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Belhus Park, Thurrock, Report on Analytical Earthwork, UAV and Geophysical Surveys, April 2021

Matthew Bristow, Neil Linford, Sarah Newsome and Andrew Payne

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BELHUS PARK, THURROCK, REPORT ON ANALYTICAL EARTHWORK, UAV AND GEOPHYSICAL SURVEYS, MARCH 2021

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SUMMARY

Analytical earthwork, Uncrewed Aerial Vehicle (UAV) and Ground Penetrating Radar (GPR) surveys were conducted at Belhus Park, Thurrock to assist the 'People of the Fanns' volunteer project, researching the former Tudor mansion and gardens that once stood on the site, now used as a municipal golf course. The analytical earthwork survey recorded a circular topographic anomaly found on the fairway immediately south west of the manor house ruins, possibly the location of a water garden feature depicted in a painting of Belhus House and Park of around 1710. Digital photography captured by the UAV survey covered an extensive area of the park and was used to generate high resolution digital terrain models through Structure from Motion (SfM). The very high ground resolution of the SfM data has allowed many subtle topographic details across the park land to be identified, together with subsequent Second World War activity and the current golf course operations. GPR survey (2.45ha) was conducted in the vicinity of the manor house to complement the ground and UAV survey techniques and confirmed the survival of paths and walls related to the water garden, together with anomalies associated with the original manor house, gardens and a possible gate house.

CONTRIBUTORS

The UAV and analytical earthwork surveys were conducted by Matthew Bristow and Sarah Newsome of the Historic England Archaeological Survey and Investigation Team and the GPR survey was conducted by Neil Linford, and Andrew Payne of the Historic England Geophysics Team.

ACKNOWLEDGEMENTS

The authors are grateful to colleagues from Impulse Leisure for allowing access to the golf course to allow the surveys to take place.

ARCHIVE LOCATION

Fort Cumberland, Portsmouth (Geophysical Survey), The Engine House, Swindon (Analytical Earthwork Survey).

DATE OF SURVEY

The fieldwork was conducted between 23rd to 25th March 2021 and the report completed on 28th June 2021. The cover image shows the GPR survey in progress with the remains of the manor house in the immediate background (photograph taken by Matthew Bristow).

CONTACT DETAILS

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INTRODUCTION

Analytical earthwork, Uncrewed Aerial Vehicle (UAV) and Ground Penetrating Radar (GPR) surveys were conducted at Belhus Park, Thurrock to assist volunteers working on a recent historic designed landscape project run jointly by Land of the Fanns and the Gardens Trust, to investigate the former Tudor mansion and gardens that once stood on the site. Belhus is the remnant of a mid-18th century park by Lancelot Brown, with additions by Richard Woods (Register of Parks and Gardens: 1000738), currently used as a golf course and leisure centre since 2000. The manor was tenanted from the 14th century and passed through marriage to the Barrett family who rebuilt Belhus House towards the end of the 16th century, obtaining a licence in 1618 to make a park and elaborate parterre garden, probably shown on an estate map of 1619 and a bird's-eye view of the property in the early 18th century (Figure 1). Following a period of neglect, the house and grounds were brought up to date by Lord Dacre between 1744 and 1777, with Lancelot Brown commissioned to remodel the grounds between 1753 and 1763 (Historic England 1987). During the Second World War Belhus was damaged by military occupation, leading to the house being demolished in 1957.

The aim of the current survey was to establish whether any remains of the original early 17th century formal gardens survive in association with both topographic and extant water features noted across the site (P Lobley *pers comm*). A large, circular depression to the south west of the manor house was of particular interest given its possible association with the original water garden features, although no evidence of these survived to the first edition of the Ordnance Survey mapping.

The park at Belhus is retained under grass, with the central section laid out as a golf course that contains bunkers, greens and raised tees defined by strips of late 20th century shrub and tree planting. Coarse and fine loamy permeable soils of the Hurst (841b) Association have developed over superficial deposits of Quaternary Lynch Hill sand and gravel overlying clay, silt and sand of the London Clay Formation, a sedimentary bedrock formed approximately 48 to 56 million years ago in the Palaeogene Period (Soil Survey of England and Wales 1983; Geological Survey of Great Britain 1996). Surface conditions were generally down to short mown grass over the golf course fairways with some areas of longer grass in the rough. Weather conditions were generally dry throughout the period of the field work.

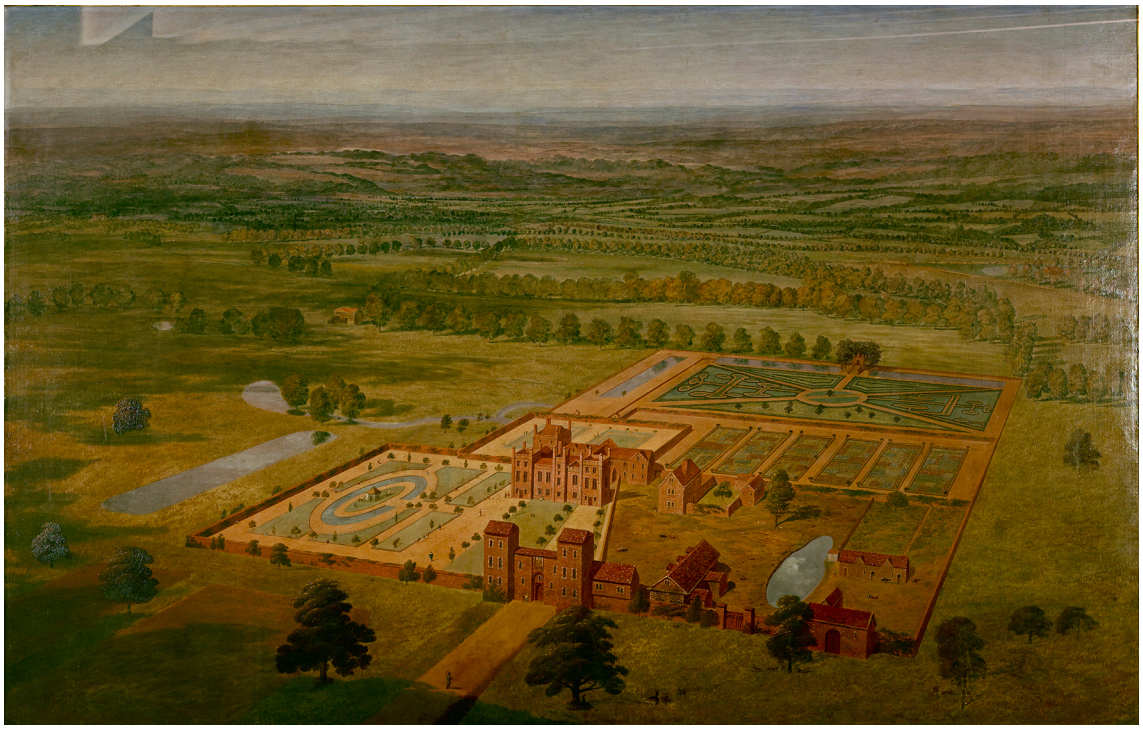


Figure 1 Belhus Mansion Painting, c1710 unknown artist in the style of Jan Siberechts with permission from Thurrock Museum.

METHOD

Analytical earthwork survey

The analytical earthwork survey was solely targeted to record the circular garden feature and the outline of the house foundations. Earthwork detail was surveyed using a Trimble R8 survey grade GNSS receiver adjusted to the National Grid Transformation OSTN15 via the Trimble VRS Now Network RTK delivery service. This uses the Ordnance Survey's GNSS correction network (OSNet) and gives a stated accuracy of 0.01-0.015m per point with vertical accuracy being half as precise.

The survey data was downloaded into Trimble Business Centre software to process the field codes and the data transferred into AutoCAD for editing. The survey plans were completed at 1: 1000 scale using digital drawing techniques. The drawings were cleaned and slopes were hachured to indicate relative strengths (Figure 6 and 14).



Figure 2 DJI Mavic Pro quadcopter drone in operation at the site.

UAV SfM survey

Aerial photography was acquired using a DJI Mavic Pro quadcopter drone (Figure 2) owned by Historic England and operated under the Civil Aviation Authority operator ID OP-2N8JDJL. A pre-programmed mapping flight covering an area of 17 acres (shown in Figure 3) was carried out using the Drone Deploy operating system. The flight captured 305 overlapping 12-megapixel JPEG images each from an altitude of about 50m above ground level, resulting in a ground resolution of 1.54cm per pixel. These images were processed in Agisoft Metashape to create a high-quality orthomosaic photograph and a Digital Terrain Model (DTM) of the survey area (see Figures 6, 7 and 8). Positional accuracy of the model was improved by referencing 7 ground targets, (Figure 4) established with the GNSS equipment mentioned above. The DTM GeoTIFF was visualised in Agisoft Metsahape by classifying the dense point cloud and building the DTM. The drone was also used to take a number of 4K fly-through videos of the survey area and various oblique still photographs of the remains of the Belhus house (Figure 5). The flights were undertaken in accordance with the procedures in Historic England's, 'Small Unmanned Aircraft Operations Manual v2.0' (2021) that underpins the organisation's Permission for Commercial Operations accreditation with the

Civil Aviation Authority. Processing and visualisation was carried out in accordance with our published guidelines (Historic England 2017).



Figure 3 UAV pre-programmed mapping flight covering an area of 17 acres.



Figure 4 Ground targets established with GNSS to improve the positional accuracy of the SfM model.

Ground Penetrating Radar survey

A 3d-Radar 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 Global Navigation Satellite System (GNSS) receiver, together with a second R8s base station receiver established using the Ordnance Survey VRS Now correction service, was mounted on the GPR antenna array to provide continuous positional control for the survey collected along the instrument swaths shown on Figure 9. Data were acquired at a 0.075m by 0.075m sample interval across a continuous wave stepped frequency range from 40MHz to 2.99GHz in 4MHz increments using a dwell time of 3ms. 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 11. 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 0.105m/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 about 0.13m intervals from the ground surface, shown as individual greyscale images in Figures 10, 12 and 13. Further details of both the frequency and time domain algorithms developed for processing this data can be found in Sala and Linford (2012).

Due to the size of the resultant data set a semi-automated algorithm has been employed to extract the vector outline of significant anomalies shown on Figure 14. The algorithm uses edge detection to identify bounded regions followed by a morphological classification based on the size and shape of the extracted anomalies. For example, the location of possible pits is made by selecting small, sub circular anomalies from the data set (Linford and Linford 2017).

RESULTS

UAV SfM and earthwork surveys

The significant topographical features captured during the UAV flight [dtm1 - 25] discussed in the following text are highlighted on the Digital Terrain Model, Figure 8 (for clarity the 'dtm' prefix has been omitted from certain features). The features are described as they relate to the three main historic elements of the survey area: the gardens to the north of the house, the gardens to the west of the house and the site of the house itself. The results of the targeted earthwork survey will be described as part of the discussion of the west gardens.

The north gardens

The site of the formal gardens depicted on both the 1618/19 estate survey and the late-17th century topographical painting, is located immediately to the north of the remains of Belhus House (Figures 1 and 5). In 2021, the former gardens are overlaid by the fairways of the 13th, 14th, 15th and 16th holes of Belhus Park Golf course and are now separated from the house by a line of trees south of the 13th fairway. Most features visible on the ground relate to the 20th century golf course, however a number of more subtle earthworks were captured by the UAV flight which likely relate to the 17th century garden landscape.

North of the north-western corner of the former house, [dtm1] extends broadly NNE for about 50m from the northern edge of the terrace on which Belhus House was constructed [dtm15], continuing the alignment of the house's western elevation. It defines the division between lower ground to the west and a level terrace which extends eastwards away from it. At the northern end of [dtm1], [dtm2] defines a pair of right-angled turns which step the western edge of the terrace in by about 7m. This step may represent evidence of the junction between the small walled garden immediately north of the house and the wider designed landscape to the north, a feature shown on both the maps of 1586 and 1619, and on the topographical painting. This feature also appears to align with [gpr24], described below and interpreted as the subtle evidence of a former path.

The western edge of the garden terrace is harder to trace north of [dtm2] due to the cutting of the golf course creek [dtm25] and the construction of a raised tee box [dtm22]. However, there is subtle evidence of a faint scarp between the terrace and the lower ground at [dtm3]. A far more substantial bank [dtm4] situated about 20m west of [dtm3] and mirroring the alignment of both the western façade of the former house and [dtm1] extends for about 100m towards the norther extent of the survey area. With the truncated remains of terrace to the east, it defines a long, rectilinear area of lower ground [dtm5]. The location and alignment of this feature and its geometric proportions and broadly flat base strongly suggest fractional remains of the western of two canalised ponds shown on the 1619 map and the topographical painting, to flank the northern gardens. That the golf course creek runs through [dtm5] before terminating in a pond [dtm26] may further support this conclusion.

To the east of the pond, a subtle scarp [dtm6] may define the northern extent of the terrace on which the gardens north of the house were laid out. The 1618/19 map and later painting both suggest that the edge of the terrace was defined by a second canalised pond, aligned broadly east to west and parallel to the house. The creation of the pond [dtm26] and wider landscaping for the golf course render interpretation of [dtm6] very tentative, however it may represent fractional remains of the southern bank of the northern canalised pond.

Of the formal gardens which formerly occupied the terrace defined by [dtm1-6], the UAV survey was unable to identify any coherent features.

The west gardens

The gardens to the west of Belhus House, depicted in 1586 as a walled orchard divided into four quadrants and in 1619 as walled formal garden dominated by a central circular water feature, lie underneath the golf course's 10th fairway. Clearly visible on both the ground and from the air, [dtm7] comprised a well-

defined ditch, about 10m wide which described a circle with a diameter of about 40m, with a circular terrace at its centre [dtm8]. The earthworks which comprised the circular feature were recorded and are shown in Figure 6. A tapering ridge, about 9m long, [dtm9] was recorded during the earthwork survey as crossing the eastern side of the circular ditch, forming a causeway between the central terrace and the wider landscape, a feature which the historic topographical depictions confirm to have been part of the arrangement of the west gardens.

North of the circular ditch, the earthwork survey recorded a faint scarp [dtm10] which extended northwards from the ditch and which corresponds directly with GPR anomaly [gpr9]. This feature terminated at an east-west scarp [dtm11] which appeared to define the northern boundary of the west garden and which appears to turn to the south to define the western boundary.

The recorded earthworks and [dtm7-11] clearly represent the remains of the formal gardens located to the west of Belhus house and correspond directly to the geophysical anomalies [gpr5-13]. The circular ditch [dtm7] may originally – as the topographical painting suggests – have been filled with water; forming the centre piece of a walled garden divided into four quadrants. One of the paths which defined these quadrants may have created [dtm10], while the causeway which gave access to the central circular terrace, clearly survives as [dtm8].

Belhus Hall

The footprint of Belhus Hall survives as clear foundations and standing brick and masonry walls which rise to about 0.5m. The walls and foundations are shown clearly on the DTM [dtm13] in addition to several faint earthworks which identify the location of the house's former internal divisions. The north eastern corner of the house has been truncated by the sweep of the 12th fairway, creating a curved scarp [dtm19] about 23m in length where the corner of the building has been landscaped away. The level terrace on which the remains of the house sit is defined on its western and northern sides by scarps [dtm14] and [dtm15] above shallow ditches, features visible on the ground as well-defined earthworks. To the south of [dtm14], the ditch extends southwards, though its character changes once south of the house to include a series of regular depressions which may indicate the location of wall buttresses. Neither the historic maps nor the topographical painting depict a western wall south of the house, however oblique aerial photographs taken in 1929 [Historic England Archive, EPW026322] show a low wall enclosing the house and matching the location and alignment of [dtm14-16]. This wall enclosed a tennis court south of the house, following the line of scarp [dtm17].



Figure 5 Example of the oblique still photographs of the remains of the Belhus Hall captured during the drone survey.



Figure 6 Analytical earthwork survey superimposed over the orthomosaic photograph '(Surveyed at 1:1000 – image not to scale).

To the east and south-east of the remains of the house, a series of regular depressions [**dtm19**], on a different alignment to the house and visible on the

ground as exposed pieces of hardstanding, mark the location of the service buildings which served Belhus Hall.

Wider landscape

Within the wider landscape covered by the UAV survey, most of the features identified relate to the Belhus Park golf course. Three raised rectangular terraces [dtm20-22] comprise the tee boxes of the 10th, 11th and 14th holes respectively, while the creek and pond [dtm27] and [dtm26] were also created as part of the golf course.

The most substantial earthwork visible on the ground appears to be associated with the 19th century landscape and comprises a curving ridge which approaches the site of the house from the north-west, joins the terrace the house sat on and then curves away to the south-west [dtm24] and [dtm25]. The 1929 aerial photograph shows this curved ridge carrying tracks which approached the house from the north and south. This ridge was later bisected by the golf course creek, exposing a section made up of building rubble including 'frogged bricks', further confirming the ridge relates to a later phase of Belhus' history.Ground Penetrating Radar survey

A graphical summary of the significant GPR anomalies, [gpr1-53] discussed in the following text, superimposed on the base OS map data, is provided in Figure 14 (for clarity the 'gpr' prefix has been omitted from certain anomalies).

The very near-surface data between 0.0 and 2.5ns (0.0 to 0.13m) is dominated by the response to the differing length of grass between the closely cropped fairways and areas of rough. There is also a high amplitude anomaly [gpr1] associated with the raised ridge crossing the survey area from north to south. There is also evidence for some surface vehicle tracks [gpr2] close to the club house, a golf tee [gpr3] and possible animal burrows or tree roots [gpr4].

From approximately 5.0ns (0.26m) a circular high amplitude anomaly [gpr5], approximately 18m in diameter, appears to indicate the central path of the water feature depicted in the c1710 painting. The path is approximately 2m wide and from between 7.5 and 12.5ns (0.39 to 0.66m) shows evidence for both inner and outer retaining walls. The outer circular path [gpr6] appears from between 7.5 and 12.5ns (0.39 to 0.66m) with a diameter of approximately 37m, and a profile that gently slopes inwards with increasing depth, perhaps suggesting the edge of the circular pond.

The approximately 60m square paths [gpr7], enclosing the circular path and ponds, are visible from between 5.0 and 22.5ns (0.26 to 1.18m). These paths are approximately 5m wide with surviving evidence for a retaining wall [gpr8] to the

north and east, and a ribbed construction pattern beneath the original surface. Connecting paths [gpr9-11] join [gpr7] from the north, south and west to the outer circular path [gpr6], with the path from the east [gpr12] continuing through to the central island and two possible statue bases or tree bowls [gpr13]. Linear anomalies [gpr14] found between 15.0 and 20.0ns (0.79 to 1.05m) pass through the central island immediately to the north of [gpr12], perhaps suggesting a wider, offset path or service conduit.

The paths to the south are less clear due, perhaps, to both the modern tree planting between the two fairways and a broad raised earthwork [gpr15] passing east west across the survey area. Some partial linear anomalies [gpr16] may represent the original square layout, but do not share the same form as the other paths with little evidence for a compacted or gravel surface. There is also less evidence for a surviving path south from the central water feature, although a prominent discrete anomaly [gpr17], approximately 1.3 m square between 12.5 and 15.0ns (0.66 to 0.79m), may perhaps represent a statue base.

A number of both low and high amplitude linear anomalies [gpr18] between 17.5 and 22.5ns (0.92 to 1.18m), suggest a pattern of land drains crossing the water garden and apparently meeting a more substantial conduit or drain [gpr19] that appears to fall to the south. This seems to be a rather complex arrangement of either water supply or drainage, with another more shallow service [gpr20], also falling to the south between 7.5 and 17.5ns (0.39 to 0.92m), but perhaps this represents a service not connected to the drainage network.

A rectilinear wall-type anomaly [gpr21] cuts across the south east corner of the square path and there is possibly a broad ditch [gpr22] heading to the north. It is unclear whether [gpr21] and [gpr22] form part of the original design, although they do respect the orientation of the main rectilinear path system. The orientation of the water garden does appear to be shared by the concentric rectilinear walls [gpr23] and subtle evidence for paths [gpr24] found between 7.5ns (0.39m) onwards immediately to the north of the manor house. This may well represent the gardens shown in this area on the c1710 painting, although the actual location appears to be displaced to the east with respect to the water garden. A pair of short, parallel wall footings [gpr25] protrude from the north west corner of [gpr23], but do not appear to be replicated on the north east corner. Further, more tentative low amplitude anomalies are found immediately north of [gpr23] that may, possibly, represent a continuation of the garden remains together with better defined path type responses [gpr26] and [gpr27] which corroborate further detail found in the painting. A more complex group of anomalies [gpr28] shares the same alignment as [gpr26] and [gpr27], but appear to be bounded by short parallel wall-type responses. It is possible that [gpr28] represents a broader walled path, enclosing the garden design with

some more tentative evidence to the east for a gravel surface [gpr29] and further fragmented walls [gpr30] partially described within the survey area.

Three large conduits [gpr31] are found to the north of the mansion and fall towards a single linear anomaly, perhaps suggesting the original drainage for the buildings as these do not appear to be modern services and head towards the “stench pipe” approximately 700m to the north (Listed building entry number 1224062). Other short linear anomalies [gpr32] may also represent drains or conduits but do not appear to connect with the main outfall [gpr31] to the north.

There is some evidence for internal walls [gpr33] within the mansion with slightly deeper planar reflections possibly indicating intact floors. A relatively broad high amplitude anomaly [gpr34] is found from 2.5ns (0.13m) onwards, possibly a gravel path bounded by a wall [gpr35] to the north, together with fragmented wall-type anomalies [gpr36] that are found immediately to the east of the mansion. In places rectilinear low amplitude anomalies [gpr37] may suggest robbed out wall footings rather than ditches, possibly indicating courtyards or enclosures rather than more substantial structural remains.

Better defined building remains appear to the south at [gpr38], the known location of the former stable block, and [gpr39] found in association with both parch marks and partial concrete remains visible on the surface. These structural remains are also cut by apparent services [gpr40-43], although it is difficult to suggest whether these are associated with more recent activity or the original manor house.

Possible structural remains [gpr44] are also found between 12.5 and 22.5ns (0.66 to 1.18m) approximately 20m to the south of the manor house in the location of the suspected gate house with, perhaps, rubble from the earlier site of this building depicted on the c17th estate map immediately to the north. There is also some evidence for an enclosing wall [gpr45] creating an approximately square courtyard and, perhaps, the further structural remains [gpr46] immediately to the east. A similar square courtyard abuts [gpr45] to the east and suggests a compacted or gravel surface [gpr47] bounded by two low amplitude anomalies, [gpr48] and [gpr49]. While [gpr48] may represent a partially robbed out wall footing [gpr49] has a broader, more amorphous form and may, possibly, represent an in-filled pond in a similar location to the elliptical water feature shown to the south east of the manor house on the painting.

Further to the south of the survey area a series of linear anomalies [gpr50-52] possibly represent some form of drainage conduit or other services, found at slightly different depths but all falling to the north. The course of [gpr50-52] is difficult to ascertain beyond the raised earth work [gpr15] and all three pass

through an east west orientated linear anomaly [gpr53] that appears to terminate on or immediately before meeting [gpr1]. It is difficult to determine whether [gpr53] represents a service, perhaps a drainage conduit although there is no evident fall along its length and no apparent collector unless this is incorporated into [gpr1].

CONCLUSIONS

The Ground Penetrating Radar (GPR) and UAV survey have produced successful results over most of the site and confirmed significant elements of the original garden design beneath the golf course fairways. The survival of the circular water feature to the south west of the manor house is of particular interest and the pattern of paths and walls corroborates a contemporary, false perspective painting of the gardens at this time. The location of the gardens to the north of the house appears to be slightly offset to the west compared to the painting and the survival of structural remains to the east is more fragmented, perhaps due to the later remodelling of the house and gardens together with the Second World War activity at the site. The GPR survey has also revealed a substantial network of buried conduits and services across the site that may well, in part, be associated with the water supply or drainage from both the house and water gardens. Given the apparent fidelity of the contemporary painting and the remarkable survival of the 17th century garden remains in the immediate vicinity of the manor house, extending the survey further to the north may identify below-ground elements of the gardens where the creation of the golf course has removed above ground evidence.

LIST OF ENCLOSED FIGURES

Figure 1 Belhus Mansion Painting, c1710 unknown artist in the style of Jan Siberechts with permission from Thurrock Museum.

Figure 2 DJI Mavic Pro quadcopter drone in operation at the site.

Figure 3 UAV pre-programmed mapping flight covering an area of 17 acres.

Figure 4 Ground targets established with GNSS to improve the positional accuracy of the SfM model.

Figure 5 Example of the oblique still photographs of the remains of the Belhus House captured during the drone survey.

Figure 6 Analytical earthwork survey superimposed over the orthomosaic photograph '(Surveyed at 1:1000 – image not to scale).

Figure 7 Orthomosaic photograph of the survey area superimposed over the base OS mapping data (1:2000).

Figure 8 Digital Terrain Model (DTM) of the survey area superimposed over the base OS mapping data (1:2000).

Figure 9 Location of the GPR instrument swaths superimposed over the base OS mapping data (1:1000).

Figure 10 Greyscale image of the GPR amplitude time slice from between 10.0 and 12.5ns (0.53 – 0.66m), superimposed over the base OS mapping data. The location of representative GPR profiles shown on Figure 11 are also indicated (1:1000).

Figure 11 Representative topographically corrected profiles from the GPR survey shown as greyscale images with annotation denoting significant anomalies. The location of the selected profiles can be found on Figures 9, 10 and 14.

Figure 12 GPR amplitude time slices from between 0.0 and 30.0ns (0.0 to 1.58m) (1:2500).

Figure 13 GPR amplitude time slices from between 30.0 and 60.0ns (1.58 to 3.16m) (1:2500).

Figure 14 Graphical summary of significant GPR anomalies superimposed over the base OS mapping and analytical earthwork survey (1:1000).

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Figure 7

BELHUS PARK, THURROCK,
Orthomosaic photograph, March 2021



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0 120m

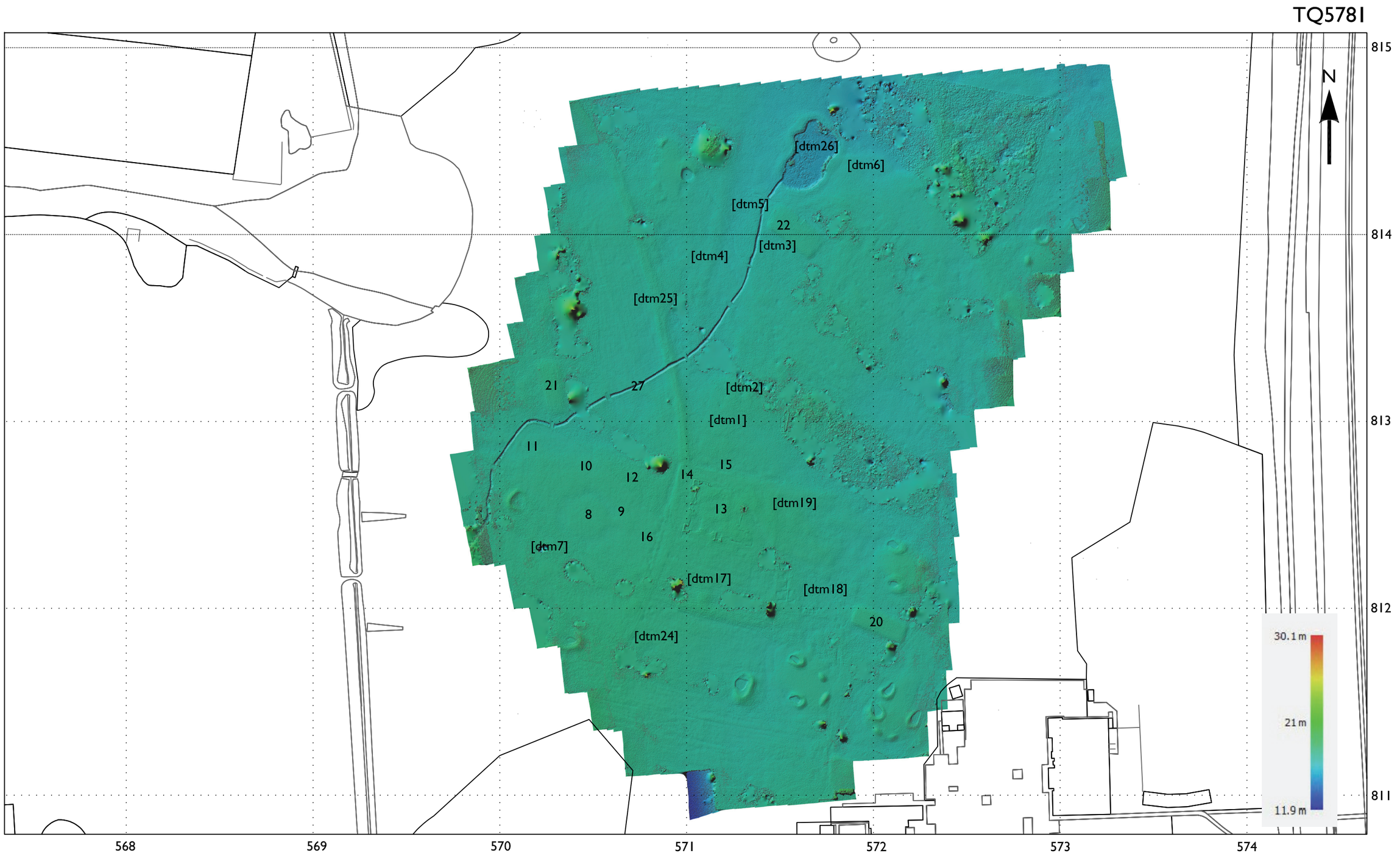
1:2000

Geophysics Team 2021

Historic England

Figure 8

BELHUS PARK, THURROCK,
Digital Terrain Model, March 2021



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0 120m

1:2000

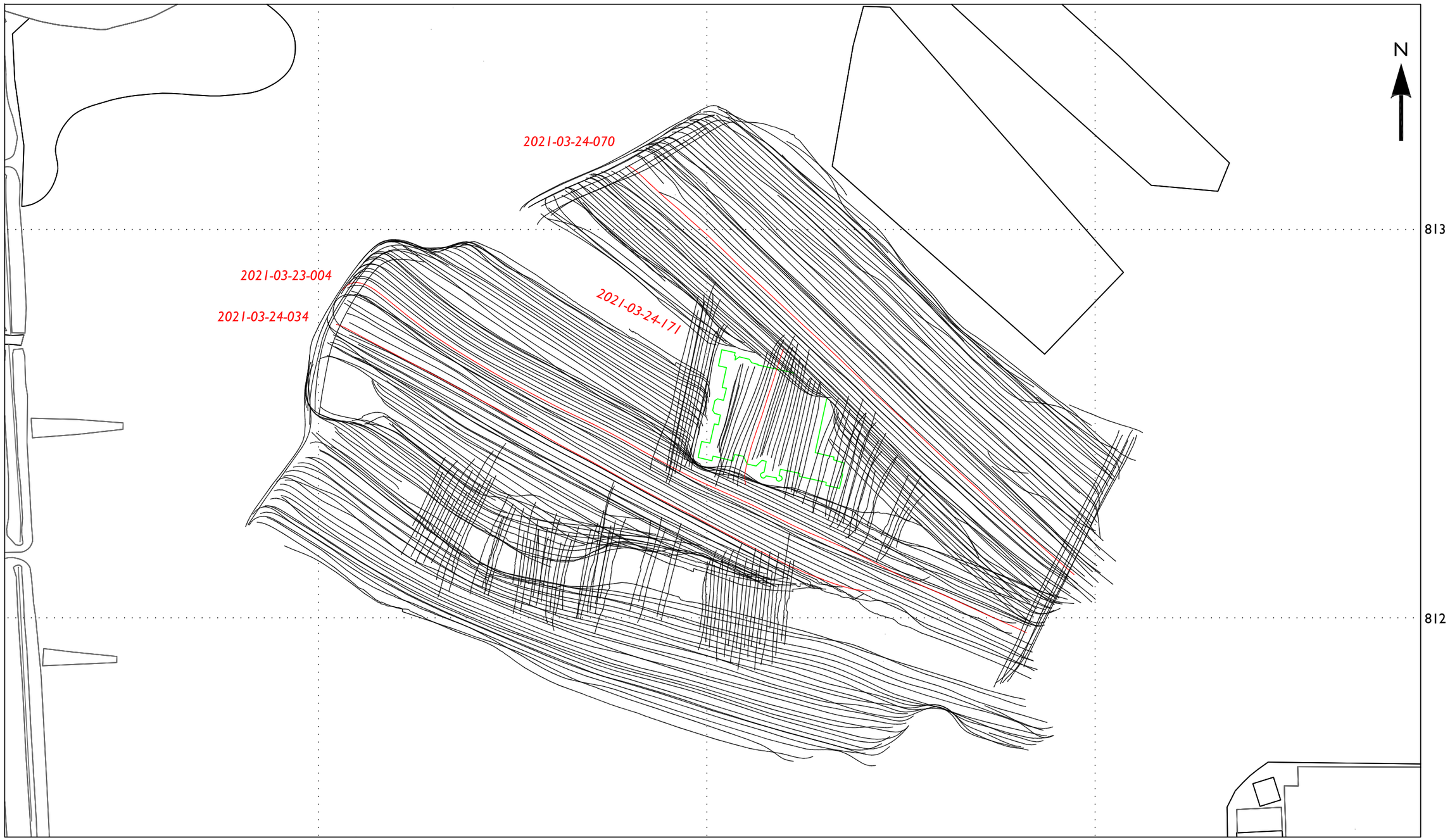
Geophysics Team 2021

Historic England

Figure 9

BELHUS PARK, THURROCK,
Location of GPR instrument swaths, March 2021

TQ5781



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Visible remains of manor house

0 60m

1:1000

Ground Penetrating Radar survey swaths

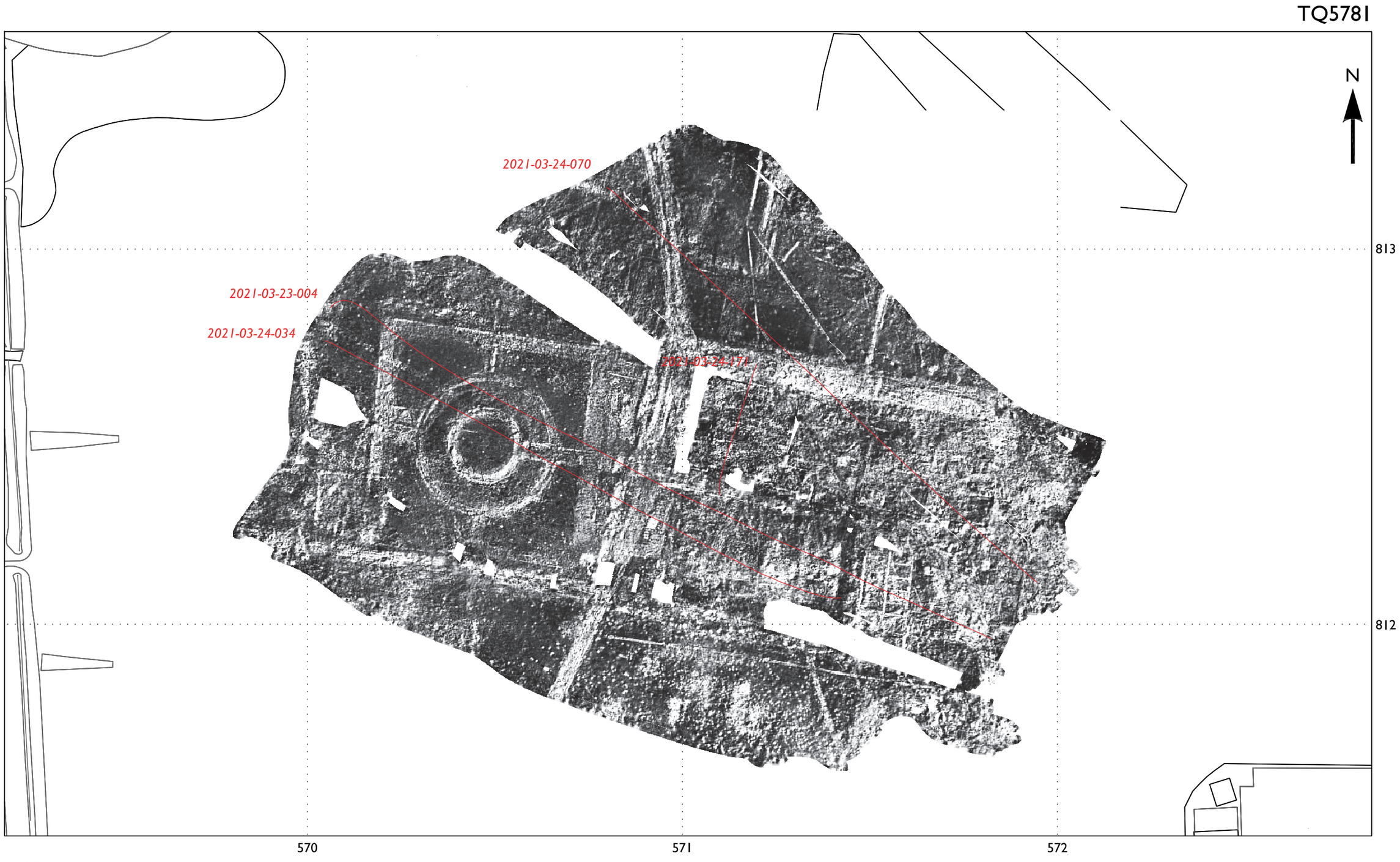
2021-03-24-001 Location of selected GPR profiles shown on Figure 11

Historic England

Geophysics Team 2021

Figure 10

BELHUS PARK, THURROCK,
GPR amplitude time slice between 10.0 and 12.5ns (0.53 - 0.66m), March 2021



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Visible remains of manor house

0 60m

1:1000

Low *High*
relative reflector strength

2021-03-24-001 Location of selected GPR profiles shown on Figure 11

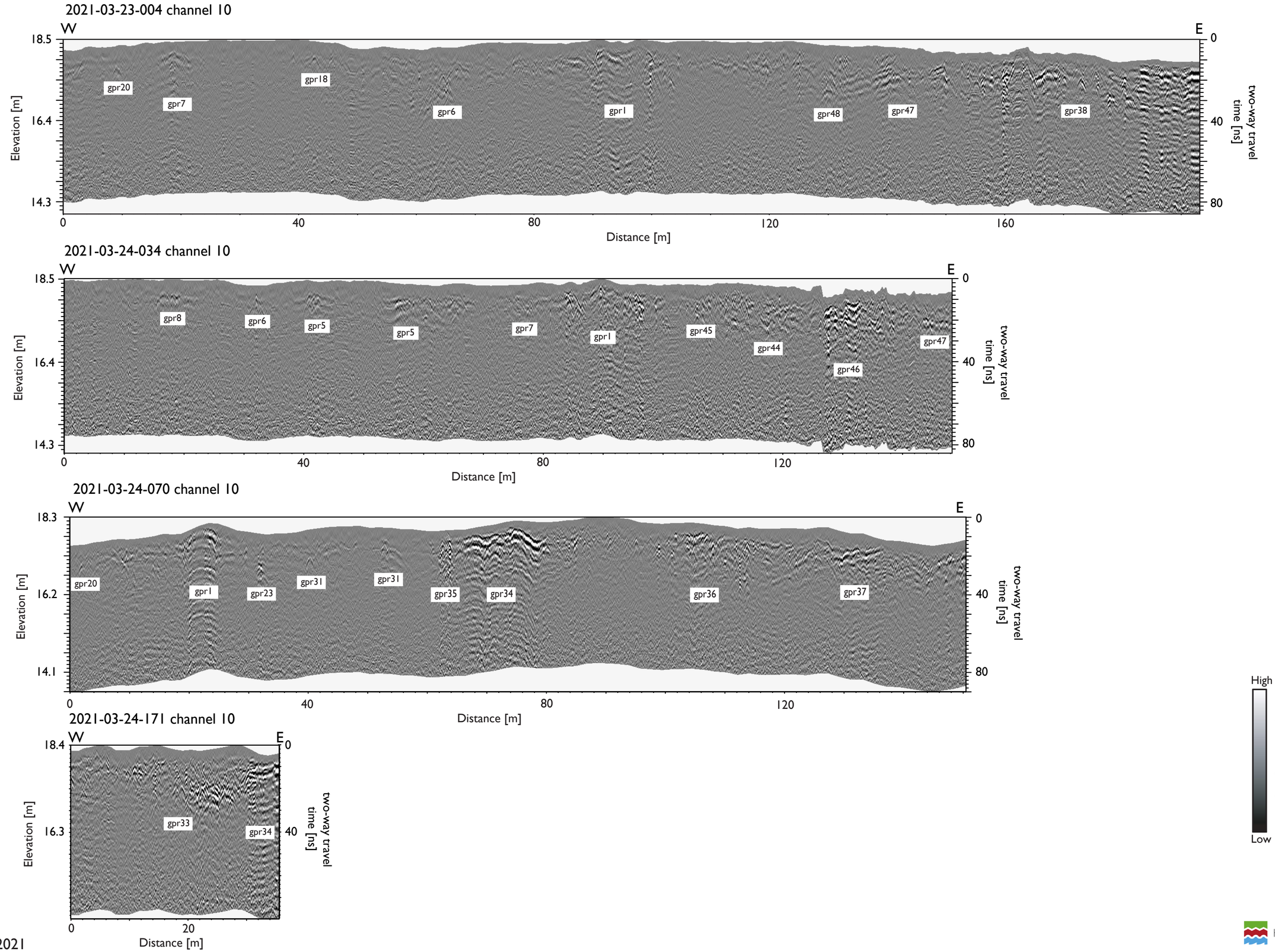
Historic England

Geophysics Team 2021

BELHUS PARK, THURROCK

Figure 11

Topographically corrected GPR profiles, March 2021



Geophysics Team 2021

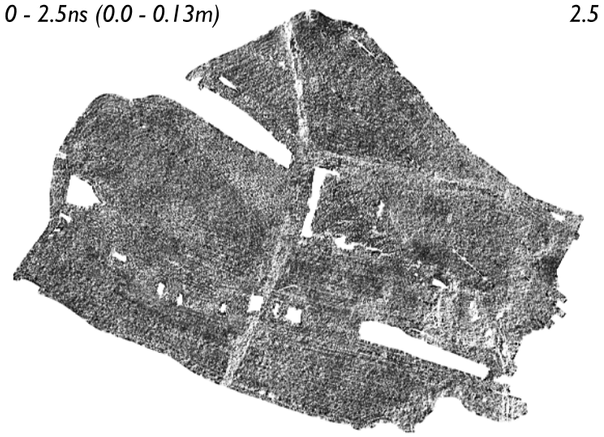
Historic England

Figure 12

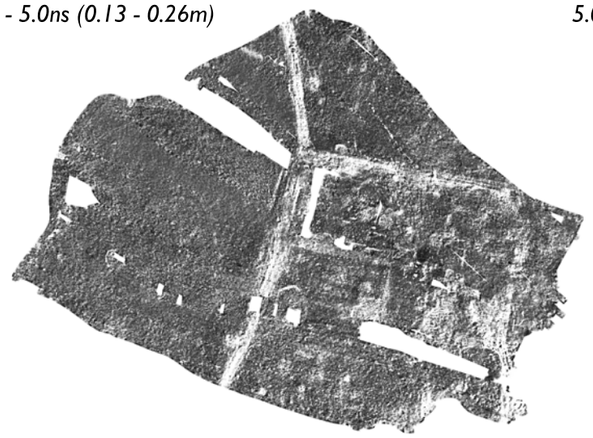
BELHUS PARK, THURROCK,
GPR amplitude time slices between 0.0 and 30.0ns (0.0 - 1.58m), March 2021

N

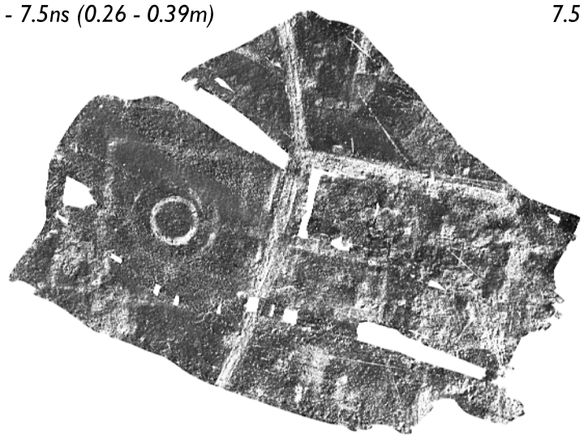
0 - 2.5ns (0.0 - 0.13m)



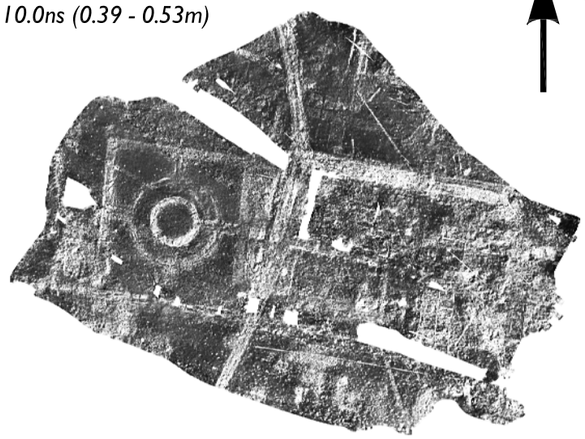
2.5 - 5.0ns (0.13 - 0.26m)



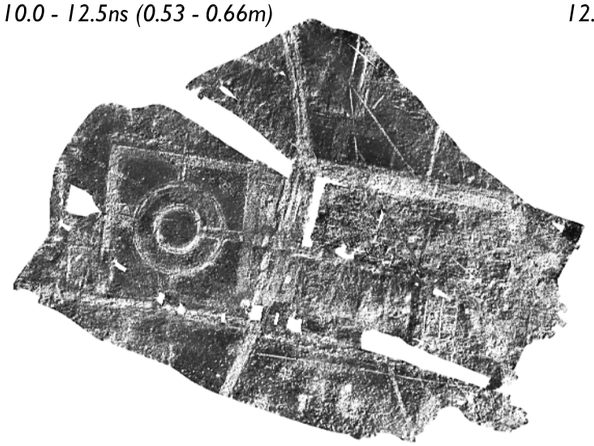
5.0 - 7.5ns (0.26 - 0.39m)



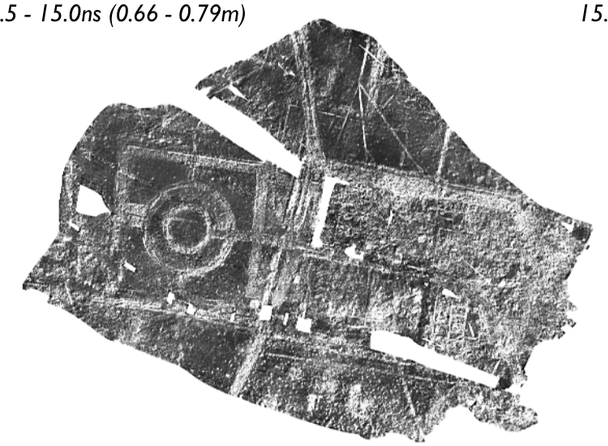
7.5 - 10.0ns (0.39 - 0.53m)



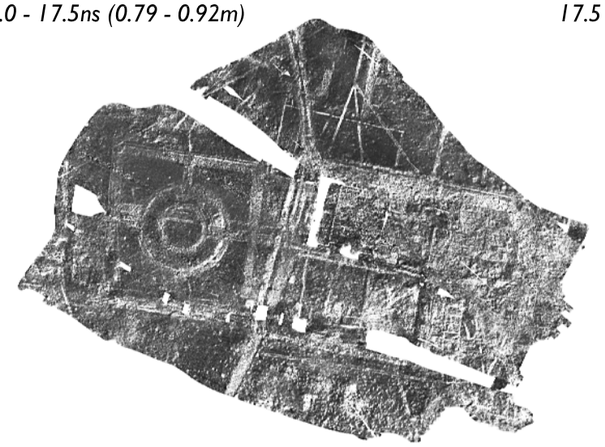
10.0 - 12.5ns (0.53 - 0.66m)



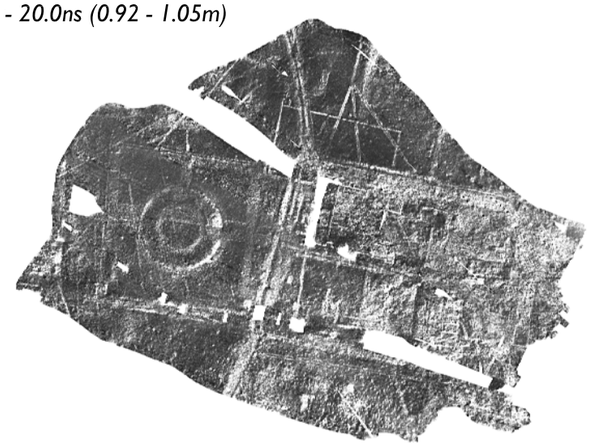
12.5 - 15.0ns (0.66 - 0.79m)



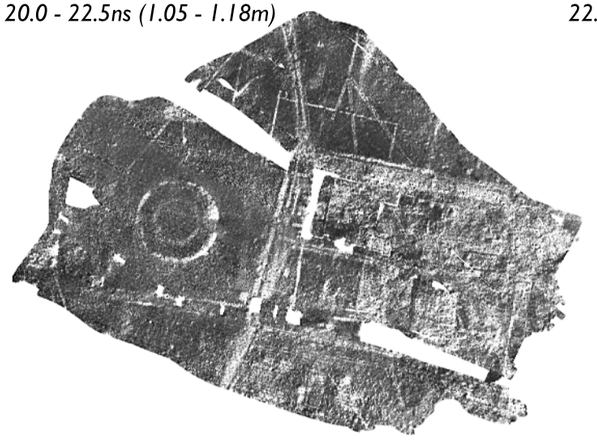
15.0 - 17.5ns (0.79 - 0.92m)



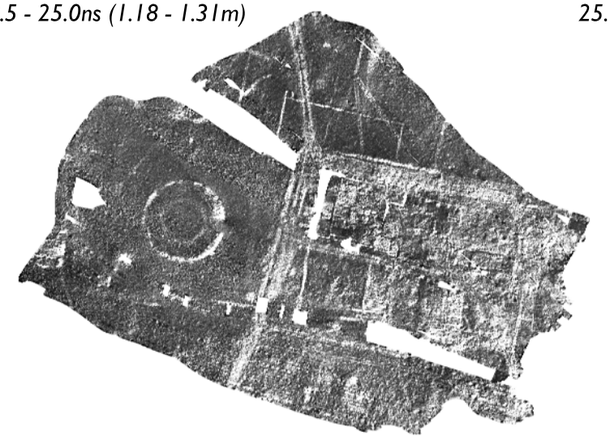
17.5 - 20.0ns (0.92 - 1.05m)



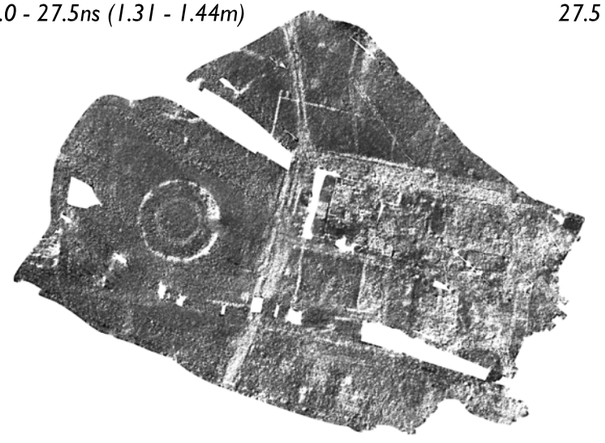
20.0 - 22.5ns (1.05 - 1.18m)



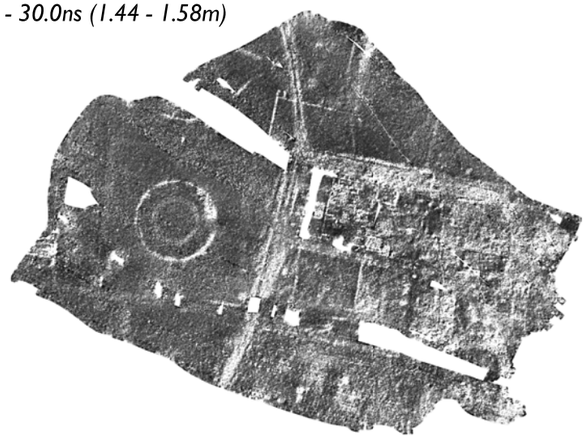
22.5 - 25.0ns (1.18 - 1.31m)



25.0 - 27.5ns (1.31 - 1.44m)



27.5 - 30.0ns (1.44 - 1.58m)



Low — *High*
relative reflector strength

0 — 90m

1:2500

Geophysics Team 2021

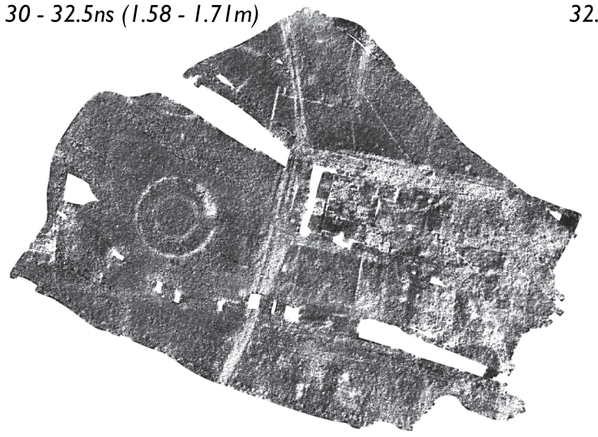
Historic England

Figure 13

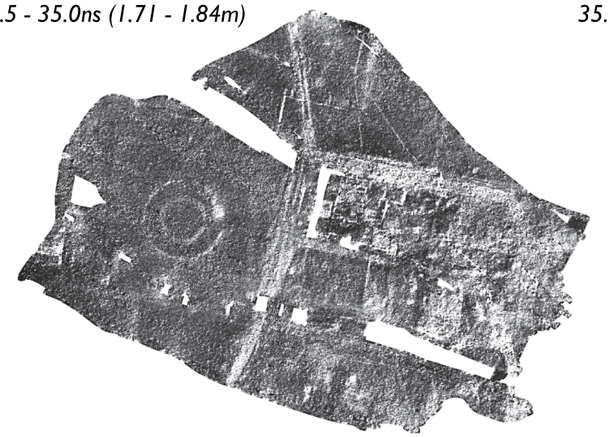
BELHUS PARK, THURROCK,
GPR amplitude time slices between 30.0 and 60.0ns (1.58 - 3.15m), March 2021

N

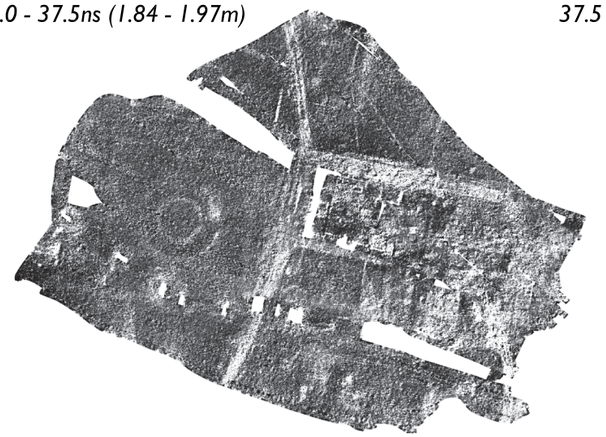
30 - 32.5ns (1.58 - 1.71m)



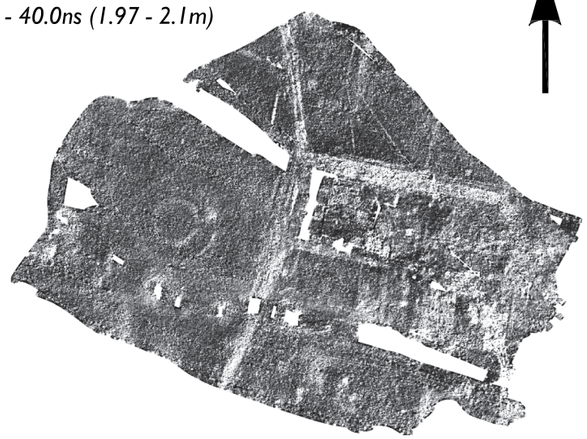
32.5 - 35.0ns (1.71 - 1.84m)



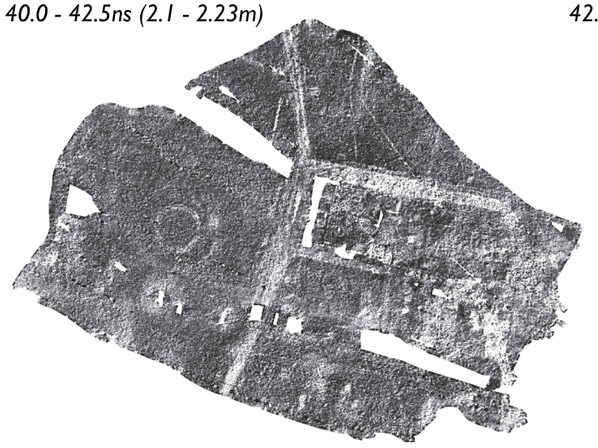
35.0 - 37.5ns (1.84 - 1.97m)



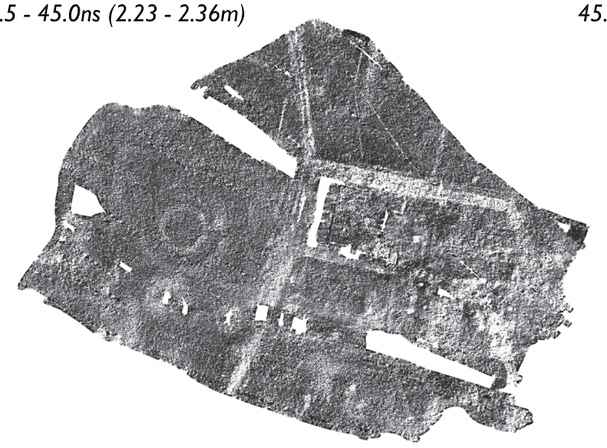
37.5 - 40.0ns (1.97 - 2.1m)



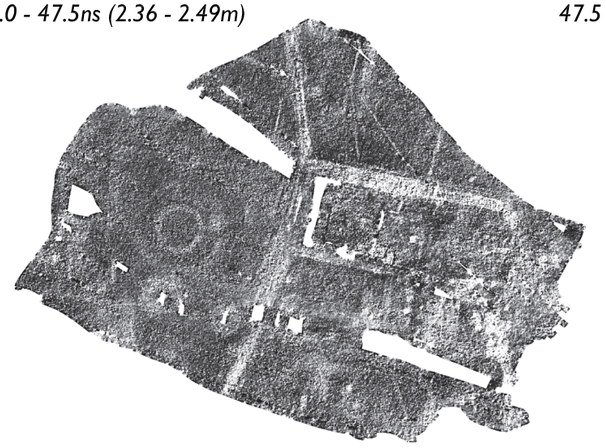
40.0 - 42.5ns (2.1 - 2.23m)



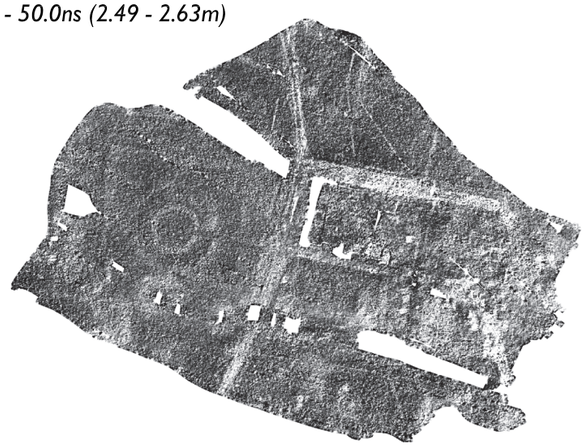
42.5 - 45.0ns (2.23 - 2.36m)



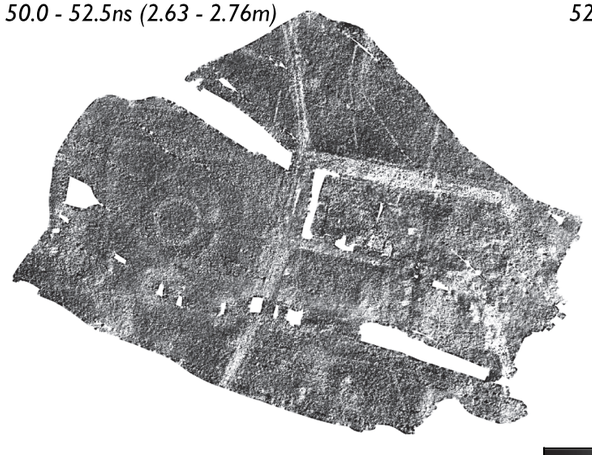
45.0 - 47.5ns (2.36 - 2.49m)



47.5 - 50.0ns (2.49 - 2.63m)



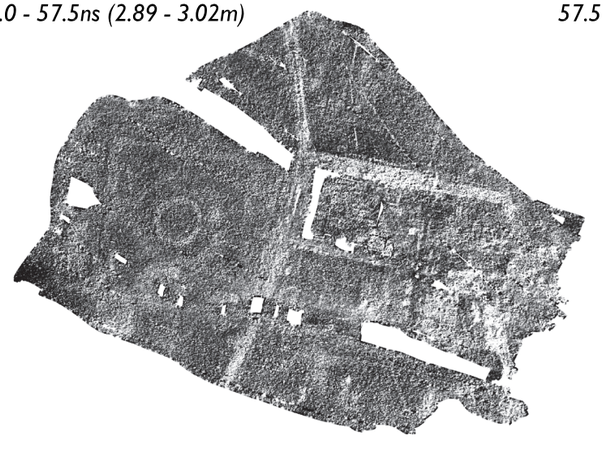
50.0 - 52.5ns (2.63 - 2.76m)



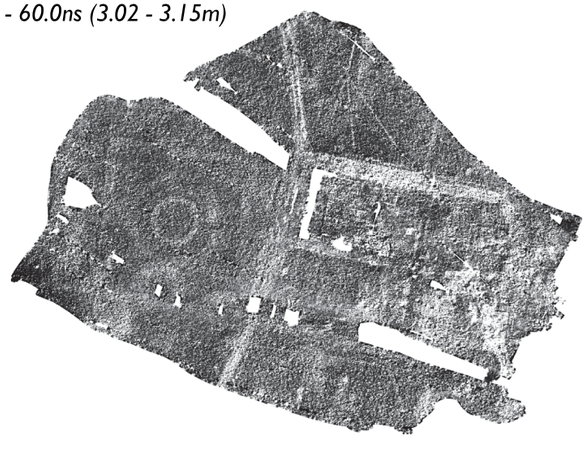
52.5 - 55.0ns (2.76 - 2.89m)



55.0 - 57.5ns (2.89 - 3.02m)



57.5 - 60.0ns (3.02 - 3.15m)



Low *High*
relative reflector strength

0 90m

1:2500

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Historic England

Figure 14

BELHUS PARK, THURROCK,
Graphical summary of significant GPR anomalies, March 2021

TQ5781

N

813

812

570

571

572

2021-03-24-070

2021-03-23-004

2021-03-24-034

2021-03-24-171

[gpr1] [gpr2] [gpr3] [gpr4] [gpr6] [gpr8] [gpr15] [gpr20] [gpr22] [gpr23] [gpr26] [gpr27] [gpr30] [gpr33] [gpr34] [gpr36] [gpr37] [gpr38] [gpr39] [gpr50] [gpr51] [gpr53]

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Earthwork hachures

Visible remains of manor house

0 60m

1:1000

low amplitude reflectors

high amplitude reflectors

anomalies of known or recent origin

2021-03-24-001 Location of selected GPR profiles shown on Figure 11

Historic England

Geophysics Team 2021



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