Warkworth Castle, Northumberland (England)

Report on two geophysical surveys (2020, 2021) funded by the Castle Studies Trust - 30 June 2021

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Table of Contents

Cover image: photograph of Warkworth Castle and the modern suburb of Maudlin, taken from the riverside road to Amble east of the castle and village. © William Wyeth

Table of Figures

<u>Note</u>: figures from the two separate archaeological reports by Archaeological Services – Durham University retain their own figure numbering.

Summary
Geophysical surveys undertaken on behalf of English Heritage Trust (EHT) by Archaeological Services – Durham University (ASDU), funded by grants from the Castle Studies Trust, explored two areas of Warkworth Castle in Northumberland, in advance of a project by EHT to re-interpret the history of the castle. The first (2020) survey, of the castle earthworks proper, revealed several features relating to substantial buildings within the bailey enclosure as well as features on the unenclosed, eastern part of the earthwork. The second (2021) survey, of a field called St John's Close, associated with the historically-attested park c.300m south of the castle, was explored for evidence relating to the boundary and gate of the park. This revealed clusters of linear and circular features underlying the extant ridge-and-furrow earthworks which, though of archaeological interest, probably date to the prehistoric period. A possible track leading to the location of a speculated park gate was also detected.

Introduction
This document presents the results from geophysical surveys undertaken at Warkworth Castle in 2020 and 2021. It introduces the project which has spurred the research questions which underlay these surveys, an historical, architectural and archaeological outline of the site, as well as summaries of the 2020 and 2021 surveys which touch upon the medieval period of the castle's occupation. The report closes with a discussion of the ramifications of both surveys for thinking on Warkworth Castle. The full reports, detailing technical specifications, method statements and a fuller discussion of the findings, are appended at the end.

'Warkworth Castle: Stories in Stone' and the Research Context
From 2019-2023 EHT is investing in a transformation of the visitor experience at Warkworth Castle (Northumberland, England, NGR centre: NU 24721 05764), including new visitor centre and overhauled interpretation scheme. In this preliminary phase of the 'Warkworth Castle: Stories in Stone' project, it is essential to establish early on any new thinking or understanding of the standing (and subsurface) evidence for the castle's history. It is a scheduled ancient monument and a Grade I listed building. The presentation of the monument is that of ruin, displayed largely for its architectural interest, however, the 'Duke's Rooms' are roofed and semi-furnished. The interpretation scheme on the site is minimal, chiefly Office of Works-style signs identifying the function of a given room. Visitors are currently invited to use an audio guide to explore the history and details of the site's architecture.

A central ambition of the larger 'Stories in Stone' project is to enable us to speak with confidence about how Warkworth Castle looked and was experienced in embodied terms in several periods of its medieval life. This is because we believe (and hold as a central curatorial ambition) that Warkworth is well-placed to give an authentic experience of life in a castle, owing to the outstanding quality of its remains. Much has been written on the landscape turn in Anglophone castle studies, by among others Creighton (2002) and Liddiard.[1] Research on the embodied experience of medieval complexes has shifted from

[1] Creighton, 2002; Creighton, 2009; Liddiard, 2012.

the schematic spatial studies by Faulkner, to more formalised studies informed by both graph theory and structuralism of Gilchrist (for nunneries), Richardson, Mol and most recently Weikert (for manors).[2] Recent methodological-theoretical innovations include a phenomenological and sensorial-centric approach advocated by Cooper and a distinctly anthropological avenue pursued by Johnson.[3] These iterations of the study of space, place and its experience have their merits and will implicitly inform contributions towards the Warkworth interpretation project, but in order for their potential to be met, it is necessary to ground our understanding in facts. These facts will be established and queried by our investigation of both the castle earthworks and the nearby field of St John's Close.

Figure 1. Photograph of the Great Tower at Warkworth Castle, built late 14th century. View looking east from the western base of the motte, outside the embrace of the curtain wall. © William Wyeth

Though the highlight of Warkworth is undoubtedly its late medieval Great Tower (Figure 1), it has too often overshadowed what remains an equally impressive and largely under-appreciated earlier residence from the golden age of castles as well as a rich and diverse landscape, which have hitherto not featured prominently in the canon of high-status complexes of similar stature and material extent.

In terms of the preferred approach to answer the research questions detailed below, geophysical survey enables the relatively rapid and non-invasive identification of sub-surface features of potential archaeological significance and can involve a suite of complementary

[2] Faulkner, 1958; Faulker, 1963; Gilchrist, 1997; Richardson, 2003a; Richardson, 2003b; Mol, 2012; Weikert, 2020.
[3] Cooper, 2017; Johnson, 2018.

techniques such as magnetometry, earth electrical resistance, ground-penetrating radar, electromagnetic survey and topsoil magnetic susceptibility survey. Some techniques are more suitable than others in particular situations, depending on site-specific factors including the nature of likely targets; depth of likely targets; ground conditions; proximity of buildings, fences or services and the local geology and drift.

Overview of History of Warkworth Castle

Warkworth Castle is an impressive aristocratic fortified residence situated on the banks of the river Coquet and occupying a commanding position above the town of Warkworth, Northumberland.[4] The castle is a scheduled ancient monument and a Grade I listed structure. The castle is regarded a showpiece building belonging to the powerful Percy family, though much of its standing fabric pre-dates its Percy tenure. Although it did play a part in the border struggles, its defensive structures are largely for display.

As presently understood, the earliest earthworks date to the early 12th century, and its earliest standing remains to between the late 12th-early 13th centuries. The identity of the architect or patron of its early earthworks remains is not settled. There are two possible scenarios: first that it was built by Henry of Scotland (1114-1153), who from 1139 was Earl of Northumberland, and was the son of David I of Scotland. The other possibility is that it was built with the support of Henry II of England, who retook possession of Northumberland in 1157, and under whose auspices a similar complex at Harbottle emerged. Whoever built the early castle was almost certainly developing an association with a lordship centre at Warkworth that was much older. In 737 Ceolwulf granted Warkworth to Lindesfarne along with the present parish church of St Lawrence. The place-name elements of Warkworth are as follows: '**Weorca*' or '**Weorce*', in both cases a feminine personal name; and *worð*, meaning an enclosure (in the sense of enclosed settlement). Both elements are Old English (OE).[5]

Sections of the east and west curtain walls are all that remain of this phase of construction. In 1157x64 the castle was granted to Roger Fitz Eustace whose descendants added to the castle with the construction of the gatehouse, Carrickfergus Tower, domestic buildings and in 1249 the rebuilding of the great hall in the bailey. It is very likely the 14th-century Great Tower presently atop the motte replaced an earlier structure of timber or stone. In 1311 the castle was acquired by the Crown and later, 1332, was granted to Henry Percy, lord of nearby Alnwick. It was the Percy, created earl of Northumberland at the coronation of Richard II in 1377, who initiated Warkworth's most ambitious building project following his elevation: the construction of the Great Tower (Figure 1). The fourth earl (c.1449–1489) began the building of a large collegiate church in the bailey around 1480, however, after his murder in 1489 it appears that the project was abandoned and the construction never completed. His scheme for an overhauled bailey, however, is reflected in the configuration of the kitchen block, Little Stair Tower and redeveloped chapel. The foundations of the church incorporate a passage connecting the bailey and the Great Tower. The rebuilding of the hall range in the bailey was also undertaken at this time, including the imposing Lion Tower with its impressive display of heraldic sculpture.

[4] What follows is largely drawn from Goodall, 2006.
[5] Key to English Place-Names (KEPN), 2021.

Figure 2. Photograph of Percy lion relief sculpture on N face of Great Tower. At least one claw is composed of metallic material or finish. © Historic England Archive

The castle was described as being in disrepair in 1550. The seventh earl, Thomas Percy (1528-1572) may have commissioned at 1567 survey of the castle in advance of remodelling the castle, but his participation in the unsuccessful Rising of the Northern Earls (1569) eventually lead to his execution. The Percy family temporarily lost control of the castle following the ninth earl's imprisonment for his alleged involvement in the Gunpowder Plot of 1605, and thereafter castle was then leased to Sir Ralph Gray who allowed it to fall into further ruin.

During the years of the Civil War the castle was garrisoned by royalist forces, however, it was surrendered to the invading Scots in 1644. The Great Tower suffered further damage at the hands of the widow of the eleventh earl, who granted material from the structure to one of her estate officers for the building of a new house.

The castle was left to deteriorate for most of the next century until the late 1700s when there was a renewed interest in the history of the structure. Successive heads of the Percy family, by now (from 1766) elevated to the dukedom of Northumberland, began to take an active interest in the castle. In the 1850s the fourth duke employed Anthony Salvin to restore the

Great Tower, re-roofing the southern arm creating an apartment now known as the ‘Duke’s Room’. Some decades earlier, in the mid-1830s, the area around the castle been leased out, as ‘Castle Green and Banks’, to a certain John Common.[6] The castle became a tourist attraction administered by the Northumberland Estate, however, in 1922 responsibility for the castle was handed to the Office of Works other than the ‘Duke’s Rooms’ which did not come into guardianship until 1987.

In a more general sense, the castle sits within an impressive medieval (loosely defined) landscape. The Great Tower, though later in date, also references a clear castle-settlement relationship in its presentation, on the townward face of the tower, of a storey-high Percy lion relief (Figure 2). The planned settlement, comprising an axial road from the castle at the base of the loop in the River Coquet, to the parish church and medieval fortified bridge at the curve of the river, is an essential piece of evidence in understanding the castle’s early development (Figure 3).

Figure 3. Oblique aerial view of Warkworth castle and village, looking north. The parish church and fortified bridge are visible at the top of the image. © Historic England Archive.

The 2020 Survey: Earthworks of the Castle

A full account of aims, method statements and results can be found in the full report (appended). What is presented below is a brief account, drawing attention to summarised elements of the survey only.

Overview of Architecture of Warkworth Castle

Refer to Figure 4 for what follows.

[6] T(he) N(ational) A(rchives) IR 29/25/461, ‘Tithe apportionment of Warkworth’, 1839.

Phase 1 (?early 12th century): Earthworks

As has already been mentioned, at present the earliest portion of the castle is considered to comprise the earthworks, of two parts.[7] Firstly, a motte of c.60m (N-S) x c.50m (E-W) at its base, rising to a much-modified platform, is situated at the north of the site. Arrayed to its south is the bailey, a raised trapezium-shaped platform c.70m across (E-W) nearest the motte, broadening to c.100m across at its southern extent, and approximately 90m long (N-S). In terms of surrounding ditches (seemingly always intended as dry features), the best-surviving portions appear on the southern and edge of the bailey. Here the ditch is over 20m wide, though it is likely it has been recut and remodelled. There is no ditch apparent on the eastern edge, though it may have been subsumed by the modern road there; this may also be the case for a possible ditch enclosing the motte on its eastern and northern sides. The western side of the earthworks may have possessed a ditch, though the ground here falls steeply towards the River Coquet to the west.

Three curiosities of the earthworks are worth noting. Firstly, there is no trace whatsoever of a ditch separating the bailey from the motte. Evidently, the ground here has been much altered through successive periods of construction on both the motte-top and the nearer portions of the bailey. It is possible the former presence of a ditch here is confirmed by the angular external buttresses on the exterior faces of the curtain walls rising up from the bailey to meet the late medieval Great Tower; certainly, a section of the castle (Figure 4) suggests the medieval floor level here is lower than in the bailey. Secondly, the present north-western extent of the bailey earthworks is unlike its counterpart on the north-eastern side; there, the earthwork returns westwards, forming an angle, whereas in the north-west the earthwork carries northwards. This curiosity may be settled by considering the local topography noted above, namely that the ground to the west of the castle falls towards the river side here. Lastly, it appears that the spread of earth comprising the lower portion of the south-eastern motte mound overlies the north-eastern return of the bailey platform here. It is not clear if this was a planned arrangement (which would seem unlikely), and so it must therefore be attributed to earthwork engineering at some point during the castle's history. Certainly, whenever this was dated, whatever considerations were involved must have overridden a direct concern for maintaining a ditch in this portion of the castle.

For want of evidence it is difficult to say with certainty what kinds of structures may have existed on the earthworks when they were completed. If occupied, the castle likely featured a building of high status atop the motte, with a mixture of high- and low-status buildings in the enclosure, whose form and character were dictated by the functional needs and cultural-social requirements of the castle's owner. We may envisage a great hall, a chamber block, facilities for food storage and preparation, as well as buildings to feed and house horses. The whole may have been surrounded by a timber palisade, and accessed via a gate house on the bailey's southern or eastern flank.

[7] This section is largely drawn from Goodall, 2006, with supplementary observations.

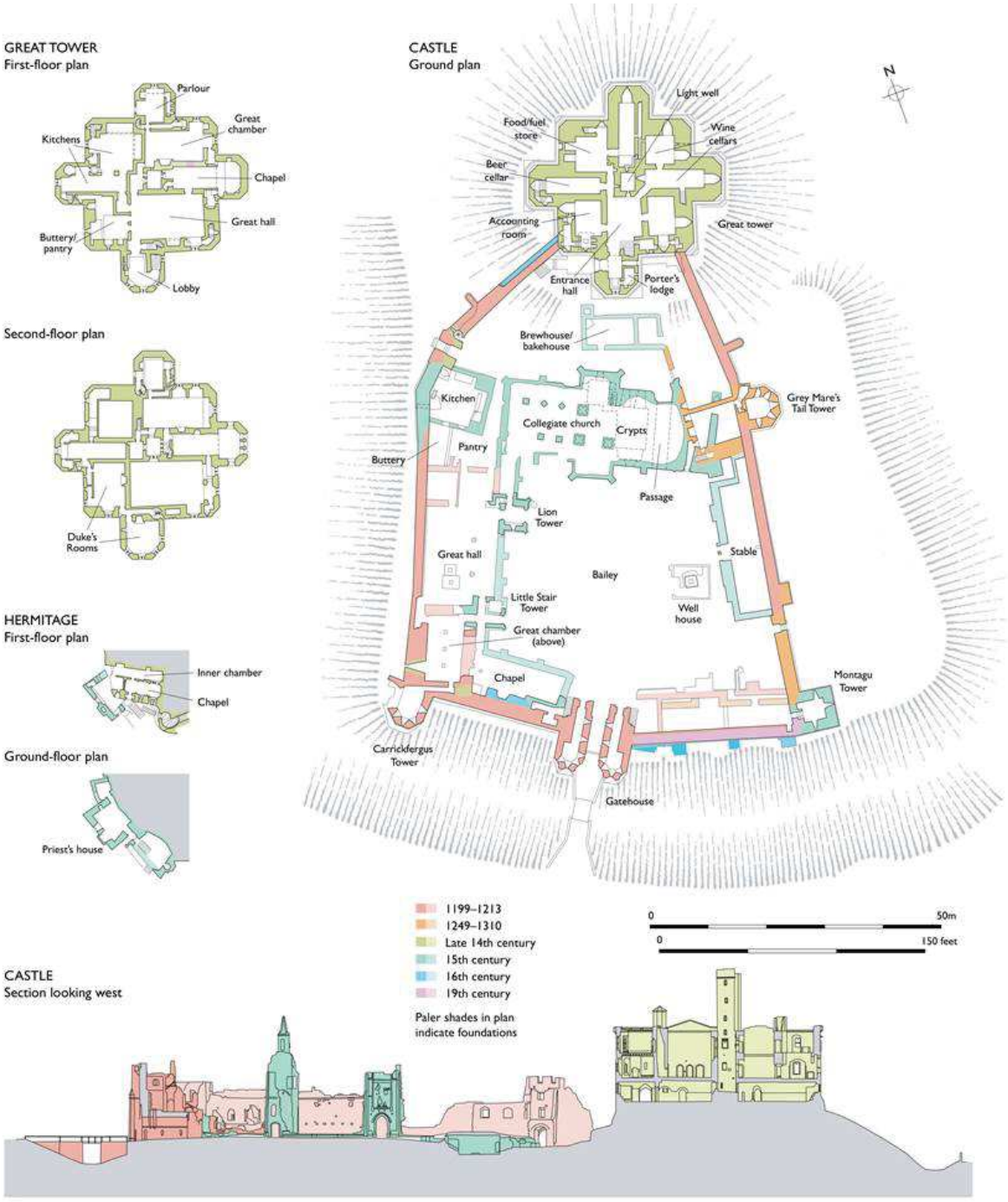

Figure 4. Coloured phase plan and partial phase elevation of Warkworth Castle and Hermitage. © Historic England Archive

Phase 2 (late 12th-early 13th century): First stone structures

As presently understood, the first phase of structures which survive at the castle were constructed in the late 12th-early 13th century; a specific range of c.1199-1213 is proposed by the EHT guidebook. This period is significant in the architectural history of the castle for one reason: the plan of the walls, and indeed two of the portals into the castle enclosure, were fixed and largely unchanged during this early period. The stone gatehouse, sitting approximately mid-way along the southern run of massive curtain wall of mixed phasing, represents the slightly diminished remains of a substantial structure towering over the

primary, formal entrance in the enclosure (see Figure 5). Polygonal towers with angular buttresses project into the fronting ditch on deep foundations, and these flank a passageway with pointed vaulting, punctuated by a portcullis slot and protected on its southern extent by checks for two doors opening outwards. Long arrowslits with cross slits and splayed triangular feet, nestled between the external buttresses, give light to side-chambers either side of the passage, which in the later 16th century served as a porter's lodge and prison respectively. Above the passageway and side-chambers was a chamber which in the 16th century pertained to the earl; it may have operated in many different capacities prior to this, but was feasibly a high-status space of sorts throughout. The next level above may have hosted a fighting platform or timber hoarding of c.1400, supported by a series of stone brackets and joist holes along the upper levels below the present line of the wall-head on the external, southern face of the gatehouse.

Figure 5. Gatehouse of Warkworth Castle, looking east. Chris Gunns / Warkworth Castle, entrance / CC BY-SA 2.0.

The gatehouse was originally flanked on either side by stone curtain walls, which survive fragmentarily on the west side of the structure (see Figure 5), perhaps a later rebuild), and appears to have been demolished and rebuilt on its eastern half. The south-west corner of the curtain wall is marked by the D-shaped, polygonally-sided Carrickfergus Tower, so-named for the association of a branch of the Lacy family (with whom the Percys of Warkworth were closely associated) who possessed the castle of that name in Ulster. Two upper floors within the Tower had latrines and fireplaces, marking them as apartments, while the ground-floor basement, lit by deep arrowslits of similar character to those in the gatehouse, had no facilities, but was accessed via the ground-floor basement of the adjacent

chamber block. The irregular relationship between the north-western corner the Carrickfergus Tower and the western curtain wall carrying north cannot be explained; it may simply represent an adaptive concession to engineering during the construction of both structures.

The Carrickfergus Tower is part of a cluster of high-status buildings in this corner of the enclosure also dated to the late 12th-early 13th century; it is joined by the chamber block and the great hall, arrayed along the western curtain wall north of Carrickfergus Tower. The chamber block, with a ground-floor basement and first-floor chamber, was much remodelled later and has since been heavily robbed, but sufficient evidence survives to show that it was linked to the ground-floor great hall via a wide staircase built within the western curtain wall. It is assumed that the first-floor of the chamber was joined by the chambers within Carrickfergus to offer a series of apartments for the owners and administrators of Warkworth Castle. The great hall today is roughly on the same footprint as its early phase, originally featuring a small eastern aisle, but it appears it retained its high end to the south, and the north end provided both a formal, ceremonial entrance (NE corner) and access to service buildings arrayed further north still. The hall was heated by a hearth and was presumably lit by windows in the much-diminished eastern wall; the western wall, comprising the thick curtain wall, does not appear to have been lit by windows, though it retains traces of the original lateral stone bench set along its internal face.

A further building belonging to this period of construction is the postern gate, located north of the later kitchens, in the north-west of the bailey. It was through this gate that food, drinks and other goods were likely delivered for much of the castle's history, being both close to the castle buildings which consumed them and near to the borough and roads by which those goods were secured and transported. Given that the Coquet is also tidally navigable below the castle here, it is entirely plausible that river was also used to bring in victuals to sustain the castle community.

Between the Carrickfergus Tower and the gatehouse is the location of a later medieval chapel; it is likely the remains here are simply later iterations of an earlier building here dating to the first construction phase at the castle; its position relative to the gatehouse, great chamber and great hall suggest this is feasible.

The curtain wall is the last structure belonging to the construction at the castle dated to the late 12th-early 13th centuries. The curtain wall follows the western and southern edges of the earlier bailey earthworks, but curiously returns northwards c.30m from the bailey earthwork's south-eastern corner, carrying northwards with a slight pivot beyond the Grey Mare's Tail Tower to meet the Great Tower atop the motte. The effect of this is twofold; the bailey retains a roughly equal amount of space enclosed on its western and eastern sides, ensuring (at least in plan) a degree of axial symmetry. But this is at the expense of creating a broad platform of unenclosed ground to the east of the curtain wall, encompassing approximately 25m x 80m. The exclusion of this space an intentional act, which is one research question to be answered by survey.

<u>Phase 3 (mid-13th-early 14th centuries): Amendments to the East Curtain Wall.</u>
The next phase of construction at the castle, undertaken a generation or two after the earliest works were completed, comprise significant amendments to parts of the east curtain wall. Traces of primary-phase curtain wall survive here to suggest that the course of the

curtain was not substantially altered, but at the very least, a new tower was built (likely replacing an earlier one) and the curtain nearest to the south-eastern corner of the enclosure was rebuilt or remodelled.

The Grey Mare's Tail Tower is the most obvious and substantial of these changes. Likely replacing an earlier tower – the change in curtain wall-line here makes this a likelihood – the Tower hosts unusually long, two-storey externally-facing arrow loops punctuating its five external faces. Internally it comprised a ground and a first-floor, each independently accessible from a building constructed on the interior face of the curtain around the same time the Tower was built. A series of wall-set cupboards and a mural staircase in the southern wall of this building are all that survive. A thin partition wall on the north side suggests it carried northwards along the curtain wall towards the motte, but its northern limit is not certain.

In 2005, timber embedded across the head of an internal opening for an arrowslit was carbon-dated through wiggle matching to yield a felling date in the 1290s, suggesting the tower was largely complete in the last decade of the 13th century. The intended use of Tower upon completion is not clear; its primary phase features no fireplaces usually associated with accommodation, though a suite of latrines was built at the same time, in the angle of the tower and curtain wall carrying northwards (see Figure 6). The expansive provision of arrowslits may suggest it was intended as a defensive measure, but its position overlooking a broad platform of flat ground surrounding the tower on three sides somewhat negates this view. It may feasibly be imagined primarily as a device to impress travellers along the road to the east, offering a secondary, additional security measure in times of war.

A pair of latrines was constructed at wall-head level on the curtain wall to the south of the Grey Mare's Tail Tower, a massive buttress (housing chutes) carrying eastwards to support this new feature. South of these new facilities, feasibly only accessed by a parapet walk either via the Grey Mare's Tail Tower, a lost staircase within the bailey, or a precursor to Montagu Tower to the south, the curtain wall was rebuilt. This may have been necessitated by the insertion of a precursor to the later postern here, or by the rebuilding of the corner tower located here. Additionally, a small range of buildings dating to this phase of construction was built on the interior face of the south curtain wall, to the east of the gatehouse. Very little is known about them, except the fine mouldings of door jambs to the easterly of the buildings.

Figure 6. Photograph of latrine chambers adjacent to the Grey Mare's Tail Tower, looking south-west. © William Wyeth

Phase 4 (late 14th century): The Great Tower

Small changes to the buildings in the bailey are ascribed to a further two or three generations following the completion of works on the east curtain wall. These include the blocking, expanding, refacing or remodelling of doorways, passages and windows. There was also quite a substantial remodelling of the north-western postern, perhaps with the insertion of apartments above the passage. The largest change in this period, however, was the construction of the Great Tower atop the motte.

The Great Tower was probably constructed after 1377, when Henry Percy was made 1st Earl of Northumberland, when the castle had been a Percy holding for around forty years. The surface of the motte very likely hosted an earlier structure of some sort, though its form and extent are not known. In archaeological terms, the subsequent construction of the Great Tower have likely removed much structural evidence, its massive foundations and enormous weight probably occasioning a severe broadening and lowering of the mound in the process. From a construction and planning perspective, the Tower is best appreciated by considering its plan; the array of its outline is that of a square with projecting polygonal lobes, the whole carried up to three stories below a now-lost parapet of ornamental stone figurines, below which survive faintly-discerned armorial panels held aloft by angels and weathered figures. The problem of light provision for such a deep building is solved by a light well or lantern at the core of the structure, which also acted to collect rainwater to provision of scullery or cleaning space of sorts in the north lobe ground floor. Slightly off-centre of the Tower is a plain square-plan turret which rises well above the parapet and roof line, housing one of several stairs to the roof, which must have been integral to the use of the Tower as an area of entertainment. The turret also very likely hosted (as it does today) a tall banner.

In terms of facilities discerned through surviving features, the Tower can be understood as a castle within a castle; it retains the complement of spaces which feature (or are suspected) in the bailey – a hall, several chambers, a chapel, a kitchen, numerous areas of storage – but ingeniously arranged and linked (or concealed) from each other within the tight confines of the symmetrical Tower plan. There are 64 doorways identified in the Tower, the sheer number of which gives an impression of the control and management of spaces within quite a confined area.[8] The three external entrances to the Tower are arrayed as to dictate how they were used; the ‘postern’ door (see Figure 9) opening onto the motte top outside the embrace of the curtain wall gives access for victuals to the storage and food preparation spaces of the Tower, in the north-west at ground and first-floor levels. The ‘internal’ portal situated in a diametrically opposed position, within the embrace of the curtain at the south-east corner of the Tower, appears to similarly have operated as an opening for victualing; it is located close to the position of the later brewhouse and bakehouse and has relatively clear access to both beer and wine cellars in the Tower, suggesting that it may be oriented specifically to the provision of those items (Figure 7 and Figure 4). The last external portal is that by which the Tower is accessed today, to the west of the aforementioned ‘internal’ postern, is the formal or ceremonial route into the building. It is marked by (restored) architectural ostentation and a (probably ornamental) portcullis controlled via a reception chamber above.[9]

[8] Data from a study undertaken in November 2020.

[9] The portcullis is deemed ornamental because no such feature is provided for either of the posterns, the external of which is arguably far more vulnerable than the ceremonial portal discussed here.

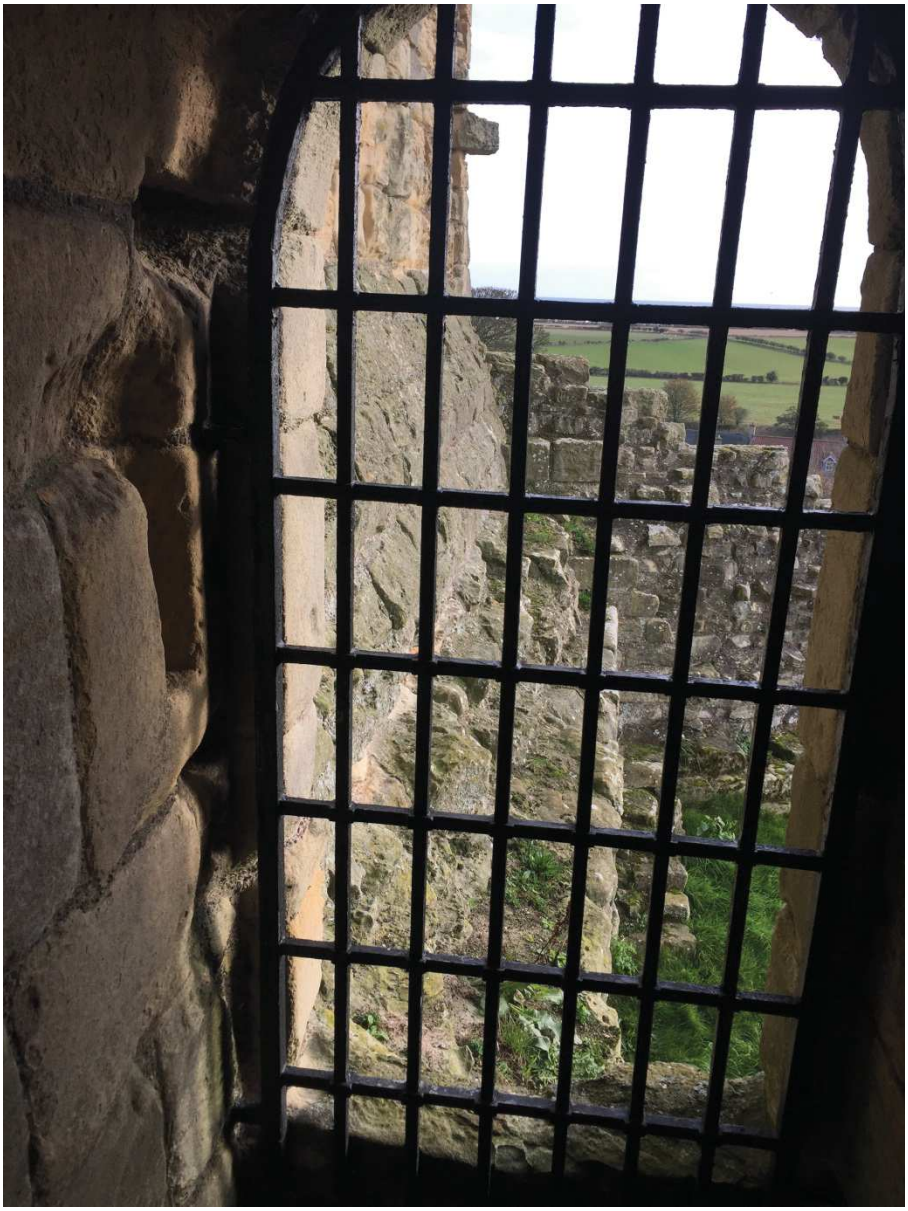

Figure 7. Photograph of the ‘internal’ postern of the Great Tower looking east. The scarring on the Great Tower plinth indicates the former presence of a platform or stairs here, perhaps carrying to the wall-wall of the east curtain in the distance or descending to the bailey. © William Wyeth

The other chambers on the ground floor of the tower include an accounting chamber, provided with a strong-room set in its floor as well as a small but comfortable office or apartment in the thickness of the west wall. Its proximity to the formal entrance to the castle is pertinent to its identification. Additionally, at the core of the tower’s ground floor there is a poorly-lit entrance hall giving access to six different doors; in the south-east corner of this is a broad staircase which rises to the first-floor reception area or lobby. The route features architectural ostentation (elaborate doors, windows) which characterises the formal or ceremonial route through the building. The first-floor lobby is well-lit on three sides and features stone benches. It gives access to a further small lobby and the screens passage at the west end of the Tower’s great hall. Doorways giving access to service rooms punctuate the west hall of this area, while doors on the north and east give access to the great chamber (via a further lobby), the chapel and, via a discrete door on the south-east corner, the wine cellar. These last three represent aspects of the great hall as a space for exclusive

consumption (wine) and privileged access to religious services (chapel). The lobby separating access to the chamber reflects the fact that it is located at the lower end of the hall, by necessity of space. The hall was originally heated by a central hearth, and air-flow facilitated by smoke-flues constructed into the heads of the windows set in the south-eastern and eastern walls. At some point this arrangement was deemed unsatisfactory (perhaps the design did not work well enough) and one of the two windows in the south wall was converted into a conventional fireplace, presumably suggesting the hearth was abandoned.

The chapel is perhaps the most elaborately ornamented space in the Tower as it stands today, its intricate windows, niches for statues and sedilia giving a sense of the space when first built and inhabited. The eastern end of the chapel was also brightly lit, being nestled within the eastern lobe of the Tower. North of the chapel, as previously mentioned, was the great chamber, as well as access to further suits of rooms with latrines and fireplaces set within the north-east portion of the tower at second and third floors. Turning to the western portion of the Tower's first floor, there are two kitchens differently provisioned with features for undertaking substantial feasts. Two enormous fireplaces sit in the northern kitchen, which had a high-set ceiling to allow for heat and steam. The western kitchen contained ovens, a servery and (at third floor) small accommodation chambers, probably connected to household officials concerned with the running of the kitchen.

What is now referred to as the Duke's Rooms are located at the third floor, situated in the southern lobe of the Tower, that which overlooks the bailey. The space is much restored, but its position and privileged routes of access to both the formal lobby below and the kitchens suggest it was designed to host a further household official, perhaps a senior figure like the steward.

Phase 5 (15th century): A Re-Ordered Bailey?

The broad range of this phase of changes to the castle reflects recognition that the features described were late in relative chronological terms, but that they may not have been undertaken within a single campaign (though the mutual integration of buildings makes this plausible). The most substantial change was the insertion of a collegiate church within the northern part of the bailey, sitting on an east-west alignment and in effect sealing off the area around the foot of the motte from the rest of the enclosure. Goodall suggests it may have been built in the 1480s, but remained uncompleted upon its patron's murder in 1489.[10] It is not clear if this building replaced an existing structure across the northern part of the bailey. The church is cruciform in plan with very small transepts and arcades, resulting from the confined space into which it was inserted. The east end is at scale, with space for a high altar and choir and two large crypts below. Below the church and east of the larger of the crypts is a finely-wrought passage with numerous mason's marks, providing one of two routes to access the Great Tower, and the only formal means by which to do so, the other being via a narrow, possibly covered passage between the west end of the church and the east wall of the kitchen. This last was probably created or retained for victualing purposes, given its proximity to the services at the north end of the hall, and the north-western postern giving access to the Coquet and borough beyond.

The other major buildings of this phase include the Lion's Tower and the Little Stair Tower. Both were built during the remodelling of the bailey great hall, and represent an

[10] Goodall, 2006, p. 15, the patron being the 4th Earl.

augmentation of accommodation (both featuring chambers at higher levels) as well as the means to portray motifs of heraldic ancestry, in the form of the Lion Tower. The sculptural elements comprise representative devices of the families associated with the Percys; pride of place is reserved for the Percy Lion, while the ancient Percy arms and those of the de Lucy family also feature. Small badges include those of the house of York, a further Percy device, and that of the Herbert family with whom the Percys were connected in the 1470s. The remodelling of the hall was intended in part to bring more light into the building, with the walls of the aisle being raised and large windows inserted. The Little Stair Tower, whose distinctive pinnacle remains, provided more elaborate and direct access into the chamber block in the south-western corner of the enclosure. Also remodelled during this period was the chapel here, though there are few material remains here.

The remodelling of the hall may have been joined by the rebuilding of the kitchen, which also included the complete rebuilding of part of the western curtain wall here – a substantial feat. This kitchen in the bailey is roughly the same size as the larger of the two in the Great Tower, and featured two large fireplaces and a large slops drain built into the rebuilt curtain wall emptying westwards. The size of the corner walls of this new kitchen as well as the massiveness of the adjacent curtain suggest it also rose quite high, to allow for high temperatures and smoke evacuation.

Two further structures are dated to this period, and very likely represent replacements of like buildings on the same or proximate locations; the brewhouse/bakehouse building in the shadow of the Great Tower, and the stable building arrayed along the inside face of the eastern curtain wall, between the Grey Mare's Tail Tower to the north, and the newly-constructed Montagu Tower to the south. The stable is long and narrow and features a broad entrance. It may have retained grain or fodder storage at a higher level, and is positioned away from many of the accommodation and service buildings in the bailey, but within accessible reach of the formal entrance to the castle at the southern gatehouse.

The final major structure dated to the 15th century, but somewhat less elaborate than its coeval buildings, is the Montagu Tower. As already noted, it likely replaces at least one, if not more, phases of corner tower located at the angle of the castle's primary-phase curtain wall. Goodall suggests it was built by John Neville, Lord Montagu, who was Earl of Northumberland from 1464-9. It contained lodgings in its upper two levels and in the 16th century its ground-level space was a stable.

Phase 6 (16th century): Rebuild and Repair

This phase of construction at the site, perhaps its last which may be termed 'medieval', took the form one substantial rebuilding of the eastern half of the south curtain wall, and amendments to the chapel and north-western curtain wall. The significance of the south curtain rebuilding is great, but it is not well-understood. It spears that the curtain wall was carried out further southwards, but not on a straight line, appearing to bow southwards before returning to meet the line of the original curtain as it was butted against by the Montagu Tower. It must be stressed that the fragmentary remains of demolished or robbed walls for this period are difficult to interpret and may give a misleading impression of the extent of the 16th-century rebuilding of the curtain here. The 19th-century rebuilding of the curtain wall here has also obscured much.

Objectives

The survival of substantial portions of medieval buildings within the enclosure of the curtain wall in the bailey of Warkworth Castle made it very likely that there were further archaeologically significant subsurface features which assist in the telling of the story of the site's development. Our aim was thus to establish the extent of those features. The survey examined three discrete areas (see appended report for plan):

Area 1: the area of the bailey enclosed by the present 12th-century curtain wall.

- Our objective was to establish the survival and extent of subsurface features connected to suspected buildings which occupied this area of the castle earthworks.

Area 2: the strip of unenclosed land to the east of the bailey wall, but still on the earthwork bailey platform.

- Our objective was to establish the extent and survival of subsurface features in this area, in order to help establish why this area was not enclosed within the curtain wall circuit.

Area 3: the level area atop the motte mound itself. The architectural evidence for an earlier structure is contested and ambiguous, but renewed geophysical examination may tip the scales of the argument one way or the other.

- Our objective was to establish the presence of materials predating the late 14th-century Great Tower and any features which may develop our understanding of the Great Tower itself.

Methods

It was considered probable that cut features such as ditches and pits might be present on the site, and that other types of feature such as trackways, wall foundations and fired structures (for example ovens and hearths) might also be present. Given the anticipated nature and depth of targets, and the non-igneous geological environment of the study area, three complementary geophysical survey techniques were selectively considered appropriate: magnetometer, earth electrical resistance and ground-penetrating radar (GPR). All three techniques were applied to Areas 1 and 3. However, electrical resistance was the only technique used in Area 2 due to practical and safety issues associated with working on such steep ground. The surface area of the three areas totalled approximately 0.3ha.

Results and Discussion

Numbers in bold refer to features on Figure 8, overleaf.

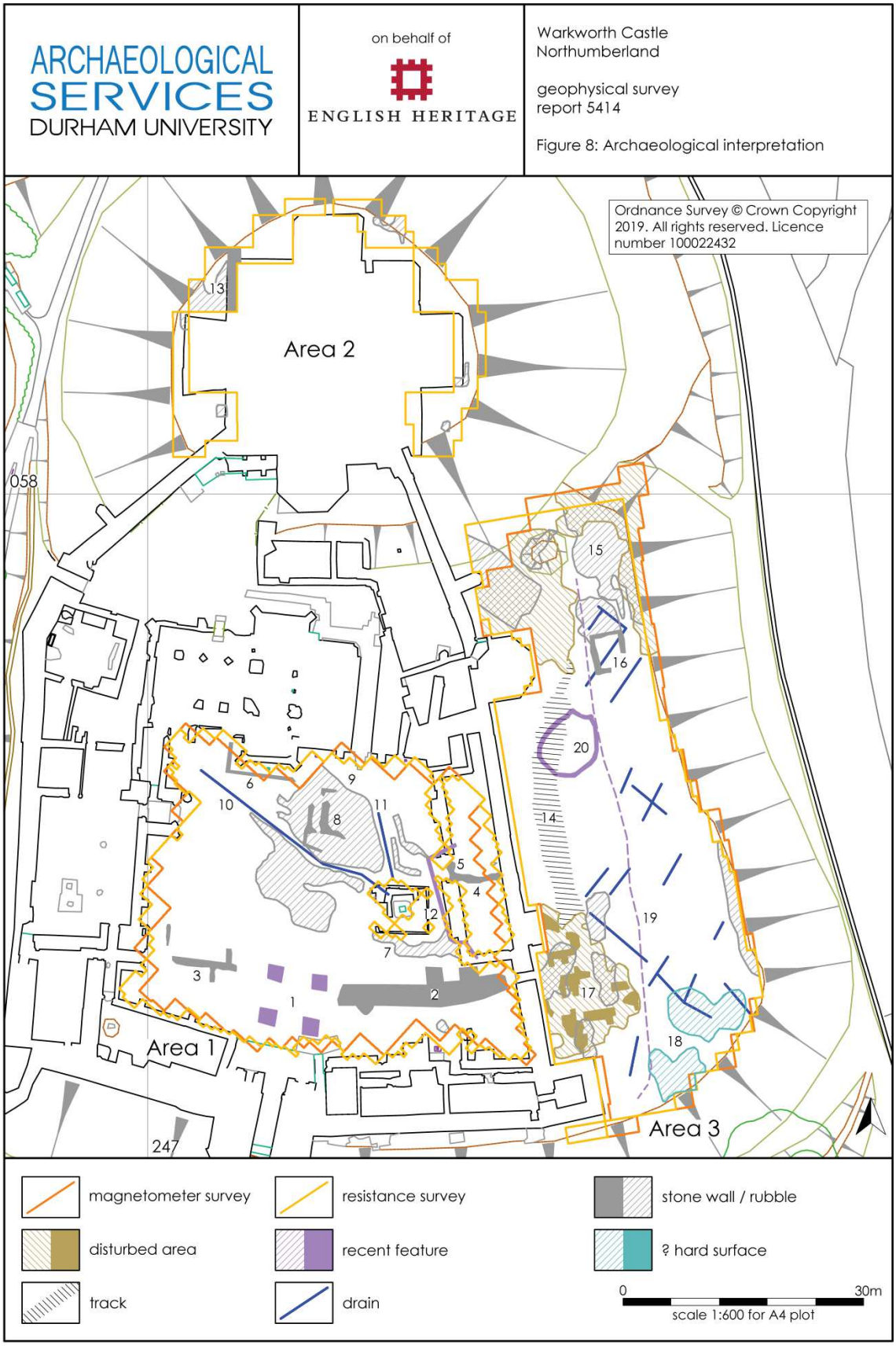

Figure 8. Survey plan of Warkworth Castle detailing archaeological interpretation of geophysical surveys across Areas 1-3. Ordinance Survey © Crown Copyright

Area 1

The area of the enclosed bailey yielded certain features which may represent wall footings. Two features (**2, 3**) were located in the south of the bailey, roughly parallel to respectively the eastern and western portions of the south curtain wall flanking the gatehouse. Feature **2** is the most substantial, measuring approximately 22m in length and extending to the east curtain wall at the location of the small portal leading onto the unenclosed eastern portion of the bailey earthworks. It also features two short, roughly parallel projections of suspected wall footings carrying north of the east-west trajectory of the feature. The western may represent a buttress, the eastern a fragment of walling carrying north towards the present stables block. Feature **3** is similarly parallel to the curtain wall, though at the south-west part of the bailey. It is far narrower than **2**, perhaps representing an extension of it. Though the western trajectory of feature **3** stops c.5m short of meeting any standing buildings, it too appears to carry towards an extant portal, here the Little Stair Tower.

If representing the remains of medieval wall footings, features **2** and **3** both appear to predate the entrances they appear to carry into. This is contingent upon accepting that their respective eastward and westward trajectories do indeed carry to meet standing structures in the bailey, and in accepting that they are medieval in origin. Following these points, in terms of chronology the eastern portal within the curtain wall which would appear be post-date feature **2** is presently dated to the late 14th century, cut into a curtain wall which is presently dated to between the mid-13th-early 14th centuries[11]. The Little Stair Tower is dated to the 15th century.[12] Thus, in rough terms, features **2** and **3** may tentatively pre-date these respective features, though the evidence is by no means decisive.

Towards the northern end of the bailey and adjacent to the 15th-century footings of the collegiate church, feature **6** may represent a kerb or wall associated with the church itself. This L-shaped feature nestles parallel to the south-western corner of the southern transept of the church, and so is reasonably inferred to be coeval and associated with it. Feature **8** is a probably wall footing in an area of rubble in the northern portion of the bailey, located roughly equidistant between the collegiate church south transept and the well house. Further possible footings or kerbs are concentrated around it (feature **9**). No chronological framework can be suggested for these two features. The survey of Warkworth Castle by George Clarkson in 1567 lists features in this part of the castle which add some detail to the results from Area 1. There is ambiguous evidence for a building which may approximate feature **3**: "[…] and in the courtayne between the gatehouse and the west towre in the corner beynge round of diverse squares, called Cradyfargus, is a fare and comely buyldinge, a chapel, and diverse houses of office one the ground; and above the great chambre, and the lords lodging […].[13] Regarding a possible building in the location of feature **2**, it is of interest that the same survey records "From the gate-house towre to the towre in th' est corner, called [blank] ys no buyldinge, but onely a curtayne wall, fare and of new buyldinge; and in that towre is a stable one the ground, and thre lodgings above […]."[14] It is clear that the exposed masonry foundations, as well as those proposed by feature **2**, antedate the middle of the 16th century. The foundations of some buildings here were recovered during the clearance excavation of the castle in the 1920s, and have tentatively been associated with

[11] Goodall, 2006.
[12] Goodall, 2006.
[13] Grose, 1782, p. 154
[14] Grose, 1782, p. 155. The unnamed building is the Montagu Tower.

the early phases of the castle's occupation (phases 2-3). A photograph of those works suggests part of feature **2** may have been exposed at that time and an aerial view of around a decade later suggests it remained in some form.[15] It is unclear if these visible features were subsequently covered over or removed.

Area 2

A possible stone-lined drain was identified (feature **13**) during the motte-top portion of the survey. This feature may be associated with the postern in the Great Tower granting access from the motte-top into a chamber associated with food storage, or the openings of drains from the tower emptying here (Figure 9). The postern is presently blocked up, an undated changed, but perhaps undertaken in the 19th century, when a portal linking the chapel and great chamber within the Great Tower was also blocked. The drain may thus relate to the medieval use of the postern, clearly devoted to servicing the tower rather than any defensive consideration; or, the drain may be a post-medieval insertion.

Figure 9. Photograph of the postern within the Great Tower, giving access to the motte-top area outside the embrace of the curtain walls, in the north-west of the ground floor. Note the door threshold is seamless with the floor level of the passage inside, for ease of use. © William Wyeth

Area 3

An elongated area (**14**) of what is suspected to represent packed earth, perhaps an unmetalled track approximately 3m wide, was identified to the east of the east curtain wall in this unenclosed part of the bailey earthworks. Feature **14** extends roughly parallel to the central portion of the east curtain wall. Its southern end appears to be associated with the

[15] Historic England photo library, reference K030787 (from private collection); Historic England card box, 'Warkworth, Northumberland', card reference number 4646_096.

eastern wall portal mentioned above, and its northward trajectory from there looks to respect the projection of the Grey Mare's Tail tower (see Figure 8, Figure 10).

Figure 10. Photograph of Grey Mare's Tail Tower, Warkworth Castle, looking north-west. © Historic England Archive.

In terms of chronology, all that may be surmised from the present dating of associated structures is that the suspected metalled track post-dates the construction of the Gray Mare's Tail tower (c.1249-1310). The long life of the portal in the east curtain wall (beginning in the late 14th century) means that, at most, the track dates from the later 13th-14th century up to the near present. Because of a lack of reasonable chronology for this feature, it is difficult to suggest why this eastern portion of the bailey earthworks was excluded from the circuit of the late 12th-century curtain walls. However, what feature **14** can perhaps tell us is that this eastern portion of the bailey was in frequent use at some point in the castle's late medieval-early modern history for a packed earth path to leave a clear archaeological signature. It may be speculated that this path suggests that the eastern part of the bailey was in continuous use while the castle was inhabited, as it is difficult to imagine frequent external traffic from outside the bailey and castle onto this eastern portion (after all, the bailey is surrounded by a ditch). The presence of a postern leading to this space may be taken to suggest that there was a medieval use for this area. Perhaps it was a garden or an area for grazing horses? Several portions of area 3 featured anomalies (**15**, **16**) which may represent rubble concentrations, presently not ascribable to a chronological phase. Any of the features in Area 3 might relate to the existing horse-mill at Warkworth which is inferred

from the necessity, outlined in the 1538 entry for a survey of Warkworth, for "A *new* horse mill."[16]

The 2021 Survey: St John's Close and Adjacent Field

A full account of aims, method statements and results can be found in the full report (appended). What is presented below is a brief account, drawing attention to summarised elements of the survey only.

In order to support the objective of the 'Warkworth Castle – Stories in Stone' project, to tell nuanced and engaging stories about the castle to the public, it was deemed essential to develop our understanding and appreciation of the landscape context of castle in its (late) medieval heyday.

Medieval Landscape of Warkworth Castle

Much of the present area around Warkworth Castle retains features or associations which speak to the broadly medieval history of the area around the site. The Hermitage, fortified bridge (a toll collection point rather than a security measure), and plan of Warkworth village itself, are prominent examples. A market at Warkworth was first attested in 1223.[17] The Parish church dates architecturally to the early 12th century, though fragments of dressed stone (crosses and grave markers) found in association with it are variously dated to between the 10th-11th.[18] Henry I gave the parish church to his chaplain Richard de Aurea Valle, upon whose death it passed in 1132 to the newly-established Bishopric of Carlisle.[19]

Several medieval associations can be made with field-names; a park at Warkworth (discussed below) is joined by a larger park in neighbouring Acklington attested in since the 13th century, and a further, perhaps upland, park at Rothbury.[20] Hangman's Acre (*Hangmanacre* 1485-6) may pertain to rights of ingangthief confirmed in charter to Roger fitz Richard by Henry II in the 12th century.[21] The Chapel of St Mary Magdalene, documented from the 13th century, no longer survives as a standing building, but the modern suburb of Maudlin preserves its name, and excavations of the area of the chapel have yielded further building remains.[22] In the late medieval period, Maudlin comprised part of the demesne lands of the Percys here, alongside Old and New Barns farms.[23] Salt-works associated with Warkworth and Amble were given as gifts to monastic foundations by the rulers of the castle from the last quarter of the 12th century, and both attested names (*Saltgrese* 1471, *Pan Rocks* 1896) speak to this industry.[24] Typically, references to salt processing go hand in hand with numerous references to fishing rights and fisheries around the Coquet, including a mid-13th-century reference to income from a "little boat called a coble", *p[ar]va navic[ul]a qui vocatur Cobel*.[25]

[16] Anon., 1892, entry 335, italics by authors.
[17] Letters, 2005, 'Northumberland'.
[18] Church of St Lawrence listing entry, 1969; Cramp & Craig, 1984.
[19] Carlton & Ryder, 2014, p. 144.
[20] Hodgson, 1921, p. 112, citing Hodgson, 1899, pp. 55, 337.
[21] Hodgson, 1899.
[22] St Mary Magdalene's list entry, 1987.
[23] Hodgson, 1899, p. 113.
[24] Beckensall, 2016; Fowler, 1878, p. 211.
[25] Hudson Turner, 1844, pp. 97-8.

Figure 11. Plan of Warkworth by Thomas Wilkin (1772). 'Pond Close' is visible to the east of the castle location. © Collection of the Duke of Northumberland, Sy: B.III.2.a.

A fish house "below the castle", fishing ponds and salt for salting salmon, are all attested in a return of 1485-6.[26] Two references, perhaps related, speak to either fish ponds or animal enclosures. The two "*vinef*" [*viveria*] of 1170x7, and "*Lez Vyverz*" of 1471 and 1485, may reference the Middle English *vivere*, 'ponds', or Latin *vivarium*, 'ponds' or 'animal pends'.[27] The precise location of this feature is not certain, though if connected with fishing (rather than an animal enclosure) and situated close to the castle, a good candidate is the field 'Pond Close', to the east of the castle as depicted in Thomas Wilkin's plan of 1772 (see Figure 11).[28]

The Park: Extent and Content

Since Hodgson's comprehensive and detailed review of the documentary history of Warkworth (including the castle but also the park), there appear to have been no studies of the park of Warkworth Castle specifically, nor indeed medieval parks in Northumberland as an area of research in archaeology. Warkworth did not appear (at least in name) in Cantor and Hatherly's preliminary list of 1979, though it does in the 1983 gazetteer.[29] In this respect,

[26] Hodgson, 1899, p. 114.
[27] Hudson Turner, 1844; Beckensall, 2016. The charter must be dated to between the marriage of Roger fitz Richard to Adelize de Vere after the death of her first husband in 1170, and Roger's own death in 1177.
[28] Also identified thus in TNA IR 29/25/461, 'Tithe apportionment of Warkworth', 1839, plot 15.
[29] Cantor & Hatherly, 1979; Cantor, 1983, pp. 56-7.

studies by Moorhouse in the Yorkshire Dales and Winchester in Cumbria appear to offer the most material for comparison with the features at Warkworth, though each park and each region must be considered on its own terms.[30] These studies, as others, suggest that it was common for parks to contain a multitude of different buildings, facilities and industrial activities, and that their respective importance to the park economy changed over time. These points are distinct from the subtler, less documented and under-researched cultural and social meaning of these enclosed spaces.[31]

There are several references to individuals of the Percy household connected to activities in the park; Richard Makson is named parker in 1486-7, and an unnamed 'Palycer' is noted in 1570.[32] Two years later, expenses were detailed for mending the boundary; 35 posts, 32 rails, as well as nine waggons to carry the materials "[…] from various places of Sunderland park […] for repair of the palings of the said park, 5s. 3½d."[33] In 1537 the park contained young and old oak and ash trees valued at over £119.[34] By 1616, Sir Ralph Gray, the tenant of much of the lands adjacent to the park, was reported to be destroying the park pale, to the detriment of the deer population.[35]

At least some of these names and features may be associated with the park adjacent to the castle, which is depicted in some detail in an estate map of 1620x3 (Figure 13).[36] As already noted, the park is first mentioned in the middle of the 13th century as 'Sunderland'. The precise extent of this earlier park is not known, though it may be inferred by the earliest reference to it, which specifies that it was half a league in circuit.[37] With this in hand, it remains to be established the precise location of 'Sunderland' in relation to the park which was expanded around 1480, appearing to encompass the area which is recognised today.[38] The name appears in the document-rich 15th century, appearing in the Percy bailiff rolls for 1471-2: "agistment of cattle feeding in the demesne lands called Sunderland and Stanecrofte, 69s".[39] It is known from the 1620x3 estate map that a field called 'Stony Crofts' (see Figure 13-Figure 15) lay at the heart of the late medieval park, but it is not clear what relation this has to the name 'Sunderland'. Thus, the name 'Sunderland' may have been used for an amalgamation of the other known field-names in the park, or perhaps is used as a name for the wider park itself – although this would conflict with the 1471-2 reference (essentially duplicating names), the accounting records are not necessarily faultless. Returning to the extent of the park, it is suggested by Hodgson that parcels of land were acquired north of the Coquet in the later 15th century. Curiously, this area appears to includes the late 14th century Hermitage (thus, pre-dating the park's expansion), which may therefore have been built on a parcel of demesne land.[40]

[30] Moorhouse, 2007a; Winchester, 2007.
[31] Mileson, 2007.
[32] Hodgson, 1899, pp. 114, 116.
[33] Hodgson, 1899, p. 114, for year 1488-9.
[34] Hodgson, 1899, p. 115.
[35] Hodgson, 1899, p. 117.
[36] Beckensall, 2016, p. 104 has Robert Norton's map dated to 1620, Hodgson, 1899, p. 112, dates it to 1623.
[37] Hodgson, 1899, p. 112.
[38] Hodgson, 1899, p. 113.
[39] Hodgson, 1899, p. 113; Hodgson, 1921, p. 50.
[40] Goodall, 2006, p. 28; see Hodgson, 1899, p. 113, notes 1-2, for evidence for expansion.

Figure 12. Photograph of 'Orchard Meadow' looking west across the Coquet from within the Great Tower. © William Wyeth

Lastly, it is worth commenting upon the small size of the 13th-century park, if half a league is rendered as 1.2km (0.8 miles) in circuit. There is no obvious arrangement of fields from the 1620x3 survey which encompasses this circuit. The combination of the fields named 'Orchard meadow' and 'l[. . .] bank' to the south of it give a total circuit of 1.4km (0.87 miles) (see Figure 13-Figure 15); this may represent the original 'Sunderland park' of the 13th century, but other combinations are possible.[41] Whatever the case, such small parks adjacent to residences are a recognised phenomenon in 13th-century England.[42] The intervisibility of 'Orchard Meadow' from within the late 14th-century Great Tower is noteworthy; Winchester has speculated that its builder, Henry Percy, 1st Earl of Northumberland, may also have been responsible for the enclosure called 'Deer Orchard' at Cockermouth Castle in Cumbria, perhaps "[…] a deliberate attempt to keep deer within sight of the castle […]."[43]

[41] The name of the field south of Orchard meadow is not discernible from the 1620x3 estate map. The 1839 tithe map calls in 'Plantation Park Leazes, which is probably a more recent name: TNA IR 29/25/461, 'Tithe apportionment of Warkworth', 1839, plot 38.
[42] Mileson, 2009, p. 89. Mileson's work does not make a reference to Warkworth, though the trends observed at Warkworth fit within a recognised history of parks in England in many respects.
[43] Winchester, 2007, p. 175.

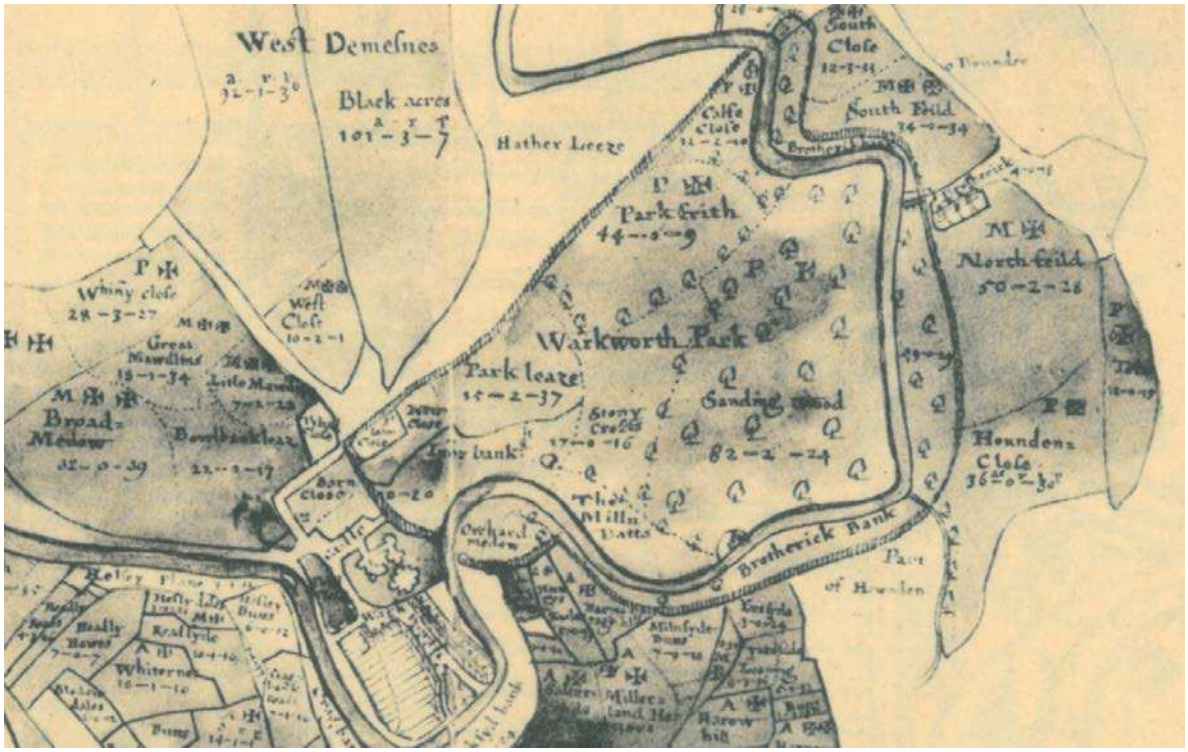

Figure 13. Detail of drawing of 1620x3 of 'The lower part of the manor of Warkworth...', from Hodgson 1899, p.151. Top is south-west. The original manuscript: Collection of the Duke of Northumberland, AC: O.XVI.1.b.

Wider evidence also gives a sense of the dynamic exploitation of the park resources in its medieval period. The place-name of Hound Dean (*Hewneden* 1480, *Hounden-mouth* 1567, *Houndens Close* 1620) may perhaps reference associations with hunting dogs within the park.[44] In 1487-8 expenses were claimed for the creation of a new pinfold within Sunderland park, as well as for hay to feed deer, and a further pinfold to keep them.[45] Several expenses recorded also attest to certain parts of the managed parks of Warkworth and nearby Acklington being used to graze the horses of the Warkworth Castle household.[46] References in the 15th century to cattle grazing are also common. The 1620x3 estate map records a field named 'Barn Close' (perhaps *Berne-yard* 1471-2), probably the 'Garden Close or Castle Field' of the 1839 tithe map.[47] The finger of land carrying from 'Stony crofts' to the southern boundary of the park could represent a relict strip field, a route (implying a gate) to access the interior of the park for pannage or agistment, or perhaps a relict game management boundary (Figure 13-Figure 15). 'Sanding Wood' may reference the cultivation of hazel, while the 'frith' element of 'Park frith' is interpreted in a Cumbrian context as indicating a wooded enclosure set aside for hunting.[48] The 'Old Quarry' just north of Warkworth Mill as depicted on the 1st edition OS (25-inch) map (centring on NU 23765 06176) is named 'Crag Head Close' in 1840; in Yorkshire, such names are understood as relating to medieval

[44] Moorhouse, 2007a, p. 117, on cognate dog-related place-names and hunting parks in North Yorkshire; *cf* (Beckensall, 2016, p. 106), which suggests *Houndenz Close* 1620 as referring to the ground 'lying in a hollow', so *not* referring to hounds.
[45] Hodgson, 1899, p. 114.
[46] Hodgson, 1899, pp. 50, 55.
[47] Hodgson, 1899, p. 113; TNA IR 29/25/461, 'Tithe apportionment of Warkworth', 1839, plot 13.
[48] Beckensall, 2016, p. 105; Winchester, 2007, p. 175.

quarrying.[49] Field-names of the mid-18th century include 'Pale-end close' and 'Gilden-close', this last perhaps cognate with the Yorkshire placenames derived from Old Norse *gildri*, 'snare'.[50]

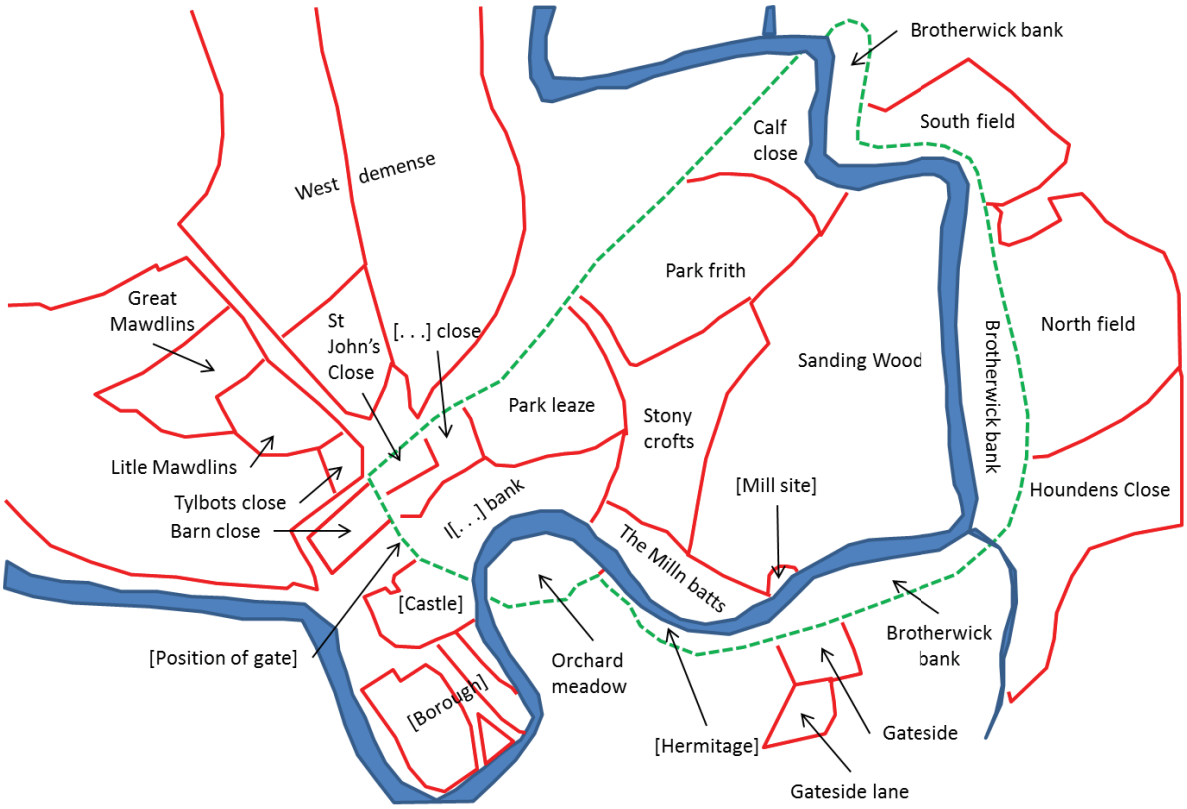

Figure 14. Sketch of selected property and field boundaries and associated names from the 1620x3 estate map. The green dotted line is the park boundary, top is south-west. By William Wyeth

[49] Ordnance Survey, 25 inch to the mile, England and Wales, 1841-1952 Northumberland (Old Series) (Birling; Brotherwick; Low Buston) XXXIX.15 (published 1897); TNA IR 29/25/89, 'Tithe apportionment of Low Buston', 1840, plot 6; Moorhouse, 2007b, p. 2.
[50] Hodgson, 1899, p. 119, n.1; for possible etymology see Moorhouse, 2007a, p. 121, though speculatively identified thus in this case.

Figure 15. Sketch of selected approximate field boundaries and field names projected onto modern satellite imagery. Satellite imagery © Google Earth, annotation William Wyeth.

The Park Gates and St John's Close

Through the evidence available it is apparent that a great many activities were associated with the park at Warkworth, not (as has traditionally been assumed) simply hunting. As an intensively-exploited demesne territory, the park had distinct boundaries (if shifting, in the longer term), which means that understanding access points into the park is important, especially in order to understand how the park may have been understood and engaged with by the household and community at Warkworth Castle. There are three recognised park gates, though more probably have existed. A reference in 1488-9 to a "*watergate*" places this feature "to the west of the said park [Sunderland]."[51] It may be depicted on the 1620x3 estate map, at the junction of the North field, South field and park boundary (see Figure 13-

[51] Hodgson, 1899, p. 114.

Figure 15). The shape of fields leading to this gate, somewhat funnel-like in profile, may hint that this was a point in the park pale in which deer were encouraged to enter the park bounds, along the small but deep stream ravines which enter the Coquet along the north bank either within or close to the park boundary. A second possible park gate is attested in the 1620x3 estate map on the north side of the Coquet close to the position of the Hermitage. Two field names noted by Beckensall, *Yateside Lonnin* and *Lain Close*, may demonstrate an entry here, though none is depicted in the vicinity.[52] This gate may be that mentioned in a 1567 description of the park: "the mill-yate". The context of this reference, being preceded by the area called "Houwnden-mouth" and followed by "th' east corner of the payle at th' end of th' Orcharde medowe […]" places this gate on the north bank of the Coquet.[53] The reference to the mill, whose site is quite close to these known named features, suggests it may be the *yate* implied by the 1620x3 field-name. The final gate is both depicted as a tall round-headed portal on the 1620x3 estate map (see Figure 13-Figure 15) and is likely referenced in the 1567 description of the extent of the park at Warkworth, which is noted by Hodgson: "viz from Cradyfargus towre overe to the park yate ys [blank] from thence to th' east noyke or corner of the close called Sanct John's close […]."[54]

In terms of access, this last portal provides the simplest means to access the park enclosure as depicted in 1620x3 from the castle proper. Is it also situated closest to the best-known topographic evidence for the park which survives in the present: the traces of ditch and bank topped by cherry trees at the south-easternmost corner of the park boundary. These earthworks represent only part of what can be reasonably considered a typical park boundary; such features usually have a high outer bank (topped by a pale) to prevent animals in the park interior from escaping. The worn remains of this outer bank may just be perceived in the photos below (Figure 16-Figure 18), partly within the modern field and partly underlying the modern footpath in the foreground. The 1567 description notes that the boundary of the majority of the park is decayed, "[…] save onelu from the west noyke of the sayd close of Sanct John's to the Water of Cockett at Watersh[eugh] cont [blank] ys well and trymelye hedged with good and well grown quyckwood as ditched and skowred, so in all that parte of the payle the dear shew no passage forth of the said park, all the other partes thereof ys so decayed […]."[55]

[52] Beckensall, 2016, p. 105.
[53] Quote: Hodgson, 1899, p. 115.
[54] Hodgson, 1899, p. 115.
[55] Hodgson, 1899, pp. 115-6.

Figure 16. Photograph of south-easternmost corner of park (within historic St John's Close), from the modern footpath linking Morwick road (the southern boundary of the 1620x3 park) and Warkworth Castle car park, looking south-west. The raised ground on the right in the middle distance marks the angle of the bank, the slightly raised ground on the left (by the back fence line) may represent the outer pale bank. © William Wyeth.

Figure 17. Photograph of south-easternmost corner of park (within historic St John's Close), from the modern footpath linking Morwick road and Warkworth Castle, looking east. The weather-beaten cherry tree on the left in the middle distance marks part of the suspected park pale earthworks. The outer bank may be marked by the raised ground in the foreground. © William Wyeth.

Figure 18. Photograph of south-easternmost corner of park (within historic St John's Close), from the modern footpath linking Morwick road and Warkworth Castle, looking north-west. The ditch running northwards is visible in the middle distance, with an inner bank surviving too. The modern pathway sits in a raised causeway leading towards the castle which may partly overlie the outer park pale bank. © William Wyeth

When considering access to both the castle and park in the medieval period, a description proposed changes to access of the castle by George Clarkson (bailiff to the then-Earl Thomas) in 1567 is invaluable. It records that "The castell of Warkworth ys situate one the river of Cocket […] and one the sowth part ys the waye and passadge to and from the sayd castell by two severall ways […]." These suggested routes of access would develop existing routes, and comprise:

> "[…] the waye that goyth towardes the sowth by the loyninge were most expedyent thendes of the said loyninge strongly ditched casten or made wth stone wall and the hye streate to be made to goo thorow the demaynes and the same casten in a loyning there w^{t}h a stronge quickwood hedge casten of eyther syde the stones of thold cawseye taken awaye and a cawseye newly made wthin that ground of the saide demaynes viz. from the northende of a medowe close called Tybbettes close eastward to one hye waye that goyth to the gate of the demaynes, and alonge the same waye to the sayd gate of the demaynes, and alonge the same waye to the sayd gate w^{ch} might be done wth small chardges, and that done, the parke wold not onely be on that syde well inclosed the dear have feadinge nighe the gate of the sayd castell but also yt shold be a great strength to the sayd parke, castell and groundes joyninge upon the same- a better passadge than that that nowe ys in all respectes, and hurt to no person, so that the same were well and orderlye done or made […]."[56]

[56] Hodgson, 1899, p. 91.

> '[…] the way that goes towards the south by the lane is most expedient. The sides of the said loan would be strongly ditched, thrown up, or made with a stone wall. And the high street would be made to go through the demesne, created by throwing up a lane there, with a strong quickwood hedge placed on either side. The stones of the old causeway would be taken away, and the causeway made anew within the grounds of the said demesne, namely from the north end of the meadow called Tylbots Close eastwards to a highway that goes to the gate of the demesnes, and along the same way to the said gate, all of which might be done with small expense. These changes being done, the park would not only be enclosed on one side, the deer having access to feeding near the gate of the said castle, but also it should be a great strength to the said park, castle and grounds adjoining upon the same – a better passage than that that now is in all respects, and causing hurt to no-one, so that the same were well and orderly done or made.'[57]

It is apparent that the two routes to the castle in question relate respectively to the modern footpath which features in Figure 16-Figure 18, and the route of Morwick Road, which respects the southern boundary of the park towards is eastern end, and turns northwards at the south-east corner of 'Barn Close' on the 1620x3 estate map (see Figure 13-Figure 15).

The field of St John's Close is attested in the estate map of 1620x3 and the tithe map of 1839, situated in the south-east corner of the park as it is depicted. Anecdotal evidence from local sources postulates the presence of a Hospitaller property in the area of the field, but there is no evidence for any building of any description belonging to the Order.[58] The Hospitallers had a local preceptory at Chibburn (9km to the S)[59] whose proximity argues against any administrative presence here, though it does not negate the possibility of properties leased by the Hospitallers being located in or around the Close. Hodgson's *History of Northumberland* relates that at the suppression of monasteries the field was held by the Hospitallers and yielded 3*s*.[60] The returns referred to, for 1549-50, do not directly identify the close ("3s […] for the rent of a close there [i.e. Warkworth]"),[61] but Hodgson's inference to that effect is reasonable. They also suggest the Order held two cottages in the parish which were leased out. Beckensall associates the field with the Order's centre at Mount St John at Felixkirk in North Yorkshire.[62] Founded in the reign of Henry I (1100-35) by William de Percy, it was recorded as a ruin in 1338,[63] though the preceptory continued to yield revenue from lands in Yorkshire, Westmorland and Northumberland, as testified in the 1535 *Valor Ecclesiasticus*.[64] It is not certain when the field was granted to the Hospitallers. If the grant was by a member of the Percy family – the Percys, after all, retained their ancestral

[57] Extract is rendered for legibility rather than closeness to original text. 'Loyning' is rendered as 'lane', cognate with northern Middle English and early modern English 'lone' or 'loan': A Dictionary of the Older Scottish Tongue (up to 1700), accessed 17/6/21, which offers "An enclosed track for animals through cultivated or park land; a grassy strip serving as a milking place: a common road or green of this sort." "Tybbettes close" is rendered Tylbots Close from Beckensall, 2016, p. 106.
[58] This view may conflate the Hospitaller connection with St John's Close and the well-attested presence of a Hospital to St John Baptist in Warkworth parish: Keys to the Past list entry: Hospital of St John (Warkworth), 2021, reference N5401.
[59] Nicolson, 2014, p. 7.
[60] Hodgson, 1899, p. 115, n.7.
[61] Crossley, 1937, p. 120.
[62] Beckensall, 2016, p. 105); Larking & Kemble, 1857, p. 228, n. *sub* entry for p.47.
[63] Page, 1974.
[64] Page, 1974.

residence at Topcliffe 11km (c.7 miles) south-west of Felixkirk – it may have been made upon occasion of the grant by Edward III to Henry Percy of the castle in 1328. It must be made clear, however, that this is wholly speculation.

Presently, the field of St John's Close contains open grassland, intermittently used for pasture and temporary parking during the Warkworth Fair (Figure 19). The northern two-thirds of the adjacent field which was also subject to survey contains a broad east-west aligned ridge and furrow (Figure 20). Areas of suspected earthworks, comprised a bank and areas of depression, are also noted in the south and east of the field (see Figure 16-Figure 18).

Figure 19. Satellite image of area to the south of Warkworth Castle, with the area of survey marked in red. © Google Earth.

Figure 20. Photograph of St John's Close, ridge-and-furrow earthworks carrying into distance. The ridges feature as light raised banks, the furrows as darker parallel features. © William Wyeth

Objectives

The objectives for the survey sought to answer three sets of questions drawing on present understanding of the park and castle, and drawing on an increased emphasis within castle studies of a landscape context to high-status centres in the medieval period. These questions are listed below:

1. Establish the location and eastern extent of a park pale which is attested in a late 16th-century document and early 17th-century map, but for which surface evidence is ambiguous. The park of Warkworth is attested in the 13th century, though its extent was probably smaller than that attested later.
2. Establish the location of an entranceway into the park briefly referred to a late 16th-century document and possibly depicted in a 17th-century plan;
3. Establish evidence for a routeway – perhaps a metalled track, perhaps a hollow way – running parallel to the postulated park boundary, which may also represent an early route to the castle's gatehouse from the south-west.

The draft report of a comprehensive survey of the standing remains at Warkworth Castle undertaken by Simpson & Brown Architects has indicated that the primary stone phase of the south curtain wall has been altered on its eastern half. This would suggest that the curtain wall, originally bookended with angular towers with a centrally-placed gatehouse, was oriented towards St John's Close (SSW) rather than directly southwards. This in turn has fostered the theory, to be tested by subsurface survey, that the original route to access

the castle was from this quarter, rather than how it is accessed at present, from the east. The details provided by the 1567 survey somewhat affirms that there was a routeway here. Considering the suspected early dating of the park boundary, this postulated route may well have run parallel to the eastern park boundary, by St John's Close. Thus, the survey would endeavour to establish the presence of a routeway here.

Methods

The whole area was examined with magnetic survey, and targeted coverage over a 0.5ha selected area used electrical resistance and ground-penetrating radar.

	Magnetic	*Electrical resistance*	*Ground-Penetrating Radar*
Entire area (2.2ha)	X		
Selected area (0.5ha)	X	X	X

Results and Discussion

Numbers in bold refer to features on Figure 21.

Broad parallel bands of alternate positive and negative magnetic anomalies have been detected across the northern part of the survey area; these anomalies correspond to a similar pattern of alternate high and low resistance anomalies. The anomalies reflect the existing ridge and furrow earthworks (**1**); in this instance the positive magnetic/high resistance anomalies reflect the upstanding ridges (more topsoil/less moisture), while the negative magnetic/low resistance anomalies indicate the furrows (less topsoil/more moisture) (see also Figure 20). These features are also evident as weak reflections in the upper part of the GPR data. The ridge and furrow is aligned broadly-east-west, with furrows typically spaced at 6-7m intervals. There is no headland evident at the eastern end of the ridge and furrow, and the earthworks appear to have been truncated by the broad linear cut along the eastern side of the field. The date of the ridge and furrow is not known, but it may be noteworthy that its southern extent appears to respect the boundary with St John's Close to the south (no longer extant as a standing feature), which is depicted as a distinct enclosure in the 1839 tithe map. The slightly curved, broad pattern of the ridge-and-furrow is typical of earlier medieval typologies of the earthwork, when teams of oxen were used to draw the plough.[65]

Many additional positive magnetic anomalies were also detected, the majority of which probably reflect materials within former ditches. The largest of these probable ditch features was detected in the central-western part of the survey, at the southern edge of the rig and furrow. The ditch forms an oval enclosure (**2**), measuring up to 33m across; the ditch itself typically measures approximately 1.5m in width. This feature is equally prominent in the resistance data, as a high resistance anomaly. Whilst the magnetic anomaly is typical of a soil-filled feature, a high resistance anomaly would be expected to reflect either a well-drained sediment, stone/brick materials or a void, for example. However, this feature is probably cut into the boulder clay subsoil and is unlikely to be well-drained (as opposed to the upstanding cultivation ridges). It seems likely that the fills of the ditch therefore comprise both sediments and stone. Iron minerals within the local rock here could also contribute to the magnetic anomalies associated with both sediment and stone. Whilst some small and

[65] Historic England, 2018, p. 8.

weak, magnetic and resistance, anomalies can be discerned within the enclosure, they cannot be confidently interpreted as the remains of internal features.

Figure 21. Survey plan of St John's close near Warkworth Castle detailing archaeological interpretation of geophysical surveys. Ordinance Survey © Crown copyright

A circular feature (**3**) was detected approximately 20m east of the probable enclosure (**2**). This feature was also clearly detected as both a positive magnetic anomaly and a high resistance anomaly, and could represent a ring-ditch filled with both sediment and stone. The ditch measures approximately 14m in diameter.

A similar, though more angular, feature (**4**) was detected in the north of the survey, again recorded as both positive magnetic and high resistance anomalies. The magnetic anomalies appear to reflect parts of four sides of a square, however, the resistance anomaly, which is more complete, appears hexagonal. This feature also measures approximately 14m across and could comprise both sediment and stone within a ditch or trench. Partial correspondence with some high amplitude GPR reflections (eg at 21-24ns) could also indicate the presence of stone in part of the feature.

Although it is not possible to determine from the geophysical results, it appears that these features underlie the ridge and furrow: they are not visible on aerial photographs of 1947 of the area around the castle, which tends to suggest too that they are not related to activities around the Second World War.[66] Two of the authors (Mark Douglas and Duncan Hale) also walked over the ridge earthworks but could not discern any cuts or disturbance of the earthworks which might be associated with features **2**-**5**. In form and extent, they are similar to ring ditches, either burial monuments or unenclosed round-houses, from the prehistoric period. A recent discussion of these monuments in Northumberland has noted that in general, ring-ditches with diameters greater than c.20m are generally considered the remains of structures other than houses (i.e. ritual/burial monuments, or enclosing ditches of archaeologically absent houses).[67] This study noted that radiocarbon dates from a small number of excavations in Northumberland (and the wider Borders) demonstrated that unenclosed roundhouses were current over a period of more than a millennium, from c.1800BC to 400BC.[68] Thus, feature **2** may represent a prehistoric enclosure, and features **3**-**4** (and perhaps **5**, see below) adjacent house-plots or barrows.

Two further positive magnetic anomalies also have corresponding high resistance anomalies: one short arcuate feature (**5**), possibly part of another former ring-ditch, was detected to the north of (**2**) and (**3**); and a longer, sinuous, probable ditch feature (**6**) was detected immediately south of (**3**). Whilst the shapes and sizes of features **2-6** are well-defined, the precise nature of the features is uncertain, since the magnetic and resistance data could indicate both sediments and stone. Ditches could have had stony material backfilled into them, or perhaps some of these features were construction trenches with some stone footings remaining.

Two rectilinear positive magnetic anomalies were detected near the south-east corner of the survey. The anomalies almost certainly reflect soil-filled features (**7**), perhaps ditches or trenches associated with a former structure. The southern part of the feature may have been truncated by a service pipe. Feature **7** stands in contrast to features **2**-**6** in being (from current evidence) a square-sided feature. It is tempting to ascribe this different form to a different chronology, but the evidence is too slight to permit this conclusion.

[66] See 'Britain from Above' website, aerial photograph of Warkworth Castle and environs (1947), https://www.britainfromabove.org.uk/en/image/EAW006062.
[67] Passmore & Waddington, 2009, p. 140.
[68] Passmore & Waddington, 2009, p. 141.

Several small, discrete positive magnetic anomalies have been detected across the field, which could possibly reflect small pits or postholes. Various additional positive magnetic anomalies have been detected throughout the survey; these are typically very weak and/or of very limited extent, however, they provide slight indications of possible further soil-filled features such as gullies or small pits.

A straight and narrow high resistance anomaly and two corresponding negative magnetic anomalies were detected aligned east-west across the central part of the survey. High amplitude linear reflections (eg at 12-18ns) were also recorded to the immediate south, broadly corresponding to the magnetic and resistance anomalies. These anomalies could possibly reflect a wall-footing or similar, serving as a field boundary (**8**). This feature lies at the southern limit of the ridge and furrow and corresponds to the northern side of the enclosed area shown on the 1st edition OS maps, and broadly also the northern side of St John's Close as shown on the 1620x3 estate map (Figure 13). The southern side of this feature on the early OS map is preserved in the existing line of trees in the southern part of the modern field, along the top edge of a linear depression.

Whilst there is no direct geophysical evidence for the broad linear depression along the east and south sides of the field (**9**), there is geophysical evidence for the apparent truncation of the ridge and furrow in the east and a raised concentration of small dipolar magnetic anomalies within the feature along both sides of the field, particularly along the southern side. This feature may perhaps be interpreted as a track, appearing to be cut into the ridge-and-furrow. It is noteworthy that its eastern terminus is situated approximately in the position of the round-headed portal featured on the 1620x3 estate map (Figure 13).

Although the GPR technique detected reflections associated with the ridge and furrow and the probable former field boundary, it recorded very few reflections associated with the probable oval enclosure, ring-ditches and other potential archaeological features. Occasional weak linear magnetic anomalies and weak linear GPR reflections were detected in the field; the most prominent magnetic anomaly crosses the southwestern part of the field (**10**). These anomalies could reflect plastic pipes or stone drains. Two chains of intense dipolar magnetic anomalies were detected across the southern part of the field. These anomalies almost certainly reflect ferrous pipes (**11, 12**).

Many small, discrete, dipolar magnetic anomalies were detected across the survey area. These almost certainly reflect near-surface items of ferrous and/or fired debris, such as horseshoes, chain links and brick fragments, for example, and in most cases have little or no archaeological significance. A sample of these is shown on the geophysical interpretation plan, however, they have been omitted from the archaeological interpretation plan.

Discussion of the Ramifications of Surveys for Thinking on Warkworth Castle

In terms of meeting the objectives of the survey, the process of examining subsurface features which can illuminate thinking on the development of Warkworth Castle has been successful. The study of the earthworks of the castle gave great insight into the extent of a massive structure built close to the eastern side of the south curtain wall. Although there were no traces of clear structures (at least medieval in date) in the area of the bailey left unenclosed by the primary-phase curtain wall, it is clear that this area was used in some

capacity in the late medieval period. Its unenclosed-ness is yet to be fully explained, but it may more comfortably be associated with the south-eastern postern, which opens up further avenues of research. The findings from the motte-top surface are ambiguous, but may also speak to the use of the postern in the Great Tower here which supports the view that the castle was accessed and navigated in a variety of ways by different parts of its community.

The survey of St John's Close and the adjacent field, though not necessarily revealing medieval structures, did suggest that there was further material to investigate here, should the opportunity arise. Clearly the extant ridge-and-furrow in the northern portion of the surveyed area is only the most obvious survival of a deep and complicated story of the park, as the outline of its history noted above already suggests. It is not possible to date the earthworks beyond a loosely comparative method which suggests they sit in the earlier portion of broadly medieval cultivation. That they overlie suspected prehistoric remains is confirmation of this; it may also be chronologically useful to recognise that the ridge-and-furrow is cut by a curving track or path across the area surveyed, whose eastern terminus appears to be positioned close to the suspected location of the eastern, round-headed park gate depicted on the 1620x3 map (Figure 13). If the path and gate can be thusly associated, then the cultivation earthworks have a *terminus ante quem* of the early 17th century.

In a more general sense, the complicated story of the features within the park testify to what must have been a dynamic and changing medieval picture of this portion of the wider complex, which Hodgson's extensive documentary study has already shown. Beckensall's recent study of place-names, combined with analogous materials from Yorkshire and Cumbria, show that the park at Warkworth was intensively if sporadically exploited; on occasion, it was passively managed through the granting of agistments and the collection of income from the sale of underwood and timber; other times, it was more pro-actively managed, as evidenced by the late 15th-century expansion, occasioning increased focus on cultivation or cow-herding within the park and the construction and maintenance of associated infrastructure.

Overall, the two surveys have yielded valuable new information on the history of Warkworth Castle and its landscape. They have answered certain questions but, in typical fashion, have both left others unanswered and created new avenues of inquiry.

Recommendations for Future Work

It is clear that there is more work to be done to pursue the threads of research these surveys have revealed.

On a micro-level, GPR not very successful in St John's Close and adjacent field, in terms of yielding fruitful results. The magnetometry survey was very successful, while resistance bore adequate results within the remit of the research questions of the survey. In drier conditions, GPR may have been more successful. Given the success of the magnetometry in this particular area, an expanded survey of parkland would likely yield further archaeologically-significant results, with the advantage of being cheap and rapid. This enterprise fits well with a further recommendation, of an initial inspection of the known and suspected park boundaries in the landscape today. It is feasible that other segments of medieval park pale survive, which might provide further dating, typological or chronological information which

could inform our understanding of the park's history. If a formal survey of possible earthworks is not possible, an informal assessment would doubtless yield fruitful results.

Another possible avenue of future work would be to 'ground-truth' chosen features identified by the survey in the castle itself and in the fields surveyed. The costs and benefits of such an exercise would need to be carefully considered (i.e. preservation and conservation of features versus results yielded which could improve management and understanding of the areas examined); this is especially the case in the castle itself.

Going forward, it would be desirable to put forward the assessment of these results in a peer-reviewed publication. However, further assessment of the standing buildings, comparable features in the park, and a more sustained characterisation of the ridge-and-furrow, would make this a more substantial contribution to the study of the castle. It had been hoped that a recent detailed standing building survey undertaken at Warkworth Castle could be more fully incorporated into this report, but constraints have prevented this. When the results of that examination can be considered alongside the results presented here, perhaps a publication can be considered.

Lastly, it has already been mentioned that the park at Warkworth almost certainly did not operate in isolation during its medieval use. The parks at nearby Acklington and more distant Rothbury should be assessed and compared with the information concerning Warkworth. [69] The parkland of Alnwick Castle, the great Percy fortress so close to Warkworth, should also feature. It is apparent that the parks of medieval Northumberland have the potential to inform current debates around the nature and extent of castle-landscape interaction, which would act as an effective counterweight, assisted by work in Cumbria and Yorkshire, to the dominance of the English Midlands in castle park studies.

[69] Moorhouse, 2007a, p. 125.

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Acknowledgements

Mark Douglas and Will Wyeth would like to extend their thanks to the Castle Studies Trust for awarding funds to undertake the surveys and their forbearance in the delayed delivery of this report. They would also like to thank Duncan Hale and colleagues at Archaeological Services – Durham University for undertaking the survey, and to Duncan for agreeing to review this report, which draws substantially on the survey reports appended here. The staff at Warkworth Castle has been generous with our study of their castle and we are grateful for their hospitality. The Northumberland Estate graciously provided access to St John's Close, and the Collection of the Duke of Northumberland gave permission to reproduce material. Neil Linford of Historic England kindly discussed both reports and offered recommendations, for which we are very grateful; Brian Kerr, Clare Broomfield and Matt Oakey of Historic England, and Jeremy Ashbee of English Heritage Trust, have generously offered advice and support, with thanks. Any errors and interpretations remain ours alone and do not necessarily reflect the views of our employers.

Appendices – full archaeological reports

Appended below are the full reports by Archaeological Services – Durham University. Note, these reports retain their own pagination, figure numeration and references.

ARCHAEOLOGICAL SERVICES
DURHAM UNIVERSITY

on behalf of

ENGLISH HERITAGE

Warkworth Castle
Northumberland

geophysical surveys

report 5414
November 2020

Durham University

Contents

Figures

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1. Summary

The project

1.1 This report presents the results of geophysical surveys conducted for the English Heritage project 'Warkworth Castle: Stories in Stone'. The works comprised magnetometer, electrical resistance and ground-penetrating radar surveys in the castle bailey and on land to the immediate north and east of the bailey.

1.2 The works were commissioned by English Heritage, funded through a grant from the Castle Studies Trust, and conducted by Archaeological Services Durham University.

Results

1.3 Two of the three geophysical techniques used can be adversely affected by the prevailing weather, however, in this instance the weather conditions were favourable in that the surveys were undertaken during a dry spell following a period of rain. The survey results demonstrate the complementary nature of the three techniques.

1.4 Probable wall remains were identified at several locations, including the footings of a very substantial and well-defined wall aligned east-west in the outer ward of the bailey. It is likely that this wall was an early feature of the castle.

1.5 Further potential wall remains were identified elsewhere in the bailey, on the motte next to the keep and on the bailey platform east of the curtain wall. Some areas of probable rubble were also detected, which could also contain wall-footings.

1.6 A probable former unmetalled track has been identified outside the east bailey wall, heading north from the east postern.

1.7 Two drains have been detected associated with the well. Several probable drains have also been detected on the bailey platform east of the curtain wall.

1.8 Two areas of rubble and probable disturbed ground were detected in the north and south-west of the eastern bailey platform.

1.9 Some of the geophysical anomalies almost certainly reflect recent activities and features. These include probable concrete and steel socket-bases for a super-structure (that was never erected) in the south of the courtyard; a very near-surface linear feature by the west wall of the stables; lawnmower tracks; a narrow footpath; and a possible former flowerbed.

2. Project background

Location (Figures 1 & 2)

2.1 Surveys were undertaken at Warkworth Castle (NGR centre: NU 24721 05764), which is located in the neck of a tight meander of the River Coquet, occupying a commanding position above the village of Warkworth in Northumberland. The castle (and land immediately adjacent) is a Scheduled Ancient Monument (SAM, List Entry no. 1011649) and the buildings are Grade I Listed. The older part of the village lies directly north of the castle. From Warkworth the Coquet flows 2km south-east to join the North Sea at Amble.

2.2 Three geophysical techniques were used, with surveys undertaken in three areas totalling approximately 0.3ha:

Area 1 the central, open part of the bailey enclosed by the present 12th-century curtain wall (magnetic, electrical resistance, GPR)

Area 2 the top of the motte adjacent to the late 14th-century keep/Great Tower (electrical resistance only)

Area 3 the strip of unenclosed land to the east of the bailey wall, but still on the earthwork bailey platform (magnetic, electrical resistance, GPR)

Objectives

2.3 The principal aim of the surveys was to assess the nature and extent of any sub-surface features of potential archaeological significance within the specified areas, and so contribute to current research on the castle's history and inform a new scheme of interpretation for the site.

2.4 Specifically, it was intended that the intramural sub-surface remains (Area 1) would inform an understanding of how the site developed into its present courtyard arrangement of ranges and that survey at the top of the motte (Area 2) might establish the presence of near-surface materials predating the late 14th-century Great Tower; the architectural evidence for an earlier structure is contested and ambiguous. Also, the exclusion of the eastern part of the earthwork castle (Area 3) from the medieval stone walling scheme is a particular research question to be targeted by this research.

2.5 The regional research framework *Shared Visions: The North-East Regional Research Framework for the Historic Environment* (Petts & Gerrard 2006) contains an agenda for archaeological research in the region, which is incorporated into regional planning policy implementation. In this instance, the scheme of works was designed to address the following research priorities: Early Medieval EMi. Landscape, EMii. Settlement, EMiii. Architecture, EMvi. Christianity; Later Medieval MDi. Settlement, MDii. Landscape, MDiv. Castles and defensive structures, MDv. Churches and religion.

Methods statement

2.6 The surveys have been undertaken in accordance with instructions and a brief from the client, a technical specification prepared by the Historic England Geophysics Team, a Methods Statement provided by Archaeological Services Durham University and national standards and guidance (see para. 5.1 below).

2.7 Since the geophysical surveys were within a scheduled area, they were undertaken in accordance with the conditions of a licence granted by Historic England (HE) under Section 42 of the Ancient Monuments and Areas Act 1979 (as amended by the National Heritage Act 1983). The Historic England Geophysical Survey Database Questionnaire is included here as Appendix I.

Dates

2.8 Fieldwork was undertaken on 3rd-6th November 2020. This report was prepared for November 2020.

Personnel

2.9 Fieldwork was conducted by Duncan Hale and Mark Woolston-Houshold. The geophysical data were processed by Duncan Hale and Richie Villis. This report was prepared by Duncan Hale, with illustrations by Janine Watson. The project manager was Peter Carne.

Archive/OASIS

2.10 The site code is **WWC20**, for **W**ark**W**orth **C**astle 20**20**. The survey archive will be retained at Archaeological Services Durham University; a copy of the raw geophysical data, the final report text, figures and associated electronic drawing files will also be supplied to the Historic England Geophysics Team. Archaeological Services Durham University is registered with the **O**nline **A**cces**S** to the **I**ndex of archaeological investigation**S** project (**OASIS**). The OASIS ID number for this project is **archaeol3-408904.**

Acknowledgements

2.11 Archaeological Services Durham University is grateful to the landowners and to Dr Mark Douglas and Dr Will Wyeth of English Heritage for facilitating this scheme of works.

3. Historical and archaeological background

3.1 The following background information is taken from the project's 'Description of Scope' (Appendix II) prepared by English Heritage.

3.2 Warkworth Castle is an impressive aristocratic fortified residence situated on the banks of the River Coquet and occupying a commanding position above the town of Warkworth, Northumberland. Historically the castle is understood as a showpiece building belonging to the powerful Percy family.

3.3 As presently understood, the earliest earthworks date to the early 12th century, and its standing remains to between the late 12th-early 13th centuries. The identity of the architect of its early earthworks remains is not settled. There are two possible scenarios: first that it was built by Henry of Scotland (1114-1153), who from 1139 was Earl of Northumbria, and was the son of David I of Scotland. The other possibility is that it was built with the support of Henry II of England, who retook possession of Northumberland in 1157, and under whose auspices a similar complex at Harbottle emerged. Whoever built the early castle was almost certainly developing an association with a lordship centre at Warkworth that was much older; Warkworth is mentioned in a 737 gift to Lindesfarne from Ceolwulf, King of Northumbria.

3.4 Sections of the curtain walls and the gatehouse are all that remain of this phase of construction. In 1157 the castle was granted to Roger Fitz Richard, Constable of Newcastle, whose descendants added to the castle with the construction of the gatehouse, Carrickfergus Tower, domestic buildings and in 1249 the rebuilding of the great hall in the bailey. It is very likely the 14th-century Great Tower presently atop the motte replaced an earlier structure of timber or stone. In 1311 the castle was acquired by the Crown and later, in 1332, was fully acquired by Henry Percy, lord of nearby Alnwick. It was Henry Percy, created Earl of Northumberland at the coronation of Richard II in 1377, who initiated Warkworth's most ambitious building project following his elevation: the construction of the Great Tower. The fourth earl (c.1449–1489) began the building of a large collegiate church in the bailey around 1480, however, after his murder in 1489 it appears that the project was abandoned and the construction never completed. His scheme for an overhauled bailey, however, is reflected in the configuration of the kitchen block, Little Stair Tower and redeveloped chapel. The foundations of the church incorporate a passage connecting the bailey and the Great Tower entrance. The rebuilding of the hall range in the bailey was also undertaken at this time, including the imposing Lion Tower with its impressive display of heraldic sculpture.

3.5 The geophysical survey results will be used in conjunction with a comprehensive architectural/standing buildings survey of the castle undertaken in 2019 on EHT's behalf by Addyman Archaeology/Simpson & Brown.

4. Landuse, topography and geology

4.1 At the time of fieldwork, each survey area comprised cut grass.

4.2 Area 1, the outer ward in the enclosed part of the bailey, contained standing buildings and fragmented structural remains; the survey area extended across the former stables and a well, sited within a well-house. This area also contained occasional metal signage and barriers, bins, a cabin immediately east of the main entrance and evidence of historical interventions.

4.3 Only very limited space was available for Area 2, being on top of the steep motte. It was possible to collect some data adjacent to the keep, or Great Tower.

4.4 Area 3 comprised the open ground east of the bailey wall but still on the larger earthwork bailey platform.

4.5 Area 1 was predominantly level with a mean elevation of approximately 25m OD. The surveyed parts of Area 2 occupied slopes between 27-30m OD. Area 3 was gently undulating, with elevations typically between 23-24m OD by the tower in the south and between 21-22m OD in the north adjacent to the motte.

4.6 The underlying solid geology of the area comprises Stainmore Formation (mudstone, siltstone and sandstone), which is overlain by both till and the artificial deposits of the medieval earthworks.

5. Geophysical survey

Standards

5.1 The surveys and reporting were conducted in accordance with the Chartered Institute for Archaeologists (CIfA) *Standard and Guidance for archaeological geophysical survey* (2014, updated 2020); the *EAC Guidelines for the Use of Geophysics in Archaeology* (Schmidt *et al*. 2015); the Archaeology Data Service & Digital Antiquity *Geophysical Data in Archaeology: A Guide to Good Practice* (Schmidt 2013); and the European GPR Association's Code of Practice (www.eurogpr.org/codeofpractice.htm).

Technique selection

5.2 Geophysical survey enables the relatively rapid and non-invasive identification of sub-surface features of potential archaeological significance and can involve a suite of complementary techniques such as magnetometry, earth electrical resistance, ground-penetrating radar, electromagnetic survey and topsoil magnetic susceptibility survey. Some techniques are more suitable than others in particular situations, depending on site-specific factors including the nature of likely targets; depth of likely targets; ground conditions; proximity of buildings, fences or services and the local geology and drift.

5.3 In this instance, it was considered probable that cut features such as ditches and pits might be present on the site, and that other types of feature such as trackways, wall foundations and fired structures (for example ovens and hearths) might also be present.

5.4 Given the anticipated nature and depth of targets, and the non-igneous geological environment of the study area, three complementary geophysical survey techniques were considered appropriate: magnetometer, earth electrical resistance and ground-penetrating radar (GPR). All three techniques were applied to Areas 1 and 3; electrical resistance was the only technique used in Area 2.

5.5 The magnetic technique, fluxgate gradiometry, involves the use of magnetometers to detect and record anomalies in the vertical component of the Earth's magnetic field, which can be caused by variations in magnetic susceptibility or permanent magnetisation; such anomalies can reflect archaeological features.

5.6 Given the proximity of buildings and the likely presence of wall-footings and paths/tracks, an electrical resistance survey was also appropriate; earth electrical resistance survey can be particularly useful for mapping stone and brick features. When a small electrical current is injected through the earth it encounters resistance which can be measured. Since resistance is linked to moisture content and porosity, stone and brick features will give relatively high resistance values while soil-filled features, which retain more moisture, will provide relatively low resistance values.

5.7 Similarly, high-resolution ground-penetrating radar (GPR) survey was considered appropriate for detecting smaller features, as well as the remains of cut and built features. GPR generates a short high-frequency radar pulse which is transmitted into the ground via an antenna; the energy is reflected by buried interfaces and the return signal is received by a second antenna. The amplitude of the return signal relates to the electromagnetic responses of different sub-surface materials and conditions, which can be features of archaeological or historic interest. The time

which elapses between the transmission and return of radar pulses to the surface can be used to estimate the depth of reflectors. As well as conducting traditional 2D area surveys, GPR also has a depth component and so can be used to create 3D models of the data, provided sufficient data are collected at closely-spaced intervals; these models can then be viewed in plan at selected depths known as 'time-slices' (or 'depth-slices' where time has been converted to estimated depth).

Field methods

5.8 A 20m grid was established across each survey area and related to the Ordnance Survey (OS) National Grid using a Leica GS15 global navigation satellite system (GNSS) with real-time kinematic (RTK) corrections typically providing 10mm accuracy.

5.9 Magnetic gradient measurements were determined using a Bartington Grad601-2 dual fluxgate gradiometer. A zig-zag traverse scheme was employed and data were logged in 20m grid units. The instrument sensitivity was effectively 0.03nT, the sample interval was 0.25m and the traverse interval was 1m, thus providing 1,600 sample measurements per 20m grid unit.

5.10 Measurements of earth electrical resistance were determined using a Geoscan RM15D Advanced resistance meter with an MPX15 multiplexer and a mobile twin probe separation of 0.5m. A zig-zag traverse scheme was employed and data were logged in 20m grid units. The instrument sensitivity was 0.1ohm, the sample interval was 0.5m and the traverse interval was 1m, thus providing 800 sample measurements per 20m grid unit.

5.11 GPR data were collected using a Malå GeoScience Ramac X3M radar control unit, mounted directly onto a 500MHz centre-frequency shielded antenna. The antenna and control unit were mounted in a rugged cart with a RAMAC XV monitor attached and an odometer on one wheel to trigger the GPR pulses. The time window was set to 67.5ns, to enable the logging of reflections down to approximately 3.5m depth. Returned energy wavelets were recorded from many depths in the ground to produce a series of reflections at each location, called a reflection trace. Series of traces collected along each transect produce a radar profile or radargram. For these surveys, data traces were logged at 0.05m intervals along parallel traverses spaced 0.25m apart. The start and end points of each traverses were again related to the OS National Grid using a Leica GS15 global navigation satellite system, as above.

5.12 Magnetic and resistance data were downloaded on site into a laptop computer for initial inspection and processing; GPR data were inspected on site using the Malå Ramac XV11 system. All datasets were backed up on removable media and subsequently transferred to a desktop computer for processing, interpretation and archiving.

Area 1 GPR and magnetometer surveys

Area 1 Resistance survey

Area 2 The motte and keep

Area 3 GPR survey

Data processing

5.13 Geoplot v4 software was used to process the magnetic gradient and electrical resistance data and to produce continuous tone greyscale images of the raw (minimally processed) data. The greyscale images are presented in Figures 3-4; positive magnetic and high resistance anomalies are displayed as dark grey, while negative magnetic and low resistance anomalies are displayed as light grey. Palette bars relate the greyscale intensities to anomaly values in nanoTesla/ohm, as appropriate. Trace plots of the data were also prepared and examined but are not presented in this report.

5.14 The following basic processing functions have been applied to the magnetometer data:

clip	clips data to specified maximum or minimum values; to eliminate large noise spikes; also generally makes statistical calculations more realistic
zero mean traverse	sets the background mean of each traverse within a grid to zero; for removing striping effects in the traverse direction and removing grid edge discontinuities
interpolate	increases the number of data points in a survey to match sample and traverse intervals; in this instance the data have been interpolated to 0.25m x 0.25m intervals

5.15 The following basic processing functions have been applied to the resistance data:

add	adds or subtracts a positive or negative constant value to defined blocks of data; used to reduce discontinuity at grid edges (Area 3 only)
de-spike	locates and suppresses spikes in data due to poor contact resistance
interpolate	increases the number of data points in a survey to match sample and traverse intervals; in this instance the data have been interpolated to 0.25m x 0.25m intervals

5.16 ReflexW v7.5 software was used to process the GPR profiles, to stack and interpolate the profiles to produce a 3D data volume, and to produce greyscale images of time-slices (Figures 5-6).

5.17 Combinations of the following processing functions have been applied to the GPR profiles:

dewow	removes very low frequency components by subtracting the mean from each trace
static correction	moves the start times for traces in each profile to 0nS

gaining the data	compensates for energy loss as the radio pulse penetrates deeper and/or amplifies the area of interest by adding a determined value
bandpass filter	removes low-amplitude frequencies
background removal	reduces data ringing
average xy-filter	used to suppress trace and time dependent noise (high frequency components)

5.18 A 3x3 square (9 point) median filter has been applied to the time-slices to smooth the data and preserve anomaly edges.

5.19 GPR profiles and time-slices have been examined. In this instance, the time-depth conversion is based on a soil velocity of 0.1m/ns; the velocity is only an estimate based on a hyperbola fitting technique and therefore any depths mentioned in the text below are only approximate. A series of depth-slices is presented in Figure 6.

Interpretation: anomaly types

5.20 Colour-coded geophysical interpretation plans are provided for the magnetometer and resistance surveys in Figures 3-4. Three types of magnetic anomaly have been distinguished in the data:

positive magnetic	regions of anomalously high or positive magnetic field gradient, which may be associated with high magnetic susceptibility soil-filled structures such as pits and ditches
negative magnetic	regions of anomalously low or negative magnetic field gradient, which may correspond to features of low magnetic susceptibility such as wall footings and other concentrations of sedimentary rock or voids
dipolar magnetic	paired positive-negative magnetic anomalies, which typically reflect ferrous or fired materials (including fences and service pipes) and/or fired structures such as kilns or hearths

5.21 Two types of resistance anomaly have been distinguished in the data:

high resistance	regions of anomalously high resistance, which may reflect foundations, tracks, paths and other concentrations of stone or brick rubble
low resistance	regions of anomalously low resistance, which may be associated with soil-filled features such as pits and ditches

Interpretation: features

General comments

5.22 A colour-coded archaeological interpretation plan is provided in Figure 7. For ease of reference, anomaly labels shown bold in the text below (eg **1**, **2** etc) are also shown on the archaeological interpretation plan.

5.23 Small, discrete dipolar magnetic anomalies have been detected across both magnetometer survey areas. These almost certainly reflect near-surface items of ferrous and/or fired debris, such as horseshoes and brick fragments, for example, and in most cases have little or no archaeological significance. A sample of these is shown on the geophysical interpretation plan, however, they have been omitted from the archaeological interpretation plan.

Area 1, the outer ward

5.24 The magnetic survey of this area is characterised by a relatively high concentration of both large and small dipolar magnetic anomalies. The larger anomalies reflect the iron grate over the well and steel sockets for a once-proposed steel-framed structure (**1**) in the south of the survey. The sockets appear to be set in large, square concrete bases, which were detected as high resistance anomalies and well-defined high amplitude GPR reflections. The socket bases were set in a square arrangement measuring approximately 7m along each side. The southernmost socket is obscured in the magnetic data by a very strong positive magnetic anomaly associated with an adjacent steel-framed cabin to the immediate south.

5.25 Several high resistance anomalies in this area almost certainly reflect stone wall footings. The largest of these (**2**) was detected aligned east-west in the south-eastern quarter of the courtyard, south of the well-house and stables and north of the former buildings inside the southern curtain wall. The feature was not detected magnetically, but it is particularly clear as well-defined high-amplitude reflections in the GPR data, especially from 0.75-1.5m below ground level. A similar, though narrower, linear high resistance anomaly (**3**) detected in the south-west of the courtyard is probably a continuation of this former wall. In the east, the wall-footing measures approximately 22m in length, extending eastward to join the curtain wall where the east postern is now located, indicating that the two features are not contemporary and that the footing is almost certainly earlier. Measuring 3m in width, this footing is comparable in width to the curtain wall and must be associated with a very substantial wall. The eastern end of this wall joins the curtain wall at the southern end of a section believed to date to the 12th century, while the western part is broadly aligned with the 12th-century south wall of the hall and the southern end of a section of curtain wall built on a 12th-century foundation.

5.26 Substantial projections to the north and south of the wall could reflect the remains of adjoining walls or possibly buttresses. One such projection near the east end of the wall appears to represent another wall, which extends northward and joins the stable block at its south-west corner, effectively extending the length of the stables' west wall. A short length of this east-west wall (**2**) was exposed in the 1930s by HM Office of Works, was recorded in plan and by photograph, and subsequently removed.

5.27 All three geophysical techniques detected anomalies consistent with a wall footing (**4**) across the central part of the stable block and also a door threshold or sill (**5**) in the west wall of the stables.

5.28 Further possible wall or kerb remains (**6**) were detected in the north of the area, close to the south transept of the unfinished church; these were detected as very near-surface high-amplitude GPR reflections. A small area of probable rubble outside the south-west corner of the stables may also contain a wall footing (**7**),

aligned east-west; detected as both high resistance and high-amplitude GPR reflections.

5.29 The area of probable rubble in the north-central part of the area could contain some footings (**8**), evident in the GPR data, and is also bounded on its north-east and north-west sides by linear, relatively high resistance anomalies, possibly further footings or kerbs/edging stones (**9**). The rubble is cut by two linear features, almost certainly drains (**10**, **11**) associated with the well. The drains were detected by all three techniques, as strong positive magnetic linear anomalies, as narrow low resistance anomalies and as narrow, linear, high amplitude GPR reflections.

5.30 Several small and irregular positive magnetic anomalies were detected in the courtyard area. The anomalies are considered to be too strong to reflect soil-filled features, such as pits, and are more likely to reflect fired or burnt materials, though such materials could be within cut features or in discrete deposits. The absence of any corresponding low resistance anomalies supports the interpretation of spread deposits rather than pit-fill deposits.

5.31 Recent features in this area comprise the four socket bases (**1**) in the south of the courtyard, and probably a very near-surface linear feature (**12**) in the GPR data close the west wall of the stables; no corresponding magnetic or resistance anomalies were identified here and the precise nature and function of the feature is uncertain, but it could reflect some sort of service or drain.

Area 2, the motte

5.32 Only very limited electrical resistance survey was possible here, on the steep ground adjacent to the keep. Several high resistance anomalies were detected, one of which is consistent with that of a stone wall footing, or perhaps a stone-lined drain (**13**); high resistance values were consistently recorded over a distance of 8m, aligned north-south at the north-west corner of the keep.

5.33 The additional, discrete, high resistance anomalies here are also likely to reflect the presence of stone, possibly as rubble.

Area 3, the eastern bailey

5.34 A broad band of relatively high magnetic susceptibility materials was detected aligned broadly north-south near the curtain wall; slightly raised resistance values were also recorded here (**14**). In each case the anomalies measure up to 3m in width. The nature of the anomalies indicates that the feature is unlikely to comprise deposits of either stone or brick rubble or clinker, or a soil-filled ditch, but that it is likely to be predominantly comprised of earth, sufficiently compressed to create both magnetic and soil moisture contrasts (though insufficient to provide GPR reflections). This is interpreted as a former unmetalled track. At its southern end the track (in the resistance data) appears to be associated with the east postern, while in the north the feature curves north-eastward around the Grey Mare's Tail Tower before becoming indiscernible due to the presence of stronger anomalies there.

5.35 The northern end of this area is characterised by broad concentrations of both high resistance and very strong magnetic anomalies. The resistance anomalies almost certainly indicate the presence of stone (or brick), probably in the form of rubble, while the magnetic anomalies indicate the likely presence of ferrous and/or fired

materials. The anomalies probably reflect deposits of mixed rubble and disturbed ground (**15**). One concentration of probable rubble corresponds to a broad low mound noted during survey.

5.36 Some narrow, linear, high resistance anomalies (**16**) detected to the immediate south of the rubble/disturbed area could possibly reflect the remains of wall-footings for a small structure, measuring approximately 5m square.

5.37 A concentration of intense dipolar magnetic anomalies was detected in the south-western part of this area (**17**), outside the east postern and north of the Amble or Montague Tower; concentrations of high resistance values were also recorded here. The most intense magnetic anomalies almost certainly reflect ferrous metals, some perhaps being lengths of reinforced steel bar or similar, for example. Other anomalies here probably reflect rubble and otherwise disturbed ground.

5.38 The resistance survey detected discrete patches of low resistance in the south-east corner of this area (**18**), but no corresponding anomalies were identified with the other techniques. The resistance anomalies almost certainly indicate increased soil moisture here, which is often associated with soil-filled features, however, no such features are readily identified in the other datasets. The anomalies could simply indicate small patches of higher water retention, perhaps unlikely given their location on higher ground above a very substantial castle ditch, unless drainage there has been impeded; these anomalies could therefore reflect moisture pooling on buried clay deposits, or other hard surfaces, which have not been detected.

5.39 The GPR survey of this area detected a few features that were not detected by the other techniques. These were all detected in the uppermost GPR data, evident on the nominal 0.25m bgl depth-slice: one slightly curved, narrow, linear reflection running almost the whole length of the grass here represents the compacted earth along an existing footpath (**19**); a series of parallel curvilinear anomalies across the area reflects the movements of lawnmowers; a sub-oval feature (**20**) in the northern half of the survey is also presumed to reflect recent activity, and in this instance could possibly reflect the edges of a feature such as a former flowerbed, for example.

5.40 Several narrow, linear magnetic anomalies and GPR reflections have been detected, predominantly within Area 3. Many of these lie on the same alignment, north-east/south-west, while a few others are aligned perpendicular to the former. These anomalies are interpreted as possible land drains.

6. Conclusions

6.1 Geophysical surveys have been undertaken at Warkworth Castle in Northumberland in order to contribute to research informing a new scheme of interpretation for the site.

6.2 Two of the three geophysical techniques used can be adversely affected by the prevailing weather, however, in this instance the weather conditions were favourable in that the surveys were undertaken during a dry spell following a period of rain. The survey results demonstrate the complementary nature of the three techniques.

6.3 Probable wall remains were identified at several locations, including the footings of a very substantial and well-defined wall aligned east-west in the outer ward of the bailey. It is likely that this wall was an early feature of the castle.

6.4 Further potential wall remains were identified elsewhere in the bailey, on the motte next to the keep and on the bailey platform east of the curtain wall. Some areas of probable rubble were also detected, which could also contain wall-footings.

6.5 A probable former unmetalled track has been identified outside the east bailey wall, heading north from the east postern.

6.6 Two drains have been detected associated with the well. Several probable drains have also been detected on the bailey platform east of the curtain wall.

6.7 Two areas of rubble and probable disturbed ground were detected, in the north and south-west of the eastern bailey platform.

6.8 Some of the geophysical anomalies almost certainly reflect recent activities and features. These include probable concrete and steel socket-bases for a super-structure (that was never erected) in the south of the courtyard; a very near-surface linear feature by the west wall of the stables; lawnmower tracks; a narrow footpath; and a possible former flowerbed.

7. Sources

CIfA 2014 *Standard and Guidance for archaeological geophysical survey*. Chartered Institute for Archaeologists

Petts, D, & Gerrard, C, 2006 *Shared Visions: The North-East Regional Research Framework for the Historic Environment*. Durham

Schmidt, A, 2013 *Geophysical Data in Archaeology: A Guide to Good Practice*. Archaeology Data Service & Digital Antiquity, Oxbow

Schmidt, A, Linford, P, Linford, N, David, A, Gaffney, C, Sarris, A & Fassbinder, J, 2015 *EAC Guidelines for the Use of Geophysics in Archaeology: Questions to Ask and Points to Consider*. EAC Guidelines **2**, Namur

Appendix I: Geophysical Survey Database Questionnaire

Historic England

English Heritage Geophysical Survey Database Questionnaire

Survey Details

Name of Site: WARKWORTH CASTLE

County: NORTHUMBERLAND

NGR Grid Reference: NGR centre: NU 24721 05764

Start Date: 3 November 2020 **End Date:** 6 November 2020

Geology at site (Drift and Solid):
Stainmore Formation, overlain by till and artificial deposits.

Known archaeological Sites/Monuments covered by the survey
Scheduled Monument: 'Warkworth Castle Motte and Bailey Castle, Tower Keep Castle and Collegiate Church' (SM 23234, HA 1011649) Listed Building Grade I.

Archaeological Sites/Monument types detected by survey
Wall-footings, rubble, former track, drains

Surveyor (Organisation, if applicable, otherwise individual responsible for the survey):
ARCHAEOLOGICAL SERVICES DURHAM UNIVERSITY

Name of Client, if any:
Dr M Douglas, Senior Properties Curator, English Heritage

Purpose of Survey: RESEARCH/INTERPRETATION

Location of:
a) Primary archive, i.e. raw data, electronic archive etc:
ARCHAEOLOGICAL SERVICES DURHAM UNIVERSITY

b) Full Report:
NORTHUMBERLAND HER
HISTORIC ENGLAND (NORTH EAST OFFICE, NEWCASTLE)
HISTORIC ENGLAND (GEOPHYSICS SECTION, PORTSMOUTH)
OASIS ref: **archaeol3-408904**
ARCHAEOLOGICAL SERVICES DURHAM UNIVERSITY

Technical Details

Type of Survey: MAGNETOMETRY

Area Surveyed, if applicable: 0.3ha

Traverse Separation, if regular: 1m **Reading/Sample Interval:** 0.25m

Type, Make and model of Instrumentation:
BARTINGTON GRAD601-2

Land use at the time of the survey: Managed GRASSLAND

Type of Survey: RESISTANCE

Area Surveyed, if applicable: 0.3ha

Traverse Separation, if regular: 1m **Reading/Sample Interval:** 0.5m

Type, Make and model of Instrumentation:
GEOSCAN RM15 & MPX15

Probe configuration: TWIN

Probe Spacing: 0.5m

Land use at the time of the survey: Managed GRASSLAND

Type of Survey: GROUND-PENETRATING RADAR

Area Surveyed, if applicable: 0.3ha

Traverse Separation, if regular: 0.25m **Reading/Sample Interval:** 0.05m

Type, Make and model of Instrumentation:
Malå GeoScience RAMAC X3M

Land use at the time of the survey: Managed GRASSLAND

Appendix II: Project specification

DESCRIPTION OF SCOPE

Geophysical Survey at Warkworth Castle, Northumberland.

Summary

From 2019-2023 English Heritage is investing in a transformation of the visitor experience at the site with an overhauled interpretation scheme and possibly including a new visitor centre. In this preliminary phase of the 'Warkworth Castle: Stories in Stone' project, it is essential to establish early on any new thinking or understanding of the standing (and subsurface) evidence for the castle's history. It is a scheduled ancient monument and a Grade I listed building. The presentation of the monument is that of ruin, displayed largely for its architectural interest, however, the 'Duke's Rooms' are roofed and semi-furnished. The interpretation scheme on the site is minimal, chiefly Office of Works-style signs identifying the function of a given room. Visitors are currently invited to use an audio guide to explore the history and details of the site's architecture. Geophysical survey, funded through a grant from the Castle Studies Trust, is required at three locations around the castle to assist with this research. The survey will consist of a magnetic, GPR and earth resistance survey depending on the suitability of the techniques to the individual site conditions detailed in the specification. Tenders are invited for this work to be concluded with a report by 30th November 2020.

Background

Warkworth Castle is an impressive aristocratic fortified residence situated on the banks of the river Coquet and occupying a commanding position above the town of Warkworth, Northumberland. Historically the castle is understood as a showpiece building belonging to the powerful Percy family.

As presently understood, the earliest earthworks date to the early 12th century, and its standing remains to between the late 12th-early 13th centuries. The identity of the architect of its early earthworks remains is not settled. There are two possible scenarios: first that it was built by Henry of Scotland (1114-1153), who from 1139 was Earl of Northumbria, and was the son of David I of Scotland. The other possibility is that it was built with the support of Henry II of England, who retook possession of Northumberland in 1157, and under whose auspices a similar complex at Harbottle emerged. Whoever built the early castle was almost certainly developing an association with a lordship centre at Warkworth that was much older; Warkworth is mentioned in a 737 gift to Lindesfarne from Ceolwulf, King of Northumbria.

Sections of the curtain walls and the gatehouse are all that remain of this phase of construction. In 1157 the castle was granted to Roger Fitz Richard, Constable of Newcastle, whose descendants added to the castle with the construction of the gatehouse, Carrickfergus Tower, domestic buildings and in 1249 the rebuilding of the great hall in the bailey (see Figure 1). It is very likely the 14th-century Great Tower presently atop the motte replaced an earlier structure of timber or stone. In 1311 the castle was acquired by the Crown and later, 1332, was fully acquired by Henry Percy, lord of nearby Alnwick. It was Henry Percy, created earl of Northumberland at the coronation of Richard II in 1377, who initiated Warkworth's most ambitious building project following his elevation: the construction of the Great Tower (Figure 2). The fourth earl (c.1449–1489) began the building of a large collegiate church in the bailey around 1480, however, after his murder in 1489 it appears that the project was abandoned and the construction never completed. His scheme for an overhauled bailey, however, is reflected in the configuration of the kitchen block, Little Stair Tower and redeveloped chapel. The foundations of the church incorporate a passage connecting the bailey and the Great Tower entrance. The rebuilding of the hall range in the bailey was also undertaken at this time, including the imposing Lion Tower with its impressive display of heraldic sculpture.

Archaeology

There are three areas being proposed for the survey, the approximate extent of which are outlined in Figure 2. The areas to be surveyed (red blocks) are illustrated, though the precise extent will be dependent on variable factors like weather and site access:

- Firstly, the area of the bailey enclosed by the present 12th-century curtain wall, as well as the strip of unenclosed land to the east of the bailey wall, but still on the earthwork bailey platform. The exclusion of this area of the earthwork castle from the medieval stone walling scheme is a particular research question to be targeted by this research. The intramural subsurface remains will inform our understanding of how the site has developed into its present courtyard arrangement of ranges

- Secondly, we aim to examine the subsurface remains of the motte mound itself, to establish the presence of near-surface materials predating the late 14th-century Great Tower. The architectural evidence for an earlier structure is contested and ambiguous, but renewed geophysical examination may tip the scales of the argument one way or the other.

- Thirdly and finally, we aim to investigate the subsurface remains of a field proximate to the medieval access route to the castle at St John's Close, ~350m SW of the castle. Early cartographic material suggests it may retain medieval buildings associated with the former empaled hunting park. [**this area subsequently excluded from survey requirement**]

The architecture and history of Warkworth is of national significance, and its great tower is arguably of international architectural importance. EHT's project aims to explore this significance through a wholly new interpretation scheme, telling the fascinating stories associated with the site. It also aims to shed further light on the story of its buildings and their changes over time. This survey will dovetail with a comprehensive architectural/standing buildings survey of the castle undertaken in 2019 on EHT's behalf by Addyman Archaeology/Simpson & Brown. The preliminary findings of these efforts have helped shape our aims for this geophysical survey.

Site conditions

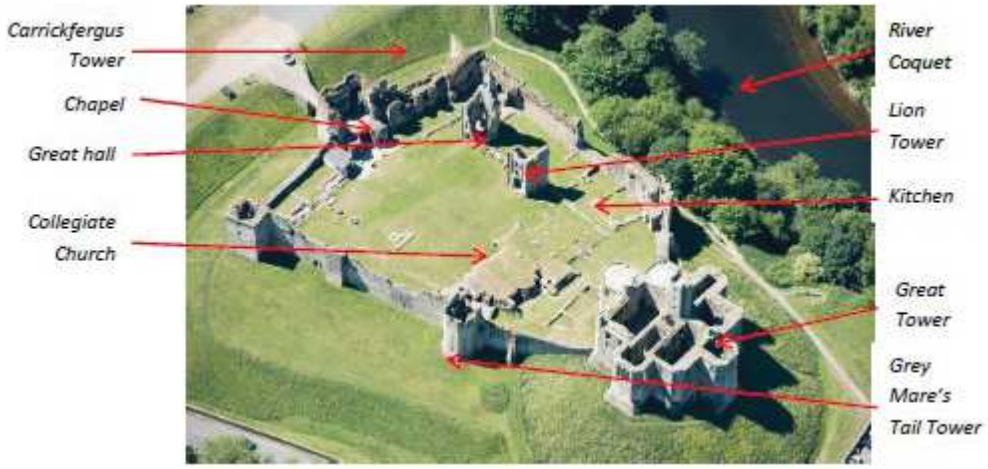

Figure 1: A selection of features within the castle. Oblique aerial photograph of castle looking South-West. © Historic England (Emma Trevarthen).

The areas where survey is required are down to well-kept grass although the following conditions should be noted:

The bailey is interrupted in places by standing buildings and other fragmented structural remains that may impede geophysical survey. There has also been extensive historical intervention in this area that will impact the quality and interpretation of the survey results (see additional information). A combination of magnetic, earth resistance and GPR survey is required in this area.

Only limited survey over the accessible, flat areas of the motte mound surrounding the Great Tower are required using earth resistance.

The majority of St John's Close is covered by east-west orientated rig and furrow, although there is

potential for the survival of building remains here. The whole area is to be covered with magnetic survey, with subsequent targeted coverage over 1ha using earth resistance and GPR. Figure 3 shows the results of a recent utilities survey of the site [**area excluded**].

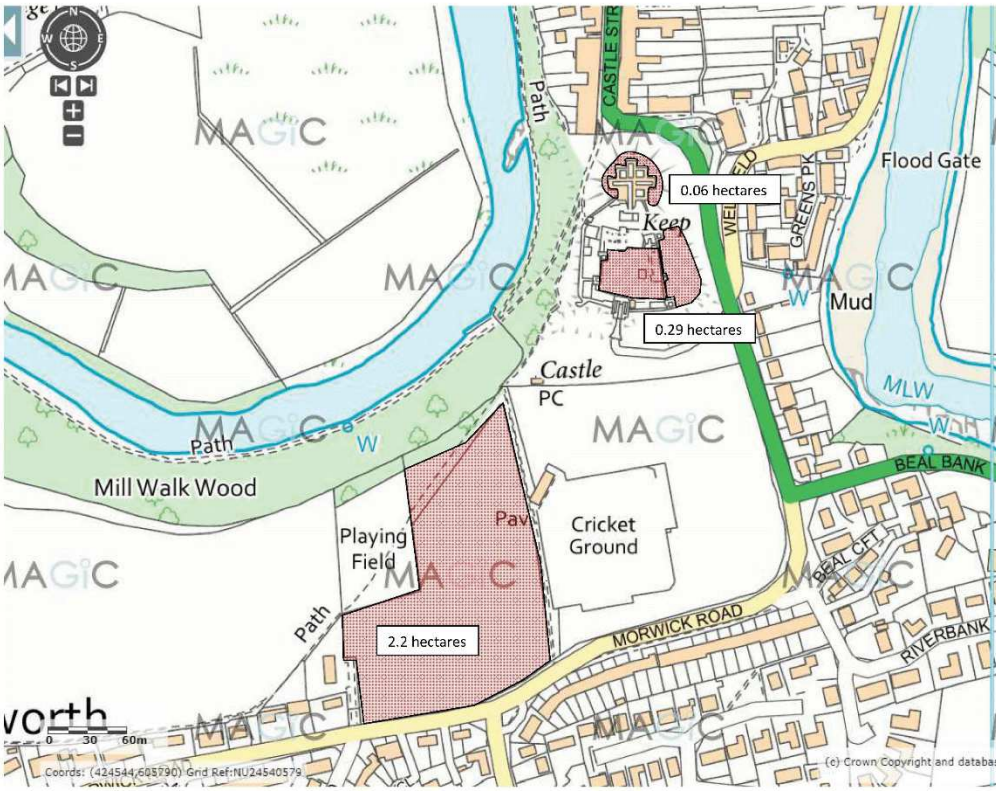

*Figure 2. Location of the three sites where geophysical survey is required from the north: motte mound (0.06ha), bailey (0.29ha) [and St John's Close (2.2ha): **excluded**]*

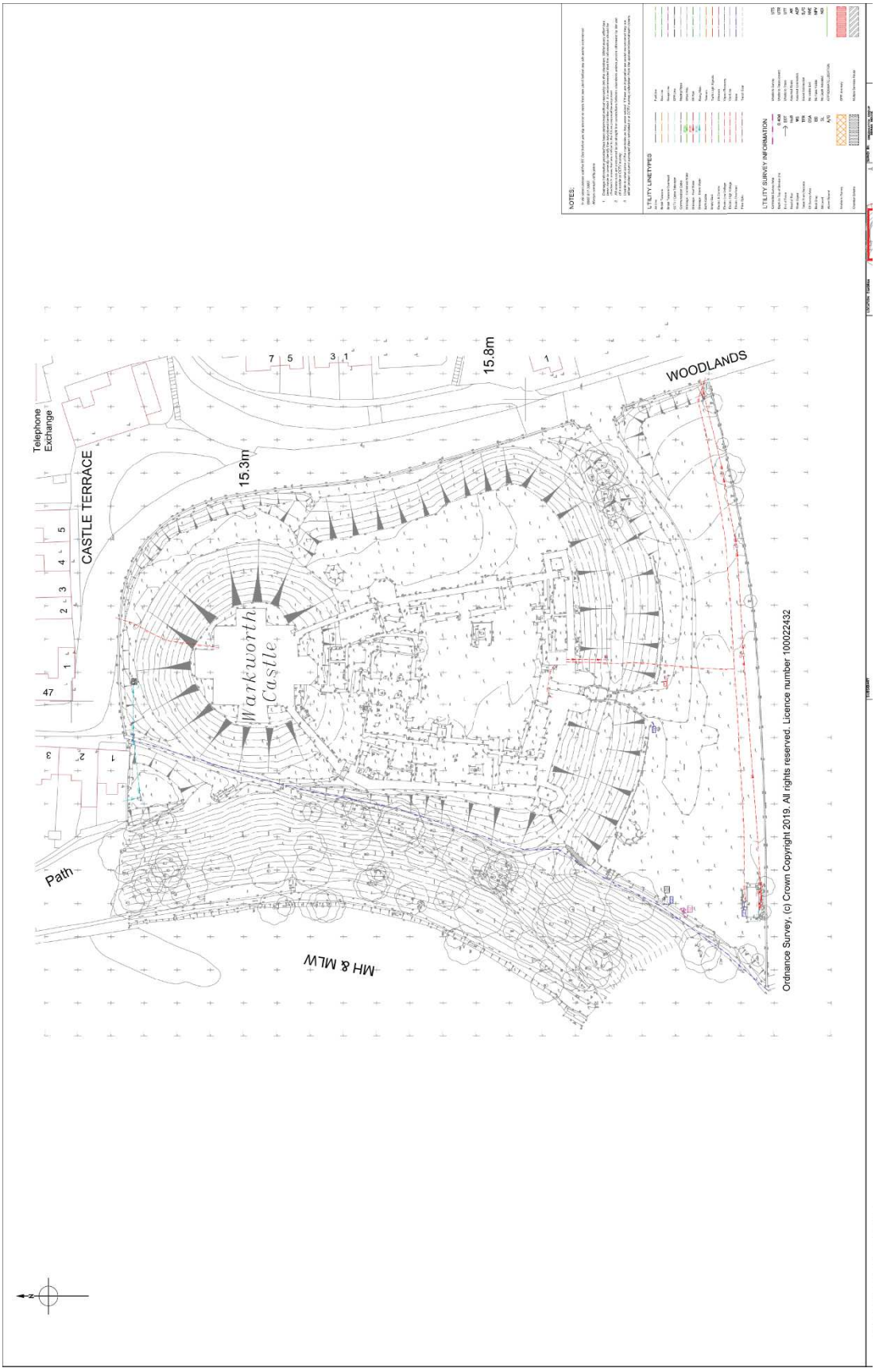

Figure 3. Underground utilities survey.

The geophysical survey requirement

The objective of the survey is to attempt to locate significant anomalies related to any surviving archaeology or historic invtervention. Details of the techniques required for the survey are given below.

Specification

1. The magnetic survey is to be conducted with a fluxgate gradiometer or similar instrument, either hand held or a cart based array. Readings must be recorded at intervals of 0.25m x 1.0m (or closer) over a survey area of ~0.29ha within the bailey [and ~2.2ha within St. John's Close – **excluded**].

2. The Ground Penetrating Radar (GPR) survey should be conducted with a suitable centre frequency antenna to be determined on site following appropriate field tests. Data should be recorded at a minimum sample interval of 0.05m intervals along parallel transects separated by a minimum of 0.5m to enable the presentation of the resulting data set through a series of horizontal amplitude time slices. It is anticipated that a centre frequency of approximately 500MHz would be most suitable for this survey. GPR survey will be required over an area of ~0.29ha within the bailey [and 1.0 ha within St. John's Close – **excluded**].

3. The earth resistance survey will use either the Twin Electrode (Twin Probe) configuration with a mobile probe spacing of 0.5m, or a wheeled resistivity square array system with probe spacings of 0.75m. Readings should be recorded at 1.0m x 1.0m intervals (or closer). Every effort should be made to ensure that a uniform dataset is acquired in which discontinuities of measurement levels at grid edges are minimised. Earth resistance survey is required over level areas of the motte mound surrounding the Great Tower (0.06ha), the bailey (0.29ha) [and 1.0 ha within St. John's Close – **excluded**].

4. Any temporary survey grid established over the site should be accurately measured in to permanent landmarks or discreetly positioned permanent marker pegs by the geophysical survey team. The temporary survey grid should be removed after the completion of fieldwork unless other arrangements have been agreed to facilitate further work on the site. Location measurements, provided in the final survey report, should allow the temporary survey grid to be exactly relocated from readily identifiable landmarks or marker pegs if necessary. In addition, the location of the temporary survey grid should be co-registered to the Ordnance Survey National Grid and any permanent markers established at the site.

5. The fieldwork must be concluded and 3 copies of a full report provided by 30th November 2020. A copy of the raw geophysical data, the final report text, figures and associated electronic drawing files must also be supplied to the Historic England Geophysics Team in an appropriate, mutually compatible electronic format. Historic England reserves the right to include appropriate reports in its Research Department Report Series.

6. All fieldwork, data processing and reporting must follow recommendations set out by English Heritage (2008).

7. Fieldwork on site must be conducted with a high degree of professionalism. Extreme care must be taken to avoid trip hazards caused by trailing equipment leads or survey grid markers during the conduction of the survey. Contractors will be responsible for preparing a Risk Assessment prior to the commencement of work.

8. Contractors should also provide a confirmation of procedures for safe site working with regard to the current COVID-19 situation, and abide by all local safety procedures and requirements at the site.

It is the policy of Historic England to retain all Intellectual Property Rights over all goods and services produced during the performance of a Historic England contract. This includes all images, survey data, outputs, derived products and reports (see clause14 below).

Access

Access to site to be arranged through liaison with English Heritage.
There is public access to the site and it is probable that there will be some local interest.

Section 42 Licence
To be provided for the chosen contractor.

Ofcom GPR/WPR Licence
Evidence for a suitable licence for the operation of ground or wall penetrating radar covered by Ofcom guidance note OfW 350 (18 September 2019) should be provided by the chosen contractor.

Maps
Digital mapping and site plans will be provided to the successful contractor for the creation of figures in the final report.

References

English Heritage 2008 *Geophysical survey in archaeological field evaluation*, 2nd edn. Swindon, Historic England.

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DURHAM UNIVERSITY

on behalf of
ENGLISH HERITAGE

Warkworth Castle
Northumberland

geophysical survey
report 5414

Figure 1: Site location

site location

0 1km
scale 1:20 000 for A4 plot

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Northumberland

geophysical survey
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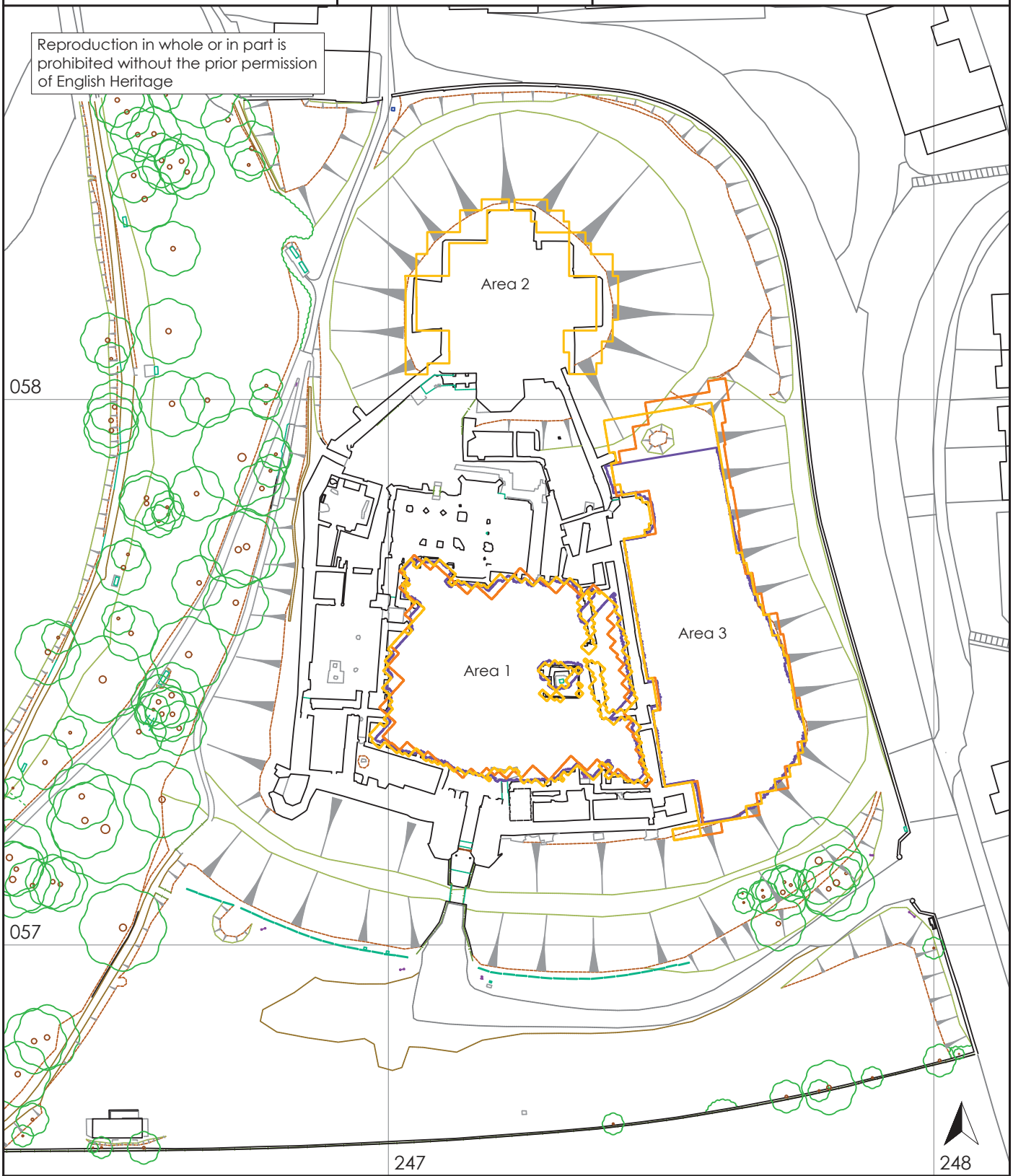
Figure 2: Location of surveys



magnetometer survey

resistance survey

GPR survey

0 50m
scale 1:1000 for A4 plot

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magnetometer survey
-4 nT 6

dipolar magnetic anomaly
positive magnetic anomaly
negative magnetic anomaly

0 30m
scale 1:600 for A3 plot

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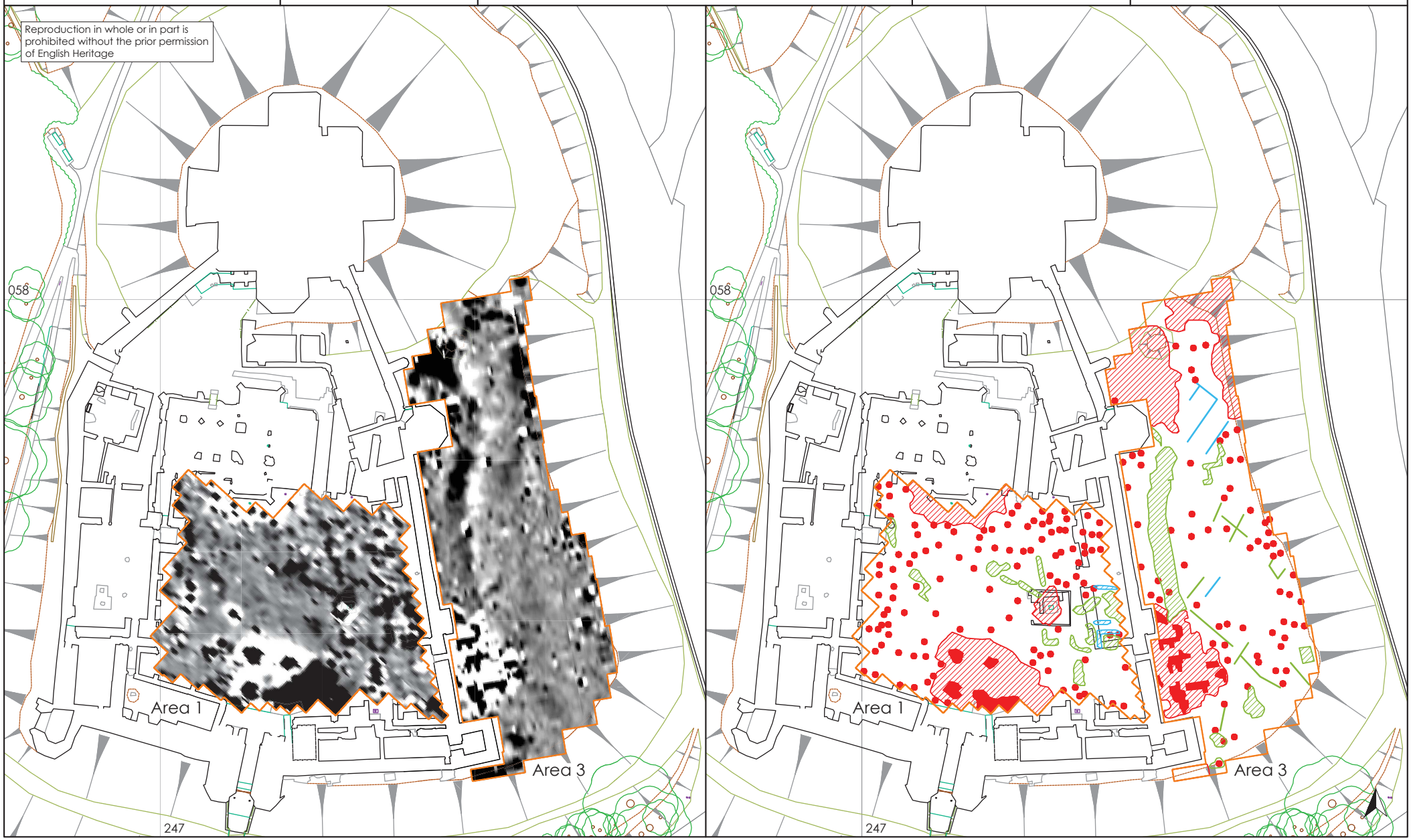
Northumberland

geophysical survey
report 5414

Figure 3: Magnetometer survey and geophysical interpretation



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resistance survey
20 (Areas 1 and 2) ohm 70
25 (Area 3) ohm 45

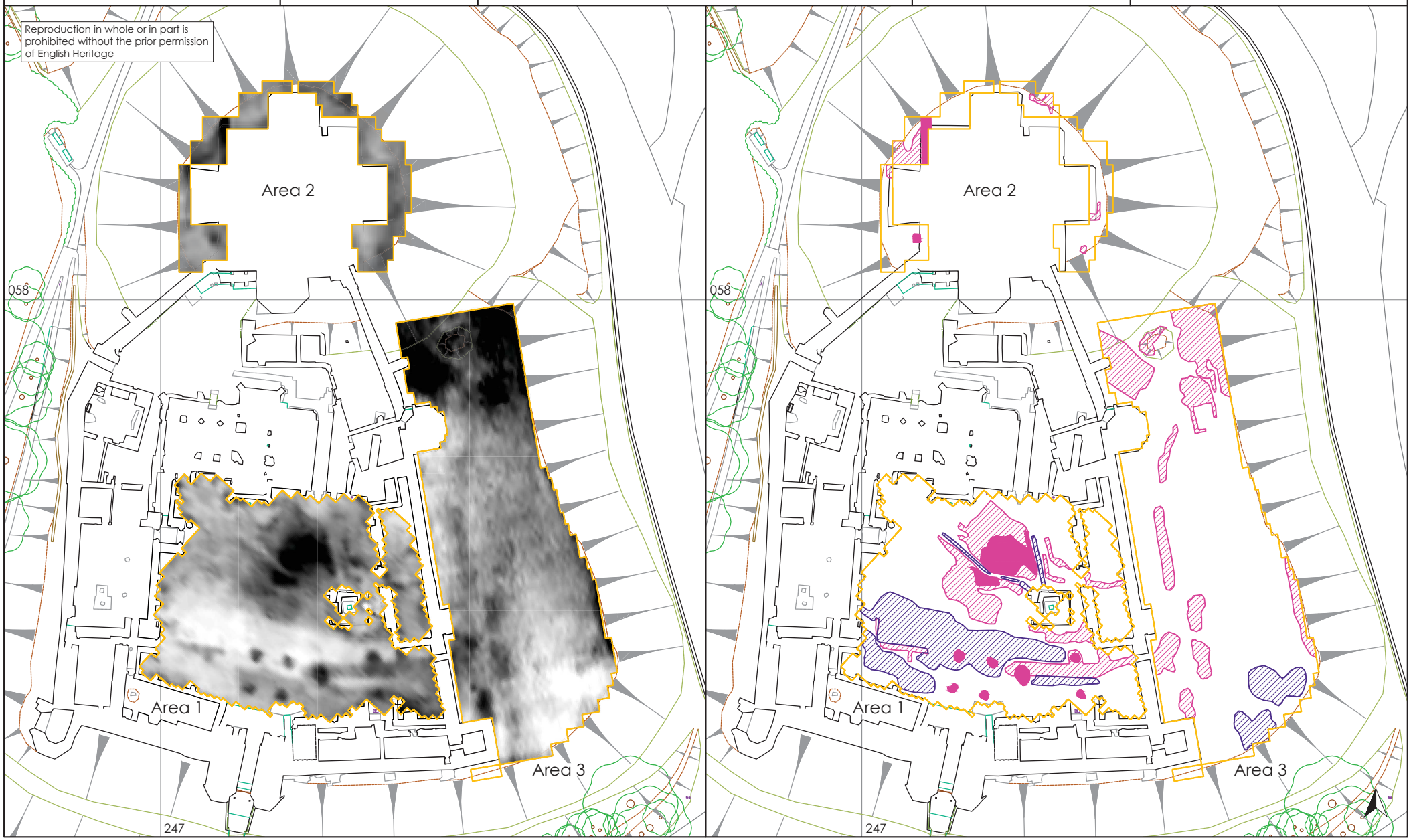
high resistance anomaly
low resistance anomaly

0 30m
scale 1:600 for A3 plot

Warkworth Castle
Northumberland

geophysical survey
report 5414

Figure 4: Resistance survey and geophysical interpretation



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Warkworth Castle
Northumberland

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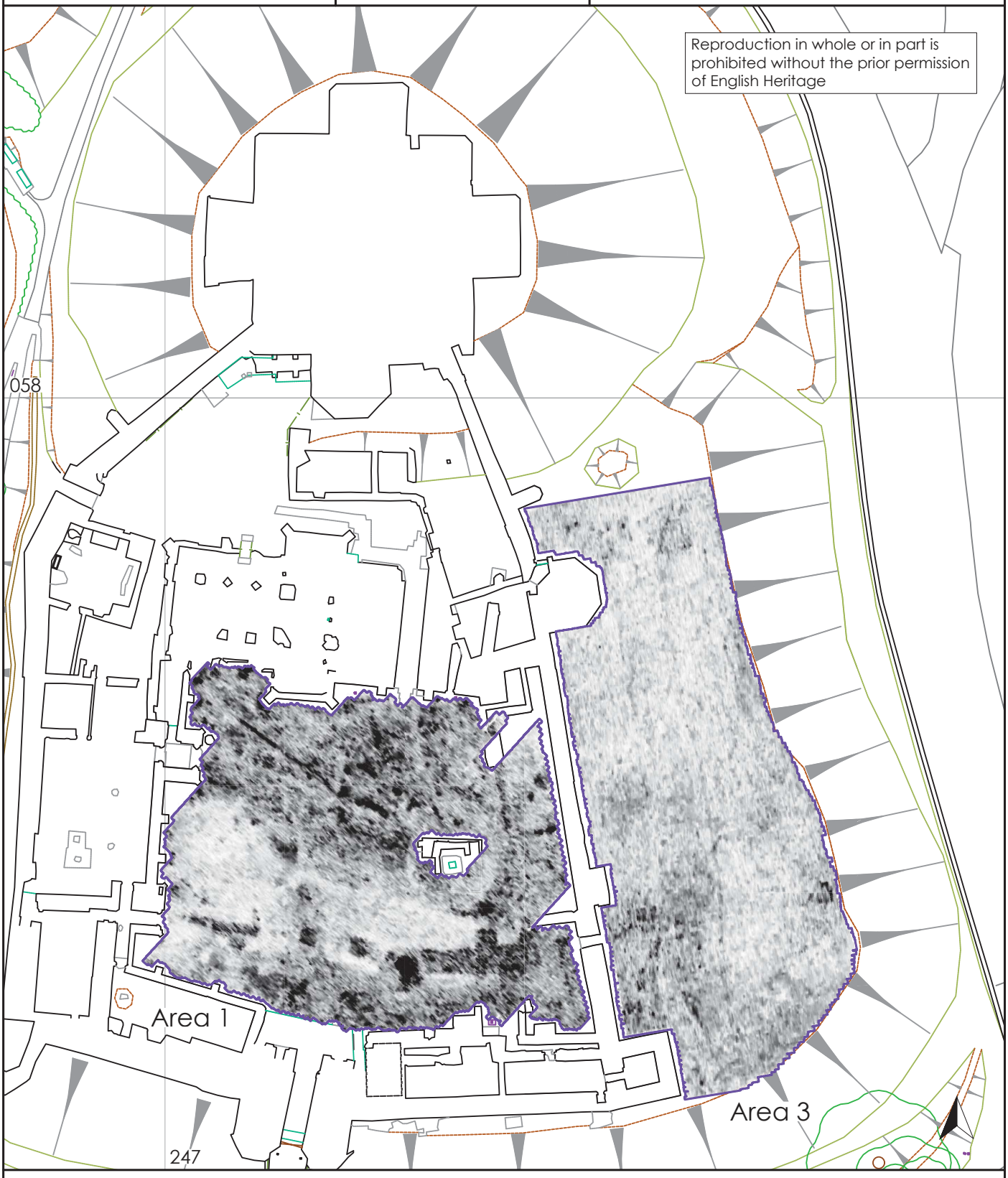
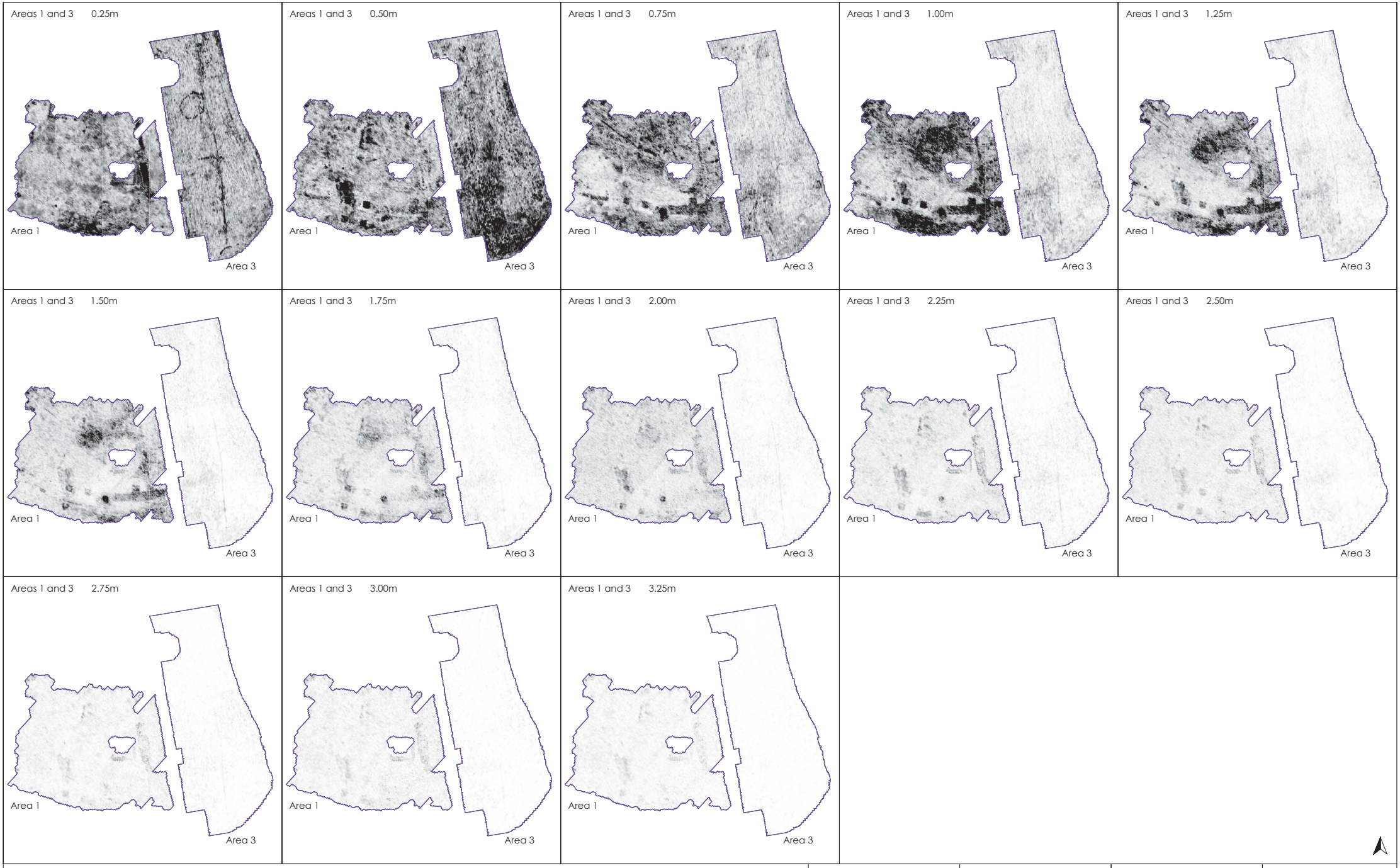
Figure 5: GPR survey, sample data from estimated 0.75m depth



GPR survey

0 30m
scale 1:600 for A4 plot



GPR outline

0 25m
scale 1:500 for A1 plot

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Figure 6: GPR depth-slices

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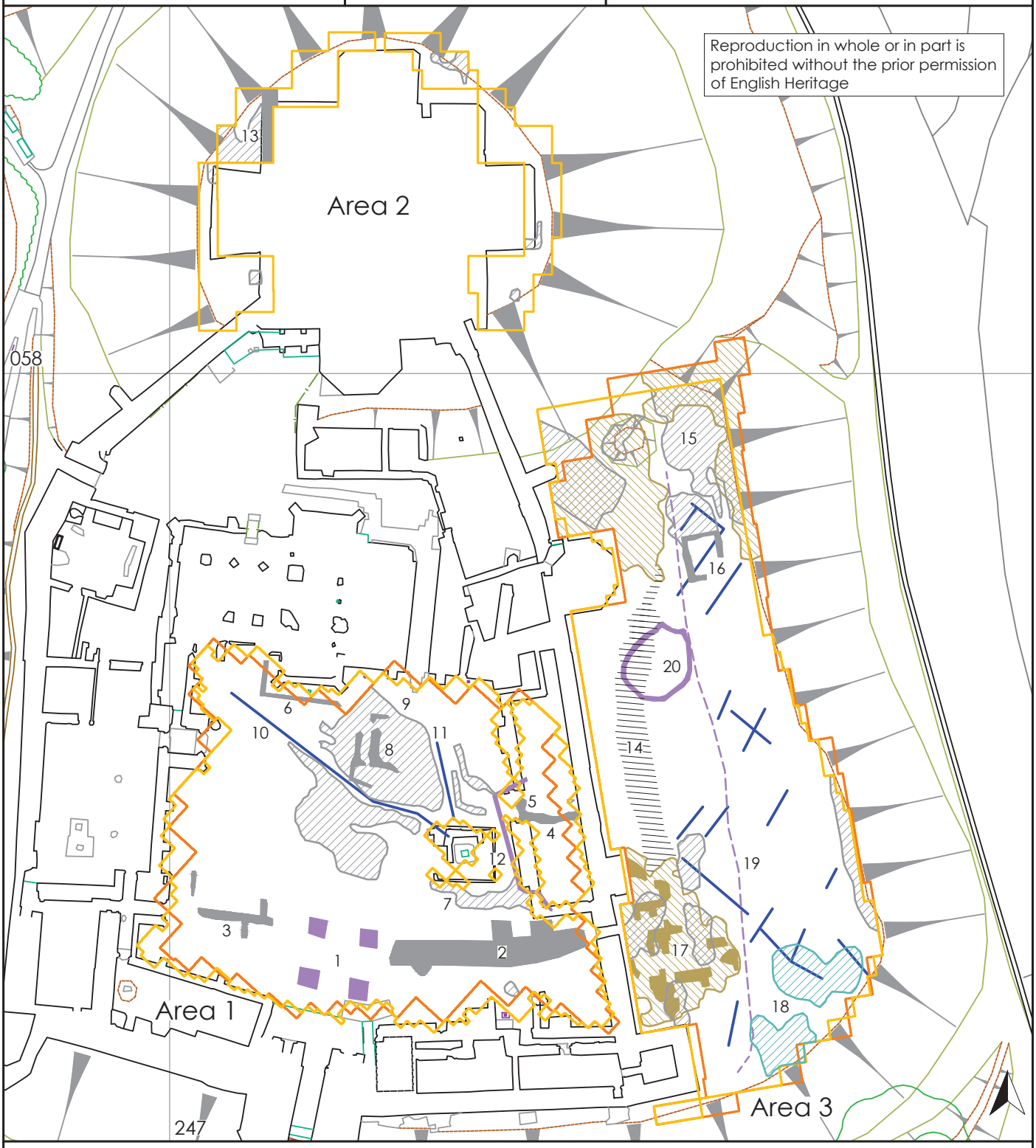
Figure 7: Archaeological interpretation



magnetometer survey
resistance survey
stone wall / rubble
disturbed area
recent feature
? hard surface
track
drain

0 30m
scale 1:600 for A4 plot

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on behalf of

ENGLISH HERITAGE

St John's Close
Warkworth
Northumberland

geophysical surveys

report 5482
May 2021

Durham University

Contents

Figures

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1. Summary

The project

1.1 This report presents the results of geophysical surveys conducted at St John's Close, Warkworth, Northumberland. The works comprised magnetometer, electrical resistance and ground-penetrating radar surveys of a 2ha field just south-west of the castle.

1.2 The works were commissioned by English Heritage, funded through a grant from the Castle Studies Trust, and conducted by Archaeological Services Durham University.

Results

1.3 The three geophysical techniques have detected a broad range of anomalies and probable feature types.

1.4 Anomalies and reflections associated with the upstanding ridge and furrow remains were detected across the northern part of the field.

1.5 Further magnetic and resistance anomalies probably reflect an oval enclosure, at least one ring-ditch and another similarly-sized more angular feature, as well as the potential partial remains of several other features; the angular feature appears to be hexagonal in the resistance data. The nature of these magnetic anomalies is more typically associated with soil-filled features, while the corresponding high resistance anomalies would typically indicate stone, for example. While the exact nature of these features is therefore uncertain, it is likely that they comprise both sediments and stone within cut features such as ditches or construction trenches. Occasional high amplitude GPR reflections could also indicate the presence of stone in parts of these features. In the archaeological interpretation plan, these anomalies are presented as 'soil-filled' features. In terms of relative chronology, inspections of the upstanding cultivation ridges at the locations of these anomalies did not identify any apparent cuts through the ridges; it is likely that these features pre-date the ridge and furrow cultivation.

1.6 Positive magnetic anomalies with no corresponding resistance or GPR anomalies are interpreted as soil-filled features, typically ditches, gullies and pits.

1.7 A probable former field boundary has been identified aligned east-west across the central part of the field. This former boundary may contain stone footings and corresponds to a field boundary shown on the earliest OS maps. The northern boundary of 'St John's Close', as shown on Norton's map of 1624, also broadly corresponds to the location of this feature.

1.8 Two ferrous pipes and occasional probable drains were also detected across the field.

2. Project background

Location (Figures 1 & 2)

2.1 Geophysical surveys were undertaken at St John's Close, just south-west of the castle at Warkworth in Northumberland (NGR centre: NU 24591 05519). To the north was steep wooded ground down to the River Coquet; to the north-east was Warkworth Castle; to the east was a cricket ground; to the south was Morwick Road with housing along its south side; and to the west was housing and a playing field. In the north-western corner of the site, beyond two fences and a footpath, was a small overgrown area containing trees. The older part of the village lies directly north of the castle. From Warkworth the Coquet flows 2km south-east to join the North Sea at Amble.

2.2 Three geophysical survey techniques were used. Magnetometer survey was initially conducted over the main field (2.15ha), but it was not practicable to survey the small area beyond the fences and footpath to the north-west; subsequent earth electrical resistance and ground-penetrating radar (GPR) surveys targeted the central part of the field (0.5ha) where the magnetic survey had identified potential archaeological features.

2.3 The surveys at St John's Close complement recent geophysical surveys conducted at the castle (Archaeological Services 2021).

Objectives

2.4 The principal aim of the surveys was to assess the nature and extent of any sub-surface features of potential archaeological significance within the specified area, and so contribute to the English Heritage project 'Warkworth Castle: Stories in Stone', ongoing research into the castle's history which will inform a new scheme of interpretation for the site.

2.5 Specifically, the surveys were to investigate the sub-surface remains of a field at St John's Close, close to the medieval access route to the castle. Early cartographic material suggests the field may retain medieval buildings associated with the former empaled hunting park.

2.6 The regional research framework *Shared Visions: The North-East Regional Research Framework for the Historic Environment* (Petts & Gerrard 2006) contains an agenda for archaeological research in the region, which is incorporated into regional planning policy implementation. In this instance, the scheme of works was designed to address the following research priorities: Early Medieval EMi. Landscape, EMii. Settlement, EMiii. Architecture; Later Medieval MDi. Settlement, MDii. Landscape, MDiv. Castles and defensive structures, MDv. Churches and religion.

Methods statement

2.7 The surveys have been undertaken in accordance with instructions and a brief from English Heritage and a technical specification prepared by the Historic England Geophysics Team (presented in Appendix I), a Methods Statement provided by Archaeological Services Durham University and national standards and guidance (see para. 5.1 below).

2.8 The specified works were undertaken in two lots: the first comprised surveys at the castle in 2020 (Archaeological Services 2021), the latter comprising surveys at St

John's Close (this report). Due to funding arrangements, the area for targeted earth resistance and GPR surveys at St John's Close was reduced from 1ha to 0.5ha.

Dates

2.9 Fieldwork was undertaken on 1st-3rd March 2021, during a very cold, dry and generally foggy spell after a period of wet weather. This report was prepared for May 2021.

Personnel

2.10 Fieldwork was conducted by Duncan Hale. The geophysical data were processed by Duncan Hale and Richie Villis (GPR). This report was prepared by Duncan Hale, with illustrations by Janine Watson. The project manager was Duncan Hale.

Archive/OASIS

2.11 The site code is **WSJ21**, for **W**arkworth **S**t **J**ohn's Close 20**21**. The survey archive will be retained at Archaeological Services Durham University. Archaeological Services Durham University is registered with the **O**nline **A**cces**S** to the **I**ndex of archaeological investigation**S** project (**OASIS**). The OASIS ID number for this project is **archaeol3-421011.**

Acknowledgements

2.12 Archaeological Services Durham University is grateful to the tenant and landowner, to the Castle Studies Trust and to Dr Mark Douglas and Dr Will Wyeth of English Heritage for facilitating this scheme of works.

3. Historical and archaeological background

3.1 A map produced by Robert Norton in 1624 ("The lower part of the Manor of Warkworth…") shows the large empaled Warkworth Park extending west from the castle. St John's Close is shown as a small parcel of land, measuring up to approximately 126m east-west by 67m north-south, in the south-east corner of the park, approximately 200m south-south-west of the castle; a similar enclosed area is also shown on the 1st edition Ordnance Survey maps of 1866 and 1876.

3.2 Recent works include an architectural/standing buildings survey of the castle by Addyman Archaeology/Simpson & Brown in 2019, and geophysical surveys at the castle in 2020 (Archaeological Services 2021), both undertaken for English Heritage.

3.3 The following background information is taken from the project's 'Description of Scope' (Appendix I) prepared by English Heritage, and focuses on the castle area.

3.4 Warkworth Castle is an impressive aristocratic fortified residence situated on the banks of the River Coquet and occupying a commanding position above the town of Warkworth, Northumberland. Historically the castle is understood as a showpiece building belonging to the powerful Percy family.

3.5 As presently understood, the earliest earthworks date to the early 12th century, and its standing remains to between the late 12th-early 13th centuries. The identity of the architect of its early earthworks remains is not settled. There are two possible scenarios: first that it was built by Henry of Scotland (1114-1153), who from 1139 was Earl of Northumbria, and was the son of David I of Scotland. The other

possibility is that it was built with the support of Henry II of England, who retook possession of Northumberland in 1157, and under whose auspices a similar complex at Harbottle emerged. Whoever built the early castle was almost certainly developing an association with a lordship centre at Warkworth that was much older; Warkworth is mentioned in a 737 gift to Lindesfarne from Ceolwulf, King of Northumbria.

3.6 Sections of the curtain walls and the gatehouse are all that remain of this phase of construction. In 1157 the castle was granted to Roger Fitz Richard, Constable of Newcastle, whose descendants added to the castle with the construction of the gatehouse, Carrickfergus Tower, domestic buildings and in 1249 the rebuilding of the great hall in the bailey. It is very likely the 14th-century Great Tower presently atop the motte replaced an earlier structure of timber or stone. In 1311 the castle was acquired by the Crown and later, in 1332, was fully acquired by Henry Percy, lord of nearby Alnwick. It was Henry Percy, created Earl of Northumberland at the coronation of Richard II in 1377, who initiated Warkworth's most ambitious building project following his elevation: the construction of the Great Tower. The fourth earl (c.1449–1489) began the building of a large collegiate church in the bailey around 1480, however, after his murder in 1489 it appears that the project was abandoned and the construction never completed. His scheme for an overhauled bailey, however, is reflected in the configuration of the kitchen block, Little Stair Tower and redeveloped chapel. The foundations of the church incorporate a passage connecting the bailey and the Great Tower entrance. The rebuilding of the hall range in the bailey was also undertaken at this time, including the imposing Lion Tower with its impressive display of heraldic sculpture.

4. Landuse, topography and geology

4.1 The survey area comprised one field of grassland, intermittently used for pasture and for parking during the Warkworth fair.

4.2 The land was predominantly level with a mean elevation of approximately 25m OD, however, the northern two-thirds of the field were covered by broad east-west aligned rig and furrow and there was a broad linear depression along the eastern and southern sides of the field; several trees along the northern edge of this depression correspond to a former field boundary, shown on the 1st edition OS map of 1876. The depression or 'hollow-way' could be a former access route to the castle.

4.3 The underlying solid geology of the area comprises strata of the Stainmore Formation (mudstone, siltstone and sandstone), which are overlain by Devensian till.

5. Geophysical survey

Standards

5.1 The surveys and reporting were conducted in accordance with the Chartered Institute for Archaeologists (CIfA) *Standard and Guidance for archaeological geophysical survey* (2014, updated 2020); the *EAC Guidelines for the Use of Geophysics in Archaeology* (Schmidt *et al*. 2015); the Archaeology Data Service & Digital Antiquity *Geophysical Data in Archaeology: A Guide to Good Practice*

(Schmidt 2013); and the European GPR Association's Code of Practice (www.eurogpr.org/codeofpractice.htm).

Technique selection

5.2 Geophysical survey enables the relatively rapid and non-invasive identification of sub-surface features of potential archaeological significance and can involve a suite of complementary techniques such as magnetometry, earth electrical resistance, ground-penetrating radar, electromagnetic survey and topsoil magnetic susceptibility survey. Some techniques are more suitable than others in particular situations, depending on site-specific factors including the nature of likely targets; depth of likely targets; ground conditions; proximity of buildings, fences or services and the local geology and drift.

5.3 In this instance, it was considered possible that cut features such as ditches and pits might be present on the site, and that other types of feature such as trackways, wall foundations or fired structures (for example ovens and hearths) might also be present.

5.4 Given the anticipated nature and depth of targets, and the non-igneous geological environment of the study area, three complementary geophysical survey techniques were considered appropriate: magnetometer, earth electrical resistance and ground-penetrating radar (GPR).

5.5 The magnetic technique, fluxgate gradiometry, involves the use of magnetometers to detect and record anomalies in the vertical component of the Earth's magnetic field, which can be caused by variations in magnetic susceptibility or permanent magnetisation; such anomalies can reflect archaeological features.

5.6 Given the possible presence of wall-footings and paths/tracks, an electrical resistance survey was also appropriate; earth electrical resistance survey can be particularly useful for mapping stone and brick features. When a small electrical current is injected through the earth it encounters resistance which can be measured. Since resistance is linked to moisture content and porosity, stone and brick features will give relatively high resistance values while soil-filled features, which retain more moisture, will provide relatively low resistance values.

5.7 Similarly, high-resolution ground-penetrating radar (GPR) survey was considered appropriate for detecting smaller features, as well as the remains of cut and built features. GPR generates a short high-frequency radar pulse which is transmitted into the ground via an antenna; the energy is reflected by buried interfaces and the return signal is received by a second antenna. The amplitude of the return signal relates to the electromagnetic responses of different sub-surface materials and conditions, which can be features of archaeological or historic interest. The time which elapses between the transmission and return of radar pulses to the surface can be used to estimate the depth of reflectors. As well as conducting traditional 2D area surveys, GPR also has a depth component and so can be used to create 3D models of the data, provided sufficient data are collected at closely-spaced intervals; these models can then be viewed in plan as 'time-slices' (or 'depth-slices' where time has been converted to estimated depth).

Field methods

5.8 A 20m grid was established across the survey area and related to the OS National Grid using a Leica GS15 global navigation satellite system (GNSS) with real-time kinematic (RTK) corrections typically providing 10mm accuracy.

5.9 Magnetic gradient measurements were determined using a Bartington Grad601-2 dual fluxgate gradiometer. A zig-zag traverse scheme was employed and data were logged in 20m grid units. The instrument sensitivity was effectively 0.03nT, the sample interval was 0.25m and the traverse interval was 1m, thus providing 1,600 sample measurements per 20m grid unit.

5.10 Measurements of earth electrical resistance were determined using a Geoscan RM15D Advanced resistance meter with an MPX15 multiplexer and a mobile twin probe separation of 0.5m. A zig-zag traverse scheme was employed and data were logged in 20m grid units. The instrument sensitivity was 0.1ohm, the sample interval was 1m and the traverse interval was 1m, thus providing 400 sample measurements per 20m grid unit.

5.11 GPR data were collected using a Malå GeoScience Ramac X3M radar control unit, mounted directly onto a 500MHz centre-frequency shielded antenna. The antenna and control unit were mounted in a rugged cart with a RAMAC XV monitor attached and an odometer on one wheel to trigger the GPR pulses. The time window was set to 72ns, to enable the logging of reflections down to approximately 3.5m depth (assuming a mean soil velocity of 0.1m/ns; however, the subsequent estimated soil velocity was close to 0.06m/ns, so reflections were actually logged to a depth of just over 2m bgl). Returned energy wavelets were recorded from many depths in the ground to produce a series of reflections at each location, called a reflection trace. Series of traces collected along each transect produce a radar profile or radargram. For these surveys, data traces were logged at 0.05m intervals along parallel traverses spaced 0.5m apart. The start and end points of each traverse were again related to the OS National Grid using a Leica GS15 global navigation satellite system, as above.

GPR survey at St John's Close

GPR survey at St John's Close

5.12 Magnetic and resistance data were downloaded on site into a laptop computer for initial inspection and processing; GPR data were inspected on site using the Malå Ramac XV11 system. All datasets were backed up on removable media and subsequently transferred to a desktop computer for processing, interpretation and archiving.

Data processing

5.13 Geoplot v4 software was used to process the magnetic gradient and electrical resistance data and to produce continuous tone greyscale images of the raw (minimally processed) data. The greyscale images are presented in Figures 3-5; positive magnetic and high resistance anomalies are displayed as dark grey, while negative magnetic and low resistance anomalies are displayed as light grey. Palette bars relate the greyscale intensities to anomaly values in nanoTesla/ohm, as appropriate. Trace plots of the data were also prepared and examined but are not presented in this report.

5.14 The following basic processing functions have been applied to the magnetometer data:

clip	clips data to specified maximum or minimum values; to eliminate large noise spikes; also generally makes statistical calculations more realistic
zero mean traverse	sets the background mean of each traverse within a grid to zero; for removing striping effects in the traverse direction and removing grid edge discontinuities
de-stagger	corrects for displacement of geomagnetic anomalies caused by alternate zig-zag traverses
interpolate	increases the number of data points in a survey to match sample and traverse intervals; in this instance the data have been interpolated to 0.25m x 0.25m intervals

5.15 The following basic processing functions have been applied to the resistance data:

add	adds or subtracts a positive or negative constant value to defined blocks of data; used to reduce discontinuity at grid edges
de-spike	locates and suppresses spikes in data due to poor contact resistance
interpolate	increases the number of data points in a survey to match sample and traverse intervals; in this instance the data have been interpolated to 0.25m x 0.25m intervals

5.16 ReflexW v7.5 software was used to process the GPR profiles, to stack and interpolate the profiles to produce a 3D data volume, and to produce greyscale images of profiles and time-slices (Figures 6-8).

5.17 Combinations of the following processing functions have been applied to the GPR profiles:

dewow	removes very low frequency components by subtracting the mean from each trace
static correction	moves the start times for traces in each profile to 0nS
gaining the data	compensates for energy loss as the radio pulse penetrates deeper and/or amplifies the area of interest by adding a determined value
bandpass filter	removes low-amplitude frequencies
background removal	reduces data ringing

5.18 GPR profiles and time-slices have been examined. In this instance a hyperbola fitting technique was used to estimate mean soil velocity; 23 individual hyperbolas were picked across separate profiles. Estimated velocities between approximately 0.0481m/ns – 0.0722m/ns were measured, with a mean of 0.0632m/ns. Time-depth conversions are based on this estimated mean soil velocity and therefore any depths mentioned in the text below are also estimates.

5.19 Following static correction of the profiles, time-zero was adjusted to the first arrival time (approximately 5ns). This gave a time-window of 66.52ns; given the estimated velocity of 0.0632m/ns the maximum data depth was *c.* 2.10m. 422 samples were stacked to produce a 3D data cube, with one slice per sample, giving each slice a thickness of *c.* 0.158ns (*c*. 0.005m). To produce the depth-slices presented here the data between 0 and 60ns were evenly divided into 20 slices, giving each slice a thickness of 3ns (*c*. 0.095m). Selected profiles are presented in Figure 7; a series of depth-slices is presented in Figure 8.

5.20 The GPR data were collected in three survey periods over two days; the ground conditions were slightly different during each survey session and this appears to

have caused the slight differences in the GPR reflections between one session and the next. The variation is more evident in the time-slices which represent greater depths (eg below 30ns/1m).

Interpretation: anomaly types

5.21 Colour-coded geophysical interpretation plans are provided for the magnetometer and resistance surveys in Figures 4-5. Three types of magnetic anomaly have been distinguished in the data:

positive magnetic	regions of anomalously high or positive magnetic field gradient, which may be associated with high magnetic susceptibility soil-filled structures such as pits and ditches
negative magnetic	regions of anomalously low or negative magnetic field gradient, which may correspond to features of low magnetic susceptibility such as wall footings and other concentrations of sedimentary rock or voids
dipolar magnetic	paired positive-negative magnetic anomalies, which typically reflect ferrous or fired materials (including fences and service pipes) and/or fired structures such as kilns or hearths

5.22 Two types of resistance anomaly have been distinguished in the data:

high resistance	regions of anomalously high resistance, which may reflect foundations, tracks, paths and other concentrations of stone or brick rubble
low resistance	regions of anomalously low resistance, which may be associated with soil-filled features such as pits and ditches

Interpretation: features

5.23 A colour-coded archaeological interpretation plan is provided in Figure 9. For ease of reference, anomaly labels shown bold in the text below (eg **1**, **2** etc) are also shown on the archaeological interpretation plan.

5.24 The three geophysical techniques have detected a broad range of anomalies and probable feature types.

5.25 Broad parallel bands of alternate positive and negative magnetic anomalies have been detected across the northern part of the survey area; these anomalies correspond to a similar pattern of alternate high and low resistance anomalies. The anomalies reflect the existing ridge and furrow earthworks (**1**); in this instance the positive magnetic/high resistance anomalies reflect the upstanding ridges (more topsoil/less moisture), while the negative magnetic/low resistance anomalies indicate the furrows (less topsoil/more moisture). These features are also evident as weak reflections in the upper part of the GPR data. The ridge and furrow is aligned broadly-east-west, with furrows typically spaced at 6-7m intervals.

5.26 There is no headland evident at the eastern end of the ridge and furrow, and the earthworks appear to have been truncated by the broad linear cut along the eastern side of the field.

5.27 Many additional positive magnetic anomalies were also detected, the majority of which probably reflect materials within former ditches. The largest of these probable ditch features was detected in the central-western part of the survey, at the southern edge of the rig and furrow. The ditch forms an oval enclosure (**2**), measuring up to 33m across; the ditch itself typically measures approximately 1.5m in width. This feature is equally prominent in the resistance data, as a high resistance anomaly. Whilst the magnetic anomaly is typical of a soil-filled feature, a high resistance anomaly would be expected to reflect either a well-drained sediment, stone/brick materials or a void, for example. However, this feature is probably cut into the boulder clay subsoil and is unlikely to be well-drained (as opposed to the upstanding cultivation ridges). It seems likely that the fills of the ditch therefore comprise both sediments and stone. Iron minerals within the local rock here could also contribute to the magnetic anomalies associated with both sediment and stone. Whilst some small and weak, magnetic and resistance, anomalies can be discerned within the enclosure, they cannot be confidently interpreted as the remains of internal features.

5.28 A circular feature (**3**) was detected approximately 20m east of the probable enclosure (**2**). This feature was also clearly detected as both a positive magnetic anomaly and a high resistance anomaly, and could represent a ring-ditch filled with both sediment and stone. The ditch measures approximately 14m in diameter.

5.29 A similar, though more angular, feature (**4**) was detected in the north of the survey, again recorded as both positive magnetic and high resistance anomalies. The magnetic anomalies appear to reflect parts of four sides of a square, however, the resistance anomaly, which is more complete, appears hexagonal. This feature also measures approximately 14m across and could comprise both sediment and stone within a ditch or trench. Partial correspondence with some high amplitude GPR reflections (eg at 21-24ns) could also indicate the presence of stone in part of the feature.

5.30 Two further positive magnetic anomalies also have corresponding high resistance anomalies: one short arcuate feature (**5**), possibly part of another former ring-ditch, was detected to the north of (**2**) and (**3**); and a longer, sinuous, probable ditch feature (**6**) was detected immediately south of (**3**).

5.31 Whilst the shapes and sizes of features **2-6** are well-defined, the precise nature of the features is uncertain, since the magnetic and resistance data could indicate both sediments and stone. Ditches could have had stony material backfilled into them, or perhaps some of these features were construction trenches with some stone footings remaining.

5.32 Two rectilinear positive magnetic anomalies were detected near the south-east corner of the survey. The anomalies almost certainly reflect soil-filled features (**7**), perhaps ditches or trenches associated with a former structure. The southern part of the feature may have been truncated by a service pipe.

5.33 Several small, discrete positive magnetic anomalies have been detected across the field, which could possibly reflect small pits or postholes.

5.34 Various additional positive magnetic anomalies have been detected throughout the survey; these are typically very weak and/or of very limited extent, however, they provide slight indications of possible further soil-filled features such as gullies or small pits.

5.35 A straight and narrow high resistance anomaly and two corresponding negative magnetic anomalies were detected aligned east-west across the central part of the survey. High amplitude linear reflections (eg at 12-18ns) were also recorded to the immediate south, broadly corresponding to the magnetic and resistance anomalies. These anomalies could possibly reflect a wall-footing or similar, serving as a field boundary (**8**). This feature lies at the southern limit of the ridge and furrow and corresponds to the northern side of the enclosed area shown on the 1st edition OS maps, and broadly also the northern side of St John's Close as shown on Norton's 1624 map. The southern side of this feature on the early OS map is preserved in the existing line of trees in the southern part of the modern field, along the top edge of a linear depression.

5.36 Whilst there is no direct geophysical evidence for the broad linear depression along the east and south sides of the field (**9**), there is geophysical evidence for the apparent truncation of the ridge and furrow in the east and a raised concentration of small dipolar magnetic anomalies within the feature along both sides of the field, particularly along the southern side.

5.37 Although the GPR technique detected reflections associated with the ridge and furrow and the probable former field boundary, it recorded very few reflections associated with the probable oval enclosure, ring-ditches and other potential archaeological features.

5.38 Occasional weak linear magnetic anomalies and weak linear GPR reflections were detected in the field; the most prominent magnetic anomaly crosses the south-western part of the field (**10**). These anomalies could reflect plastic pipes or stone drains.

5.39 Two chains of intense dipolar magnetic anomalies were detected across the southern part of the field. These anomalies almost certainly reflect ferrous pipes (**11**, **12**).

5.40 Many small, discrete, dipolar magnetic anomalies were detected across the survey area. These almost certainly reflect near-surface items of ferrous and/or fired debris, such as horseshoes, chain links and brick fragments, for example, and in most cases have little or no archaeological significance. A sample of these is shown on the geophysical interpretation plan, however, they have been omitted from the archaeological interpretation plan.

6. Conclusions

6.1 Geophysical surveys have been undertaken at St John's Close in Warkworth, Northumberland, in order to contribute to research informing a new scheme of interpretation for the wider castle area.

6.2 The three geophysical techniques have detected a broad range of anomalies and probable feature types.

6.3 Anomalies and reflections associated with the upstanding ridge and furrow remains were detected across the northern part of the field.

6.4 Further magnetic and resistance anomalies probably reflect an oval enclosure, at least one ring-ditch and another similarly-sized more angular feature, as well as the potential partial remains of several other features; the angular feature appears to be hexagonal in the resistance data. The nature of these magnetic anomalies is more typically associated with soil-filled features, while the corresponding high resistance anomalies would typically indicate stone, for example. While the exact nature of these features is therefore uncertain, it is likely that they comprise both sediments and stone within cut features such as ditches or construction trenches. Occasional high amplitude GPR reflections could also indicate the presence of stone in parts of these features. In the archaeological interpretation plan, these anomalies are presented as 'soil-filled' features. In terms of relative chronology, inspections of the upstanding cultivation ridges at the locations of these anomalies did not identify any apparent cuts through the ridges; it is likely that these features pre-date the ridge and furrow cultivation.

6.5 Positive magnetic anomalies with no corresponding resistance or GPR anomalies are interpreted as soil-filled features, typically ditches, gullies and pits.

6.6 A probable former field boundary has been identified aligned east-west across the central part of the field. This former boundary may contain stone footings and corresponds to a field boundary shown on the earliest OS maps. The northern boundary of 'St John's Close', as shown on Norton's map of 1624, also broadly corresponds to the location of this feature.

6.7 Two ferrous pipes and occasional probable drains were also detected across the field.

7. Sources

Archaeological Services 2021 *Warkworth Castle, Northumberland: geophysical surveys*. Report **5414**, Archaeological Services Durham University

ClfA 2014 *Standard and Guidance for archaeological geophysical survey*. Chartered Institute for Archaeologists

European GPR Association *Code of Practice*

Petts, D, & Gerrard, C, 2006 *Shared Visions: The North-East Regional Research Framework for the Historic Environment*. Durham

Schmidt, A, 2013 *Geophysical Data in Archaeology: A Guide to Good Practice*. Archaeology Data Service & Digital Antiquity, Oxbow

Schmidt, A, Linford, P, Linford, N, David, A, Gaffney, C, Sarris, A & Fassbinder, J, 2015 *EAC Guidelines for the Use of Geophysics in Archaeology: Questions to Ask and Points to Consider*. EAC Guidelines **2**, Namur

Appendix I: Project specification

DESCRIPTION OF SCOPE

Geophysical Survey at Warkworth Castle, Northumberland.

Summary

From 2019-2023 English Heritage is investing in a transformation of the visitor experience at the site with an overhauled interpretation scheme and possibly including a new visitor centre. In this preliminary phase of the 'Warkworth Castle: Stories in Stone' project, it is essential to establish early on any new thinking or understanding of the standing (and subsurface) evidence for the castle's history. It is a scheduled ancient monument and a Grade I listed building. The presentation of the monument is that of ruin, displayed largely for its architectural interest, however, the 'Duke's Rooms' are roofed and semi-furnished. The interpretation scheme on the site is minimal, chiefly Office of Works-style signs identifying the function of a given room. Visitors are currently invited to use an audio guide to explore the history and details of the site's architecture. Geophysical survey, funded through a grant from the Castle Studies Trust, is required at three locations around the castle to assist with this research. The survey will consist of a magnetic, GPR and earth resistance survey depending on the suitability of the techniques to the individual site conditions detailed in the specification. Tenders are invited for this work to be concluded with a report by 30th November 2020.

Background

Warkworth Castle is an impressive aristocratic fortified residence situated on the banks of the river Coquet and occupying a commanding position above the town of Warkworth, Northumberland. Historically the castle is understood as a showpiece building belonging to the powerful Percy family.

As presently understood, the earliest earthworks date to the early 12th century, and its standing remains to between the late 12th-early 13th centuries. The identity of the architect of its early earthworks remains is not settled. There are two possible scenarios: first that it was built by Henry of Scotland (1114-1153), who from 1139 was Earl of Northumbria, and was the son of David I of Scotland. The other possibility is that it was built with the support of Henry II of England, who retook possession of Northumberland in 1157, and under whose auspices a similar complex at Harbottle emerged. Whoever built the early castle was almost certainly developing an association with a lordship centre at Warkworth that was much older; Warkworth is mentioned in a 737 gift to Lindesfarne from Ceolwulf, King of Northumbria.

Sections of the curtain walls and the gatehouse are all that remain of this phase of construction. In 1157 the castle was granted to Roger Fitz Richard, Constable of Newcastle, whose descendants added to the castle with the construction of the gatehouse, Carrickfergus Tower, domestic buildings and in 1249 the rebuilding of the great hall in the bailey (see Figure 1). It is very likely the 14th-century Great Tower presently atop the motte replaced an earlier structure of timber or stone. In 1311 the castle was acquired by the Crown and later, 1332, was fully acquired by Henry Percy, lord of nearby Alnwick. It was Henry Percy, created earl of Northumberland at the coronation of Richard II in 1377, who initiated Warkworth's most ambitious building project following his elevation: the construction of the Great Tower (Figure 2). The fourth earl (c.1449–1489) began the building of a large collegiate church in the bailey around 1480, however, after his murder in 1489 it appears that the project was abandoned and the construction never completed. His scheme for an overhauled bailey, however, is reflected in the configuration of the kitchen block, Little Stair Tower and redeveloped chapel. The foundations of the church incorporate a passage connecting the bailey and the Great Tower entrance. The rebuilding of the hall range in the bailey was also undertaken at this time, including the imposing Lion Tower with its impressive display of heraldic sculpture.

Archaeology

There are three areas being proposed for the survey, the approximate extent of which are outlined in Figure 2. The areas to be surveyed (red blocks) are illustrated, though the precise extent will be dependent on variable factors like weather and site access:

- Firstly, the area of the bailey enclosed by the present 12th-century curtain wall, as well as the strip of unenclosed land to the east of the bailey wall, but still on the earthwork bailey platform. The exclusion of this area of the earthwork castle from the medieval stone walling scheme is a particular research question to be targeted by this research. The intramural subsurface remains will inform our understanding of how the site has developed into its present courtyard arrangement of ranges

- Secondly, we aim to examine the subsurface remains of the motte mound itself, to establish the presence of near-surface materials predating the late 14th-century Great Tower. The architectural evidence for an earlier structure is contested and ambiguous, but renewed geophysical examination may tip the scales of the argument one way or the other.

- Thirdly and finally, we aim to investigate the subsurface remains of a field proximate to the medieval access route to the castle at St John's Close, ~350m SW of the castle. Early cartographic material suggests it may retain medieval buildings associated with the former empaled hunting park. [**this report**]

The architecture and history of Warkworth is of national significance, and its great tower is arguably of international architectural importance. EHT's project aims to explore this significance through a wholly new interpretation scheme, telling the fascinating stories associated with the site. It also aims to shed further light on the story of its buildings and their changes over time. This survey will dovetail with a comprehensive architectural/standing buildings survey of the castle undertaken in 2019 on EHT's behalf by Addyman Archaeology/Simpson & Brown. The preliminary findings of these efforts have helped shape our aims for this geophysical survey.

Site conditions

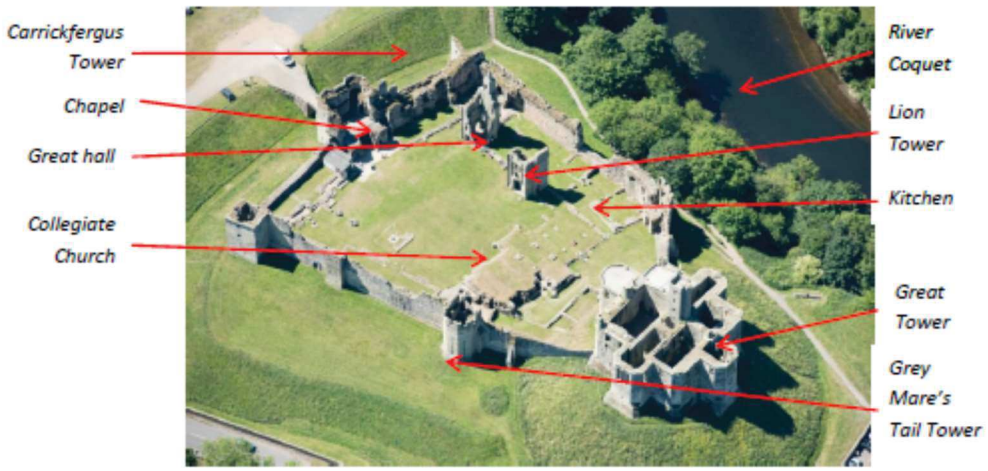

Figure 1: A selection of features within the castle. Oblique aerial photograph of castle looking South-West. © Historic England (Emma Trevarthen).

The areas where survey is required are down to well-kept grass although the following conditions should be noted:

The bailey is interrupted in places by standing buildings and other fragmented structural remains that may impede geophysical survey. There has also been extensive historical intervention in this area that will impact the quality and interpretation of the survey results (see additional information). A combination of magnetic, earth resistance and GPR survey is required in this area.

Only limited survey over the accessible, flat areas of the motte mound surrounding the Great Tower are required using earth resistance.

The majority of St John's Close is covered by east-west orientated rig and furrow, although there is

potential for the survival of building remains here. The whole area is to be covered with magnetic survey, with subsequent targeted coverage over 1ha using earth resistance and GPR. Figure 3 shows the results of a recent utilities survey of the site.

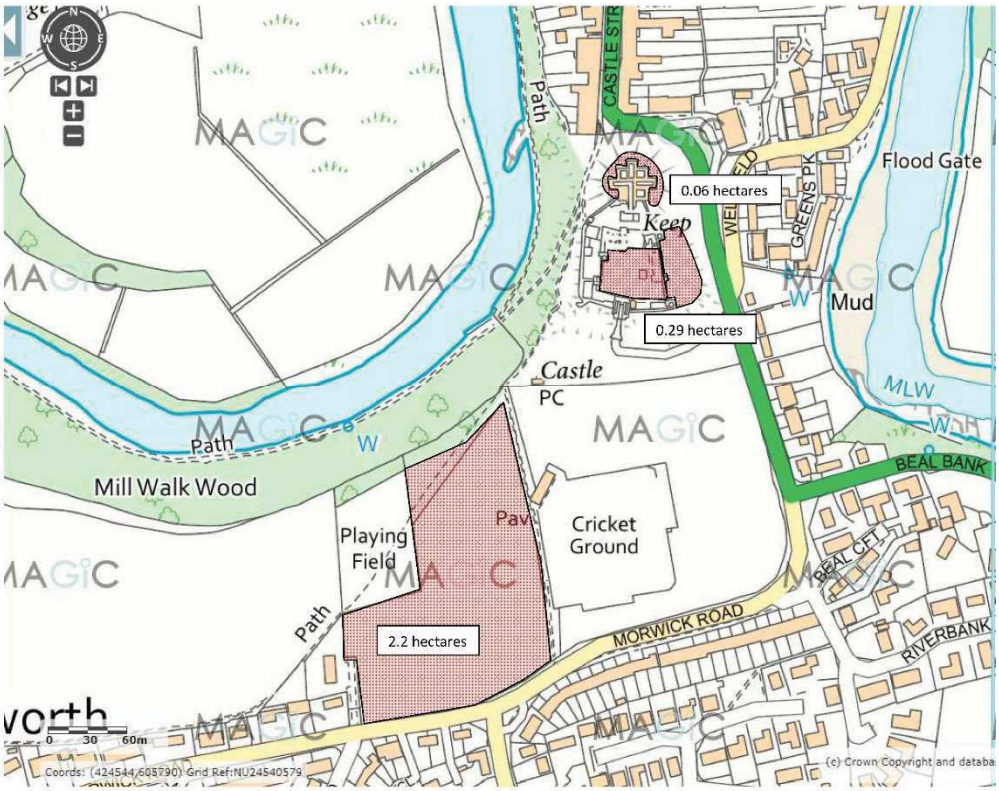

Figure 2. Location of the three sites where geophysical survey is required from the north: motte mound (0.06ha), bailey (0.29ha) and ***St John's Close (2.2ha)***

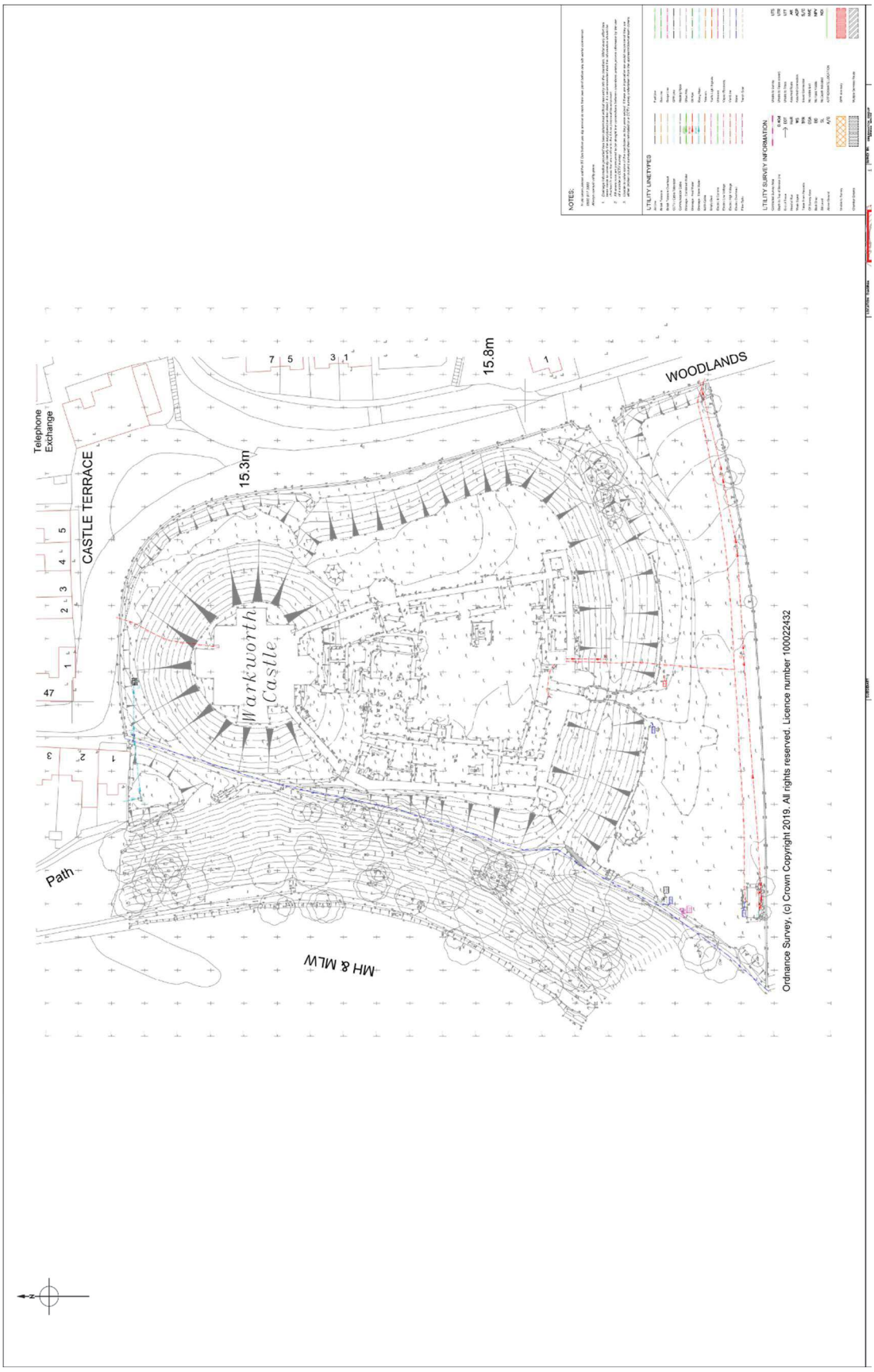

Figure 3. Underground utilities survey.

The geophysical survey requirement

The objective of the survey is to attempt to locate significant anomalies related to any surviving archaeology or historic invtervention. Details of the techniques required for the survey are given below.

Specification

1. The magnetic survey is to be conducted with a fluxgate gradiometer or similar instrument, either hand held or a cart based array. Readings must be recorded at intervals of 0.25m x 1.0m (or closer) over a survey area of ~0.29ha within the bailey and ~2.2ha within St. John's Close.

2. The Ground Penetrating Radar (GPR) survey should be conducted with a suitable centre frequency antenna to be determined on site following appropriate field tests. Data should be recorded at a minimum sample interval of 0.05m intervals along parallel transects separated by a minimum of 0.5m to enable the presentation of the resulting data set through a series of horizontal amplitude time slices. It is anticipated that a centre frequency of approximately 500MHz would be most suitable for this survey. GPR survey will be required over an area of ~0.29ha within the bailey and 1.0 ha within St. John's Close.

3. The earth resistance survey will use either the Twin Electrode (Twin Probe) configuration with a mobile probe spacing of 0.5m, or a wheeled resistivity square array system with probe spacings of 0.75m. Readings should be recorded at 1.0m x 1.0m intervals (or closer). Every effort should be made to ensure that a uniform dataset is acquired in which discontinuities of measurement levels at grid edges are minimised. Earth resistance survey is required over level areas of the motte mound surrounding the Great Tower (0.06ha), the bailey (0.29ha) and 1.0 ha within St. John's Close.

4. Any temporary survey grid established over the site should be accurately measured in to permanent landmarks or discreetly positioned permanent marker pegs by the geophysical survey team. The temporary survey grid should be removed after the completion of fieldwork unless other arrangements have been agreed to facilitate further work on the site. Location measurements, provided in the final survey report, should allow the temporary survey grid to be exactly relocated from readily identifiable landmarks or marker pegs if necessary. In addition, the location of the temporary survey grid should be co-registered to the Ordnance Survey National Grid and any permanent markers established at the site.

5. The fieldwork must be concluded and 3 copies of a full report provided by 30th November 2020. A copy of the raw geophysical data, the final report text, figures and associated electronic drawing files must also be supplied to the Historic England Geophysics Team in an appropriate, mutually compatible electronic format. Historic England reserves the right to include appropriate reports in its Research Department Report Series.

6. All fieldwork, data processing and reporting must follow recommendations set out by English Heritage (2008).

7. Fieldwork on site must be conducted with a high degree of professionalism. Extreme care must be taken to avoid trip hazards caused by trailing equipment leads or survey grid markers during the conduction of the survey. Contractors will be responsible for preparing a Risk Assessment prior to the commencement of work.

8. Contractors should also provide a confirmation of procedures for safe site working with regard to the current COVID-19 situation, and abide by all local safety procedures and requirements at the site.

It is the policy of Historic England to retain all Intellectual Property Rights over all goods and services produced during the performance of a Historic England contract. This includes all images, survey data, outputs, derived products and reports (see clause14 below).

Access

Access to site to be arranged through liaison with English Heritage.
There is public access to the site and it is probable that there will be some local interest.

Section 42 Licence
To be provided for the chosen contractor **(not necessary for St John's Close)**.

Ofcom GPR/WPR Licence
Evidence for a suitable licence for the operation of ground or wall penetrating radar covered by Ofcom guidance note OfW 350 (18 September 2019) should be provided by the chosen contractor.

Maps
Digital mapping and site plans will be provided to the successful contractor for the creation of figures in the final report.

References

English Heritage 2008 *Geophysical survey in archaeological field evaluation*, 2nd edn. Swindon, Historic England.

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Figure 1: Site location

site boundary

0 1km
scale 1:20 000 for A4 plot

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0 50m
scale 1:1000 for A3 plot

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Figure 2: Survey overview

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0 50m
scale 1:1000 for A3 plot

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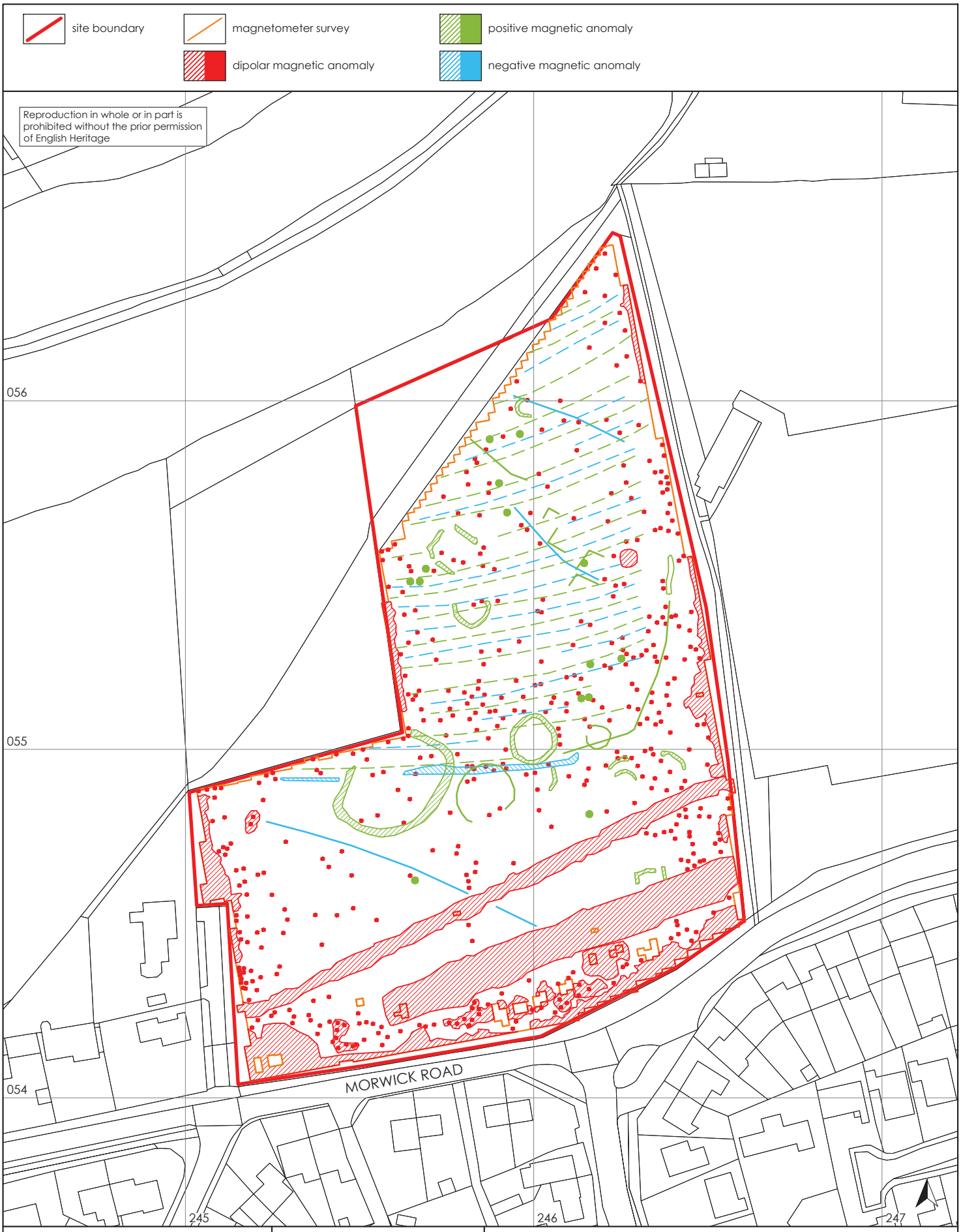
Figure 3: Magnetometer survey



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0 50m
scale 1:1000 for A3 plot

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Figure 4: Geophysical interpretation of magnetometer survey

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site boundary
resistance survey
high resistance anomaly
low resistance anomaly
15 ohm 35

0 50m
scale 1:1000 for A3 plot

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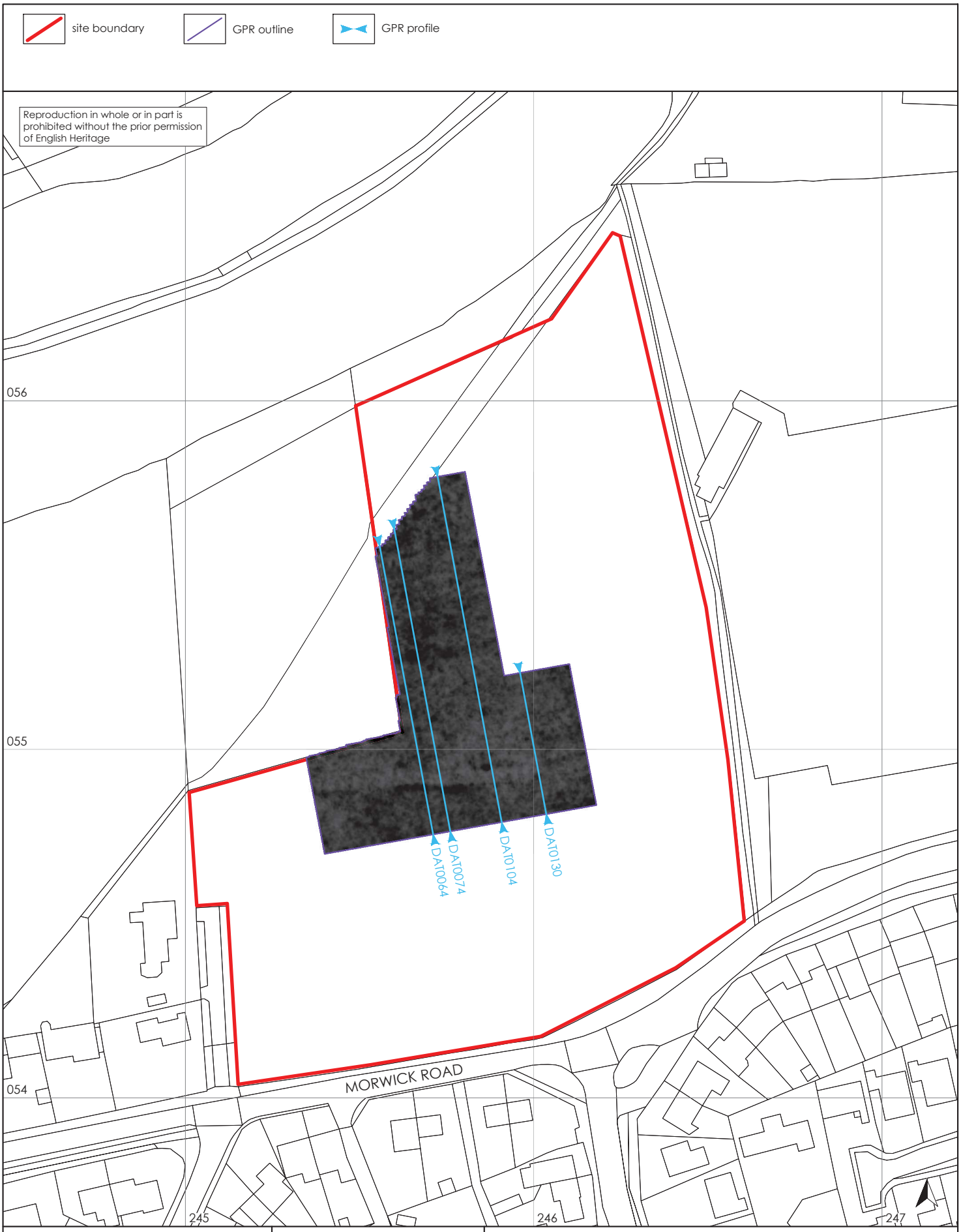
Figure 5: Resistance survey (A) and geophysical interpretation (B)



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0 50m
scale 1:1000 for A3 plot

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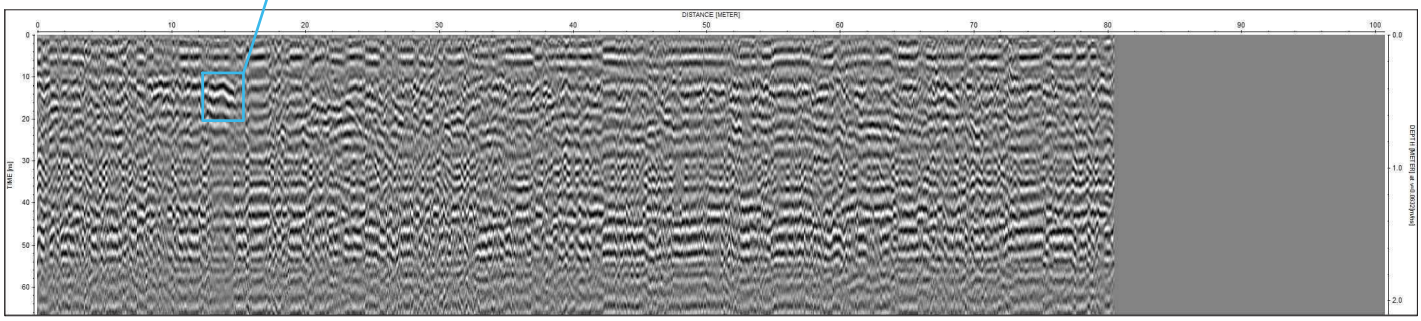
Figure 6: GPR survey with profile locations

DAT0064_x=32m



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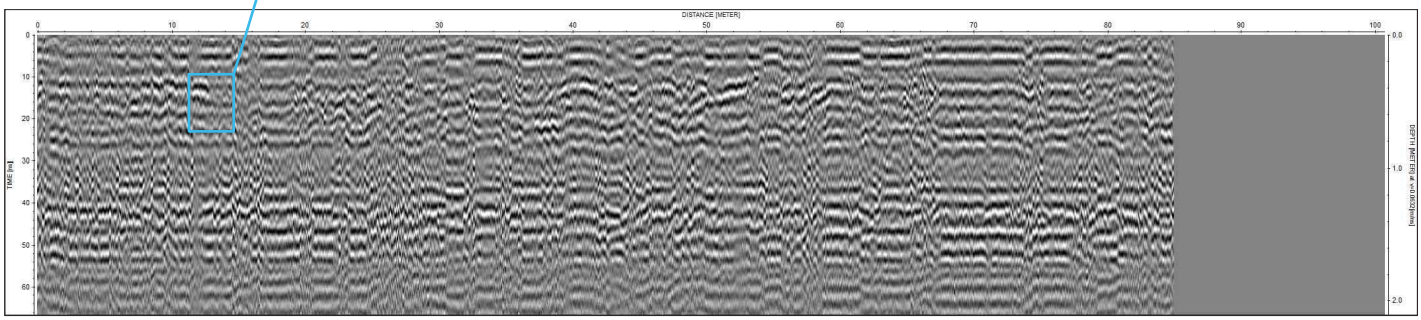

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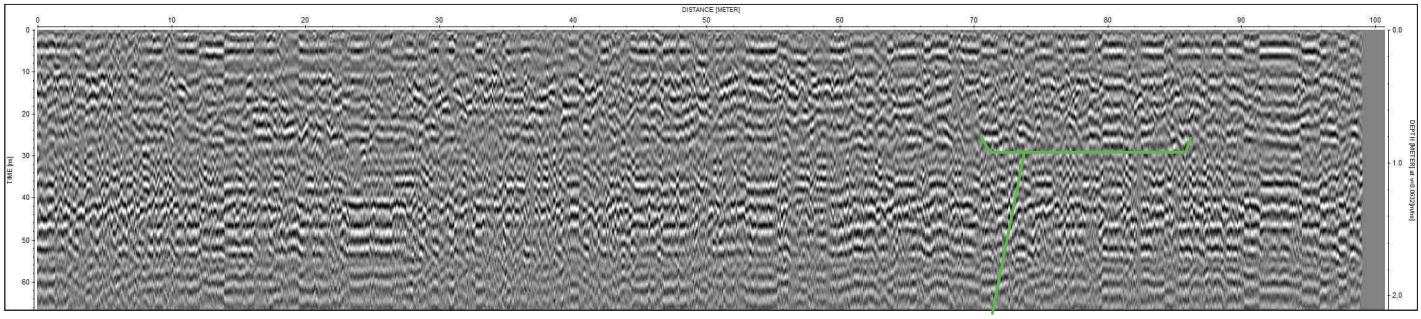

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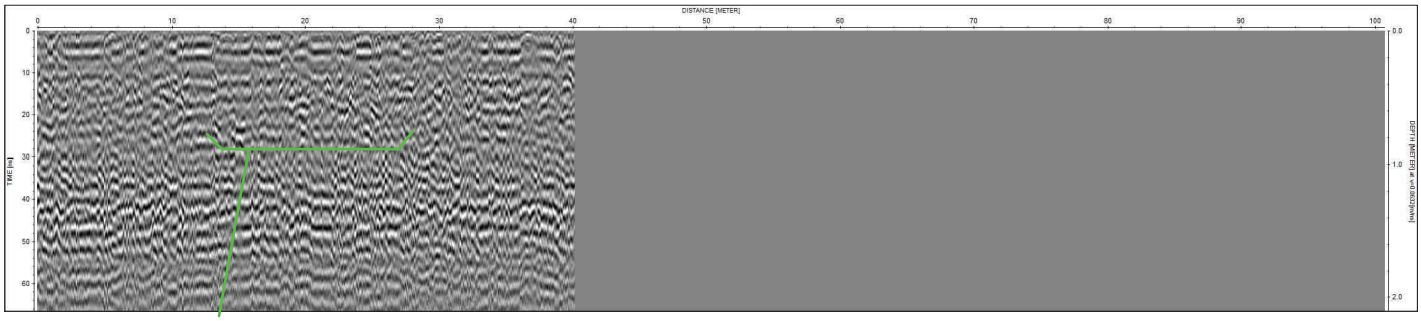

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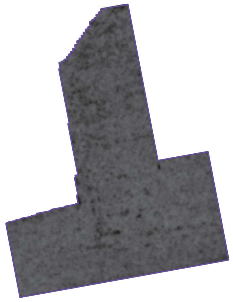
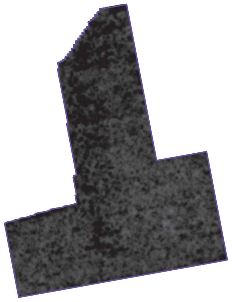
Figure 7: GPR profiles

GPR_00-03ns_0.10-0.19m

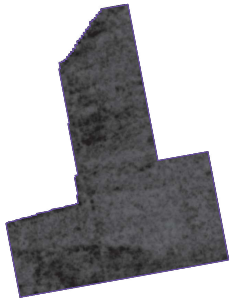


GPR_0-06ns_0.19-0.29m

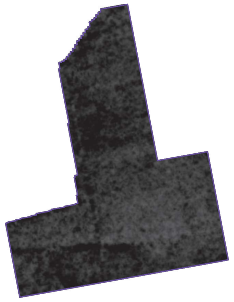


GPR_06-09ns_0.29-0.38m

GPR_09-12ns_0.38-0.48m



GPR_12-15ns_0.48-0.57m



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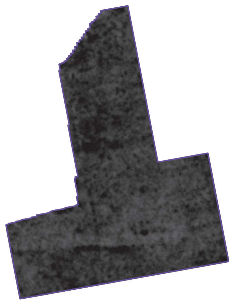
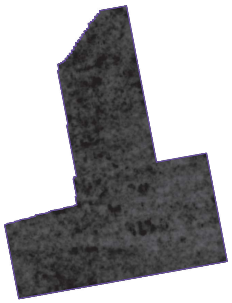
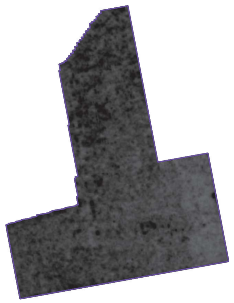


GPR_18-21ns_0.67-0.76m

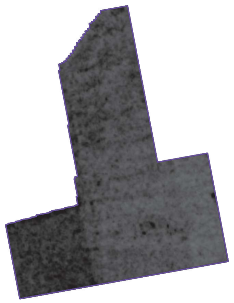


GPR_21-24ns_0.76-0.86m

GPR_24-27ns_0.86-0.95m



GPR_27-30ns_0.95-1.05m



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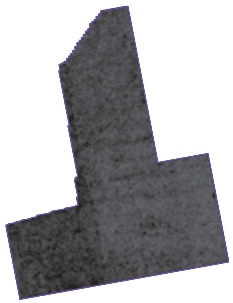
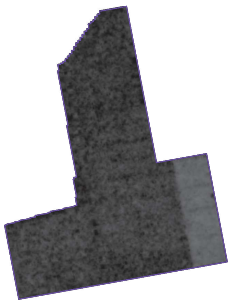


GPR_33-36ns_1.14-1.24m



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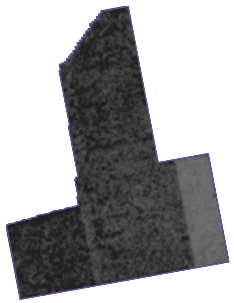
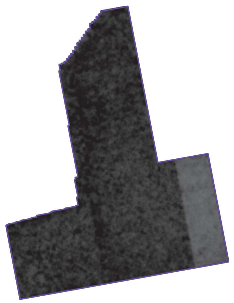
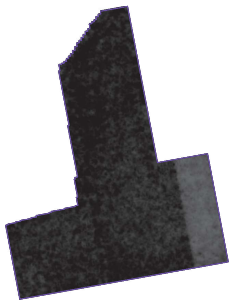


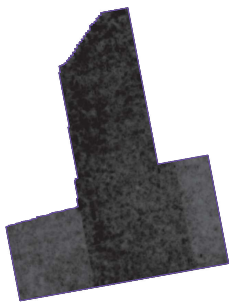
GPR_39-42ns_1.33-1.43m



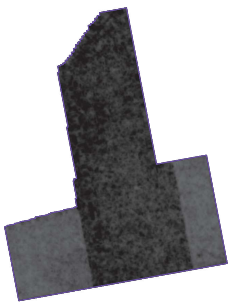
GPR_42-45ns_1.43-1.52m



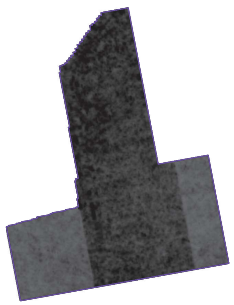
GPR_45-48ns_1.52-1.62m



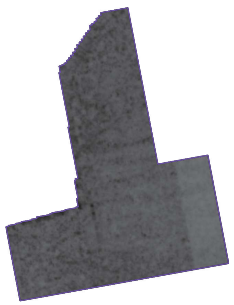
GPR_48-51ns_1.62-1.71m



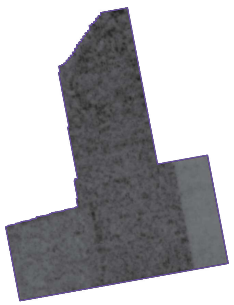
GPR_51-54ns_1.71-1.81m



GPR_54-57ns_1.81-1.90m



GPR_57-60ns_1.90-2.00m



GPR outline

low relative reflector strength high

0 50m
scale 1:1000 for A1 plot

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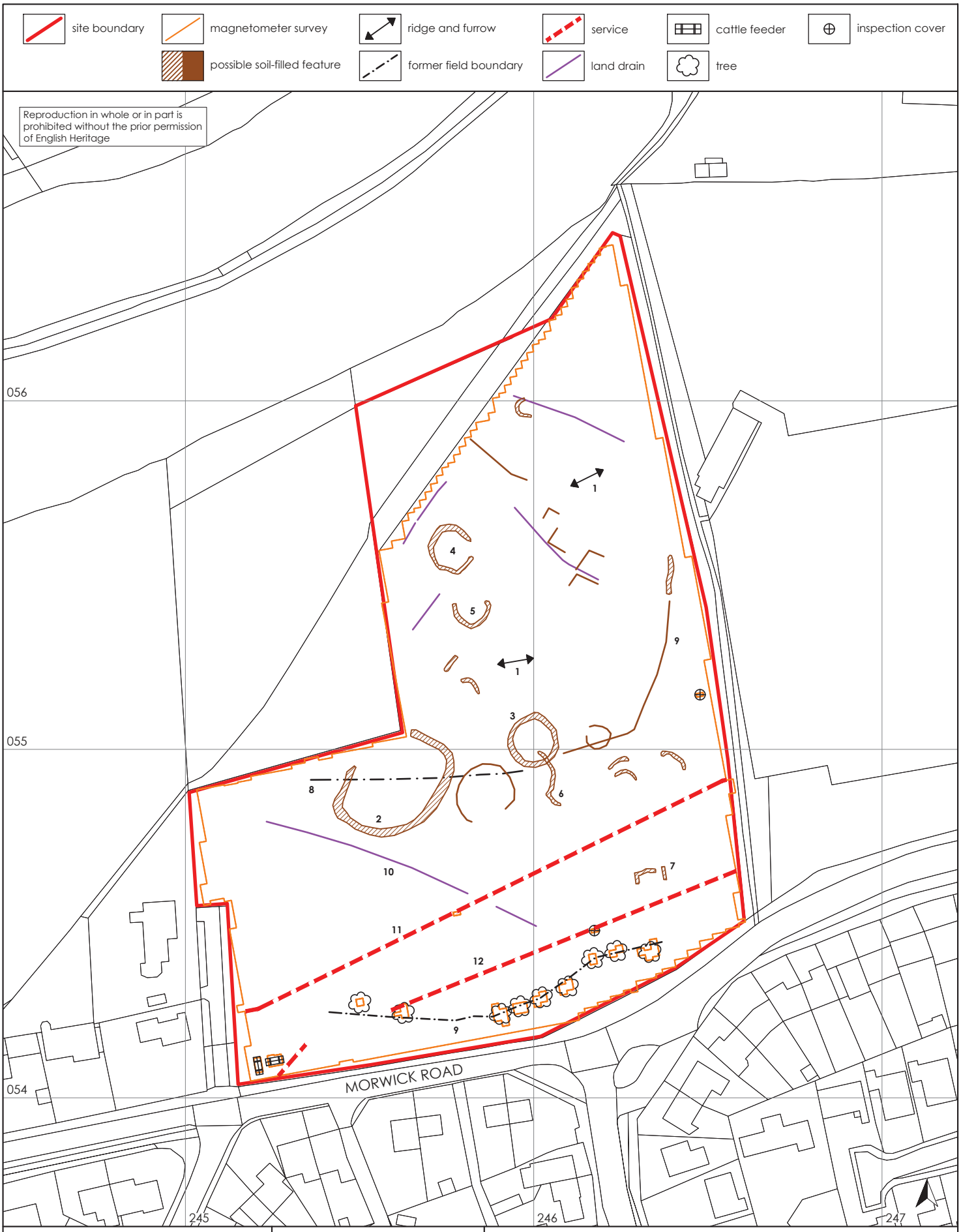
Figure 8: GPR depth-slices



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0 50m
scale 1:1000 for A3 plot

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Figure 9: Archaeological interpretation