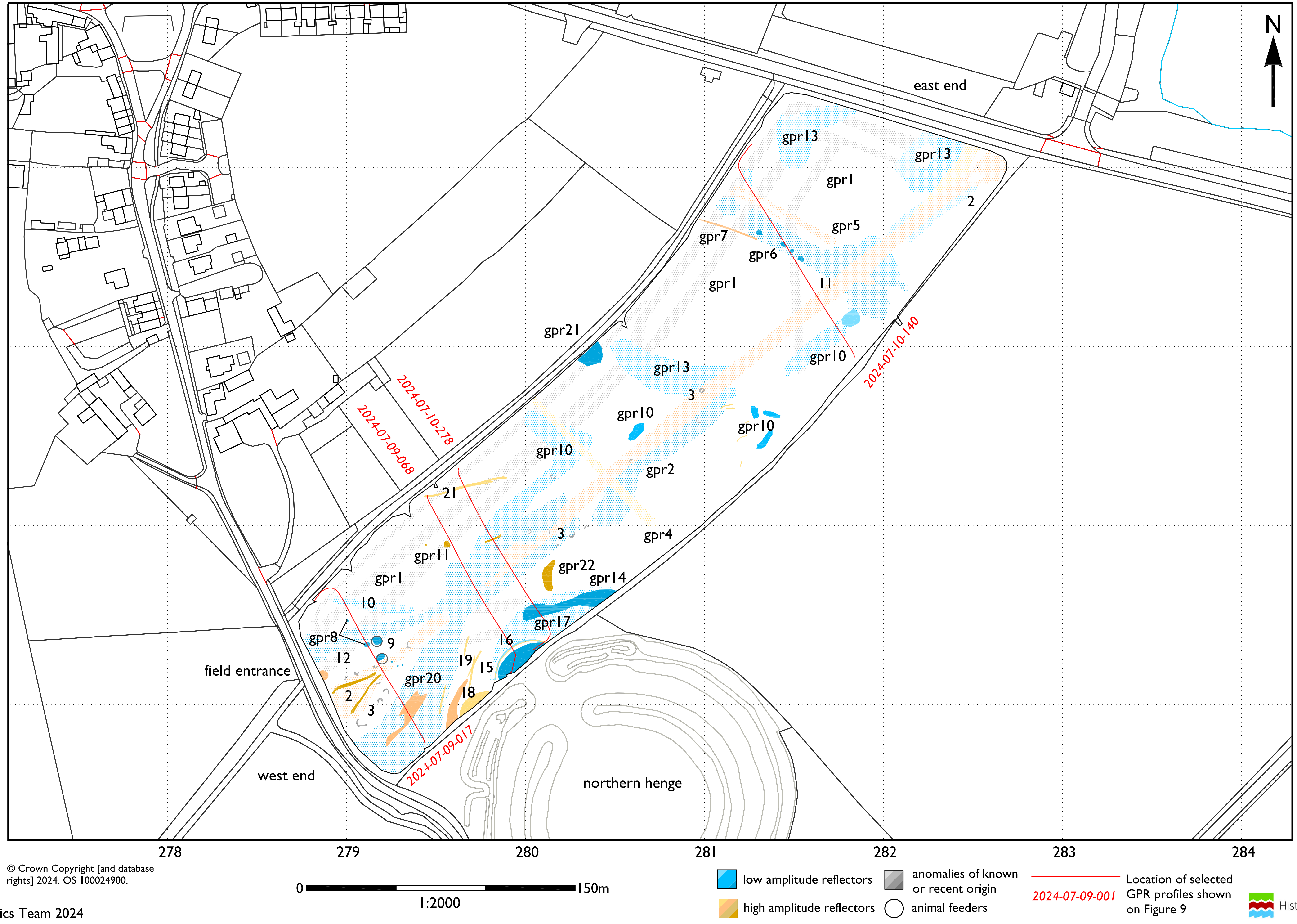

Geophysics Team 2024

Historic England

Figure 15

# THORNBOROUGH NORTHERN HENGE, WEST TANFIELD, NORTH YORKSHIRE

## Graphical summary of significant GPR anomalies, July 2024






Geophysics Team 2024

Historic England

Historic England

# Historic England's Research Reports

We are the public body that helps people care for, enjoy and celebrate England's historic environment.

We carry out and fund applied research to support the protection and management of the historic environment. Our research programme is wide-ranging and both national and local in scope, with projects that highlight new discoveries and provide greater understanding, appreciation and enjoyment of our historic places.

More information on our research strategy and agenda is available at HistoricEngland.org.uk/research/agenda.

The Research Report Series replaces the former Centre for Archaeology Reports Series, the Archaeological Investigation Report Series, the Architectural Investigation Report Series, and the Research Department Report Series.

All reports are available at HistoricEngland.org.uk/research/results/reports. There are over 7,000 reports going back over 50 years. You can find out more about the scope of the Series here: HistoricEngland.org.uk/research/results/about-the-research-reports-database.

Keep in touch with our research through our digital magazine *Historic England Research* HistoricEngland.org.uk/whats-new/research.

ISSN 2398-3841 (Print)
ISSN 2059-4453 (Online)