



**LOW
BORROWBRIDGE
ROMAN FORT,
LOW
BORROWBRIDGE,
CUMBRIA**

**Geophysical Survey
Phase 2**



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SUMMARY

Lunesdale Archaeological Society (LAS) have conducted a number of investigations at Low Borrowbridge Roman Fort (NGR NY 6094 0127) over the last few years, including the excavation of a high status building to the south of the fort. As a result of this excavation and due to the lack of knowledge about the associated extra-mural settlement, in 2014, LAS requested, that Oxford Archaeology North (OA North) carry out a programme of geophysical survey within a field to the south of the fort (NGR NY 6106 0099). Most of the area of the fort is a scheduled monument (SM List Entry Number 1007240) and survey was carried out outside of the scheduled area. The Phase 1 survey was carried out in April and July 2014.

The survey revealed several responses suggestive of differently aligned field systems, as well as features potentially associated with an extra-mural settlement. There was also an alignment of ditched features that coincided with the orientation of Low Borrowbridge fort to the north. One of the field systems was clearly later than features potentially associated with the extra-mural settlement. A putative connection to the fort in the form of a possible hollow-way was also visible. Several responses suggestive of buried structures of potential archaeological origin were also present.

LAS requested that OA North return to carry out a further programme of geophysical survey both within the fort and the wider scheduled and un-scheduled area. A Section 42 License was issued by Historic England granting permission for geophysical survey on the Roman Fort and scheduled area and OA North carried out the Phase 2 survey on 17th – 21st August 2015. Volunteer assistance was utilised throughout the survey and LAS used a resistance meter under the supervision of OA North. Five areas were surveyed (Areas 1 - 5) totalling 2.45ha of magnetometry and 2.2ha of resistivity.

The Phase 2 survey revealed numerous responses that may be of archaeological significance. The surveys have expanded the conclusions drawn from Phase 1 and have yielded significant information about the hitherto unknown internal layout of Low Borrowbridge Roman Fort (Area 1). There are at least three buildings located in the centre of the fort platform that conform to a fairly standard pattern with a headquarters building in the centre, granaries to the east and a commander's house on the west side. The buildings appear to face south and evidence of the *via praetoria*, which leads from the headquarters building to the south wall is also present. Other buildings were also discovered both to the north and south of the central range. Banks and ditches located on the west side of the fort platform are suggestive of an earlier phase, which if proved correct is of archaeological importance.

A rectangular arrangement of linear responses present to the south-east of the fort are also of particular archaeological interest and may be evidence of either Roman or pre-Roman enclosures. These are not aligned with the current fort, any other field boundaries or the road.

Ground truthing in the form of trenching was recommended in order to determine the true nature of the fort buildings and putative earlier phase. Investigation of the rectangular responses in Area 5 was also recommended in order to determine their true nature. Expansion of the Phase 1 survey may also aid clarification of the nature of settlement to the south of the fort.

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Oxford Archaeology North (OA North) would like to thank Graham Hooley for commissioning the project and for his support and assistance during the course of the survey. Also due thanks is Jackie Hooley for downloading and compiling the resistance data. OA North would also like to thank the enthusiastic volunteers of the Lunesdale Archaeology Society (LAS) who took part in the survey. Finally, special thanks are due to the landowner who kindly granted permission for the surveys to take place on his land.

The magnetometer survey was undertaken Karl Taylor and the electrical resistance survey by Karl Taylor and LAS volunteers. The report and drawings were produced by Karl Taylor. The project was managed by Karl Taylor and Alan Lupton edited the report.

1. INTRODUCTION

1.1 CIRCUMSTANCES OF THE PROJECT

- 1.1.1 Lunesdale Archaeological Society (LAS) have conducted a number of investigations at Low Borrowbridge Roman Fort (NGR NY 6094 0127) over the last few years, including the excavation of a high status building to the south of the fort. As a result of this excavation and due to the lack of knowledge about the associated extra-mural settlement at Low Borrowbridge, in 2014, LAS requested, that Oxford Archaeology North (OA North) carry out a programme of geophysical survey (OA North 2014) within a field to the south of the fort (NGR NY 6106 0099). Most of the area of the fort is a scheduled monument (SM List Entry Number 1007240), therefore the survey (Phase 1) was undertaken in the area of the field outside of the scheduled area. The Phase 1 survey was carried out over two separate visits on 2nd April and 18th and 19th July 2014. An important element of the survey was to involve members of LAS and a number of volunteers both assisted with the survey and carried out data collection.
- 1.1.2 The survey revealed several responses suggestive of buried archaeological remains. A great number of the responses were not visible in both data plots. There were several linear responses suggestive of two differently aligned field systems, as well as features potentially associated with an extra-mural settlement. There was also an alignment of ditched features that coincided with the orientation of Low Borrowbridge fort to the north. One of the field systems was visible in both data sets and was clearly later than features potentially associated with the extra-mural settlement. A putative connection to the fort in the form of a possible hollow-way was also visible.
- 1.1.3 Further non-invasive investigation of the remainder of the field containing the survey area, as well as additional fields, was recommended in order to try to gain additional information as to the nature and extent of features of archaeological potential.
- 1.1.4 Following on from the recommendations made after the Phase 1 survey, in 2015, LAS requested that OA North return to carry out a further programme of geophysical survey both within and outside of the scheduled monument area (Fig 1). Following an application for scheduled monument consent (SMC) by LAS, a Section 42 License was issued by Historic England granting permission for geophysical survey on the Roman Fort itself and within the scheduled area. OA North were commissioned by LAS and carried out the Phase 2 survey on 17th – 21st August 2015. Again, volunteer assistance was utilised throughout the survey and LAS used their own recently acquired resistance meter under the guidance of OA North.
- 1.1.5 This report sets out the results of the Phase 2 geophysical survey and provides an interpretation of the results, along with recommendations for further work.

1.2 LOCATION AND BACKGROUND TO THE AREA

- 1.2.1 ***Location, Geology and Topography:*** the site is situated within the Tebay Gorge, formed as the River Lune carved its way through an ancient fault line between the Lake District fells of Jefferies Mount and Whinfell on the west and the glacial

rounded Tebay and Howgill Fells to the east. The fort is positioned at the confluence of the River Lune and Borrow Beck forming the junction of Borrowdale and the Upper Lune Valley (Fig 1). In total, five areas were surveyed (Areas 1 – 5, Fig 2). Area 1 comprises the platform of the Roman Fort (NGR NY 60943 01273), of which 1.0ha was surveyed with magnetometry and 1.02ha with electrical resistance. Area 2 was located in the south-west corner of the field between the fort and West Coast mainline railway (NGR NY 60892 00191), of which 0.1ha was surveyed with magnetometry and 0.04ha was surveyed with electrical resistance. Area 3 was located within a small field to the north-east of the fort in-between the road and River Lune (NGR NY 66997 01380), of which 0.11ha was surveyed with magnetometry and 0.09ha was surveyed with electrical resistance. Area 4 was located in a field to the west of the main farm buildings and to the south of the fort (NGR NY 60950 01154), of which 0.18ha was surveyed with electrical resistance. Area 5 was located in a field to the east of the Phase 1 survey in-between the road and the River Lune (NGR NY 61153 01065), of which 1.23ha was surveyed with magnetometry and 0.86ha with electrical resistance.

- 1.2.2 The underlying bedrock comprises the Coniston Group consisting of sandstone, siltstone and mudstone. The overlying superficial deposits alluvium (clay, silt, sand and gravel) over the south end of the site, with river terrace deposits (silt, sand and gravel) over the north end (www.bgs.ac.uk). The soils are slowly permeable seasonally wet acid loamy and clayey (www.landis.org.uk).
- 1.2.3 Area 1 was laid down to pasture, sloped gently to the east and was bounded by post and wire fences and dry-stone walls. A bank ran along the western boundary. Area 2 sloped to the south and consisted of rough grazing, boggy in places, and was bounded to the west by a high metal fence. A water pipe ran through the area. Area 3 was fairly level, overgrown and was bounded to the west by a post and wire fence, and to the east by a dry-stone wall. A large tree was present at the northern end of the survey area. Area 4 was a large flat field laid down to a silage crop, bounded on the west side by a post and wire fence and hedgerow. Areas of woodland bounded the east and south sides. The North West Ethylene Pipeline (NWEP) crosses the south-east corner of the field.
- 1.2.4 **Background:** the pass of Tebay Gorge is an historic north/south thoroughfare between the mountains of the eastern Lake District and the Howgill Fells. There has been a succession of transport routes through the area, including a prehistoric trading route, a Roman road, drovers and pack horse routes as well as latterly, the West Coast main line railway and the M6 motorway (ACTion with Communities in Cumbria 2013).
- 1.2.5 **Prehistoric period:** the main prehistoric site within the surrounding area is a putative Bronze Age/Iron Age settlement at High Carlingill on the lower slopes of the eastern side of the Lune valley (OA North 2013). Other sites in the area are a Bronze Age cairn at Tebay Gill, and the findspot of a Bronze Age spearhead approximately 1km to the south of the cairn. A further possible cairn is located on Gibbet Hill. Three worked flints were found during the excavation of Powsons Farmstead and interpreted as being deposited as a result of hillwash from the fells (Lambert 1996).
- 1.2.6 There appears to have been a partial abandonment of the uplands in the early Iron Age, possibly due to a deterioration of the climate (Quartermaine and Leech 2012). This put pressure on the better lowland agricultural land, and, as a result, hillforts

and enclosed settlements were established to protect these areas. Multivallate hillforts, with possible Iron Age origins, are known from the surrounding region including the Wasdale Foot settlement, to the north of the area on the Shap Fells, and at Scarside Plantation, to the north-west of Shap (SM 22511). Enclosed settlements were characterised by having prominent outer enclosing walls or banks, typically topped with a palisade, and containing a series of grouped round houses. Approximately 5km to the north of the survey area is an example of an enclosed settlement at Castlefolds, Orton (SM 23634) which occupies a flat-topped limestone knoll close to the summit of Great Asby Scar (OA North 2013)

- 1.2.7 **Roman period:** the Roman fort (SM 13265) and associated bath house, *vicus* and cemetery are located at Low Borrowbridge, at the junction of the river Lune and Borrow Beck (*ibid*). The fort is on Wicker Street, the Roman road from Manchester to Carlisle which runs through the eastern part of the Lake District and was the primary north/south communication line through North West England for the substantial Roman forces stationed on the western side of Hadrian's Wall (OA North 2005a and b; Lambert 1996, 48). Remains of the bridge, which took the road over the river Lune to the north of the fort, have been found at Low Borrowbridge.
- 1.2.8 Despite the considerable presence of the Roman army throughout the region, the cultural impact on the native population was slight (OA North 2013). The settlements occupied during this period were developments of the enclosed settlements prevalent during the Iron Age. They incorporated outer defensive banks even though the presence of the Roman army, maintaining local peace, made them somewhat redundant (OA North 2003; 2005a).
- 1.2.9 The cemetery, located to the south of the survey areas, was part excavated in 1991 and 1992 during the installation of the North West Ethylene Pipeline (NWEP) (Lambert 1996); which two large pits and seventeen ditched enclosures were found (*ibid*). The pipeline route skirted the banks of the Lune and cut across the lower part of the Area 4 field and also revealed part of the Roman road heading south. Pottery found during the excavation suggested that the cemetery was in use from the mid third to fourth centuries (*ibid*). A tombstone of Aelia Sentica also found during the excavations is the only surviving inscription to have been discovered in association with the fort. There was however, no mention of the fort or date (*ibid*). A findspot of a possible tombstone was discovered in the 1940s and reported as being approximately 1 mile to the south of the fort. The tombstone may, therefore, have been part of the cemetery associated with the fort (OA North 2013).
- 1.2.10 **Medieval Period:** Low Borrowbridge fort may have remained a stronghold in the period immediately following the withdrawal of Roman occupation of Britain, although this was probably short lived, as there is little evidence for continued occupation of the known Romano-British sites in the area with the exception of a settlement to the east of the fort (Lambert 1996, 48).
- 1.2.11 Evidence for early medieval activity from excavations and surviving remains is extremely limited (OA North 2013). Following the cessation of organised Roman military occupation in Britain, most of Cumbria became part of the rapidly fluctuating early medieval kingdoms in the region: firstly Rheged in the sixth and seventh centuries and then the expanding and conflicting kingdoms of Northumbria and Strathclyde (Higham 1986; Bingham 1995). The Lune valley was a focal point of this conflict (Lambert 1996, 48). Settlement in the valley appears to have discontinued for some time in the early medieval period (*ibid*). Analysis of pollen

samples from upland peat deposits at Carlingill (SD 6275 9980), and Archer Moss (NY 6330 0062) indicate a phase of woodland clearance in the Roman period, followed by a long period of woodland regeneration.

- 1.2.12 The Lune valley was an important drove-way from Galloway to London for several centuries (OA North 2013). A twelfth century charter mentions a drove-way named Galwaithegate (the Galloway Road), which ran south-west from Low Borrowbridge towards Lambrigg Park (Hindle 1998, 103 and 109). A drove-way noted during the archaeological work for the NWEF appears to be located on this route (Lambert 1996). Southwards from Low Borrowbridge cattle were driven either south-south-west along the Galwaithegate or south-south-east along the former Roman road to Sedburgh, named Howgill Lane on its route southwards from Carlingill Bridge (Hindle 1998, 109; Lambert 1996, 67). To the north, Lune's Bridge is first mentioned in documents of 1379, and took the Kendal to Appleby road across the river Lune (OA North 2013).
- 1.2.13 The settlement in Tebay may have from suffered repeated Scottish raids following the wars of Independence. However, settlement spread south, west and east from Tebay in the later fourteenth century, and extended along the Lune valley to include Borrowbridge, Brockholes and Carlingill (Lambert 1996, 55).
- 1.2.14 **Post-medieval period:** post-medieval sites close to the survey area are of a very similar range to those which have been attributed to the medieval period (OA North 2013). Lynchets which appear to predate land enclosure were probably associated with the seventeenth/eighteenth century farmhouse of Tebaygill. A farmhouse, named Roundthwaite (Grade II Listed), has a date stone of 1730 over its upper byre door. There is also a ruined barn at Low Carlingill, a sheep fold or stack stand at High Carlingill; and sheep folds shown on the first edition OS map (OA North 2013).
- 1.2.15 Trackways in the form of hollow-ways and terraces ascend from the Lune Valley to the peat cutting areas on Blease Fell (*ibid*). A pair of hollow-ways run from the road between Low Carlingill and High Carlingill farms to the west side of Grains Gill; and a track runs from Brockholes Wood on the north side of Cleugh Gill (*ibid*). The valley farms are thought to be of eighteenth/nineteenth century date and the peat cutting is likely to be of roughly the same date (*ibid*).
- 1.2.16 Salterwath Bridge was ruinous in 1811 and rebuilt in 1824 (Lambert 1996, 69), but it is unknown when the original bridge was built, and it may in fact have been another Roman crossing point of the Lune (OA North 2013).
- 1.2.17 **Industrial period:** the arrival of the railways represents the first major change in this area of the Lune valley for several centuries (Lambert 1996, 63). The Lancaster and Carlisle Railway was opened in 1846 and now serves as the West Coast main line. During construction of the railway, it was proposed that the line run directly through the fort but following a review, the route was shifted to the west.
- 1.2.18 To the west of the railway, the M6 Motorway was constructed in 1967 (ACTION with Communities in Cumbria, 2013). Any extra-mural settlement that may have been present to the west of the fort would undoubtedly have been destroyed. Similarly, the field immediately to the south of the fort (Area 5) was drained and levelled to provide a temporary camp for the construction workers (*ibid*).

2. METHODOLOGY

2.1 PROJECT DESIGN

- 2.1.1 The following methodology was used as the basis for the survey, and the work was consistent with the relevant standards and procedures of Historic England (English Heritage 2008) and the Chartered Institute for Archaeologists (CIfA 2014), and generally accepted best practice. Two techniques were used for the survey, magnetometry and electrical resistance.

2.2 GEOPHYSICAL SURVEY

- 2.2.1 **Magnetometer Survey:** the preferred geophysical technique in the detection of many archaeological remains is a magnetometer area survey, which is effective in locating 'positively magnetic' material, such as iron-based (or 'ferrous') features and objects, or those subjected to firing, such as kilns, hearths, and even the buried remains of brick walls. This technique is also widely used to locate more subtle magnetic features associated with settlement and funerary remains, such as boundary or enclosure ditches and pits or post-holes, which have been gradually infilled with more humic material. The breakdown of organic matter through micro-biotic activity leads to the humic material becoming rich in magnetic iron oxides when compared with the subsoil, allowing the features to be identified by the technique. In addition, variations in magnetic susceptibility between the topsoil, subsoil and bedrock have a localised effect on the Earth's magnetic field. This enables the detection of features, such as silted-up or backfilled pits, due to the fact that the topsoil has more magnetic properties than the subsoil or bedrock, resulting in a positive magnetic anomaly. Conversely, earthwork or embankment remains can also be identified with magnetometry as a 'negative' feature due to the action in creating the earthwork of depositing the relatively low magnetic subsoil on top of the more magnetic topsoil. In this way, magnetometry is a very efficient technique and is recommended in the first instance by Historic England (2008) for such investigations.
- 2.2.2 **Magnetometry Equipment:** the strength of the present geomagnetic field in Great Britain is approximately 50,000nT (nanoTesla). Most buried archaeological features usually result in very weak changes of less than 1nT to the magnetic field (Clark 1990, 65). The instrument used for this survey was a *Bartington* Grad 601-2 dual sensor fluxgate gradiometer, which has a sensitivity of 0.1nT when used in the 100nT range setting.
- 2.2.3 **Electrical Resistance or Resistivity:** the use of electrical resistance area survey is often seen as being complementary to magnetometry and is recommended by English Heritage where there is a strong presumption that buried structures or buildings are present that are not easily identifiable with magnetic methods. The technique requires injecting a small electric current into the ground via steel probes, and measuring the response with an earth resistance meter. The technique relies on the variable ability of the soil to resist an applied electrical current by the resistance meter from a pair of mobile probes to a corresponding pair of remote, static probes. The resulting resistance measurements (in ohms) can be used identify to buried features, which often have either a higher or lower resistance to the current than the background soil. Cut features that have been subsequently infilled, tend to be less

resistant to the current flow and appear as low-resistance anomalies, whereas solid features such as structural remains tend to be more resistant to the current flow and appear as high-resistance anomalies. One of the main disadvantages of the technique, when compared with magnetometry, is that data collection over the same size of area is a much slower process.

- 2.2.4 **Resistivity Equipment:** the instruments used for this survey were a *Geoscan Research* RM15-D resistance meter with PA20 frame system set to single twin mode. The other instrument used was an M.M. Resistivity Meter; Model 216M with a bespoke frame set to single twin mode.
- 2.2.5 **Sampling Interval:** the survey area was divided into 30m x 30m grids. Magnetometry sampling was at 0.25m intervals, with inter-transect distances of 1m, equating to 3600 sample readings per grid. The survey was carried out in 'zigzag' mode, with precautions to minimise any heading error during the magnetometry survey. In total, an area of approximately 2.45ha was surveyed with magnetometry (Fig 2). Resistivity sampling was at 1m intervals with inter-transect distances of 1m, equating to 900 sample readings per grid. In total, an area of 2.2ha was surveyed with resistivity (Fig 2). All survey grid nodes were staked out with canes using a *Leica* 1200 series RTK GPS system. Survey guidelines and traverse canes were then staked out.
- 2.2.6 **Data Capture and Processing:** magnetometry and resistance data were captured in the internal memories of the instruments and downloaded to a portable computer on-site and backed-up on to a USB drive. The individual grids were combined to produce an overall plan of the surveyed area, or 'composite'. The results were analysed and basic initial processing was carried out on-site using either *Geoplot 3* by *Geoscan Research* or *Terrasurveyor* by *DW Consulting*.
- 2.2.7 Final processing of magnetometry raw data was undertaken off site in accordance with Historic England guidelines (English Heritage 2008) to remove any instrument error or survey effects in order to enhance more subtle anomalies normally associated with archaeological features. All data were clipped by the appropriate values where necessary and the following processing steps carried out.
- Zero median grid/traverse was applied to correct slight baseline shifts between adjacent survey lines;
 - The data were selectively 'de-staggered' where necessary, to remove any displacement caused by surveying in zigzag mode. This is sometimes required when surveys are carried out on boggy, wet, overgrown or steeply-sloped areas;
 - The data were de-spiked where appropriate in order to remove random spikes. Random spikes are usually caused by erroneous small ferrous objects.
- 2.2.8 Final processing of resistivity raw data was undertaken off site in accordance with Historic England guidelines (English Heritage 2008) to remove any instrument error or survey effects in order to enhance more subtle anomalies normally associated with archaeological features. All data were clipped by the appropriate values where necessary and the following processing steps carried out.
- The data were de-spiked in order to remove high contact readings;
 - The grids were edge matched in order to correct for changes in the position of the remote probes

- A high pass filter was applied which removes variations in the background geological response;
- A low pass filter was applied where appropriate, which can improve the visibility of weak archaeological features;

2.2.9 ***Presentation of the results and interpretation:*** the presentation of the data for the site involves a print-out of the processed data as a grey-scale plot for each of the magnetometry surveys (Figs 3 - 5) and resistivity surveys (Figs 6-8), together with individual (Figs 9 – 11 and 12 - 14), and combined (Figs 15 and 16) interpretation plots.

2.3 ARCHIVE

- 2.3.1 A full professional archive has been compiled in accordance with current CIfA and Historic England guidelines. The project archive represents the collation and indexing of all the data and material gathered during the course of the project.
- 2.3.2 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 CIfA in that organisation's code of conduct. OA North conforms to best practice in the preparation of project archives for long-term storage. OA North practice is to deposit the original record archive of projects with the appropriate repository.
- 2.3.3 The Arts and Humanities Data Service (AHDS) online database project *Online Access to index of Archaeological Investigations* (OASIS) will be completed as part of the archiving phase of the project.
- 2.3.4 The geophysical survey data will be archived with the Archaeology Data Service (ADS) in accordance with the guidelines published by the ADS (Schmidt 2002)

3. SURVEY RESULTS

3.1 GENERAL OBSERVATIONS

3.1.1 Both magnetometry and resistance survey data sets were, in common with the Phase 1 surveys, successful in identifying numerous responses of potential archaeological interest. Area 1 (the fort platform) and Area 5 (the field to the east of Howgill Lane at the southern end of the survey area), contain responses of potential archaeological significance, Areas 2, 3 and 4 less so. Also, in common with the Phase 1 survey, both techniques have provided complimentary data highlighting the importance of using both techniques. The following sections outline the results of the survey, describing the types of features that are potentially present within the survey areas, commencing with Area 1, the fort platform. The numbering system for features follows on from the Phase 1 survey (OA North 2015).

3.2 RESULTS

3.2.1 **Area 1 (Figs 4, 7, 10 and 13):** the survey area was contained within the boundaries of the fort platform that occupies an elevated position to the north-west of the farm buildings. Both data sets within the fort are fairly complex.

3.2.2 **Building remains:** there are several rectilinear responses visible in both data sets that are indicative of structural remains mainly present across the centre of the survey area (F17, Figs 10 and 13). Within the magnetometry data is an obvious area of magnetic disturbance containing several rectilinear magnetic responses. The resistance data clearly shows several high resistance rectilinear responses some of which are within, and surrounded by, areas of high resistance. The combined results suggest three distinct buildings. Some of the linear responses from each data sets correlate but many of the magnetic responses lie within the interior of the buildings suggestive of internal structural remains and/or hypocaust-heated buildings.

3.2.3 To the south-east of the central range of responses, further, albeit more fragmented, evidence of buildings is present in both data sets, within more general areas of magnetic disturbance and high resistance (F18, Figs 10 and 13). Other, medium-high resistance linear responses are present at the northern end of the fort area suggestive of further structures. The northernmost part of the fort contains an area of magnetic disturbance potentially indicative of settlement activity, together with further linear responses indicative of buildings.

3.2.4 **Roads:** to the south of the central range is a north/south aligned low resistance linear response that runs between the southern boundary of the area and the central range of buildings (F19, Fig 13). This, although slightly off centre, may be evidence of the *via praetoria*. A similarly 'quiet' area in front of the south side of the buildings visible in both data sets may be due to the *via principalis*, this is also off centre. There is no evidence for any of the gates.

3.2.5 **Other features:** there are several responses that may be indicative of earthworks. The most obvious of these is a series of curvilinear magnetic responses in the north-

west corner of the survey area suggestive of banks (negative) and ditches (positive) (F20, Fig 10). Similar responses are also present in the south-west and south-east corners, which allude to the survival of an earlier phase of fort. If this is correct, it would be of significant archaeological importance.

- 3.2.6 A high amplitude magnetic response is present close to the north end of the easternmost building (F21, Fig 10). This appears, from analysis of trace plot data, to be suggestive of a thermo-remnant feature, such as a hypocaust-heated building.
- 3.2.7 Three east/west aligned linear responses that are visible in the resistance data, cross the width of the fort platform and are reminiscent of drainage features such as modern French drains. There are several magnetic and high resistance responses located around the edges of the survey area that are due to the current field boundaries. Finally, there are a number of random magnetic spikes.
- 3.2.8 **Area 2 (Figs 4, 7, 10 and 13):** this area is located close to the railway embankment of the West Coast mainline to the south-west of the fort platform. The magnetometry data contains an area of magnetic disturbance running up the western side due to the tall steel railway boundary fence. There is also a high amplitude response at the southern end that is probably due to a buried metallic pipe. A medium-high resistance response is also present in the same area. The northern part of the survey area contains a discrete high resistance response of unknown origin. This survey area was restricted in size due to the boggy ground.
- 3.2.9 **Area 3 (Figs 4, 7, 10 and 13):** located in between the River Lune and the modern road, this area was similarly restricted in size, limiting meaningful interpretation.
- 3.2.10 **Hollow-way:** a suspected hollow-way ran through the area which appears to be represented in both data sets (F22, Figs 10 and 13). The parallel arrangement of the magnetic responses suggest ditches flank the hollow-way, while the high resistance linear responses are suggestive of banks.
- 3.2.11 **Other features:** areas of magnetic disturbance may be of some potential archaeological interest however, discrete areas of medium and high resistance in this area are probably due to trees and geology.
- 3.2.12 **Area 4 (Figs 4, 7, 10 and 13):** this area was only surveyed with resistance and is located within a field to the west of the farm that once contained a camp that housed construction workers for the M6 motorway.
- 3.2.13 There are several high and low resistance responses visible in the survey data with no discernible pattern. One or two of the lower amplitude responses are vaguely rectilinear or square but are unlikely to be of any archaeological importance. The small size of the area makes meaningful interpretation difficult.
- 3.2.14 **Area 5 (Figs 5, 8, 11 and 14):** located to the east of the Phase 1 survey area, this area was selected in order to determine if responses detected during the Phase 1 survey were replicated or extended further to the east. In the event, a number of responses of potential archaeological importance were found to be directly related to those present in the Phase 1 survey area.

- 3.2.15 **Enclosures:** of immediate interest are a series of linear responses arranged in a rectangular pattern that appear to be of at least two, maybe three, phases and are suggestive of enclosures (F23, Figs 11 and 14). They are of similar amplitude and appearance to responses interpreted as field systems that were visible in the Phase 1 survey data (OA North 2014). They are visible as positively magnetic and low resistance responses indicative of ditches that clearly do not respect field alignments or the route of Howgill Lane.
- 3.2.16 **Earthworks:** the Phase 1 survey highlighted a number of low resistance responses that were thought to be indicative of features such as ditches. These extend into Area 5 and are of similar characteristics (F24, Fig 14). There are also two fairly weak negatively magnetic linear responses that lie adjacent and are suggestive of banks (F25, Fig 11). Similarly, there are corresponding high resistance areas also indicative of banks (F26, Fig 14). The linear responses (F23) appear to be later than these.
- 3.2.17 **Extra-mural settlement:** clear responses suggestive of extra-mural settlement identified during the Phase 1 survey, are not present in either of the Phase 2 data sets. The results from both the magnetometry and resistance surveys show less archaeological activity within this field than that of Phase 1. There are, however, several discrete positively magnetic responses within the survey area that may of archaeological potential, particularly at the northern end (F27, Fig 11), which are usually indicative of features such as pits.
- 3.2.18 **Other features:** several short linear, curvilinear and circular positively magnetic responses are visible. Two circular responses in particular may be of archaeological interest and are situated at the end of a long linear response (F28, Fig 11); one has a negatively magnetic interior suggestive of a mound. The interior of one of the enclosures described in *Section 3.2.15* contains a number of weak linear magnetic responses, one of which is 'L-shaped' (F29, Fig 11).
- 3.2.19 Finally, there are areas of magnetic disturbance either due to the presence of field boundaries or, in the case of an linear arrangement of alternating positively and negatively magnetic responses crossing the south-east corner of the survey area, the North West Ethylene pipeline. A further, smaller pipeline crosses the northern part of the survey area. Several magnetic spikes are present that are due to individual ferrous objects.

4. CONCLUSIONS

4.1 DISCUSSION

- 4.1.1 In common with the Phase 1 survey, both geophysical survey techniques have revealed numerous responses that are, potentially, of substantial archaeological significance. The surveys have added to and expanded the conclusions drawn from the Phase 1 survey. Of the five areas surveyed, Areas 1 and 5 have yielded significant information about the internal layout of Low Borrowbridge Roman Fort and potential Roman enclosures to the south-east.
- 4.1.2 **The Fort:** little was previously known about the interior of Low Borrowbridge Roman Fort (Bidwell 2009). Limited excavations had taken place in 1883 that found that the south gate had been removed, the east gate had two carriageways that projected beyond the fort wall, while the west gate was simpler (*ibid*). The north gate had been demolished and the wall carried on across it (*ibid*). In 1950, excavations revealed two ditches beyond a fort wall on the west side in front of a rampart (Hildyard 1951).
- 4.1.3 The survey has revealed the existence of at least three buildings located in the centre of the fort platform. These appear to conform to a fairly standard fort arrangement, with a headquarters building in the centre, granaries to the east and a commander's house on the west side. The interior of the buildings is magnetically complex suggesting the presence of thermo-remnant material, perhaps relating to a hypocaust. The buildings appear to face south and evidence of the *via praetoria*, which leads from the headquarters building to the south wall, is also present.
- 4.1.4 To the north and south of the central range of buildings, the survey data suggests the presence of further buildings, probably barrack blocks and other ancillary structures. A noticeable gap in the southern range of these buildings appears to allow the *via praetoria* to pass through.
- 4.1.5 There is evidence to suggest that an earlier phase of fort survives in the form of banks and ditches that are particularly visible on the west side, curving around the north-west corner (F20). If these responses are evidence of an earlier phase, this is of archaeological importance.
- 4.1.6 **The Enclosures:** the rectangular array of linear responses present in both the Phase 1 survey and Area 5 are of particular archaeological interest and may be evidence of either Roman or pre-Roman activity. They are not aligned with the current fort or any other field boundaries. However, other responses suggest some settlement activity took place in and around the enclosures.

4.2 RECOMMENDATIONS

- 4.2.1 The recommendations made during the Phase 1 survey (OA North, 2014) suggested expanding the non-invasive investigation in order to characterise the nature of the responses, and to determine if responses continued into adjacent fields. In this regard, the survey of Area 5 has succeeded and further expansion of Area 5 is unlikely to add any additional information. Ground truthing in the form of trenches across several responses (F23 and F27 for example) in Area 5 is therefore recommended as the next appropriate step in the investigation. Expansion of the

Phase 1 survey, however, may still aid clarification of the nature of settlement to the south of the fort.

- 4.2.2 The survey of the fort platform has provided significant information regarding the layout of the hitherto unknown interior of Low Borrowbridge fort. Not only have several buildings been identified in the survey results, but an earlier phase of fort defences may also be present. The responses present within the fort are prime targets for investigation in the form of trenching; in particular, investigation of the ditches (F20) suggestive of an earlier phase.

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- Land Information System www.landis.org.uk

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