



LAND TO THE WEST OF NORTON PRIORY, HALTON CHESHIRE

Archaeological Geophysical Survey



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SUMMARY

Oxford Archaeology North (OA North) was commissioned to manage a geophysical survey and produce an archaeological analysis and recommendations for further work on land to the west of Norton Priory, Halton, Cheshire (NGR SJ 547 831). Halton Borough Council intends to develop the site, which equates to 14ha, for residential and open space purposes and is looking to submit a planning application to this effect. A desk-based assessment was undertaken by OA North of the wider area as part of the Castlefields Regeneration Scheme (OA North 2002). A high archaeological potential was identified during this assessment and, consequently, the Planning Archaeologist at Cheshire County Council (CCC) advised that a geophysical survey should be undertaken in the first instance to assess the potential for below-ground archaeological remains. The results of the geophysical survey will aid in the determination of the requirements for subsequent evaluation trenching during the planning process.

OA North subcontracted the geophysical survey to Stratascan Ltd. This consisted of a reconnaissance survey of the whole site employing a magnetic susceptibility survey and magnetometer scanning survey. From these results, areas of archaeological potential were identified mainly along the eastern side of the site. The western side of the site showed very low levels of magnetic activity and susceptibility enhancement. An area of approximately 1ha was targeted with a detailed gradiometer and electrical resistance survey along the eastern side of the site. This coincided with the approximate position of an infilled ornamental pond (Site 31, OA North 2002), once associated with Norton Hall.

The results from the combined detailed survey were successful in producing a complementary data set. This has enabled both a more informed interpretation. The most obvious anomaly in the detailed magnetometer results is a linear feature showing bipolar (i.e. alternate negative and positive values) responses running on an almost north/south course that correlates with a high resistance linear. This has been interpreted as a deeply buried service or drain, the purpose of which may relate to the draining of the infilled ornamental pond.

The resistivity results also showed a square high resistance feature, the position of which overlapped with the approximate position of a cropmark (Site 38, *ibid*), observed within the infilled pond. Furthermore, the Cheshire Sites and Monuments Record (SMR 66/1/4; *ibid*) states that the infilled pond produced a large structural timber during drainage works in 1986. The drain appears to run into the square structure, but its position on the northern edge of the survey area prevents any clear observations as to whether the drain runs to it or through it.

There was no indication of the infilled pond within the results of the geophysical survey. However, this is probably due to the infilled pond occupying the majority of the northern half of the survey area preventing the differentiation between the normal soil or background response from that of the pond. The likely depth of the infilled pond would also be beyond the range of depth penetration for the resistance survey. Nevertheless, amorphous anomalies observed within the location of the pond in the magnetometer data, which extends more eastwards than the resistance data, may be associated with the infill material.

Despite the potential for possible stone structural remains associated with the Priory complex no such features were found during the survey. This is mainly due to the majority of the detailed survey area coinciding with the infilled pond. However, the reconnaissance techniques would struggle to locate such non-magnetic materials in order to provide a target for the more suitable detailed resistance survey. Therefore, based on the present evidence, it cannot be ruled out that such features do not occur elsewhere across the site.

It is recommended that the features of archaeological potential identified in the survey results are further investigated with a programme of evaluation trenching. This should aim to target the probable square structure correlating with the cropmark, and investigate its relationship with the probable drain. It is also recommended that the amorphous-shaped anomalies seen in both data sets, but representing different features, should also be further investigated.

The trial trenching should also look to evaluating areas not included in the detailed survey. Additional areas of potential identified in the reconnaissance survey remain unknown as to their underlying cause. Areas of focus should include the eastern side of the site where enhanced magnetic susceptibility levels were observed, the area of enhancement to the north-west of the Norton Priory complex, the more central area of the site showing a band of increased magnetic activity, and the cause as to why the west side of the site is almost devoid of any enhancement or magnetic activity.

ACKNOWLEDGEMENTS

Oxford Archaeology North would like to offer thanks to Philip Esseen of Halton Borough Council for commissioning the project, and to Lynne Smith of the Norton Prior Museum for her help and the use of the facilities during the fieldwork. Thanks are also extended to Mark Leah of Cheshire County Council for his help and advice.

The geophysical survey was undertaken by Stratascan Ltd. The report was written by Emily Mercer, who also managed the project.

1. INTRODUCTION

1.1 CIRCUMSTANCES OF THE PROJECT

- 1.1.1 Halton Borough Council intends to develop land to the west of Norton Priory, Cheshire (centred NGR SJ 547 831; Fig 1) for residential and open space purposes and is looking to submit a planning application to this effect. A desk-based assessment was undertaken by Oxford Archaeology North (OA North) of the wider area as part of the Castlefields Regeneration Scheme (OA North 2002). As part of the ongoing evaluation of the area, and due to the high archaeological potential of the site, the Planning Archaeologist at Cheshire County Council (CCC) has advised that a geophysical survey should be undertaken in the first instance to assess the potential for below-ground archaeological remains. The results of the geophysical survey will aid in the determination of the requirements for subsequent evaluation trenching during the planning process.
- 1.1.2 OA North was commissioned to manage a geophysical survey on the site, to consist of a reconnaissance survey of the whole site, followed by a targeted detailed survey. This short report will present an analysis of the results in accordance with the known archaeological resource, as per the previous assessment (*ibid*), and present recommendations for any further work.

1.2 SITE DESCRIPTION, LOCATION AND GEOLOGY

- 1.2.1 The area identified for geophysical survey consists of 14ha of flat rough pasture or scrub land that was used as a playing field more recently. This is situated 4km to the north-east of the town of Runcorn, in the district of Halton, Cheshire. It is bordered by the A558 to the north and the Bridgewater Canal to the south, with Norton Priory lying immediately to the east and Haddock's Wood to the west.
- 1.2.2 The site is situated along the southern side of lower reaches of the river Mersey, on land slightly higher than the flood plain to the north. Therefore, the drift geology is largely a product of fluvial activity along the Mersey and further inland are boulder clays, which were deposited during the various glacial episodes (Countryside Commission 1998; Higham 1993; Hebblethwaite 1987). It lies on a band of Keuper Sandstone with Upper Mottled Sandstone to the north and Waterstones to the south (IGS 1971).
- 1.2.3 The overlying soils are mostly of the Bridgnorth and Clifton Associations, with the Bridgnorth soils being typical brown sands (usually wind blown) and the Clifton soils being typical stagnogleys (Lawes Agricultural Trust 1983). The brown sands are suitable for arable and pasture, being of Grade 2 landuse, whereas the stagnogleys are Grade 3 and most suited for grassland.

2. METHODOLOGY

2.1 PROJECT DESIGN

2.1.1 A project design (*Appendix 1*) was submitted by OA North to Halton Borough Council for a geophysical survey of the proposed development area and archaeological analysis of the results. The project design was prepared in accordance with a verbal brief provided by Mark Leah, Planning Archaeologist (CCC). The project design was adhered to in full and the work was consistent with the relevant standards and procedures of the Institute of Field Archaeologists, the English Heritage guidelines for geophysical surveys (1995), and generally accepted best practice.

2.2 GEOPHYSICAL SURVEY

2.2.1 **Introduction:** the survey area of 14ha was subject to a reconnaissance survey as the first phase of investigation, to identify anomalies of possible archaeological significance. The combined techniques of magnetic susceptibility survey and magnetometer scanning were employed. An area of archaeological potential equating to approximately 1ha was then selected to target with more detailed survey, using a magnetometer survey and resistance survey.

2.2.2 A detailed methodology and description of the techniques and configurations have been provided in the geophysical survey report (*Appendix 2*).

2.2.3 **Reconnaissance survey:** two techniques were used to undertake a rapid assessment of the site; magnetometer scanning and magnetic susceptibility. These rapid survey techniques are currently the only commercially available options, although individually neither of the techniques is effective in locating stone foundations that may be associated with the Priory complex. However, it is possible to locate magnetic enhancement or disturbance and debris associated with buildings, for example iron nails, hinges, and hearths. Therefore, the application of a combined approach would strengthen their overall efficiency as a reconnaissance technique in identifying areas of most potential.

2.2.4 Both surveys were carried out on 20m parallel north/south transects across the whole of the proposed development site. The magnetometer scanning survey involved continuous monitoring of the readings using a dual sensor Bartington Grad 601-2 Magnetic Gradiometer in scanning mode. Areas of interest were classified and recorded onto a site plan in order to show their distribution and any obvious patterning (Fig 2, Stratascan Ltd 2006). Readings for the magnetic susceptibility survey were taken every 20m along the grid lines using a Bartington MS2D field coil and presented as a greyscale plot (Fig 3, *ibid*).

2.2.5 **Detailed survey:** an area equating to approximately 1ha was chosen for detailed survey on the east side of the proposed development area. Activity and areas of enhancement were observed suggestive of remains of archaeological potential in this area. Encompassed within the detailed survey

area were 'blank' areas within the reconnaissance survey results that were used as a control.

- 2.2.6 A 30m grid was employed for both the magnetometer survey and resistance survey. The baseline (AB, Fig 4, *ibid*) was referenced from known points on the site. The magnetometer survey was undertaken using a dual sensor Bartington Grad 601-2 Magnetic Gradiometer with readings taken at 0.25m along traverses with 1m separation. The resistance survey employed a Geoscan Research RM15 used in conjunction with a multiplexer MPX15 on a twin probe array, with readings taken at 1m centres along traverse with 1m separation.

2.3 ARCHIVE

- 2.3.1 A full professional archive has been compiled in accordance with the project design (*Appendices 1 and 2*), and in accordance with current IFA and English Heritage guidelines (English Heritage 1991). The archive will be deposited with the Cheshire County Record Office and copies of the report will be forwarded to Cheshire SMR on completion of the project.

3. ARCHAEOLOGICAL AND HISTORICAL BACKGROUND

3.1 INTRODUCTION

- 3.1.1 The following has been reproduced as a brief synopsis of that information collated for the purposes of the initial desk-based assessment (OA North 2002), which should be referred to for further detailed information (*ibid*).

3.2 PREHISTORIC PERIOD

- 3.2.1 There is clear evidence of man's activity in Cheshire from the Palaeolithic to the Neolithic period but nothing is known in close proximity to the outlined proposed development area (Higham 1993); this may be due to the lack of fieldwork in this part of the county, the ephemeral nature of the cultures in this region, or the changes in coastline and river courses, and their relation to settlements and activity. From the north side of the Mersey at Ditton Brook three excavated sites produced scatters of worked flints and waste flakes, indicating Mesolithic activity in the area (Cowell 1992). There is some suggestion from the assemblages and the range of tools produced that the remains may represent several visits to the area, which was probably open land, adjacent to both the river and deciduous forest further inland (Cowell 2000a).
- 3.2.2 The Bronze Age has also provided no definite evidence in the study area, although further away to the south-east there are burial mounds recorded (Higham 1993) and a Middle Bronze Age axe was found while the Manchester Ship Canal was under construction in 1892 (*ibid*).
- 3.2.3 During the Iron Age, the area was part of the land occupied by the Cornovii tribe, and although boundaries between tribes are speculative, the Mersey appears to have served as the boundary between the Cornovii and the Brigantes to the north (Cunliffe 1991, 188). A site on the northern side of the Mersey at Brook House (SJ 473 850), excavated in 1993 and interpreted as high status, revealed the remains of two Iron Age concentric enclosures marked by ditches and banks (Cowell 2000b). Within the inner enclosure was a circular building with a causeway leading across the enclosure to the building's entrance; other associated features included several pits, a four-posted structure, and a hollow containing metalworking residues. There appeared to have been a period of abandonment, which has speculatively been linked to the arrival of the Roman military in the region, before the site was re-occupied in the second century AD (*ibid*).

3.3 ROMAN PERIOD

- 3.3.1 There is considerable evidence for Roman activity around the Mersey in the vicinity of the proposed development area. The large Roman industrial site of Wilderspool lies approximately 10km to the north-east (Shotter 1997, 82; Hinchcliffe and Williams 1992), and 20km to the south-west is Chester, a legionary fortress established sometime in the AD 70s (Salway 1981, 139). The route between the two places has not been established with certainty but it

is suggested that it passed along the south of the Mersey (Shotter 1997, 35). The site of a Roman camp is marked on modern Ordnance Survey (OS) maps, on the basis of fieldwork carried out in the 1930s (Newstead and Droop 1934), although subsequent work in the 1960s suggested that this was probably a Roman agricultural site (Brown *et al* 1975).

3.4 MEDIEVAL PERIOD

- 3.4.1 ***Halton and Norton Townships:*** the earliest document to contain a clear reference to the area is Domesday Book (Morgan 1978). It describes the manors of *Heletune* (Halton), the capital manor of Runcorn Parish in the hundred of Tunendune (Higham 1993, 155), held by Orme and *Nortune* (Norton) held by Ansfred. The name Halton was possibly introduced when the Barony of Halton was given by Roger Lacy to his brother Richard. ‘Halton’ and variations of it appear in Domesday Book, the name probably means ‘*farm at a heathery place*’ (Dodgson 1970, 153-154). Domesday Book describes the size of the manors: Halton was the larger with 20 carucates, while Norton only had six. Halton also had more woodland, more fishermen, and several prominent landholders were mentioned, but interestingly the area of meadow was smaller than in the manor of Norton. Both entries indicate that there may have been some depreciation in land values or disturbances in the working of the manors prior to the Domesday assessment, as they are described as having become ‘waste’ since the rule of Edward the Confessor, possibly when the Normans were attempting to establish their authority in the North West.
- 3.4.2 ***Norton Priory:*** the Priory of St Bertelin was established in 1115, by William fitzNigel, as an Augustinian house in Runcorn, but in 1134 it was relocated, by a distance of 4km, to Norton, immediately to the east of the survey area. This was at the request of Roger, Bishop of Chester, and it was dedicated to St Mary. Excavations of the remains, from 1970 to 1987, elucidate the development of the Priory from its earliest temporary buildings, probably erected to house both the canons and the vast army of workmen needed to build such a fine Romanesque monastery (Greene 1987). By the end of the twelfth century the stone buildings of the monastery were not only complete, but were being expanded to accommodate more members of the order. In the thirteenth century the Priory precinct was surrounded by a complex moated system (Site 13, OA North), that was connected to the Priory main drain (Greene 1987). Despite the setback of a major fire in 1236, and the more general financial and social problems of the fourteenth century, Norton had attained the status of mitred Abbey by 1391, which reflected its wealth and position in the area at this time, and its Abbot was a senior and much respected member of the Augustinian Order. The monastery was expanded and beautified over the years in order to reflect this much-enhanced status and the enlarged complex is likely to have occupied part of the eastern side of the proposed development site. The nearby village of Norton is known to have had its genesis in the medieval period, probably a ripple effect of the Priory’s growing wealth and status (LUAU 2000).
- 3.4.3 The Abbey (as it then was) met its end in April 1536, in the first phase of Henry VIII’s Dissolution of all religious houses, under the aegis of Sir Piers Dutton, and all its lands and holdings were examined. Unusually, it remained

unsold until 1545 when the manor was bought by Sir Richard Brooke of Leighton (Greene 1987, 31). The Brooke family adapted the Abbot's quarters to their own use and created a substantial partly timber-framed house on the site. This incorporated numerous elements from the Priory, including the west range. The majority of the remainder of the Priory, including the church, was demolished rapidly. It is thought this was in part due to reuse as building material, but also in asset stripping to pay for the large mortgage raised to purchase the property (*ibid*).

- 3.4.4 Records from the Priory and other sources show that the Mersey was prone to flooding and that flood defences were constructed in the form of embankments (*ibid*). This, combined with drainage of the manor's marshlands, increased the land available for agriculture and other activities. Nearby Oxmoor, to the south-west, is mentioned in the 1536 *Augmentation Office Commissioners' Accounts* (PRO SC6/HenryVIII/410 26259) and its name suggests that the area may have been used for grazing in the medieval period (Dodgson 1970, 32). These accounts give a glimpse of the economy and landscape of the area at the very end of the medieval period, suggesting that there was pasture land/meadows near to the Mersey, with arable use further inland, together with a variety of relatively small-scale industrial activity from mills, fisheries and woodland (OA North 2002).

3.5 POST-MEDIEVAL PERIOD

- 3.5.1 The Brooke family remained in residence for the next 400 years during which time, the Tudor hall was besieged by Royalists in 1643. However, it survived until some time between 1727 (Buck and Buck Print) and 1757 (John Eyes 1757 Estate map of Norton Priory; Plate 2) when it was demolished and a new Georgian mansion was constructed (OA North 2002). Only the undercroft of the west range of the monastery survived, serving as cellars to a new house in the Classical idiom, which stood until the site was abandoned in 1928, after which it, too, was demolished (LUAU 2000). Indeed the Brookes owned the land until it was given to the Norton Priory Museum Trust.
- 3.5.2 The estate map of 1757 (Plate 2) is a '*map of the manor and lordship of Norton in the parish of Runcorn, together with a plan of Norton Hall, the seat of Sir Richard Brooke, baronet*'. It is topographically accurate, drawn to scale, and includes a great level of detail, although the accompanying estate book documenting the details has been lost. The map shows that the complex moated system established in the thirteenth century is still apparent (Site 18, OA North 2002) but it is likely to have been infilled during the construction of the Georgian mansion and extensive landscaping some time after. Evidence from the map shows that there seemed to be a broad continuation of the later medieval landuse and economy in the general area. However, the continuing expansion of parkland into the nineteenth century was to the disadvantage of agricultural land (*ibid*).
- 3.5.3 Drawn prior to the insertion of the Bridgewater Canal it provides a useful examination of the land before this major episode of landscaping. The most interesting aspect is the large, regular shape of a millpond to the immediate west of the Priory site (Site 31, *ibid*; Fig 2). This was created by damming the Bannerstitch Brook that flows to the west of the Priory, northwards to the

Mersey (*ibid*). Aerial photographs of the area show the location of the feature, which may still exist in an infilled state (*ibid*), to be accurate.

- 3.5.4 A watercolour and ink drawing dating to *c* 1770 (Plate 3) shows the millpond with boats on it, indicating a recreational use. The narrow northern outlet of the pond passes by a water mill to the north (Site 32, *ibid*: Fig 2). The area seems to have been subject to water management from the medieval period since there were moats around the Priory and large drains at that time, known through excavation and from several documents (Greene 1989). The Brooke Family clearly maintained the moat system and it is possible that the millpond could also date back to the medieval period. The area immediately around the hall was shown as parkland, although the land to the west of the millpond was shown as agricultural fields.
- 3.5.5 The mid nineteenth century Tithe Map (OA North 2002), show that these fields were used for either arable or a mixture of meadow and pasture, with pastoral land use being the greater, and oats being the predominant crop on the arable fields. The area of the proposed development remained as parkland centred on Norton Hall, although the millpond had been infilled prior to the drawing up of the Tithe Map. The site continued to remain undeveloped until the present day.
- 3.5.6 **Communications:** the development of the local industries was closely linked with corresponding development of the transport network. In the mid eighteenth century, Francis, the third Duke of Bridgewater, began implementing a plan for a waterway. This, the Bridgewater Canal, was the first canal in Britain and was partly open by 1761. By 1767 it was open as far down as Runcorn and was fully open by 1772; it was used to carry coal, cotton, maize and other agricultural products up until 1975 (Hadfield 1984).
- 3.5.7 To the north of the survey area is the Manchester Ship Canal. Although it was not opened in this form until 1894, there has been a man-made waterway along this stretch since 1740, called the Mersey and Irwell Navigation. The River Mersey meanders to the north of the study area, making the transport of raw materials difficult, and there was thus a great impetus to create a controllable and navigable route. The Mersey and Irwell Navigation was open to water traffic by 1740 (*ibid*).
- 3.5.8 The area also saw the development of the railway system in the nineteenth century, with several lines running into the Runcorn peninsula where there was a major transport exchange between canals, roads, railways and shipping. The twentieth century saw a boom in road transport and associated with this and the growth of the chemical industry, there has been a rapid expansion of urban areas to accommodate an increasing population, following the establishment of the Runcorn New Town in 1964.

3.6 ARCHAEOLOGICAL POTENTIAL

- 3.6.1 The assessment undertaken by OA North in 2002 showed the proposed development site outlined for geophysical survey existed as probably agricultural land or meadowland during its association with the monastery, and later Abbey. The size of the monastic complex, as it grew in status and wealth,

is believed to have extended into the north-east corner of the survey area. Subsequent to its Dissolution and purchase by the Brookes family (see *Section 3.4*, above), Norton Hall, as it became known, encompassed much of the surrounding area in its ever-increasing parkland.

- 3.6.2 In association with the hall, and positioned to its west, a millpond or ornamental lake was created. The exact date of its origin is not known, but it is first identified from cartographic sources in the early eighteenth century. This may have occurred at the same time as the demolition of the Tudor hall and construction of the Georgian mansion. This millpond was situated on the eastern side of the proposed development area and is likely to have been used to power a mill to its north, within the northern limits of the survey area, although there are watercolours showing its use for recreational purposes. The millpond was infilled prior to the drawing up of the Tithe map in the mid nineteenth century, but its exact position was revealed in aerial photographs in 1973.
- 3.6.3 The same aerial photographs also showed a square-shaped cropmark sited within the infilled millpond, indicating a later feature (approximate position shown on Fig 2, Site 38 (OA North 2002)). The Cheshire Sites and Monuments Record (SMR 66/1/4; *ibid*) states that the infilled pond produced a large structural timber during drainage works in 1986.
- 3.6.4 Elsewhere within the proposed development site, the lack of any previous development other than the use of the area for agriculture and later parkland may have preserved earlier archaeological remains *in situ*.

4. DISCUSSION OF THE SURVEY RESULTS

4.1 INTRODUCTION

4.1.1 The following analysis and discussion are based on the results produced in the geophysical survey report (Stratascan Ltd 2006; *Appendix 2*). It is not intended to entirely replicate the full results but to present a précis during analysis and possible further interpretation. This interpretation is shown in Figure 3.

4.2 ANALYSIS OF THE RESULTS

4.2.1 **Reconnaissance survey:** the magnetometer scanning survey (Fig 2, *ibid*) showed levels of magnetic activity along the eastern edge of the survey area, towards Norton Hall/Priory and associated parkland. There are also two further 'bands' of distinct activity within the area, running approximately north/south. The first is approximately 100m from the eastern site boundary showing some linear patterning. The second area is 100m further westwards and more disperse in nature. Magnetic activity can also be seen to correlate with the disused tennis courts in the southernmost area of the survey.

4.2.2 The magnetic susceptibility results (Fig 3, *ibid*) show similar potential for archaeological activity along the eastern edge of the survey area, particularly to the south-west and north-west of the Norton Priory complex. There are also enhanced levels of susceptibility in the area of the disused tennis courts (Fig 2) in the south-east corner of the site.

4.2.3 The area of potential along the eastern edge of the survey area observed in both reconnaissance survey results may be associated with the trackway that runs between the Bridgewater Canal in the south and the crossing over the A558 to the north. However, it is possible that it may represent activity associated with the Priory or later Hall. The very western edge of the site showed little in the way of magnetic activity or in levels of susceptibility enhancement. For these reasons the detailed survey was positioned on the eastern side of the site. It incorporated areas of potential outlined in the reconnaissance survey, together with areas showing little activity of enhancement to act as a control. The area to the north-west of the Norton Priory complex could not be incorporated in the detailed survey, nor could the western side of the site that had shown very low values due to the limits of the survey requirements.

4.2.4 **Detailed survey:** the results from the combined detailed survey have successfully produced complementary data sets. This has enabled both a more informed interpretation due to the compilation of characteristics, and in some instances has been able to provide information regarding a feature in one data set not otherwise observed in the other.

4.2.5 The most obvious anomaly in the detailed magnetometer results is a linear feature showing bipolar (i.e. alternate negative and positive values) running on an almost north/south course (Figs 5-8, *ibid*). This correlates with a high

resistance linear (Figs 10 and 11, *ibid*) and has been interpreted as a deeply buried service; the trench backfilled with gravel or similar. It is possible that this feature relates to a modern drain (Fig 3), the purpose of which may relate to the infilled pond.

- 4.2.6 The magnetic values produced by the drain have effectively wiped out a 25m swathe in the results, masking any more subtle anomalies associated with archaeological features. However, there is an area of magnetic disturbance at its northern end. Not much information can be gleaned from the magnetic data, but the resistivity data clearly shows a square high resistance feature (Figs 10 and 11, *ibid*). The position of this feature can be seen to overlap with the approximate position of the cropmark (Site 38) plotted on Figure 3, observed within the infilled pond, and it is possible that the precise location of the cropmark needs to be repositioned. The Cheshire SMR recorded a structural timber, suggesting that the high resistance represents a building. However, this is not comprised of brick as the results from the magnetometer survey do not correlate with such material. The magnetic disturbance overlying this feature is likely to relate to debris associated with the structure.
- 4.2.7 The drain appears to run into the square structure, but its position on the northern edge of the survey area prevents any clear observations as to whether the drain runs to it or through it.
- 4.2.8 Other discrete linear features observed in the resistivity results (Figs 10 and 11, Stratascan Ltd 2006) are likely to relate to numerous other drains (high resistance), or drainage channels (low resistance). There cannot be discerned from the magnetometer data due to their being masked by magnetic debris or disturbance in the data (Figs 5-8, *ibid*). This is of particular relevance for the southern area of the detailed survey; high levels of magnetic activity have effectively masked any other features within it that are known from the resistivity data set.
- 4.2.9 The detailed survey has been positioned within the approximate position of the infilled pond. However, there is no indication of this within the results of the geophysical survey. One possibility may be due to the relative size of the survey area compared to the infilled pond feature, which prevents the differentiation between the normal soil or background response from that of the pond. The likely depth of the infilled pond would also be beyond the range of depth penetration for the resistance survey.
- 4.2.10 Nevertheless, the amorphous anomalies observed within the magnetometer data, which extends further eastwards than the resistance data, may be associated with the infill material (Fig 3; Figs 5-8, *ibid*). These features may be of archaeological potential but would post-date the infilling of the pond. The anomalies of high resistance outside of the approximate position of the pond have few characteristics precluding any further interpretation.

5. CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

- 5.1.1 The combined geophysical survey has been successful in the location of features of archaeological potential. The use of the complementary survey techniques of magnetometry and resistivity has shown the effectiveness in their application to sites of archaeological potential. In many cases magnetometry is often preferred due to it being a rapid survey technique and consequently, less costly than resistivity, with less consideration to the archaeological remains being investigated. In this instance, the resistivity survey results have located the cropmark (Site 38, OA North) of which little was known. Resistivity has also provided additional information in areas obscured by high levels of magnetic activity or disturbance.
- 5.1.2 However, given the potential for possible stone structural remains associated with the Priory complex, the reconnaissance techniques were likely to struggle in locating such non-magnetic materials. Therefore, based on the present evidence, it cannot be ruled out that such features do not occur elsewhere across the site, particularly taking into consideration the position of the survey area over the infilled pond.
- 5.1.3 In addition, the limitations of the detailed survey to approximately 1ha have resulted in areas of potential identified in the reconnaissance remaining unknown as to their cause, such as the very eastern edge of the site and the area to the north-west of the Norton Priory complex. Similarly, the very low levels seen in the reconnaissance survey on the western side of the site are equally as puzzling. However, it would not be practical to divide the detailed survey within each of these areas as small survey areas make it difficult to differentiate between understanding the normal variations within the soil, due to its heterogeneity, and those variations caused by archaeological features.

5.2 RECOMMENDATIONS

- 5.2.1 In order to investigate the features identified from the survey as being of archaeological potential, it is recommended that a programme of evaluation trial trenching is undertaken. This should aim to target the probable square structure, and investigate its relationship with the probable drain. It is also recommended that the amorphous-shaped anomalies seen in both data sets, but representing different features, should also be further investigated.
- 5.2.2 The trial trenching should also look to evaluating areas not included in the detailed survey. Areas of focus should include the eastern side of the site where enhanced magnetic susceptibility levels were observed, the area of enhancement to the north-west of the Norton Priory complex, the more central area of the site showing a band of increased magnetic activity, and the cause as to why the west side of the site is almost devoid of any enhancement or magnetic activity.

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Plate 2: Estate Map of Norton Manor (Eyes 1757)

Plate 3: Ink and watercolour drawing of Norton Manor (Norton 1770)

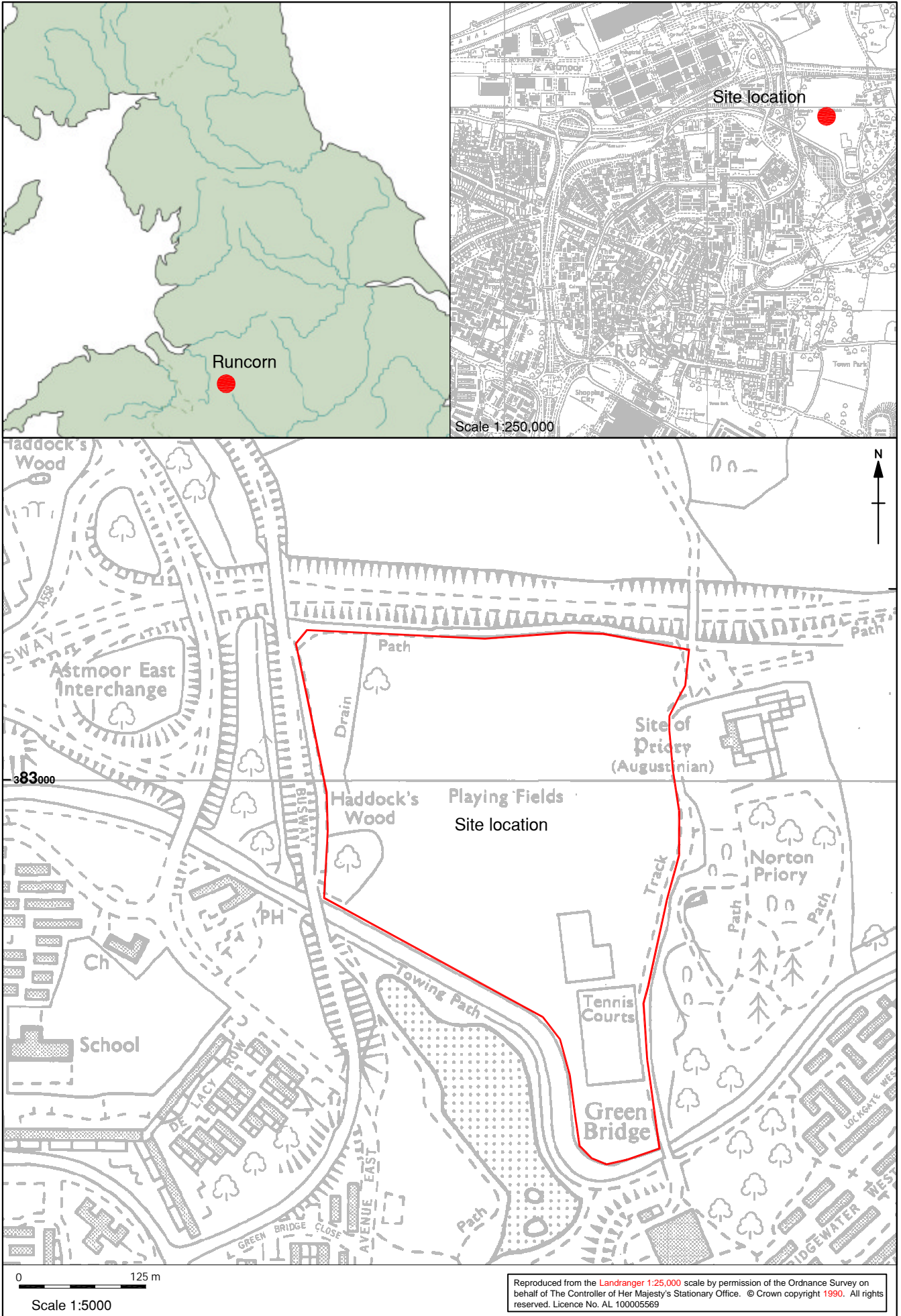


Figure 1: Site Location

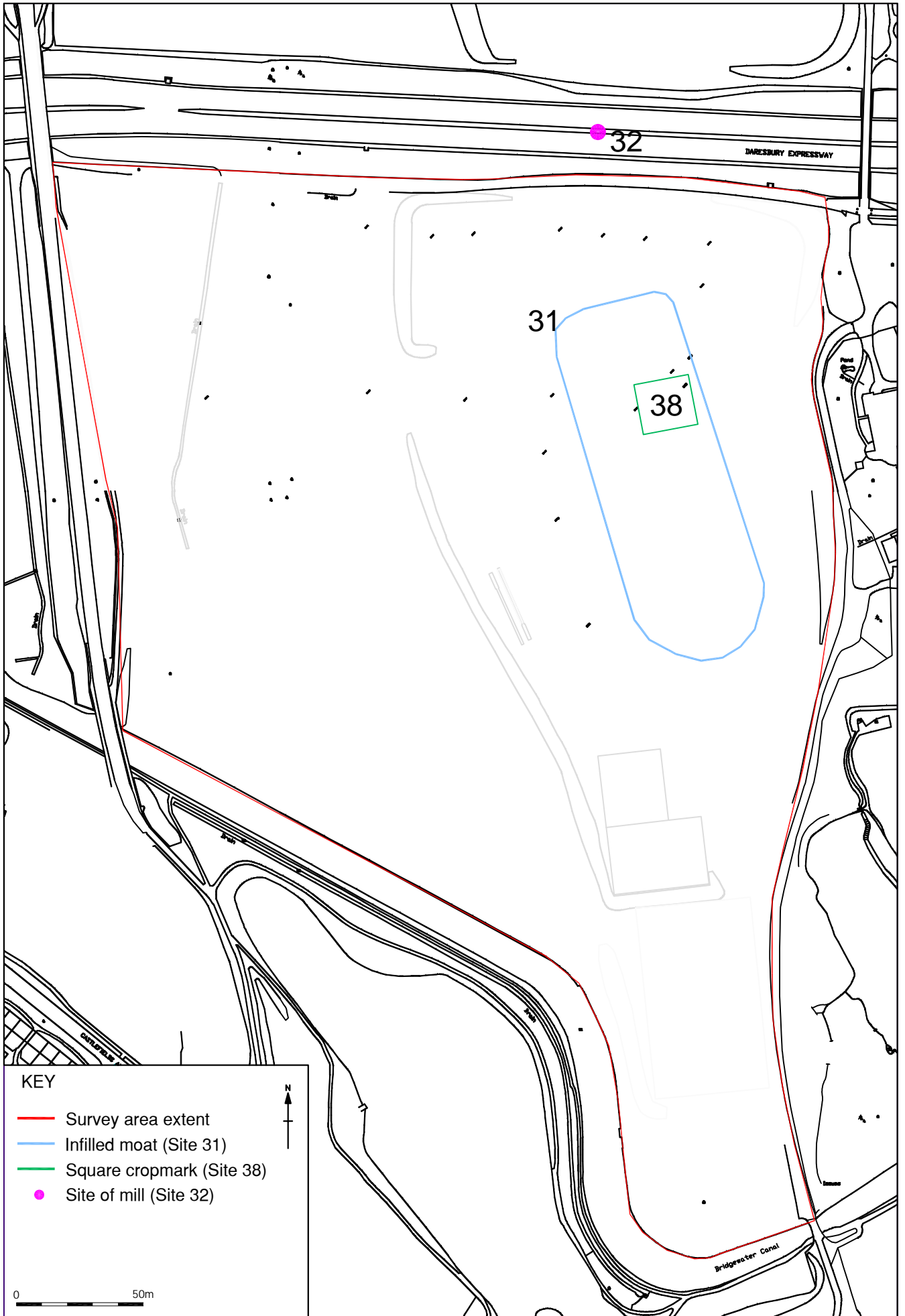


Figure 2: Plan showing pertinent archaeological gazetteer sites (OA North 2002)



Figure 3: Interpretation plot of geophysical survey features



Plate 1: Aerial photograph looking to the south-east over Norton Priory, with the square cropmark visible in the foreground (Hunting Survey 1973)

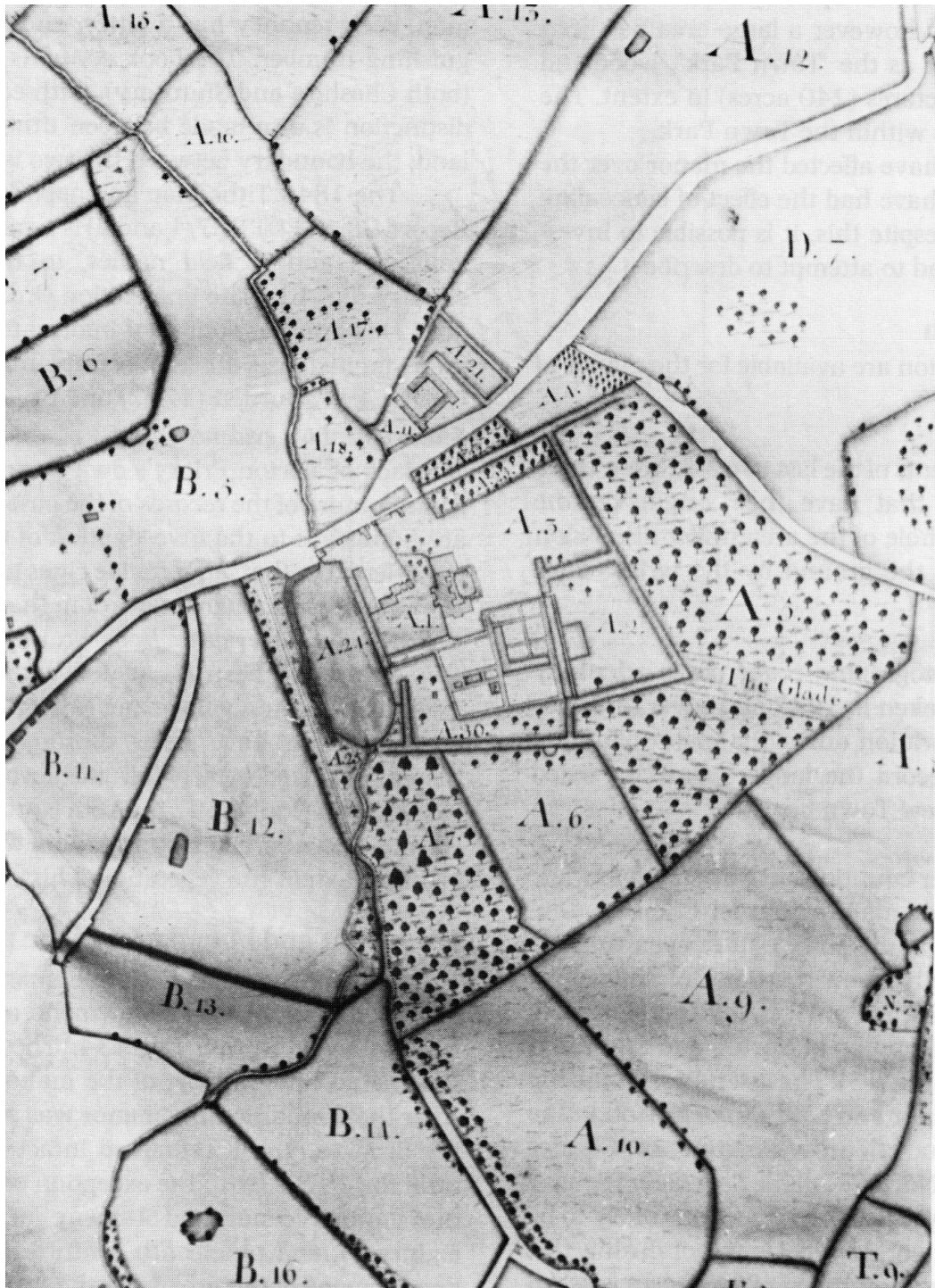


Plate 2: Estate Map of Norton Manor (Eyes 1757)

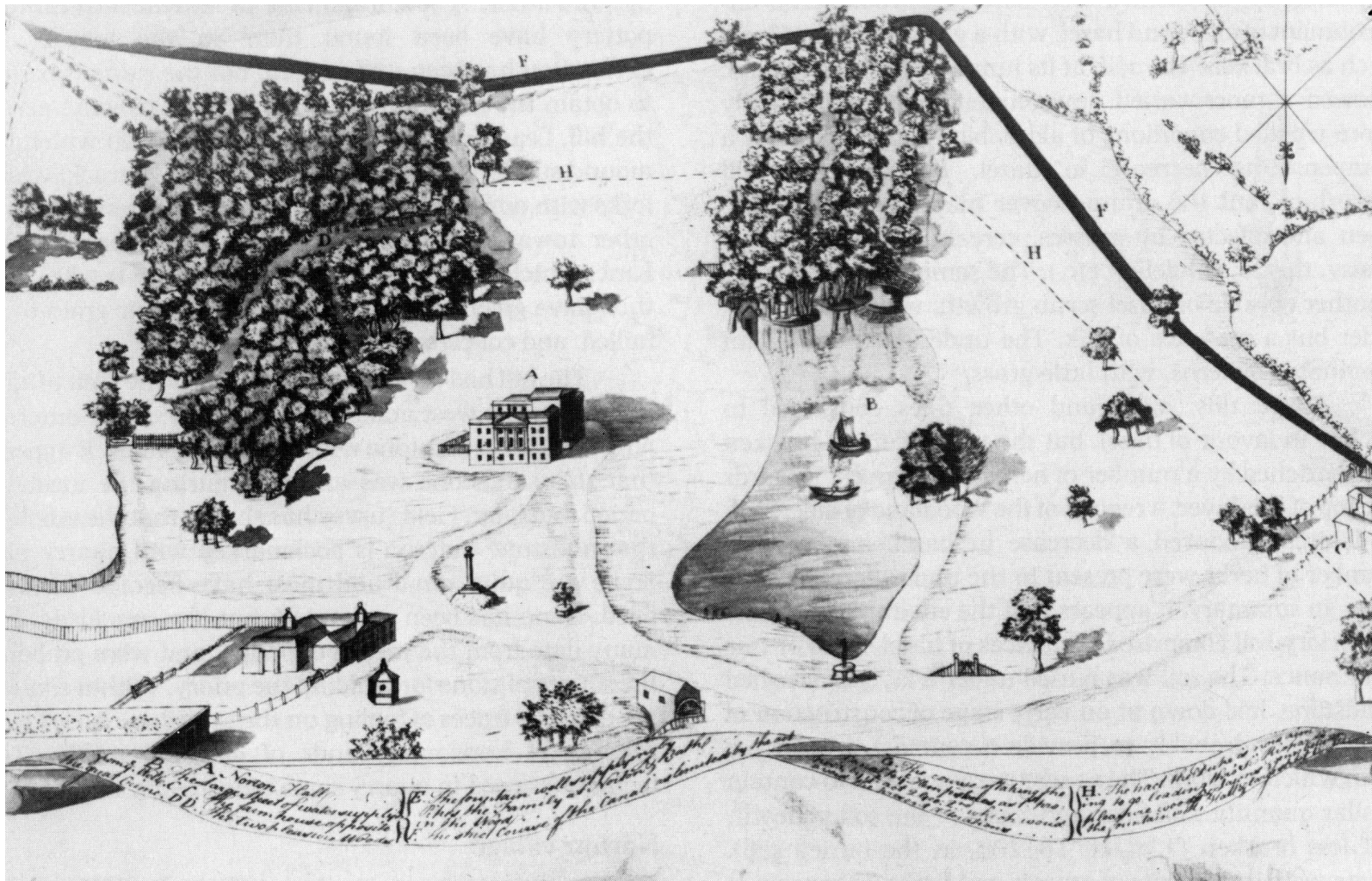


Plate 3: Ink and watercolour drawing of Norton Manor (Norton 1770)

APPENDIX 1: PROJECT DESIGN

1. INTRODUCTION

1.1 PROJECT BACKGROUND

1.1.1 Halton Borough Council (hereafter the 'client') propose to develop land to the west of Norton Priory, Runcorn, Cheshire (centred SJ 547 831) for residential and open space purposes. Oxford Archaeology North (OA North) has been requested to submit proposals to commission and manage a geophysical survey on the site, which is required prior to the determination of a planning application. The site lies in an area of high archaeological potential. Consequently, the client has been advised by Cheshire County Council's Environment Planning Service (Archaeology) that a reconnaissance survey of the whole site is initially carried out, followed by a targeted detailed survey.

1.2 ARCHAEOLOGICAL BACKGROUND

1.2.1 The proposed development site lies immediately to the west of the remains of the medieval monastery of Norton Priory and is therefore within the monastic complex, where it is likely to contain below-ground remains pertaining to associated structures. The Priory was dedicated to St Mary and was founded at Norton in 1134, approximately 1 km from the village of Norton, which is known to have had its genesis in the medieval period, and was thus broadly contemporary with the Priory. The Augustinian canons of the Priory of St Bertelin, founded in Runcorn in 1115, were relocated to the site at the request of Roger, bishop of Chester. Excavations on the remains, from the 1970 to 1987, elucidate the development of the Priory from its earliest temporary buildings, probably erected to house both the canons and the vast army of workmen needed to build such a fine Romanesque monastery. By the end of the twelfth century the stone buildings of the monastery were not only complete, but were being expanded to accommodate more members of the order. Despite the setback of a major fire in 1236, and the more general financial and social problems of the fourteenth century, Norton had attained the status of mitred Abbey by its end, and its Abbot was a senior and much respected member of the Augustinian Order. Of course the monastery was expanded and beautified over the years in order to reflect this much-enhanced status.

1.2.2 Originally founded by William fitz Nigel, second baron of Halton, and moved to Norton by his successor, William fitz William, the Priory became the burial place of lesser members of their family, but never, it seems, of the barons themselves. From the mid-twelfth century its principal benefactors were the Duttons, descendants of Odard, a founder donor, who adopted it as their burial place and continued to maintain a family chapel there until the Dissolution.

1.2.3 The Abbey (as it then was) met its end in April 1536, in the first phase of Henry VIII's Dissolution of all religious houses. Eight years later the site was sold to the Brooke family, who remained in residence for the next 400 years. Moving into the Abbot's accommodation and retaining the monastic kitchen complex and other buildings of the outer courtyard for their use. In the mid-eighteenth century most of the old house was demolished. Only the undercroft of the west range of the monastery survived, serving as cellars to a new house in the Classical idiom, which stood until the site was abandoned in 1928, after which it, too, was demolished.

1.3 OXFORD ARCHAEOLOGY NORTH

1.3.1 Oxford Archaeology North, in its former guise of Lancaster University Archaeological Unit (LUAU), was commissioned by English Heritage to order and upgrade the archive of the excavations from the 1970s and 80s. The archive had been maintained previously by the Norton Museum Trust staff who had worked on it as resources allowed. This work was supplemented by LUAU during the process of collating a *MAP2* assessment. Following the submission of the assessment OA North was commissioned to undertake a post-excavation analysis, funded by English Heritage, in order to bring the entire Norton Priory assemblage to publication, which is forthcoming.

1.3.2 OA North has the professional expertise and resources to undertake the project detailed below to a high level of quality and efficiency. OA North is an Institute of Field Archaeologists (IFA) **registered organisation, registration number 17**, and all its members of staff operate subject to the IFA Code of Conduct.

2. OBJECTIVES

2.1 The following programme has been designed to evaluate the archaeological potential of the proposed development site using non-intrusive investigative methods to English Heritage guidelines (1995). This information will be used to determine whether further archaeological investigation is required. The necessary stages to achieve these ends are as follows:

2.2 GEOPHYSICAL SURVEY

2.2.1 **Reconnaissance Survey:** the whole of the proposed development site, equating to 14ha, will be subjected to rapid survey to identify areas of possible archaeological significance in order that they may be targeted with more detailed work.

2.2.2 **Detailed Survey:** a detailed geophysical survey will be carried out over 1ha, as identified by the geophysical contractor on-site following the reconnaissance survey, to determine the nature and extent of any archaeological remains.

2.3 REPORT PRODUCTION

2.3.1 Preliminary results can be made available within one week of completion of the fieldwork, and the final report will be produced for the client within eight weeks, unless otherwise agreed at the time of commission between the client and OA North. A site archive will be produced to English Heritage guidelines (1991) and in accordance with the *Guidelines for the Preparation of Excavation Archives for Long Term Storage* (UKIC 1990).

3. METHODS STATEMENT

3.1 INTRODUCTION

3.1.1 The two most commonly used techniques to undertake an effective geophysical survey in the location of archaeological remains are magnetometer and electrical resistance surveys. These allow below-ground remains to be located in a non-intrusive manner, and are often applied to the same site as they produce complementary results. However, on larger sites where detailed survey is not suitable for reasons such as time and budget constraints, these are often preceded with a reconnaissance survey, which can very rapidly assess the site to locate areas of most potential to then focus on with a more detailed survey.

3.1.2 Nevertheless, the results are very much dependent on the type of instrument that is used, and the method of data collection using the chosen instrument. These choices are based on the objectives of the survey, but there are external factors including the local geographical positioning of the site and topographic features, current and past land use, the solid and drift geology, and available resources such as time and budget.

3.1.3 In this case, a number of options have been given in line with the advice from the Cheshire County Council's Planning Archaeologist, and those that are most suitable for this site and the anticipated archaeological remains.

3.1.4 The techniques are defined below and will be carried out according to English Heritage Guidelines (1995).

3.2 RECONNAISSANCE SURVEY

3.2.1 The two techniques used to undertake a rapid assessment of a site in the form of a reconnaissance survey are magnetometer scanning and magnetic susceptibility. However, neither of the following techniques individually are effective in the location of stone building foundations, such as those expected on the site in association with the Priory. By applying both techniques it may strengthen their overall efficiency as a reconnaissance in identifying the areas of most potential.

3.2.2 **Magnetometer Scanning:** this technique employs a magnetometer, in this instance it will be a Bartington Grad601-2, to scan the ground along 20m parallel transects. It works on the same principal as the detailed magnetometer survey (see 3.3.1-3.3.4, below) as it is effective

in locating anomalies associated with cut features, such as ditches, areas of burning, such as hearths or kilns, and brick structures. The difference to a detailed survey is that in order to make a rapid assessment the readings are not logged but are interpreted by a competent and experienced surveyor. Areas of magnetic activity are identified and assessed for their archaeological potential, for example very strong ferrous responses identified in a linear trend are ignored as these are usually associated with underground services. The areas of magnetic activity are marked either by canes inserted into the ground or by marking the location on a plan of the site.

- 3.2.3 **Magnetic Susceptibility:** topsoil possesses a certain level of naturally derived iron oxides. Under certain conditions these iron oxides become magnetically enhanced through past anthropogenic activity, such as burning, or the decomposition of humic material associated with settlement or other such sites. The varying degree of enhancement, compared to the background level, can be measured using a field coil which provides a rapid scan. This provides areas to target with the higher resolution technique of magnetometry.
- 3.2.4 The equipment that will be used is an MS2 Magnetic Susceptibility meter manufactured by Bartington Instruments Ltd. A field coil, known as an MS2D, assesses the top 200mm or so of topsoil. To overcome any problems of ground contact all readings will be taken 4 or 5 times and the average recorded. Obvious localised "spikes" will be ignored.
- 3.2.5 Unlike the magnetometer scanning, the readings are logged to produce a greyscale output showing the general trend of enhancement across the site.

3.3 DETAILED TARGETED SURVEY

- 3.3.1 **Magnetometry:** a magnetic, or magnetometer, survey is usually the first choice for a geophysical survey owing to its ability to be carried out relatively quickly (due to recent improvements in commercially available instruments), and is therefore more cost effective. Consequently, magnetometry is a very efficient technique and is recommended in the first instance by the English Heritage Guidelines (1995) for such investigations.
- 3.3.2 Magnetometry will easily locate 'positively magnetic' material such as iron-based features and objects, or those subjected to firing such as kilns, hearths, and even the buried remains of brick walls. Therefore, this technique is suitable in the detection of features associated with industrial activity. This technique can also be widely used to locate the more subtle magnetic features associated with settlement and funerary remains, such as boundary or enclosure ditches and pits or postholes, which have been gradually infilled with more humic material. The breakdown of organic matter through microbiotic activity leads to the humic material becoming rich in magnetic iron oxides when compared with the subsoil, allowing the features to be identified. Conversely, earthwork or embankment remains can also be identified with magnetometry as a 'negative' feature due to the action in creating the earthwork of upturning the relatively low magnetic subsoil on to the more magnetic topsoil. This technique is classed as a *passive* technique as it relies on measuring the physical attributes, or the magnetic field, of features that exist in the absence of a measuring device, such as a kiln or ferrous object (Schmidt 2001, 6).
- 3.3.3 However, the main drawback to magnetic surveys is that non-thermoremanent features, such as stone building remains, or those features with magnetic susceptibility levels similar to those of the background (particularly in areas where the parent material of the topsoil has very low magnetic susceptibility levels) will fail to be seen in the magnetic survey results. Therefore, a complementary or more suitable technique, such as an earth resistance survey, is advised in addition, given the potential for buried stone foundations at the Priory site.
- 3.3.4 **Methodology:** a vertical gradiometer will be employed, the Bartington Grad601-2, with a sensor separation of 1.0m. The instrument is held above ground from which data are captured in the internal memory, and then downloaded to a portable computer for processing. The survey area will be divided into a 20m or 30m grid system dependant on the suitability of the site conditions. Within this grid system, sampling will be at a minimum of 0.25m intervals on a 1.0m traverse separation.
- 3.3.5 **Electrical Resistance Survey:** non-magnetic stone structures or megaliths cannot be easily identified with magnetometry. Therefore, stone building remains may be difficult to identify or interpret without the use of electrical resistivity.

3.3.6 This technique is classed as an *active* technique as it requires physically injecting a current into the ground and measuring the response (*ibid*). An earth resistance meter relies on the properties of the moisture retained within the soil to pass an electrical current through the ground from a pair of mobile probes, mounted on a frame, to a pair of remote probes. The resistance is measured between the probes and can identify buried remains when compared to the background resistance. Cut features that have been subsequently infilled tend to be more moisture retentive and thereby less resistant to the current. These features manifest as low resistance anomalies. Structural remains or buried megaliths are more resistant to the current flow and are seen as high resistance features.

3.3.7 **Methodology:** a Geoscan Research RM15 resistivity meter with a multiplexer will be employed. The standard methodology for an electrical resistance survey is to have the two mobile probes mounted horizontally on a frame at a distance of 0.5m apart. These probes literally make contact with the ground and will produce a depth of penetration of approximately 0.5m-1.0m. The data are captured in the internal memory of the RM15 and then downloaded to a portable computer. The survey area will be divided into the same 20m or 30m grid system also used for the magnetic survey, and which ever size is deemed more suitable to the site conditions. Within this grid system, sampling will be at 1.0m intervals on a 1.0m traverse separation.

3.4 REPORT AND ARCHIVE

3.4.1 **Report:** one bound and one unbound copy of the report will be submitted to the client, and two copies to the County HER within six months of completion. This will include the analysis and recommendations for any further work. The report will include;

- a site location plan related to the national grid
- a front cover to include the planning application number and the NGR
- the dates on which all elements of the fieldwork was undertaken
- a concise, non-technical summary of the results
- an explanation to any agreed variations to the brief, including any justification for any elements not undertaken
- brief historical background
- a description of the methodology employed, work undertaken and results obtained
- plans and sections at an appropriate scale showing the location and position of deposits and finds located
- recommendations concerning any subsequent mitigation strategies and/or further archaeological work
- a copy of this project design, and indications of any agreed departure from that design
- the report will also include a complete bibliography of sources from which data has been derived.

3.4.2 This report will be in the same basic format as this project design; a copy of the report can be provided on CD, if required.

3.4.3 **Confidentiality:** the final report is designed as a document for the specific use of the client, and should be treated as such; it is not suitable for publication as an academic report, or otherwise, without amendment or revision. Any requirement to revise or reorder the material for submission or presentation to third parties beyond the project brief and project design, or for any other explicit purpose, can be fulfilled, but will require separate discussion and funding.

3.4.4 **Archive:** the results will form the basis of a full archive to professional standards, in accordance with current English Heritage guidelines (*The Management of Archaeological Projects, 2nd edition, 1991*) and the Guidelines for the Preparation of Excavation Archives for Long Term Storage (UKIC 1990). The project archive represents the collation and indexing of all the data and material gathered during the course of the project. The deposition

of a properly ordered and indexed project archive in an appropriate repository is considered an essential and integral element of all archaeological projects by the IFA in that organisation's code of conduct. The paper archive will be deposited with the Cheshire Record Office within six months of the completion of the fieldwork.

4. OTHER MATTERS

4.1 ACCESS

4.1.1 It is assumed that access will be arranged by the client. Should there be any special requirements, please inform OA North at the earliest opportunity in order that this information can be relayed to the geophysical survey contractors.

4.2 DIGITAL MAPPING

4.2.1 It is anticipated that digital mapping of the site will be supplied by the client in a dxf or dwg format, prior to the survey commencing. Should this be unavailable, mapping will be required for purchase and costed as a variation.

4.3 WORK TIMETABLE

4.3.1 *Geophysical Survey*: this element is anticipated to take between two to four days, depending on the choice of survey techniques, to complete.

4.3.2 *Preliminary Geophysical Survey Results*: these can be made available within one week of completion of the report.

4.3.3 *Report*: a report will be submitted within eight weeks of the completion of the fieldwork, unless otherwise agreed.

4.4 STAFFING PROPOSALS

4.4.1 The project will be under the direct management of Emily Mercer BA (Hons) MSc AIFA (OA North Senior Project Manager) to whom all correspondence should be addressed. Emily is an experienced archaeological geophysicist, having worked across the UK, Sweden and Turkey.

4.4.2 The survey will be carried out by Stratascan Ltd, who are market leaders of archaeological and engineering geophysical surveys.

4.5 MONITORING

4.5.1 OA North will consult with the client regarding access to the site. Whilst the work is undertaken for the client, CCC's Planning Archaeologist will be kept informed of the work.

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APPENDIX 2: GEOPHYSICAL SURVEY REPORT

Geophysical Survey Report

Norton Priory, Cheshire

for

Oxford Archaeology North



June 2006

J 2161

David Elks MSc. AIFA



Document Title: **Geophysical Survey Report
Norton Priory, Cheshire**

Client: Oxford Archaeology North

Stratascan Job No: 2161

Techniques: Magnetometer scanning, magnetic susceptibility,
detailed magnetic survey, resistance survey

National Grid Ref: SJ 546 830

Field Team: Claire Graham BA., Richard Elliott BA.

Project Officer: David Elks MSc. AIFA

Project Manager: Simon Stowe BSc.

Report written by: David Elks MSc. AIFA

CAD illustration by: Simon Haddrell BEng., David Elks MSc. AIFA

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1. SUMMARY OF RESULTS

A reconnaissance magnetic susceptibility and magnetometer scanning survey were carried out over 14ha of scrub land adjacent to Norton Priory, Cheshire. Based on these results an area of 1ha was selected to target with detailed magnetic survey and resistance survey.

The results show several anomalies across the site, some of which are of probable modern origin, some of possible archaeological origin. Others in the north of the site are less clear and would require further investigation to clarify their exact origins.

2. INTRODUCTION

2.1. Background synopsis

Stratascan were commissioned by Oxford Archaeology North to undertake a geophysical survey of an area adjacent to Norton Priory outlined for residential development.

2.2. Site location

The site is located adjacent to the western side of Norton Priory, Runcorn, Cheshire at OS ref. SJ 546 830.

2.3. Description of site

The survey area is 14ha of scrub land on the western side of Norton Priory. The underlying geology is Permian and Triassic sandstones (British Geological Survey South Sheet, Fourth Edition Solid, 2001). The overlying soils are of the Clifton soil association. These consist of slowly permeable seasonally waterlogged reddish fine and coarse loamy soils with some deep coarse loamy soils (Soil Survey of England and Wales, Sheet 3 Midland and Western England).

2.4. Site history and archaeological potential

The site is located adjacent to Norton Priory which is a Scheduled Ancient Monument. The survey area is thought to be the location of a former mill pond/ornamental lake which during drainage works in 1986 revealed a structured timber building. Within the infilled lake a square shape crop mark has been observed which is believed to post date the infill of the lake (Hughes & Carter, 2002).

Although the detection of timber features is unlikely through the use of geophysics the archaeological potential of the site is considered high.

2.5. Survey objectives

The objective of the survey was to locate any features of possible archaeological origin in order that they may be assessed prior to development.

2.6. Survey methods

The reconnaissance techniques of magnetometer scanning and magnetic susceptibility were employed over the whole of the survey area. Based on these results an area was targeted for detailed magnetic survey and resistance survey.

More information regarding these techniques is included in the Methodology section below.

3. **METHODOLOGY**

3.1. Date of fieldwork

The fieldwork was carried out over 4 days from 5th June 2006 to 8th June 2006. Weather conditions during the survey were sunny and hot.

3.2. Grid locations

The location of the survey grids has been plotted in Figure 4.

3.3. Description of techniques and equipment configurations

3.3.1 Magnetic Susceptibility

Alteration of iron minerals in topsoil through biological activity and burning can enhance the magnetic susceptibility (MS) of that soil. Measuring the MS of a soil can therefore give a measure of past human activity and can be used to target the more intensive and higher resolution techniques of Magnetometry and Resistivity. Measurements of MS were carried out using a field coil which provides a rapid scan and has the benefit of allowing "insitu" readings to be taken.

The equipment used on this contract was an MS2 Magnetic Susceptibility meter manufactured by Bartington Instruments Ltd. A field coil known as an MS2D was used to take field readings. This assessed the top 200mm or so of topsoil. To overcome the problem of ground contact all readings were taken 4 or 5 times and an average taken. All obvious localised "spikes" were ignored.

3.3.2 Magnetometer

Although the changes in the magnetic field resulting from differing features in the soil are usually weak, changes as small as 0.2 nanoTesla (nT) in an overall field strength of 48,000nT, can be accurately detected using an appropriate instrument.

The mapping of the anomaly in a systematic manner will allow an estimate of the type of material present beneath the surface. Strong magnetic anomalies will be generated by buried iron-based objects or by kilns or hearths. More subtle anomalies such as pits and ditches can be seen if they contain more humic material which is normally rich in magnetic iron oxides when compared with the subsoil.

To illustrate this point, the cutting and subsequent silting or backfilling of a ditch may result in a larger volume of weakly magnetic material being accumulated in the trench compared to the undisturbed subsoil. A weak magnetic anomaly should therefore appear in plan along the line of the ditch.

The magnetic survey was carried out using a dual sensor Grad 601-2 Magnetic Gradiometer manufactured by Bartington Instruments Ltd. The Grad 601-2 consists of two high stability fluxgate gradiometers suspended on a single frame. Each sensor has a 1m separation between the sensing elements giving a strong response to deep anomalies.

3.3.3 Resistance

This method relies on the relative inability of soils (and objects within the soil) to conduct an electrical current which is passed through them. As resistivity is linked to moisture content, and therefore porosity, hard dense features such as rock will give a relatively high resistivity response, while features such as a ditch which retains moisture give a relatively low response.

The resistance meter used was an RM15 in conjunction with an MPX15 manufactured by Geoscan Research and incorporating a mobile Twin Probe Array. The Twin Probe array consists of two sets of parallel probes mounted adjacently with the associated remote probes positioned approximately 15m outside the grid. The instrument uses an automatic data logger, which permits the data to be recorded as the survey progresses for later downloading to a computer for processing and presentation.

Though the values being logged are actually resistances in ohms they are directly proportional to resistivity (ohm-metres) as the same probe configuration was used through-out.

3.4. Sampling interval, depth of scan, resolution and data capture

3.4.1 Sampling interval

Magnetometer scanning

The magnetic scanning survey was carried out along lines 20m apart.

Magnetic susceptibility

The magnetic susceptibility survey was carried out on a 20m grid with readings being taken at the node points.

Detailed magnetic survey

Readings were taken at 0.25m centres along traverses 1m apart. This equates to 3600 sampling points in a full 30m x 30m grid.

Resistance survey

Readings were taken at 1.0m centres along traverses 1.0m apart. This equates to 900 sampling points in a full 30m x 30 grid. All traverses were surveyed in a “zigzag” mode.

3.4.2 Depth of scan and resolution

Magnetic Susceptibility

The MS2D coil assesses the average MS of the soil within a hemisphere of radius 200mm. This equates to a volume of some 0.016m³ and maximum depth of 200mm. As readings are only at 20m centres this results in a very coarse resolution but adequate to pick up trends in MS variations.

Magnetometer

The Grad 601-2 has a typical depth of penetration of 0.5m to 1.0m. This would be increased if strongly magnetic objects have been buried in the site. The collection of data at 0.25m centres provides an appropriate methodology balancing cost and time with resolution.

Resistance survey

The 0.5m probe spacing of a twin probe array has a typical depth of penetration of 0.5m to 1.0m. The collection of data at 1m centres with a 0.5m probe spacing provides an appropriate methodology balancing cost and time with resolution.

3.4.3 Data capture

Magnetometer scanning

The readings are observed on site with any areas of interest marked manually on to a site plan. This plan is then digitised in to CAD at the end of the job.

Magnetic susceptibility

The readings are logged manually on site, and then transferred to the office where they are entered into a computer and grey scale plots are produced.

Detailed magnetic survey

The readings are logged consecutively into the data logger which in turn is daily downloaded into a portable computer whilst on site. At the end of each job, data is transferred to the office for processing and presentation.

Resistance survey

The readings are logged consecutively into the data logger which in turn is daily downloaded into a portable computer whilst on site. At the end of each job, data is transferred to the office for processing and presentation.

3.5. Processing, presentation of results and interpretation

3.5.1 Processing

Magnetometer scanning

No processing of the data has been undertaken.

Magnetic susceptibility

No processing of the data has been undertaken.

Detailed magnetic survey

Processing is performed using specialist software known as *Geoplot 3*. This can emphasise various aspects contained within the data but which are often not easily seen in the raw data. Basic processing of the magnetic data involves 'flattening' the background levels with respect to adjacent traverses and adjacent grids. 'Despiking' is also performed to remove the anomalies resulting from small iron objects often found on agricultural land. Once the basic processing has flattened the background it is then possible to carry out further processing which may include low pass filtering to reduce 'noise' in the data and hence emphasise the archaeological or man-made anomalies.

The following schedule shows the basic processing carried out on all processed magnetometer data used in this report:

Zero mean traverse *Last mean square fit = off*
Despike *X radius = 1 Y radius = 1*
 Threshold = 3 std. dev.
 Spike replacement = mean

Resistance survey

The processing was carried out using specialist software known as *Geoplot 3* and involved the 'despiking' of high contact resistance readings and the passing of the data through a high pass filter. This has the effect of removing the larger variations in the data often associated with geological features. The net effect is aimed at enhancing the archaeological or man-made anomalies contained in the data.

The following schedule shows the processing carried out on the processed resistance plots.

Despike *X radius = 1*
 Y radius = 1
 Spike replacement
High pass filter *X radius = 10*
 Y radius = 10
 Weighting = Gaussian

3.5.2 Presentation of results and interpretation

Magnetometer scanning

Spots of interest are plotted into CAD and are categorised using the key provided (see Figure 2).

Magnetic susceptibility

The presentation of the data for this site involves a grey scale plot of the field measurements overlain onto a site plan (see Figure3).

Detailed magnetic survey

The presentation of the data for each site involves a print-out of the raw data both as grey scale (Figure 5) and trace plots (Figure 6 and 7), together with a grey scale plot of the processed data (Figure 8). Magnetic anomalies have been identified and plotted onto the 'Abstraction and Interpretation of Gradiometer Anomalies' drawing for the site (Figure 9).

Resistance survey

The presentation of the data for the site involves a print-out of the raw data as a grey scale plot (Figure 10), together with a grey scale plot of the processed data (Figure 11). Anomalies have been identified and plotted onto the 'Abstraction and Interpretation of Resistance Anomalies' drawing (Figure 12).

4. RESULTS

4.1. Reconnaissance

The magnetometer scanning survey has identified two general areas of interest. Along the eastern edge of the site and an approximately 100m further west are regions where increased magnetic activity has been located. This includes both weak and moderate enhancements which are typical of archaeological features. The magnetic susceptibility results also show enhanced levels along the eastern edge of the survey area, supporting this as an area to target with detailed surveys. The second area 100m in shows some enhanced magnetic susceptibility readings but some low values as well. This area has also been selected for detailed survey, with the low values acting as a control measure.

4.2. Detailed magnetic survey

The detailed magnetic survey has identified a number of geophysical anomalies many of which probably relate to modern features, while some may have an archaeological origin.

Running north to south through the survey area is a moderately strong bipolar linear anomaly, approximately 25m wide with magnetic values up to around +/- 100nT. The cause of this anomaly is ambiguous. It has the characteristics of a metallic service, except a metallic service would have values far in excess of +/-1000nT, rather than +/-100nT. This raises the possibility that it may represent a deeply buried service which has lower values because it is further from the gradiometer sensors. One further

possibility is a shallow, and wide, fired clay feature, although what purpose this would serve is unclear. At its northern end is an area of magnetic debris which is indicative of localised ground disturbance.

A further area of magnetic debris is observed in the south of the site covering a large area. It also seems to contain some strong magnetic responses probably relating to ferrous objects. Again this is evidence of ground disturbance and is probably of modern origin. Other strong bipolar anomalies are present across the site that are also probably related to modern ferrous objects.

In the east of the site weak positive responses are observed. These take the form of both linear anomalies and some area coverage anomalies. These responses may be associated with cut and consequently infilled features of archaeological origin.

Within the north west corner of the survey area several parallel positive linear anomalies are seen which are probably associated with ploughing activity.

4.3. Resistance survey

The resistance survey has enabled the identification of several anomalies adding further evidence to support interpretations made from the magnetic data.

A high resistance linear anomaly is observed to run north to south following the same course as the ambiguous bipolar anomaly observed in the magnetic data. It is likely that the high resistance response does not directly relate to the pipe itself, rather to the infill of the associated trench. The trench may be filled with a granular material to aid drainage surrounding the pipe and as a result would return a higher resistance anomaly. At the northern end of the high resistance linear response is a high resistance square anomaly. This may be associated with the square crop mark mentioned in the site history. The high resistance linear anomaly seems to end at this point. As the anomaly occupies the area where the moderate bipolar anomaly is seen in the magnetic data, it is possible that the square anomaly is overlying a deeply buried service beneath. Further investigation would be required to clarify the exact relationships of these features.

Elsewhere in the resistance data several high resistance linear and high resistance area anomalies are observed which may be related to stone features of an archaeological origin. In the southern section of the data a low resistance linear response is observed, without a corresponding magnetic anomaly, although this is located within the area of magnetic debris which may block out any weak anomalies. This is probably related to a cut feature of possible archaeological origin.

Also observed within this area is a linear anomaly which is composed of both low resistance values and high resistance values along its length. It is not clear what this is caused by although it may be related to a field drain.

As also seen in the magnetic data, parallel anomalies are observed in the north west of the site which are probably associated with ploughing activity.

5. CONCLUSION

The reconnaissance geophysical survey helped identify areas to target that proved to show anomalies of interest in the follow up detailed surveys. Several anomalies in the north of the site remain ambiguous and would benefit from further investigation to help clarify their origins.

6. REFERENCES

British Geological Survey, 2001. *Geological Survey Ten Mile Map, South Sheet, Fourth Edition (Solid)*. British Geological Society.

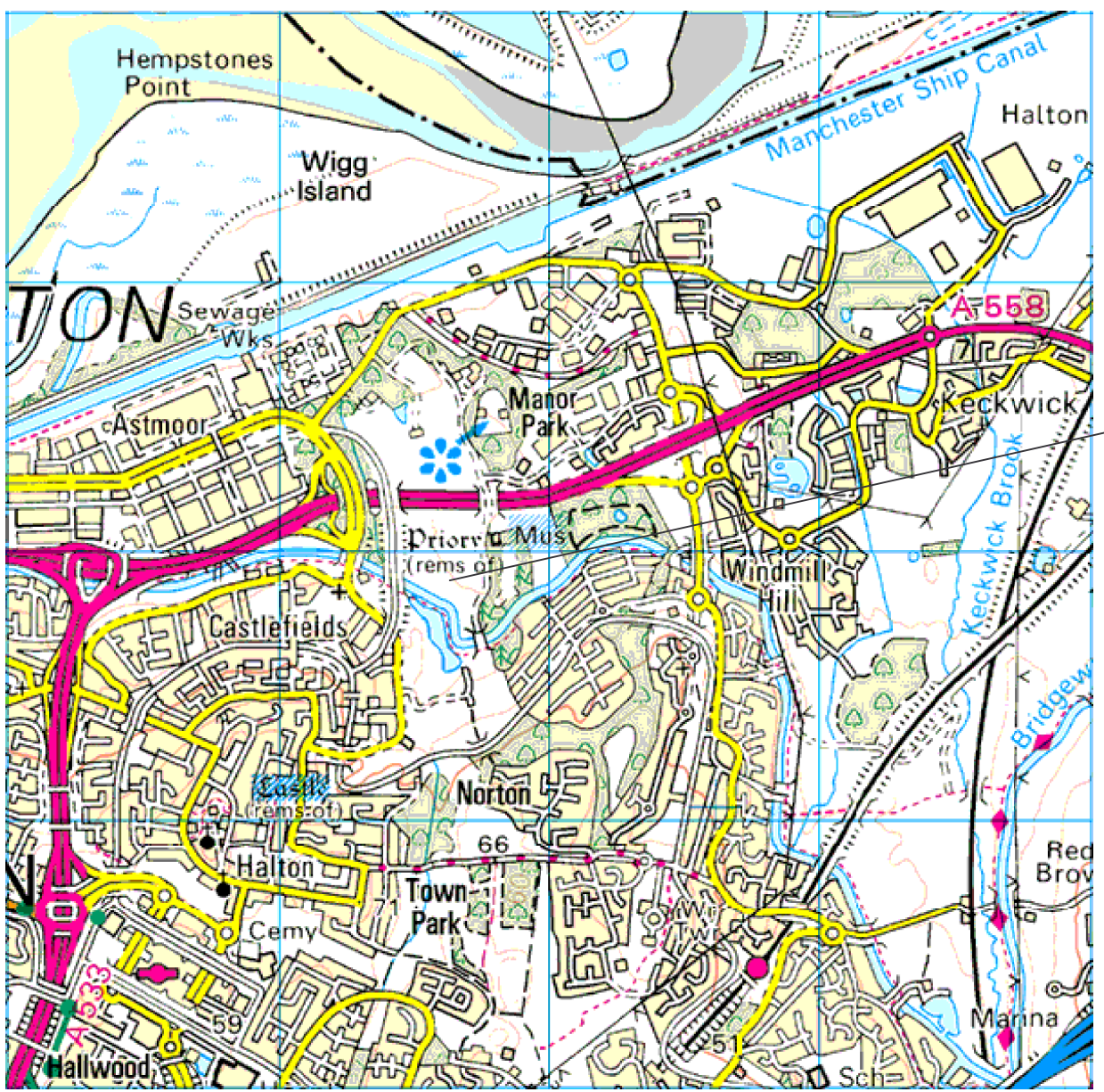
Hughes, V. & Carter, M. 2002. Castlefields Regeneration Scheme: Halton, Cheshire. Oxford Archaeology North.

Soil Survey of England and Wales, 1983. *Soils of England and Wales, Sheet 3 Midland and Western England*.

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 OS 100km square = SJ



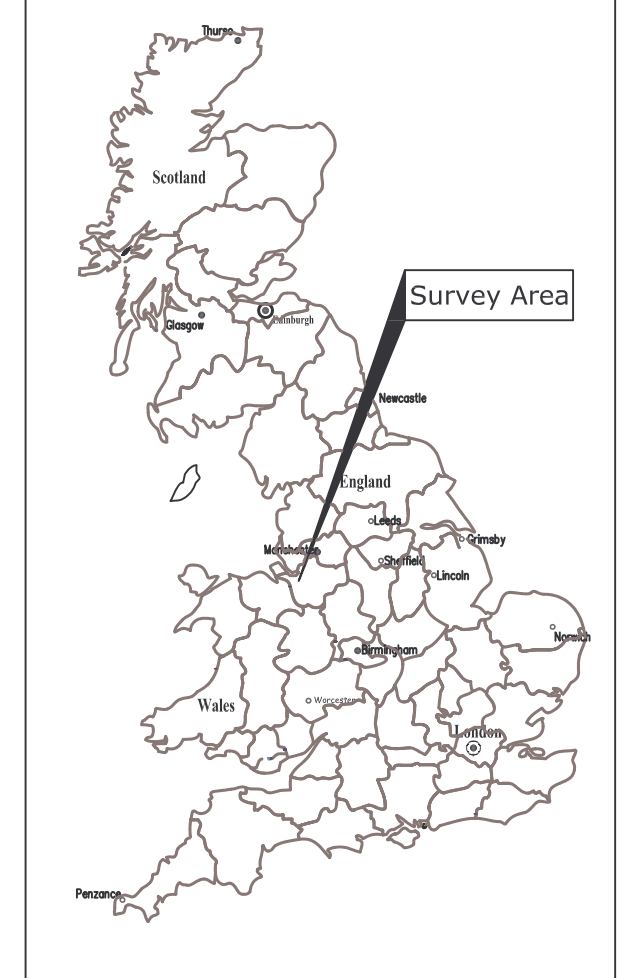
85
84
83
82
81



SURVEY AREA

53 54 55 56 57

Amendments		
Issue No.	Date	Description
-	-	-



Site centred on NGR SJ 546 830

Client
OXFORD ARCHAEOLOGY NORTH

Project Title Job No. 2161
GEOPHYSICAL SURVEY - NORTON PRIORY, CHESHIRE

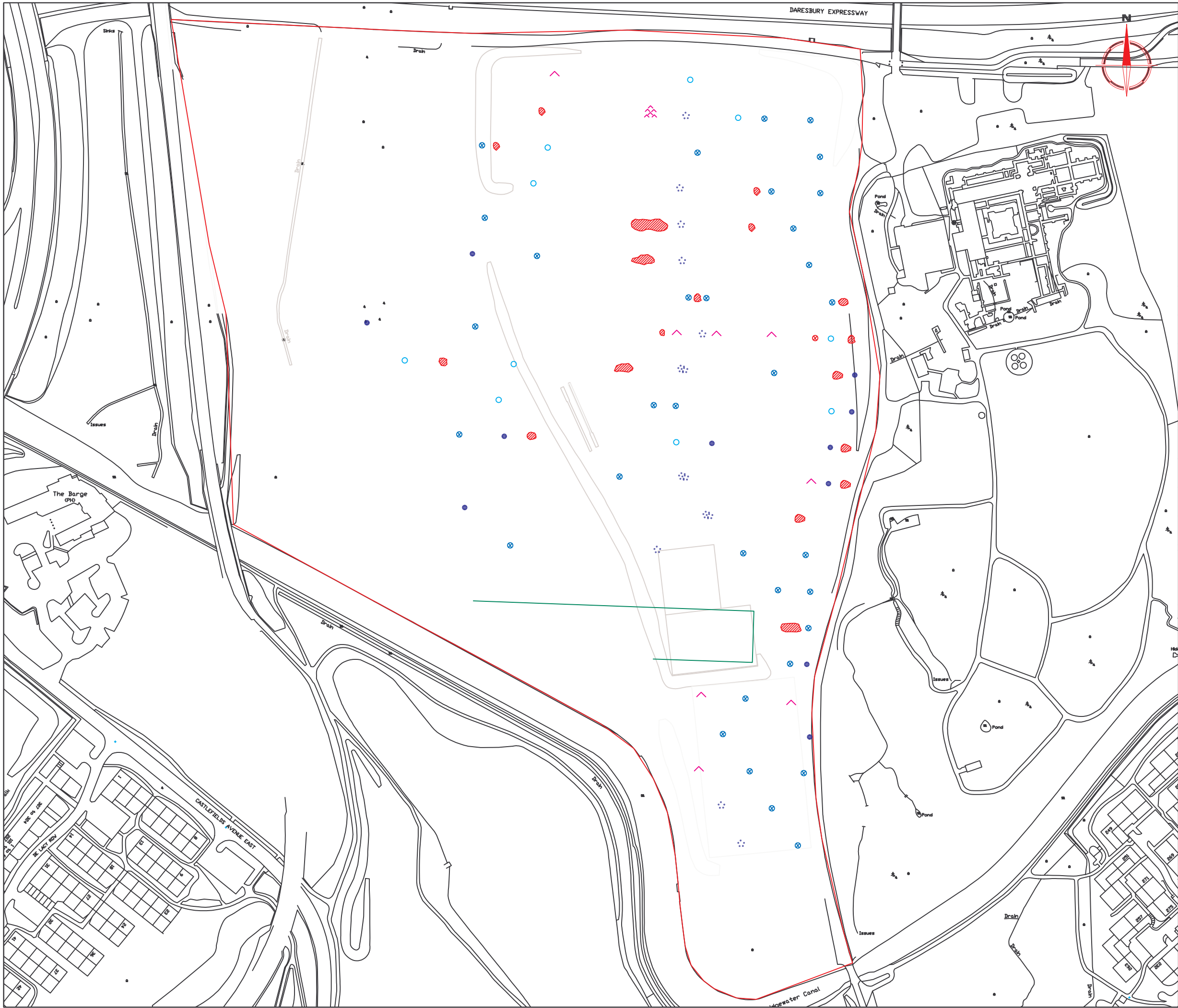
Subject
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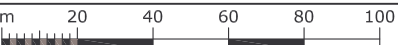
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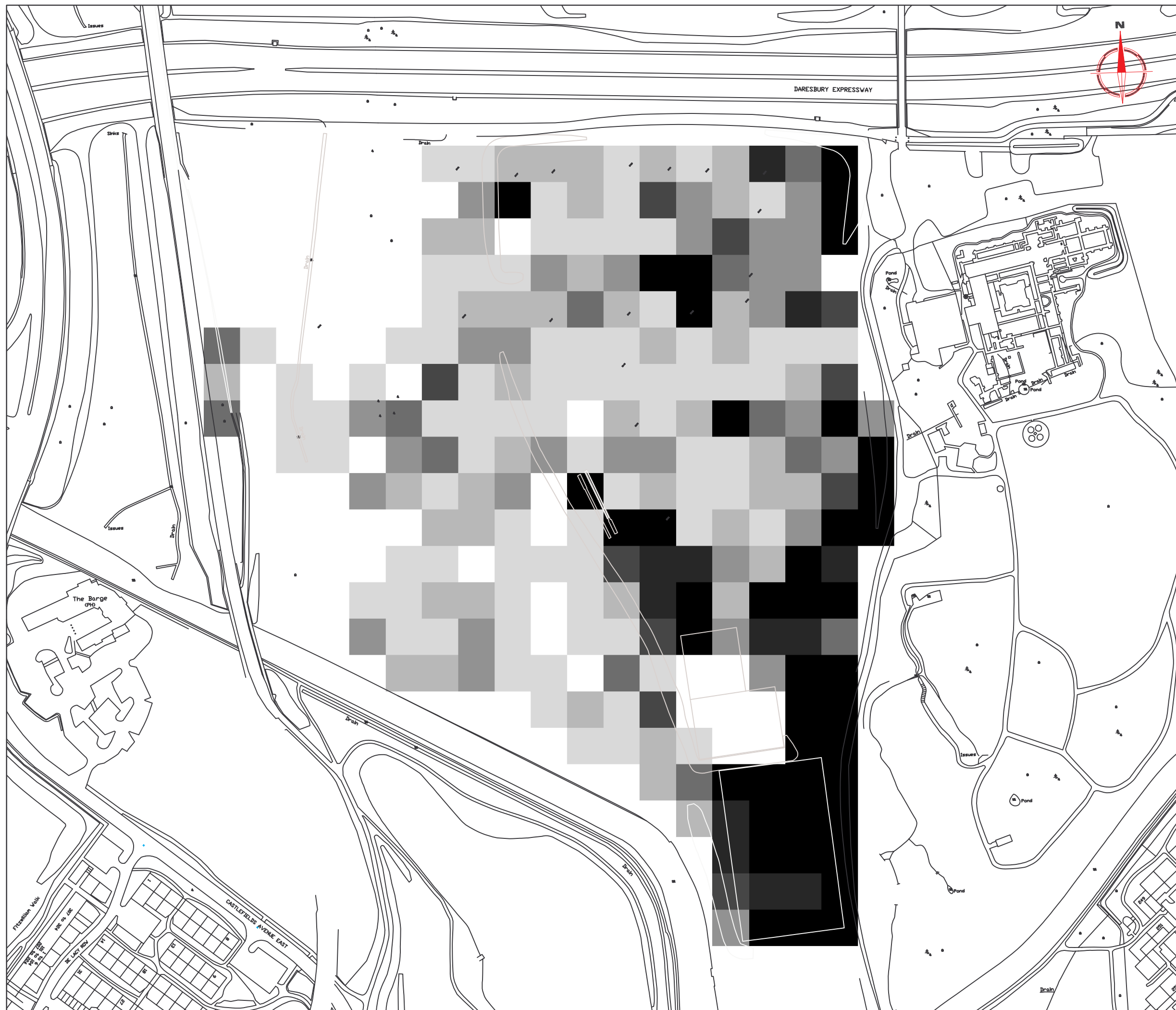


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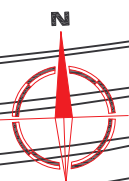
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Client		
OXFORD ARCHAEOLOGY NORTH		
Project Title		Job No. 2161
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Subject		
RESULTS OF MAGNETOMETER SCANNING		
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Plot	Checked by	Issue No.
A3	SAS	01
Survey date	Drawn by	Figure No.
JUNE 06	SH	02




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Issue No.	Date	Description
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x10⁻⁸ SI Units

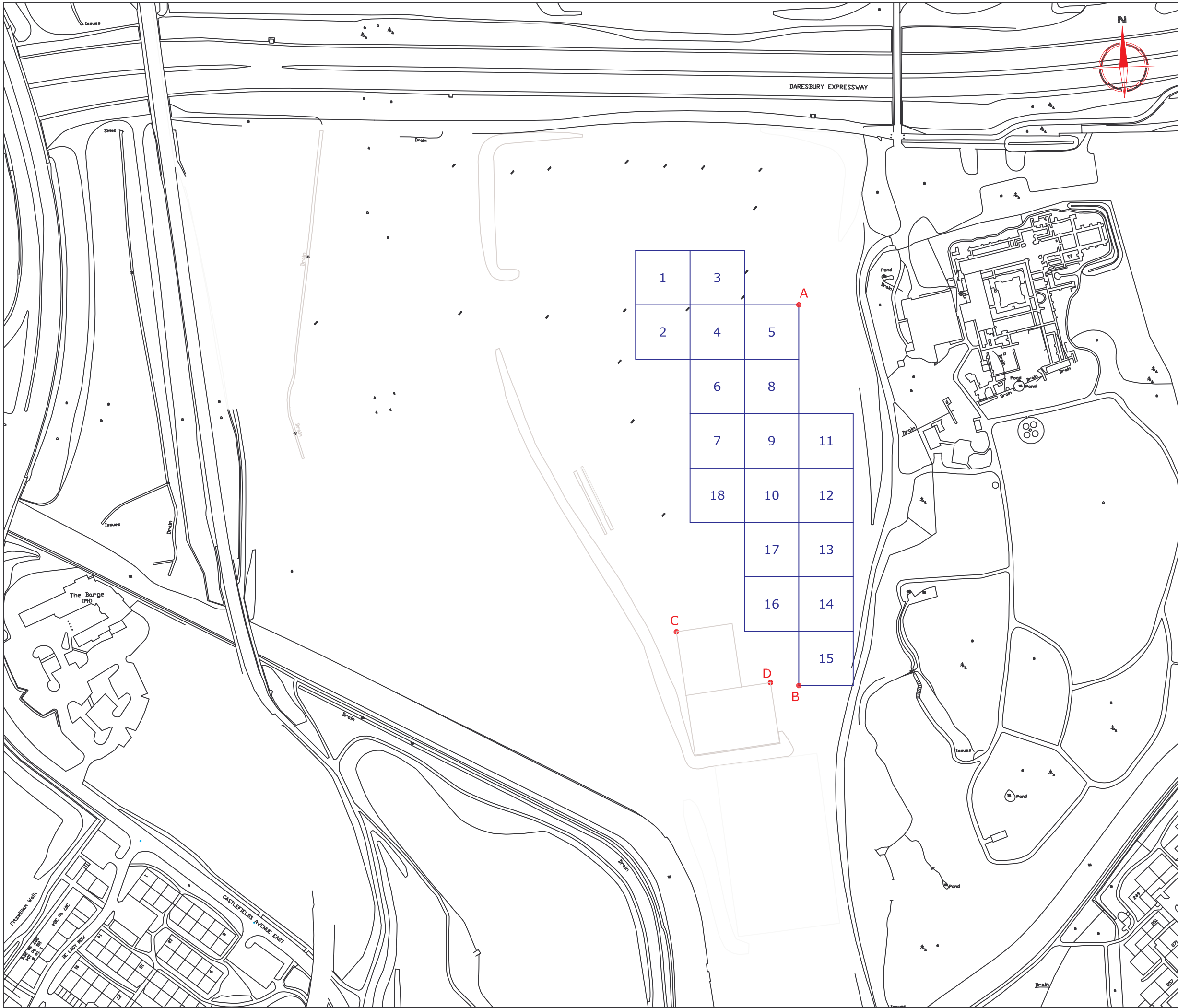
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Subject	PLOT OF RAW MAGNETIC SUSCEPTIBILITY DATA	



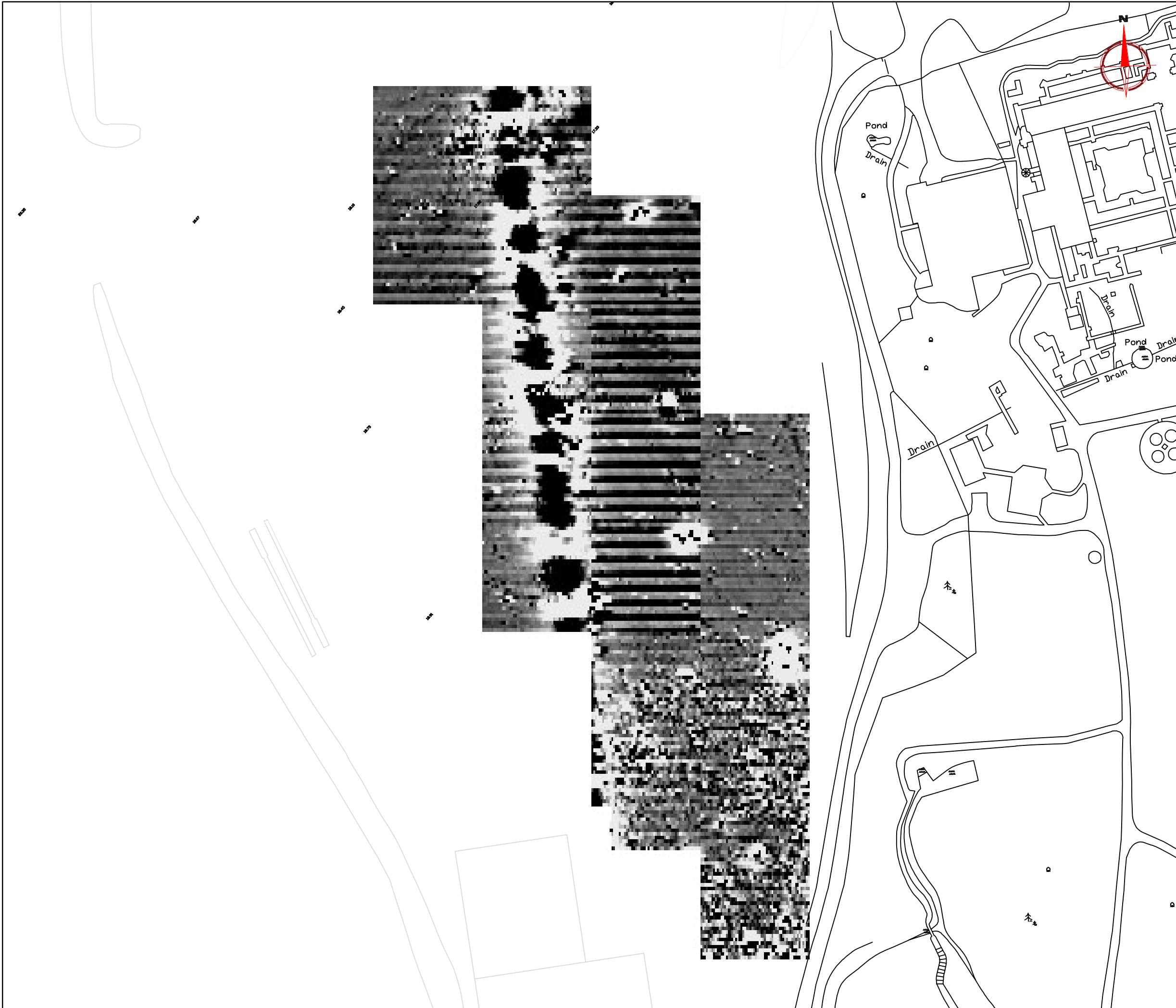
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Plot	Checked by	Issue No.
A3	SAS	01
Survey date	Drawn by	Figure No.
JUNE 06	DGE	03



Amendments			
Issue No.	Date	Description	
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REFERENCING INFORMATION			
A-B	210m	A-C	193.75m
B-C	73.60m	B-D	16.28m
A-B	Base line		
C,D	Referencing points on tennis courts		
2	Grid number		
Client			
OXFORD ARCHAEOLOGY NORTH			
Project Title		Job No. 2161	
GEOPHYSICAL SURVEY - NORTON PRIORY, CHESHIRE			
Subject			
SITE PLAN SHOWING LOCATION OF TARGETED SURVEY GRIDS AND REFERENCING			
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A3	SAS	01	
Survey date	Drawn by	Figure No.	
JUNE 06	DGE	04	



Amendments		
Issue No.	Date	Description

Plotting parameters

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Minimum -8nT (white)

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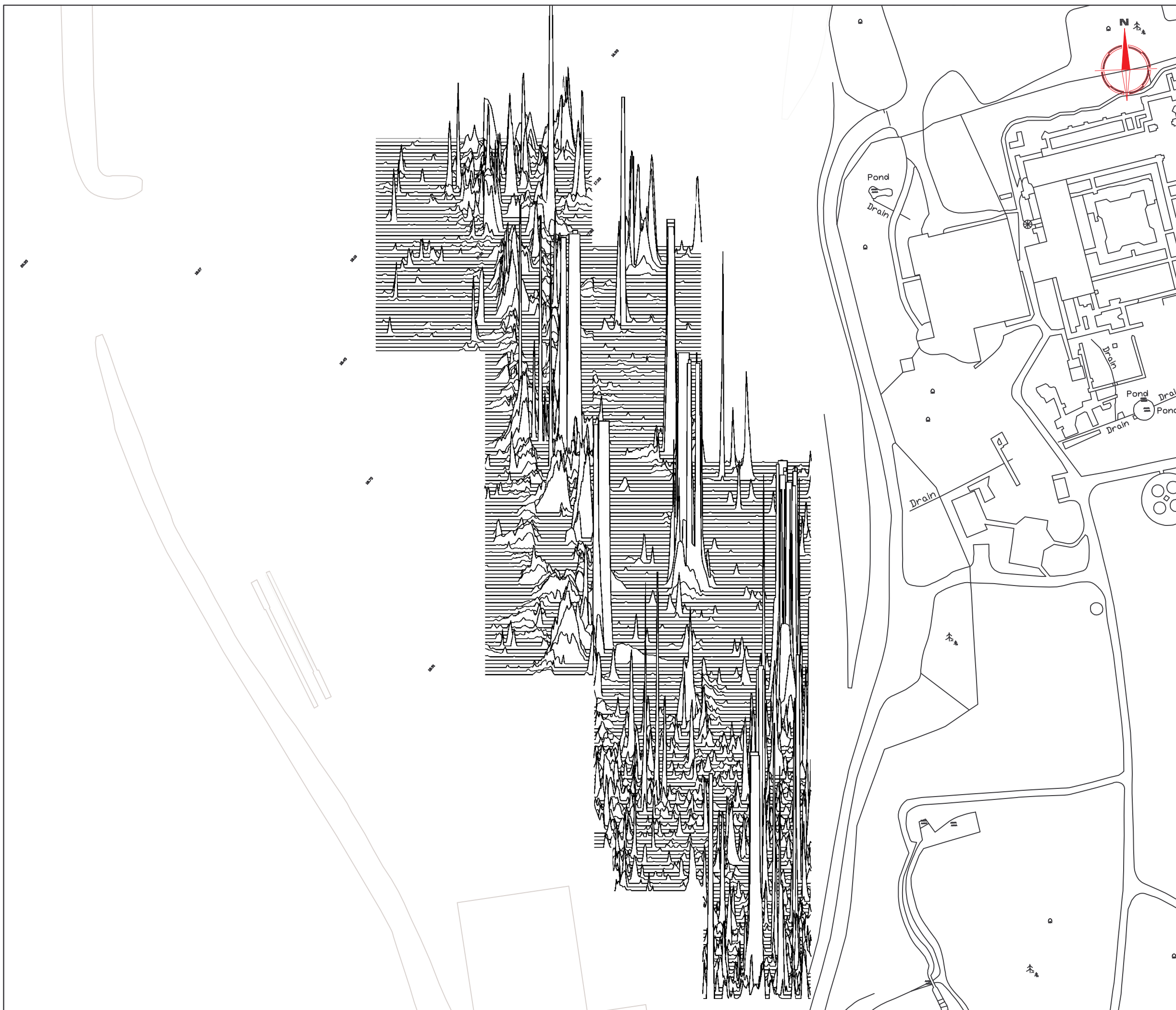
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**GEOPHYSICAL SURVEY -
NORTON PRIORY, CHESHIRE**

Subject
PLOT OF RAW GRADIOMETER DATA

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Scale 0m 10 20 30 40 50
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Plot A3	Checked by SAS	Issue No. 01
Survey date JUNE 06	Drawn by DGE	Figure No. 05



Amendments		
Issue No.	Date	Description
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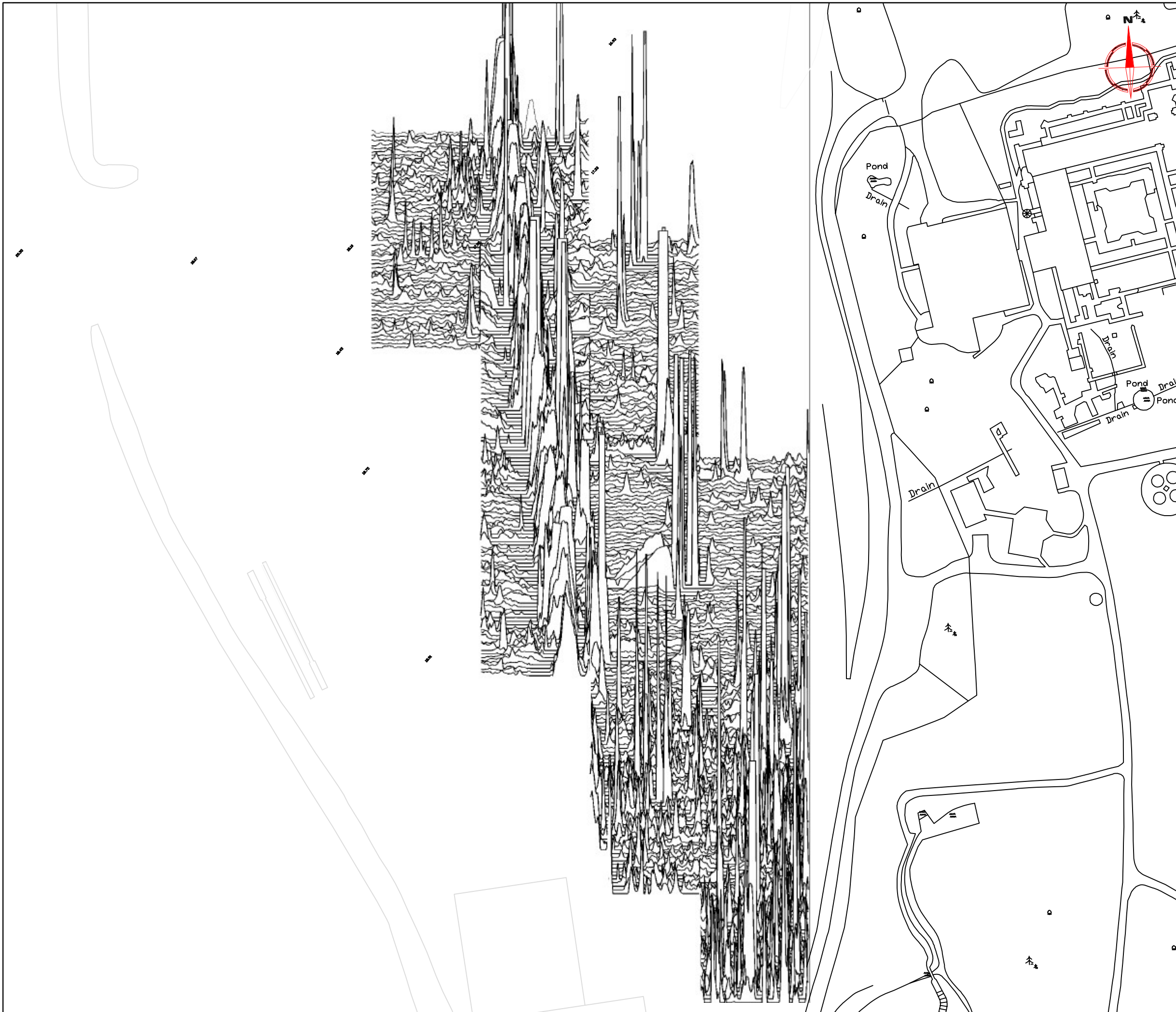
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Client	OXFORD ARCHAEOLOGY NORTH
Project Title	Job No. 2161 GEOPHYSICAL SURVEY - NORTON PRIORY, CHESHIRE
Subject	TRACE PLOT OF GRADIOMETER DATA SHOWING NEGATIVE VALUES

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Scale	0m 10 20 30 40 50				
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Plot	A3	Checked by	SAS	Issue No.	01
Survey date	JUNE 06	Drawn by	DGE	Figure No.	06



Amendments		
Issue No.	Date	Description
-	-	-

Plotting parameters	200nT
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(Positive values displace above the trace line. Hidden values have not been plotted)	120nT
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Client
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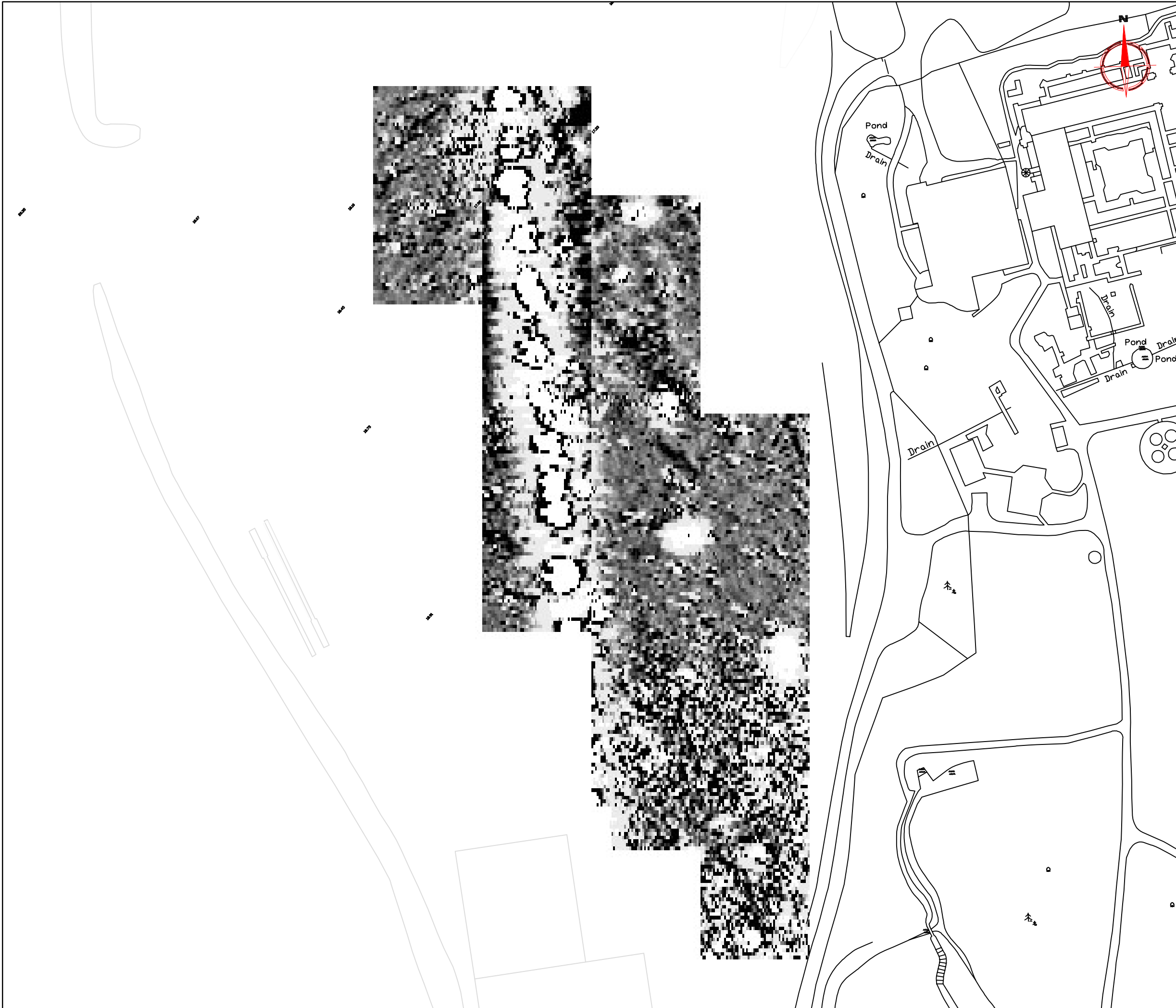
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**GEOPHYSICAL SURVEY -
 NORTON PRIORY, CHESHIRE**

Subject
**TRACE PLOT OF GRADIOMETER DATA
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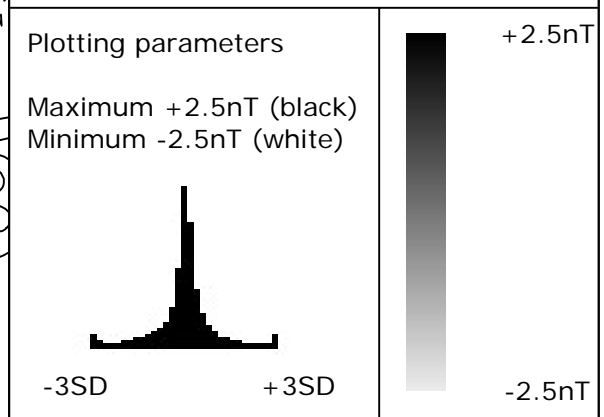
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Survey date JUNE 06	Drawn by DGE	Figure No. 07



Amendments		
Issue No.	Date	Description
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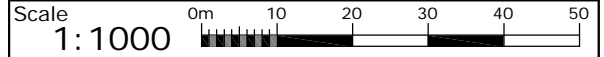


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NORTON PRIORY, CHESHIRE**

Subject
**PLOT OF PROCESSED
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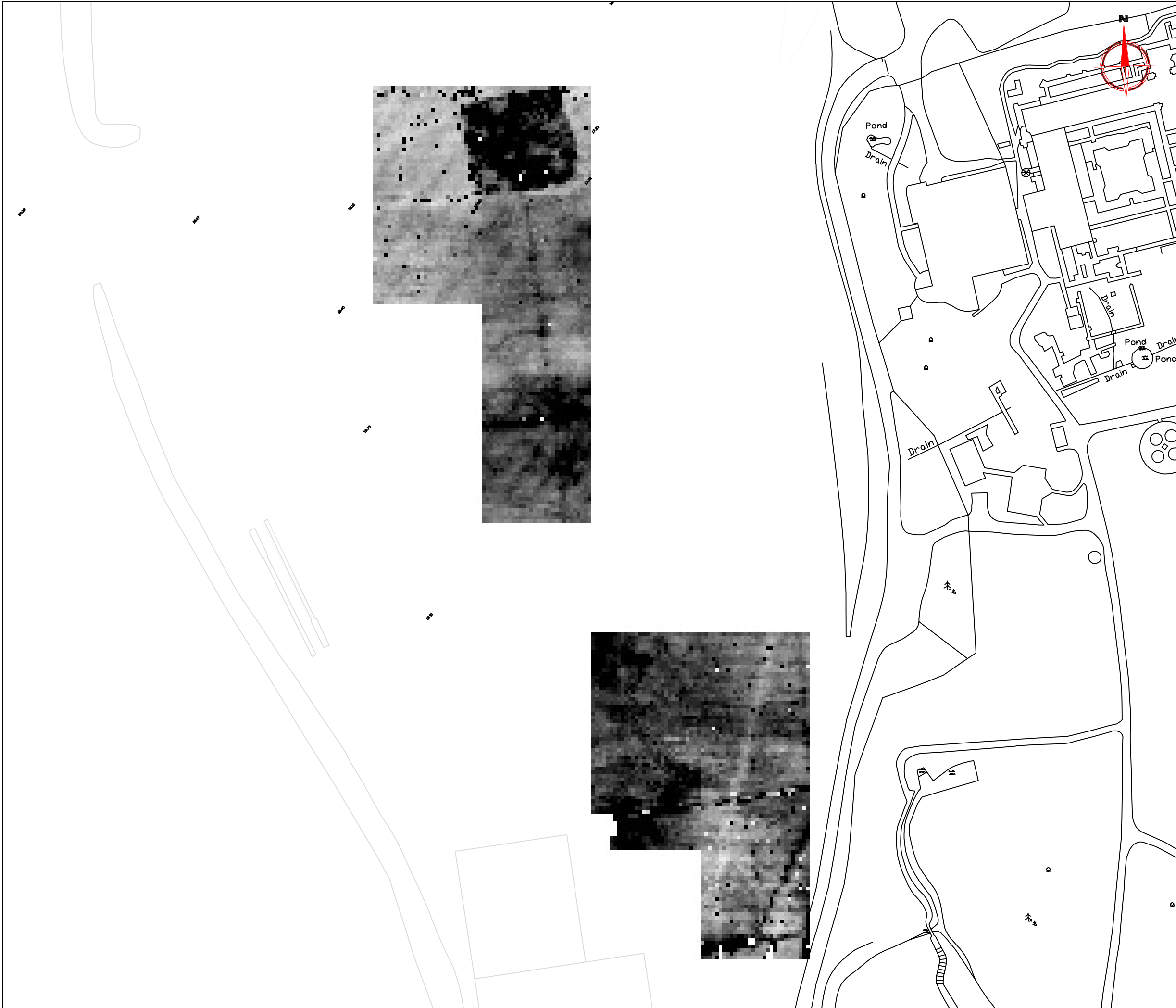
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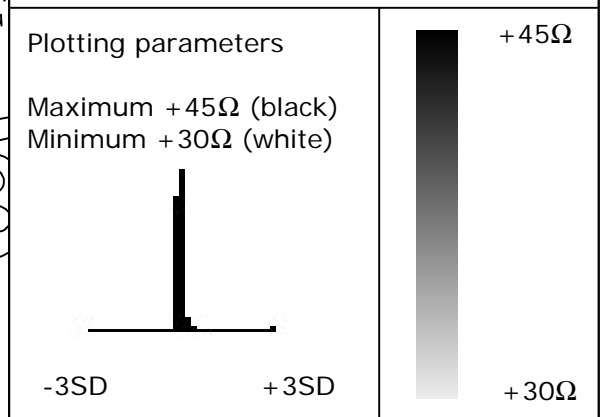
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Survey date JUNE 06	Drawn by DGE	Figure No. 08



Amendments		
Issue No.	Date	Description
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-	-	-
KEY		
	Linear anomaly - Possibly related to ploughing activity	
	Positive linear anomaly - cut feature of possible archaeological origin	
	Area of positive response - possible cut feature / pit of archaeological origin	
	Moderately strong bipolar response - uncertain origin	
	Magnetic debris - evidence of ground disturbance or scatter of ferrous objects	
	Magnetic disturbance - probably caused by modern magnetic interference	
Client		
OXFORD ARCHAEOLOGY NORTH		
Project Title		Job No. 2161
GEOPHYSICAL SURVEY - NORTON PRIORY, CHESHIRE		
Subject		
ABSTRACTION AND INTERPRETATION OF GRADIOMETER ANOMALIES		
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Plot	Checked by	Issue No.
A3	SAS	01
Survey date	Drawn by	Figure No.
JUNE 06	DGE	09



Amendments		
Issue No.	Date	Description
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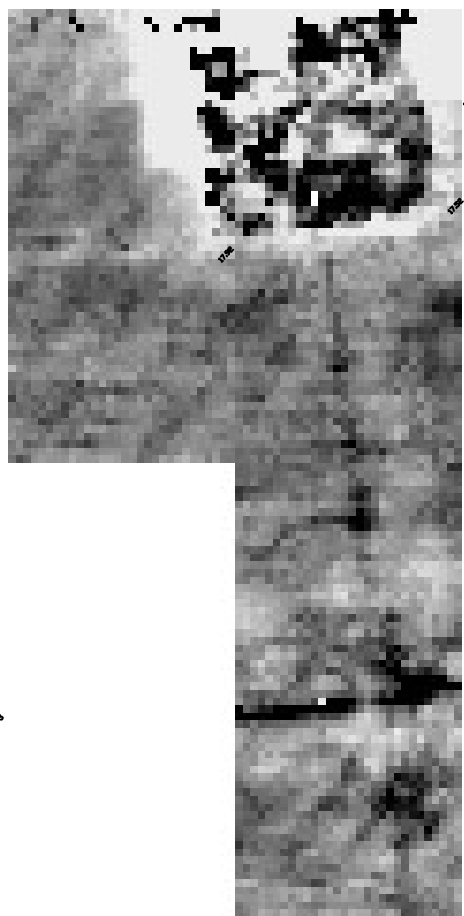
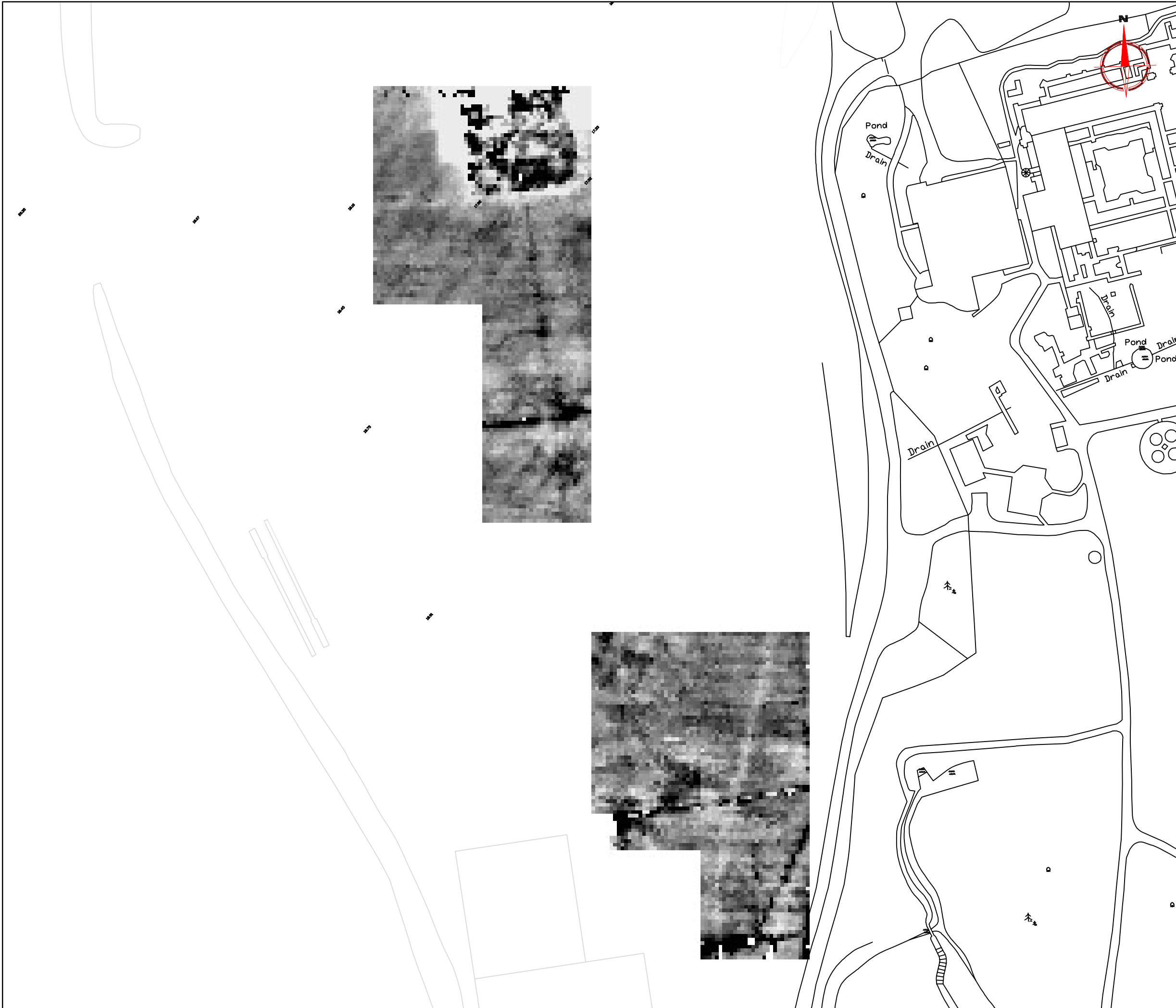
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**GEOPHYSICAL SURVEY -
NORTON PRIORY, CHESHIRE**

Subject
**PLOT OF RAW RESISTANCE
DATA**

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Plot A3	Checked by SAS	Issue No. 01
Survey date JUNE 06	Drawn by DGE	Figure No. 10



Amendments		
Issue No.	Date	Description
-	-	-
-	-	-

Plotting parameters

Maximum +6Ω (black)
Minimum -6Ω (white)

-3SD +3SD

+6Ω
-6Ω

Client
OXFORD ARCHAEOLOGY NORTH

Project Title Job No. 2161
**GEOPHYSICAL SURVEY -
NORTON PRIORY, CHESHIRE**

Subject
**PLOT OF PROCESSED
RESISTANCE DATA**

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Survey date JUNE 06	Drawn by DGE	Figure No. 11

