Long-term Landscape Development in south-east Northumberland using Orientation Analysis

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Abstract

The following thesis will explore the extent to which antecedent rural landscape features endured into later periods in south-east Northumberland using bespoke models built in GIS, and statistical analysis to calculate and compare the orientation of linear human-made features including boundaries, settlements and agricultural traces, and assess their relationship with underlying terrain.

The extent to which antecedent systems of land use may have influenced those which came after has preoccupied archaeologists and historians for many years in other parts of England; but has never been discussed in the current study area, which lay beyond the northern frontier of the Roman Empire. Chronological gaps in settlement and land-use have been identified, between the second and sixth-century AD; and between the ninth and twelfth-century AD. It is the purpose of the current research to produce evidence which may help to shed light on how people lived and worked in the landscape at these times. Numerous large-scale, developer-funded excavations during the last twenty years have transformed our knowledge of the region. The rich grey literature resource resulting from these projects are here placed into a research context which reaches beyond the chronological constraints of the sites and features themselves. The results of these analyses, in light of recent research in the region and beyond, has led to a proposition that if boundary features present on 1st edition Ordnance Survey maps share orientation with nearby ancient boundaries and settlement enclosures, they could represent long-standing land-divisions from at least the late Iron Age to the nineteenth-century and in some cases into the present. In general, however, many boundaries present on 1st edition ordnance survey mapping conform to underlying slope direction, which makes the above claim more ambiguous.

Front cover image: The south-east Northumberland Coastal plain looking east from Earsdon village (photograph: author)

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1 Contents

1 Introduction

The following study encompasses an area between the Rivers Tyne and Wansbeck with a distinctive landscape history from the late second-century AD onwards, from which two interconnected questions have dictated the direction of the research: what happened to the landscape of south-east Northumberland following the changes wrought by the Roman administration in the second-century AD, through the collapse of Roman administration by the early fifth-century AD, and into the medieval period and beyond; and did any settlements, boundaries or tracks continue to be used into the recent past? The drive of the Roman army into northern territories, typified by the building of Hadrian's Wall in AD 122, has been shown through excavations to coincide with a demise of many rural settlements, at least in on the south east coastal plain of Northumberland (Hodgson *et al.* 2012; Roberts 2015). It has also been suggested that these lands were exploited to some extent by the Roman administration (Hodgson *et al.* 2012: 217-220; Roberts 2015), but to what extent, and whether existing boundaries were maintained, or endured, remains unclear. These changes are empirically connected with gaps in our knowledge of settlement and land-use in the region, which this study aims to address through the application of a new methodology centred on the analysis of relative orientation and conformity to slope direction amongst settlements, boundaries and tracks.

The 2006 North East Regional Research framework (NERF hereafter) (Petts and Gerrard 2006) played a key role in defining the direction of this research.[1] It stated the extent to which the prehistoric and Roman landscape influenced proceeding periods is still open to debate; and the long-term continuity of boundaries, dykes and other elements of field systems (Petts and Gerrard 2006: 157). The current study area lies mostly in the region north of Hadrian's Wall; and was for large parts of the Roman period beyond the Roman province of 'Britannia'. What became of this area following the building of Hadrian's Wall in AD 122 is central to this study. In the current study area either side of the Roman period, evidence for settlement and land use is similar to elsewhere in southern Britain. Rectilinear settlements and associated field systems are common features in late Iron Age, Anglo-Saxon Hall

[1] This is due to be superseded (Petts forthcoming); however, at the time of writing this was yet to be disseminated, so this research will refer to the 2006 edition.

settlements in the Anglo-Saxon period, and nucleated planned villages and open fields were common by the twelfth-century. The difference in the current study area is the impact of Hadrian's Wall, which appears on current archaeological evidence to have led to a degree of settlement abandonment in the region stretching roughly 16km to the north (Hodgson *et al.* 2012).

Previous studies concerned with continuity and change in boundary use have been most prevalent in the south and east of England and the midlands, including Wessex (Bonney 1972; 1979), Essex (Rodwell 1978; Drury and Rodwell 1980), Warwickshire (Ford 1979), Cambridgeshire (Harrison 2005; Oosthuizen 2006), Somerset (Aston and Gerrard 2013), East Anglia (Williamson 1987; 1988; 2016), Northamptonshire (Williamson *et al.* 2013). The current study area is, however, under-represented in studies concerning long-term change and continuity. A recent study by Rippon *et al.* (2015) is geographically bounded to the former Roman Province, portrayed in its title, the 'Fields of Britannia', the northern limit being Hadrian's Wall. This and other research projects conducted on areas within the Roman province of Britannia are very useful comparative studies, but do not provide an accurate context for activity in the region north of Hadrian's Wall. Whilst some studies are providing a debate on the history of the region at this time (Collins 2012; Hodgson *et al.* 2012; Roberts 2015; Smith *et al.* 2016), none have tried to bridge the chronological gap by exploring the longevity of boundaries and other linear units, using their orientations and conformities to slope direction.

The archaeology of Roman Britain is seen as quite separate from that of the medieval period; and a similar separation exists between the early, middle and late Anglo-Saxon periods (Rippon *et al.* 2015: 4). The compartmentalisation of research into the 'Roman', 'Saxon' and 'medieval' periods perpetuates the impression of discontinuity. As the archaeological record becomes less visible by the 5th century AD, so Romanists cease to study it (Rippon *et al.* 2015: 6-7). This is certainly changing, as can be seen through recent studies, some of which focus on the current study area (Collins 2012; Roberts 2015); whilst others cover larger areas (Gerrard 2013; Oosthuizen 2015; Rippon *et al.* 2015).

We also have little understanding regarding the development of settlement and land-use from the early medieval into the later medieval period despite developer-funded work offering occasional keyhole glimpses (Muncaster *et al.* 2014*.;* TWM 2010*;* The Archaeological Practice 2015). Excavations of the Anglo-Saxon settlement at Shotton (Muncaster *et al.* 2014) revealed a rare glimpse into how people lived during the period in the region; and showed many commonalities with similar settlements elsewhere. This discovery, along with North Seaton (The Archaeological Practice 2015), currently sits in isolation in the current study area, and the period between the end of the Anglo-Saxon settlement at Shotton and the first documented appearance of medieval nucleated villages in the twelfth-century is relatively blank in terms of settlement and land use. On the origins of medieval nucleated villages, there is little evidence that the documented 'harrying of the North' following the Norman Conquest reached the current study area (Kepple 1979), so a degree of continuity could be implied compared with further south; but ultimately, we do not know at the time of writing.

The NERF also stated that research into settlements was required at a sub-regional level; for example, looking at if the layout of nucleated villages is genuinely late (after AD 1100), then what settlement forms preceded them? (Petts and Gerrard 2006: 169). Aspects of distribution, morphology, economic and social contexts of medieval nucleated villages within the current study region have been extensively studied (Roberts 1987; 2008; Wrathmell 1975; Dixon 1984; Roberts and Wrathmell 2000; Wrathmell 2012); but the issue of medieval village origins remains understudied compared with other areas in eastern England and the Midlands (for example Lewis *et al.* 2001; Brown and Foard 1998; Aston and Gerrard 2013; Jones and Page 2006; Oosthuizen 2006; Wrathmell 2012; Hamerow 2012). Studies of medieval villages in Northumberland have historically tended to focus more on the demise and desertion rather than origins (Wrathmell 1975; Dixon 1984; 2014). For example, excavations during the 1980s at Alnhamshiels in north Northumberland (Dixon 2014) focused on the economy and demise of the medieval settlement rather than exploring possible relationships between the medieval settlement and earlier remains within and around the site. This is not to belittle the Dixon's important discoveries; but exemplifies how research agendas have dictated the construction of historic narratives at different times.

1.1 Aims and objectives of the research

This study will explore how the cumulative structure of the landscape has developed over long periods in south east Northumberland from the late Bronze Age to the present. The following aims and objectives will act as the theoretical and practical framework underpinning the study.

Aim 1: To explore how analysing orientation and conformity to underlying slope direction can inform ideas of landscape development over long periods

- Objective 1: Review existing studies which have a focus on relative orientation of linear landscape features
- Objective 2: Identify possible gaps in archaeological data in the study area within the chronological parameters of the research, including a thorough review of existing grey literature.
- Objective 3: Build a dataset of all known linear human-made features within the study area, including undertaking a detailed analysis of LiDAR and Google Earth imagery.

"Our problem has not… been a paucity of data. It has been our failure to interrogate it in the most effective ways" (Williamson 2003: 27). Data-driven research projects, often incorporating underused information from developer-funded projects, have recently addressed this statement to an extent (for example Rippon *et al.* 2015; Smith *et al.* 2018). The NERF identified a lack of landscape-based approaches to settlement and land use in the region, however (Petts and Gerrard 2006: 137-138; 146; 153). Objective 1 will be met later in this chapter through a critique of existing studies which have included the analysis of orientation to assess long term landscape development. This will inform aim 2 and objectives 4 and 5.

Objective 2 will explore chronological gaps in the archaeological record within the study area; and question whether they are real or a product of how the archaeological record has been compiled in the region. Boundaries and route-ways depicted on 1st edition Ordnance Survey mapping have long thought to represent centuries if not millennia of human activity in the landscape, with ancient patterns "present but deeply concealed…by the background noise of the detail which results from the compression of evidence from many periods into one place" (Roberts and Wrathmell 2002). Boundaries in general have been found to have a higher survival value than settlements; and reliance on the latter for evidence of continuity has sometimes been misplaced (Bonney 1972: 185; Hazelgrove 2002). Studying the orientation and conformity to slope direction of these features has the potential to offer insights into the longevity of antecedent settlement and land-use on later arrangements. The abandonment of settlements in the late Iron Age and early Roman periods may not always imply the abandonment of systems of land management and its representative features.

Objective 3 will be addressed through the characterisation and transcription of landscape features including pit alignments, Iron Age/early Roman settlement enclosures and dated boundaries; Anglo-Saxon settlements; medieval nucleated villages, medieval ridge and furrow and post-medieval ridge and furrow to form the main datasets for the study. Also included are boundaries and routeways depicted on 1st edition Ordnance Survey mapping, dating to the middle of the nineteenth-century.

Aim 2: To devise an implement innovative and non-intrusive methods to explore long term landscape development using existing data

- Objective 4: Devise a metric method for calculating and comparing the orientation of linear features
- Objective 5: Devise a method for measuring and comparing conformity to underlying slope direction using tools and scripts in GIS, and comparative methods in Excel.

This study is pivoted around a newly devised method for calculating the orientation and slope direction conformity of very large datasets of transcribed linear human-made features. To address objectives 4 and 5 specifically, a GIS methodology will be devised to calculate and analyse the orientations a metric dataset representing linear human-made landscape features. Using the model devised in this study for calculating and analysing orientation and slope direction conformity enables large numbers of polylines to be tested, which would be extremely time-consuming and more subjective using visual perception methods.

Analysing the orientation of artificial linear features in the landscape relative to underlying slope direction offers an alternative narrative to how and why such features are oriented in particular ways. If certain settlements, boundaries, routeways and traces of ancient and historic ploughing are found to be oriented in a similar way to underlying slope direction, it could be assumed that natural topography had some influence on their layout. Comparing the results of each dataset will reveal possible trends in conformity and non-conformity to underlying slope direction over time. Distribution patterns of the results will determine whether conformity slope direction is evident more in the upland western context than along the coastal plain in the east.

Aim 3: To explore whether, and how, ancient and historic landscape units endured into later periods

- Objective 6: Visualise and analyse the extent to which the orientations of dated ancient and historic linear features relate to surrounding boundaries and tracks present on 1st edition Ordnance Survey mapping
- Objective 7: Visualise and analyse relative extents of conformity to underlying slope direction in the dataset.

Aim 3 sits alongside the following question: to what extent might pre-existing landscape features have been perceived and exploited by later generations? The inclusion of features depicted on 1st edition Ordnance Survey mapping is to examine links between dated ancient and historic landscape features and those still present in the recent past, some of which survive into the present. The orientations of these features can be compared with known, dated features to identify correlations and potential patterns at different scales, something which has never been explored prior to this study. Correlations in orientation between features dating to different periods may indicate that at least some elements of the landscape in the nineteenth century have much earlier origins; and that some landscape features endured through the empirical gaps in archaeological data highlighted through Aim 1 and objective 2.

The results of these calculations will be discussed in terms of current research around long-term change and continuity and how relative orientations and conformity to underlying slope direction can inform this. Following the analysis of features across the whole study area, case-studies will address the research aims and objectives at a township and lower scale.

This research is different from many other landscape archaeology studies in that a ‘reverse’ retrogressive analysis will be implemented. A retrogressive analysis starts with the ‘known and understood present landscape’ and gradually works backwards to the less well-known past. This allows one to trace individual features back into the past and to reconstruct progressively earlier landscapes (Tolan-Smith 1997: 71). The problem with this is that the 'known and understood present landscape' is usually the depiction of landscape features on a map. As Aim 3 hopes to address, the boundaries, tracks and settlements shown on post-medieval and early modern mapping are likely the result of centuries, if not millennia, of human activity. Therefore, to say the present landscape is well understood is misleading. The evolutionary approach used in the current research begins with features which have been excavated and dated to specific time periods, such as Bronze Age pit alignments, for example, and works forward from this. The case studies in chapter 6 are the best example of the current approach in that the earlier features are analysed against those from later periods, for example the orientations of pit alignments and late Iron Age or early Roman period boundaries.

The earliest dated landscape features such as pit alignments and Iron Age and early Roman period ditches associated with settlement enclosures will be followed by features dating to later periods, such as medieval villages and furlongs, and in particular linear features depicted on 1st edition Ordnance Survey mapping to look for similarities in orientation and patterns of conformity to underlying slope direction. Using relative orientation analysis and slope direction conformity analysis represents a novel method of determining whether features present on early modern mapping, some of which are still extant, have any relationship with historic and ancient features which have since disappeared. Traditional retrogressive analysis would not allow this, as the process would begin with features present on Ordnance Survey mapping, and as the prehistoric features could not be seen, any relevant boundaries would be eliminated from the process. Applying this method highlights the randomness of the features used in the study, especially those depicted on 1st edition Ordnance Survey mapping.

1.2 Underlying terms concepts explained

Before going any further, some key terms and concepts used throughout the study will now be explained to provide clarity and consistency for the remainder of the study.

‘Orientation’ will be used to describe the direction in degrees at which a human-made linear feature is positioned. Although orientations throughout the dataset will vary between 0 and 359 degrees, values will be presented between 0 and 180 degrees, as whether the feature is ‘uphill’ or ‘downhill’ is irrelevant to the analysis; and a feature oriented at 270 degrees is the equivalent of 90 degrees.

‘Slope direction’ is used to describe the orientation of a slope, the direction in which the downward or upward slope is facing, depending on the orientation value being within the parameters of 0-180. This will be explained fully in chapter 2. The use of the term ‘slope’ in this research will only refer to the ‘steepness’ of the terrain when explicitly stated as such. More than one term can be used to explain this concept, such as ‘the grain of slope’, or ‘the lie of the land’. These two terms will be also used during the text as they represent a more textured way of describing the landscape as seen and experienced by people in the past and the present. For the methodological sections, however, which deal more specifically with the technical detail of the research, the term ‘slope direction’ will be used.

‘Aspect’ will be used specifically in reference to the metric data derived from a 50m Digital Terrain Model (DTM). Aspect values represent the downslope direction of the terrain between each recorded cell and its neighbours, in this case at a resolution of 50 metres. These values are initially ranged between 0 and 359 degrees; however, for the purposes of this analysis any values between 180 and 359 were exchanged for the equivalent between 0 and 179 degrees, for the same reasons given in the previous paragraph. Aspect can also be termed as slope direction, which is why the latter is used throughout to describe the comparative factor to linear human-made features; and, to provide a distinction from the ‘aspect’ data derived from the 50m DTM.

‘Conformity’ will be used to describe the relationship between human-made linear features and underlying slope direction; or the extent to which a transcribed linear feature in the project dataset shares orientation with the underlying ‘aspect’ value derived from the 50m DTM. The conformity values in this context are not empirical measurements, but the result of calculated comparisons between the orientations of linear human-made features and the slope direction, be it uphill or downhill. Conformity may also be used to describe the relationships between features dating to different periods.

1.3 Landscape Archaeology and Scale

The concept of scale is crucial to archaeological inquiry, whether from the biography of a single artefact to pan European synthesis (Reynolds 2011: 67). Landscape archaeology projects are distinguished by their scale of observation, which is always broader than a single site and its immediate surroundings (Tolan-Smith 1997: 3-4). Studies where scale is applied to individual problems are rare, however (Reynolds 2011: 68). The current study will look for patterns in landscape development at different scales. Considering chronological scale there might be indications in the results for the endurance of some landscape features over millennia, such as routeways or territorial boundaries; or in other cases, centuries, for example medieval ridge and furrow furlongs encased in later enclosed fields. In spatial terms the study deals with features of many different scales, from settlement enclosures, to medieval ridge and furrow selions, to boundaries and tracks and Roman Roads which traverse the entire study area. In geographic terms the results will be analysed principally at two scales, regionally across the entire study area; and locally through case studies at the scale of individual townships and lower. Interpretations and discussions of results will firstly be made at the scale of the study area of south-east Northumberland before a series of case-studies will consider the results at a local scale. Interpretations at these scales will be compared, for example in looking for broad distributions of orientations across the study area and the more nuanced relationship between linear features and the direction of slope upon which they sit. The concept of scale therefore has a significant bearing on both initial assumptions and discussions of results in this research.

Some existing studies have argued for continuity of boundaries and land-use over long periods through similarities in orientation between boundaries and other linear units dating to different periods (Rodwell and Drury 1980; Williamson 1987; Oosthuizen 2006; Rippon *et al.* 2015). These assumptions are based amongst other things on analysing the landscape from a regional perspective, leading to the idea that coaxial fieldscapes present on 1st edition Ordnance Survey mapping originated in prehistory and Roman times. Coaxial fieldscapes are also present on 1st edition Ordnance Survey mapping throughout much of the study area. When analysed at a regional level, patterns may emerge in the arrangements relating to certain orientations. Viewing the data at a regional scale is probably what has led to scholars in the past seeking, and often asserting a case for, continuity in landscape patterns. When viewed at a local level, and when considering the influence of underlying slope direction at this scale, the idea of large-scale planning of boundary systems will be questioned. Different scales therefore lead us to consider the different social and economic implications behind decisions taken which have led to the composition of the human-made landscape in different periods. Interpretations will also consider individual feature types and what they may have been used for. This will lead to distinctions depending on scale, such as the Devil's Causeway Roman road which traverses much of the study area, and a single medieval furlong, which might only be 30 metres long. These two landscape features had different purposes and relationships with local and regional topography; and any relationships to underlying slope direction will be considered with this in mind.

1.4 Location, geology and topography

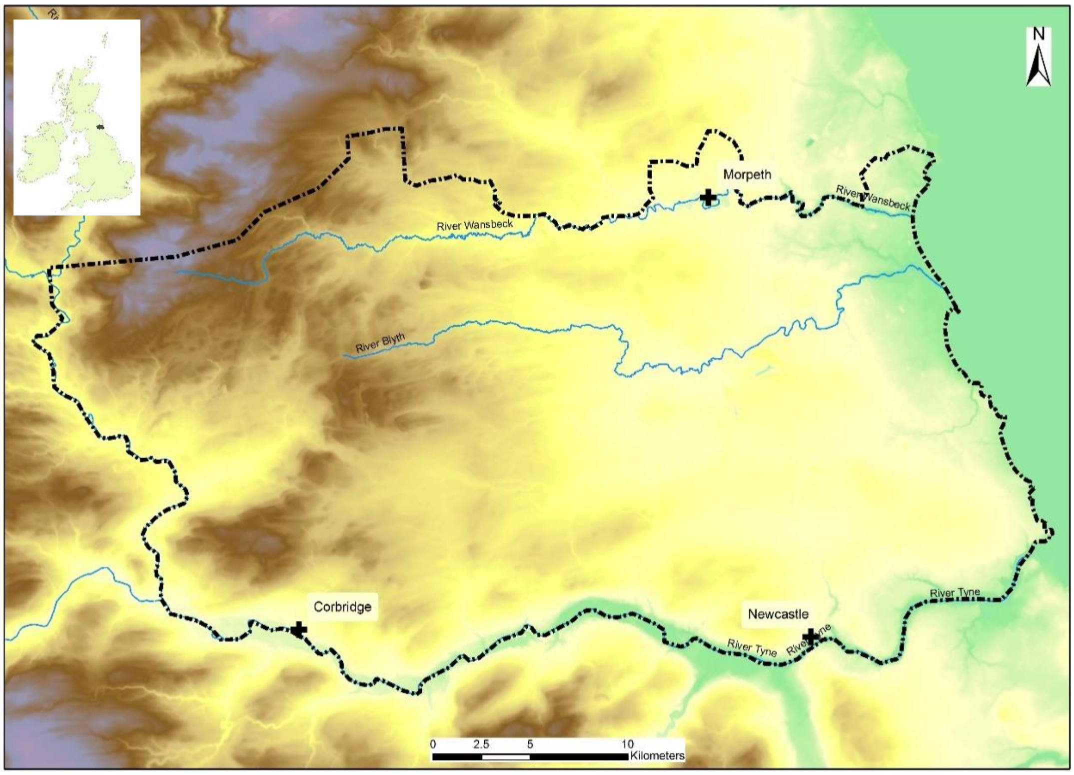

Figure 1.1 Study area location

Most landscape archaeology projects have defined spatial and temporal limits. In terms of the spatial aspect, it has been common practice in the past to define a study area in terms of some regular, arbitrary geometric shape. Study areas defined by grid lines have very little meaning in human terms (Tolan-Smith 1997: 4), which is something the current study was aware of in setting out the spatial extents as defined by major rivers and the North Sea. The area chosen should not be seen from the outset as holding any particular importance as a land unit at any point in the past. An effort has been made to imply this through the use of natural topographic features, but it cannot be assumed from the outset. The spatial extents of the study area are also governed by logistics in data capture and analysis. The current study area lies in North-East England, in what are now the counties of Northumberland and Tyne and Wear, but historically has been situated within the counties of Northumberland and Durham (pre-1974), the Anglo-Saxon kingdom of Northumbria, the early-medieval polity of Bernicia; and possibly the Iron Age Votadini territory (Roberts 2015). The study area is bounded to the south by the River Tyne and the river Wansbeck in the north. The North Sea forms the eastern boundary and River

North Tyne forms the western boundary. Specific excavated sites relevant to the current study areas just north of the river Wansbeck extend the study area slightly.

The south-east Northumberland coastal plain sits upon Pennine Middle Coal Measures, with the area further west and north comprising Yoredale Group - Limestone, Sandstone, Siltstone and Mudstone (BGS: online). Areas such as this have a reputation for being considered blank for pre-medieval settlement, however clay geologies and soils are not as poor as they are often made out to be, and developer-led projects are increasing the opportunities for clay landscapes to be explored archaeologically (Mills and Palmer 2007: 7-9). Analysis of historic Google Earth imagery in the current study has bolstered this view through the discovery of many previously unknown rectilinear settlement enclosures thought to be of Iron Age or early Roman date. The most common soils along the coastal plain are seasonally waterlogged which overlie boulder clay. These heavily textured clay soils have poor natural drainage but can make fertile farmland using artificial drainage. Brown soils lie on better drained glacial till or glacial and alluvial sand and gravels and are found around the floors of the major river valleys such as the Tyne, Blyth and Wansbeck (Williams 2015: 5).

Large areas along the coastal plain between the Rivers Tyne and Wansbeck have been subjected to large-scale open-cast mining which, along with urban and suburban expansion over the last century have created disadvantages and advantages to understanding the region's past (Figures 1.2 and 1.3). Areas within Shotton township, for example, had already been subjected to open-cast mining prior to the archaeological investigations discussed here, destroying any archaeological potential for a large portion of the area around the recorded settlements, for example; but without the large-scale development and associated excavations, we would not have the rich archaeological resource from this area of multi-period activity. Since the introduction of planning legislation (PPG16, now NPPF) in 1990, modern development has led to the discovery and excavation (and it should be said, subsequent destruction) of numerous regionally important archaeological sites, many of which are included in this research.

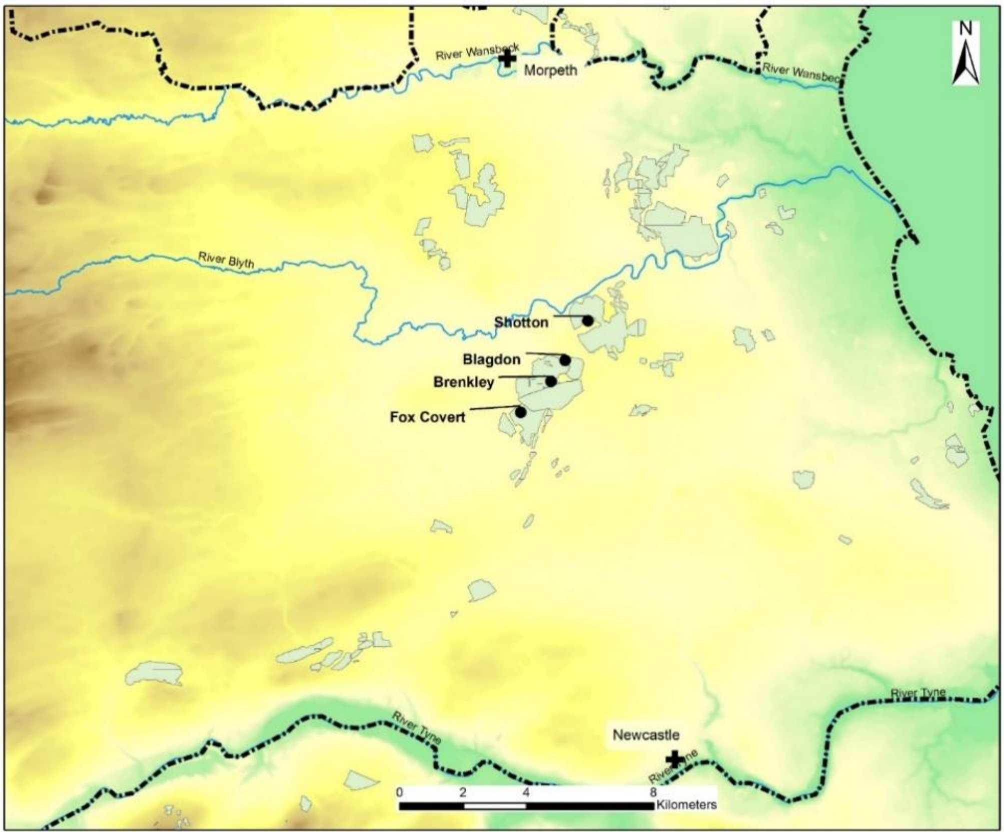

Figure 1.2 Known large-scale mineral extraction sites by 2015, along with the locations of key sites in the text (50m DTM downloaded from Edina Digimap 2017)

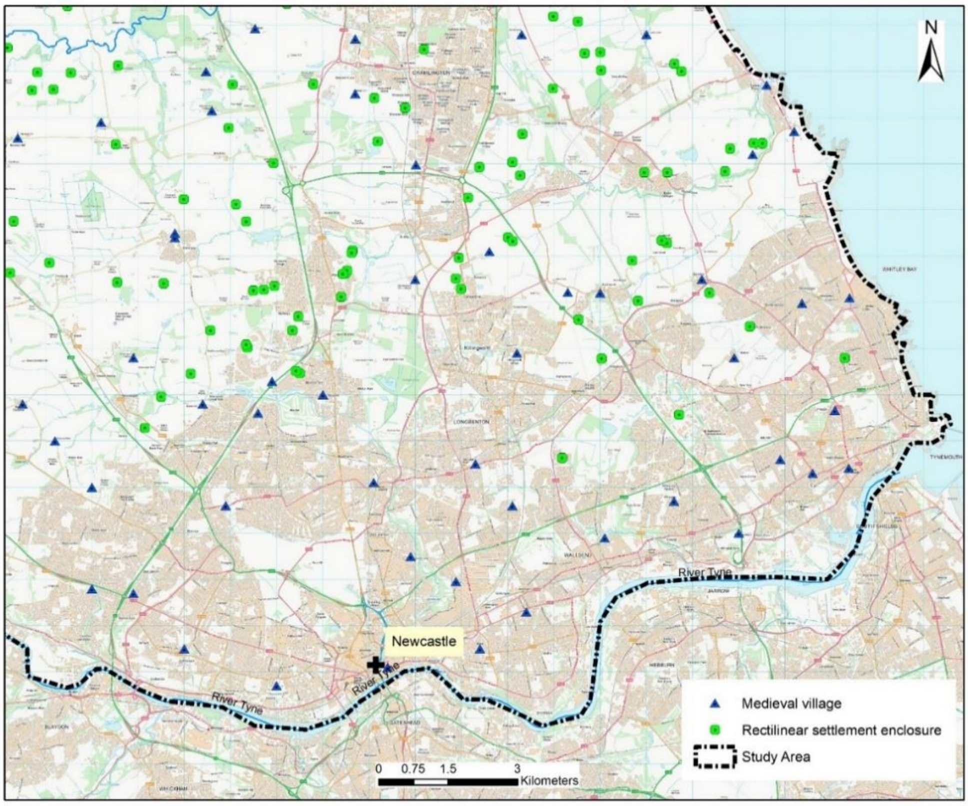

Figure 1.3 Modern map showing urban development in the study area (Mapping: Ordnance Survey 2019)

In terms of land-use, fields make up around 50 percent of land use in the study area (Williams 2015: 36). Agricultural land use along the coastal plain is largely arable, characterised by large unenclosed fields, separating rural villages and farms, many of which have medieval cores. Small pockets of pasture often lie in the vicinity of villages and scattered eighteenth-century farms. Further west, where the terrain becomes more pronounced, pasture is the primary agriculture, but arable is still practiced and has been historically.

1.5 Chronological parameters

The chronological parameters of this research span both prehistoric and historic periods, and broadly encompass the Bronze Age to the present day. Historic parameters will be referred to throughout the study, as they are the basis for which data about the past has historically been organised. Using established chronologies, the following feature types will be analysed in terms of their orientations and conformity to underlying slope direction:

- Known and established settlement types- Iron Age/early Roman rectilinear settlement enclosures; Anglo Saxon hall complexes, nucleated villages.
- Prehistoric pit alignments scientifically dated to the Bronze Age and Iron Age
- Excavated ditches associated with Iron Age and/or early Roman settlements.
- Traces of medieval and post-medieval ridge and furrow
- Boundaries and tracks depicted on 1st edition Ordnance Survey mapping, some of which survive into today's landscape.

1.6 Gaps in knowledge and 'intermittent continuity'

Rather than seeking to shoehorn unbroken continuity into long narratives of the past, it can be more constructive to think in terms of intermittent use of sites over long periods, usually with long intervals in-between. Bradley has said this in the past (1987: 15), highlighting weaknesses with the concept of 'ritual continuity' using the Milfield Basin landscape in north Northumberland to show that unbroken continuity of a ritual nature could not be established on chronological or cultural grounds. Ritual continuity implies the same, or a similar belief system, represented by monumental landscape features, having an unbroken sequence over long periods; in the case of Yeavering, Hope-Taylor (1977) suggested from at least the Neolithic to the post-Roman period. Bradley saw the evidence for this as thin, instead concluding that

Yeavering, and other sites displaying similar characteristics, were in fact the result of long sequences of intermittent monument construction, often involving multiple re-appropriations of pre-existing monuments. Boundaries, tracks and traces of ridge and furrow form the bulk of the data analysed in this research. Using multi-period sites, the current study has highlighted a dynamic between occupation and land-use from different periods on or around the same site, but with significant gaps between these phases. This is not to say that unbroken continuity through long periods is impossible; but it is difficult to detect in the archaeological record.

Human-made landscape features can endure over long periods in their physical state. How they are interpreted can be dependent on what use they are deemed to have to successive generations. Features along the Milfield Plain in Northumberland, for example, show a sequence of intermittent monument construction beginning at least in the Neolithic (Bradley 1987: 15). It has been found that between the Thames and the Humber, 49 early and middle Anglo-Saxon settlements showed evidence for reuse of earlier monuments, including Bronze Age barrows, Neolithic long barrows, Iron Age hillforts and prehistoric enclosures and boundaries (Crewe 2008: 1). It is likely therefore that many prehistoric landscape features were still visible in the Anglo-Saxon period. The many enclosures reduced to cropmarks or low earthworks beneath medieval and later ploughing layers would no doubt have been highly conspicuous to people occupying the landscape in the post-Roman and early medieval periods; and were probably not passive elements of successive landscapes, just as they are not today, but probably for different reasons.

There has been less consideration of long-term links evident in settlements, fields and boundaries compared with the study of Neolithic and Bronze Age ritual monuments and their re-appropriation during the Iron Age and Roman periods (Chadwick and Gibson 2013: 1). Unlike monumental structures such as henges, stone circles and burial mounds, it could be that the importance and longevity of low banks and shallow ditches associated with field systems have be taken for granted in research contexts. Can studies of monuments and temporal endurance offer any help in understanding whether more practical landscape features were also maintained, or re-used, by successive generations? If, as it has been demonstrated, early medieval societies placed such importance on prehistoric monuments, would this same importance have been placed on features such as existing field banks and ditches?

Boundaries and tracks are the threads which hold together the fabric of the human-made landscape between different phases of occupation and land use. Developing a deeper understanding of these features is crucial to understanding how they emerged, endured, changed; or disappeared. It has been argued elsewhere, for example, that boundaries underwent many changes in the Anglo-Saxon period, and many excavated boundaries found running parallel to, or beneath, medieval hedges or headlands could be of Roman or post-Roman date (Rippon 1991: 49; Rippon *et al.* 2015; Williamson 2016: 280). The current research will aim to identify what the landscape beyond settlements from different periods contained that might be used to identify and measure aspects of change and continuity.

1.7 Orientation and alignment: the research context

This study is focused on the analysis of the landscape of south east Northumberland, albeit at different scales. British landscape archaeology is a well-established field of study (Hoskins 1955; Aston 1985; Rackham 1986; Fleming 1998; Johnson 2007a) and sometimes contested by those championing empirical, processual methods of research based on the gathering and analysis of data, and those studying the landscape from a more contextual, or post-processual standing (for an example of this lively debate see Fleming 2007 and Johnson 2007b). Processualists have recently softened their positivist language of testing data and now insist that archaeologists' ideas about the past must be evaluated according to the evidence and that this should be done in a robust manner. Post-processualists now take care to stress that interpretations of the past are at the very least constrained by the nature of the evidence (Johnson 2010: 119-120). The current study will in seek to add to the existing body of work in British landscape archaeology studies, but through specific empirical methods of analysing existing themes around long-term landscape development, namely relative orientation and conformity to underlying slope direction. Therefore, the focus of the remainder of this chapter will be on British landscape studies which have a similar focus.

By the nineteenth-century it was commonly thought that human activities were strongly defined by the physical landscape. This approach changed in the early 20th century through a focus on the notion that people effected major changes on the landscape and the importance of temporal as well as spatial relations between elements of the landscape. The geographer Carl Sauer stated that the landscape is in a “continuous process of development or of dissolution or replacement (Sauer 1925 in Kluiving and Guttman-Bond 2012: 11-12). From these observations the term ‘cultural landscape’ originated, which carries the implication that a landscape owes much of its character to human intervention rather than the other way around (Kluiving and Guttman-Bond 2012: 11-12). This study will explore the dynamic between human will and the natural landscape through measuring and analysing the relative orientations of human-made linear structures and how they related to the lie of the land.

The research potential of grey literature and developer-funded archaeology is now widely recognised (Webley *et al.* 2012; EnglaID: online; Rippon *et al.* 2015; Blair 2018). In the current study area, the findings from developer funded archaeology has recently been placed into research contexts with a focus on the Iron Age and early Roman period (Proctor 2009; Hodgson *et al.* 2012). This study has taken data from developer-funded archaeology in the region and placed it into a research context of analysing linear features in terms of relative orientation and conformity to underlying slope direction, by observing how features from different periods relate to each other rather than being bounded by a period specific narrative. It sits within a growing body of research from elsewhere in Britain and Europe (EnglaID online; Rippon *et al.* 2015; Lovschal 2014). In some studies, long-term orientation trends have been interpreted as showing at least a degree of continuity in settlement and land-use (Oosthuizen 2006; Rippon *et al.* 2015) although this has since been questioned (Williamson 2016). These ideas and others will now be explored further.

It has been stated in section 1.2 that since the mid-20th century scholars have recognised that patterns of land-use and settlement in different periods are often linked by similar alignments and orientation; and these have generally been interpreted as markers of continuity in land-use and systems of agrarian organisation. During the 1960s and 70s the possibility of pre-Anglo-Saxon origins for some medieval boundaries in Wessex based on shared alignments of features dating to different periods was recognised, which suggested the long-term continuity of territorial organisation (Bonney 1979: 169-185). Like many other studies (for example Drury and Rodwell 1980; Fleming 1998; Oosthuizen 2006), Bonney's theories were based on visual perception and the comparison of distributions of sites and linear features depicted on historic maps, aerial photographs and historic maps and estate plans. This is a plausible but subjective approach when applied to a small number of boundaries. It would not be practical for analysing large datasets, however. Bonney's findings in Wessex are echoed in other parts of Britain; and it has become the accepted paradigm amongst many scholars that the landscape present by the medieval period comprised at least some boundaries and routeways which had much earlier origins based on shared alignment and orientation (Fowler and Taylor 1978; Ford 1979; Drury and Rodwell 1980; Fleming 1978; 1998; McOmish *et al.* 2002; Oosthuizen 2006; Rippon *et al.* 2015).

Tied in with these theories is the idea of 'co-axial' field systems, which are clearly present on 1st edition Ordnance Survey mapping in many parts of Britain and beyond. The term 'co-axial' is used in this context to describe a regular pattern of boundaries and tracks arranged in roughly rectangular fashion, or along two axes or directions to form a grid-like appearance. The best evidence for ancient co-axial field systems can be found along the Salisbury Plain where large swathes of earthworks remain intact (McOmish *et al.* 2002); however, many other examples can be found in England, such as Dartmoor, Nottinghamshire and the Yorkshire Wolds. These key sites show many morphological similarities, including orientation, with field systems present on 1st edition Ordnance Survey mapping. It is perhaps due to this that many of these later depictions are assumed to have prehistoric origins. The notion that co-axial field systems existed in their form despite natural terrain has been discussed by some scholars (for example Field 2008: 202). This assertion will be assessed through slope direction conformity analysis.

Co-axial arrangements of boundaries and tracks are also known as 'Celtic fields' (Field 2008), 'cohesive' or 'brickwork'. They are often arranged around a main spinal axis (Historic England 2018). It is for this reason that later in the study, two axes will be used to explore common orientations, for example 30 and 120 degrees, which represent the right angles of a rectangular system. The other reason for this is that excavations have shown that roughly rectangular field patterns did exist in prehistory, such as those discovered at Pegswood and East Wideopen in the current study area.

Arguments for continuity are traditionally based on two approaches. The first is the excavation of ditches beneath medieval boundaries being dated to the Roman period by the character of their fill. Some medieval fields have subsequently been ascribed earlier origins due to their boundaries sharing common orientation with nearby excavated features of prehistoric or Roman date (Rippon *et al.* 2015). The second approach is concerned with topographic analysis, focusing on boundary patterns in the modern landscape being dated to the Roman period or earlier based on horizontal stratigraphy; normally by the fact that the patterns do not conform to those represented by Roman military roads (these could be prehistoric though) or other linear earthworks, or because they share a common orientation, implying deliberate planning, over areas more extensive than medieval manors or parishes (Williamson 2016: 264). These observations of long-term continuity are the starting points for the analytical element of this research.

The following section will address studies of change and continuity in the landscape which are focused specifically on orientation and alignment. Through studying the approaches mentioned above it has become apparent that it is rarely explained how orientations are calculated. The following paragraphs will take a critical look at existing approaches to analysing orientation and slope direction conformity to inform and validate the methods devised for the current research.

1.8 Horizontal stratigraphy

Most existing research on the relative chronologies and orientations of linear features in the landscape is based on the concept of horizontal stratigraphy, an approach which unpicks the composite elements of a given landscape based on relative conformity, the common factor for which in many cases is orientation (for example Drury and Rodwell 1980; Williamson 1987; Rippon 2015). Interpretations are usually based on data gleaned from early Ordnance Survey maps, aerial photography and field observations (Tolan-Smith 1997; Oosthuizen 2006). Comparing the orientation of boundaries and tracks dating to different periods is reliant on the presence of features which can be dated, and typically in existing studies these consist of known Roman roads or medieval township boundaries. An early example of this comes from Essex, where the perceived shared orientation of extensive patterns of field boundaries depicted on early Ordnance Survey mapping were thought to result from ancient large-scale planning (Rodwell 1978; Drury and

Rodwell 1980). It was also noticed that some of these field systems covered areas larger than medieval vills; and that Roman roads were often completely at odds with them, which was thought to suggest they had been laid out in the early Roman period or before. Similar observations have recently been made in the Bourne Valley, Cambridgeshire, where relict fragments of a regular system of land division were believed to be fossilized within the furlongs and strips of the medieval landscape (Oosthuizen 2006). From this and other evidence, it was proposed that banks, paths and other linear features occurring at right angles to the cross-valley linear features are part of a ‘proto-common field’ laid out on a large scale; and is illustrated in Figure 1.4 (Oosthuizen 2006: figure 4.1). Oosthuizen applied retrogressive mapping and deconstructive analysis techniques to the same area, both of which led to broadly similar results in revealing elements of the ancient landscape (*ibid*: 77-80). Oosthuizen found it difficult to objectively exclude field boundaries that do not conform to the general orientation framework (2006: 77-78), something the current approach will do by being able to extract linear units of particular orientations.

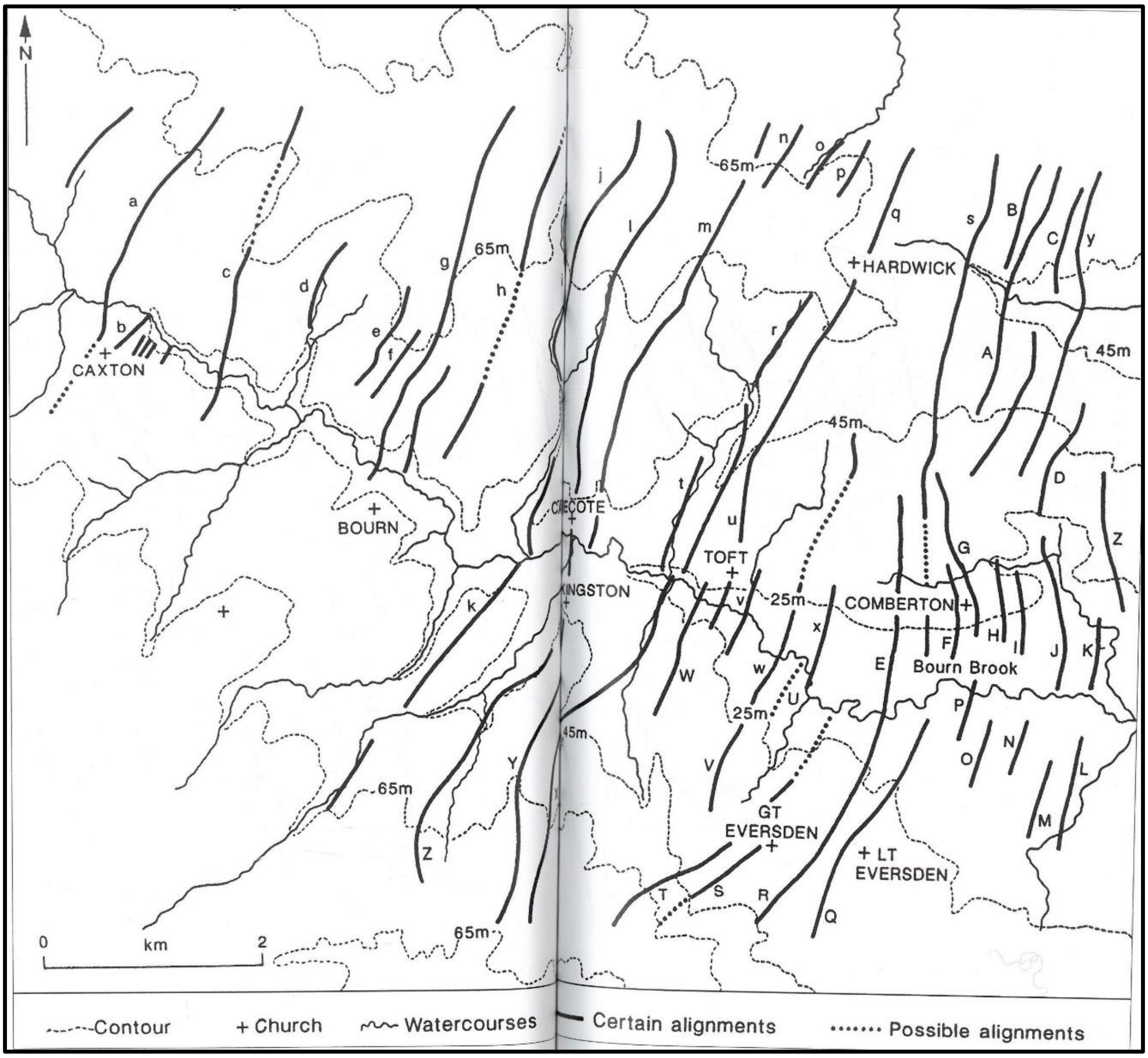

Figure 1.4 Ancient alignments along the Bourne Valley in Cambridgeshire (from Oosthuizen 2006: fig 4.1)

One component of the recent ‘Fields of Britannia’ research project exploring the legacy of Roman period fields into the Middle Ages compared the orientations of excavated ditches dating to the Roman period with those of surrounding field boundaries present on Ordnance Survey maps (Rippon *et al.* 2015: 105-107). It was argued that similarity in orientation and alignment, borne out in the statistic that 64 percent of excavated Romano-British field systems in lowland England share a common orientation or alignment with those dating to the medieval period, suggested that many Roman fields had morphed into medieval ones (Rippon *et al.* 2015: 323). Rippon *et al.*’s research specifically straddled traditional historical parameters (*ibid*: 16-17), an approach shared by the current study; but the geographic limits did not extend north of Hadrian’s Wall. This is a shame as it would have been interesting to compare the results of the current research with those of the Fields of Britannia project. The approach takes the concept of horizontal stratigraphy a step further by including only excavated boundary ditches dated to the Roman period. The following criteria for comparison was used to characterise and quantify conformity and non-conformity between the two datasets: surrounding fields on completely different orientations, entailing no continuity whatsoever; those with the same orientation to within five degrees, entailing possible continuity; and those sharing a specific alignment with a later feature, which also suggests continuity (*ibid*: 99-100; fig 3.7). This is a useful framework for analysis, but nowhere in the monograph, or in the supporting online resource for the project, is it made clear how the orientations of linear features were calculated and compared. This can be said of almost all previous studies involving the comparison of orientations (for example Drury and Rodwell 1980; Oosthuizen 2006). Whilst effectively illustrating valid arguments, the data remains as passive as it was when first viewed on a map or aerial photograph.

Tom Williamson has recently responded to theories centred on continuity, for which he was once an advocate (Williamson 1986; 1987; 1998), arguing that much of the evidence cited in support of continuity of land division can in fact be interpreted as discontinuity between Roman Britain and medieval England (Williamson 2016: 264-265). He suggested that many so-called coaxial field systems which underpin previous theories, are not single entities, but originated as a series of tracks linking resources which were gradually filled in, culminating in the appearance of a single planned entity (*ibid*: 268-277). Shared orientation and alignment of these features was therefore a coincidental response to local topographic conditions over long periods. To illustrate this, Williamson deconstructed the perceived coaxial field patterns of the Dengie peninsular in Essex into north-south and east-west oriented boundaries and tracks, revealing a dominant east-west axis of long linear boundaries and tracks throughout the region. Many of these were interpreted as ‘resource linkage networks’ in the region, linking different topographic and land-use contexts, such as arable, pasture and woodland. The north-south linear features were often relatively short, localised and patchy in distribution, but cumulatively formed the basis of miniature coaxial landscapes when combined with the dominant east-west features (*ibid*: 271-277). In his arguments, Williamson is not disowning the notion of continuity; and argues that some extant linear features probably have endured from prehistory into the medieval period and beyond, in this case the long linear features connecting various resources.

Williamson's recent arguments are strengthened by excavations on part of the field system around Thurrock, elements of which were attributed to the Roman period by the afore-mentioned Rodwell (1978), showed they dated in fact to the medieval period (Wilkinson 1988: 126-128). Even with excavation and modern scientific dating it cannot be categorically said that the boundaries were not older though. Williamson himself discussed the complex taphonomy and post-depositional processes on and around historic and ancient boundaries, such as the regular re-cutting of ditches. The longer a boundary exists, the more maintenance it will have gone through, to the extent that primary cuts and fills would be impossible to identify (2016: 279-280). This is a perennial problem in the study of ancient and historic boundary systems.

1.9 Grid-planning: Roman 'cadastres' and Anglo-Saxon settlements

Using statistical methods, mathematician John Peterson explained the oblique nature of Roman roads in relation to field systems as result of Roman planning, or *cadastres* (Peterson 1998; 1990; 2004). Roman *cadastres* are systems of land allocation, based on a square surveyed grid, set out for demarcating, allotting, recording and taxing land (Peterson 1988: 133; 1990: 254; 2004: 61). Peterson's work is heavily influenced by studies of the same phenomena in Italy and southern France, where evidence is more compelling, being closer to the Roman heartlands. In Roman-period Italy, for example, evidence of streams often diverted down the axis of grids, or *cadastres*, imply a drainage function (Peterson 2004: 61). Details such as this simply do not exist in English examples. Peterson drew together evidence from studies in England which propose that elements of the modern landscape have their origins in prehistory or the Roman period, and which are based on a common north-north west orientation. The method used by Peterson involved constructing grids in Roman units and overlaying them onto historic maps; the grid was then aligned with tracks and boundaries present on early Ordnance Survey maps, sometimes containing transcribed cropmark boundaries and ancient monuments such as Bronze Age barrows. The corners of a constructed grid were identified as points at which

Roman roads passed on an oblique trajectory to the grid. Figure 1.5 illustrates the results of this method applied in Middlesex.

Figure 6. Central Middlesex and Eastern A
—— Road shown on Rocque's map (1741-5)
- - - - Modern London Borough boundary

Figure 1.5 Applying the centuriated grid system on the landscape of Middlesex in the 18th century (from Peterson 1990: figure 6)

Little archaeological evidence is available to support Peterson's interpretations, which mostly derive from topographic relationships between landscape elements (Peterson 1990: 234). Whilst it cannot be denied that some linear features fit Peterson's grid system, the theories derived from the evidence are highly speculative. Peterson himself admitted that only fragments of these large centuriated Roman *cadastres* remain to be studied, and that not every line that conforms to an overlain grid will be Roman in origin, as some occur by chance; but he argued that even a modest number of proven examples would support the hypothesis, and his ideas are presented from a tentative perspective in light of 'current opinion against such an idea', which appears to relate again to Tom Williamson, who opposes if not Peterson's methods, then at least the interpretations from them. Peterson's work is therefore intended to be used as a working hypothesis from which interpretations can be compared with other theories.

John Blair has recently applied the notion of planned grids to explore the potential planning of middle Anglo-Saxon settlements (2018). Numerous examples of this phenomena are presented but the methods behind it are yet to be published at the time of writing; and are being used to explore the trend on a much larger scale (Blair, Rippon and Smart: no date). Grid systems by nature imply regular orientation within and beyond settlement units; but it does seem on present scholarship that the grid system used on Anglo-Saxon settlements was part of a new system of land management which was quite distinct from anything which came earlier in post-Roman Britain, as the morphology of settlements at this time was more irregular and unenclosed (Blair 2018: 148-150). As with Peterson's approach, the results are subjective. Where some settlement structures clearly conform to the hypothetical grid, many others on the same site do not. It also seems that, like Peterson’s work, an agenda is being pursued: this time that grid-planning was apparent across much of eastern England during the early Middle-Ages. Doing this runs the risk of ‘shoehorning’ the evidence to fit a pre-conceived theory.

1.10 Recent approaches to calculating and analysing orientation

Recent research in Italy focused on the analysis of relative orientation to explore whether landscape planning which occurred before AD 1823 left any traces in the modern landscape (Citter 2012). The aim was ultimately to understand more about landscape development in a region of Italy where large-scale excavation is untenable due to logistic and economic constraints. To do this, a portion of the *cadastre* was digitised as polylines, which were then measured, and the orientation calculated before looking for possible similarities between them. It is not explained how these calculations were made, however.

Citter went on to explain that segments of boundaries aligned with the two groups of perpendicular roads, which were known to be in existence by AD 1594 were analysed, with $\pm$1 degree of tolerance maintained to prevent any distortion of the sample, thus calibrating the error within the digitising process and the georeferencing of the maps. It was then examined how many segments could be related to both the distance from Grosseto and the cultivating potential of the soils. It was found that field boundaries aligned north-west to south-east had a closer relationship in terms of density with the more productive soils and with proximity to Grosseto. Conversely, those aligned north-east to south-west behave differently. Therefore, both phenomena appear to represent different planning contexts. The first was centred on the best land and proximity to Grosseto, whilst the second on less favourable land and indifferent to proximity to settlement (Citter 2012: 199-201). The roads in the region were therefore pivots for this analysis. In the current study area Roman roads Dere St and the Devil's Causeway can be examined in a similar way, as they also appear to have very different spatial relationships with boundaries and tracks in their vicinities, as will be shown in chapter 6. Citter's work, therefore, whilst undertaken in a very different landscape context, contains many elements, both practical and theoretical, which can inform the current research, from the calculations of orientation, to exploring the relationships between linear features, topography and underlying soils.

Returning to England, a recent AHRC-funded study of agriculture and landscape in medieval Northamptonshire included analyses of relative orientations between landscape features of different dates (Williamson *et al.* 2010; Williamson 2013). The methodology for this study suggested it was conducted using visual perception methods; but using processed DTMs to produce 1m contour lines to assess the orientation of linear features (Williamson *et al.* 2010). Archaeological features were digitised by creating polyline, polygon and point data, and drawn plans were converted to vector .dxf format for use in CAD. Some of this was clearly used to undertake various other spatial analysis in GIS; but not used to analyse orientation. The digital representations of linear archaeological features were ultimately used in plans to illustrate relationships between features from different periods (see Williamson 2016: illustration 10 and shown in Figure 1.6 below). This perhaps is not the most effective use of the data; but it may be because the subject of relative orientation was just one component of a much larger project; and as such the researchers could not investigate this in more detail.

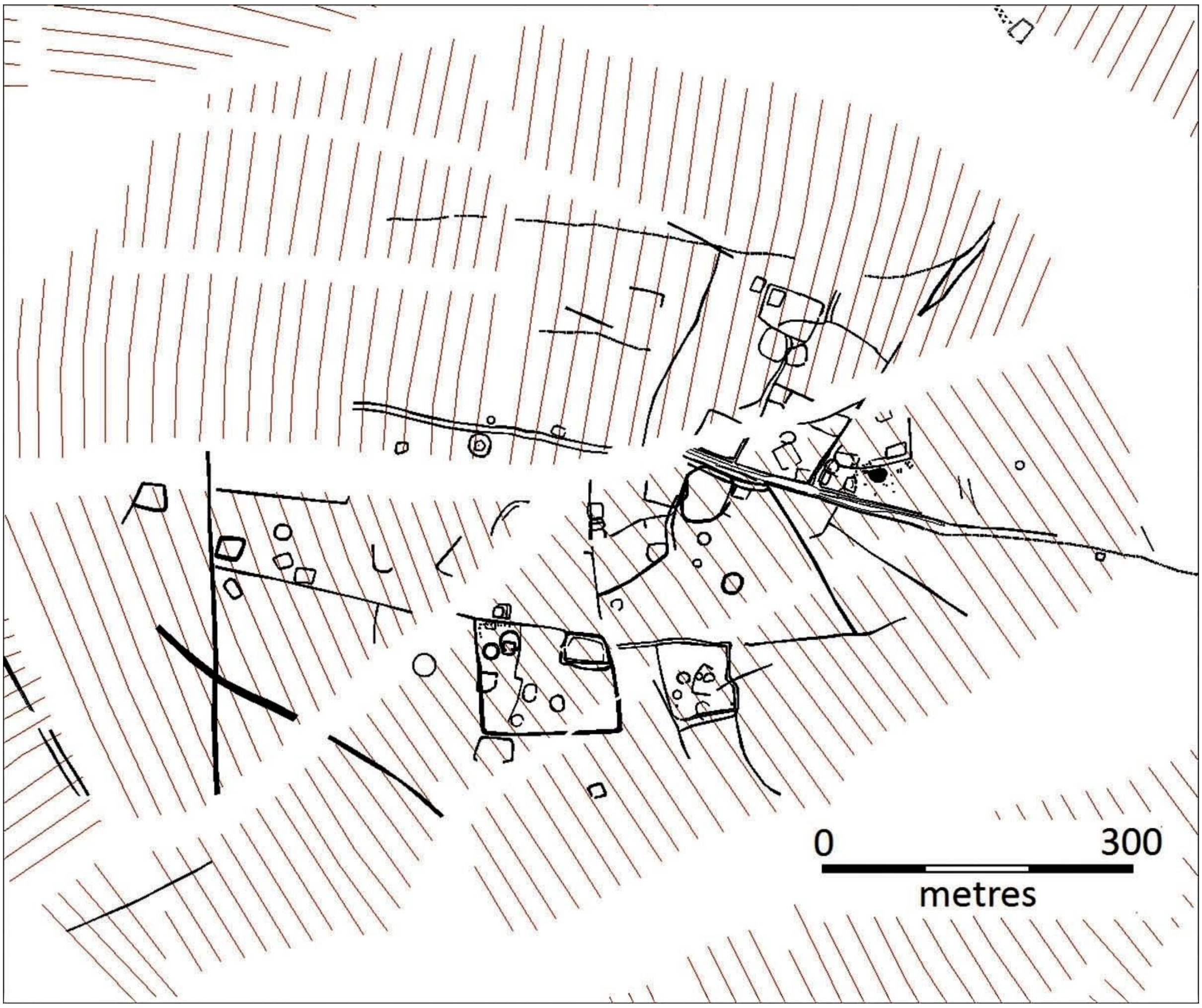

Figure 1.6 Depicting the relationships between linear features dating to different periods at Harlestone, Northamptonshire (from Williamson 2016: illus.10) Grey lines- medieval ridge and furrow; black lines- prehistoric settlements and boundaries

A component of the ‘English Landscapes and Identities’ project (hereafter EnglaID) appears to have used a similar methodological approach to orientation analysis to the one used in the current study. At the time of writing the work on orientation by one of the project researchers, Chris Green, remains largely unpublished; and was found by chance by the author on an online blog (EngLaID: no date) after the completion of the methodological and analytical component of the current research. Although the blog does not outline the specific tools used or models built to perform the analysis, the two approaches have many similarities. Both use ArcGIS software, entailing the same tools were used to perform calculations; and both incorporate the comparative study of linear archaeological units and underlying slope direction.

The current approach differs from the EnglaID project in the breadth of data studied. The EngLaID study focused on probable, but largely unexcavated, prehistoric and

Roman period field systems recorded through Royal Commission on the Historical Monuments of England (RCHME) and English Heritage (now Historic England) projects, identified through the systematic study of historic and recent aerial photographs. The EnglaID project tested through statistical and digital methods interpretations of boundary orientation which were initially derived from visual perceptive methods (McOmish *et al.* 2006); with the EngLaID results proving them to be correct. Although orientations of recorded ridge and furrow ploughing in certain areas were also tested through the EnglaID approach, the range of data was restricted to specific chronological parameters in accordance with the overall project, between 1500BC and AD 1066. The current research is not confined by these chronological parameters, enabling the orientations of boundaries and routeways present on 1st edition Ordnance Survey maps to be included in the analysis and compared with known earlier linear features. Green's work was also part of a much larger project, so maybe lacked the means or time to analyse these results further, or ask more questions of it, in the way the current research can. Nevertheless, the results of the EngLaID analysis are important to the methodological and theoretical parts of the current study and will be referred to in the next chapter.

1.11 Measuring orientation of underlying slope direction in relation to linear features

The importance of underlying topography in laying out fields with reference to practical implications such as drainage has been recognised in previous work. The orientation of medieval open field furlongs in East Cambridgeshire were studied in relation to natural topography (Harrison 2002: 40-41). Due to it not being made explicit how these comparisons were drawn, it is once again assumed that they were done using maps and visual perception. Williamson (2016) has acknowledged the importance of underlying natural topography, stating that the operation of similar agricultural or topographic influences occurred at different periods of time. He stressed that ditched boundaries were often aligned at right angles to slopes to improve drainage, and the same could be said for open field strips from which many enclosed fields developed in the late medieval and post-medieval periods (Williamson 2016: 280). Williamson is yet to produce a study to analyse these useful observations, which this research aims to explore in detail through methods explained in chapter 2. Peterson (1988; 1990), whilst referring to a clear drainage function for Roman cadastres in Italy, appears to skirt the importance of underlying slope direction or soils in his work.

Peter Topping provided a good discussion of the importance of drainage and using the lie of the land for arable fields in both prehistory and the medieval period in northern Northumberland (1983; 1989); these will be referred to in discussions of results in this research; but the methods for examining relationships between linear features and underlying topography were once again based on viewing features against contours on maps.

1.12 Summary

It could be argued that measuring and comparing the orientations of boundaries dating to different periods can be done through simple visual perception, by simply comparing orientations of features with contour data 'by-eye'; and studying the relationship between orientations of boundaries and underlying slope direction can be done in a similar way, by comparing the line of a boundary with underlying contours on maps, or using contour imagery derived from processed DTMs. But the results of these methods are completely subjective, and so are more open to criticism. They are also inadequate for analysing very large datasets over extensive areas. It is surprising that only a few recent studies have effectively harnessed the capabilities of GIS; and map-based approaches to orientation seem to take precedence over observations on the ground, perhaps to avoid too much subjectivity.

2 Orientation analysis: methods

2.1 Introduction

Following the discussion of existing studies above, this chapter will focus on the design and implementation of a new orientation and slope direction conformity analysis. Addressing Research Aims 1 and 2, and objectives 3, 4 and 5, the processes, tools and scripts behind the calculation and comparison of orientation in the landscape of south-east Northumberland will be described, from data gathering and classification, to the software and tools used to analyse the data and visualise and interpret the results. The methods described below were devised as a response to some of the studies discussed in the previous chapter, in which broad statements have been made about landscape patterns present on 1st edition Ordnance Survey mapping which were based on analysis 'by eye'. These studies highlight an important strand of research into long-term landscape development; however, a digital method enables boundaries and routeways for example to become 'active' analytical units rather than 'passive' depictions on maps. A richer, more comprehensive analysis can then be performed at both regional and local scales; and the results of both compared with each other. When dealing with data on a large regional scale, such as that of the current study area, which contains thousands of linear units, such as those present on 1st edition Ordnance Survey mapping, a method is required that can analyse them as objectively as possible, through digital, metric means. The method also allows very large datasets to be analysed using a single method as objectively as possible. This does not mean assumptions were absent from the current process, however. Assumptions prior to implementing the method were inevitable; and were in some cases carried forward and addressed in related discussions. Assumptions that conformity to slope direction would be more pronounced in areas with more undulating terrain in the west of the study area; or that a south east facing orientation would be more present in prehistoric settlement and boundary units, are addressed through the results and interpretations of the data in later chapters. References will be made to Appendix B throughout this section, which contains detailed results and calculations for all processes included in the analysis.

Taking a landscape approach at various scales, such as within the whole study area and within smaller case-study areas such as townships, it will be shown below how detailed statistical study of orientation and alignment of human-made linear features can be used to explore the extent to which elements of antecedent landscape features endured into later periods, addressing Research Aim 3 and Objectives 6 and 7. The methodology behind orientation and slope direction conformity analysis using GIS models and mathematical formulas will be presented, along with the tests performed to validate the methods, and how the results of the analysis are presented for interpretation.

2.2 Workflow

Figure 2.1 shows the overall process described and referred to in the following sections. It also links to figure 2.9 which can be found later in the text.

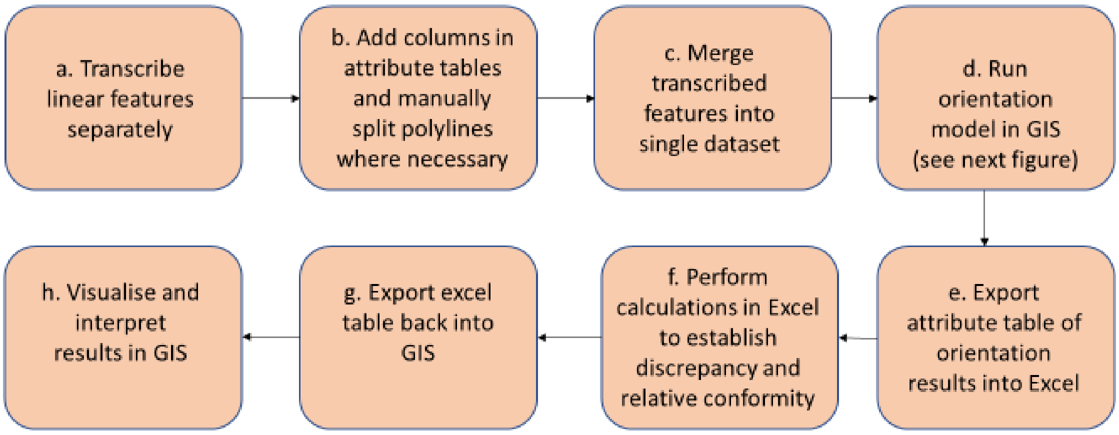

Figure 2.1 Workflow 1 depicting the overall process behind orientation and slope direction conformity analysis

2.3 The project dataset

Addressing Research Objective 3, data for this research project comprised points, polylines and polygons depending on the feature and process required. For example, points representing sites and features, either obtained from HER officers or generated by the author, were most useful in creating distribution plots, whereas polylines were required for calculating the orientation of linear features. Polygons were mainly used to define the extents of areas to be clipped.

A Microsoft Excel spreadsheet was created in the early stages of the study to compile all relevant sites and features, both procured from HER and NMR entries and those discovered through the current research. This dataset can be found in Appendix B (named ‘all_features_Northumberland’). The spreadsheet format was chosen as it provided a simple method of importing and exporting data to and from ArcGIS. The resulting visual data from this is point data based on British National Grid coordinates, which is useful for analysing the distributions of sites and features relative to specific criteria. Aside from generic data on sites, such as dating, location and HER reference number, extra columns were added to include data relevant to the specific research questions, for example, to state whether features were deemed ‘by eye’ to respect underlying slope direction. This column was made to possibly check against the results of the orientation method to see if they matched. Time constraints prevented this from being done but it would be interesting to do follow this line in further research or on an existing study or dataset. A similar approach was used for the ‘Fields of Britannia’ project (Rippon *et al.* 2015: 107); and feeds into a wider discussion regarding whether HER data is fit for purpose in research contexts (Astbury 2014).

Data collection has led to a re-characterisation of some settlements in the study area. The HER and NMR comprises over two centuries of discoveries, leading to many different terms being used to describe the morphology of the same type of feature. Rectilinear Iron Age and early Roman settlement enclosures for example are often classified in HER entries as ‘rectangular’ or ‘square’. This is unhelpful when trying to interrogate the data based on these characteristics. In the current study dataset, these terms have been grouped under the common classification of ‘rectilinear’ which made interrogation, selection and analysis in GIS far easier. Similarly, the term ‘sub-circular’ has been attributed in the current research dataset to sites originally termed ‘oval’ or ‘curvilinear’, or in one case ‘egg-shaped’. This is not to dismiss the myriad descriptive terms for these settlements lodged in HERs, which provide a rich description of site morphologies which can be useful in other contexts; but for the current research dataset, being basic linear units, broad definitions were more useful.

Point data was also essential for checking newly discovered sites against existing HER and NMR records. Addressing Objective 3, over 200 new archaeological sites and features were identified through remote sensing analysis undertaken as part of the current study, which have been deposited with the relevant Historic Environment

Record officer. Some of these, particularly Iron Age and early Roman rectilinear settlement enclosures, have been incorporated into the orientation dataset for analysis. A separate academic paper dealing with newly discovered sites in the region is in preparation at the time of writing.

2.4 Transcription and dating criteria for archaeological features included in the analysis

Fulfilling research Research Objective 3, orientation and slope direction conformity analysis requires a robust dataset of digitally transcribed linear units to return meaningful results. This section relates to workflow 1 (a) which will be referred to throughout. As we have seen, most previous analyses of relative orientation appear to have derived largely from visual observations of features on maps, plans, remote sensing imagery and evidence on the ground. This renders features largely ‘passive’ in that they can be subjectively viewed and scrutinised 'by eye'; but are unsuitable for statistical analysis over large areas which would be logistically difficult and open to criticism due to the subjectivity of the material and method. Digitally transcribing archaeological features, in this case as polylines, creates ‘active’ analytical units of any size which can be subjected to multiple calculations and statistical analyses. This is a real strength of the current approach. The digital transcription of linear features was by far the most time-consuming element of the project, culminating in the production of a bespoke dataset consisting of over 400,000 polylines and points for analysis. Working with a dataset of this size and scope, especially with the inclusion of boundaries and tracks present on 1st edition Ordnance Survey mapping, meant once the data had been analysed, results could be examined at different scales.

2.4.1 Sources

Numerous sources were consulted during the transcription process to ensure the most comprehensive dataset possible was available for analysis. These ranged from seventeenth century estate plans to LiDAR imagery, all of which will be explained in the following section. The identification of archaeological features from remote sensing imagery is dependent on numerous interrelated factors: preservation and ground conditions, and, in terms of the satellite imagery, the time of year, time of day, and conditions under which the image was captured. Add to this the presence of open-cast mining and expanding urbanisation, and it becomes clear that the distribution of identified features can only ever be a partial representation of the original, even when utilizing multiple datasets. The linear features transcribed and analysed in the current research date to many different periods and are derived from multiple data sources depending on the nature of the evidence. These sources will now be discussed in relation to their strengths and weaknesses to the identification of sites and features relevant to the current research.

2.4.2 Historic aerial photography

As stated above, the analysis of historic aerial photographs led to many new discoveries of cropmarks of probable archaeological sites and features along the coastal plain, many of which were relevant to this research. Detailed explanations regarding the formation and optimum variables (including time of year and time of day in which the image was captured, cropping regimes and climactic conditions on the day) of cropmarks can be found elsewhere (Wilson 2000; Mills and Palmer 2007; Passmore and Waddington 2009); but Deegan summed up the process succinctly: "Cropmarks are variations of leaf and stalk colour and plant height and vigour, as seen from the air" (in Passmore and Waddington 2009: 125). Aerial photographs for the current study region were obtained mainly for case-study areas from various repositories including local HERs, Historic England and Cambridge University. Although the original purpose of most vertical photography is not for archaeology, it is often incidentally useful, particularly so for identifying and characterising archaeological sites and features in areas which are now either built on or quarried. Although vertical aerial photography can be obtained for most of the country, the successful identification of archaeological features is wholly dependent on the conditions in which they were captured (Mills and Palmer 2007: 10). On clay soils, which comprise large swathes of the underlying strata in this region, crops develop later than on lighter soils little would be found through analysing aerial photography during the usual 'cropmark season'; if archaeological flights are taken when crops are showing features in lighter soils, heavier soils will appear largely barren (Mills and Palmer 2007: 11). As vertical aerial photography flights are rarely undertaken to specifically identify archaeological cropmarks, we rely on good fortune that they were done at optimum times in the year for this purpose. In the right conditions, vertical photography holds the potential for a huge amount of archaeology to be discovered in a relatively short period of time compared to that captured by site-orientated oblique aerial photography.

A collection of targeted oblique photography focusing on specific archaeological sites taken between the 1980s and 2000s by Tim Gates focused on many sites in the region; and are lodged with Historic England. Many of these photographs helped with defining the morphology and orientation of Iron Age and early Roman settlement enclosures visible as cropmarks. Aerial photographs were georeferenced in ArcMap, using specific landscape features as control points with the same ones present on Ordnance Survey 1:1000 'mastermap' tiles. From this, archaeological features relevant to the current research could be transcribed for analysis.

2.4.3 Google Earth

Systematic analysis of Google Earth satellite imagery was undertaken for the first time in Northumberland during this research, the results of which have been pivotal to numerous aspects of the research. Google Earth is an online application which renders a three-dimensional representation of earth based on satellite imagery. The satellite imagery is superimposed onto a 3D globe which allows users to visualise given areas from numerous angles. Google Earth imagery is subject to the same variables as aerial photography, so what we as archaeologists get to see is dependent on variables beyond our control. The Google Earth application comprises multiple historic satellite images, each captured under different conditions, some of which are more useful than others for showing up cropmarks. The Google Earth imagery was especially useful along the coastal plain; and new discoveries continued to be made throughout the course of the research as more imagery became available. Aside from the identification of numerous previously unknown Iron Age/early Roman rectilinear enclosure sites, Google Earth revealed a wealth of data on ridge and furrow ploughing, preserved as cropmarks beneath modern arable land. Google Earth was also useful for examining possible spatial and horizontal stratigraphic relationships between two or more features, which will be discussed later.

Features identified on Google Earth images were transcribed using the tools available in the application itself; and were saved as 'KML' files. The KML files were converted to shapefiles in ArcGIS using the 'KML to layer' tool. KML files are saved with WGS 84 coordinates which are incompatible with the British National Grid system (OSGB 36) used for the current study. This was resolved during the addition of the converted layers into ArcGIS, where the coordinates were converted to British National Grid reference through the layer properties using the 'OSGB_1936_to_WGS_1984_7' conversion method. These shapefiles could then be subjected to the same analytical methods as features transcribed in ArcGIS.

2.4.4 LiDAR

Early in the research a comprehensive analysis of LiDAR imagery between the Rivers Tyne and Tweed was undertaken using Environment Agency data. LiDAR (Light Detection and Ranging) is a remote sensing technique which depicts topographical variations and man-made disturbance, however slight. Data is gathered by means of an active laser beam transmitted from an aircraft, with the returning reflection being captured and measured (Opitz 2013: 14-15). The results of this process provide accurate three-dimensional measurements of the ground surface. LiDAR data is visualised in two main forms: digital surface model (DSM), and digital terrain model (DTM). DSMs record reflections from whatever the laser hits first, be it the ground itself or buildings and trees, for example. DTM data produces a 'bare-earth' model, thus stripping away and recording surfaces underneath vegetation and buildings (Crutchley and Crow 2009: 11). The first return is equivalent to the DSM, and the last returns are used to help calculate a DTM (Crutchley and Crow 2010: 5-6). The principle source for analysis was DSM imagery, with DTM imagery used mainly in areas of woodland.

The following factors and variables should be understood when analysing LiDAR imagery. The first consists 'interference patterns' between overlapping swathes, which can give rise to wavy lines which traverse large areas (Crutchley and Crow 2010: 26-27). These interfaces also give the appearance of ridges, which is overlapping data from initial processing. To the untrained eye this may be misinterpreted as ridge and furrow ploughing if only apparent in small areas. Figure 2.2 illustrates these issues. Another issue concerns 'rounding errors' in the processing which creates slight steps in the data that have the appearance of possible lynchets (Crutchley and Crow 2010: 26-27). It should also be noted that the processing for a DTM involves the deletion of points above a chosen angle from the plain of previous points, so features such as low banks of vegetation are problematic as the DTM can depict these as topographic; but are just artefacts of processing. It is therefore preferable wherever possible to use DSM imagery in an archaeological context.

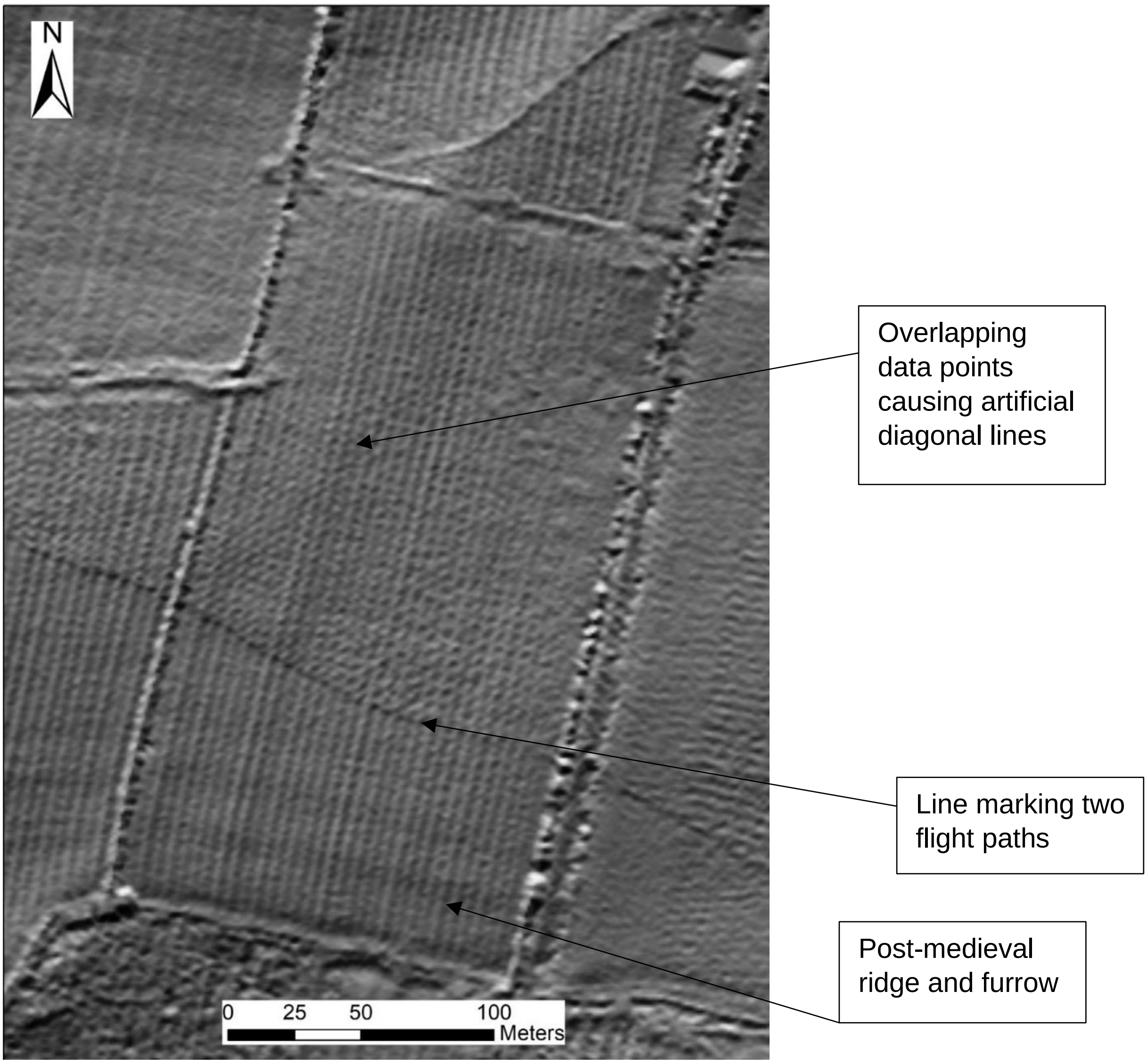

Figure 2.2 Artefacts of post-processing LiDAR data: overlapping tiles around Broad Wood, Morpeth. Hillshade image created from 1m LiDAR DTM (Environment Agency: 2016)

The procurement and analysis of LiDAR data in this study was governed by the agenda of the Environment Agency which is primarily to survey areas of flood-risk. At the time of writing coverage in the current study area was incomplete, leaving large gaps and an unavoidable bias in the collection and interpretation of data, shown in Figure 2.3. In addition, modern residential and industrial areas were omitted from the procurement strategy since they hold little potential for the detection of archaeological remains.

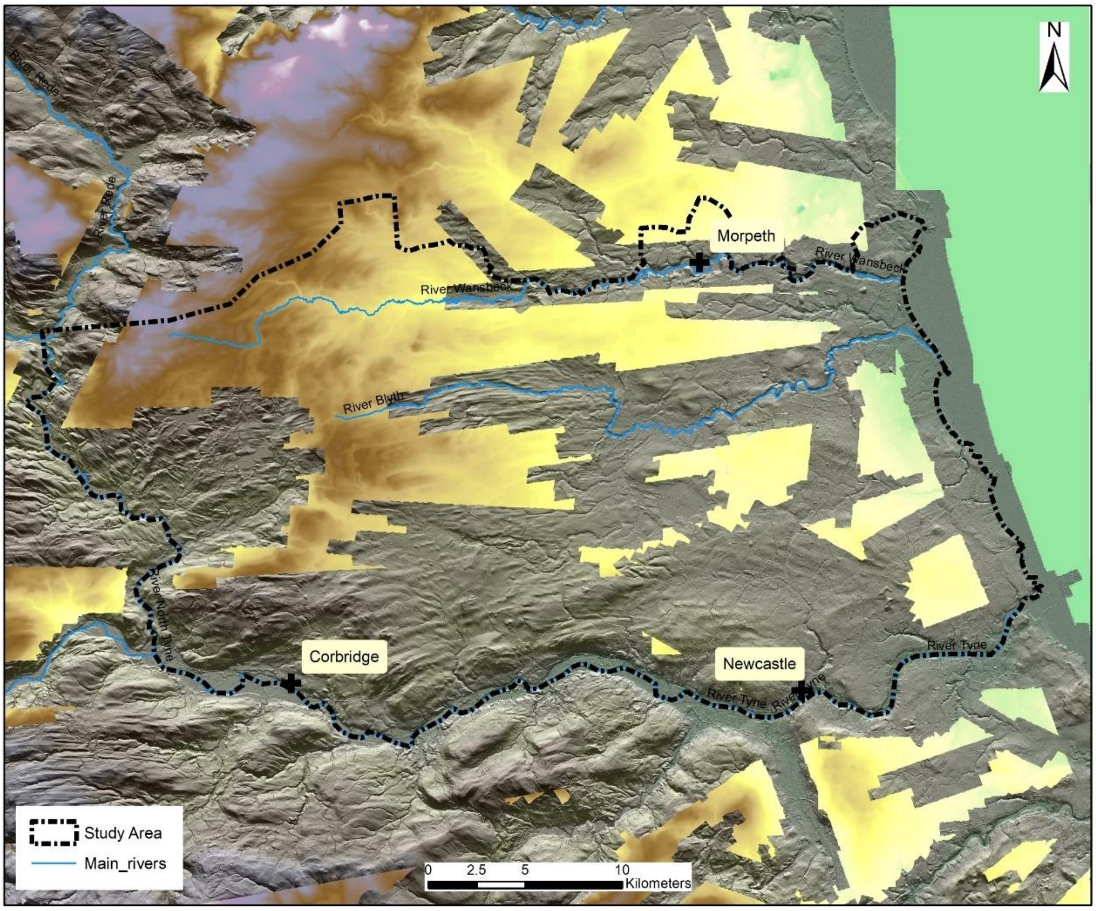

Figure 2.3 Gaps in Environment Agency LiDAR coverage as of 2019 (Hillshade lit from 180 degrees generated from 1m DTM, Environment Agency: 2019)

Multiple image processes were used for analysis. Early in the research, ‘hillshade’ imagery was used to generate imagery of the whole study area. This process generates an artificial light source that illuminates the topographic surface from a specified azimuth (Davis 2012: 12). The angles specified for analysis were 90, 180, 270 and 315 degrees. A ‘composite’ of the hillshade images was then generated, which was used to perform ‘principle component analysis’ (PCA), which mathematically transforms the data into a ‘summary’ of multiple sources, in this case the four hillshade perspectives (Kokalj et al. 2012: 104-105). Doing this saved time in the analytical process, as it was possible to identify the full extents of features without continually having to switch between individual hillshade perspectives, which by their nature leave large areas in shadow. For specific areas of interest to the current project, PCA was performed on sixteen hillshade images, which has been found to be an optimum number for visualising archaeological earthworks (Forlin 2002). The angles used began with zero degrees and proceeded at fifteen-degree intervals. It was decided against performing PCA on sixteen hillshades for the whole study area due to limitations in available hardware. Although the hillshade method enables the rapid analysis of large areas, it is not the most effective for identifying archaeology (Doneus 2013). To address this issue Local Relief Modelling (LRM) has been devised. The basic principle of LRM is that terrain surface is filtered out, leaving just discreet archaeological features and their relative elevation above or below the terrain (Novák 2014). Full details of this method, for which Novák helpfully built a model for ease of use in ArcGIS, can be found elsewhere (Novák 2014). To maximise the potential for the identification of archaeological remains in lowland contexts, LRM imagery was generated for specific areas. This largely failed to facilitate further discoveries along the coastal plain, proving that much of the landscape along the coastal plain had been subjected to considerable cultural erosion, mainly through successive phases of ploughing since the medieval period. Imagery derived from LiDAR survey therefore offers relatively little chance of identifying large numbers of probable pre-medieval archaeological features in the heavily cultivated lowlands. For upland regions the analysis of LiDAR data led to numerous new archaeological discoveries which have been deposited with the relevant HER officer. These findings lie largely beyond the current study area; and will be reported on and discussed in a separate academic paper.

2.4.5 Historic mapping

The consultation of historic mapping was essential to data collection and interpretation, with those procured ranging from seventeenth century estate plans to twentieth century Ordnance Survey maps. The earliest plans used dated to the seventeenth century; and were obtained from Alnwick Castle archives. These plans are notoriously difficult to georeference in GIS; but in most cases it was possible to cross-reference features on the plans with those present on later maps. The most useful information contained on these plans to the current study was the presence, or partial presence, of medieval furlongs before they were eradicated through various enclosure agreements throughout the post-medieval period; these provided vital clues as to the dating of certain boundaries and furlongs which add further validity to the dataset. Figure 2.4 shows the open fields and furlongs in Horsley township during the seventeenth-century.

Figure 2.4 Open-fields at Horsley, still present in on the 1621 Robert Norton map (from Tolan-Smith 1997: plate IV , reproduced by permission of His Grace the Duke of Northumberland)

Pre-enclosure estate plans provide a partial insight into medieval open-fields as they were gradually being enclosed during the late-and-post medieval period. A 1632 estate plan of Horsley township showed the layout of furlongs and individual selions contained within a four-field system (Tolan-Smith 1997). The estate plan of Ogle township, dating to AD 1632, shows a three-field system but with large portions of them enclosed. No evidence indicating the presence of furlongs is depicted on this plan a result of much of the land being under pasture at this time. Historic Landscape Characterisation (HLC) in Northumberland (Williams 2015) was also a valuable resource for understanding the composition of the landscape at different levels; and was incorporated as a shapefile dataset in ArcMap for reference.

Eighteenth-century plans were procured from Northumberland Archives. Although digitally scanned estate plans do not include spatial reference points, they were accurately surveyed at the time which enabled them to be manually georeferenced using control points, usually on the junction of two or more fields, which were still present on later and modern mapping. Estate Plans were usually produced at a township level, depicting fieldscapes and settlement during and after the process of enclosure-by-agreement, but usually before parliamentary enclosure, the results of which are shown on nineteenth-century tithe maps which were also obtained from Northumberland Archives.

Tithe plans revealed little that was not present on the more expansive 1st edition Ordnance Survey maps; but were produced with apportionment documents which detailed land ownership, and importantly for the current research, field names which offer clues as to previous land-use. For example, fields containing the name-element 'chester' have been subsequently shown to contain prehistoric and early Roman settlement enclosures, such as the recently excavated site at West Shiremoor (ASDU 2018). Agricultural practices and land-use can also be gleaned through apportionment documents, which aided with the identification of areas of former common or moorland; and arable land in relation to known medieval settlements. All historic mapping contains fragmentary evidence of medieval land-use, such as the numerous medieval furlong boundaries were re-used as field boundaries in the enclosure period, which are characterised by the reverse ‘S’ sinuous lines, illustrated in Figure 2.5.

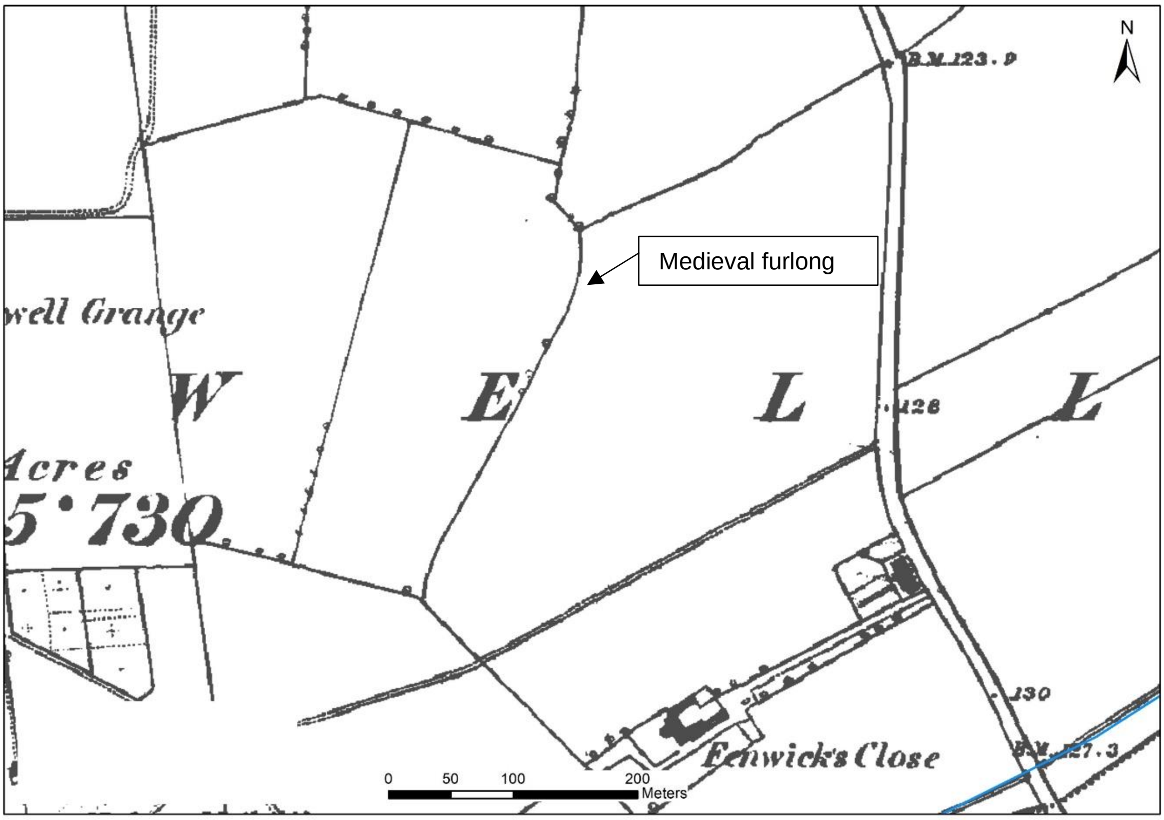

Figure 2.5 A medieval furlong or selion encased in later field boundaries depicted on 1st edition Ordnance Survey mapping east of Holywell Grange Farm (mapping downloaded from Edina Digimap, 2016)

All available historic Ordnance Survey mapping was procured from the Edina Digimap online mapping repository. All boundaries and routeways present within the study area were transcribed from 1st edition Ordnance Survey six-inch maps which date to around AD 1860. Discernible water courses used as township boundaries were excluded, as were known waggon-ways, which occur in large numbers towards the banks of the conjoined River Tyne in the east of the study area. It was also used to cross-check any identified features during the analysis of remote sensing imagery to help with the interpretation and characterisation of newly discovered sites and features. Ordnance Survey mapping procured from Edina is already georeferenced, so once the tiles are combined in a mosaic dataset, they can be added as a layer to GIS. Early in the process it was found that some of these map tiles were spatially inaccurate compared with later maps. The imprecise nature of surveying so far from the Greenwich meridian, London, which was used as the datum point by early Ordnance Survey cartographers, entails that many features, whilst being consistent in their original surveyed context, are not consistent with the same features on modern mapping (Roberts and Wrathmell 2000: 9). To overcome this, the 1st edition

Ordnance Survey mapping was viewed transparently on top of a modern 1:250 000 Ordnance Survey map, as shown in Figure 2.6. This enabled some, if not all, field boundaries which were depicted on poorly referenced tiles to be cross-checked with more accurate modern mapping.

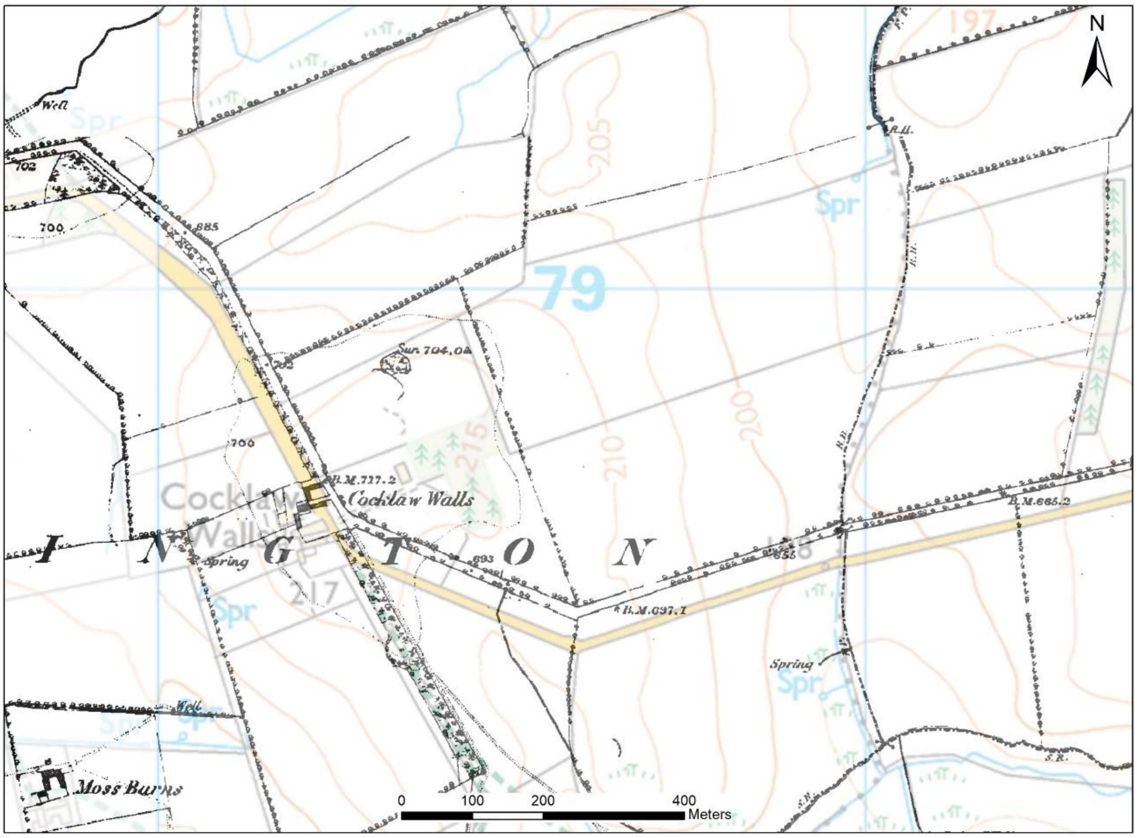

Figure 2.6 Using transparency with 1st edition Ordnance Survey mapping over modern 1:25000 (mapping: Edina Digimap Service, downloaded September 2018)

2.4.6 Geophysical survey plots and excavation plans

Geophysical survey plots, depicting primarily the results of gradiometry survey undertaken in developer-funded contexts, were used where necessary to record and assess archaeological features. Reports were obtained from the relevant HER officer or from the archaeological consultancy responsible. The main logistical benefit of gradiometry survey is its rapid application over large areas, hence its widespread use on developer-funded projects. Gradiometry, or magnetometry as it is sometimes known as, is a blunt instrument, however, and the interpretation of any geophysical survey plot should be done with the knowledge that it does not provide a comprehensive picture of what lies beneath the topsoil; and that the results are subject to many extenuating factors, detailed elsewhere (for example Gaffney and Gater: 2003). To get the full benefit of geophysical survey, multiple methods should be used in unison to record different responses beneath the soil. In the case of gradiometry the magnetic properties within the buried soils dictate the results. If no magnetically different material exists in a ditch fill compared to the soil around it, it will not be highlighted on the survey. Whilst gradiometry data often reveals the indication possible archaeological features, such as furrows associated with historic ploughing and possible prehistoric ditches, little can be substantiated prior to excavation. The presence of multiple directions of plough furrows on gradiometry plots at Choppington (AD Archaeology 2016) is an example of the benefits of gradiometry survey, providing a useful contribution to the project dataset. Geophysical survey plots were georeferenced in ArcGIS in the same way that historic maps and aerial photographs prior to analysis and transcription.

Excavation plans were crucial to the current study, accurately depicting numerous dated archaeological features: in the case of this research being boundaries, pit alignments and settlement remains. Plans for specific sites of interest were obtained through published and unpublished sources. Published site plans were scanned from the original monologue; whilst unpublished reports were requested from the HER officer or the relevant archaeological unit which undertook the research. All excavation plans were georeferenced in ArcGIS and features relevant to the current study transcribed for analysis.

2.5 Characterisation and transcription

In both upland and lowland contexts, characterising archaeological sites and features is rarely straightforward. Upland areas contain excellent preservation of archaeological sites, present as clear earthworks visible on LiDAR imagery and aerial photography. These areas often contain intricate tangles of interrelated and non-related earthworks, rendering the interpretation of archaeological features on LiDAR data extremely difficult. Conversely, lowland zones are often been subjected to extensive subsequent developments such as urbanisation, industry, and intensive agriculture. Here, ancient sites are usually only identified as cropmarks which can be difficult to untangle from centuries of agricultural activity and natural glacial phenomena such as ice-wedges.

Land-use in the post-medieval landscape had to be considered in the analysis of remote sensing data. Linear cropmarks or earthworks which appear to have little in common with surrounding existing boundaries could for example be tracks associated with more recent short-term industrial activity, such as mining or quarrying rather than ancient in origin. Regular reference to historic and modern mapping was therefore essential to avoid misinterpretation. The following section will discuss the characterisation of sites and features of specific importance to the current research. Discussions around the possible use of such features and their landscape context can be found in later chapters.

2.5.1 Rectilinear settlement enclosures

Iron Age/early Roman rectilinear settlement enclosures were relatively easy to identify by their morphological characteristics. This was helped by numerous excavations of this site type which are securely dated through scientific methods to the late Iron Age and early Roman periods. Establishing criteria for characterising these sites was important, as, for example, rectangular cropmarks at Pegswood and West Hartford interpreted as Iron Age or early Roman settlement enclosures were subsequently disproven through excavation (Proctor 2009: fig.46; Fraser 2004). Neither of these examples displayed any defining characteristics beyond their rectangular shape and dimensions. The following criteria was therefore devised, partly informed by previous work (Jobey 1960; 1970; 1973; Hodgson *et al.* 2012): at least one of the following should be present to enable positive identification as a settlement enclosure: distinctive entrances, usually on the east or south east; hut circles; and associated linear features which either project from or are aligned with enclosures. Figure 2.7 presents examples of these criteria.

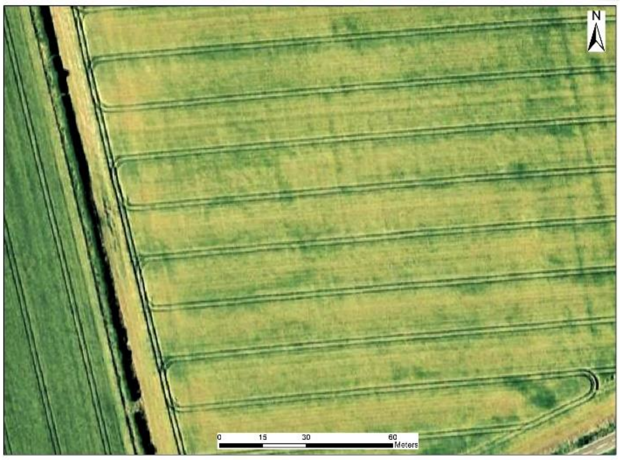

Figure 2.7 Examples of rectilinear settlement enclosures in the study area, showing the east facing entrance at Startup (left), and the internal hut circle at West Holywell Grange (right)

A handful of rectilinear settlement enclosures were identified from the LiDAR analysis, along with possible boundaries in some areas, but most newly identified ones were in the form of cropmarks visible on Google Earth imagery. Combining LiDAR and Google Earth imagery produced useful results at Waddle Bank (N11550), where a known partial cropmark of a double-ditched rectilinear enclosure with an east-facing entrance was analysed alongside LiDAR data, which revealed the western portion of the enclosure surviving as earthworks beneath scrub. Further earthworks were also identified to the south which could represent a third and even fourth bank and ditch. Figure 2.8 illustrates these findings.

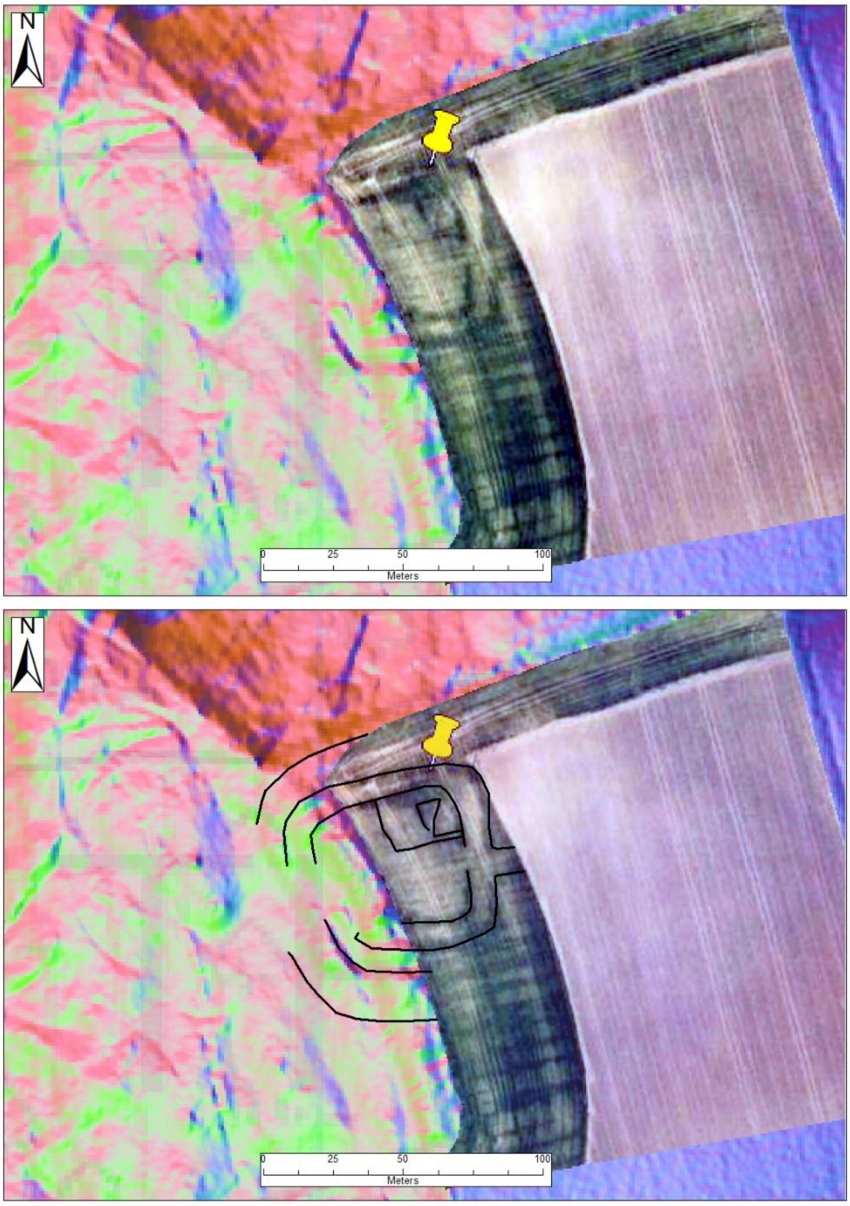

Figure 2.8 Combining cropmarks on Google Earth (right) and earthworks visible on LiDAR imagery (left) to reveal the full extent of the settlement enclosure at Waddle Bank. Principle Components Analysis using 4 hillshade images from a LiDAR 1m DTM (Environment Agency: 2016)

Newly identified sites were cross-checked against the Northumberland and Tyne & Wear Historic Environment Records and Historic England online sites and monuments register. Rectilinear settlement enclosures were transcribed from historic aerial photographs, excavation plans; and Google Earth and LiDAR images. In a few cases 'Sentinel Hub' satellite imagery (available online) was used to determine the morphology and orientation of known enclosures, such as HER 11283 and Horton Grange. Sentinel imagery is only available to view for free at a low resolution; but it contains images captured regularly over a period of two years, ensuring the enclosures could be identified on at least one image. It was always consulted prior to ordering historic aerial photographs of a given site from Historic England, which carried a financial cost.

The analysis of orientation requires polyline data. This works fine for field boundaries, ridge and furrow and tracks, which are effectively 'lines'; but settlements consist of multiple linear units. In the case of rectilinear enclosures, polylines were digitally transcribed through the centre of each enclosure to represent their orientation. It is acknowledged that this method creates subjectivity; but every care was taken to accurately transcribe the polyline to faithfully represent the orientation a given settlement.

2.5.2 Boundaries and tracks associated with prehistoric and early Roman settlements

Whilst accurate scientific dating is largely absent from ditches around Iron Age and early Roman settlements, the shared orientation with enclosures and the fact they underlie medieval ridge and furrow suggests they are contemporary, or close to contemporary. This is not to say that some may have originated much earlier, or some later in the Roman period or even the Anglo-Saxon period; but it is beyond the scope of the current study to investigate this further. An example of this latter distinction was excavated west of Blyth in a developer-funded context (HER N22890). Although no dating evidence was recovered from this feature, it was overlain by broad ridge and furrow and so was assumed to predate the twelfth century. The ditch has therefore been included in the analysis, even though we cannot say for certain exactly how old the ditch is. A single example of a possible Anglo-Saxon boundary ditch was excavated at Fox Covert; and is included in the dataset as an ancient (pre-medieval) boundary, but of Anglo-Saxon date. There is nothing to say, however, that this ditch did not have much earlier origins, such are the complexities of trying to accurately date these features, as will be shown in the next chapter, where a discussion of the possible uses of these boundaries can also be found.

2.5.3 Linear cropmarks and earthworks

In some cases, features present on remote sensing could be tentatively characterised on morphological grounds as buried ditches associated with pre-medieval settlement and land-use through comparison with excavated and dated examples. For the aforementioned ‘Fields of Britannia’ project, cropmark evidence was only included where it could be securely dated through subsequent excavation to determine whether it was of late prehistoric or Roman date (Rippon *et al.* 2015: 107). The current study is less concerned with this distinction; and instead seeks to identify more generalised patterns of land use development over long periods, such as the continuation of a grain of orientation in the landscape: in other words, to determine whether boundaries dating to either late prehistory *or* the Roman period endured into the medieval period and beyond, as set out in Research Aim 3.

Identifying and characterising cropmarks and earthworks as boundaries associated with pre-medieval settlement and land-use is problematic. Natural geological phenomena, such as ice wedges, are commonly visible as cropmarks in the right conditions; and have in the past been mistaken for evidence of prehistoric, Roman or early medieval field systems, notably around Yeavering in north Northumberland (Hope-Taylor 1977: 46; Gates 2005: 71-73). Large swathes of ice wedge cropmarks are present on Google Earth imagery, many of which are intermingled with linear cropmarks which could represent ancient or historic boundaries and tracks. It was important, therefore, to gain an understanding of the physical nature and appearance of these features by consulting existing studies in the region. The most useful of these studies was undertaken at New Bewick, north of the current study area (Gates and O’Brien 1988). Ice-wedge gullies typically present as ‘branched’, which would be difficult to account for in terms of coherent human-made field-systems (Gates 2005: 73); and excavations have proven this feature-type to be geological in origin (Evans 1972 in Gates 2005). Aerial photography also shows natural phenomena such as paleochannels which are bands of deeper soil and so affect crop growth at the same time as archaeological features, mainly on alluvial floodplains. On clay soils tertiary deposits and shallow valleys occur, which may have influenced the location and function of past settlements and associated activity; and recording this information is crucial (Mills and Palmer 2007: 10-11). The main criteria used to determine the provenance of cropmarks and earthworks was whether they projected from or ran parallel or perpendicular to rectilinear settlement enclosures, as so many do in excavated examples in the region.

2.5.4 Field boundaries and routeways present on nineteenth century mapping

The basis for transcribing all boundaries and routeways on 1st edition Ordnance Survey mapping is rooted in Roberts and Wrathmell's observation that many aspects of earlier land-use and settlement were preserved and depicted on nineteenth century maps (2000: 7). Orientation analysis, including comparisons with known earlier linear human-made features such as pit alignments and ditched boundaries associated with Iron Age and early Roman enclosed settlements offers a chance to explore this further. Transcribing all field boundaries present on first edition Ordnance Survey maps was the most time-consuming task undertaken in this research; but was deemed necessary as it represented a baseline dataset for the whole study area from which other linear units could be compared with.

Field boundaries were transcribed as separate polylines according to whether they were orientated roughly north to south, or east to west. This approach was taken to test research carried out by Tom Williamson (2016) in the Dengie Peninsular in Essex, in which he suggested that north-south linear boundaries preceded those oriented east-west, the latter representing later infill which create the field systems that persisted until at least the mid nineteenth-century. Undertaking this in the current study proved quite useful as a visual exercise, but it was found that the orientations could be better calculated using script in ArcGIS. Field boundaries and routeways which are also township boundaries were transcribed as the latter for data consistency. The two polyline datasets representing north-south, and east-west boundaries were merged in GIS to form a single polyline dataset alongside the former.

2.5.5 Township boundaries

Establishing a chronological sequence for township boundaries carries great research potential. They could, either in whole or in part, be important pivot points from which the landscape developed over long periods spanning multiple historical parameters. Very few township boundaries have been excavated, so we have little idea of the chronology of these boundaries in the current study area. During work undertaken in advance of development near Seghill, trenches were excavated through an upstanding township boundary, although no dating evidence was found (TWM 2006). This is partly due to schemes of investigation which would not have placed great importance on establishing a chronological context for township boundaries; and they are often omitted from intrusive schemes due to ecological constraints.

Dixon (1984) focused on establishing the existence of medieval 'vills' and the approximate medieval boundary based on that recorded by the Ordnance Survey in the nineteenth century. The result of this process was the patterning of township boundaries. New townships were removed from the analysis, but old vills no longer visible could only be partially reconstructed. Seventeenth-century estate plans helped to confirm the late medieval antiquity of many boundaries still extant in the nineteenth century (Dixon 1984: 82). Dixon's methodology for the mapping of township boundaries will be adopted for transcribing those in the current study area, which was never undertaken by Wrathmell (1975) in his thesis based on the same region.

Township boundaries are depicted on the 1st edition Ordnance Survey map as dashed lines. They are also labelled according to morphology. Abbreviation lists for these were consulted online (Ordnance Survey: no date) to establish the terminology: 'R.H' is an abbreviation of 'root of hedge' and occurs in great numbers along the coastal plain. Further west, 'F.W' meaning 'face of wall' is the dominant boundary classification. A column was added in the attribute table for township boundaries for this information to be added. This enabled certain classifications such as 'C.R' (centre of a river), to be omitted from orientation analysis as they do not represent human-made features and would skew the results. Some sinuous boundaries, whilst not depicted as such on mapping, may well be dried up rivers and streams.

Although these linear features present on 1st edition Ordnance Survey mapping were transcribed and characterised in different ways, they were merged to form a single shapefile consisting of all linear human-made features, whilst keeping the original separate polyline data. These shapefiles can be accessed in Appendix B, in the GIS folder. This way different feature types could be analysed both in isolation and homogenously.

2.5.6 Medieval ridge and furrow

Although much has been lost to later development and agricultural practices, numerous fragments of medieval open-field furlongs survive as earthworks and cropmarks within the study area, characterised by broad ridges and furrows with a distinctive ‘reverse S’ shape. Although exact dating for medieval ridge and furrow remains problematic (see O’Brien and Adams 2016 for example), it is broadly assumed that traces displaying these characteristics date largely from between the twelfth- and fifteenth-centuries, with some possibly later. We are probably seeing on the ground and in remote sensing imagery only the final traces of a slowly evolving system of agriculture which has been subjected to numerous alterations; and we cannot discount the notion that some may be of much earlier date (Taylor 1981: 18-20). The direction of ridge and furrow may not always have followed the orientation of that captured on aerial photography, LiDAR and satellite imagery. Geophysical survey plots and excavation plans regularly reveal more than one direction of ridge and furrow ploughing in a given area. In some cases, multiple orientations can be discerned, often perpendicular to each other; whilst other examples show multiple directions which do not share a common alignment, for example, see Felton for excavation (AD Archaeology 2018); and Choppington for gradiometry results (AD Archaeology 2016).

Evidence of ridge and furrow was transcribed from a variety of sources. Where available, historic estate plans provided the best evidence, such as the seventeenth century estate plan of Horsley. As has already been stated, these plans are almost impossible to accurately georeference onto modern mapping, but as part of her PhD research Myra Tolan-Smith transcribed these features onto an Ordnance Survey plan which could be accurately georeferenced in GIS (Tolan Smith 1997). A plan of Ogle township, dating to AD 1632 depicts the partial enclosure of the former medieval open fields. From this, open fields could be transcribed from field names and boundaries and comparing them with those still present on 1st edition Ordnance Survey maps. LiDAR imagery was useful in areas where modern ploughing had not obliterated earthwork evidence. Only small pockets of this kind of evidence survive along the coastal plain, but, where Environment Agency coverage permitted, was plentiful further west in upland areas. Along the coastal plain cropmarks provided the most fruitful evidence; and the afore-mentioned furlong boundaries or individual selions depicted as surviving field boundaries on Ordnance Survey maps were transcribed to bolster the evidence-base. Time constraints prevented the transcription of all available evidence for ridge and furrow across the whole study area; and instead specific areas were chosen to reflect various topographic conditions. These are: the coastal plain, particularly around the townships of East and West Brunton where cropmark evidence is good; the area centred on the townships of Whalton and Ogle, which contain good cropmark and earthwork evidence; the upper lowlands around Throckrington which contain a wealth of preserved ridge and furrow earthworks; and finally, the banks of the conjoined Tyne within the afore-mentioned township of Horsley. One polyline was drawn to represent a furlong, again due to time constraints. Survey and excavation plots were used to analyse small pockets of evidence, such as that depicted on geophysical plots at Spital Hill and Choppington.

The criteria for characterising ridge and furrow as medieval were:

- broad (over 5m between the centre of furrows)
- Reverse ‘S’ shape

2.5.7 Post-medieval ridge and furrow

Post-medieval ridged ploughing has been transcribed within the case-study areas to provide a context for studying the differences in orientation and slope direction conformity between probable medieval and post-medieval and later ridged ploughing. Addressing Research Aim 3, post-medieval ridge and furrow provides a chronological link between the medieval period and boundaries and tracks depicted on nineteenth century Ordnance Survey mapping. At least two types of post-medieval ridged ploughing have been identified in the analysis: that portraying straight but broad ridges, which may also be late-medieval in date; and straight, narrow ridges resulting from steam-ploughing and under-drainage in the eighteenth and nineteenth centuries (Williamson 2002). Adding a further ‘late medieval’ criteria for classifying ridge and furrow was considered, but the evidence is too variable to differentiate. The two classifications settled on were ‘medieval’ and ‘post-medieval’ ridge and furrow ploughing. As with the broad reverse ‘S’ type, dating post-medieval ridge and furrow based on morphological characteristics is extremely difficult. What broadly characterises this from medieval ridge and furrow is how straight the ridges are despite local topographic conditions.

Across the study area the morphology of ridge and furrow was extremely varied. Reverse ‘S’ shaped selions consisting of both broad and narrow ridges were frequently observed; whilst in other areas, straight ridge and furrow was present in fields that were bounded by reverse ‘S’ banks. The latter is evidence of medieval furlongs which were probably enclosed and ploughed in the post-medieval period, but we cannot be certain of this. Classification was also difficult where only fragments of ridge and furrow survived, such as short stretches of very broad ridge and furrow that did not portray the reverse ‘S’ at the terminal; this could be interpreted as either medieval ridge and furrow, of which only the central section of the selions survive; or alternatively later ridge and furrow that did not include reverse ‘S’ at its terminals. Where the criteria could not be met, the evidence was omitted from the analysis to maintain consistency. Fields in the eastern portion of Whalton township provide a good example of the varying widths, and depths, of straight ridge and furrow. These issues highlight the need to establish firmer chronologies for ridge and furrow ploughing, and ways of charting morphological development from the medieval period to the nineteenth century, which will be returned to in the final chapter.

2.5.8 Roman Roads and Hadrian’s Wall

Three Roman roads are present in the current study area; Dere Street, The Devil’s Causeway and the Military Road. The lines of Dere Street and the Devil’s Causeway were transcribed from the first edition Ordnance Survey map for analysis. The Military Road was omitted from analysis it runs largely alongside and parallel to Hadrian’s Wall within the current study area.

2.6 Orientation and slope conformity analysis: methodology

We turn now to Aim 2 and Objectives 4 and 5, and the practical elements of building a GIS model to calculate and compare the orientations and conformities to underlying slope direction of the units described above. The process involves many stages, most of which are consequential in that the completion of one stage informs the next, shown in Figure 2.9. Closely following a staged process was essential to the success of the technique and the production of meaningful results. Before the analysis could take place, a few more steps had to be taken, which will now be described. These steps will be cross referenced with those outlined in workflow 1 (Figure 2.1).

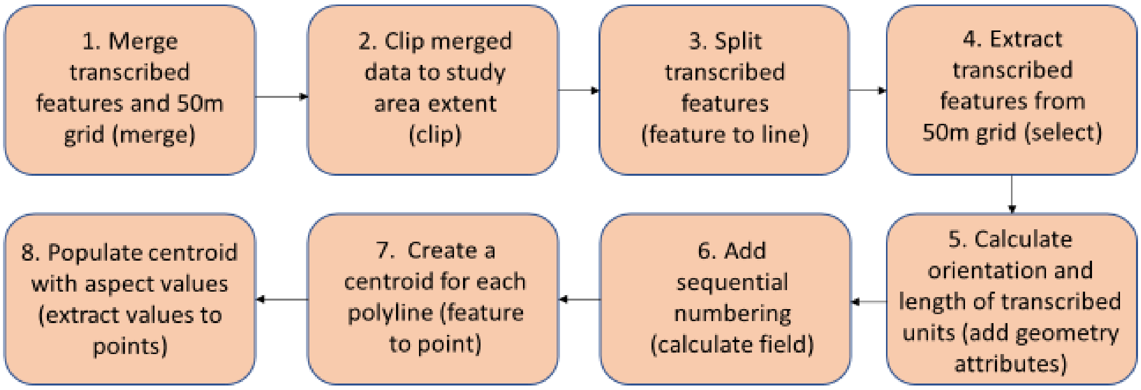

Figure 2.9 Workflow 2, showing the steps required for analysis of orientation and slope direction conformity. Terms in brackets refer to the tool used in ArcMAP.

2.6.1 Preparing the data

Despite the rigorous methodology for characterising and transcribing archaeological features, it was found during the initial testing process that the data required additional characterisation to make it suitable for the orientation analysis. This involved creating and populating data columns in attribute tables; and omitting certain features from datasets; and is shown in Figure 2.9 (b). For example, transcribed roads, footpaths and field boundaries present on 1st edition Ordnance Survey mapping were deleted where they occupy the same line as township to prevent duplicate entries being calculated. The decision was also taken to extract from the data any boundaries represented by watercourses. This probably did not eradicate all boundaries which follow water courses, as some may lie upon relict dried up streams and paleochannels.

More attribute fields and values were added to the datasets to both extract certain feature types, and to ‘join’ datasets in the visualisation process; the reasons for this will be explained in detail later. These functions were incorporated into the overall model. For the purposes of joining datasets, a unique ID number was generated which would form a common value between the split boundary features and the centroid features which result from the orientation calculations explained below. A field was added using the ‘Add_Field’ tool, and labelled ‘join_ID’, and assigned as a short integer field.

2.6.2 Extracting features from overall merged datasets

As is explained above, features depicted on first edition Ordnance Survey mapping were transcribed separately, with the relevant attribute field populated in the following way:

- ‘NS’ (North-south boundary)
- ‘EW’ (east-west boundary
- ‘FP’ (footpath)
- ‘RT’ (road track)
- ‘DC’ (Devil’s Causeway)
- ‘DS’ (Dere Street)
- ‘HW’ (Hadrian’s Wall)
- ‘TS’ (township)

These features were merged into a single dataset for orientation and slope direction conformity analysis; but it was also useful to scrutinise them individually after the orientation had been calculated. To do this, fields were generated in the attribute table in ArcGIS for each individual feature to signify their use. To use the example of the Hadrian’s Wall polyline dataset, an attribute text field was generated, named ‘Type’, which was populated with the text ‘HW’. These steps were repeated for all other features transcribed from 1st edition Ordnance Survey mapping. This attribute field was used in the ‘select by attributes’ tool to extract individual features from the overall dataset using SQL expressions, for example:

- Type= ‘HW’

The selected data, in this case the Hadrian’s Wall polyline, could then be exported as a separate .shp file to be viewed and analysed in isolation.

2.6.3 Manually splitting polylines

For the analysis of linear orientation to return coherent results, it was deemed necessary to manually split transcribed linear features by inserting vertices within them to form straight lines. Sinuous lines with more than one change in direction would have produced invalid results due to the nature of the method, which relies on calculating a mean value from the first and last points of a polyline. Important factors in this were: did the sum of the polyline reflect a near-straight line from the start point to the end, even if there were slight fluctuations within the whole; and did these small fluctuations reflect the topographic conditions over which they traversed? If so in the case of the latter, a split had to be made. But wherever possible boundary features were kept as one polyline to reflect their form and dimensions. Polylines representing boundaries were manually split at points where the direction turned significantly enough to skew the results. To test how this could work in practice, an Iron Age ditch beneath the medieval village at Shotton was used, in the context of just analysing the orientation of the boundary rather than comparing it with underlying slope direction. The ditch in question has three main orientations so cannot be analysed as a single unit by calculating the difference between the start and end of the representative polyline. The polyline was split into three separate units representing the changes in direction, shown in Figure 2.10, and the orientation calculated for each.

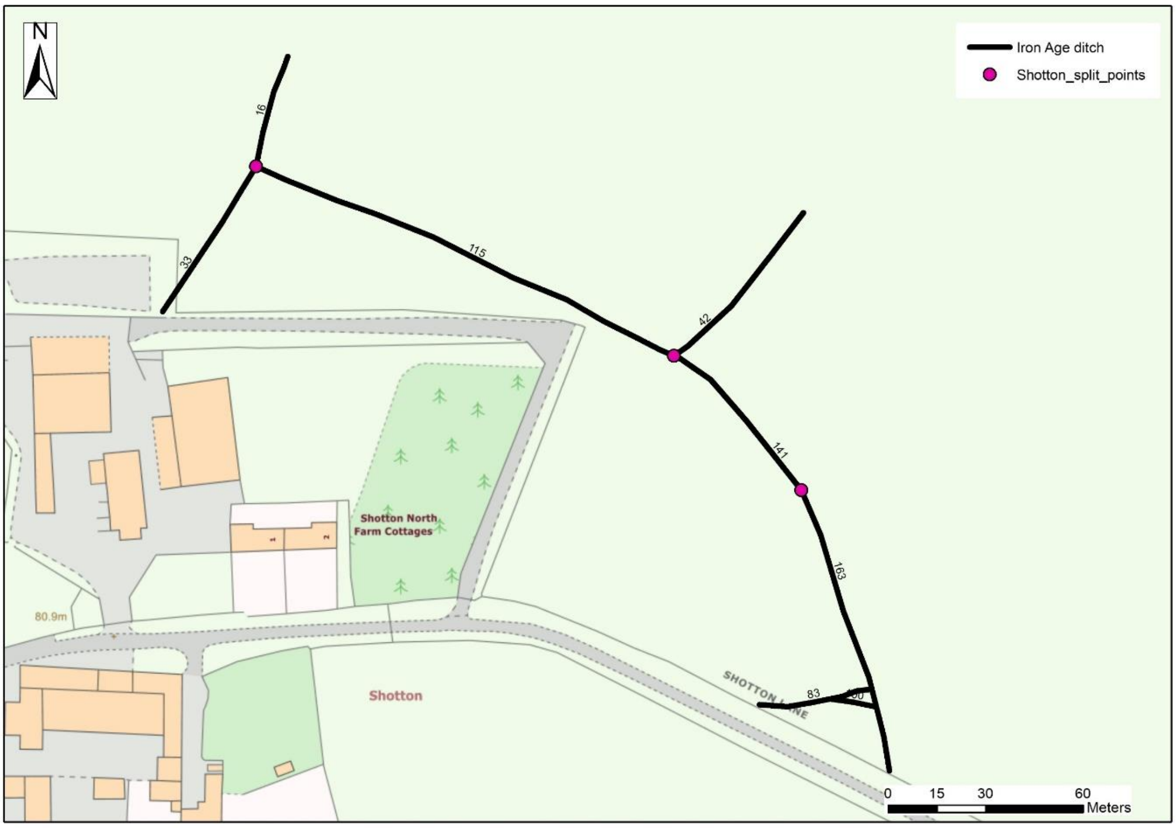

Figure 2.10 Creating 'split' points in the main Iron Age ditch polyline at Shotton (mapping Edina Digimap, 2018)

This enabled the creation of single polylines which ran in one direction, with room for small deviance, rather than multiple changes to the direction, especially at extreme degrees. Boundaries still appear continuous, as they are depicted on maps and other sources, but vertices placed at turning points meant that they were effectively 'split' into straight sections more suitable for the script and models used to generate centroids and assign aspect values. This does entail that more sinuous boundaries which were laid out in one event cannot be examined as-a-whole as the separate vertices split it into sections. These sections can be examined in isolation but are ultimately values to be included in the overall statistical analysis. Boundaries in this way can be studied statistically, by what proportion are oriented in certain ways rather than the orientation of the whole boundary, which will consist in some cases of multiple orientations. The following section will take this a step further. This was deemed necessary for the success of the method as not splitting sinuous boundary polylines would have skewed the results. If necessary, averages of slope direction conformity can be calculated from split polylines; but the general aim is to calculate the percentage of a boundary which does conform, so this method is the best way of doing this.

2.6.4 Establishing 'aspect'

Examining the extent to which linear archaeological features conform to slope direction requires a comparative dataset representing the direction of slope in degrees at the centroid point of each boundary line, as is shown in workflow 2 (8) (Figure 2.9). 'Aspect' data, derived from the most recent 5m DTM plots obtained from the Edina mapping repository, was initially deemed the most suitable for this task. It soon became clear, however, that the radical changes to large areas of the coastal plain in the last twenty years through open-cast mining was reflected in the most recent DTMs. This distorts the process of comparing boundaries with underlying slope direction. To overcome this, DTM data backdated to 2006 was procured from Edina. Unfortunately, this was only available at 50 metre resolution; the practical and theoretical ramifications of which will be discussed below. After building mosaic datasets from the multiple DTM tiles, 'aspect' raster imagery was produced in ArcGIS. The values in each 50m square cell in the output aspect raster image reflect the compass direction that the slope faces at that location. Areas deemed to be 'flat' on 50 metre resolution aspect data are assigned the value -1 (ArcGIS: online). As a result, any features which are situated within blocks containing this value could recorded as conforming to slope direction.

The ArcGIS tools and process used for creating aspect data are as follows:

- Obtain 50m DTM
- Data Management> Raster>Raster Dataset>Mosaic to new raster (Merges multiple raster datasets into a single raster)
- 3D analyst>raster surface>aspect (Derives aspect from a raster surface. The aspect identifies the downslope direction of the maximum rate of change in value from each cell in relation to its neighbours. The values of the output raster are the compass direction of the aspect)

2.6.5 Splitting polylines on points at which aspect changes

During trials of the orientation model it became clear that many boundary lines traversed multiple values of 50m square of aspect data. The start of a line could therefore fall within a different aspect value to the end of the line; and furthermore, the start or end of a boundary line may only traverse a comparatively small portion of a given aspect value, with the majority located within a different aspect value. Applying the bearing calculation explained below, the values at the start and end of a line are given equal value importance, even though only a small portion occupies one of the aspect values. This therefore affects the accuracy of the results, so the decision was taken to split the boundary polylines at points where the underlying aspect changed, in this case at 50m intervals. With such a large dataset, this could not be done manually.

Aspect data is in raster format, so cannot be used as a template for splitting boundary polylines. To overcome this, the following process was devised. First, a polygon shapefile was created as a clip template for the whole study area. Next, a 50m square vector grid was built using the extents of the clip template using ‘ET Geowizards’, a standalone add-on to ArcGIS which performs this task more effectively than any tool within the ArcGIS suite. The 50m vector grid was then manually aligned at the highest resolution (1:1) with the corners of the squares comprising the raster aspect image. The 50m vector grid now represented the changes in aspect values from which boundary polylines could be split; and the raster values of the aspect data could still be accurately extracted at the centroid points along the polylines. Although this method artificially creates numerous polylines out of a single boundary, rendering a physical boundary which may have been built in a single event into a series of separate polylines, it was deemed necessary for the analysis to maintain integrity.

2.6.6 Building a model for orientation

Research Aim 2 and Objectives 4 and 5 are concerned with integrating multiple GIS tools and scripts into one working GIS model that could be used to interrogate a dataset of any size consisting of polylines representing linear landscape features. The model concerned with comparing the orientation of linear features with underlying slope will be addressed first, as it is by far the most complex. The following steps are referenced in Workflow 2 (Figure 2.9).

The first step in this process was to "merge" all boundary polylines with the previously mentioned 50m vector grid to form a single polyline shapefile, shown in Workflow 2 (1). This was necessary for the splitting of boundary polylines at vertices along the 50m vector grid; and both had to be part of the same shapefile for the calculations to work. Next, the merged data was clipped to a desired extent, using a given polygon template, using the 'clip' function (Workflow 2, step 2). From the merged boundary and grid shapefile, boundary features at points at which they crossed the lines of the 50m vector grid were 'split' using the 'feature to line' tool (Workflow 2, step 3). As this function also splits the 50m grid vertices, the boundary polylines themselves had to be extracted from the 50m grid using the 'selection' command (Workflow 2, step 4). To explain how this was done, prior to the running of the model, a text attribute field named 'Boundary' was added in attribute tables for all boundary features, and subsequently populated with the value 'Yes'. Back in the model, the 'select' tool was then used to extract all features which contained 'Yes' in the 'Boundary' field, thus eliminating all polylines associated with the grid, and creating a new temporary shapefile comprising the split boundary polylines. This was named using the prefix "no_grid".

Temporary files are automatically generated at each stage in this process from which the next step can be taken. During the process of building the model, it was found that it had to be executed in two separate parts. The reason for this is that the next step, consisting of a script for "adding Geometry attributes" to perform field calculations on the orientation of polylines, cannot be performed on a temporary file like the other functions within the model. Therefore, the permanent shapefile generated by extracting the boundary data from the grid had to be used to add the geometry attributes. The possibility of adding geometry attributes before running the model, or at the first point in the model, was explored; however, the data here had to be split before the geometry attributes could be assigned so was deemed untenable.

The "add geometry attributes" script enables multiple calculations can be performed on the data. First, 'LINE_START_MID_END' was calculated, which adds easting and northing values for the start, end and mid-point of each polyline (Workflow 2, step 5). The tool also allows for other attributes such as length to be calculated, which was chosen as it was deemed useful to extract some boundary polylines which are less than 5m, of which some will exist from the split function detailed above. Most importantly, orientation can be calculated within this script, using 'Line_Bearing', which calculates the azimuth of a line between two coordinates, in this case those at the start and end. The next step used the 'calculate field' tool to populate the previously mentioned 'Join_ID' field, using a script found online (ArcGIS: online) to produce sequential numbers relating to each feature (Workflow 2, step 6).

The final two steps of the process are concerned with calculating the orientation of underlying slope (aspect) at points which underlie the transcribed boundaries, tracks and settlements. The first step uses the 'Feature to Point' tool to generate a centroid (point in the middle of the feature) for each boundary polyline (Workflow 2, step 7). Finally, the 'Extract Values to Points' tool uses the 'Feature to Point' centroid and the values within the aspect raster data to populate the centroid with the aspect value at that location, which, like the orientation calculations described above, is in degrees (Workflow 2, step 8). This step completes the orientation analysis model in ArcGIS; and the resulting data can be interrogated further in both ArcGIS and Microsoft Excel.

2.6.7 Running the model without splitting

Calculating orientation of linear archaeological features without splitting at 50m intervals was a more straightforward process; and was ideal for rectilinear settlement enclosures, as their orientation polylines were single, straight units, but some boundaries and tracks did need to be manually split where they were found to be too sinuous. This was the best approach to take when disregarding the relationship in orientation between feature and underlying slope direction. The process is explained in workflow 3 (Figure 2.11), using some of the tools from the previous analysis concerning underlying aspect; and all models can be accessed in Appendix B, in the 'toolbox' within the GIS folder.

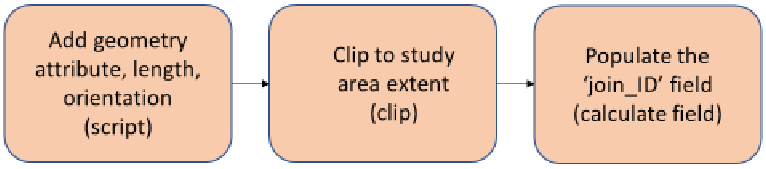

Figure 2.11 Workflow 3 showing steps taken to calculate orientations of transcribed features. ArcGIS tools in brackets

2.6.8 Data management and cataloguing

The processes described above, undertaken on multiple linear features, generated numerous large data files which had to be carefully catalogued and managed to avoid confusion between feature types, the process undertaken, and case-study. This was done by creating clear file structures within ArcGIS, both by site name and feature type. 'Personal geodatabases' were used in all cases to store the orientation results data. Although not very popular amongst modern users of ArcGIS, it was what the author felt most comfortable with. A consistent naming format was used throughout with each case-study area given a specific code (for example MHF being Morley Hall Farm), alongside those given to specific archaeological features (for example MHF_Rect representing the orientation of rectilinear settlement enclosures at Morley Hall Farm). The landscape elements analysed in each case study are described below in Table 2.1.

Prefix	Feature	Date range
PAL	Pit alignments	Bronze Age/Iron Age
ANC_BOU	Linear ditches and banks (ancient boundary)	Prehistoric or early Roman
RECT	Rectilinear settlement enclosures	Iron Age/early Roman
EMS	Settlement structures	Early Medieval
MNV	Nucleated village	Medieval
MRF	Ridge and furrow ploughing	Medieval
PMRF	Ridge and furrow ploughing	Post-medieval
SEN	Township boundaries, footpaths and tracks present on 1st edition Ordnance Survey mapping in south-east Northumberland	Various

Table 2.1 Linear features analysed in the current study, with file prefixes

The labelling system for the numerous shapefiles generated through the orientation model and subsequent calculations is represented by the prefixes shown in Table 2.2.

Prefix (_)	Description
Merge	Polyline data merged with 50m^2 vector grid representing changes in underlying aspect
CLIP	merged data clipped to study area extent
SPLIT	Polyline data split at contact points with 50m vector grid
NO_GRID	split polylines extracted from 50m vector grid using select>boundary ”Yes” command
FTP	split polylines represented by centroid
VTP	orientation in degrees of the centroid
ABS	function in exel. Bearings of in degrees rounded up to two decimal places.
Disc	File containing discrepancy values between feature and aspect

Table 2.2 Functions performed in ArcGIS to undertake orientation and slope conformity analysis

An example of a complete file using these prefixes is: “SEN_no_grid”

Prefix (_)	Site
SHO	Shotton excavated multi-period site
FOX	Fox Covert excavated multi-period site
WHL	Whalton townships
EWN	Excavated Iron Age/early Roman complex of settlement and boundaries
DCW	Devil's Causeway

Table 2.3: Prefixes for case-study areas

As linear features are tested both for their orientation alone, and against underlying slope direction, or aspect, the calculations had to be undertaken separately; this resulted in two separate datasets for each feature type and case-study. To avoid confusion, files generated from the same feature, but different analysis, were given specific prefixes in their naming. For example, Rectilinear settlement enclosures analysed were named 'RECT' where compared with underlying slope; and 'RECT1' where just the orientation was measured. Other prefixes were used for specific analyses which will be referred to in the next chapter.

2.7 Testing the model

It was deemed necessary to undertake various statistical tests to explore the validity of the approach; and these will now be addressed. First, the usefulness of splitting polylines at aspect changes will be explored using the example of Ogle and Whalton townships. In this area, 586 complete unsplit polylines representing field boundaries, tracks and township boundaries were analysed using 50m aspect data to calculate slope direction. Of these, 144 (24.6%) were found to conform to within 10 degrees of slope direction. Now using split polylines, which generated 4710 units, with orientation value signified as a centroid were generated from the splitting process. Of these 1215 (25.8%) conformed to within 10 degrees of underlying slope direction, with 3495 (74.2%) not conforming. This test suggests that splitting the polylines on points at which aspect changes has little effect; but spatially the two methods may not produce the same results. As it was explained below, some boundaries traverse multiple aspect values, so the orientation of an 'unsplit' boundary cannot be compared with a single aspect value within its total distance. This is why the lines had to be split at points where underlying aspect, representing slope direction, changed.

2.7.1 Resolution of aspect data, and effects on results

We will now deal with different resolutions of aspect data and the effects on results, which have been found through testing to be dependent on the resolution of the DTM aspect model used. This will be demonstrated using the excavated Iron Age settlement enclosures and related boundaries at Morley Hill Farm. Using the 'ANC_BOU1' dataset, an excavated ditch relating to the nearby settlement enclosures was automatically split according to changes in underlying aspect using the tools and processes explained above. The total length of this ditch is 166 metres.

Using the 50m aspect data to perform comparative orientation analysis between boundary and underlying aspect resulted in five data points along the polyline. From these a total length of 35 metres conformed to within 20 degrees of underlying aspect. When the process was repeated using 5m aspect data (see Appendix B, GIS, MHF and geodatabase: MHF5m) it produced different results. A total of 44 points were generated from the splits along the polyline with aspect data. From these the total length of the ditch which conformed to within 20 degrees of underlying aspect was 107m. Figure 2.12 shows the lengths of conformity in real terms.

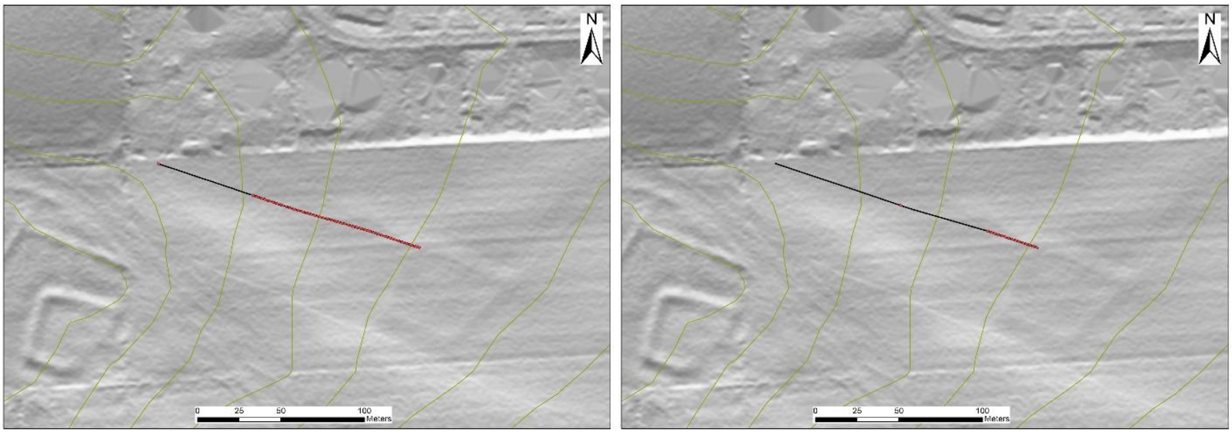

Figure 2.12 Comparison of slope conformity of an Iron Age ditch at Morley Hall Farm, using 5m (left) and 50m aspect data (right). Black line indicates the ditch, with red indicating conformity to within 20 degrees of underlying slope. Green lines indicate contours. Hillshading from 180 degrees on 1m DTM LiDAR data, downloaded from Environment Agency, 2017.

These results show a clear discrepancy in results depending on the resolution of aspect data. Coupled with the spitting of 'whole' boundaries which take a sinuous course, this presents a challenge to the analytical process. It is a problem of scale, and neither resolution is necessarily correct or incorrect depending on the feature type and the scale at which they are being interpreted. On the one hand, the micro-variations in 5m resolution data may misrepresent the ‘general’ lay of the land on which a feature sits; whilst the 50m resolution data may be too general in representing slope morphology over short distances, which could impact the analysis of shorter boundaries.

The possibility of using the two resolutions interchangeably depending on the feature analysed was also entertained: for example, using 50m resolution aspect data to analyse longer polylines representing boundaries which run for over 100m; and shorter polylines including those representing rectilinear settlement enclosures, analysed with 5m resolution data. It was also considered whether analysing polylines which occupy areas now quarried could be analysed using the 2006 aspect data; and areas that have not undergone quarrying done using the higher resolution 5m aspect. It was ultimately decided that adopting any of the above ideas would risk the consistency of the comparative process between dated ancient boundaries and those present on 1st edition Ordnance Survey maps, as the results from each would derive from different resolutions of aspect data. As a result, the 2006 DTM was used for all features as it represented the truest depiction of the topography of the study area before large-scale open cast mining in the region. This said, the possibility for exploring some of the alternatives outlined above could be undertaken as a separate research project; and will be discussed further in the conclusion.

2.7.2 Statistical analysis versus ‘by-eye’

Statistical analysis of dated ancient boundaries produced unexpected results when compared with analysis ‘by-eye’. At East Wideopen, for example, a linear ditch which was part of the excavated prehistoric field system, was initially deemed ‘by-eye’ to conform to the slope on which it was situated, as it appeared to run perpendicular to the contours on the Ordnance Survey 1:25000 map. Orientation analysis, however, showed a 20-degree discrepancy between the two. Whilst this suggests that the boundary was not completely at odds with the underlying slope direction, it does show that relying on judgement ‘by-eye’ may not be a robust technique. The contours at this location are spaced at over 100 metres apart on the Ordnance Survey 1:25000 map, which, compared with the 50 metres provided by the DTM aspect model, does not represent changes topographic which are important for the accuracy of the analytical model. Figure 2.13 illustrates these results.

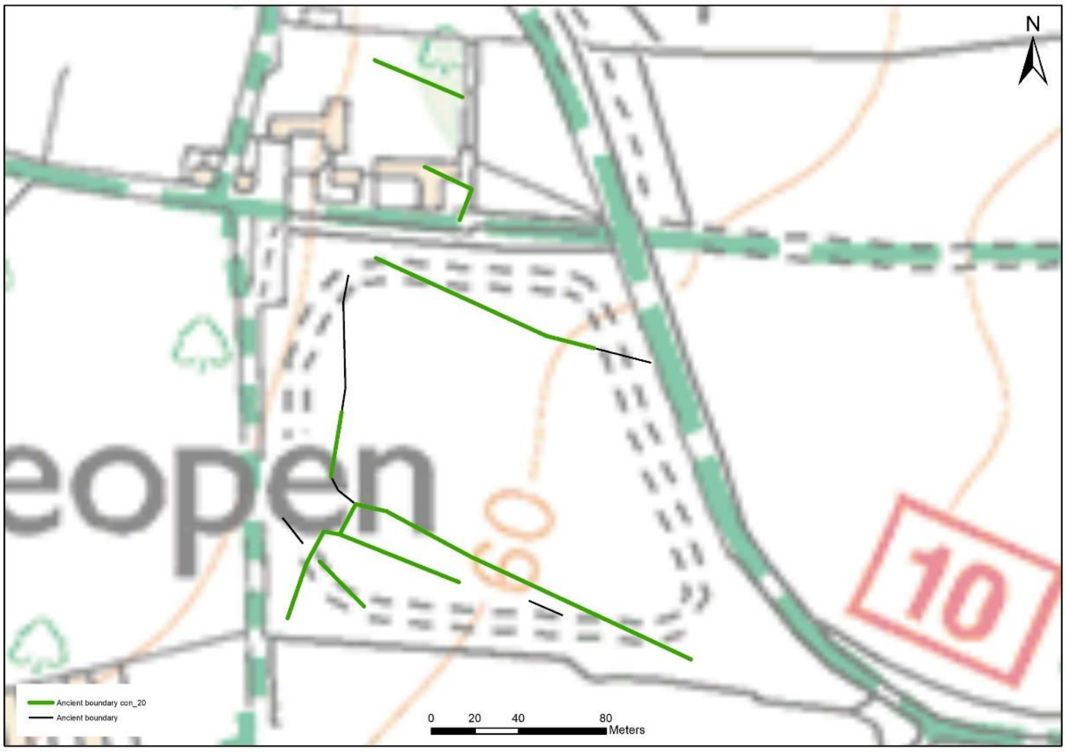

Figure 2.13 East Wideopen by eye vs orientation and conformity analysis (Ordnance Survey 1:250000 mapping downloaded from Edina Digimap, 2017)

The same test was performed on the ditches associated with the settlement enclosures at Morley Hill Farm, but this time, by-eye, using 5m resolution contour data for reference. The ditch appears to comfortably conform to the underlying slope direction, represented by contour vectors spaced at roughly 30m apart. Testing this using the orientation model once again produced contrasting results, showing there to be a 62-degree discrepancy between the orientation of the ditch and underlying slope direction. Viewing the relationship against the detailed contour data once more, it was observed that the feature traversed a discreet, but significant, change in local relief; and that this had the effect of distorting the overall results of orientation analysis*.* These results question the validity of methods employed in previous studies discussed in chapter 1.

2.8 Statistical analysis

2.8.1 Interrogating the data

The next stage of interrogation was performed in Microsoft Excel, firstly by importing the attribute table for the 'Extract Values to Points' (VTP) file from ArcGIS into an Excel spreadsheet (Figure 2.1 stage e). Orientation for both linear features and underlying aspect comprised values from zero to 359 degrees. This range was deemed unnecessary, as, for example, 315 degrees is the same as 135 degrees; and as there is no direction of travel implied in the aspect or slope direction, only the values on one side of the compass are required. The range of values required for the following calculations was 0-179.9 degrees. To convert those values between 180 and 360 to their converse values, the following steps were taken in Excel:

First, two columns were created to represent orientations of linear features and underlying aspect respectively: 'Orient_180' and 'Aspect_180'. These two columns were populated with the orientation values, so all were within the parameters of 0 and 179.9 degrees. To do this, orientations of the feature and underlying aspect ('line_bearing' and 'rastervalu' respectively) were 'custom sorted' into lowest to highest values; and those between 0 and 179 were copied and pasted into the 'Orient_180' field. For values between 180 and 359, the following function was applied which generated values between 0-179 for the remaining aspect values:

- =**cell**-180

The next step in exploring the relationship between orientations of linear units and underlying slope direction was to calculate the discrepancy between the two. In Excel a further column was created, named 'discrepancy'. The following Excel function was applied to the whole column:

- =ABS(field "x"-field "y")

Once the discrepancy had been calculated for each entry, the frequency of conformity, or non-conformity, of feature to underlying slope direction was calculated. Two further columns were created, one populated with values ranging from 0 to 180 in intervals of 10; and another, titled 'frequency', populated with the following function:

- {=FREQUENCY(M2:M15,O2:O15)}

The results of these calculations were then viewed as a bar chart to visualise the trends towards conformity or non-conformity. The closer the value is to 0, 90 or 180, the more a feature can be seen to conform to underlying slope direction.

2.8.2 Presenting the results in ArcGIS

The Excel sheet, updated with the calculations discussed above, could then be exported back into ArcGIS in .csv format to visualise and examine the findings. The 'MID_X' and 'MID_Y' values within the data were used as spatial reference upon importing. Visualising the results in ArcGIS enabled clusters and patterns to be identified in the relative distributions of boundaries that did, or did not, conform to within certain degrees of underlying slope direction. The next step was to find a way of visualising which boundaries conformed to within certain degrees of slope direction. The dataset containing the discrepancy values (_disc) had to be joined with the line data generated after the split with the 50m grid (_no_grid). The area of Backworth township, including boundaries and tracks depicted on an estate plan dating to 1757 will now be used to explain this process. The imported file containing discrepancy and frequency values was named ‘BAC1757_disc’, and that containing the polylines with bearings for the linear features named ‘BAC1757_no_grid. These two files were joined using the ‘JOIN_ID’ field generated as part of the orientation model. The .shp file ‘BAC1757_no_grid’ now contained the discrepancy values which can be interrogated through SQL scripts embedded in the ‘select by attributes’ tool. For analysis which does not include splitting boundaries at points where aspect changes, the common attribute for the join was ‘ORIG_FID’, as these values remained consistent throughout the analysis in different datasets. Using the example of rectilinear settlement enclosures, the two .shp files to be joined are: “RECT1_clip” and “RECT1_disc”.

2.8.3 Visualising ‘Discrepancy’

One question which arises from the above discussion is: where is the line between conformity and non-conformity to underlying slope direction? This provided a statistical challenge to how the results could be interepreted. To visualise relative conformity and non-conformity of linear features to underlying slope direction, thresholds in degrees had to be explored. This was undertaken using methods in ArcGIS, where visualisation of the boundaries themselves could be compared with underlying slope direction at various degrees of conformity; in other words, the boundaries which either run up and down a slope, or across a slope. The former consists of values around 0 and 180 degrees, whilst the latter relates to values around to 90 degrees, as visualised in Figure 2.14 in the fields around Monkseaton.

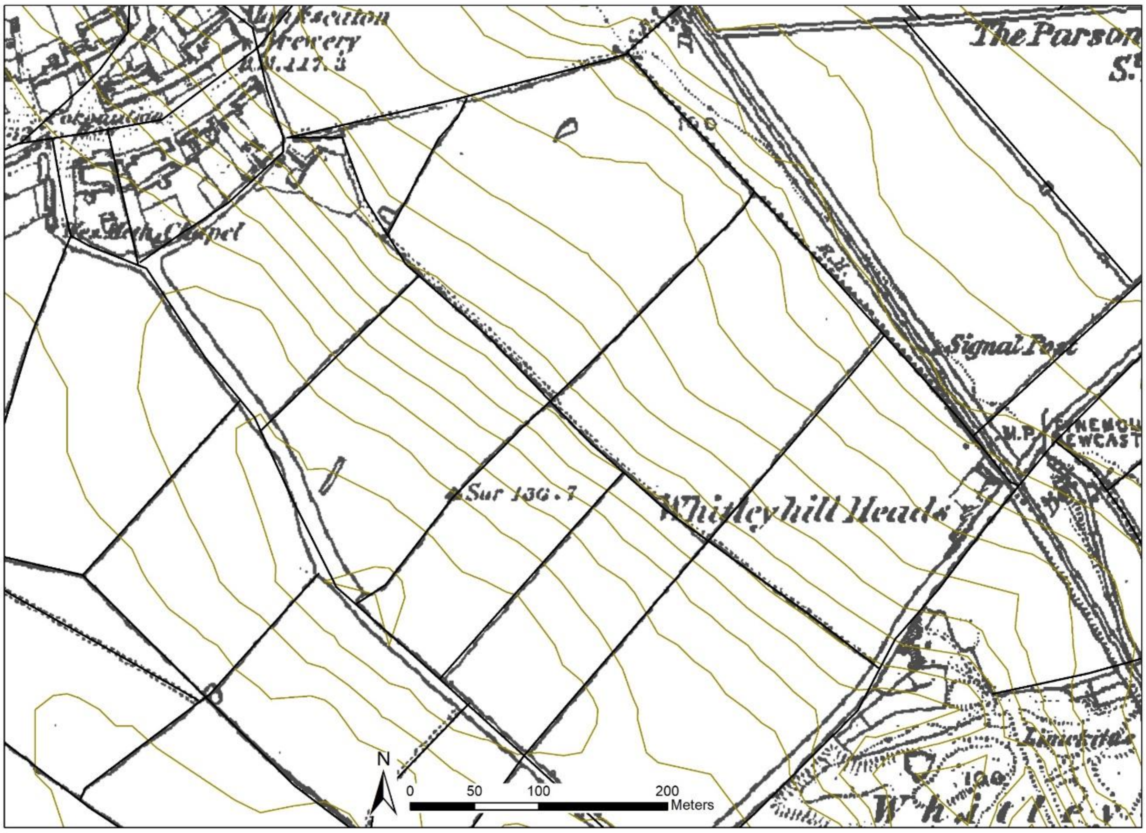

Figure 2.14 Field boundaries and tracks around Monkseaton village showing high slope conformity as shown on the 1st edition Ordnance Survey map (downloaded from Edina Digimap, 2017)

The first threshold tested was ± ten degrees, using the following parameters: 0-10, 80-100 and 170-179. Features presenting these discrepancy values can be interpreted as conforming to within ten degrees of underlying slope direction; whilst those with discrepancies of between 40-80 and 110-160 represent features which do not conform to within ten degrees of underlying slope direction.

In ArcGIS entries containing these discrepancy values were extracted from the main dataset using the following expression in “select by attributes” query builder:

- *Discrepancy >=80 AND Discrepancy <=100 OR Discrepancy <10 OR Discrepancy >170.*

Conversely, the following expression was used to extract those entries which did not conform to within 10 degrees of underlying slope direction:

- *Discrepancy >=10 AND Discrepancy <=80 OR Discrepancy >=100 AND Discrepancy <=170*

These selected entries can then be exported as a separate .shp file to be viewed spatially.

Using a discrepancy threshold of ± 20 degrees, the following parameters would be included: 0-20, 70-110 and 160-179; and for ± 30 degrees, 0-30, 60-120 and 150-179. Using the Backworth area (BAC) as an example, the above processes will now be explained in practice. Within the attribute table of the joined ‘BAC1757_VTP’ and ‘BAC1757_disc’ file, entries were selected and exported which contained a discrepancy value firstly of ±10 degrees. A comparatively low proportion of boundaries were found to conform to underlying slope direction within these parameters. The data was then selected, extracted and visualised to show boundaries which conformed to within 20 and 30 degrees respectively of underlying slope to determine a reasonable threshold value. To determine further whether the ±20 or ±30 degree- discrepancy thresholds were viable, the extracted datasets were visualised against a 50m contour dataset, the same data used to produce the aspect raster images. In the case of BAC1757, 20 and 30 degrees was found to be a reasonable discrepancy, as illustrated in Figure 2.15, with 30 degrees discrepancy being the upper limit: any higher was considered too high a threshold. It is acknowledged that using a 30 degrees threshold takes a large chunk out of 180 degrees; and it was therefore decided that both ± 20 and 30 degrees should be used for the proceeding analysis to provide a more balanced picture.

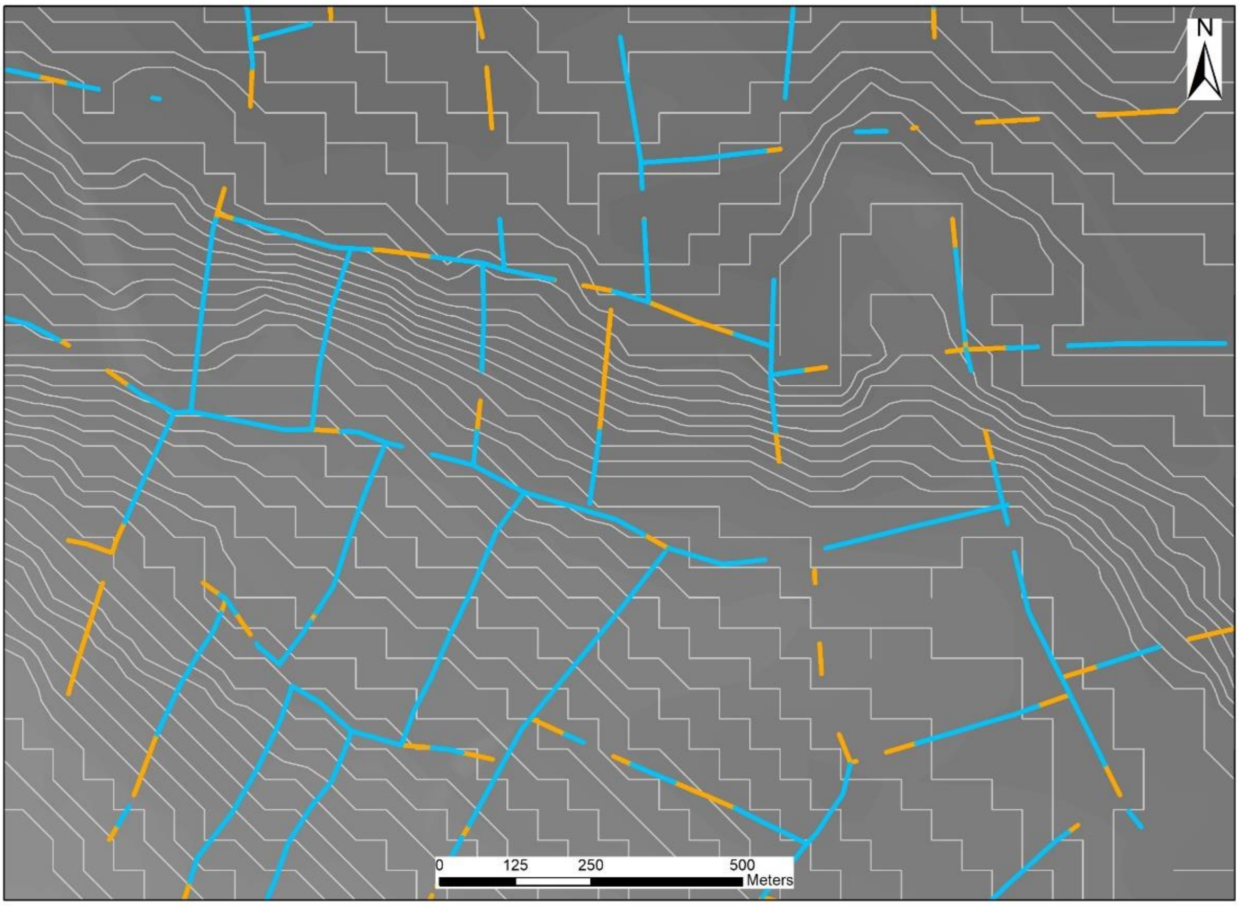

Figure 2.15 Visualising levels of discrepancy between boundary orientation and underlying slope direction, using SEN boundaries and tracks where orange lines represent conformity to within 20 degrees of underlying slope direction; and blue lines represent 30 degrees conformity. 50m DTM downloaded from Edina Digimap, 2017.

Using SEN_no_grid

SQL expression:

- Orient_180 >=80 AND Orient_180 <=100 OR Orient_180 <10 OR Orient_180 >170

Exported as SEN_0_90_180

SQL expression:

- Orient_180 >=20 AND Orient_180 <=40 OR Orient_180 >=110 AND Orient_180 <=130

Exported as SEN_30_120_prop

2.8.4 Different thresholds of conformity to underlying slope direction

It will be shown in the presentation of the results that comparing the mean orientations for the 50m aspect data and linear features shows different results. Below are the mean orientations calculated for the following: all boundaries and route-ways depicted on 1st edition Ordnance Survey maps; and for the raster aspect imagery at both 50 and 5 metre resolutions. The right angles for each are included throughout the results to provide a basis for the possibility and likelihood of rectilinear field enclosures.

- Mean orientation for SEN_no_grid: 8/98 degrees
- Mean orientation of 50m aspect: 58/148 degrees
- Mean orientation of 5m aspect: 73/163 degrees
- Mean orientation of SEN_no_grid-Aspect_180: 82/172 degrees.

Comparing the mean orientation for BAC_SEN1 and that of the 50m aspect, using Backworth township as an example, shows a common orientation around 70/160 degrees, as shown below:

- Mean aspect 50m 75/165 degrees.
- Mean orientation 1757 boundaries: 84/174 degrees
- Mean orientation 1860 boundaries: 71/161

The mean orientation of the boundaries and route-ways present on the 1757 estate plan is 84/174 degrees, slightly different to the mean aspect of 75/165; but still quite close. This sits in contrast with the proportions of linear units calculated as being within 20 degrees of underlying slope, calculated at only 47%.

- BAC4_no_grid: 48636m
- BAC4_con20: 22786m (47%)
- BAC4_non20: 25849m (53%)

The results change dramatically when using a 30 degrees threshold between orientations of linear features and aspect values, where 69 percent of boundaries were deemed to conform to underlying slope direction; and almost 90 percent conform to within 40 degrees. The 40 degrees threshold is therefore far more in keeping with the comparisons of average orientations. There is a huge difference in the results depending on the threshold used. This, along with the similarities in mean orientations of features and aspect, raise the question of to what extent did people in the past pay heed to natural topography?

Extending this out to the whole SEN dataset shows that across the study area, seventy percent of boundaries conform to within 30 degrees of underlying slope direction, as opposed to 49 percent of those conforming to within 20 degrees.

- SEN_no_grid_180: 7735730m
- SEN_con30: 5464326m (70%)

SEN conforming to within 30 degrees of underlying slope direction are distributed throughout the study area, with no obvious concentrations or gaps apart from the far south-east of the coastal plain and around major river valleys shown in Figure 2.18, below. Whole boundaries are regularly seen to conform. Those found to not conform to within 30 degrees of underlying slope direction are also distributed throughout the study area, but this time the units are far more fragmentary. Next, we will look at the proportions of SEN_con30 in terms of the orientations themselves to see if any distinct patterns emerge.

SEN_con30 total length: 5464326m

Orientation	Length (m)
SEN_con30_10_100	1233897
SEN _con30_20_110	771729
SEN _con30_30_120	572265
SEN _con30_40_130	584519
SEN _con30_50_140	815267
SEN _con30_60_150	1352640
SEN _con30_70_160	2031620
SEN _con30_80_170	2210148
SEN _con30_0_90_180	1831705

Table 2.4 Overall lengths of orientations amongst boundaries and tracks present on 1st edition Ordnance Survey mapping which conform to within 30 degrees of underlying slope

The results of this exercise are consistent with general orientations, reflecting the relative proportions of orientations in the dataset. There are interrelated factors to consider when interpreting the meanings behind this data. First, the amount of analysed rectilinear settlement enclosures oriented ±10 of cardinal points is higher than those close to 30 or 120 degrees; and this may well be down to the fact that there is an extra variable in the calculation for the former. To explain, the ± 10 degrees of 30/120 comprises two thresholds, between 20 and 40 degrees; and between 110 and 130 degrees. The ±10 degrees of 0 and 90 includes any values around 180, which is the same as 0. The results included in this section will be revisited and expanded upon in chapter 4.

2.8.5 Visualising with the ‘graded colour method’

Although applying strict threshold parameters for determining underlying slope direction conformity such as those described above is of use to the interpretation of results, it also carries the risk of omitting values on the fringes which should be considered as having higher levels of conformity than others. To resolve this, degrees of conformity were expressed in ‘graded colour’, so that all values can be represented visually. This method consists of the following steps

- SEN_disc ‘joined’ to SEN_no_grid
- Use “Select by attributes” query builder for the next step:
- SEN_disc.Discrepancy >=0 AND SEN_disc.Discrepancy <=90
- Export as “SEN”
- SEN_disc.Discrepancy >=90 AND SEN_disc.Discrepancy <=180

Using the ‘symbology’ function in ArcGIS for the “SEN_disc” dataset, a colour gradient was custom-made in the properties tab so that all values around 0 and 90 degrees, and 90 and 180 degrees were a single colour (in this case dark red), whilst those values in between were white. This meant that conformity could be represented by a single colour. This graded colour scale was then saved in ArcGIS for future use. Figure 2.16 depicts the results in the symbology tab:

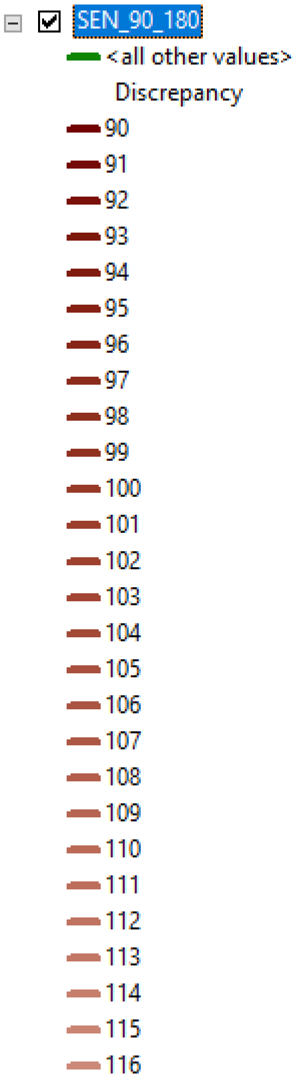

Figure 2.16 Graded colour relating to slope direction conformity values using symbology

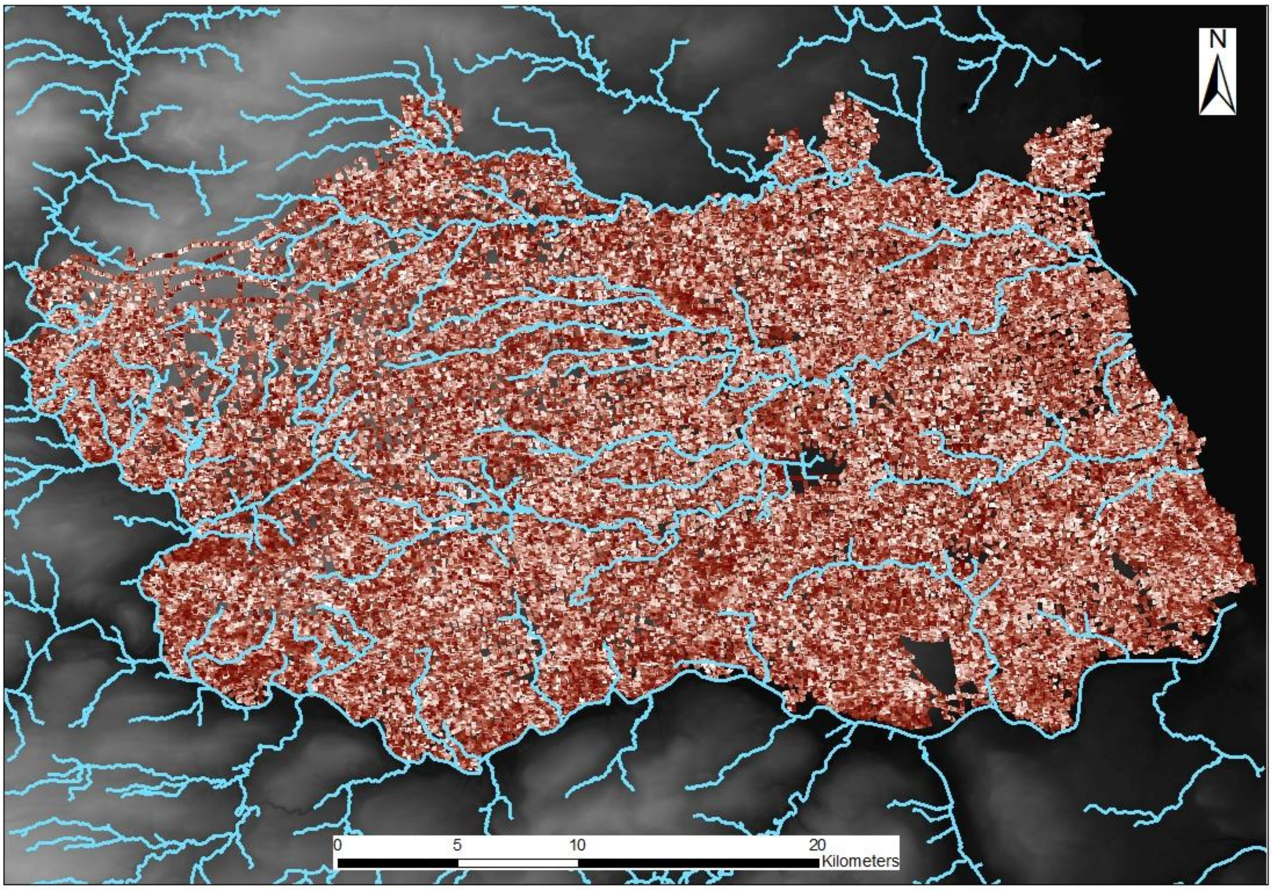

Figure 2.17 SEN conformity across the study area. Areas in red represent high conformity to within 30 degrees of underlying slope direction; and white areas represent low levels of conformity to underlying slope direction. DTM Edina Digimap: 2018)

The validity of this method was proven to an extent by the fact that the greatest density of conformity across the study area was on the slopes of river valleys, where it is to be most expected given the assumptions outlined in chapter 1. Figure 2.17 shows how this is visualised for the SEN dataset across the whole study area. These results and how they inform some of the assumptions made prior to the analysis will be discussed and visualised in more detail in chapters 4-6.

3 Ancient and Historic Settlement and land-use in south-east Northumberland: what we know, and how we know it

Before presenting the results of the methods described in the previous chapter, the following chapter will address Research Objective 1 in drawing together relevant existing evidence relating to settlement and land-use within the current study area between the late Bronze Age and early modern period; and importantly, explore how the data has been collected. It will not be an exhaustive review of evidence between the chronological parameters in the region, which can be found elsewhere (for example Brooks *et al.* 2002; Petts and Gerrard 2006). Instead it will examine how modes of investigation largely correspond with the nature of the evidence, and how acknowledging this dynamic is crucial to understanding how the archaeological and historical record has developed in the current study area and beyond. A large proportion of data used in the current research derives from developer-funded excavations and surveys; and the strengths and weaknesses of this approach will be addressed throughout. Evidence will be presented on a historical period-by-period basis, as this is how data about the past is most often collated and presented.

3.1 Pit alignments

Pit alignments are considered to represent the earliest known large-scale divisions in the landscape (Waddington 1997; Passmore and Waddington 2009: 250; Hodgson *et al.* 2012: 185-186). They typically consist of sub-rectangular pits closely spaced, and in single lines which is typical of the early first millennium BC (Hodgson *et al.* 2012: 185). The pit alignment excavated at Fox Covert in the current study area is shown in Figure 3.1s below.

Figure 3.1 Excavations of the pit alignment at Fox Covert (photo: TWM 2010)

The original form of pit alignment systems remains unclear, but it is widely accepted that they formed a component of a varied and complex system of land division (Waddington 1997: 24; Spratt 1993: 134; Deegan and Foard 2007: 82; Hodgson *et al*. 2012: 185), demarcating parcels of land resources such as pasture land or woodland, and access to rivers, therefore serving as a form of control and preserving the allotment of a community from exploitation by others (Hodgson *et al*. 2012: 185). Systems of pit alignments elsewhere in England are thought to represent the gradual division of the landscape into rectangular blocks following deforestation in the Bronze Age (Spratt 1993: 134; Deegan and Foard 2007: 82). The idea of pit alignments arranged in this regular way has implications for the relationship with the lie of the land. If a rectangular layout was envisaged, for example, then how would this have been managed in terms of conforming to the lie of the land? Slope direction conformity analysis will enable this idea to be explored further, as will be shown later in the study.

A ritual dimension has been suggested for the pit alignments excavated in the Ewart Park complex (Harding 1981: 132), maybe as the dating (Neolithic to early Bronze Age based on the ceramic assemblage) drew associations with the numerous ceremonial monuments in the local area dating to a similar period. The notion of Prehistoric monuments as embodiments of the natural world is a well-trodden path, for example, Neolithic henges in Britain are believed by some to have been laid out to reflect the course followed by nearby rivers (Richards 1996a; 1996b; Bradley 2000). This dimension will be also discussed in more detail later in how it ties in with the notion of regular blocks being demarcated by pit alignments.

Pit alignments in south-east Northumberland have been recognised only fortuitously through developer-funded excavation (Hodgson *et al.* 2012); and none were identified as cropmarks beforehand. Artefactual evidence is rare from excavations of pit alignments in this region, confined to tertiary flint flakes of Neolithic or early Bronze Age date at Bladgon Park 1 and Fox Covert (Hodgson *et al.* 2012: 107-110). In north Northumberland numerous examples of pit alignments have been identified in greater numbers as cropmarks through aerial photographic analysis (Deegan and Gates 2009; Gates 2012); and some have been excavated (Miket 1981; Harding 1981; Passmore and Waddington 2009; 2012).

Artefactual and scientific dating methods have yielded dates ranging from the late Neolithic to the early medieval periods, although problems of superimposition and re-deposition persist (Passmore and Waddington 2009: 249-250). The Milfield basin in north Northumberland is composed of lighter clay soils, along with tracts of river alluvium, in contrast to the heavy clay subsoils which underlie the coastal plain in south-east Northumberland (Gates 2009: 135). More surely await discovery through strategic aerial reconnaissance and excavation in south east Northumberland as was recently shown at Ugham, slightly north of the study area, where evaluation trenching revealed a previously unknown pit alignment (AD Archaeology 2018b). The author has identified possible cropmark evidence of pit alignments in the fields north of Earsdon in North Tyneside, adjacent to a known prehistoric enclosure (shown in Figure 2.2); but this is yet to be substantiated at the time of writing.

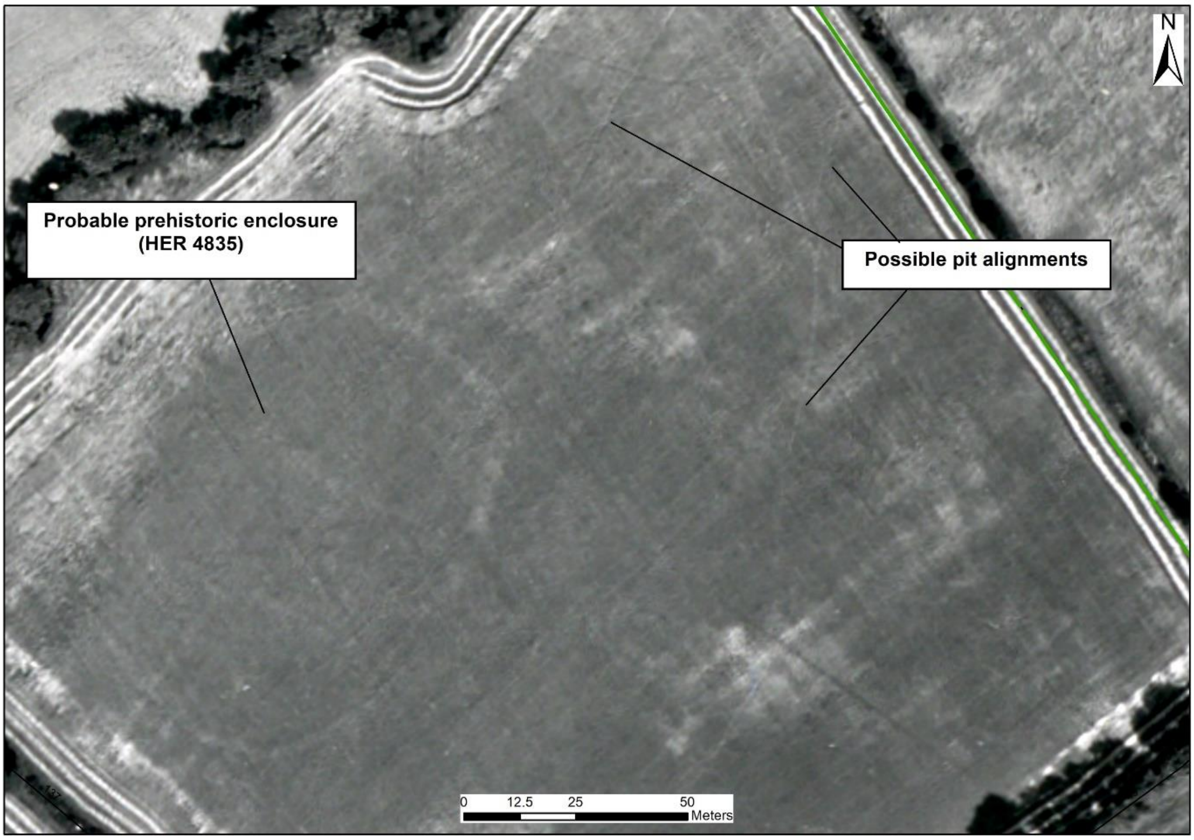

Figure 3.2 Cropmarks of possible pit alignments adjacent to a known prehistoric enclosure north of Earsdon village, North Tyneside. Aerial photograph obtained from North Tyneside libraries.

3.2 Other prehistoric boundaries and tracks

As will be seen in chapter 6, the presence of dated prehistoric and early Roman period boundary ditches was a major factor in selecting case-study areas for the current research project. The numerous modern open-area excavations along the coastal plain has enabled fragments of the boundaries, tracks and field systems associated with settlements in the late Iron Age and early Roman periods to be examined; and marks a departure from excavations of settlement sites prior to developer-funded archaeology.

Whilst the evidence shows that Iron Age and early Roman-period settlements ceased to be occupied during the Roman period, much less is known about the possible survival of associated field boundaries and route-ways. Developer-funded archaeology projects in low lying areas regularly uncover evidence for the presence of ditches dating to the Bronze and Iron Ages; however the scope of these investigations are usually quite restricted which means it is difficult to assess the nature of land-use as a whole (Field 2008: 203). Recent excavations along the coastal plain have uncovered new evidence for the presence of boundaries and tracks associated with Iron Age and early Roman settlement enclosures. Environmental evidence for wheat and barley production, along with some faunal remains, is usually recovered from the settlement remains. Together, this evidence entails the likelihood that Iron Age and early Roman period settlements were situated in a landscape which included fields of some type. It is commonly assumed that boundaries close to settlements were stock enclosures (for example Proctor 2009); and in no cases has evidence for cord rig ploughing been identified in these areas, which is unsurprising given that these sites are almost always truncated by later ploughing. The small amounts of faunal remains are deemed to be unrepresentative of the original land-use context, and much has probably been lost due to the acidic nature of the soils in the region. Comparing the orientations of these boundaries with those from other periods extant on historic mapping, some of which are still present, and with underlying slope direction, could help to build a better understanding of the wider landscape around the dense distribution of settlements in this period. It could also shed light on what the boundary ditches were actually used for. For example, a higher conformity to the lie of the land may entail that drainage was a key factor in the use of the boundary, which might mean the ditches in question were enclosing an arable field for example rather than a stock enclosure. This is not to say that stock enclosures did not require a degree of drainage; but the need would be more pronounced for draining excess surface water from crops.

Evidence for prehistoric and early Roman boundaries and tracks in the lowlands is fragmentary, and dating is usually through association rather than absolute methods. The most comprehensive evidence so far discovered was at Pegswood Moor where excavations revealed multiple phases of associated field systems arranged around a settlement complex (Proctor 2009). Other excavations along the south-east coastal plain have revealed fragments of linear features which are either attached to, or in close proximity to, rectilinear settlements, including Shotton (Hodgson *et al.* 2012); East Wideopen (North) (NAA 2016; 2018), North Seaton (Archaeological Practice 2015), Brenkley (Headland 2015); Morley Hill Farm (AD Archaeology 2015a; Headland 2018); West Shiremoor (ASDU 2018); and Spital Hill (AD Archaeology 2015b). The Northumberland coastal plain can be placed in what Chris Taylor (1972) termed a ‘zone of destruction’, where favourable conditions has led to successive phases of cultivation from prehistory to the present. This 'cultural erosion', to borrow a term from Brian Roberts (2015), restricts the potential for fully understanding the nature and extent of prehistoric and Roman period field systems. We can assume from current evidence that field systems did exist in these periods; along with the possibility that some elements of these arrangements endured into later periods or even into the present. This is one of the main reasons for including boundaries and routeways present on 1st edition Ordnance Survey mapping in the current study.

Through studying developer-funded excavation reports, and from personal experience in the field, the author has observed the rarity of recovering environmental samples scientific dating from ditches which do not form parts of a settlement enclosure; but are probably associated with it. Settlement enclosures and internal structures are usually the prime targets for excavation at the expense of enclosure ditches and pits, which have been found in some cases to provide the largest assemblages on sites (Hazelgrove 2002: 51). It is acknowledged that the chances of recovering dateable material from these features is slim, but they are often not incorporated into proposed excavation areas in schemes of investigation despite being routinely excavated in evaluation trenches. During extensive trial trenching at Shotton, for example, an 18m section of a ditch, likely to be of pre-medieval date as it was cut by later broad ridge and furrow, was only excavated for 3m of its length, which produced no finds (AC Archaeology 2006: 9-10). Features such as this are normally found running perpendicular to trial trenches, either through the trench being positioned in a way to identify the feature previously identified as a cropmark or magnetic anomaly, or purely by chance. The fortuitous positioning of the trial trench in this case, revealing such a large portion of this feature, could have been capitalised upon by the sectioning of a further portion. The ditch at Shotton was also omitted from the investigation area during the final strip map and sample phase of fieldwork.

Despite the dense concentration of rectilinear enclosed settlements identifiable as cropmarks, very few examples of directly associated boundaries and tracks have been identified compared with elsewhere in England, and in particular on different geologies. For example, cropmarks on the magnesium limestone of parts of Yorkshire cropmarks show dense concentrations of rectilinear settlement enclosures encased within extensive field systems (Roberts 2010: 28-34). The excavations at

Pegswood Moor and East Wideopen have shown that the comparative lack of cropmark evidence in the current study area is likely a result of the underlying soils and unfortunate timing of aerial photography. At Pegswood the system of boundaries and Iron Age and early Roman settlement remains had not been identified on aerial photographs; and were discovered only through trial trenching and open-area excavation. It was demonstrated that the remains of prehistoric field systems could survive later ploughing, but also that few may be recognisable as cropmarks due to their insubstantial nature, or because the features were filled with soils similar to those into which they were cut, with comparatively little organic and/or occupational debris matter being incorporated (Proctor 2009: 101-102).

3.3 Cord rig ploughing and the lack of evidence along the coastal plain

Evidence for 'cord rig' cultivation, practiced within extensive fields from the Bronze Age until at least the Roman period, is plentiful in upland Northumberland (Topping 1982; 1989; 2008; Frodsham 2006), largely due to the relative lack of subsequent activity in this landscape context. In more lowland contexts the evidence is far more fragmentary. Ard marks associated with prehistoric agricultural activities have been exposed beneath Roman military sites (Hodgson *et al.* 2001; Topping 1989), but the evidence is often difficult to interpret, characterised by a mass of lines scored into the natural soils in multiple directions. Only at South Shields could a prevailing direction of ploughing be identified (Hodgson *et al.* 2001). These examples exist in isolation, their presence owed to the position of overlying Roman remains and the measures taken before building, such as laying down layers of clay upon which to build, for example at Arbeia, South Shields, which effectively sealed previous traces of activity. Cord rig is yet to be identified in the numerous lowland developer-funded investigations, most likely due to the almost ubiquitous presence of later ploughing in the region; but it is thought that it was more widely practiced in the lowlands than evidence suggests (Frodsham 2006: 139). As stated above, excavations have recovered evidence for wheat and barley which were grown by farmers who occupied lowland Iron Age and early Roman period settlements in the region, through bulk-environmental sampling and the discovery of quern stones (Proctor 2009: 80-83; Hodgson *et al.* 2012). Despite this, we do not have firm evidence for the extents, or physical nature, of field systems in the period. The locations of arable areas have been tentatively suggested in relation to the stock enclosures and settlement at Pegswood, where linear ditches were observed extending beyond the excavation area in multiple directions (Proctor 2009: 72; fig 38). This is generally as far as the discussion has been able to progress, as so little dating evidence exists from which attempts can be made to reconstruct the nature of the wider landscape at this time. As a result of this, cord rig ploughing will not be an analysed dataset in this study.

3.4 Rectilinear enclosed settlements

Rectilinear settlement enclosures were the dominant known settlement structure during the late Iron Age and early Roman period in this region; and are becoming well-understood through the wealth of data resulting from research-led and developer-funded excavations since the 1950s. They were not the only type of settlement during the later Iron Age and early Roman period in the region, however; for example, at Blagdon Park 1 and Pegswood excavations recovered evidence of unenclosed settlement structures which were contemporaries of enclosed sites (Hodgson *et al*. 2012: 192; Proctor 2009). Furthermore, most excavations of rectilinear settlement enclosures within the study area reveal preceding unenclosed phases which are almost invisible to remote sensing in the coastal plain; so more inevitably await discovery. This said, analysing the orientation and conformity to slope direction of rectilinear settlement enclosures has key research potential; and is linked specifically to all the current research aims and objectives. The depth of clay subsoil on which most of these sites were situated are believed to have required at least an element of drainage provided by the enclosure ditches (Jobey 1970: 52), entailing it would make practical sense to orient these ditches to conform to the underlying slope direction.

Rectilinear settlement enclosures were frequently documented as ‘camps’ in nineteenth century antiquarian accounts, although, aside from those included on the first edition Ordnance Survey maps in the 1860s, the exact locations of many were not recorded with any precision (for example see J. Hodgson 1832; 1840 in Hodgson *et al.* 2012: 192; Jobey 1963: 33-34). From the middle of the twentieth-century onwards rectilinear enclosures began to be identified in large numbers as cropmarks on aerial photographs (St Joseph 1958; McCord and Jobey 1968; 1971; Deegan and Gates 2009). More evidence has recently been found through National Mapping

Programmes (NMP hereafter), which draw together multiple sources of remote sensing data for analysis, transcription and interpretation. These extensive projects have been undertaken within specific areas, such as the Hadrian's Wall corridor (NMP 2009), and the immediate coastal zone (NMP 2008); and a similar approach was undertaken around the Milfield Basin (Gates 2009). These detailed studies leave much of the current study region relatively under-studied, a discrepancy which must be acknowledged when studying distribution patterns in the region.

Figure 3.3 Excavations of rectilinear settlement enclosures at (top) Burradon (Jobey 1970: figure 1) and (bottom) Morley Hill Farm (Headland Archaeology 2018: illustration 4)

Following their identification as cropmarks, rectilinear enclosures were excavated in advance of commercial development and threat from agricultural practices in the 1960s and 1970s at Marden, Burradon (shown in Figure 3.3), and Hartburn (Jobey 1963; 1970; 1973). Stratigraphic sequences and material culture assemblages from these sites revealed evidence of settlement phasing, morphology and insights into social contexts of settlement during the period for the first time in lowland Northumberland. Despite financial constraints, the excavation and recording of these sites was undertaken to a high standard, and all were published. The same cannot be said for excavations of a further rectilinear settlement enclosure at Stannington in 1961 as part of a school project, which operated under no professional archaeological supervision (explained in Jobey 1963: 32-33). The evidence from this fieldwork remains unpublished, and as such is of little use to the archaeological record.

Rectilinear enclosed settlement sites and possible associated features have been discovered through geophysical methods, both in research-led (Biggins *et al.* 1997) and developer-funded contexts (AD Archaeology 2015b; 2016). It is, however, trial trenching and open-area excavation in developer-funded projects that provide the most robust data for enclosed rectilinear settlements (for example AD Archaeology 2015a; 2015b; Wardell Armstrong 2017a; Archaeological Practice 2015; Carlton 2016). The recording approaches on these excavations are centred on extensive sampling strategies which enable the construction of chronological frameworks and environmental sequences through scientific dating, which have enabled new theories to be postulated regarding social, economic and cultural aspects of rural life in the late Iron Age and early Roman periods (Hodgson *et al.* 2012). The reports from most of these sites remain unpublished; but are held by local councils and freely available to view on request. A small number of sites have recently been synthesised in detailed monographs already referred to (Proctor 2009; Hodgson *et al.* 2012). These research reports include more detailed discussions regarding the social and economic implications than standalone reports.

The south-east portion of the study area sits on heavy boulder clays, which, as will be also shown for almost all features from all periods, compromises the preservation of archaeological deposits. One such effect is on the preservation of fauna and flora remains. At Pegswood, for example, only very small quantities of animal bone and charred and waterlogged ancient plant remains were recovered from the already heavily truncated cut features (Proctor 2009: 2-3).

Aside from the native Romano-British settlement at Middle Gunnar Peak in advance of extensive quarrying (Jobey 1981), notably fewer developer-funded excavations have been undertaken beyond the coastal plain, largely due to the comparative lack of commercial and industrial development. Modern development therefore has a direct influence on our understanding of the archaeological record in lowland regions, and in terms of the current research, has dictated the locations of some case-study areas. Archaeological investigations in upland zones are usually research-led, which are methodologically different from developer-funded projects in terms of time, personnel and resources. This adds further distinction to the dichotomy between how and what we know about settlement and land-use in lowland and upland zones.

There are differences between recent excavations and the sites excavated by Jobey. Less emphasis is now placed on material culture assemblages, which are usually small due to subsequent cultural erosion. Scrutiny of previous approaches have shown problems with the typological dating of prehistoric pottery. At Burradon, for example, over half the pottery thought to date to the sixth- and fifth-centuries BC came from the latest context of the site, dated to no earlier than the late first-century AD (Hazelgrove 2002: 60-62). Recent developer-funded excavations at North Seaton recovered an assemblage of ceramics which was tentatively dated to the Iron Age; but could represent a continuing native tradition which may have lingered into the early medieval period (The Archaeological Practice 2015). Scientific dating methods are certainly not without problems either. Sampling strategies are prone to error in the field including the effects of post-depositional processes, and radiocarbon sequences can be inaccurate and imprecise (for a more detailed discussion of this in the current study area see Hodgson *et al.* 2012).

It should be acknowledged that George Jobey was working under tight financial constraints without the resources to be able to deliver excavation and sampling strategies on the same scale as recent developer-funded projects. Despite these limitations, Jobey did fully excavate features within given excavation areas. This approach contrasts with modern developer-led strategies, which in most cases excavate a percentage of each feature depending on the site and conditions (for an example of this in practice see Hodgson *et al.* 2012: 67-68; fig. 38). The result of this distinction is borne out in the relative assemblages of ceramics at Burradon and West Brunton. Complete excavation of all roundhouse gullies and large parts of the inner enclosure ditch at Burradon, with an overall area of 4500 square metres (0.45ha), led to the recovery of 170 sherds of pottery (Jobey 1970: 72); whereas 181 were recovered from percentages of whole structures at West Brunton from an overall excavation area measuring 12000 square metres (1.21ha), almost three times larger than the extent of excavation at Burradon. It is therefore quite likely that significant volumes of material culture have been missed, and subsequently destroyed, in modern developer-led excavations. It should also be acknowledged that in the thirty years between the two excavations modern ploughing will have had a significant effect on the amount of material available for recovery.

Evidence from excavations suggests that rectilinear settlement enclosures along the coastal dated to roughly between 100 BC and AD 200; and many were probably contemporary, which suggests a considerable degree of planning and organisation in the landscape during this time (Proctor 2009; Hodgson *et al.* 2012; ARS 2015). Although fragmented in nature, and, as has been discussed above, difficult to date with any precision, material culture assemblages carry the potential to reveal more than chronological sequences, such as insights regarding trade and exchange; and when plotted on site-plans, reveal settlement hierarchy through both the amounts and quality of ceramics and other types of material culture encountered, such as metalwork traces and small finds. At Blagdon Park 2, for example, a metalworking area was recognised through analysis of both organic material in relation to surrounding material, and concentrations of metalworking debris (Hodgson *et al.* 2012: 39).

The number of rectilinear settlement enclosures is being added to on a regular basis in the south-east Northumberland coastal plain; and this research has identified a further 68 from remote-sensing data and satellite imagery across the whole of Northumberland, with a further 82 for which there was insufficient evidence to positively attribute them as rectilinear settlement enclosures. The distribution of this settlement type, shown in Figure 3.4, shows dense concentrations along the coastal plain, leading to the implication of social and economic hierarchies and varying levels of landscape organisation which are suggested to have been largely swept away following the Roman advance in the north (Hodgson *et al.* 2012). This theory is based on excavations of only a fraction of the total number of settlements of this type known in the region, so is considered somewhat tentatively in this research; and will be discussed in more detail in later chapters.

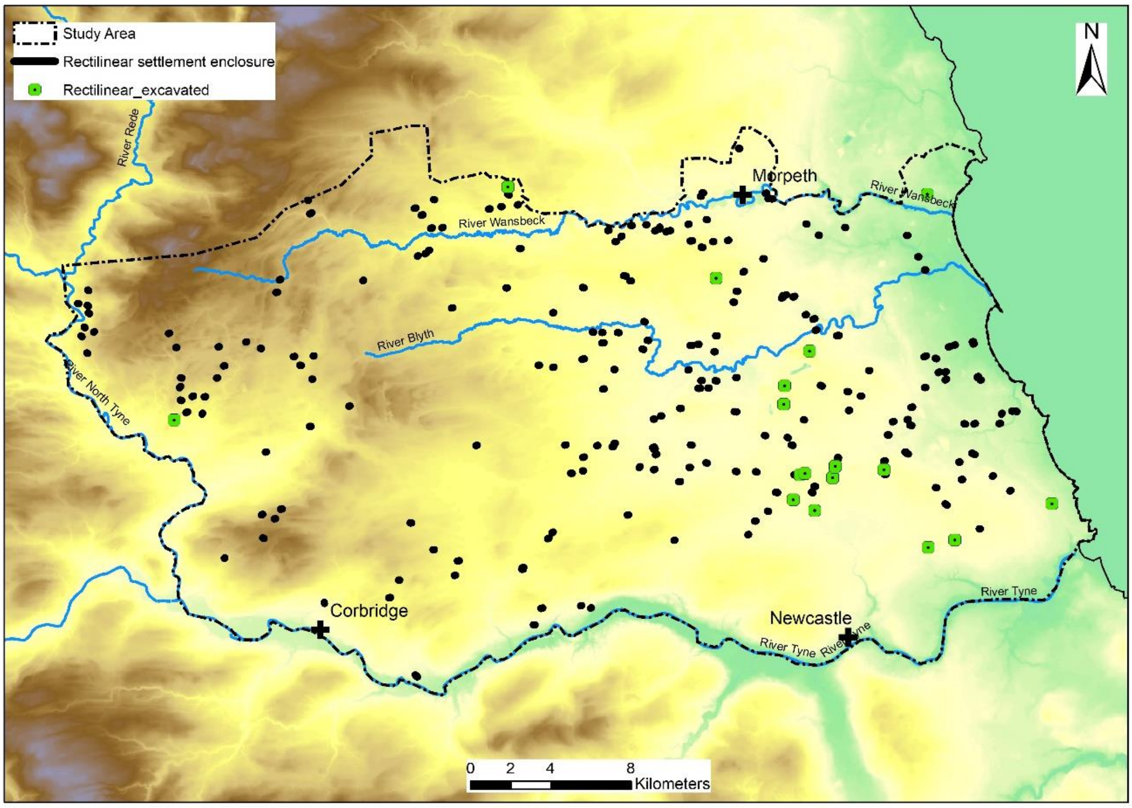

Figure 3.4 Distribution of known rectilinear settlement enclosures, including those which have been excavated, shown in green

3.5 A chronological gap between the late second- and sixth-centuries AD

As the previous section stated, scientific dating from developer-led excavations is increasingly suggesting settlement abandonment coinciding with the construction of Hadrian's Wall during the second-century AD (Hodgson *et al.* 2012: 213-220). In terms of current data, we then have an empirical, and possibly real, gap in settlement and land-use of over three hundred years until the appearance of the only currently known, dated Anglo-Saxon settlement in the region at Shotton in the sixth-century. Although the case for the abandonment of some native settlements during be the second century is compelling, in terms of the sample of settlements so far excavated, two points must be recognised. Firstly, the number of excavated sites in the region, whilst ever-growing, represents around ten percent of the total of known sites; and secondly, most excavated settlements are located in a discreet region, mostly within 10 miles of Hadrian's Wall. Excavations at Pegswood (Proctor 2009), and St George's Hospital (ARS 2016), further north from the aforementioned cluster and close to the northern banks of the River Wansbeck, suggest continued activity throughout the Roman period, particularly at St George's Hospital, so we cannot discount the possibility that at least some unexcavated rectilinear settlements further south could contain evidence of occupation lingering into the third century and beyond. Arguments have been made for the plantation of a system of 'ranches' at approximately regular intervals in the area apparently cleared of occupation after the building of Hadrian's Wall. These would have provided a regular supply of agricultural produce for troops and their families stationed at the forts and within the surrounding civil settlements (Frodsham 2006: 167-168; Hodgson *et al.* 2012: 218-219). No evidence from excavated rectilinear settlements has so far validated the argument for continuity along the coastal plain south of the River Wansbeck after the second century. Evidence of occupation into the third- and fourth-centuries, and even into the post-Roman and early medieval periods, was recovered further west on the borders of the upland zone at Huckhoe (Jobey 1959). Excavations here showed that rectangular buildings replaced roundhouses in the fourth-century (shown in Figure 3.5); and pottery characterised as post-Roman suggested the site remained in use until at least the late fourth-century, and maybe into the fifth- or sixth-century. Furthermore, the fortifications dating to the late Iron-Age phase were not repaired during subsequent occupation during the Romano-British period, which was suggested to be evidence of non-native influence and movement of trade, linked as Huckhoe was to Hadrian's Wall by its proximity to a Roman road known in later times as The Devil's Causeway (Jobey 1959: 247-252; 258-260; Hodgson *et al*. 2012: 216). Upon re-examination, the sherds thought to date to between the fifth- and seventh-centuries were deemed too small for chemical analysis which could have confirmed or denied the original interpretation (Vince 2007); and the assemblage can no longer be located, preventing further examination of its character alongside recent discoveries.

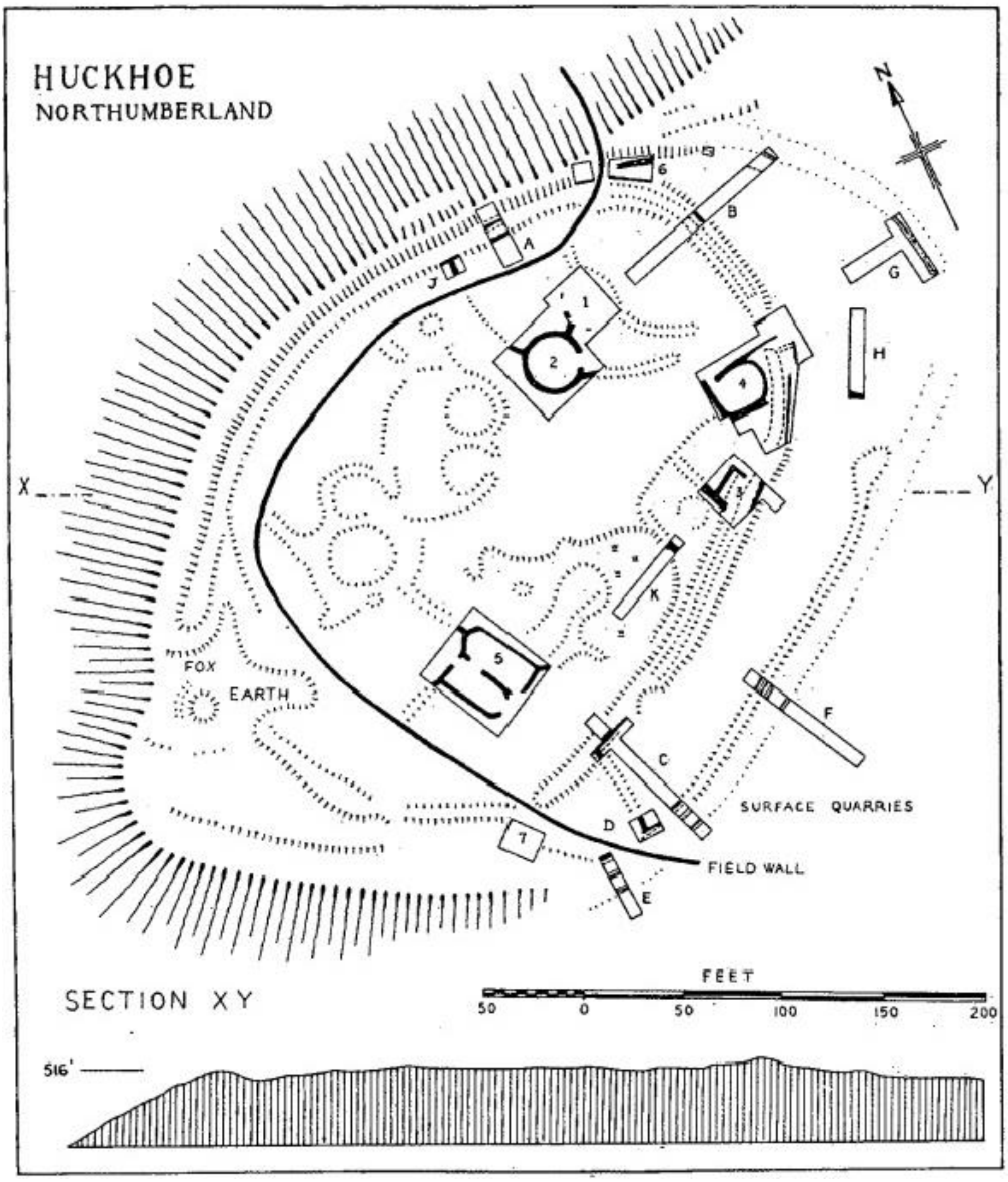

Figure 3.5 The excavated Iron Age and Roman period settlement at Huckhoe (from Jobey 1959: figure 2)

The varying topography in which Iron Age and early Roman period settlements are situated clearly affects their preservation and potential re-use in later periods. The ubiquitous rectilinear settlements are, aside from a few exceptions, commonly distributed along the fertile soils of the coastal plain; whereas sub-circular settlement enclosures are more common in the uplands. Differing subsequent agricultural activity depending on location and topography has a variable effect on existing settlement remains. For example, the earthen bank and ditch rectilinear enclosures containing timber-built dwellings along the coastal plain are more likely to be severely truncated by subsequent ridge and furrow ploughing; and are usually only visible as cropmarks or anomalies on geophysical survey plots prior to excavation.

The sturdier stone-built enclosures in more upland contexts survive far better in areas of constant pasture; or where present, ridge and furrow furlongs respect them. The data, and relative distributions, are therefore further skewed by this. This is a particularly important factor when we consider possible later occupation layers of lowland settlement sites being destroyed in comparison to those in upland contexts.

Fragments of occupation evidence in the period can be traced to the Roman to post-Roman/early medieval transition. Roman military installations along Hadrian's Wall and its environs have dominated research into Roman period settlement and land-use in the current study area. Investigations of civil settlements, or *vici*, attached to forts, have been relatively rare, although this is being addressed through geophysical survey (for example Taylor *et al.* 2000; Biggins *et al.* 2004) and excavation (Birley 2003; Snape *et al.* 2010; Archaeological Practice 2017). Excavations have shown a regular laying out of *vici*, with well-made structures, by the third-century AD, although none have been excavated to the extent to which a full layout can be seen, or their chronological sequence from origins to abandonment (Breeze and Dobson 2000: 203; McCarthy 2002: 107). No evidence is forthcoming to suggest longer occupational phases within *vici*, despite a recent hypothesis put forward by Brian Roberts (2015), who argued for a degree of continuity at Benwell between the *vici* associated with *Condercum* fort and the later medieval village. This will be discussed in more detail in a later chapter.

Evidence for continuity on and around Roman forts along Hadrian's Wall into the early medieval period in the region is patchy; but is growing steadily with more research (Collins 2011: 22; 2012: 134-137). At some forts it has been shown that defensive ditches were refurbished in the fifth-century, such as a later ditch cut across the outside of the south-west gate at South Shields, which was subsequently filled in and the gate brought back into use (Bidwell and Speak 1994: 48). It has also been suggested that a possible church occupied the *principia* forecourt at South Shields, and similar evidence was found at Housesteads (Hodgson 2017: 180-183). At Newcastle, fifth-century burials were found directly adjacent to the Roman fort suggesting either continuity of activity on or around the same site, or at least a shorter gap in activity (*ibid*: 189). Excavations of Roman forts undertaken in the nineteenth-century focused almost solely on uncovering Roman layers (Breeze and Dobson 2000); as a result, important archaeological evidence dating to subsequent periods of occupation was probably missed (Passmore and Waddington 2012: 295). Recent discoveries of post-Roman burials (Bidwell and Speak 1994), material culture (Snape 1992), and buildings (Wilmott 1997) at Roman forts would suggest this is the case. This evidence for occupation into the post-Roman period exists in a very specific context, and therefore should not be taken as representative of typical settlement in the region at this time. Isolated artefacts, such as a possible seventh-century Anglo-Saxon annular bronze brooch discovered at Chesters in the nineteenth-century, are often found in unstratified contexts (Miket: 1978) so cannot be taken as clear markers for continuous occupation or re-occupation of these sites.

Two Roman roads traverse the study area. Long stretches of Dere Street are still use, unlike the Devil's Causeway, which is largely overlain by later field systems. There have also been suggestions of an earlier date for the Great North Road (Heslop 2009; Hodgson *et al.* 2012). Detailed analysis of Dere Street has been undertaken from a surveyor's perspective (Poulter 2010), but on the whole research into Roman roads in the region is confined to the Roman period, with little examination of how they relate to boundaries, fields and settlements from earlier and later periods. A case-study will explore this dynamic through relative orientation analysis in chapter 6.

The most tangible and useful bridge spanning this period is probably onomastic, with the oldest layers of Old English place-names potentially being the most useful source of evidence for the period (Roberts 2015: 51). Brian Roberts has recently put forward the theory that between AD 400 and 600 a Romano-Celtic culture, society and economy was largely replaced by one which was largely Germanic, albeit with a degree of input which was suppressed towards the east but more prominent in the west. This assumption derives from a combination of available evidence, including archaeological excavation, place-name analysis and the study of historical documents.

3.6 The Early Medieval period (AD 410-AD 1100)

Known settlement remains dating to the early medieval period are few in the current study area. Early medieval settlements have recently been discovered through large-scale developer-funded archaeology, at Shotton (Muncaster *et al.* 2014) (shown in Figure 3.6), North Seaton (Archaeological Practice 2015); and Felton 12km north of the study area (AD Archaeology 2018a). In all cases early medieval remains were invisible to both aerial photography and geophysical (gradiometry) survey; and as with most pre-medieval features in lowland contexts, all were heavily truncated by medieval and later ploughing. Many of the possible post-built structures at Felton were difficult to interpret due to the presence of deep and wide furrows. Whilst some post-holes were discovered beneath the furrows, it is likely that many were destroyed by later ploughing. Shotton and Felton were excavated during winter months, where inclement weather conditions on already fragile archaeology impeded the recovery of evidence. Features were cut into heavy boulder-clays, which meant that standing water became a serious impediment to the survival of already fragile archaeological deposits after the removal of topsoil. These unsuitable and detrimental conditions are regularly placed on developer-funded investigations, which has a negative impact on our understanding of ancient and historic settlement and land-use in the region. These conditions are accentuated on early medieval settlement sites due to the ephemeral nature of the remains, in relation to the substantial ditches which characterise previously mentioned rectilinear settlement enclosures.

Figure 3.6 Excavations at Shotton: Hall structure A (from Muncaster et al. 2014: figure 16)

Looking a little further afield from the current study area, a clustering of early medieval settlement sites in the Milfield basin, north Northumberland, is representative of proportionately more research-led and developer-funded archaeological investigation has been undertaken in this region than in the current study area. The best known of these sites, the *villa regia* at Yeavering, was excavated in the 1950s in response to the identification of cropmarks and ongoing damage to them through intensive ploughing regimes (Hope-Taylor 1977). Other examples of settlement in north Northumberland include an excavated ninth-century building and production site associated with the nearby monastery on the island of Lindisfarne (Young and O'Sullivan 1995); and the early medieval capital of Bamburgh (Kirton and Young 2016), both investigated through research-led initiatives. These projects operated outside constraints imposed by commercial development, entailing more thorough and thoughtful excavation and post-excavation methodologies. The identification of sunken featured buildings (SFBs) as cropmarks on aerial photographs often act as markers for settlements from this period. Cropmarks at New Bewick were investigated through both geophysical survey (Glover 2010) and excavation (Gates and O'Brien 1988), clarifying the initial interpretation of SFB remains, and thus the presence of an early medieval settlement of, at present, unknown scale. Evidence from Bamburgh, Yeavering, Thirlings (O'Brien and Miket 1991), Cheviot Quarry (Johnson and Waddington 2008) and New Bewick (Gates and O'Brien 1988) have led to the proposition of a for settlement hierarchy model, with Bamburgh being the seat of the king, to the royal complexes at Yeavering, Milfield and Sprouston, followed by the probable estate centre at Thirlings; and of the lowest status so far discovered, small hamlets at New Bewick, Lanton Quarry and Cheviot Quarry (Passmore and Waddington 2012: 298-299). It is striking that similar evidence remains to be identified further south in Northumberland, where aside from Shotton and North Seaton, and Felton, most evidence for early medieval activity exists in the form of ecclesiastic sites such as the churches along the Tyne valley, many which contain large amounts of reused Roman stonework (Bidwell 2010).

It has long been assumed that the early medieval period was largely aceramic in this region (Dixon 1984: 77), a view reinforced by the small ceramic assemblages at recently excavated sites. Just five sherds of supposed 'Anglo-Saxon' pottery were recovered at Thirlings, where the small ‘Anglo-British’ assemblage was explained as the result of domestic debris being discarded away from buildings and pits (O’Brien and Miket 1991: 87-88). Problems with distinguishing between the fabrics and forms of local traditional wares of the Roman period and those of possible early medieval date are common. The problems with dating the pottery assemblage at North Seaton has already been discussed above, but it clearly shows a need for a more robust methodology for dating ceramic sherds; as the excavators of North Seaton stated, if many of the sherds recovered on early medieval sites are found to definitively date to the post-Roman/early medieval period, it could lead to the re-interpretation of ceramic assemblages, and therefore re-examination of settlement chronologies on both Iron Age/early Roman, and early medieval sites in the region and beyond.

Sampling strategies and scientific analysis and dating are therefore crucial in developing chronologies for early medieval settlements. It is normal practice on these sites that all post-holes are fully excavated, with a percentage sampled for scientific and environmental analysis. At Shotton, radiocarbon dating results were used to define two phases of early-medieval occupation, consisting of firstly an unenclosed group of halls dated to the sixth-century, followed by an enclosed settlement dating to between the late sixth- and mid-ninth-century AD. The settlement remains at Felton were similarly dated through scientific methods, with Bayesian modelling of radiocarbon dates estimating occupation of the site to between roughly AD 580 and 985 (AD Archaeology 2018a).

The circumstances surrounding the discovery of early medieval settlement remains at Shotton, North Seaton and Felton, all situated short distances from medieval villages, raises concerns regarding how many other sites of this nature have potentially been missed in advance of development, both before and after PPG16 (now the National Planning Policy Framework, or NPPF) was introduced in the early 1990s. At Shotton, archaeological remains were discovered through trial trenching, but it was not until strip and record open-area excavation that they were recognised as forming an Anglo-Saxon settlement (Muncaster *et al.* 2014: 77). At Felton, trial trenches fortuitously uncovered shallow post-hole features; and through extending of some of these trenches returns in post-hole arrangements were recognised, and samples taken for radiocarbon analysis which returned early medieval dates. It is perhaps telling that the excavators at Shotton also uncovered the settlement remains at Felton: they knew from experience what to look for. One wonders how much has been missed through the unfortunate positioning and orientation of evaluation trenches, which at only around 1.5m wide, could potentially reveal only a single post-hole that could easily be missed by over-excavating by machine, or interpreted as a natural feature, especially on sites located on complicated mixtures of sub-soils.

Few primary documentary sources exist for the period, and are often sketchy in detail, and almost all are written from the perspective of the Christian church, adding an unavoidable element of bias. Much of the primary source material, and subsequent research from it (for example Hawkes 1996; Rollason 2003) focus on the so-called ‘Golden Age’ of Northumbria, characterised through elite society and major documented events. Although they shed little light on how most of the population lived during this period, these documented events would in some cases have affected individuals and communities lower down the social scale.

Excavations are yet to identify or recover evidence for fields associated with early medieval settlements in the current study region, but environmental sampling from Shotton revealed that wheat and barley were grown by inhabitants of these settlement (Muncaster *et al.* 2014: 134-135). Along with the lack of knowledge concerning the nature of field divisions, neither do we know what form of ridged cultivation was employed to grow these crops. An abundance of evidence for ridge and furrow ploughing exists throughout the region; and it possible that some of these traces, along with boundaries and tracks depicted on 1st edition Ordnance Survey maps, and linear cropmarks and earthworks relate to early medieval land-use.

3.7 A chronological gap in knowledge between the ninth- and twelfth-centuries AD

A further gap in our knowledge of settlement and land use in the study area exists roughly between the ninth- and twelfth-centuries. The main source of evidence highlighting this gap comes from Shotton, where radiocarbon dating suggested the enclosed Anglo-Saxon settlement was abandoned between the late eighth-century and the end of the tenth-century; and excavations of the eastern end of the medieval village 450 metres to the north revealed no evidence to suggest pre-twelfth-century origins. Despite evidence showing a long sequence of occupation recovered at North Seaton, radiocarbon dating exposed a similar gap in activity on the site between the ninth- and fourteenth-centuries; as did excavations of the Anglo-Saxon settlement at Felton (AD Archaeology 2017).

The feudal system, established in England by at least the twelfth-century, is thought by some to have incorporated within it many Anglian institutions and estates, including the survival of the Northumbrian estate type known as the 'shire'. Evidence for this has been explored through the detailed analysis of eleventh-century and later documentary sources in both the south and north of the region (Wrathmell 1975: 55-59; Dixon 1984: 67-72; O'Brien 2002: 55). These studies offer glimpses of how the landscape was organised between the end of Roman administration and the Norman Conquest. No contemporary records survive regarding the establishment, development or physical characteristics of territorial organisation, so it is difficult at present to identify whether any elements of this survived the Norman Conquest. Townships, present as land units comprising villages and associated allotments, are believed to have formed from the fracturing of shires at some point before the eleventh century. They endured until the nineteenth-century, and although they may have undergone many changes, elements of these boundaries probably represent fragments of much earlier land division. This idea has been given little consideration in the current study area. Township boundaries are rarely excavated, mainly due to the ecological restrictions on hedge-banks and the threat to natural habitats. Trial trenches at Spital Hill (AD Archaeology 2015b), for example, were located to respect a township boundary within a proposed development for this very reason. It will be interesting to see how the impending strip and record excavation proceeds at this site. In the few cases where township boundaries have been excavated, dating evidence has not been recovered (TWM 2006).

Many medieval village layouts and place-names in south east Northumberland hint at late Saxon origins, and most contain Old English place-name elements; but no one idea, point of origin or even cause for regular planned villages is known (Roberts 2008: 245-248). Documentary evidence implies that medieval settlements 'just appeared' in Northumberland during the twelfth-century, fully formed and functioning as economic and social units. The prevalence of Old-English place-names in medieval villages present on eleventh-century documents have been used to infer early medieval settlement patterns (Petts and Gerrard 2006: 169; Roberts 2015); and it has been suggested that later medieval villages may lie on top of Anglo-Saxon settlement phases (Dixon 1984: 77; Muncaster *et al.* 2014: 138). Excavations in the current study area are yet to confirm or deny this hypothesis, as Shotton, North Seaton and Felton lie short distances away from medieval village cores; although studies from elsewhere have shown at least the possibility of such a phenomenon (Wrathmell 2012a; Wright 2015). Although yet to be encountered in large numbers in the current study area, possibly due to low levels of excavation on and around these sites, we cannot dismiss similar evidence also being present. Excavations within the currently-occupied village at Tynemouth revealed evidence for an earlier settlement phase oriented on a different axis to the present settlement, and an associated burial ground beneath an existing street, although neither could be securely dated, an no link could be made to the nearby seventh-century monastery (Harbottle 1978: 59; Hart 1997). The latest dated material recovered at Huckhoe were pottery sherds dating to the tenth century AD (Vince 2007: 7-10), suggesting abandonment by the eleventh century, around the time that nucleated medieval villages enter the historical records (Vince 2007: 11). This site is a rare example showing evidence spanning period in question.

Alongside being overlain by medieval ridge and furrow, Shotton, North Seaton and Felton are situated around 500 metres from a known medieval village. It is perhaps therefore a distraction to call the Anglo-Saxon settlements at Shotton, North Seaton and Felton after their nearby medieval counterparts, which may well contain Anglo-Saxon settlement evidence of their own beneath the later remains. The Anglo-Saxon settlements could have existed under a different name entirely to those given to nearby medieval villages.

Two major events are documented within this period: the Viking invasions and the Norman Conquest. Aside from the documented attacks on monasteries, notably at Lindisfarne, Hexham and Tynemouth in the late eighth- and ninth-centuries, there is very little evidence for Viking settlement in the current study area compared with Durham and Yorkshire, where the presence of Old Norse elements in place-names is common. The few Anglo-Saxon settlements excavated showed no evidence for deliberate destruction or burning; but they ceased to be occupied after the ninth-century.

It is thought that the Normans completely altered the administrative structure of many ‘northern villages’ from the eleventh-century onwards (Kapelle 1979: 159), although we do not know whether the current study region suffered the same fate. Norman influence in Northumberland is largely architectural, in churches and Motte and Bailey castles, the latter most notably present at Newcastle in the current study area but with many more examples further north. Aside from the Norman ‘harrying’ from the south, it should be remembered that Northumberland was under considerable pressure from Scottish raids (Roberts 2008: 198-199; 235). It may therefore be more instructive to look north as well as south for clues regarding changes and continuities to settlement and landscape patterns during this period in the current study area.

3.8 The Medieval period (AD 1100-1500)

Medieval nucleated villages have become synonymous with the idea of the English medieval landscape; and have been the subject of numerous studies (Beresford and Hurst 1989; Roberts and Wrathmell 2002; Roberts 2008; Lewis *et al.* 2001; Jones and Page 2006). Although dominant in the so-called ‘central province’ (Roberts and Wrathmell 2002), they were certainly not the only form of settlement during this time, with farmsteads and hamlets occurring widely. To briefly explain, the ‘central province’ is a hypothetical geographic zone in England which is defined by the presence of open-field agriculture, consisting of managed arable fields containing furlongs of ridge and furrow; and associated nucleated medieval villages. The zone extends roughly from the Bristol Channel to Northumberland.

Nucleated settlements do occur widely in south-east Northumberland, which was included in the central province by Roberts and Wrathmell (2002), in deserted, shrunken or still-occupied forms. Deserted medieval villages (hereafter DMVs) are no longer inhabited, but often still visible as earthworks, such as West Backworth; or sometimes as cropmarks such as East Brunton. Shrunken villages are usually still occupied by one or two farms, such as Shotton; or a remaining, but modern, single row such as Ogle. The use of the term ‘shrunken’ is a contested one (see Dixon 1984); but is deemed suitable for the purposes of this study which is less concerned with the present status and more with the general layout of the original village plan. Examples of these states of preservation are shown in Figure 3.7. Still-occupied medieval villages occur throughout the study area, with the medieval core encased within modern rural and urban settlements. The footprints of medieval nucleated villages are depicted on 1st edition Ordnance Survey maps, which have been used to transcribe some layouts.

Figure 3.7 Examples of medieval nucleated villages in the study area: top, earthworks at Ogle (Environment Agency); bottom left, excavations at Shotton (Google Earth); and bottom right, earthworks at West Backworth (photo: author)

Medieval nucleated villages were usually regular in shape, sometimes arranged either side of a route-way, or a ‘green’. The orientation of medieval nucleated settlements is in many cases reflected in surrounding open-fields and furlongs. It is of interest, therefore, whether there is any correlation in orientation between the two in the same area. The layout of these two types of feature may have been influenced by the lie of the land at both regional and local scales.

An abundance of research has focused on the origins of medieval villages in England (Wrathmell 2012a; Jones and Page 2006; Brown and Foard 1998; Hamerow 2012), but little of this is concerned with those in the current study area. In most cases earthworks of medieval villages represent multiple phases of both medieval occupation and subsequent, post-desertion or shrinkage activity. The site of the medieval village of West Backworth in North Tyneside exemplifies this, comprising a tangle of earthworks, some of which were clearly related to the village phase, but others indicative of post-desertion activity on the site (Astbury 2013).

Only a small percentage of nucleated villages have been excavated in either research-led or developer-funded contexts in Northumberland. This is most likely a result of the scheduling of earthworks representing deserted and shrunken sites, and that many medieval village ‘cores’ are situated beneath existing settlements, has so far spared most from large-scale modern development. West Whelpington is the most extensively excavated medieval settlement in this region, undertaken in advance of quarrying (Jarrett 1962). It was unclear to the excavators how typical West Whelpington was amongst the many deserted villages of Northumberland (*ibid*: 225), emphasising the small dataset available for studying medieval villages in the study area at the time. Little has been done since to improve this, although recent developer-funded excavations have uncovered substantial areas of medieval settlements at West Hartford (Fraser 2004), Shotton (TWM 2008; 2013) and East Sleekburn (Vindomora Solutions 2018). These examples differ from the classic medieval earthwork sites in that the only surviving remains lay buried beneath ploughsoil. The excavators at Shotton were unable to determine detailed chronologies for the various settlement remains due to poor preservation. The absence of close dating or horizontal stratigraphy meant that phasing had to be discussed on a toft-by-toft basis; and furthermore, it was found that little significant variation could be established between the pottery assemblages of certain phases (TWM 2013: 144-145). It was established through the excavation of large areas that the size of the tofts at Shotton were similar in size to smaller tofts excavated at West Whelpington and elsewhere in northern England, such as the west row at Wharram

Percy, Yorkshire (Wrathmell 2012a) and the smallest tofts at Thrislington, County Durham (TWM 2013: 144-145).

Along with nucleated villages, ridge and furrow ploughing is regularly associated with medieval landscapes. With often widely spaced ridges between five and ten metres apart, and displaying the characteristic reverse ‘S’, ridge and furrow was part of an agricultural regime in which the area around a medieval village was grouped into two or three large open-fields which formed the basis of a simple crop rotation scheme regulated by either a manorial lord or village community (Hall 2014: 1). Arable open fields were divided so that each holding in the village had access to specific narrow strips, ploughed using the ridge and furrow technique (Hall 2014: 1-2). A wealth of evidence for medieval ridge and furrow survives in the region, on historic mapping, earthworks and cropmarks, where it appears from known records that three-field systems were common (Butlin 1964: 100).

Walter of Henley in thirteenth-century recommended the best method for draining marshy land was to create ridges and ditches to enable the run-off of water (in Curtler 1909: 32). Contemporary documentary sources contain references to the clearing out of open ditches, "apparently the only drainage then known" at Michaelmas, the beginning of the farming year (Curtler 1909: 16-17). Ridges also increase the temperature of the soil, thus improving its yield potential (Topping 1989: 163-164). Despite the wealth of literature on medieval fields and farming (for example Butlin 1964; 1973; Hall 1999; 2014) there has been lack of attention given to the actual practice of medieval farming, such as the type of ploughs used, or the problems of poor drainage, studies instead relying heavily on the role of manorial lords in the organisation of the landscape (Williamson 2003: 23). The last detailed study into medieval fields and agriculture in Northumberland was undertaken over fifty years ago (Butlin 1964, although recently briefly revisited (Hall 2014). Focusing on the nature of medieval common-field practices, such as the use of four, five and six-field systems in some townships derived from medieval tax documents and late medieval and post-medieval estate plans, Butlin placed the evidence in a national context to directly compare these systems with those in the midlands and eastern England, which were, and are still, deemed to be the area of inception for the open-field system model from which all other regions followed. It was not, however, a study concerned with the furlongs within the common fields, and it is in this area that we have a relative lack of knowledge and data concerning how furlongs were laid out. This is something the current research aims to address through the analysis of orientation. If, for example, drainage was an important factor to the positioning and orientation of furlongs, we should expect to see this in the results of slope direction conformity analysis. It will also be interesting to see whether the orientation of medieval features such as village units and furlongs share orientation with other features in their vicinity, such as prehistoric settlements and boundaries or boundaries and routeways present on 1st edition Ordnance Survey mapping. The case-studies in chapter 6 will explore these ideas further.

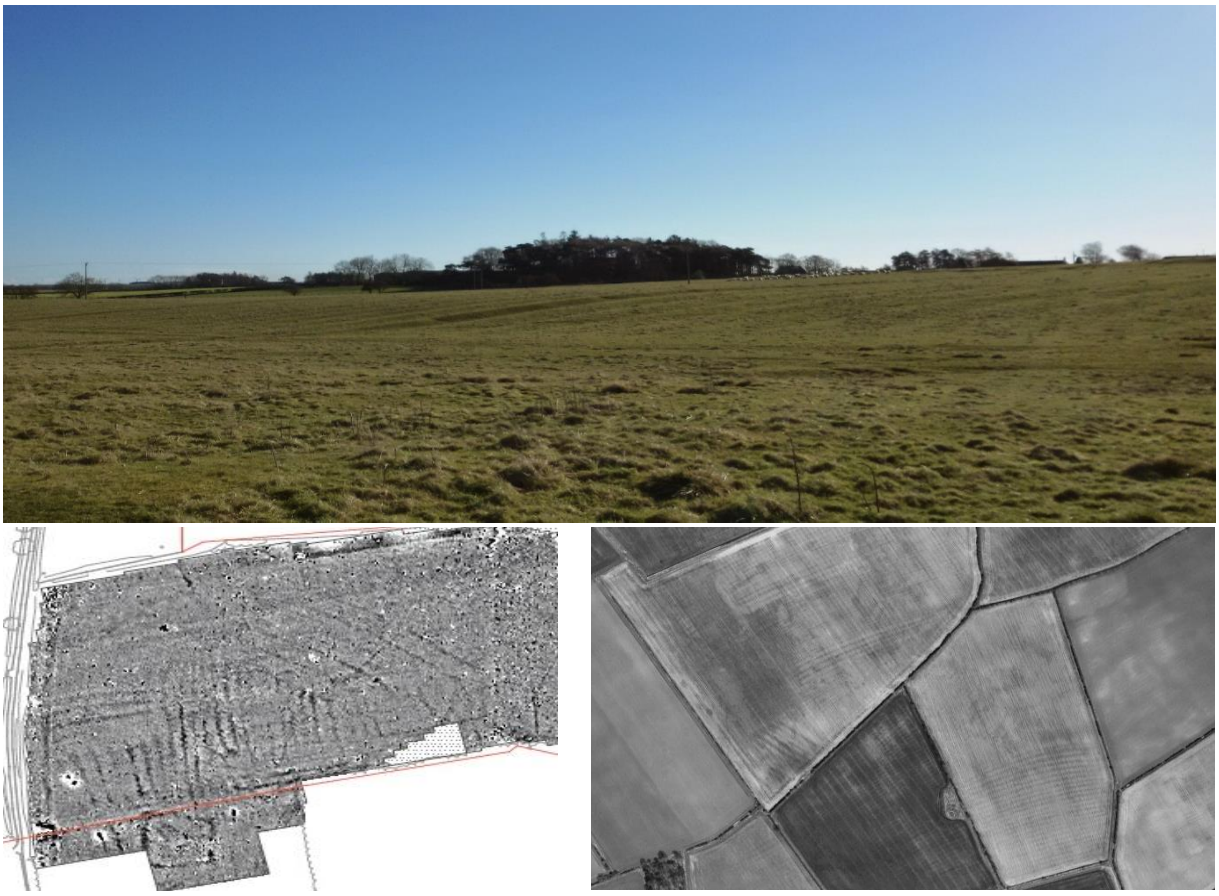

Figure 3.8 Medieval ridge and furrow in south-east Northumberland. Top, earthworks at Ogle (photo: author); bottom left gradiometry plot at Choppington (AD Archaeology 2015: figure 5); bottom right, Google Earth 2002 image showing cropmarks west of Seaton Sluice

It has been stated that studies of medieval villages in north-east England have tended not to consider the wider landscape context (Petts and Gerrard 2006: 76). This is not due to a lack of potentially available data. Developer-funded archaeology has, somewhat as a by-product, produced large amounts of new data regarding medieval and post-medieval agriculture in the region. Geophysical surveys regularly reveal large swathes of probable medieval and post-medieval ridge and furrow plough marks in lowland regions (see Figure 3.8 bottom left). Cropmarks and earthworks of ridge and furrow are abundant on aerial photography and satellite imagery, albeit more fragmentary in the lowlands as a result of modern ploughing and other forms of development. The almost ubiquitous presence of ridge and furrow on developer-funded excavations has already been mentioned in terms of the damage to earlier archaeological features; but it is rarely included in sampling strategies to determine a basis for chronology, although pottery dating to the twelfth-century and later is often found in buried furrows. A study by O'Brien and Adams (2016) stands alone in the region as a critical analysis of the morphology and chronology of ridge and furrow ploughing, although a discussion can be found concerning the medieval landscape in the Northumberland National Park, part of which is included in the study area (Frodsham 2004: 84-85). It is acknowledged that post-depositional processes, such as surface wash and later manuring impedes the successful interrogation of such data. The current project has encountered multiple variants in the ridge and furrow type which have already been discussed in the previous chapter; suffice to say these morphological variants probably represent developments over a long time-period.

3.9 Post-medieval and early modern land use (AD 1500-1945)

Post-medieval ridge and furrow acts as a chronological link between features dating to the medieval period and those depicted on 1st edition Ordnance Survey mapping, although it is recognised that the 1st edition Ordnance Survey mapping represents the culmination of at least centuries of activity. Post-medieval ridge and furrow, although it shares some morphological characteristics with its medieval predecessor, existed in a very different agricultural context. An example of its morphology can be seen in Figure 3.9. The agricultural revolution in England began long before the Parliamentary Acts of the eighteenth- and early nineteenth-centuries (Williamson 2002: 158). Open-fields in the current study area began to be dismantled in large numbers after around AD 1660; and had largely disappeared by the beginning of the eighteenth-century, by which time the economy was dominated by a mixture of cattle farming and arable, often combined in forms of ‘convertible husbandry’ (Butlin 1973). Most medieval open fields were removed through gradual piecemeal enclosure, but elements of this have endured judging by the large numbers of sinuous boundaries throughout the region in the shape of the reverse ‘S’ indicative of former furlongs and selions. The remaining open fields were steadily enclosed throughout the eighteenth-century (Williamson 2002: 125).

Figure 3.9 Medieval and post medieval ridge and furrow south of Shotton, visible on Google Earth 2002 imagery

The Historic Landscape Characterisation programme for Northumberland stated that 66 percent of 'pre-1860' field boundaries were the result of Parliamentary Enclosure, with the other 34 percent indicative of piecemeal enclosure by agreement (Williams 2015: 46-48). These statistics should be viewed with the knowledge that large tracts of Parliamentary enclosures are found in north Northumberland, where experimental farming techniques were widespread. Understanding trends in orientation and slope direction conformity for post-medieval ridge and furrow may help in dating some of the boundaries and tracks depicted on 1st edition Ordnance Survey mapping if a common alignment between the two can be found, especially in areas where common orientations between medieval and earlier features are also present. Much of the evidence for ridge and furrow in the region, especially along the coastal plain, does not display the classic reverse 'S' shape, and furthermore, shows closely spaced furrows less than four metres apart. These traits are characteristic of post-medieval ploughing.

3.10 Summary

This chapter has sought to demonstrate how the strategies and circumstances behind archaeological investigations dictate the epistemology of settlement and land-use in lowland Northumberland. Despite the wealth of archaeological data recovered on developer-funded excavations, the compromise of subsequent modern development destroying any remaining unexcavated archaeology has led to a lack of understanding of land-use between settlements in the late Iron Age, Roman or early medieval periods. In a few cases field boundaries in the immediate surroundings of settlements have been mapped and excavated within the confines of developer-funded methodologies, the reports and monographs from which say as much as they can within the confines of the excavation strategies, which usually focus on settlement structures.

It has been questioned whether the dense concentration of sites in north Northumberland, particularly in the Milfield Basin and lower Tweed valley, is reflecting disproportionately intense habitation and activity compared to elsewhere in the region; or is a product of intense developer-funded excavation, academic research and the volume of aerial photography captured and analysed (Petts and Gerrard 2006: 63). Recent developer-funded excavations and the discoveries made in south Northumberland suggest that the latter explanation may be more likely.

Heavy deposits of till dominate the geology of the south-east coastal plain; and this has been shown to impede the identification of cropmarks on the level of those found further north on the gravels and sands of the Milfield Basin, for example (Gates 2009: 135). Therefore, whilst rectilinear settlement enclosures are readily identified as cropmarks, more ephemeral features are less so, as was shown at Pegswood Moor. Crops develop later on heavy clay soils than on lighter soils, entailing little would be found through analysing aerial photography during the usual 'crop-mark season'. If archaeological flights are taken when crops are showing features in lighter soils, heavier soils will appear largely barren (Mills and Palmer 2007: 11-13). It is beyond the scope of the current study to examine whether this has affected the cropmark record in the study area, but it may go some way to explaining the discrepancy between south and north Northumberland. The cropmark record should also be seen partly as a result of research agendas (for example Gates 1997; 1999;

2000), and particularly in terms of Google Earth imagery, a product of fortuitous (or not) ground conditions and the time in which the imagery was captured.

Whilst the examples discussed above show the ever-growing dataset for exploring settlements and landscape features from numerous perspectives within the current study area, the data is rarely used to explore the dynamics of landscape change and continuity over long periods. A significant amount of archaeological data used in the current analysis has been sourced from unpublished standalone reports, or ‘grey literature’, which for the most part focus on data collected at a specific site. Space is given to discussion, but in most cases the focus is on comparisons with other similar sites known to have existed in the same time period. How these features relate long-term change and continuity in the landscape is often made less of a priority.

It is embedded in the very nature of archaeological inquiry that we can never fully understand processes and events of the past; and that interpretations are always subject to change with more data or through different theoretical approaches. On present evidence we must treat these gaps as representations of what actually happened. Excavations at West Whelpington were confined to the village unit entailing little focus could be placed on the immediate hinterlands. At Shotton we have seen that dated features from different periods were excavated and dated; these can be compared in terms of their orientations and relative locations.

We are faced with many questions concerning the identified empirical, and possibly real, gaps discussed in this chapter, and we must not lose sight of individuals and communities when we ask questions such as: what happened to the native population following the building of Hadrian’s Wall? Where did inhabitants of *vici* settlements disperse to during their decline? Why did some Anglo-Saxon settlements become depopulated around the mid ninth-century? With breaks in occupation on most excavated settlement sites, can it be shown whether any prehistoric and Roman periods boundaries endured into the medieval period and beyond by either becoming incorporated into later systems of land management? It will be a long time before current intrusive approaches are able to piece together coherent evidence for land-use and settlement over large areas, and chart changes and continuities over long periods. In the meantime, can continuity and change in land-use patterns be identified in the wider landscape through remotely analysing aspects of boundaries, tracks, settlements and agricultural practices? It is to these questions that the research will now turn.

4 Orientation and slope direction conformity analysis: regional-scale results

The settlements, route-ways, boundaries and ridge and furrow which traversed south-east Northumberland from at least the late Bronze Age until the present-day will be now analysed in terms of their orientation and conformity to underlying slope direction, addressing aims 2 and 3. The 30/120 degrees orientation (south-east to north-west or perpendicular north-east to south-west) will be used in all cases to explore how important this recognised trend in prehistoric settlement and land-use, outlined in the introduction, was in south east Northumberland. In addition, the most prevalent orientations for each feature will be studied to determine whether conformity to underlying slope direction was a significant factor in the decision-making process of those who built and used these structures, and whether certain orientations and associated levels of slope direction conformity can be attributed to certain time-periods and feature types.

File prefixes and names will be used throughout this chapter to present the results, as these wholly represent the feature and type of analysis carried out. These can be found and accessed electronically in Appendix B, within the 'orientation and conformity calculations' folder. For clarity, an extreme example will now be given using the pit alignment data:

- 'PAL_30_120_con20'

Broken down, this refers to pit alignments (PAL) oriented at ±10 of 30 or 120 degrees which conform to within 20 degrees of underlying slope direction. It should be noted here that perpendicular orientations are treated as a single entity as they represent the right angles of blocks of fields. For example, 30 degrees and 120 degrees represent a 90 degrees unit which in many cases represent rectangular fields which are particularly evident on 1st edition Ordnance Survey mapping.

4.1 Pit Alignments (PAL)

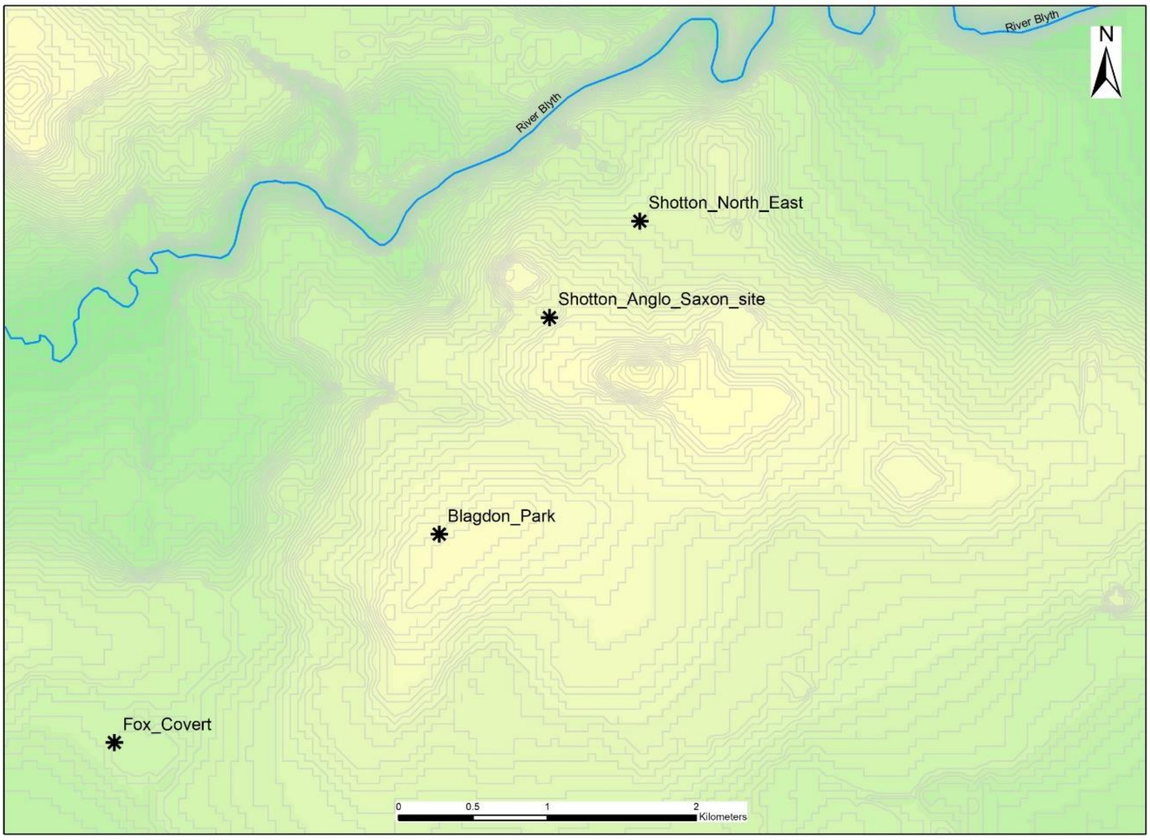

Figure 4.1 Locations of excavated pit alignments in the study area. 50m DTM downloaded from Edina Digimap, 2017)

It was difficult to make robust interpretations from this small dataset; and it was decided that excavated examples from north Northumberland should be included. The two areas will be analysed separately before comparing the results. The following section will deal firstly with pit alignments in south-east Northumberland, followed by those situated in the Milfield Plain in north Northumberland.

4.1.1 General Orientation

File prefix: ‘PAL1’

Length: 889m

Orientation	Length (m)	Percentage
PAL1_10_100	0	0
PAL1_20_110	315	35
PAL1_30_120	676	76
PAL1_40_130	361	41
PAL1_50_140	95	11
PAL1_60_150	95	11
PAL1_70_160	117	13
PAL1_80_170	117	13
PAL1_0_90_180	117	13

Table 4.1 Proportions of orientations present in pit alignments in south east Northumberland

The pit alignment at Shotton North East was oriented at 128 degrees; Shotton Anglo-Saxon site pit alignment at 144 degrees; Blagdon Park at 16 degrees; and Fox Covert at 24 degrees. The total length of pit alignments oriented within ±10 of 30 or 120 degrees is 675m of the 889m (76%); and comprises the whole excavated portions of Shotton North East and Fox Covert alignments. Figure 4.2 illustrates these results.

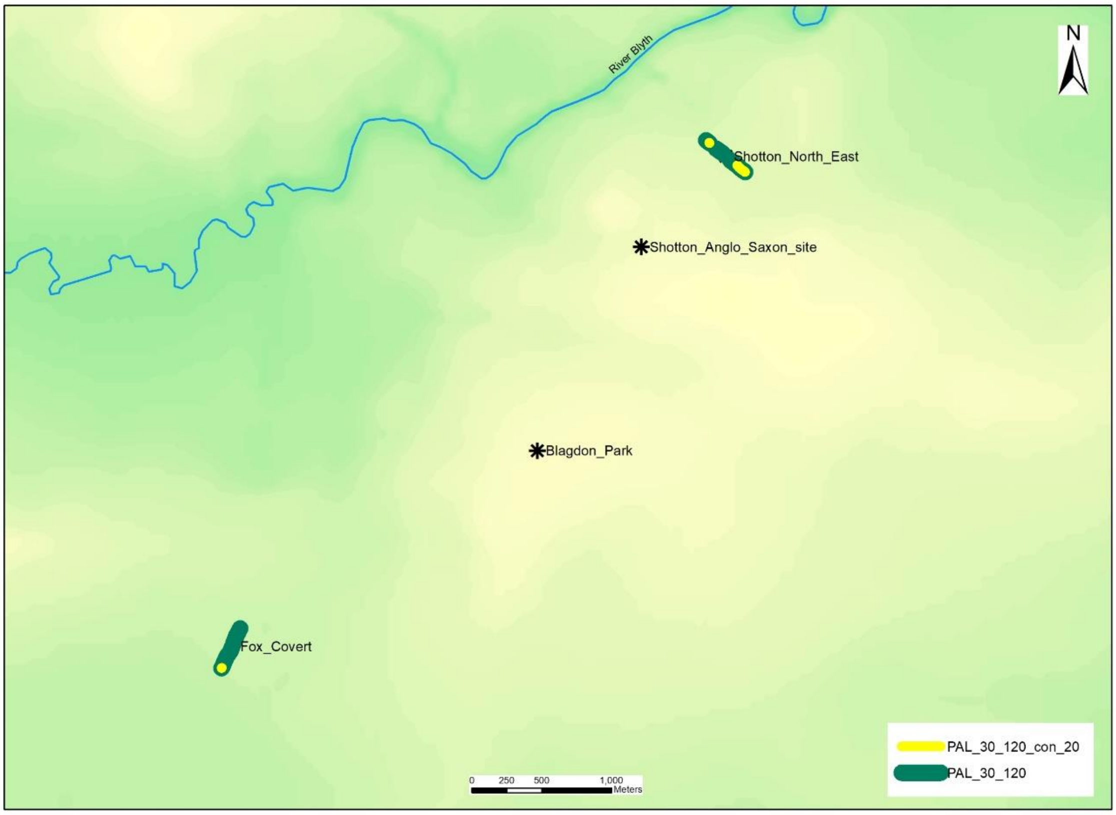

Figure 4.2 Proportions of pit alignments oriented around 30 or 120 degrees, with proportions of conformity to within 30 degrees of underlying slope (yellow) (50m DTM downloaded from Edina Digimap: 2017)

4.1.2 Conformity of pit alignments to underlying slope direction

- PAL: 889m
- PAL_con20: 308m (34%)
- PAL_non20: 580m (66%)
- PAL_con30: 567m (64%)
- PAL_non30: 322m (36%)

Thirty-four percent of pit alignment units conform to within 20 degrees of underlying slope direction. As will be shown later, this figure is much lower than that of later linear features; and the figure of sixty-four percent conforming to within 30 degrees of underlying slope direction is also low when compared with other features.

4.1.3 Comparing orientation with conformity to underlying slope direction

- PAL_30_120: 518m
- PAL_30_120_con_20: 82m (15%)
- PAL_30_120_con30: 265 (51%)

Only fifteen percent of pit alignment units which are oriented ±10 of 30/120 degrees conform to within 20 degrees of underlying slope direction; and fifty-one percent conform to within 30 degrees.

4.1.4 Results of Milfield Plain pit alignments

In north Northumberland numerous examples of pit alignments have been identified as cropmarks through aerial photographic analysis (Deegan and Gates 2009; Gates 2012), some of which have been excavated (Miket 1981; Harding 1981; Passmore and Waddington 2009; 2012). Figure 4.3 shows this distribution. Artefactual and scientific dating methods have yielded dates ranging from the late Neolithic to the early medieval periods, although problems of superimposition and re-deposition (Passmore and Waddington 2009: 246-250) should be considered when interpreting these results. The file prefix “PAL_MF_” has been used to display the results.

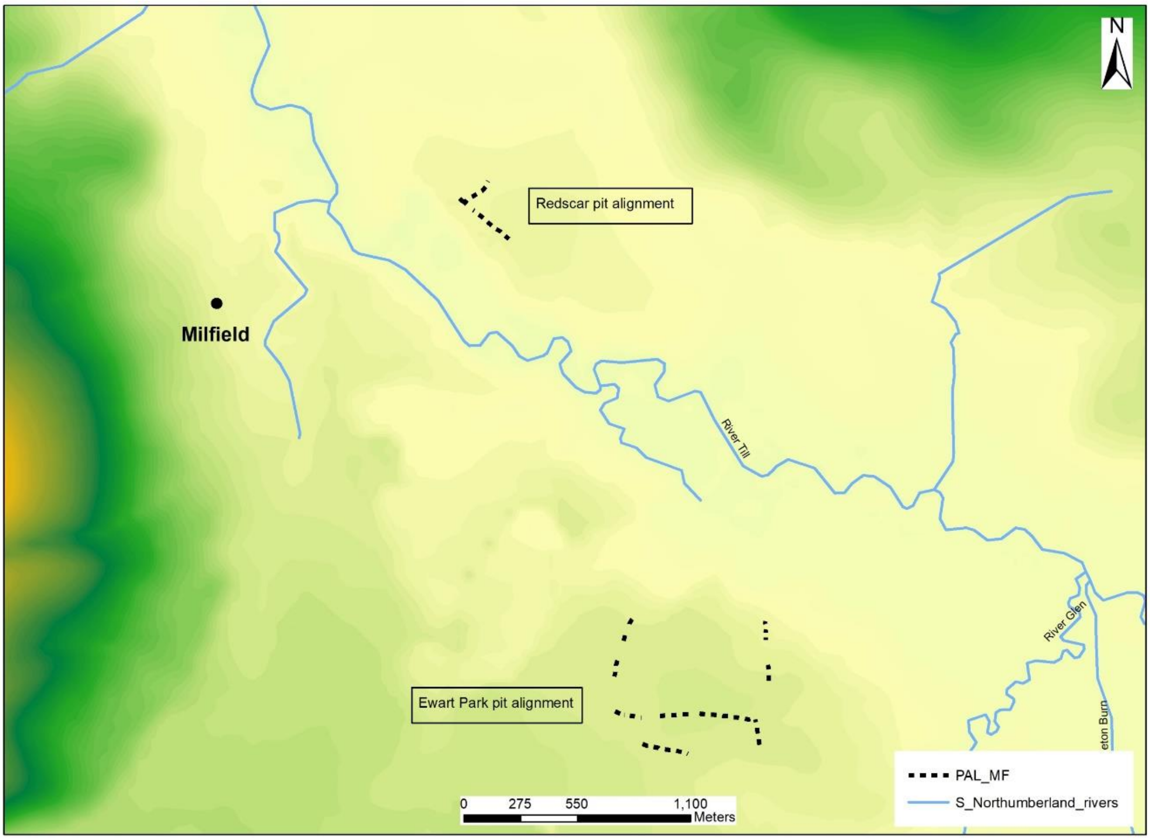

Figure 4.3 Pit alignments along the Milfield Plain (50m DTM procured from Edina Digimap: 2017)

4.1.5 Orientations

- PAL_MF: 1752m

Orientation	Length (m)	Percentage
10_100	801	46
20_110	373	21
30_120	437	25
40_130	405	23
50_140	95	5
60_150	58	3
70_160	163	9
80_170	400	23
0_90_180	800	46

Table 4.2 Proportions of orientations for pit alignments in the Milfield Plain

Two dominant orientations are present in the pit alignments along the Milfield Plain which are largely confined to separate areas. The Ewart Park complex consists of units oriented around 0/90 and 10/100 degrees; and a 30/120 degrees comprises most of the analysed units at the Redscar pit alignment, shown in Figure 4.4.

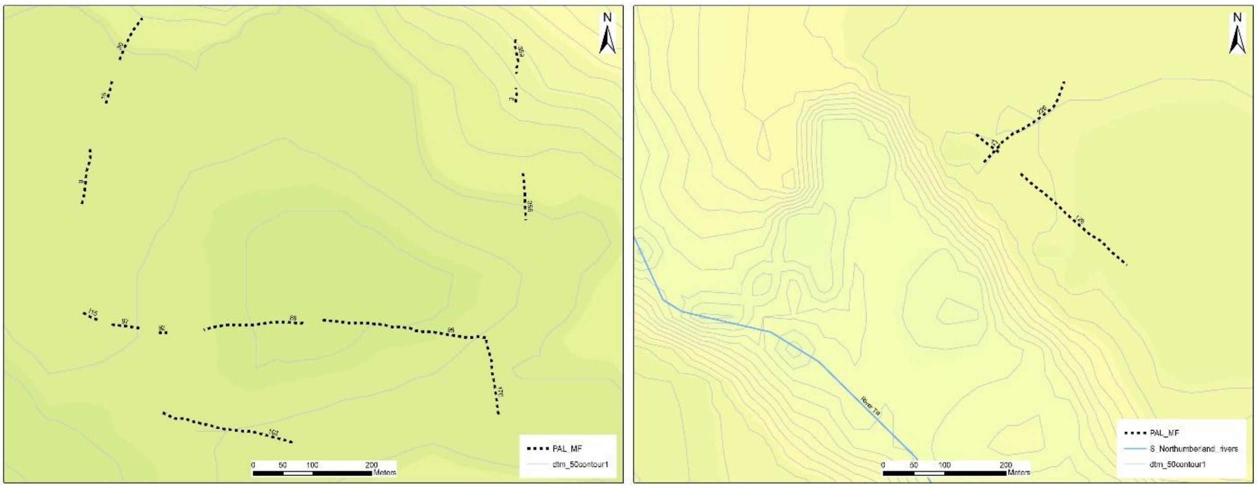

Figure 4.4 Orientations of pit alignments at Ewart (left) and Redscar (right) (50m DTM procured from Edina Digimap, 2017)

4.1.6 Conformity to underlying slope direction

- PAL_MF: 1752m
- PAL_MF_con20: 443m (25%)
- PAL_MF_non20: 1336m (75%)
- PAL_MF_con30: 825m (47%)
- PAL_MF_non30: 976m (53%)

As the results show, very few pit alignments in the Milfield Plain conformed to within either 20 or 30 degrees of underlying slope direction, with 25 and 47 degrees respectively. These are lower amounts than the pit alignments analysed in south-east Northumberland, which were 34 and 64 degrees respectively.

- PAL_MF_30_120: 437m
- PAL_MF_30_120_con30: 332m (76%)

As the results above show, seventy-five percent of the Redscar Pit alignment oriented around 30/120 degrees, which comprises much its length, conforms to within 30 degrees of underlying slope direction. It runs almost parallel to the River Till situated less than 500m to the south-west. The evidence suggests, like at Shotton, that the basis for laying out this pit alignment was the line of the river.

4.1.7 Discussion

The complex of pit alignments in the Ewart area are mostly oriented around 0/90 or 10/100 degrees. The prevalence of 30/120 degrees appears to be significant in the south-east Northumberland examples; however, the Milfield Plain pit alignments shows that this tendency may simply be the result of using rivers and other natural features as a pivot, in this case the River Till for the Redscar alignment; and the River Blyth north of Shotton. The orientation of the River Blyth immediately north of Shotton North-East pit alignment has been calculated at 49 degrees. The pit alignment at Shotton Anglo-Saxon settlement is oriented at 144 degrees, with the River Blyth to the north oriented at 51 degrees in this area, so the two are almost at right angles to one another. We do not, and will not now, know whether either of these pit alignments originally projected from the River Blyth; or if they were part of a system which included others that did, but the fact is they run close to perpendicular to the nearby river, which may have provided the initial alignment from which others could be built from.

The analysed pit alignments generally show low proportions of conformity to within 20 and 30 degrees of underlying slope direction; however, closer inspection of the results shows a more varied picture. The total length (95m) of the pit alignment to the east of Shotton Anglo-Saxon village; and the majority (102 of 117m) of that to the south of Blagdon Park 1 Iron Age settlement conform to within 20 degrees of underlying slope direction; but that at Shotton North East conforms for just 77 metres of the total excavated length of 360 metres; and at Fox covert it conforms to underlying slope direction for only 27m of the total 315m excavated. Both latter sites therefore show far greater proportions do conform to within 30 degrees of underlying slope direction.

Even with the Milfield results this remains a relatively small dataset; but trends are evident in all units showing that natural topography, in most cases rivers, and probably Prestwick Carr at Fox Covert, appear to be the basis from which pit alignments were laid out, even though some do not portray high conformity to underlying slope direction at a more detailed level. This had already been recognised by eye for the pit alignments at Shotton (Hodgson *et al.* 2012: 185); but it is confirmed through these results. Although not as obvious as the Redscar pit alignment which runs parallel to the River Till, when viewed in the context of the nearest rivers, Glen and Till, where the former joins with the latter roughly 1.5km to the east, it could be suggested that the system of pit alignments at Ewart Park reflect the way in which the river Glen runs roughly west before sharply turning north to join the river Till. LiDAR data clearly shows that the westernmost pit alignment at Ewart Park runs directly adjacent to a buried river channel, shown in Figure 4.5. This feature could have been of importance to plans made by communities regarding the use of space and resources in the late Bronze Age. Of further note is the evidence of what looks like a system of low banks representing a possible ancient field system which is oriented similarly to the pit alignments, and differently to the boundaries present by the nineteenth century. These have not been included in the analysis of prehistoric boundaries due to time constraints; but would form a useful comparative dataset to the pit alignments in this area in a further study.

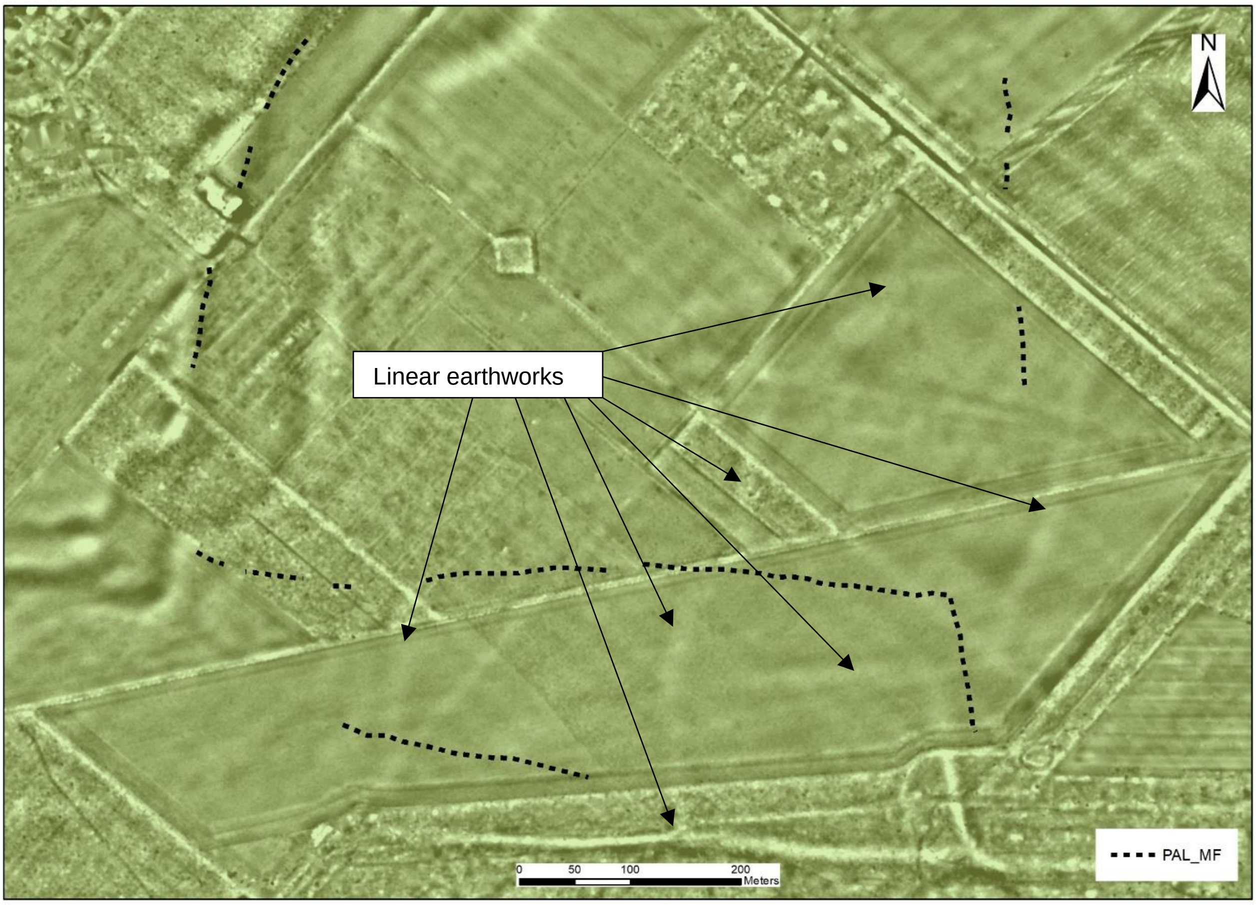

Figure 4.5 Pit alignments (PAL_MF) and earthworks of possible ancient boundaries at Ewart. (LRM performed on 1m DSM LiDAR data, Environment Agency 2018)

Both Harding and Miket (both 1981) conceded that the pit alignments in the Milfield Plain formed no coherent pattern; but the Redscar complex comprises two conjoining pit alignments that dissects a large gravel 'island' at right angles to form a large-scale partition of this area of land (Waddington 2009: 250); and the Ewart Park pit alignments bound a roughly rectangular area. Their significance depends on what scale these boundaries operated on. If they were used to separate single farming units, they would not necessarily give the appearance of a coaxial pattern; and it is here perhaps where the interpretation is flawed. Harding and Miket were perhaps looking for the large coaxial systems found further south, for example on the Salisbury Plain, in the evidence for pit alignments. The same mistake was made by this author when looking for similar large coaxial patterns in late Iron Age boundary systems associated with rectilinear enclosures. The purpose of pit alignments as territorial boundaries marking out large areas of land, as has been postulated in other studies mentioned above, is borne out in the results of slope direction conformity analysis. That the majority of the analysed units conform to within 30 degrees of underlying slope direction with far less conforming to within 20 degrees shows perhaps the need to conform to slope direction may have been practiced at a more regional scale, with the purpose of drainage not holding too much importance.

The general rather than close conformity to underlying slope direction may mark these examples out as fulfilling a similar function, using natural topography as a basis, but not conforming closely to it on a micro-scale, such as within 20 or 30 degrees of underlying slope direction for the whole length of an alignment. The earliest boundaries could therefore be extensions of natural divisions in the landscape, primarily rivers and streams but also ridges, outcrops and even changes in soils. The ritual dimension cannot be taken out of the equation though; and the symbolic importance of the lie of the land to prehistoric societies forms a link between the physical and meta-physical dimensions in which pit alignments were imagined, used and experienced.

4.2 Iron-Age/early Roman boundaries (ANC_BOU)

All analysed Iron Age and early Roman boundary units are taken from developer-funded excavations along the coastal plain. Excavations at East Wideopen and Pegswood provided the best evidence for enclosures; and Morley Hill Farm excavations produced evidence for external boundaries projecting from the settlement enclosures. Other examples are more fragmentary, such as West Shiremoor, where two short excavated stretches project from the rectilinear settlement enclosure. In most cases the analysed units are generally straight, with the sinuous ditch underlying the medieval village at Shotton being a notable exception. Some examples are very short, such as a ditch at North Seaton (5 metres); and two at Blagdon Park 2 (18 and 17 metres respectively). These are likely sections of much longer features which could not be explored further due to the constraints of developer-funded archaeology schemes. The settlement enclosures and projecting boundaries at Blagdon Park 2 and North Seaton were situated on ground which bore very little topographic variance at 50m resolution; and is thus represented in the aspect data with the value '-1’.

4.2.1 Orientations

Prefix ‘ANC_BOU1’.

- Overall length: 5726m

Orientation	Length (m)	% of dataset
ANC_BOU1_10_100	2709	47
ANC_BOU1_20_110	2344	41
ANC_BOU1_30_120	1389	24
ANC_BOU1_40_130	793	14
ANC_BOU1_50_140	668	12
ANC_BOU1_60_150	290	5
ANC_BOU1_70_160	426	7
ANC_BOU1_80_170	959	17
ANC_BOU1_0_90_180	1872	33

Table 4.3 Proportions of orientations for excavated ancient boundaries

Close to half of analysed ancient boundary units were oriented around 100 and 110 degrees. Units oriented at 30/120 degrees were fourth highest, which, as we will see from the results of other later features, shows that this orientation may have held more prominence in this period than others.

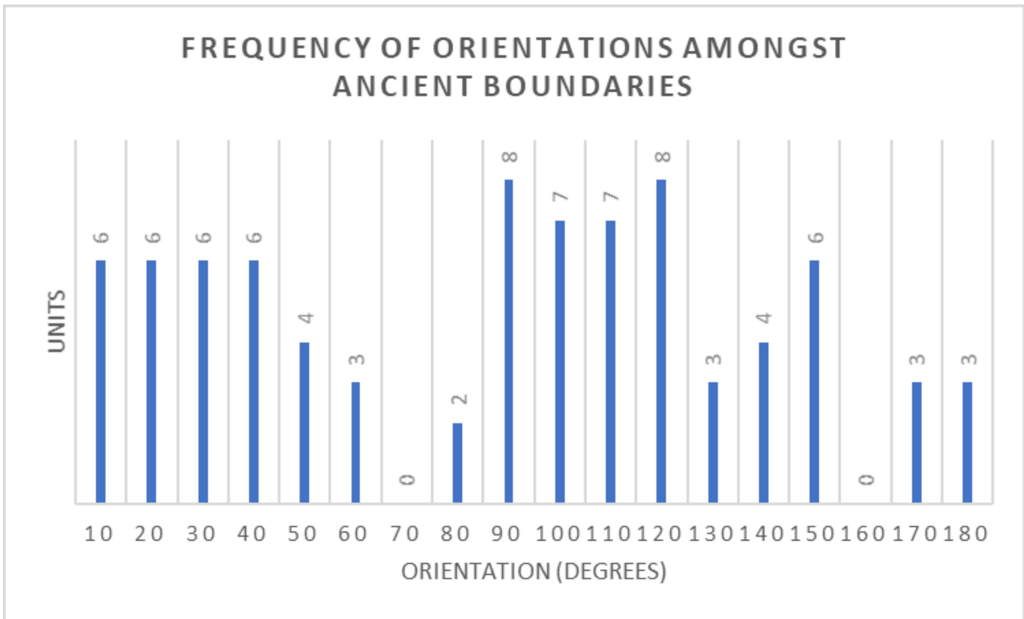

Figure 4.6 Ancient boundary orientation

4.2.2 Conformity to underlying slope direction

- ANC_BOU: 5727m
- ANC_BOU_con20: 2829m (49%)
- ANC_BOU_non20: 2898m (51%)
- ANC_BOU_con30: 4078m (71%)
- ANC_BOU_non30: 1648m (29%)

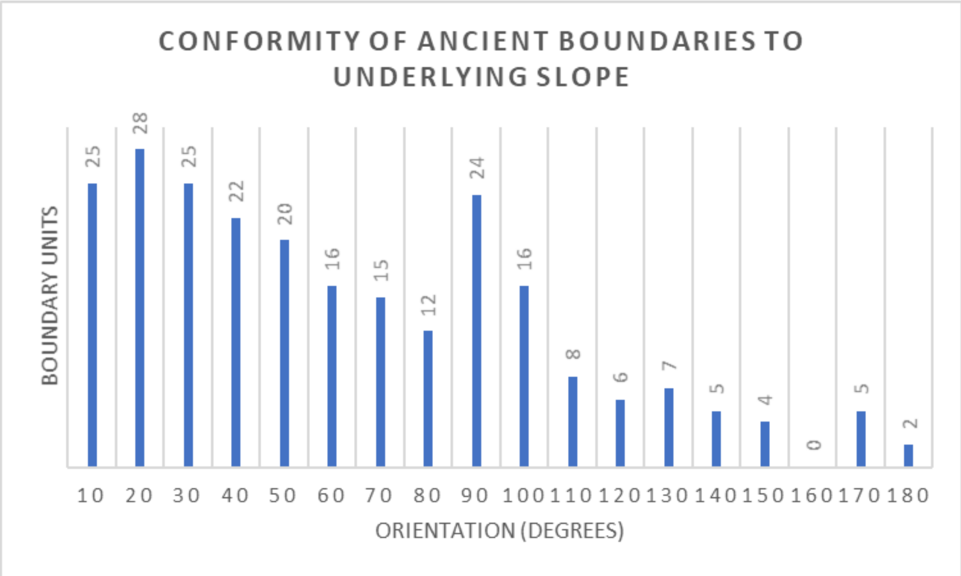

Figure 4.7 Levels of slope direction conformity amongst ancient boundaries

Whilst some ancient boundaries were found to wholly conform to within 20 degrees of underlying slope direction, such as much of the complex at East Wideopen, which can be seen in the case-study of this area later, most contained portions which both did, and did not, conform to within these thresholds. Some analysed sections were just outside the 20 degrees threshold, such as those at East Wideopen. In other cases, the distinction is more pronounced, such as the excavated ditches at West Shiremoor, with discrepancy values of 62, 48 and 52 degrees respectively: a long way from the 0 or 90 values representing conformity. A marked increase was found in the proportion of ancient boundaries which conform to ±30 degrees of underlying slope direction (71 percent compared to 49 percent of those which conformed to within 20 degrees). Almost the entire complex of ditches at East Wideopen fall within these parameters, along with large proportions of all analysed units within the dataset. Figures 4.8 and 4.9 illustrate these findings.

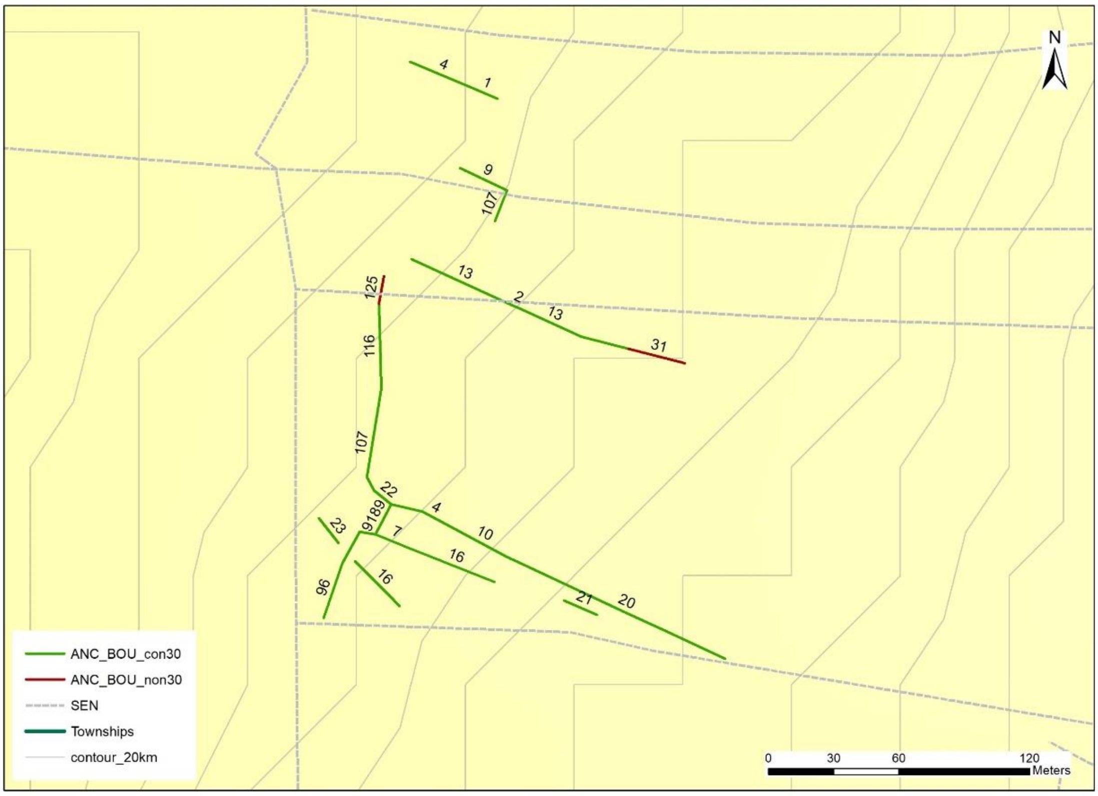

Figure 4.8 Levels of slope conformity amongst the ancient boundaries at East Wideopen

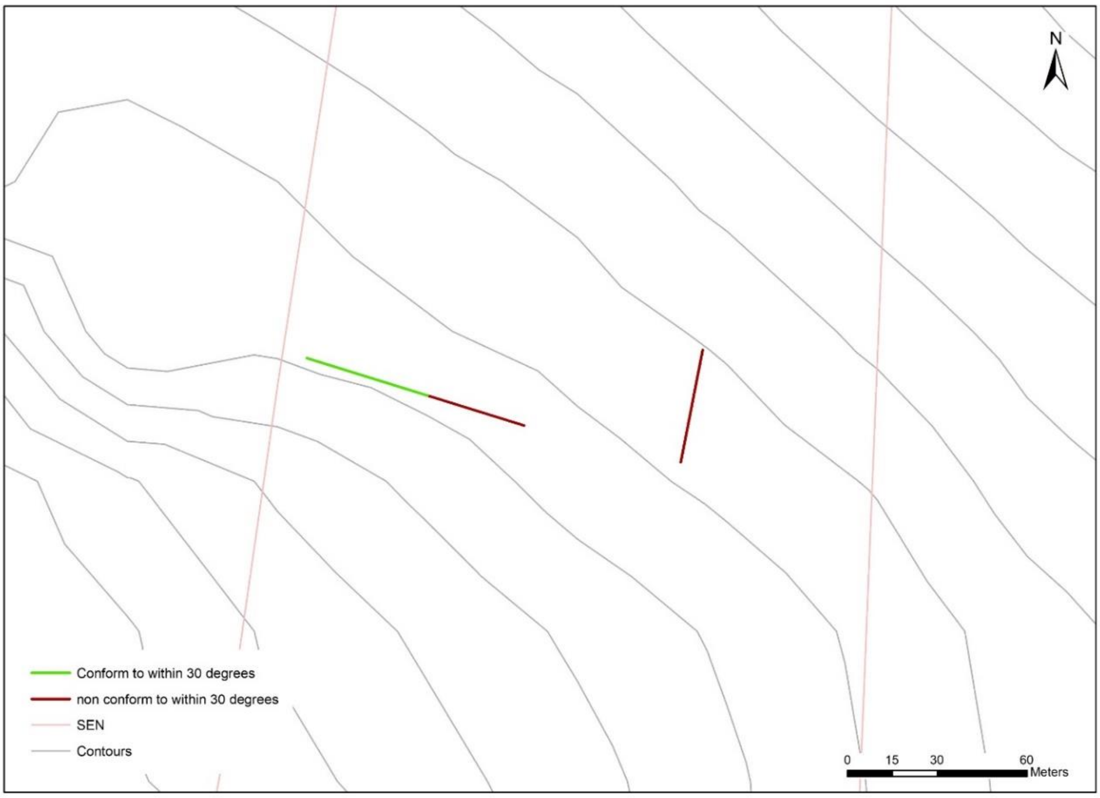

Figure 4.9 Levels of slope direction conformity at West Shiremoor

4.2.3 Comparing orientations and conformity to within 20 and 30 degrees of underlying slope direction

- ANC_BOU_10_100: 2426m
- ANC_BOU_10_100_con20: 1048m (43%)
- ANC_BOU_10_100_con30: 1490m (61%)
- ANC_BOU_10_100_non30: 936m (39%)
- ANC_BOU_30_120: 1582m
- ANC_BOU_30_120_con_20: 961m (61%)
- ANC_BOU_30_120_con_30: 1291m (82%)
- ANC_BOU_30_120_non_30: 292m (18%)

Forty percent of ancient boundaries are oriented at ±10 of 30 or 120 degrees; and forty-three percent at ±10 of 10 or 100 degrees conform to within 20 degrees of underlying slope direction. In both cases it can be assumed that conforming to underlying slope direction to this extent was probably not a key reason for how people at this time laid out their boundaries and route-ways. The levels of conformity to 30 degrees more than double for both analysed orientations.

4.2.4 Discussion

This dataset is confined to the low-lying coastal plain; and in most cases only short stretches of presumably larger boundary units excavated are currently available for analysis on a given site. In general, the most common orientation was 10/100 degrees, which is consistent with the most frequently occurring aspect values in the study area. There is, however, enough in the lengths of ditches at East Wideopen and Great Park which are oriented around 30/120 degrees to suggest this was the dominant axis for the layout of boundaries and route ways in these areas; however, these boundary systems also largely conform to within 30 degrees of underlying slope direction. The implications of these results will be further discussed in a later case-study.

4.3 Rectilinear settlement enclosures

Orientation analysis was undertaken on all known rectilinear settlement enclosures characterised according to the criteria set out in chapter 2. The dataset consists of settlements which have been excavated, those already known from aerial photographs; and those recently discovered through remote sensing analysis in the current research. The orientation of rectilinear settlement enclosures will be presented as whole units rather than length, as unlike most other linear features studied here, in almost all cases we know their full extent.

4.3.1 Orientations (file prefix RECT1)

Orientation	Units	% of dataset
RECT1_10_100	73	31
RECT1_20_110	49	21
RECT1_30_120	26	11
RECT1_40_130	13	6
RECT1_50_140	13	6
RECT1_60_150	36	15
RECT1_70_160	73	31
RECT1_80_170	98	42
RECT1_0_90_180	96	38

Table 4.4 Proportions of orientations present in rectilinear settlement enclosures

The most frequently occurring orientations amongst rectilinear settlement enclosures are between 80 and 100 degrees, shown in table 4.4. Ten percent are oriented within 10 degrees of 30/120 degrees. This is surprisingly low considering the prevalence of south-east facing entrances on associated roundhouses in this region and beyond (Hodgson *et al.* 2012: 201-203; Parker-Pearson and Richards 1994); and the relatively high proportions of ancient boundaries in the current study area. Figure 4.10 shows the absence of enclosures oriented around 30/120 degrees in the central portion of the study area.

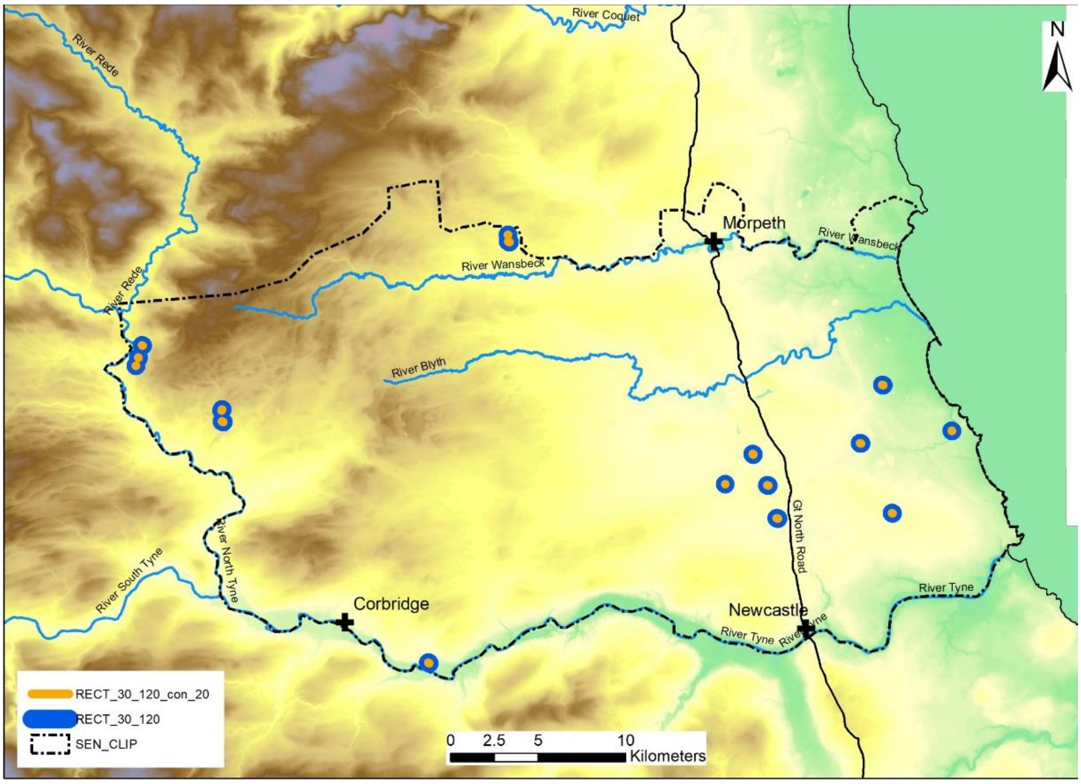

Figure 4.10 Distribution of rectilinear settlement enclosures oriented around 30 or 120 degrees, and levels of slope conformity (50m DTM downloaded from Edina Digimap, 2017)

4.3.2 Conformity to underlying slope direction (file prefix RECT)

- RECT: 16821m
- RECT_con20: 7291m (43%)
- RECT_non20: 9529m (57%)
- RECT_con30: 11552m (69%)
- RECT_non30: 5268m (31%)

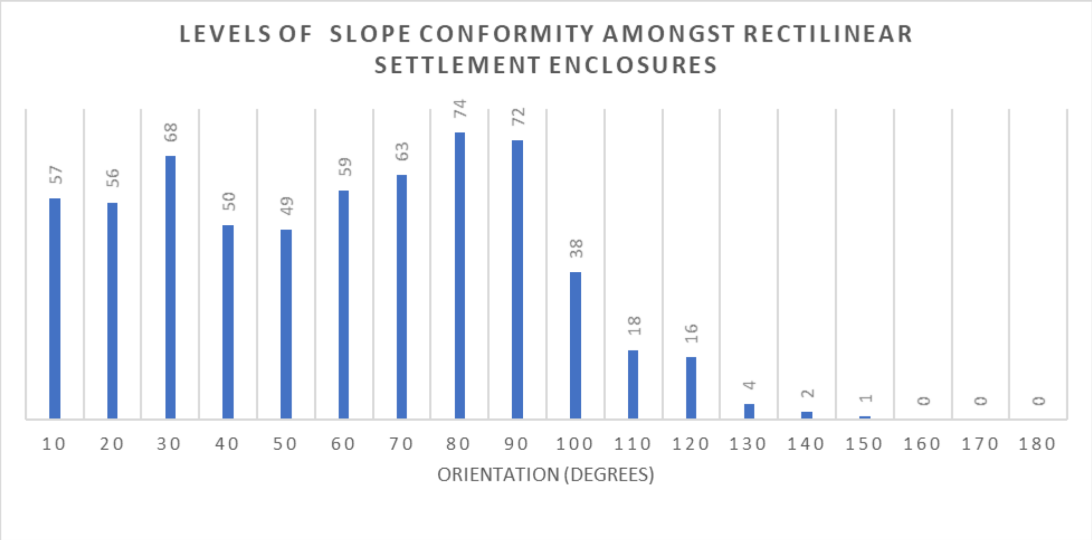

Figure 4.11 Slope direction conformity amongst rectilinear settlement enclosures

The results show a tendency to non-conformity to within 20 degrees of underlying slope direction, with fifty-seven percent falling within this threshold. Sixty-nine percent conform to within 30 degrees of underlying slope direction. Whilst most rectilinear settlement enclosures contain conforming and non-conforming parts to within 20 degrees of underlying slope direction as they traverse more than one aspect raster tile, there are examples of complete conformity and non-conformity, such as at Holywell Grange Farm, where HER 745 completely conforms; and the nearby N12029 does not at all (see Figure 4.12) Most rectilinear settlement enclosures do conform to within 30 degrees of underlying slope direction, however, which is illustrated in Figure 4.13.

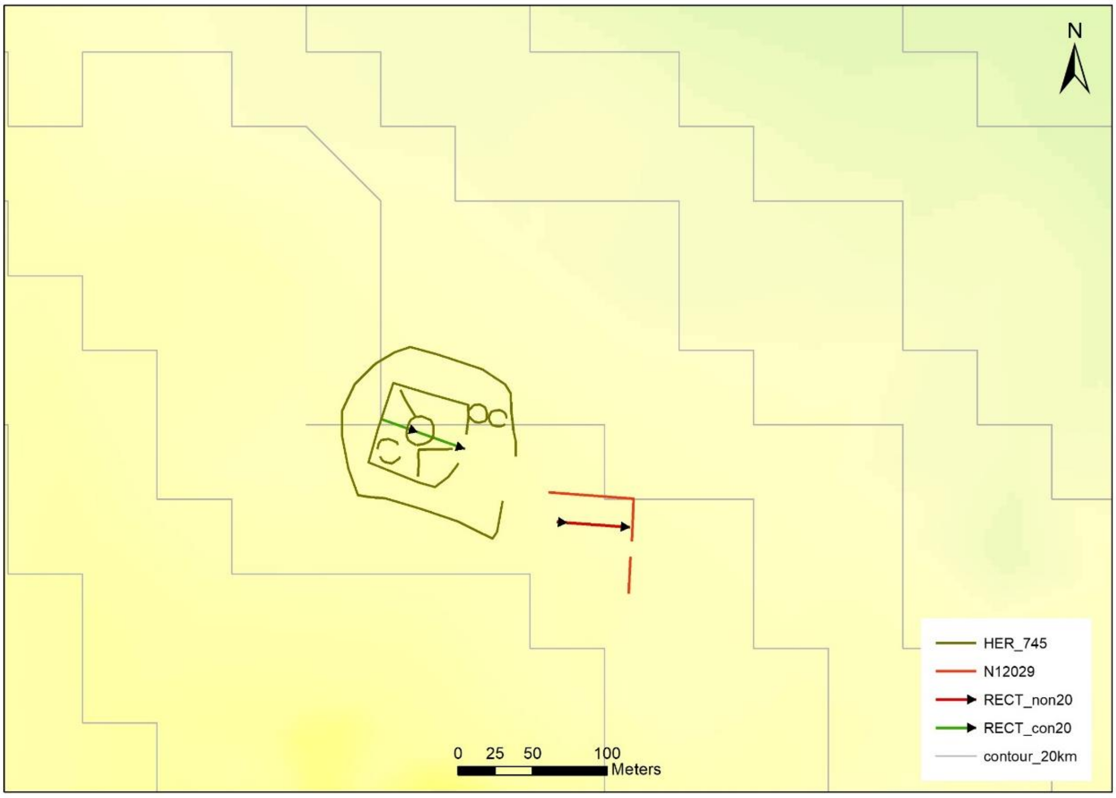

Figure 4.12 Levels of slope direction conformity at Holywell Grange Farm

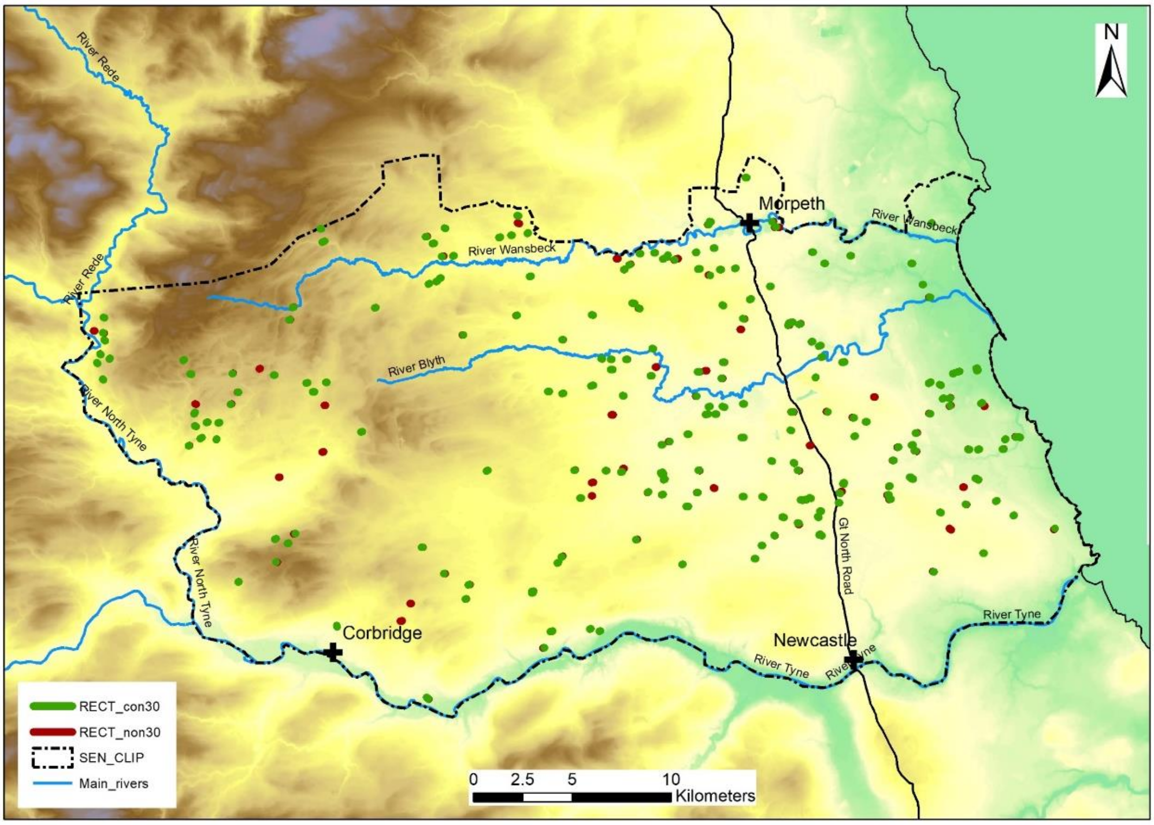

Figure 4.13 Distribution of rectilinear settlement enclosures highlighting slope direction conformity to within 30 degrees

4.3.3 Comparing orientations and conformity to underlying slope direction

- RECT_30_120: 1978m
- RECT_30_120_con20: 833m (42%)
- RECT_30_120_con30: 1370m (69%)
- RECT_80_170: 7065m
- RECT_80_170_con20: 2740m (39%)
- RECT_80_170_con30: 4779 (68%)

Forty-two percent of the total length of rectilinear settlements which are oriented ±10 degrees of 80/170 degrees conform to within 20 degrees of underlying slope direction; and for those around 30/120 degrees number thirty-nine percent. These results do not imply that a given orientation was chosen to closely conform to underlying slope direction at this extent at least. Applying a 30 degrees threshold unsurprisingly reveals a higher proportion of conformity, in line with most other linear features analysed in the current study.

4.3.4 Discussion

That only 43 percent of enclosure units conformed to within 20 degrees of underlying slope direction implies that drainage was perhaps not as big an issue as was assumed at the outset of this study. On the other hand, large proportions conform to within 30 degrees in the same way as features across the area and time period; and is further evidence that this extent was deemed adequate for a drainage purpose, if it was considered in the first place. Most of the analysed enclosures are situated along the relatively flat eastern coastal plain, although many sites, for example Spital Hill and Morley Hill farm, the topography is quite pronounced, suggesting that crests of hills were specifically chosen for settlements.

If at least some Iron Age settlements endured beyond the late second century AD, evidence for which has been recovered at St George’s Hospital (ARS 2016), it is useful to explore some of the morphological characteristics of this ubiquitous settlement form in the region. Looking beyond the basic characterisation of ‘rectilinear’, groupings sharing specific morphology and orientation can be extracted; it is in these smaller characterisations that inferences surrounding possible chronological trajectories can be made. Those north and south of the river Wansbeck are a good example of this. South of the river, in the Tranwell and Saltwick area, enclosures are very regular in shape, often with a large ‘D’ shaped outer enclosure. This regularity is mirrored at Waddle Bank, but without the ‘D’ shaped enclosure. Just north of the river, within 700m of Waddle Bank, the settlement at St George’s Hospital is very different in plan, although could still be classed as rectilinear in shape. North Seaton, also just north of the Wansbeck, is, however, very similar in proportions to settlement enclosures south of the river and towards the Tyne. Characterising sites as one thing can be unhelpful, as many sites went through a series of developments, both open and unenclosed (Hazelgrove 2002: 57-59), such as West Brandon (Jobey 1962) and many excavated examples in the current study area. Enclosures with two ditches have raised problems concerning whether they are native settlement sites or Roman military installations (McCord and Jobey 1968: 52-53).

The newly discovered enclosure at Harestane Burn 1 (NZ 15725 84574) has very regular double ditches; and is orientated at three degrees, contrasting with nearby settlement enclosures which are oriented between 60 and 80 degrees (see Figure 4.14). Conformity to underlying slope direction could be the reason for this distinction, as they all conform to within 30 degrees. Harestane Burn 1, with its regularly spaced two-ditch circuit with rounded corners, is therefore of special interest and warrants further detailed study, preferably through excavation as it could hold clues as to what was happening in the region during the Roman period. These results will be discussed in more detail later in relation to possible symbolic alignments; and on a more pragmatic scale, protection from prevailing winds, which may be reflected in associated internal dwellings.

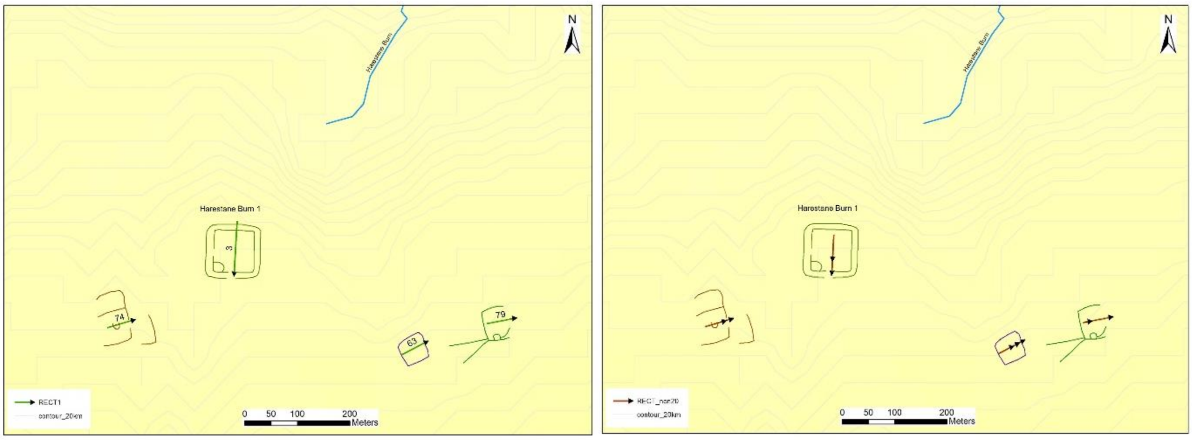

Figure 4.14 Rectilinear settlement enclosures close to the Harestane Burn, showing orientations (left) and levels of slope conformity (right)

4.4 Orientation of dated early medieval boundary ditches (EMB)

Like pit alignments, evidence for early medieval boundaries or route-ways is sparse in the region, with only three available for analysis: at Fox Covert and Shotton (both covered in more detail in later case studies) on the coastal plain; and at Fairnley (NZ 00004 88842) in the north-west of the study area. This scarcity is echoed beyond the study area, with evidence for both settlement and land-use disproportionately low compared with that of periods either side of these chronological parameters. Nevertheless, the ditch at Fox Covert and the bank at Fairnley have been scientifically dated; and the double ditches thought to represent a trackway at Shotton were dated through sharing a common alignment with an excavated and dated Anglo-Saxon settlement. The disproportionate amount of evidence in this dataset will be taken into consideration in any discussions.

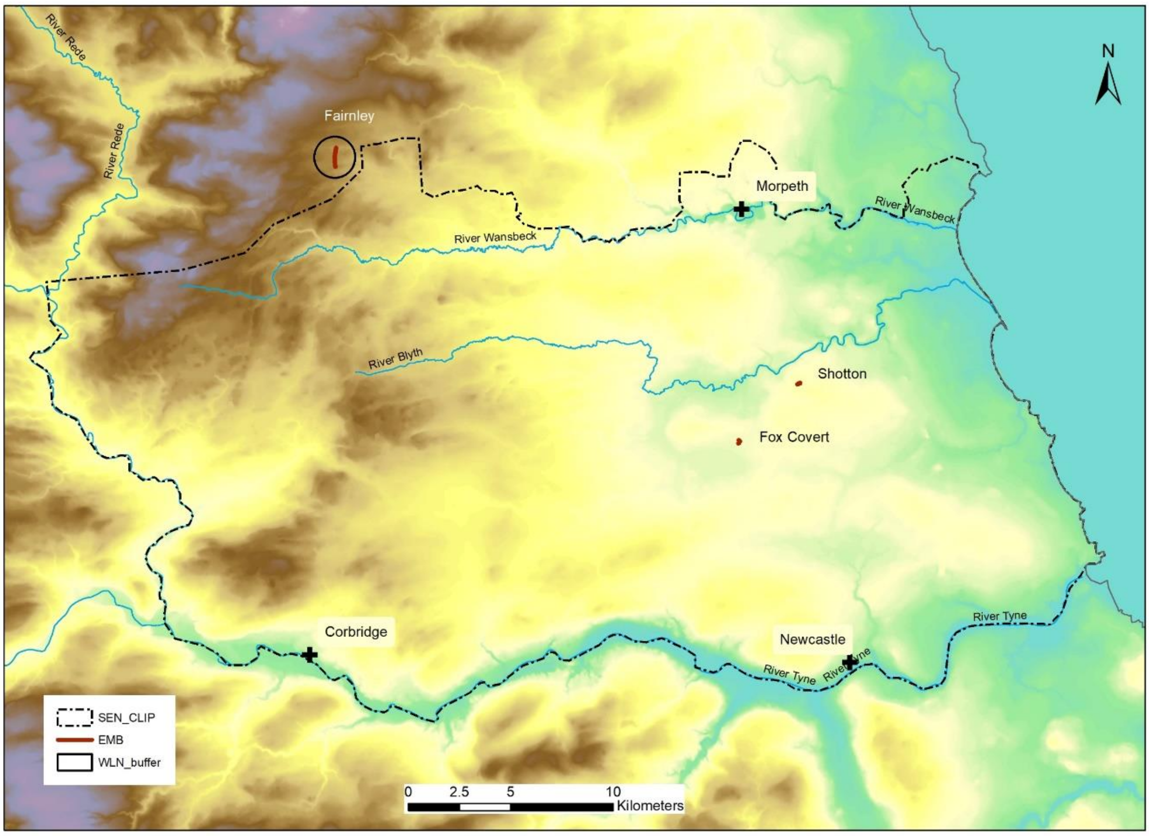

Figure 4.15 Locations of early medieval boundaries analysed within the current study area (50m DTM downloaded from Edina Digimap, 2017)

The section of ditch at Fox Covert was discovered during the same excavations as the previously mentioned pit alignment. It was dated to the tenth-eleventh century through radiocarbon dating of a pig's jawbone found in the primary fill of the ditch

(TWM 2007: 2-3). This dates the ditch to at least the very end of the early medieval period, but importantly, the ditch pre-dates the first documented and archaeological evidence for nucleated medieval villages in the region; and may represent evidence for land-use within one of the chronological ‘gaps’ this research seeks to explore. Excavation was extended to the west of the ditch, but no further features were identified. The pig skull showed signs of butchering marks, suggesting it was domestic waste, so settlement activity could have been present in the area.

The double-ditched probable drove-way associated with the early medieval enclosed settlement at Shotton produced eleventh or twelfth century from a sample high in the fill of one of the parallel ditches, which was thought to be from later intrusive material (Muncaster *et al.* 2014: 117-118). The feature could therefore be earlier or later than the settlement based on this evidence; but was deemed to be contemporary with the enclosed early medieval settlement based on proximity and similar orientation (Muncaster *et al.* 2014).

An earthwork boundary at Fairnley, has recently been dated through OSL methods to the fifth century. It is the only example of a post-Roman or early medieval boundary in the western portion of the study area (Vervust *et al.* 2020). The discovery of this came to the author’s attention late in the research and lies just beyond the study area; but it was deemed a necessary addition to bolster a very small dataset. The dating for this feature is rather vague due to the high variance either side of the 450 AD date; however, it does imply that the feature was constructed and in use sometime in the first millennium AD. This might sound like a huge chronological parameter, but there is so little evidence of settlement and land-use in this period that the feature had to be included in the analysis.

4.4.1 Orientations (file prefix EMB1)

- EMB1 total length: 1283m

Orientation	Length (m)	% of dataset
EMB1_10_100	481	37
EMB1_20_110	69	5
EMB1_30_120	145	11
EMB1_40_130	76	6
EMB1_50_140	73	6
EMB1_60_150	213	17
EMB1_70_160	140	11
EMB1_80_170	445	35
EMB1_0_90_180	926	72

Table 4.5 Proportions of orientation for early medieval boundaries and tracks

The results in Table 4.5 show that most analysed boundary units dated to the early medieval period are oriented close to cardinal points; and conversely only a tiny proportion of boundaries are oriented close to 30 or 120 degrees. The main factor influencing these results is that the boundary bank oriented around 0 degrees at Fairnley comprised a large proportion of the data, highlighting the pitfalls of a small dataset.

4.4.2 Conformity to underlying slope direction

- EMB: 1283m
- EMB_con20: 622m (48%)
- EMB_non20: 660m (52%)
- EMB_con30: 1003m (78%)
- EMB_non30: 280m (22%)

Forty-eight percent of analysed early medieval boundary units are oriented to within 20 degrees of underlying slope direction. This is a relatively low proportion compared with other analysed features. Conversely, seventy-eight percent of analysed units conform to within 30 degrees. The small dataset should again be acknowledged; and the possibility that the figures could change dramatically with more data.

4.4.3 Comparing orientations and conformity to within 20 or 30 degrees of underlying slope direction

- EMB_0_90_180: 682m
- EMB_0_90_180_con20: 396m (63%)
- EMB_0_90_180_con30: 563m (83%)
- EMB_0_90_180_non30: 119m (17%)
- EMB_30_120: 145m
- EMB_30_120_con20: 3m (0.5%)
- EMB_30_120_con30: 106m (73%)
- EMB_30_120_non30: 39m (27%)

Of the values conforming to within 20 degrees of underlying slope direction, 0.5 percent were oriented at ±10 of 30 or 120 degrees, compared with sixty three percent of those oriented at ±10 of cardinal points. The very small portion oriented around 30/120 degrees sits within the excavated ditch at Fox Covert and is of negligible value. Conversely, the whole length oriented around 30 or 120 which does not conform to within 20 degrees of underlying slope direction is also part of the boundary at Fox Covert. These results are illustrated in Figure 4.16.

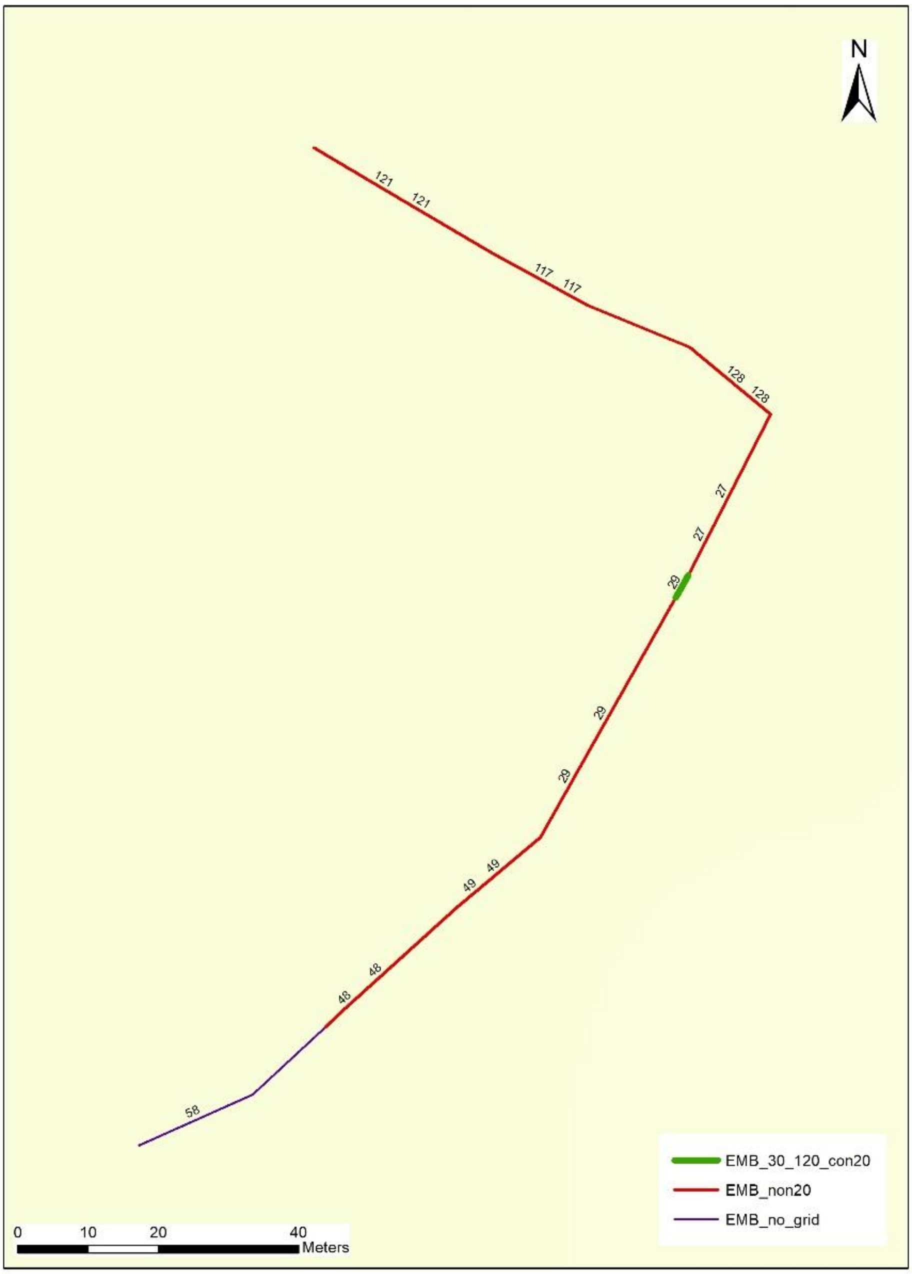

Figure 4.16 Levels of conformity to underlying slope direction for the early medieval ditch at Fox Covert

For those units conforming to within 30 degrees of underlying slope direction, eighty-three percent were oriented at ±10 of 0, 90 or 180 degrees; and seventy-three percent oriented at ±10 of 30 or 120 degrees. The former figure is comparatively higher; and refers almost wholly to the boundary bank at Fairnley.

- EMB_non20: 660m
- EMB_0_90_180_non20: 285m (43%)
- EMB_30_120_non20: 140m (21%)

Of the values which do not conform to within 20 degrees of underlying slope direction, twenty one percent were oriented at ±10 of 30 or 120 degrees, compared with 43 percent which are oriented ±10 of cardinal points. At Fairnley (prefix: WLN), Figure 4.17 shows the units oriented around cardinal points which conform to within 20 degrees of underlying slope direction.

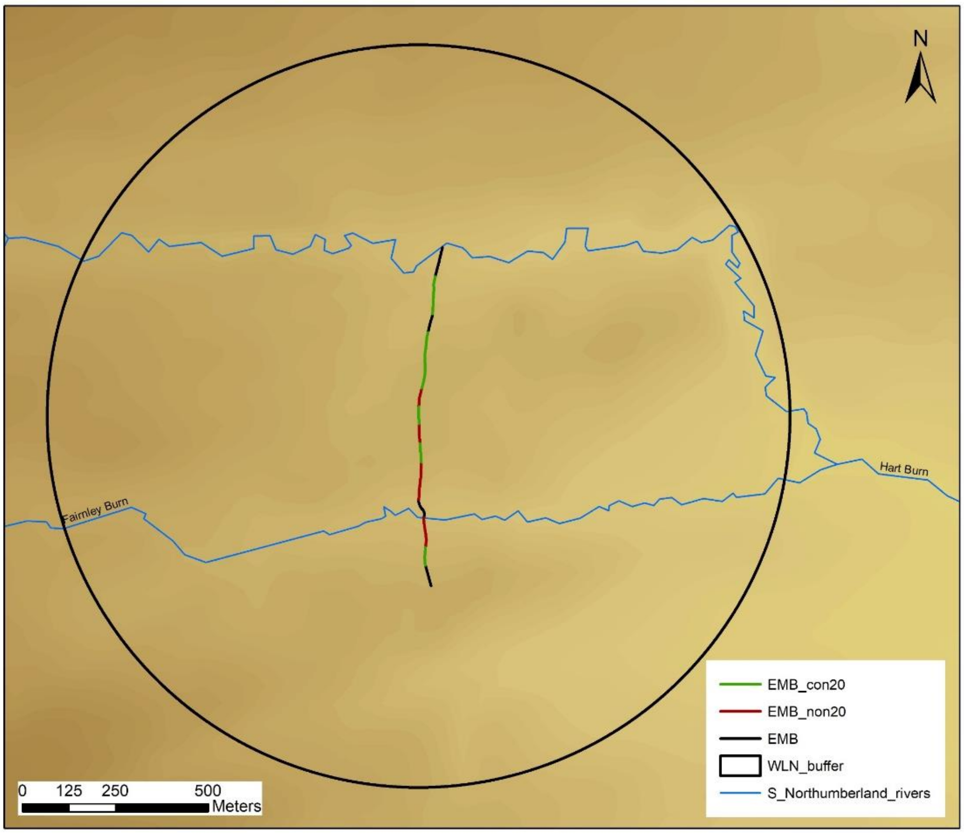

Figure 4.17 Levels of conformity to underlying slope direction for the 1st millennium dated bank at Fairnley, Wallington (50m DTM downloaded from Edina Digimap, 2017)

4.4.4 Discussion

Results from this small dataset are useful to a degree; but cannot give us any indication of orientation trends across the study are compared with other better represented features. The small size of the dataset does not allow any interpretations to be made other than there is a tendency to non-conformity to within 20 degrees of underlying slope direction; and high conformity to within 30 degrees. The real value of this data and the results will be shown in the case-studies, where their orientations and levels of conformity to underlying slope direction can be compared with nearby features dating to different periods within discrete areas.

4.5 Medieval nucleated village orientation (MNV)

Medieval nucleated villages are fairly evenly distributed across the study area, as is shown in Figure 4.18.

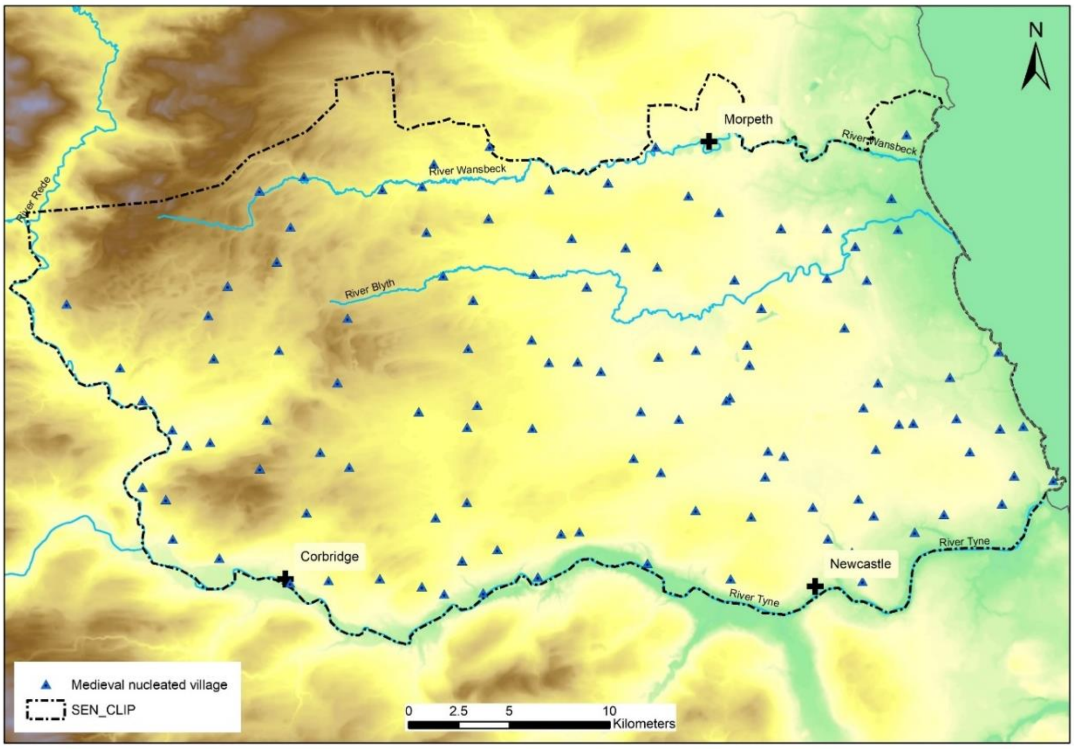

Figure 4.18 Distribution of analysed medieval nucleated village units within the current study area (50m DTM downloaded from Edina Digimap, 2017)

4.5.1 General orientation

- Total length 29826m

Orientation	Units	% of dataset
MNV1_10_100	28	24
MNV1_20_110	15	13
MNV1_30_120	4	3
MNV1_40_130	6	5
MNV1_50_140	18	15
MNV1_60_150	31	26
MNV1_70_160	48	41
MNV1_80_170	52	44
MNV1_0_90_180	34	29

Table 4.6 Proportions of orientations amongst medieval nucleated villages

As table 4.6 shows, medieval nucleated villages are most commonly oriented around 80/170 degrees. Those oriented around 70/160 degrees comprise the second highest amount; whilst 30/120 degrees represents just four percent of the total dataset.

4.5.2 Conformity to underlying slope direction

- MNV: 29827m
- MNV_con20: 14534m (49%)
- MNV_non20: 15292m (51%)
- MNV_con30: 21334m (72%)
- MNV_non30: 84493m (28%)

Most medieval nucleated villages comprise parts that both do, and do not conform to within 20 degrees of underlying slope direction, a pattern which can be seen throughout the study area and in other features. Following a familiar pattern to other features analysed in the current study, 72 percent conform to within 30 degrees of underlying slope direction.

4.5.3 Comparing orientations and conformity to within 20 degrees of underlying slope direction

- MNV_80_170: 13170m
- MNV_80_170_con20: 6713m (51%)
- MNV_80_170_non20: 6457m (49%)
- MNV_80_170_con30: 9268m (70%)
- MNV_80_170_non30: 3902m (30%)
- MNV_30_120: 862m
- MNV_30_120_con20: 390m (45%)
- MNV_30_120_non20: 472m (55%)
- MNV_30_120_con30: 511m (59%)
- MNV_30_120_non30: 351m (41%)

Of the medieval villages oriented around 80/170 degrees, only five out of 52 do not contain at least a portion which conforms to within 20 degrees of underlying slope direction (see Figure 4.19); and seventy percent of analysed units conform to within 30 degrees of underlying slope direction. Of the four villages oriented within ±10 of 30 or 120 degrees, fifty-one percent of analysed units conform to within 20 degrees of underlying slope direction; whilst fifty-nine percent conform to within 30 degrees.

This latter figure is low compared to other features in the dataset; however, with only four village units oriented in this way, it is difficult to take it as meaningful.

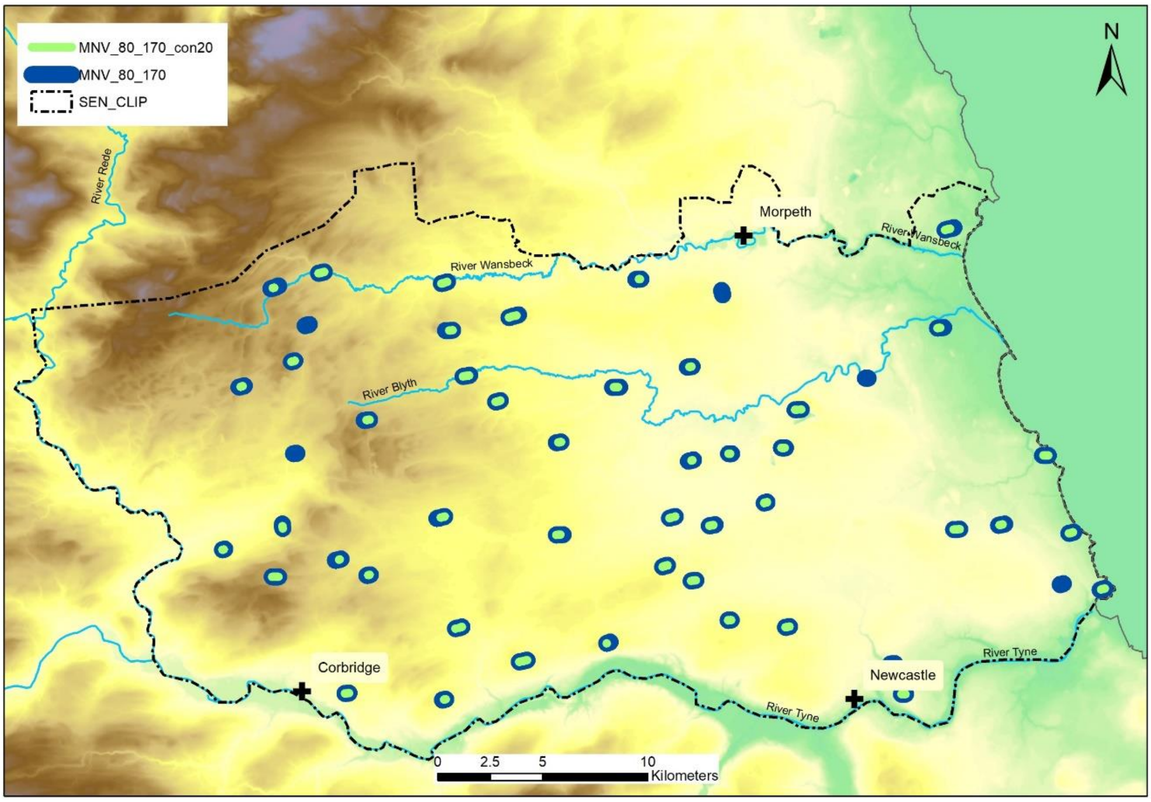

Figure 4.19 Medieval nucleated villages oriented around 80 or 170 degrees which also conform to within 20 degrees of underlying slope (50m DTM downloaded from Edina Digimap, 2017)

4.5.4 Discussion

As Figure 4.19 shows, the majority of medieval village orientations cluster around 80/170 degrees, which is also common to many other features analysed in the current study. Villages oriented around these parameters occur throughout the region, in most cases located amid similarly oriented boundaries and tracks present by the nineteenth century, shown in Figure 4.20. These results lead us to consider the possibility of either a common requirement to conform to within a certain extent of underlying slope direction underpinning their planned layout, or that they were inserted into a pre-existing network of routeways and boundaries which were oriented the same way. If both hypotheses were simultaneously correct, which is plausible, it could suggest that the pre-existing linear units were also positioned with conformity to the grain of slope in mind. There is again a significant jump in numbers conforming to underlying slope direction between 20-and 30 degrees thresholds. We should therefore be asking how important conformity to underlying slope direction was to the layout of a medieval nucleated village, especially in comparison with surrounding open-field furlongs, features which will now be addressed. When considering the constituent parts of a village, the toft, main road and back lane and in some cases a green, these would all benefit from a degree of drainage which would have been more effective through careful alignment to the grain of slope. That some parts may not conform could be due to their status in the village, with possibly the manor and its curtilage having greater conformity to slope direction; and as the village overall took on a straight linear layout, some plots of lower status may not have been established on areas which conformed to underlying slope direction.

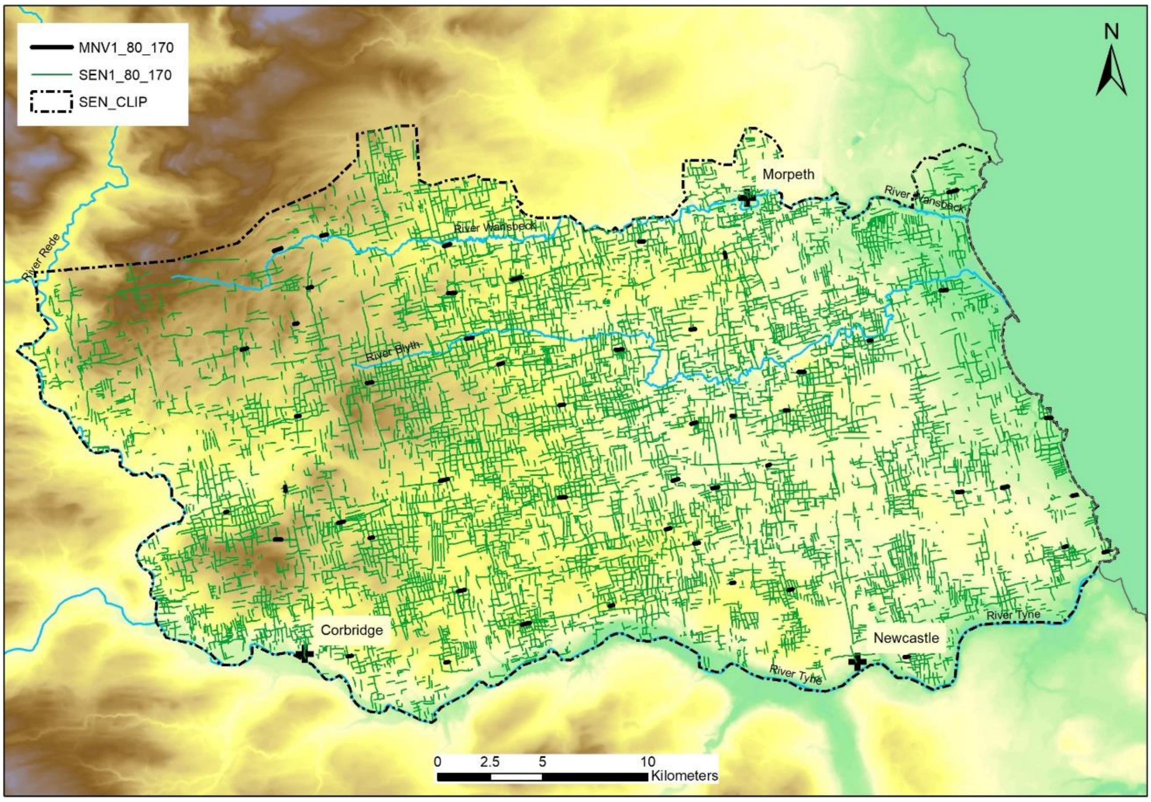

Figure 4.20 Medieval nucleated villages and 1st edition Ordnance Survey boundaries and tracks which are oriented around 80 or 170 degrees (50m DTM downloaded from Edina Digimap, 2017)

4.6 Medieval ridge and furrow (MRF)

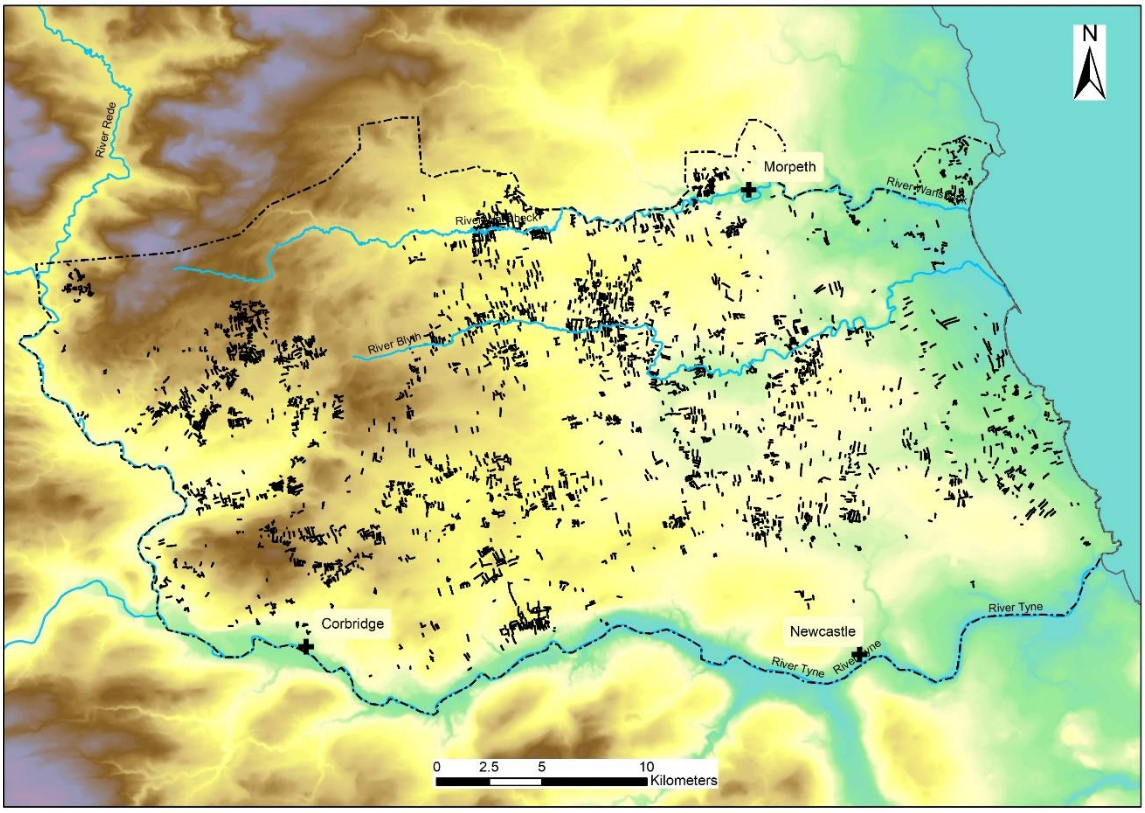

Figure 4.21 Distribution of analysed medieval ridge and furrow (50m DTM downloaded from Edina Digimap, 2017)

Single selions were transcribed to represent the general orientation of furlongs where they could be discerned. This maintained consistency in a feature type of great variance due to both nature of medieval furlong layouts and the quality and quantity of evidence across the region. The morphology of selions and furlongs is linear, but sinuous due to the reverse 'S' shape, so the 'split' data used to compare orientation with underlying slope direction was analysed rather than the full line, as using the latter would not be representative of the feature. These results are presented with the prefix 'MRFa'.

4.6.1 Orientations

MRFa total length: 581838m

Orientation	Length (m)	Percentage
MRFa_10_100	114581	20
MRFa_20_110	57622	10
MRFa_30_120	38875	7
MRFa_40_130	47949	8
MRFa_50_140	79937	14
MRFa_60_150	142538	24
MRFa_70_160	225452	39
MRFa_80_170	256850	44
MRFa_0_90_180	292139	50

Table 4.7 Proportions of orientations amongst medieval ridge and furrow units

Table 4.7 shows that the highest proportion (50%) of medieval ridge and furrow is oriented around the cardinal points, with 80/170 degrees also well represented in the data. Only seven percent is oriented around 30/120 degrees; and is the least well represented orientation in the dataset.

4.6.2 Conformity with underlying slope direction

- MRFa_180: 581838m
- MRFa_con20: 291043m (50%)
- MRFa_non20: 290795m (50%)
- MRFa_con30: 411555m (70%)
- MRFa_non30: 170283m (30%)

These results are consistent with most other analysed features in this study, with a 50-50 split for a 20 degrees threshold; and 70-30 split in favour of conformity to within 30 degrees of underlying slope direction. There are no discernible distribution patterns for either threshold when viewed regionally; but a closer look at some of the areas with multiple directions will be addressed below.

4.6.3 Comparing orientations and conformity to within 20 and 30 degrees of underlying slope direction

- MRFa_0_90_180: 292139m
- MRFa_0_90_180_con20: 144790m (50%)
- MRFa_0_90_180_non20: 147349m (50%)
- MRFa_0_90_180_con30: 203552m (70%)
- MRFa_0_90_180_non30: 88587m (30%)
- MRFa_30_120: 38875m
- MRFa_30_120_con_20: 20603m (53%)
- MRFa_30_120_non_20: 18272m (47%)
- MRFa_30_120_con30: 28976m (74%)
- MRFa_30_120_non_30: 9899m (26%)

The results show that within a 20 degrees threshold the prevalent orientation around cardinal points cannot be explained through this degree of conformity to underlying slope direction. Using a 30 degrees threshold shows seventy percent conformity for this data, once again consistent with other analysed features. The 30/120 degrees data shows similar results, but with such a small dataset they cannot be interpreted as indicative of any trend, apart from the fact that they do conform in similar proportions to the dominant orientations. This does suggest that where 30/120 degrees was used to lay out furlongs, it was to respect underlying slope direction.

4.6.4 Discussion

Although this is a large dataset, consisting of almost 600,000 metres of transcribed units spread across the study area, there are still large areas which have not been analysed due to the time constraints of the current study. There could, therefore, be evidence not yet analysed in the region which could change the composition of these results, but the similar prevalence of orientation around 80/170 and 90/180 degrees in medieval nucleated villages entails that the trends present in these results are representative of the region as a whole. Spatial trends of conformity to underlying slope direction are difficult to discern for these features; and perhaps surprisingly in the upland zone of the study area there is less conformity to underlying slope direction than further east in the lowlands. Many factors could explain this, for example the soil types and their permeability and susceptibility to drainage. These issues will be discussed further in the case-studies and overall discussion.

4.7 Post-medieval ridge and furrow (PMRF)

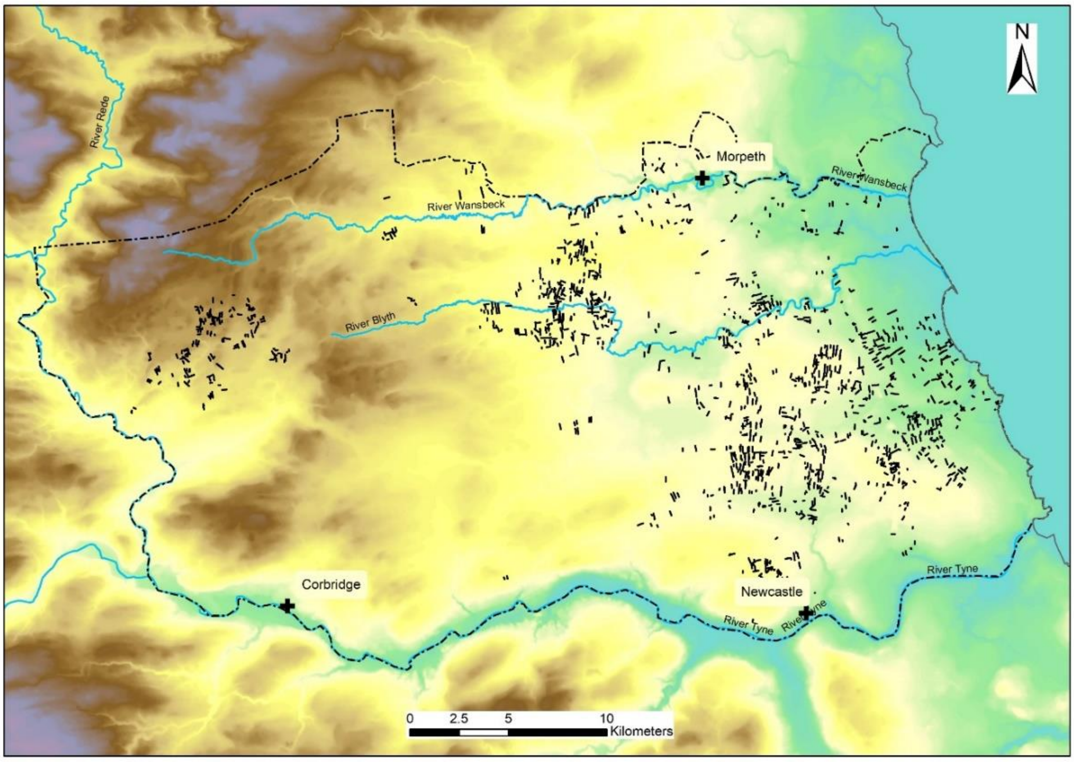

Figure 4.22 Distibution of analysed post-medieval ridge and furrow units (50m DTM downloaded from Edina Digimap, 2017)

Evidence for post-medieval ridge and furrow was transcribed in roughly the same areas as those containing evidence of medieval ridge and furrow to maintain consistency in the comparative process, although the dataset is smaller due to time constraints in the project. The distribution of analysed units is shown in Figure 4.22.

4.7.1 Orientations

File prefix ‘PMRF1’

Total length: 232748m

Orientation	Length (m)	Percentage
PMRF1_10_100	67158	29
PMRF1_20_110	31240	13
PMRF1_30_120	16149	7
PMRF1_40_130	16410	7
PMRF1_50_140	23065	10
PMRF1_60_150	39124	17
PMRF1_70_160	65854	29
PMRF1_80_170	101891	44
PMRF1_0_90_180	104601	45

Table 4.8 Proportions of orientations for post-medieval ridge and furrow

Table 4.8 shows that the greatest proportion of post-medieval ridge and furrow is oriented around the cardinal points and 80/170 degrees. Only seven percent is oriented at 30/120 degrees, the joint lowest parameter for this feature type.

4.7.2 Conformity to underlying slope direction

- PMRF: 232748m
- PMRF_con20: 116419m (50%)
- PMRF_non20: 116329m (50%)
- PMRF_con30: 163266m (70%)
- PMRF_non30: 69481m (30%)

The results of conformity to slope direction analysis are once again consistent with other features across the region, with a fifty-fifty split for the twenty degrees threshold; and a seventy-thirty split in favour of those conforming to within 30 degrees of underlying slope direction. Looking more closely at the data, taking Horton township for example, a high percentage of post-medieval ridge and furrow which conforms to within 20 degrees of underlying slope direction, which closely correlates with the boundaries and routeways present on 1st edition Ordnance Survey mapping data. Evidence in Horton township will be addressed further in later chapters.

4.7.3 Comparing orientations with conformity to within 20 degrees of underlying slope direction

- PMRF_80_170: 101891m
- PMRF_80_170_con_20: 50928m (50%)
- PMRF_80_170_non20: 50963m (50%)
- PMRF_80_170_con30: 70528m (69%)
- PMRF_80_170_non30: 31363m (31%)
- PMRF_30_120: 16149m
- PMRF_30_120_con_20: 7328 (45%)
- PMRF_30_120_non_20: 8821m (55%)
- PMRF_30_120_con_30: 11514m (71%)
- PMRF_30_120_non30: 4636m (29%)

Both sets of results suggest that the choice of a specific orientation could have been influenced by natural topographic conditions; however, proportionately less units oriented to within 10 degrees of 30 or 120 degrees conform to within 20 degrees of underlying slope direction than the numbers for 80 or 170 degrees.

4.7.4 Discussion

These results show that by the medieval period, any trend, if there ever was one, towards orienting settlement and land-use features to 30/120 degrees had all but disappeared; this is further confirmed by post-medieval ridge and furrow evidence. It can also be shown that analysed units of ridge and furrow oriented around the cardinal points increases from the medieval period into the post-medieval, from thirty-three to forty-five percent.

There is no more conformity to slope direction in the western uplands than along the coastal plain in the east. This could be due to the permeability of certain soils in the uplands rather than a disregard for the more pronounced terrain. The five-percent difference in proportions of conformity to within 20 degrees of underlying slope direction across the study area between medieval ridge and furrow (50%) and post medieval ridge and furrow (45%) is small, but possibly significant. It could represent a reduced need to respect natural topographic conditions when laying out ridge and furrow in the post-medieval period, perhaps due to improved techniques and under-drainage, which brought otherwise unusable tracts of land under arable cultivation.

4.8 Orientation of boundaries and tracks depicted on 1st edition Ordnance Survey map (file prefix: SEN)

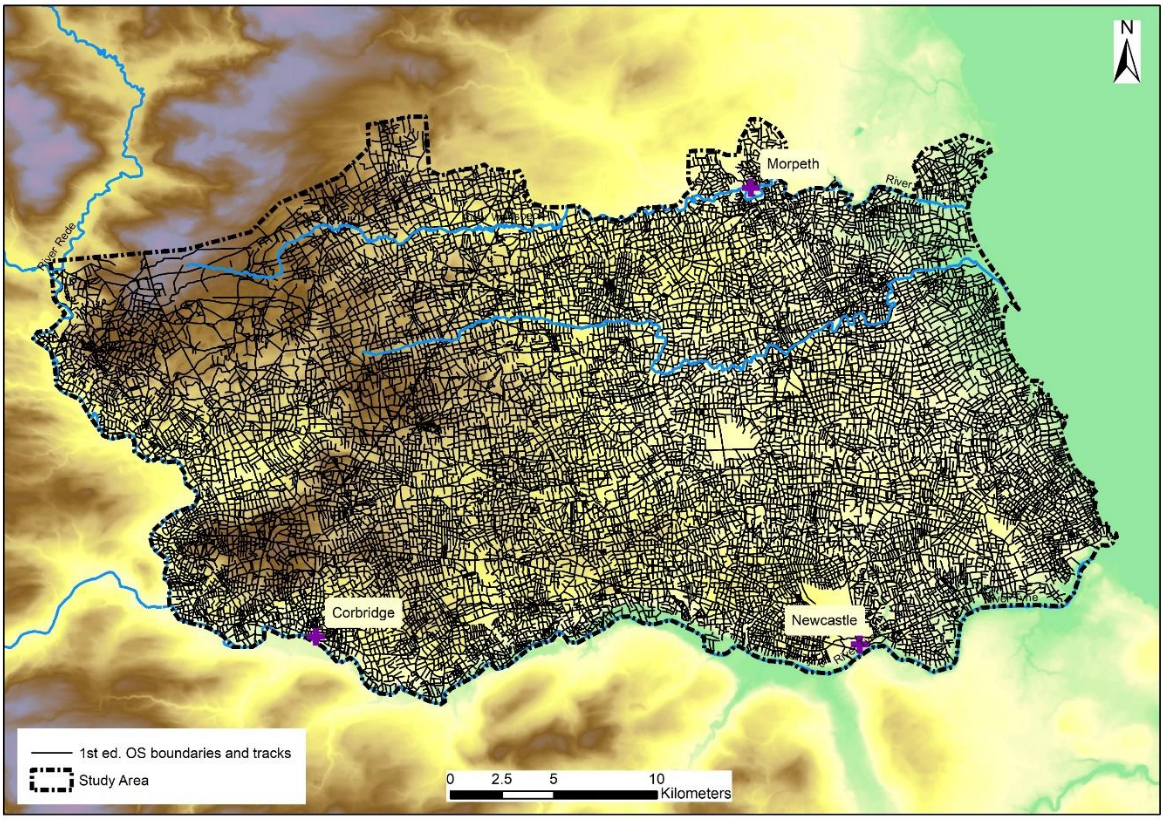

Figure 4.23 Distibution of boundaries and tracks depicted on 1st edition Ordnance Survey mapping (50m DTM downloaded from Edina Digimap, 2017)

Figure 4.23 shows the dense distribution of boundaries and tracks present in the study are by the nineteenth century. In some areas, such as Weetslade, and East and West Brunton, features present on eighteenth century estate plans have been transcribed in the dataset which show the fieldscapes in the region before the earliest Ordnance Survey maps were produced. In most cases very little change can be seen between the two maps, as much of the study area was already enclosed through agreements beginning as early as the fifteenth century; and Parliamentary Enclosure mainly affected areas of former waste or ‘moor’ in this region.

4.8.1 Orientations (file prefix SEN1)

- SEN1 total length: 7814837m

Orientation	Length (m)	Percentage
SEN1_10_100	1704713	22
SEN1_20_110	988123	12
SEN1_30_120	718947	9
SEN1_40_130	733925	9
SEN1_50_140	1054087	13
SEN1_60_150	1752675	22
SEN1_70_160	2755174	35
SEN1_80_170	3156272	40
SEN1_0_90_180	2600797	33

Table 4.9 Proportions of orientations amongst 1st edition Ordnance Survey boundaries and tracks

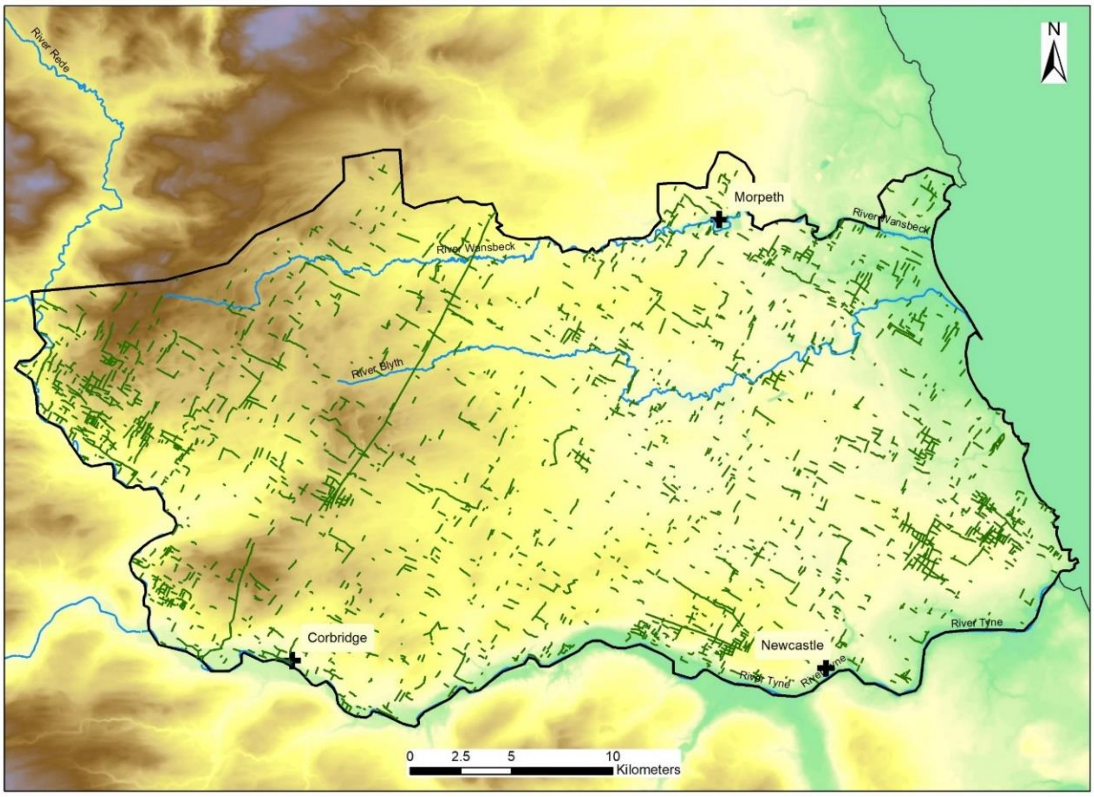

Figure 4.24 1st edition Ordnance Survey boundaries and tracks oriented around 30 or 120 degrees (50m DTM downloaded from Edina Digimap, 2017)

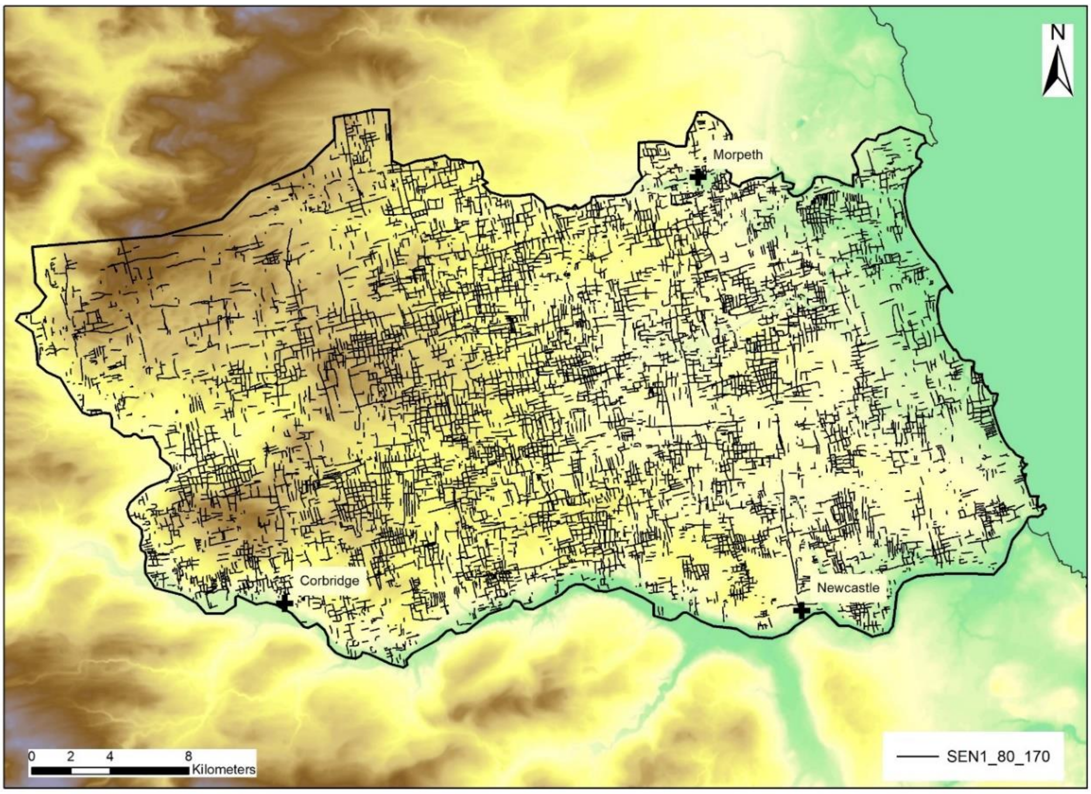

Figure 4.25 Distribution of 1st edition Ordnance Survey boundaries and tracks oriented around 80 or 170 degrees (50m DTM downloaded from Edina Digimap, 2017)

The highest proportion of 1st edition Ordnance Survey boundaries and tracks are oriented to ±10 of 80/170 degrees, shown in Figure 4.25. This orientation occurs in high densities throughout the central belt of the study area but is less prevalent along the eastern coastal plain and towards the banks of the River North Tyne in the north-west of the study area. Nine percent of the 1st edition Ordnance Survey dataset was oriented to within ±10 of 30 or 120 degrees, which mainly occur in the far west of the study area and around Monkseaton and Earsdon along the eastern coastal plain; and are shown in Figure 4.24.

The results show a high degree of variation in the orientation of boundaries and routeways present by the nineteenth century. While there is some clustering, most orientations are represented throughout the study area in varying amounts, sometimes with multiple directions represented in a discreet area such as around Great Whittington township, shown in Figure 4.26. Elsewhere, there were consistent orientations present in specific areas, such as Whalton, where 10/100 degrees is very prevalent (Figure 4.27).

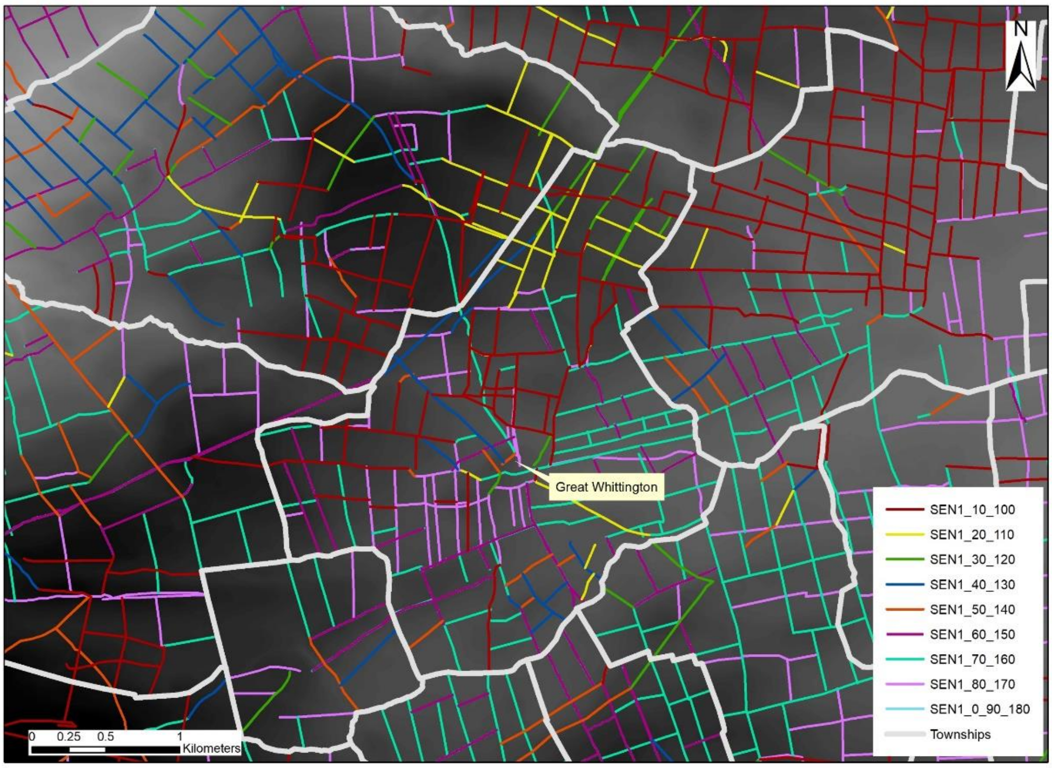

Figure 4.26 Multiple orientations amongst 1st edition Ordnance Survey boundaries and tracks around Great Whittington township (50m DTM downloaded from Edina Digimap, 2017)

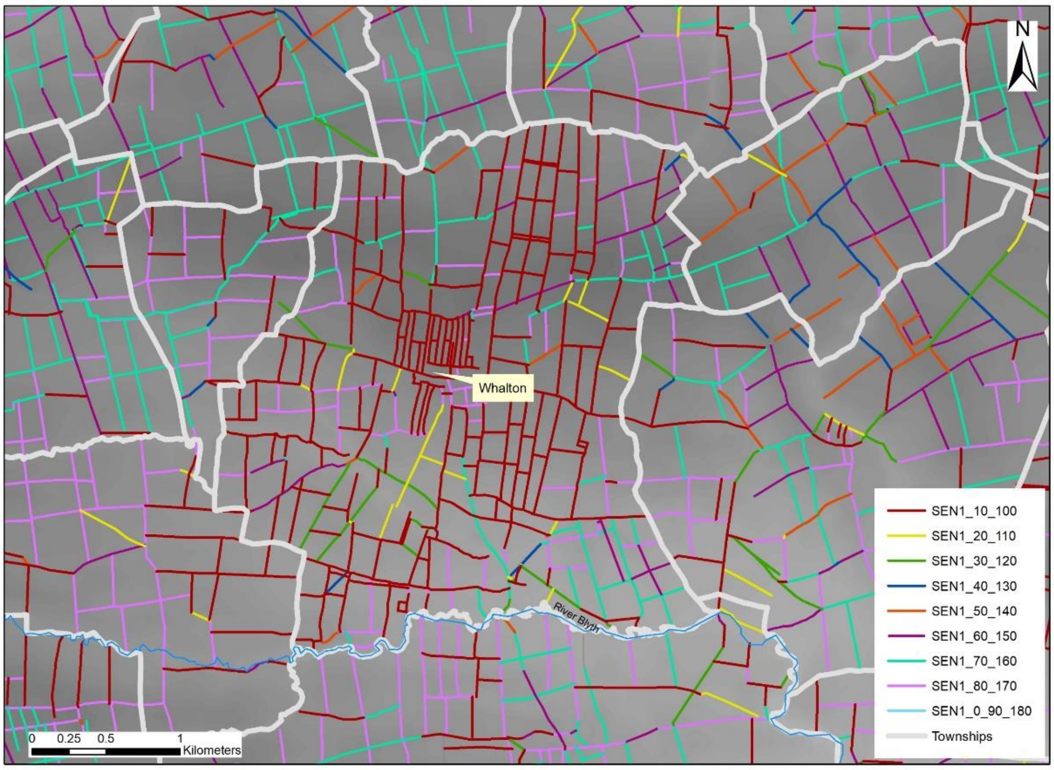

Figure 4.27 Common 10 or 100 degrees orientations present amongst 1st edition Ordnance Survey boundaries and tracks within Whalton township (50m DTM downloaded from Edina Digimap, 2017)

4.8.2 Conformity to underlying slope direction

- SEN: 7814837m
- SEN_con20: 3825492m (49%)
- SEN_non20: 3989345m (51%)
- SEN_con30: 5464326m (70%)
- SEN_non30: 2345968m (30%)

Around half the units conform to within 20 degrees of underlying slope direction, compared with seventy percent conforming to within 30 degrees.

4.8.3 Comparing orientation with conformity to underlying slope direction

- SEN_80_170: 3154618m
- SEN_80_170_con20: 1574612m (50%)
- SEN_80_170_non20: 1580006m (50%)
- SEN_80_170_con30: 2210148m (70%)
- SEN_80_170_non30: 944470 (30%)
- SEN_30_120: 795714m
- SEN_30_120_con20: 380898m (48%)
- SEN_30_120_non20: 414816m (52%)
- SEN_30_120_con30: 572265m (72%)
- SEN_30_120_non30: 223449m (28%)

The visualisation of the data implies that a proportion of every boundary oriented to within either of the 30/120, or 80/170 degrees parameters, conforms to within 20 degrees of underlying slope direction, with other parts either less so, or not at all. These results fail to show any significant trends towards conformity to underlying slope direction for either of the thresholds studied on a broad scale, with fifty percent of those oriented at ± of 80/170 degrees and forty-eight percent those oriented ±10 of 30 or 120, degrees conforming to within 20 degrees of underlying slope direction. Using the 30 degrees threshold also fails to show any general distinctions between the two selected orientations, with seventy percent of both conforming to within 30 degrees of underlying slope direction. Distribution patterns are consistent throughout the region, making it difficult to expand on these results, other than to say that conformity to within 30 degrees of underlying slope direction is a consistent factor amongst boundaries and routeways throughout the study area.

Spatially, the patterns of conformity are broadly reflective of the total numbers oriented to the two thresholds. There are concentrations of SEN1_30_120 which largely conform to within 20 degrees of underlying slope direction, such as around Murton village, shown in Figure 4.28.

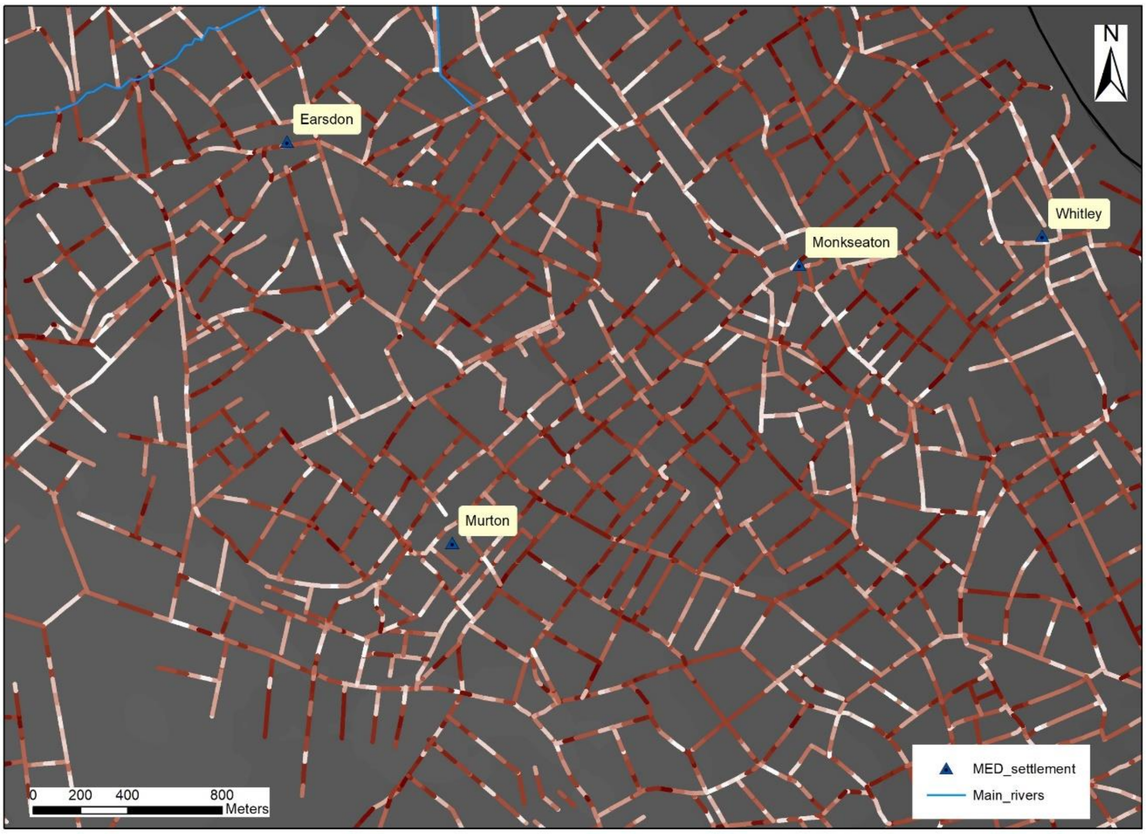

Figure 4.28 Levels of slope direction conformity around Murton Village. Red- high conformity, White- low conformity (50m DTM downloaded from Edina Digimap, 2017)

4.8.4 Discussion

Prior to the analysis, greater conformity to underlying slope direction was expected towards the west of the study area, where natural topography is more pronounced than along the coastal plain in the east, but the results do not show this: instead there are pockets of conformity spread over the whole study area; and there is little difference between the amounts of boundaries which either conform or do not conform to within twenty degrees of slope direction. Together with the graded colour method, the results show that apart from the banks of rivers, most notably the conjoined River Tyne, the River North Tyne, and the River Wansbeck, only localised areas containing higher conformity could be observed. The seventy percent of boundaries and routeway units which conform to within 30 degrees of underlying slope direction are distributed in large proportions throughout the region, which implies that, to this extent at least, those responsible for laying out boundaries and routeways were consistently mindful of respecting natural terrain to varying degrees, probably depending on the function of the feature. The factor of scale is clearly pivotal to any discussions of conformity to underlying slope direction, which will be addressed in the next chapters.

Small pockets of non-conformity are visible in the study area, such as an area south of Bedlington, which is surprising as it skirts the course of the River Blyth. Great Whittington township also contains a cluster of boundaries which do not conform to within 20 degrees of underlying slope direction (54%), which considering the evidence shown above regarding the variation in orientation of boundaries and route-ways in this area is also quite surprising. It had been assumed by the author that the many different orientations present here were to account for the high variance in underlying slope directions; however, using the 30 degrees threshold does not set this area apart from elsewhere, with 68 percent conforming to within these parameters of underlying slope direction.

4.9 Individual features present on 1st edition Ordnance Survey mapping

Individual feature types were analysed in isolation using the same methods as above, to see whether any patterns emerge, such as similarities or differences between certain features present by the nineteenth-century. Doing this may also shed light on how various features, be it township boundaries, tracks or field boundaries were laid out in relation to conformity to underlying slope direction, and particular orientations.

4.9.1 Field Boundaries

Field boundaries depicted on 1st edition Ordnance Survey mapping take many forms; and certain morphologies allow some to be dated. For example, those displaying the reverse ‘S’ sinuous shape are probably re-used medieval furrows; whilst others are straight and arranged in regular blocks, the products of Parliamentary Enclosure during the nineteenth-century. Others are less obvious and could potentially be of any date. Furthermore, some medieval furlongs could be reused earlier boundaries; and Parliamentary Enclosure period boundaries could in some cases be straightened existing boundaries to fit later patterns and trends. It is therefore difficult to unpick the linear features present on 1st edition Ordnance Survey mapping. Aim 3 of this research is to explore whether common orientations between these features and known dated earlier features can be used to form a link with the past.

4.9.2 Orientations

- SEN1_NSEW total length: 4729648m

Orientation	Length (m)	Percentage
SEN1_NSEW_10_100	1050585	22
SEN1_NSEW_20_110	503211	11
SEN1_NSEW_30_120	308501	6
SEN1_NSEW_40_130	323229	7
SEN1_NSEW_50_140	565640	12
SEN1_NSEW_60_150	1081670	23
SEN1_NSEW_70_160	1796443	38
SEN1_NSEW_80_170	2105728	45
SEN1_NSEW_0_90_180	1722928	36

Table 4.10 Orientations of boundaries depicted on 1st edition Ordnance Survey mapping

The highest proportion of boundaries are oriented around 80/170 degrees, with the smallest proportion oriented around 30/120 degrees, shown in Table 4.10.

4.9.3 Conformity to underlying slope direction

- SEN_NSEW: 4730611m
- SEN_NSEW_con20: 2372953m (49%)
- SEN_NSEW_non20: 2403657m (51%)
- SEN_NSEW_con30: 3368077m (71%)
- SEN_NSEW_non30: 1406633m (29%)

The split between conformity and non-conformity to within 20 degrees of underlying slope direction is almost equal; and a 71-29 percent split in favour of conformity to within 30 degrees of underlying slope direction is represented across the study area, with no signs of clustering, apart from around rivers and those within Horton township, which will be discussed in more detail later.

4.9.4 Township boundaries

Townships are believed to have been in existence since at least the eleventh century; and are commonly associated with medieval nucleated villages and open-field systems. It is thought by some that at least elements of township boundaries are much older; and relate to systems of land governance during the early medieval period if not before (Jones 1979, O'Brien 2002; Oosthuizen 2013). Township boundaries are common features on estate plans, in which they represent spatial, and often property extents of landowners in the post medieval period. They were still recognised units in the nineteenth-century; albeit with some changes from their original form. Many elements persist in modern parish boundaries. It has been recognised that there had been superficial changes to township boundary layouts in northern Northumberland during the post-medieval period, most commonly in areas of common waste (Dixon 1984). Some township boundaries included in this analysis may therefore be later in date. This adds to the importance of applying orientation and slope direction conformity analysis.

4.9.5 Orientations

- SEN_TS total length: 624087m

Orientation	Length (m)	Percentage
SEN1_TS_10_100	138981	22
SEN1_TS_20_110	92177	15
SEN1_TS_30_120	78195	13
SEN1_TS_40_130	81455	13
SEN1_TS_50_140	97877	16
SEN1_TS_60_150	140450	23
SEN1_TS_70_160	201248	32
SEN1_TS_80_170	227268	36
SEN1_TS_0_90_180	190658	31

Table 4.11 Proportions of orientations amongst township boundaries

As Table 4.11 shows, the highest proportion of township boundaries are once again oriented to within ±10 of 80 or 170 degrees, whilst those oriented to within ±10 of 30/120 degrees represent the lowest amounts. Certain orientations comprise large portions of single townships, such as those oriented around 10 or 100 degrees present in the north-south divisions of North Gosforth and East Brunton townships, shown in Figure 4.29. Field boundaries depicted on 1st edition Ordnance Survey mapping largely share these orientations. A similar phenomenon can be seen at Horton, where the northern and southern township boundaries are largely oriented this time around 60 degrees, which is also mirrored in the boundaries and tracks within the township, shown in Figure 4.30. In the main, however, most township units are too irregular in shape to be able to determine a dominant orientation.

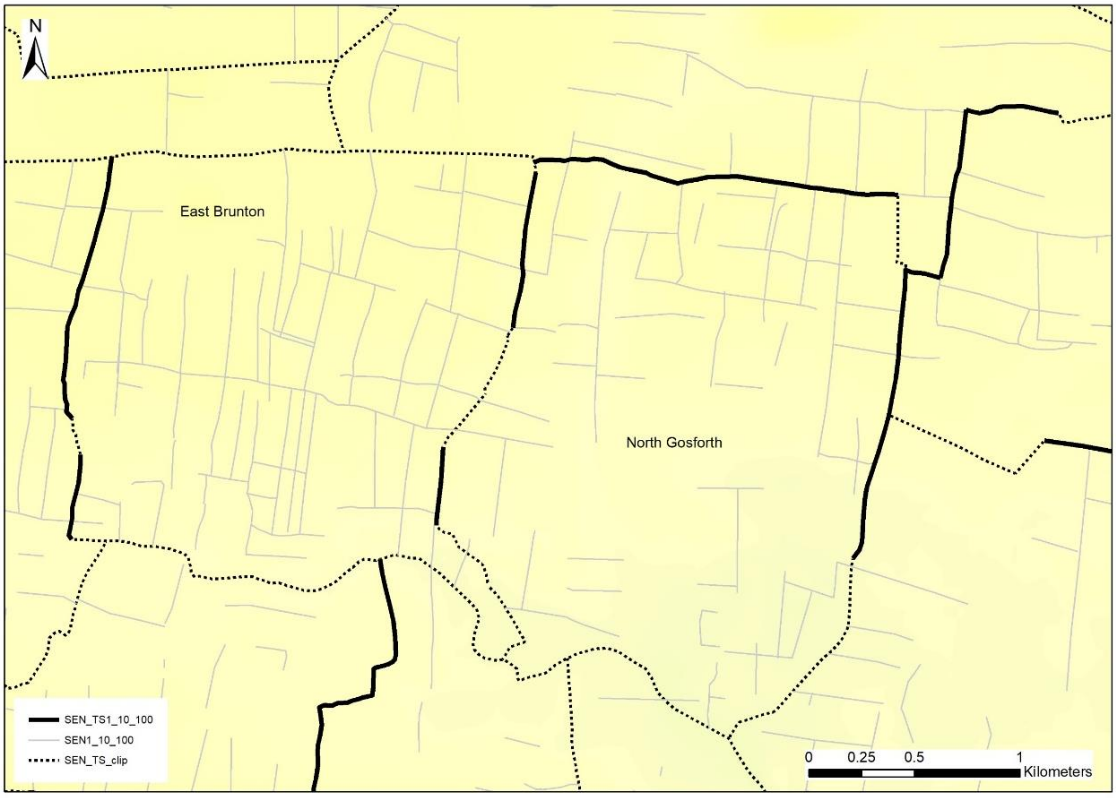

Figure 4.29 Proportions of township boundaries oriented around 10 or 100 degrees at East Brunton and North Gosforth townships (50m DTM downloaded from Edina Digimap, 2017)

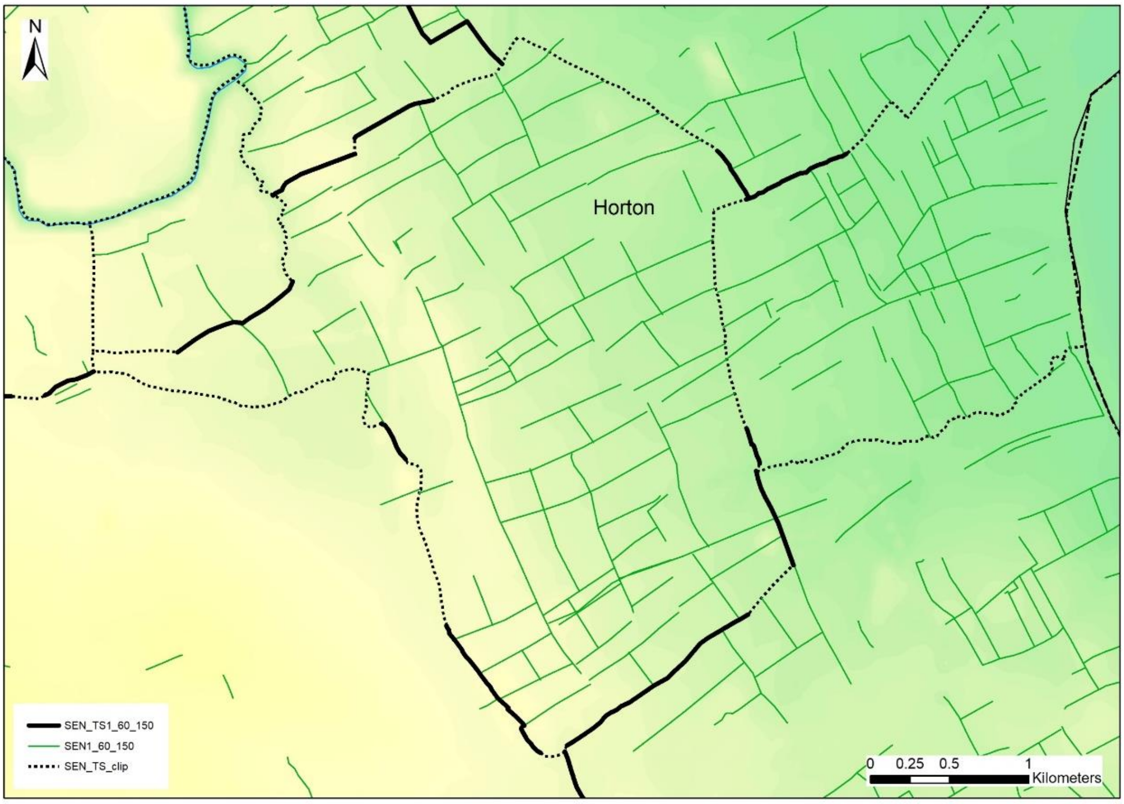

Figure 4.30 Proportions of township boundaries oriented around 60 or 150 degrees at Horton township (50m DTM downloaded from Edina Digimap, 2017)

4.9.6 Conformity to underlying slope direction

- SEN_TS: 624087m
- SEN_TS_con20: 301408m (47%)
- SEN_TS_non20: 329891m (53%)
- SEN_TS_con30: 435456m (70%)
- SEN_TS_non30:194500m (30%)

A similar picture emerges from the results using a 20 degrees threshold, although the proportions are slightly lower than the SEN data from which this is extracted. Using a 30 degrees threshold results in a 70-30 split in favour of conformity to underlying slope direction, which is consistent with the 1st edition Ordnance Survey mapping data as a whole.

4.9.7 Discussion

The dearth of township boundaries oriented around 30/120 degrees implies that by the time these units were created, by the eleventh-century at the latest, any hint of the south-east facing prevalence had all but disappeared if it had ever been there at all. On the evidence of this study any trends in pre-medieval times to orient linear landscape features towards 30/120 degrees appears unlikely; and where it does occur it is to conform to underlying slope direction. This will be discussed further in the next chapter. The dominant 80/170 degrees and cardinal points axes found here also permeate through the data from rectilinear settlement enclosures to medieval villages, to post-medieval ridge and furrow.

The seventy percent of units conforming to within 30 degrees of underlying slope direction comprise large portions of township boundaries in the region, including the whole of Monkseaton and Murton townships; and most of Horton and East and West Brunton townships along the coastal plain. Combining this with the township boundaries represented by rivers and streams shows that most township boundaries conform to within 30 degrees of underlying slope direction, as shown in Figure 4.31. These conformities are present regardless of specific orientations which suggests that the lie of the land was a key factor in the layout of territorial boundaries by the medieval period at the latest rather than a push towards an orientation or alignment for other reasons.

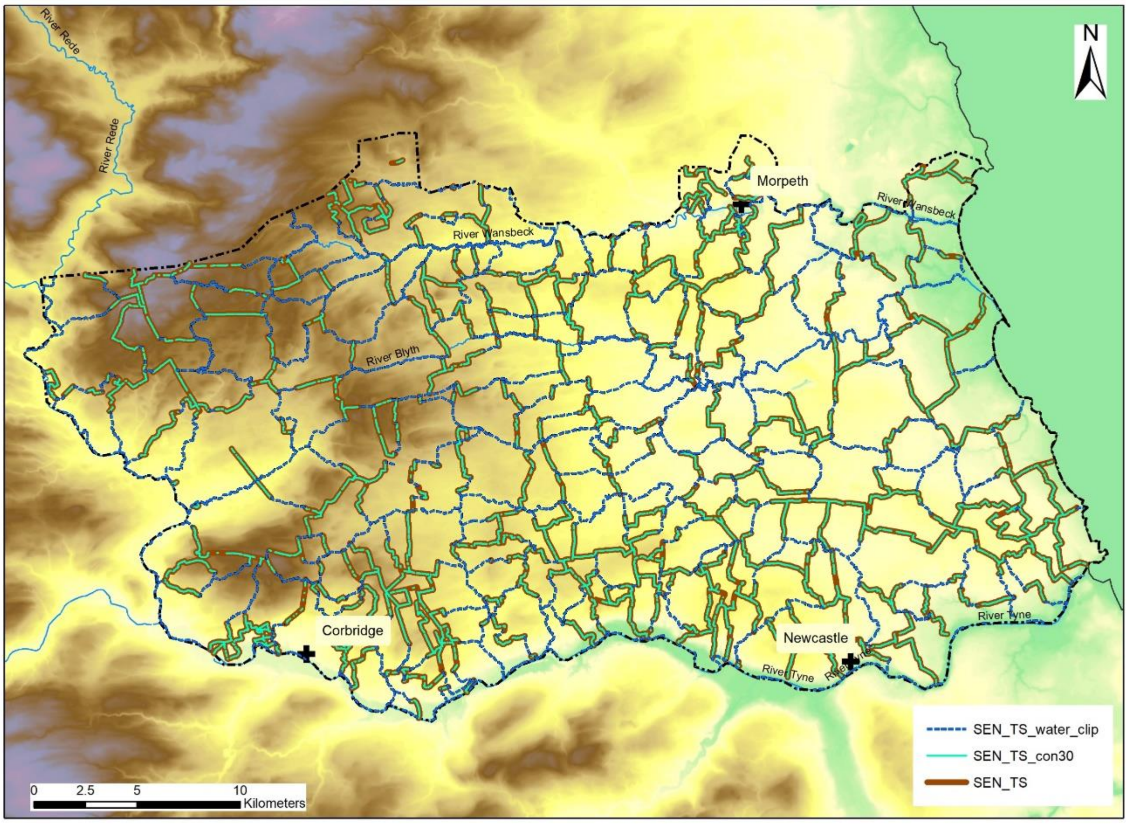

Figure 4.31 Slope direction conformity to within 30 degrees amongst analysed township boundaries. Also shown are township boundaries represented by water courses (blue) (50m DTM downloaded from Edina Digimap, 2017)

The results of this analysis lead to the question of whether townships which branched off rivers, especially major ones such as the Tyne, Blyth and Wansbeck, were established first; and others laid out in between later. The way in which so many township boundaries seem to share even a roughly similar orientation with nearby rivers imply this might be the case.

4.9.8 Roads and footpaths

Routeways are likely to be the early pivots in the landscape from which other linear features were constructed (Williamson 2016). The roads on which medieval settlements lie may well be earlier features associated with previous land-use. On 1st edition Ordnance Survey maps many of these roads have probably undergone numerous changes over many years. Examples elsewhere in England show east-west roads, for example, may have be ‘deflected’ by a north-south road for a short time before returning to its original orientation (*ibid*: 274); this can also be seen in the present study area. Some routeways may have disappeared entirely, or exist only as cropmarks or low earthworks, such as long stretches of the Devil’s Causeway Roman road, which will be analysed as a case study.

4.9.9 Orientations

Total length: 2264184m

Orientation	Length (m)	Percentage
SEN1_RFTP_0_90_180	662417	29
SEN1_RFTP_80_170	799512	35
SEN1_RTFP_70_160	728074	32
SEN1_RTFP_60_150	505029	22
SEN1_RTFP_50_140	378097	17
SEN1_RTFP_40_130	319605	14
SEN1_RTFP_30_120	301360	13
SEN1_RTFP_20_110	351420	16
SEN1_RTFP_10_100	483781	21

Table 4.12 Proportions of orientations for roads, tracks and footpaths

The results shown in table 4.12 show that once again units oriented around 80/170 are most have the most representation, at 35%; and those around 30/120 comprise the lowest proportions.

4.9.10 Conformity with underlying slope direction

- SEN_RTFP
- SEN_RTFP: 2289587.3m
- SEN_RTFP_con20: 1103143m (48%)
- SEN_RTFP_non20: 1186445m (52%)
- SEN_RTFP_con30: 1585935m (69%)
- SEN_RTFP_non30: 702248m (31%)

4.9.11 Comparing orientations with conformity to underlying slope direction

- SEN_RFTP_30_120: 333583m
- SEN_RTFP_30_120_con30: 235485m (71%)

Seventy one percent of roads, tracks and footpaths oriented within ±10 of 30/120 degrees conform to within 30 degrees of underlying slope direction.

4.9.12 Footpaths (SEN_FP)

It was observed during the transcription process that many footpaths appeared to be oriented differently to the field boundaries and roads around them. For this reason, they have been subjected to a separate study.

4.9.13 Orientations

SEN1_FP total length: 1246458m

Orientation	Length (m)	Percentage
SEN1_FP_10_100	252941	20
SEN1_FP_20_110	207267	17
SEN1_FP_30_120	187031	15
SEN1_FP_40_130	186705	15
SEN1_FP_50_140	229475	18
SEN1_FP_60_150	278261	22
SEN1_FP_70_160	381658	31
SEN1_FP_80_170	423754	34
SEN1_FP_0_90_180	346539	28

Table 4.13 Proportions of orientations amongst footpaths

The largest proportions of orientation are once again those close to 80 or 170 degrees, although there are greater proportions of footpaths oriented between 30/120 and 60/150 degrees in the far west and far east of the study area, shown in Figure 4.32. Footpaths oriented at 60/150 degrees, for example, comprise the longest lengths within Horton township, which will be discussed in a later chapter.

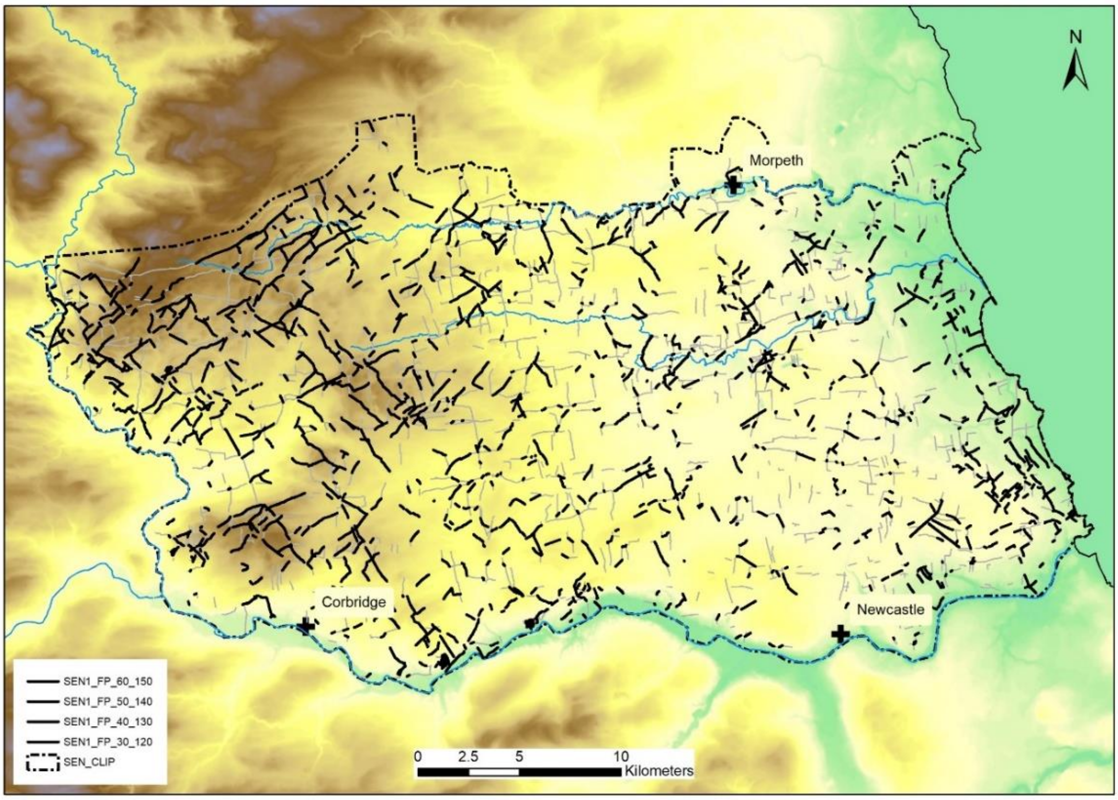

Figure 4.32 Distributions of analysed footpaths oriented around 30, 40, 50 or 60 degrees (50m DTM downloaded from Edina Digimap, 2017)

4.9.14 Conformity with underlying slope direction

- SEN_FP: 1246457m
- SEN_FP_con20: 596878m (48%)
- SEN_FP_non20: 66533m (52%)
- SEN_FP_con30: 867420m (70%)
- SEN_FP_non30: 391923m (30%)

4.9.15 Roads Orientation

- SEN1_RT total length: 1017726m

Orientation	Length (m)	Percentage
SEN1_RT_10_100	230840	23
SEN1_RT_20_110	144152	14
SEN1_RT_30_120	144328	14
SEN1_RT_40_130	132899	13
SEN1_RT_50_140	148622	15
SEN1_RT_60_150	226768	22
SEN1_RT_70_160	346146	34
SEN1_RT_80_170	375757	37
SEN1_RT_0_90_180	315878	31

Table 4.14 Proportions of orientations amongst roads and tracks

Road and track units oriented to 80/170 degrees represent the greatest proportion across the whole study area, as is shown in Table 4.14.

4.9.16 Conformity to underlying slope direction

- SEN_RT_1018310m
- SEN_RT_con20: 506263m (50%)
- SEN_RT_non20: 522910m (50%)
- SEN_RT_con30: 718515m (71%)
- SEN_RT_non30: 310325m (29%)

4.9.17 Discussion of roads and footpaths results

Prevalent orientations in both roads and footpaths cluster around 80 or 170 degrees. Those oriented to 30/120 occur in greater numbers in the far west and east of the study area; and include in their number significant portions of the Devil's Causeway, a Roman road.

Drainage must historically have been a key consideration in the positioning and layout of roads. Roman roads, for example, are usually cambered, with an agger, and additional roadside drains (Poulter 2010). Most prehistoric; and medieval and later routes, were not typically built with this sophistication, but it would make practical sense to negate the problems of drainage by utilising natural topography. It is difficult to date medieval and later roads as they did not in most cases possess the defining characteristics commonly associated with Roman roads. If some of the main routes linking medieval villages and resources had earlier origins, which is highly likely where shared orientation and alignment with, for example, rectilinear settlement enclosures were apparent, then it must also be at least implied that conformity to underlying slope direction held similar importance at different times. The paths which traverse diagonally through fields present by AD 1860 often directly follow natural topography; whereas the boundaries themselves do not. A good example of this can be seen around Cramlington village by the nineteenth-century, shown below in Figure 4.33.

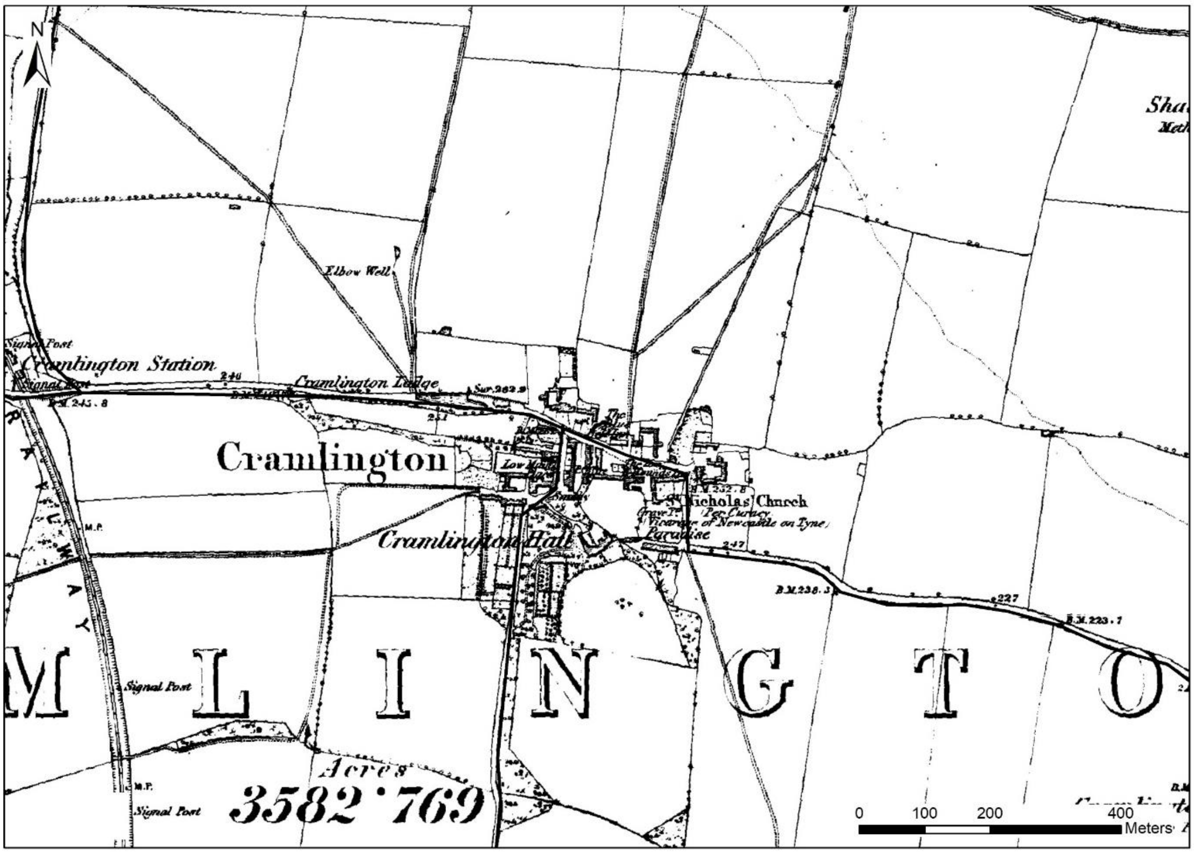

Figure 4.33 Footpaths (dotted lines) around Cramlington village as depicted on the 1st edition Ordnance Survey map (dowloaded from Edina Digimap 2017)

5 Discussion of regional-scale results

This chapter will place the results of orientation and slope direction conformity analysis into the context of change and continuity in the south-east Northumberland landscape from the late Iron Age/early Roman periods onwards, exploring what, if anything, existing elements of previous land use might have meant to the people living within landscapes at various times in the past; and the importance of the lie of the land. Distributions of orientations will be explored in the context of areas of former common, settlement morphology and relative distributions over time.

The results so far have been presented and interpreted at a mostly regional landscape scale, especially in the case of the features depicted on 1st edition Ordnance Survey mapping. At this scale, trends have emerged from analysing the results. One is that common orientations between features dating to different periods in the same area may be evidence for the endurance of some boundaries from at least the Iron Age into the present. Another is that such shared orientations could be the products of a common requirement to conform to grain of slope in different periods. These narratives may not in all cases be mutually exclusive, and the two can be shown to intertwine.

5.1 Common orientations

Table 5.1 illustrates general trends across all feature types; and acts as a starting point for the forthcoming discussion.

Feature (prefix)	Prevalent orientation (degrees)
Pit Alignments (PAL1)	30/120
Ancient Boundaries (ANC_BOU1)	10/100
Rectilinear settlement enclosures (RECT1)	80/170
Early medieval boundaries (EMB1)	0/90/180
Medieval ridge and furrow (MRFa)	90/180
Medieval nucleated village (MNV1)	80/170
Post medieval ridge and furrow (PMRF1)	80/170
1st edition Ordnance Survey boundaries and tracks (SEN1)	80/170

Table 5.1 Prevalent orientations amongst analysed linear features

All orientations are represented in various proportions across the study area, although some are more common than others. Orientations around 80 and 170 degrees were most common amongst dated features ranging from Iron Age rectilinear settlement enclosures to traces of post medieval ridge and furrow, for example. Using this, and the parameters of 30/120 which are most prevalent in pit alignments, allows the exploration of whether a ‘grain’ in orientation existed; and how it might have altered over time. Table 5.2 shows that the proportion of landscape features oriented to around 30 or 120 degrees falls incrementally over time, from 76 percent of pit alignments dating from the late Bronze Age in the current study area, to 24 percent of excavated ditches believed to date to at least the late Iron Age or early Roman period, to ten percent of late Iron Age/early Roman rectilinear settlement enclosures, to three and seven percent of medieval villages and furlongs respectively; and finally, just 5 percent of post-medieval ridge and furrow. Trends towards 80/170 degrees facing settlements, boundaries and traces of ridge and furrow takes the opposite trajectory, from zero pit alignments, to 32 percent of excavated ditches and 38 percent of rectilinear settlement enclosures dating to the late Iron Age and early Roman periods, 29 and 33 percent of medieval villages and furlongs respectively; and forty-two percent of post-medieval ridge and furrow. Using these trends, it could be argued the reason why the highest numbers of 1st edition Ordnance Survey boundaries and tracks are also oriented around 80/170 degrees is because most are of a later date. Other orientations are also strongly represented in the 1st edition Ordnance Survey boundaries results; and it should be said that with more data for prehistoric linear units the trends highlighted here could change. Whether these trends have any links to underlying slope direction is something which will be discussed later.

Linear feature	Percentage of units within ±10 of 30/120 degrees	Percentage of units within ±10 of 80/170 degrees
Pit alignments (PAL1)	76	13
Ancient boundaries (ANC_BOU1)	24	17
Rectilinear Settlement enclosures (RECT1)	10	42
Early Medieval ditches (EMB1)	11	35
Medieval ridge and furrow (MRF1)	7	44
Medieval nucleated villages (MNV1)	3	44
Post-medieval ridge and furrow (PMRF1)	5	44

Table 5.2 Percentages of analysed features oriented around 30/120, and 80 or 170 degrees

Clusters of 0/90, and 10/100-degrees orientations are prevalent in the Iron Age enclosure boundaries at West Brunton and surrounding 1st edition Ordnance Survey boundaries and tracks. Both excavated Iron Age/early Roman boundary ditches at West Shiremoor are oriented around 10/100 or 20/110 degrees, which is shared by many boundaries present by the nineteenth-century in the vicinity. A concentration of rectilinear settlement medieval and post-medieval ridge and furrow oriented at 50/140 and 60/150-degrees can be seen in and around the township of Horton, along with Seaton Delaval and Murton townships, all situated on the coastal plain; and are also well represented in Kirkharle, Little Harle and Kirkwhelpington townships further west, which contain a high concentration compared with neighbouring townships. Linear features oriented around 80-100, or 20-40 degrees are largely absent in this area; and those oriented around the former are very prevalent to the south of Kirkharle township (see Figures 5.1 and 5.2 for examples of common orientations at Kirkharle and Horton respectively).

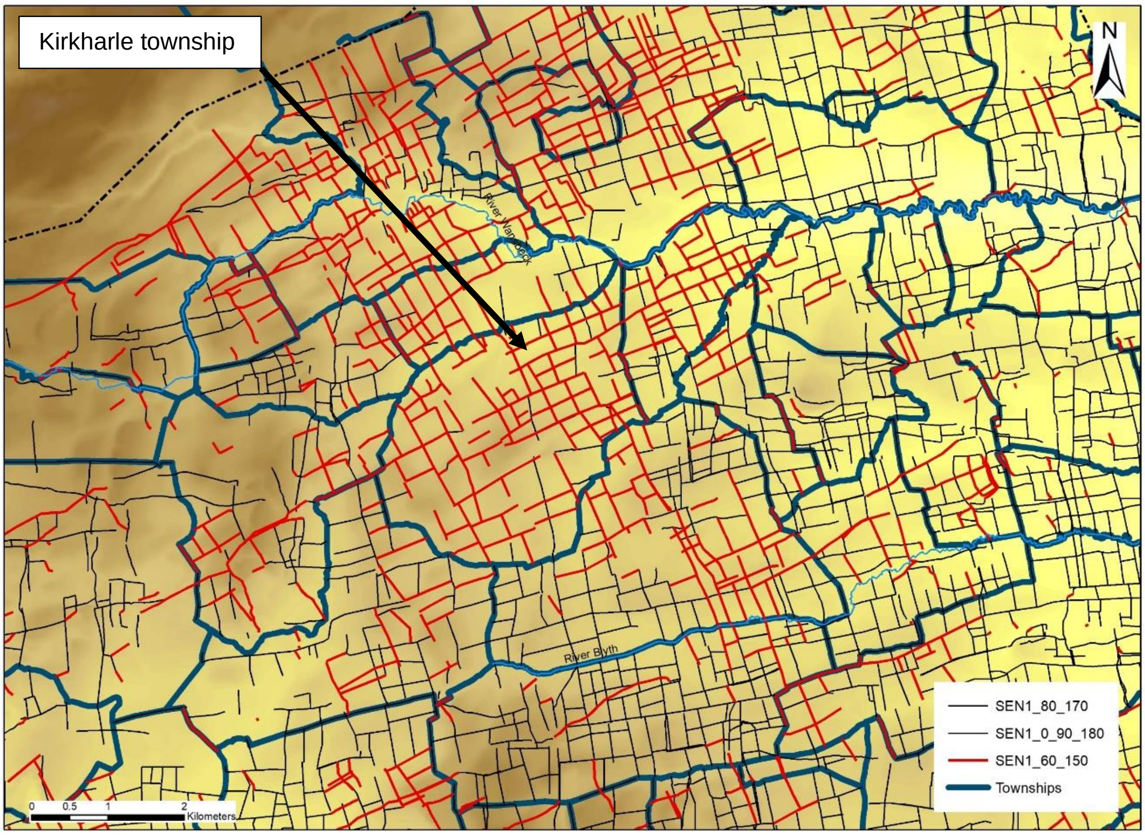

Figure 5.1 Distributions of 1st edition Ordnance Survey boundaries and tracks oriented around 60 or 150 degrees in the Kirkharle area (50m DTM downloaded from Edina Digimap, 2017)

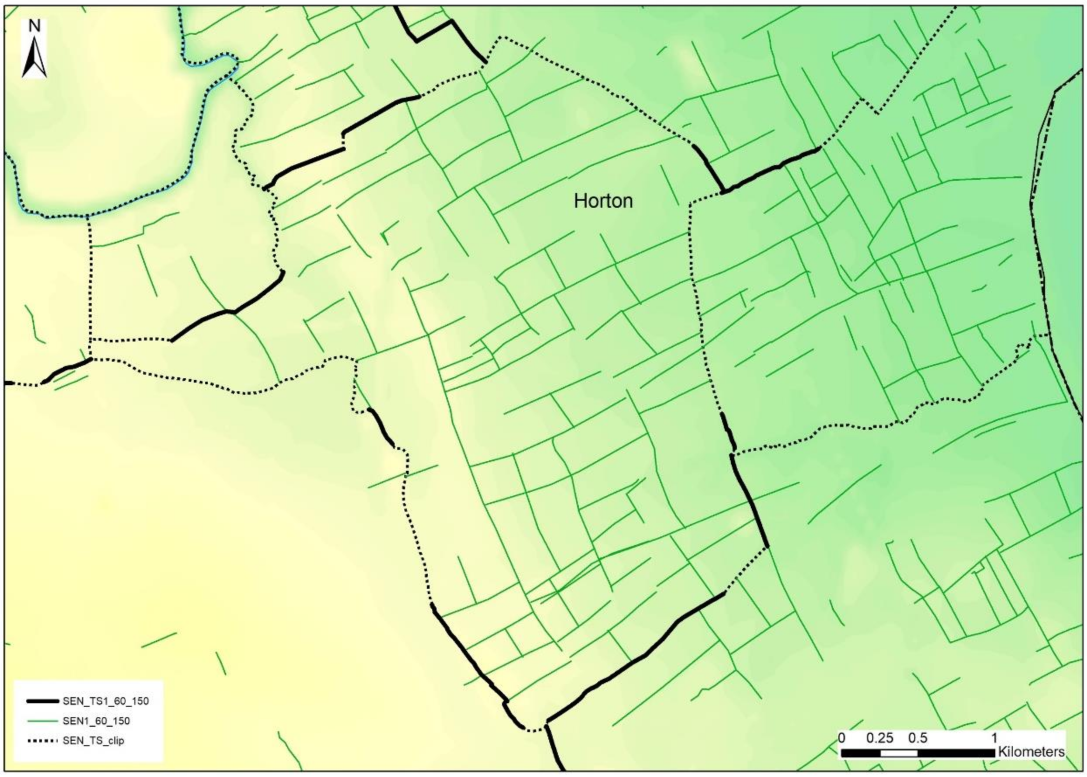

Figure 5.2 1st edition Ordnance survey boundaries, tracks and township boundaries oriented around 60 or 150 degrees at Horton (50m DTM downloaded from Edina Digimap, 2017)

Numerous boundaries and tracks oriented around 0/90 degrees represents a ‘grain’ within Matfen township, consisting of a large block of straight boundaries resulting from Parliamentary Enclosure in the nineteenth-century (Figure 5.3). It also conforms to within 20 degrees of underlying slope direction. The land was probably waterlogged for most of the year, hence the place name ‘Matfen’, and nearby ‘Fenwick’ (in- *fen*); and the apparent lack of prehistoric settlements in the region. This suggests that when the area was finally enclosed and brought into arable cultivation, the consideration of effective drainage, and with it, conformity to underlying slope, was pertinent in the minds of farmers and surveyors.

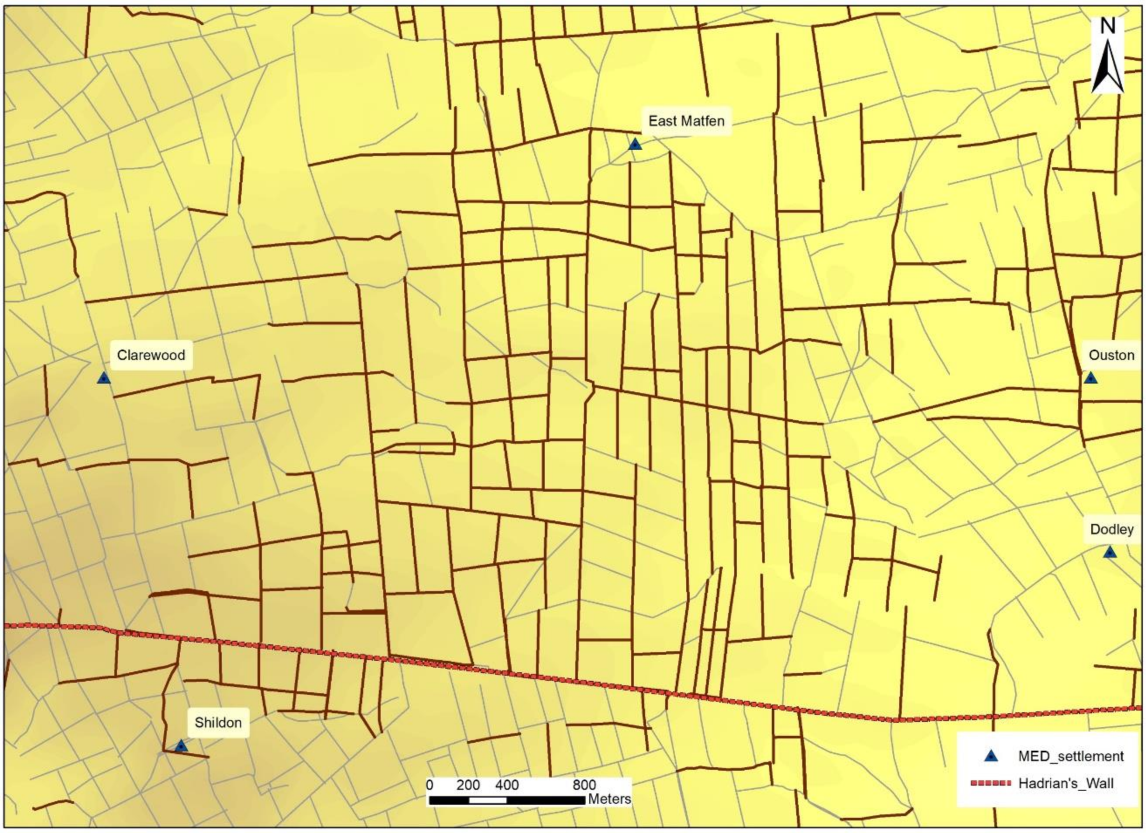

Figure 5.3 1st edition Ordnance Survey boundaries and tracks which are the product of Parliamentary Enclosure, commonly oriented around 90 or 180 degrees (50m DTM downloaded from Edina Digimap, 2017)

The most frequently occurring orientation amongst underlying slope direction derived from the 50m aspect data is 82 degrees, which goes some way to explaining the high frequencies amongst linear features from rectilinear settlement enclosures onwards which display the same orientations. These features, including medieval villages, medieval and post medieval ridge and furrow, and 1st edition Ordnance Survey boundaries and tracks, are also the largest datasets. The common orientation shared by these somewhat chronologically disparate features in terms of late Iron Age to medieval period features could be present in pit alignments and Iron Age ditches if a larger evidence base was available across the study area.

5.2 A possible 30/120 degrees trend

The idea of a common trend towards 30/120 degrees, or south-east facing settlement and land use features, has gained most traction in studies of prehistoric roundhouses, which have provoked lively debate around the structuring of space and incorporation of cosmological and symbolic principles. Studies have shown that from the late Bronze-Age onwards entrances to roundhouses were oriented predominantly east, north east and south east (Parker Pearson and Richards 1994: 47 Fig 2.4; Hodgson *et al.* 2012; Webley 2007) (see Figure 5.4); although there are many exceptions to this rule (for example see Pope 2007) (see Figure 5.5).

The trend in an east-west axis has also been identified in settlement enclosures, in that the direction from which to enter a settlement is thought to be of symbolic importance; and connected to major cosmological events, such as the rising of the sun in the east at the equinox and south-east in midwinter (see Figure 5.4). Some scholars have explored the 'sun-wise' model (Parker Pearson and Richards 1994: 48-49; Hill 1992: 66), whereby the roundhouse acted as a mini model for the Iron-Age cosmos, where spatial and cosmological order allowed belief systems to be given material form (Bruck 2008: 261).

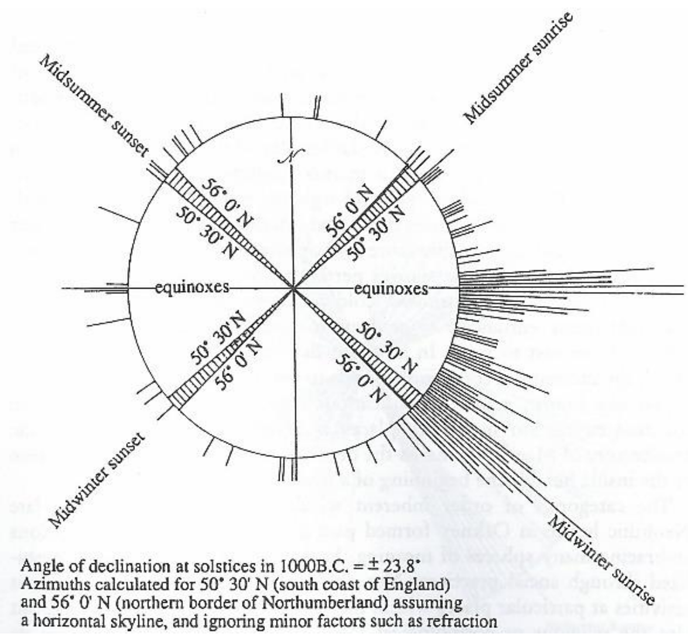

Figure 5.4 Sun-wise orientation (from Parker Pearson and Richards 1994: fig 2.4)

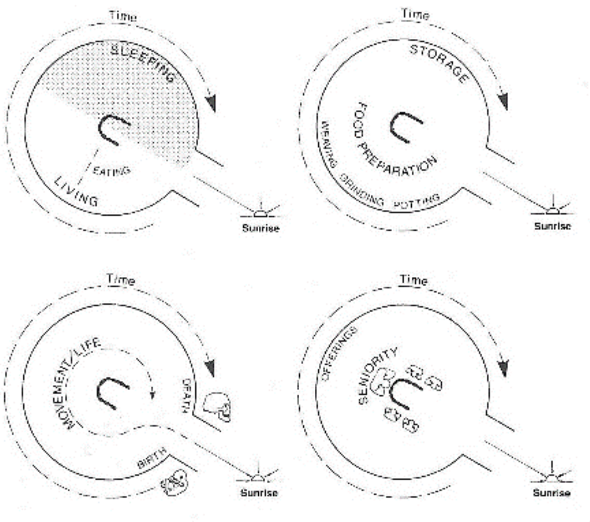

Figure 5.5 Opposing variables for the structure of space in roundhouses (from Pope 2007: fig 1)

The concept of sun-wise orientation, or ‘solskifte’, has been used to explain alignment and orientation patterns in prehistory, and to explore the laying out of medieval open fields according to the cycle of the sun (Field 2008; Homans 1942; Gorannson 1961; Roberts 2008). Homans (1942) did suggest a connection between sun-division and old popular cosmology, with its dichotomy of the world into good and bad in association with the quarters of the heavens and the course of the sun; however, this idea was taken no further, and Goransson (1961) subsequently dismissed it. It has been implied that the implementation of sun division on fields and settlements in the medieval period may have occurred “independent of seigneurial interference” (Goransson 1961: 100), suggesting a bottom-up approach driven by villagers, a simple means of distributing land in a fiscally just manner, having ‘not so much to do with mysticism’ (1961: 98). The timing of Goransson’s paper is telling though. The 1960s rise of processualism, with symbolic interpretations cast aside to make way for scientific fact. Both Homans (1942) and Beresford (1950: 355) found evidence of medieval land holding participating in good and bad locations, suggesting egalitarian management of the agricultural economy based on the sun-wise arrangement of furlongs. No dating relating to the origins of sun division has been established, but it is thought to have been established at the time medieval nucleated villages were emerging, and, along with regular furlongs, were the result of planned reorganisation (Sheppard 1973: 184). But if enough boundaries remained from previous times, and they were part of a system or regime based around the shared use of sun direction, then we might assume the same thing held importance to later communities in the medieval period, for example. This carries the implication that the boundaries and their orientations endured through the intervening period, traversing the gap between the late second and sixth centuries AD. There is evidence for a degree of sun-wise oriented medieval open fields with of Backworth village (NZ 30003 71938); however, it is difficult to say whether this is based on the solskifte model or not.

Other studies have argued that the easterly orientation of roundhouse entrances negated the effects of westerly winds and maximised sunlight into the roundhouse interior (Giles 2012: 88; Bradley 2012: 29). The idea of sun-wise and oppositional factors governing the order of space in roundhouses has been balanced through the variability in evidence by Pope (2007), who instead emphasised variation and adaption regarding use of space, shown above in Figure 5.5. It is most likely that decisions around the orientations of settlement and land-use in this period and others were driven by a variety of factors, such as a desire for light, contact, and by the potential for privacy (Pope 2007: 224). The results of this research suggest that conformity to underlying slope direction should also be included in discussions of the orientations of entrances to roundhouses. There is no reason to wholly dismiss any interpretation; and it could be that inhabitants saw the cosmological as a corollary of the pragmatic, or vice-versa (Giles 2012: 89).

Roundhouses have not been included in the analytical component of this study due to time constraints, so little can be said of these statistically; but to give one example amongst many, the entrances for roundhouses and enclosures at West Brunton and Blagdon Park 2 were found to be generally oriented east or south-east (Hodgson *et al.* 2012: 201). Whilst most rectilinear settlement enclosures have entrances which face generally to the east, reflected in the common 80 degrees orientations in the rectilinear settlement enclosures data, there were exceptions, for example at East Brunton, where one of the two settlement enclosures faced west-south-west (midwinter sunset), an orientation shared by the three roundhouses comprising an earlier unenclosed phase of occupation. Two distinct orientations (south-west or west-south-west and east or south-east) were in use at the same time in the late Iron Age dual enclosure arrangement (*ibid*: 201-203). This has been interpreted as possibly representing two different family traditions in contemporary use, one adopting an ancestral allegiance to the west, and the other adopting the more common easterly orientation (Hodgson *et al.* 2012: 201-203). The evidence from East Brunton therefore suggests that the builders of enclosure with the west facing entrance may have had a sense of the long-term and ancestral importance of the site and the construction process was influenced by past traditions (*ibid*: 203). These traditions could have been specific to this area of settlement and land-use as the orientations have been shown through excavations to be very uncommon elsewhere in the current study area.

Apart from the relatively small pit alignments dataset, the results of orientation analysis have revealed little evidence for a 30, or 120 degrees orientation in linear features on a regional scale; and the pit alignments further north at Ewart do not share this orientation either. Furthermore, slope direction conformity analysis has shown that pit alignments were laid out to generally mirror nearby river courses and other natural landscape features, which will be discussed in more detail later. Excavated Iron Age/early Roman boundary units oriented around 30/120 degrees are fourth-most common in that particular dataset, a higher proportion than for features of a later date and on 1st edition Ordnance Survey boundaries; and the 120 degrees orientation is dominant in the Iron Age boundary system excavated at East Wideopen; but, on the whole, Iron Age/ early Roman rectilinear settlement enclosures are most commonly orientated around 80/170 degrees, with just 10% of the analysed units oriented around 30/120 degrees. Should we be surprised by these relatively low figures, given existing studies of prehistoric settlement and land-use features from elsewhere?

Symbolic factors, perhaps tied in with practical considerations, could have led to the layout of regular, coaxial, fieldscapes in prehistory and beyond. Evidence for prehistoric fields along the Salisbury Plain following a common 30/120 degrees orientation and alignment could therefore be evidence of the importance of sun-wise layouts. Constructing settlements and boundaries so they conformed to certain orientations, in this case east or south-east, may have been etched into traditions passed down through generations; and could be also be related to conformity to underlying slope direction. The results have shown that the excavated ancient boundaries with the most prevalent orientation, 100 degrees, had lower levels of conformity to 30 degrees of underlying slope direction to those orientated around 30 or 120 degrees, with proportions of 61 and 82 percent respectively. This perhaps negates the importance of a south-east facing direction in prehistory being based on purely cosmological factors; but it does imply the importance of the natural landscape reflected in linear units.

The continuing practice of orienting in the same way over long periods is easy to distinguish for evidence on the same site with a relatively short gap between occupational phases, such as at East Brunton, which can be seen in the next chapter. It becomes more difficult when trying to do the same thing with Iron Age boundaries and those present by the nineteenth-century, the focus of Research Aim 3. Only three percent of medieval nucleated villages, and seven percent of medieval furlongs are oriented close to 30/120 degrees in the current study area. This implies that, even if it was there in the first place during prehistory, the orientation of 30/120 degrees no longer held importance to landowners or farmers by the time the medieval nucleated villages were laid out, and maybe before judging by the common 80/170-degree orientation amongst rectilinear settlement enclosures. The east-west tendency is striking though; and is echoed in the common aspect orientations. As we will now see, however, common orientations also appear to have strong links with the grain of slope.

5.3 Enduring landscape elements

The results of orientation and slope direction conformity analysis have shown that some 1st edition Ordnance Survey boundaries in the study area share the same 30/120 degrees orientation as excavated prehistoric ditches, most notably at East Wideopen. Hypothetical lines can be drawn to join up ancient and 1st edition Ordnance Survey boundaries at East Wideopen (Figure 5.6) and at Holywell Grange Farm; and the observation of one of the late Iron Age ditches at Pegswood running directly beneath a township boundary is further evidence. This approach is regularly used in archaeological interpretation, and has been done at Perry Oaks, Heathrow (Lewis *et al.* 2006: figure 3.46), and Spital Hill near Mitford within the current study area (AD Archaeology 2015b); but is rarely undertaken between features which are not certain to share the same date. Doing this using some features which are at present undated, namely those depicted on the 1st edition Ordnance Survey mapping, acts as a starting point at least to identifying possible ancient features encased within later systems. It goes without saying that only detailed excavation and scientific dating techniques have the potential to add any more to these propositions.

Figure 5.6 Hypothetical lines drawn between the excavated Iron Age ditches at East Wideopen and similarly oriented 1st edition Ordnance Survey boundaries to the west (50m DTM downloaded from Edina Digimap, 2017)

The social hierarchy assigned to the late Iron Age and early Roman period rectilinear settlement enclosures may have provided the mechanisms from which regularly shaped fieldscapes, including those of a coaxial nature, could have been laid out and managed. The hierarchy is based on settlement size and information from excavations regarding the activities undertaken within and around them (Hodgson *et al.* 2012). Within this model, large enclosed settlements such as those excavated at Blagdon Park and East and West Brunton could have been the residence of a chieftain, from which a territorial unit was governed containing other, possibly smaller, enclosed and unenclosed settlements. This could be done in an organised manner without the need for huge regularly oriented coaxial field systems over large areas, as is proven in the medieval open field landscape, where fields are arranged around the village unit. The evidence, albeit fragmentary, for prehistoric fields in south east Northumberland at the time of writing has been shown to bear few hallmarks of a large coaxial fieldscape, regularly oriented across a large area; although they may have existed on a more localised scale as will be shown in the next chapter.

The 1st edition Ordnance Survey map could be interpreted on this evidence as the culmination of not just centuries but millennia of change and continuity in the landscape, sometimes within very discreet settlement and land-uses phases, such as Iron Age and early Roman, from which connected elements have endured and been incorporated into later patterns. If some of the 1st edition Ordnance Survey boundaries do have prehistoric origins, we need to consider how they may have survived reorganisation in the landscape during the first millennium AD, and the possible abandonment of the settlements they were associated with. The conditions for endurance into the medieval period and beyond would be for them to either be reused as territorial boundaries, such as the possible evidence at Pegswood related to a township boundary which sits above a prehistoric ditch (Proctor 2009: 24-27); or possibly as a component of a medieval open field, such as a field boundary, furlong or individual selion, of which numerous examples can be found across the study area. A furlong within an open field at Horsley, for example, was interpreted as a relict rectilinear settlement enclosure which formed the initial component of the field from which other furlongs grew from (Tolan Smith 1997: 74).

Another possibility for the endurance of prehistoric land units into later periods would be for them to have been situated in an area of common waste through the intervening period and left undamaged by ploughing. Considering the probability that land-use between the 2nd and 9th centuries AD was weighted in favour of pasture and livestock management (Banham and Faith 2014), boundaries may well have survived in some numbers for centuries; and, if some of these areas of common or waste persisted into the medieval period and beyond, which this research suggests was quite likely, discussed below, there is no reason to suggest that even unused boundaries would have been levelled in a large area of common land. Farmers probably had enough to worry about rather than eradicating all traces of previous land use. The evidence at Morley Hill Farm for a formerly enclosed area being open for a period is bolstered by the fact that the Iron Age/early Roman period settlement enclosure ditches were still visible as faint earthworks prior to excavation, showing they silted up gradually over many centuries rather than being deliberately backfilled (Headland Archaeology 2018: 12). This would have facilitated at least the physical survival of boundaries into the late post-medieval period. A further condition would have been if they conformed to underlying slope direction, which would have helped to facilitate their reuse in later boundary systems.

It is possible that later deposits within ditch fills which could have contained evidence for the endurance of prehistoric ditches may have been destroyed through later activities such as ploughing. But if those in the vicinity which share orientation have endured since then, the theory could be entertained that the excavated ones also did for some time. This implies gradual changes within general continuity rather than sudden change which eradicated existing land-use and replaced it with something different. If, for example, a ditch was dated from the base of the primary fill to the early second-century, then gradually silted up, it could be assumed that it did not continue to be maintained; but may still have served some use. If the ditch was dated from the base of the primary fill to early second-century, then by a single secondary fill, possibly from levelling an adjacent bank (which would probably have been the original material from the digging of the ditch), it is likely that it was backfilled in a single event in the period during or immediately following the demise of the associated settlement. This was found to be the case with the droveway ditches at Shotton, discussed in chapter 6; and is indicative of more drastic change to the way land was used.

Rectilinear settlement enclosures and ditches representing probable ancient boundaries and route-ways have been observed elsewhere in some cases to be at odds with the modern fields in which they sit (Williamson 2016); whilst in other cases they share the same orientation (Ford 1979; Oosthuizen 2006; Williamson 2016); and in some both can be seen (McOmish *et al.* 2006: 202). Evidence from the excavated rectilinear settlement enclosures in the current study area suggests a common alignment in orientation at a site-specific level, showing that some settlements may have been linked by regularly shaped field systems in localised areas, such as can be implied at East Wideopen and Pegswood. Remote sensing analysis has shown that the Mount Pleasant Farm rectilinear settlement enclosure, located on the north bank of the river Blyth (HER N27766), incorporated, or was incorporated into, two parallel field boundaries which still exist (Figure 5.7). At Horsley Wood, a medieval township boundary formed the eastern side of the already mentioned Romano-British settlement (Tolan-Smith 1997: 74). If a shared or similar orientation between the orientation of rectilinear settlements and associated boundaries dating to the late Iron Age and Roman periods with surrounding 1st edition Ordnance Survey boundaries is present, this, as above, implies the latter may have originated in the same period. Elsewhere, at Hardwick, Cambridgeshire*,* Iron Age settlement and boundaries and medieval furlongs share similar orientation; and a possible Iron Age ditch has been re-used as a furlong extent, which still exists as a low bank representing a headland (Oosthuizen 2006: 36; fig 4.6).

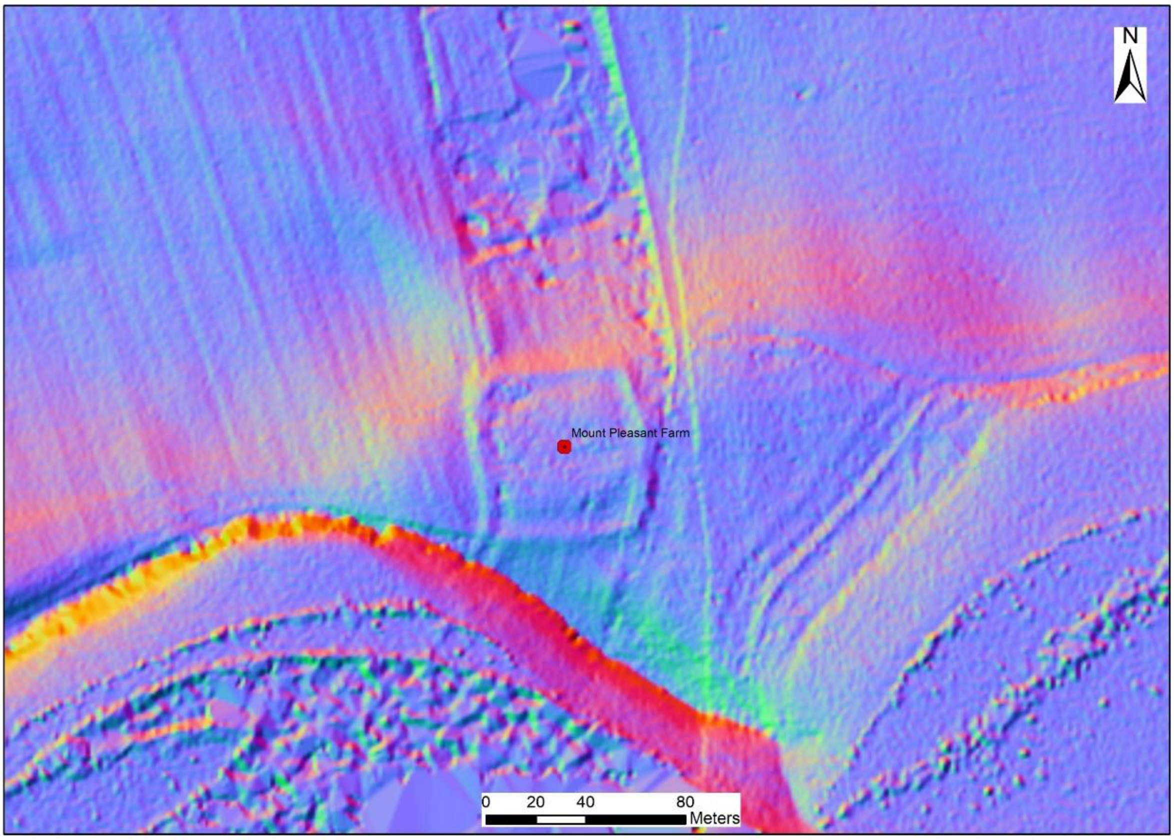

Figure 5.7 A newly identified rectilinear settlement enclosure encased within 1st edition Ordnance Survey boundaries at Mount Pleasant Farm. PCA performed on 4 hillshade images generated from 1m LiDAR DTM data (1m LiDAR DTM downloaded from Environment Agency, 2016)

Some ridge and furrow along the Salisbury Plain is clearly contained within pre-existing field lynchets whilst in other cases, ridge and furrow completely ignores pre-existing lynchets (McOmish *et al.* 2002: fig 5.3). A tithing boundary follows a prominent lynchet; however, a second tithing boundary cuts across the landscape ignoring all previous activity, including prehistoric lynchets and medieval furlongs.

This latter example suggests the land was not under cultivation when the boundary was constructed (McOmish *et al.* 2002: fig 5.3). Remaining in the Salisbury Plain, one area containing ridge and furrow lies on a spur connecting two Romano-British villages on Uphaven and Charlton Down, extending for up to 650m along contours. The width between ridges varies between five and ten metres, and furlongs are generally aligned on, and in many cases contained by, the so-called ‘Celtic’ or coaxial, field lynchets. Conversely, there is also evidence for ridge and furrow ignoring earlier boundaries. In most cases the underlying ‘Celtic’ fields have not been levelled by ridge and furrow; and this might indicate a relatively short period of cultivation, a temporary expansion into more marginal lands (*ibid*: 114).

At Barnby Moor, Nottinghamshire, a brickwork form of supposed Roman field systems was found to be overlain by an unrelated late enclosure complex of fields (Rippon *et al.* 2015: Figure 6.11). The ‘Roman’ system is, however, on the same alignment as former furlong boundaries preserved within the historic landscape within the former open fields around the medieval village of Blyth. This sequence is thought to represent a major planned landscape dating to the Roman period directly influencing the medieval landscape (*ibid*: 214-216); and in many ways encapsulates Rippon *et al.*’s argument for continuity.

The probable late prehistoric or Roman settlement remains and medieval furlongs at Harlestone, Northamptonshire, appear to illustrate high degrees of discontinuity between the two phases (Williamson 2016: illust 10; 281-282). These are shown in Figure 5.8. Through an unspecified method of analysis, Williamson stated that less than ten percent of prehistoric or Roman cropmarks within the Northamptonshire study area were oriented to within five degrees of surrounding medieval open-field strips. The minority of examples where the two share orientations were found in areas of poorly draining boulder clay, which implies the long-standing need for boundaries to be aligned according to the effective removal of water. This latter point finds common ground in the current study. Upon further inspection, the evidence at Harlestone, however, does include ancient linear cropmarks which *are* oriented to medieval furlongs and selions, most notably in the northern portion of the cropmark complex. It is therefore questionable whether comparing orientations of cropmarks, which are both undated and of unknown purpose, with evidence for furlongs and selions which can be relatively securely dated to the medieval period, provides meaningful results, as a prehistoric trackway, for example might have a different reactive relationship to the lie of the land than medieval selion strips. Williamson himself acknowledged that at least some boundaries and tracks laid out in the prehistoric and Roman periods must have endured and been incorporated into medieval land units (2016: 282). The evidence at Harlestone is a good example of this, which can also be applied to numerous sites in the current study area such as East Wideopen and West Shiremoor, in that some antecedent elements may be oriented with the later features, whilst others do not.

Figure 5.8 Relative orientations of Iron Age settlement and associated boundaries (black), and medieval furlongs (grey) at Harlestone, Northamptonshire (from Williamson 2016: illus. 10).

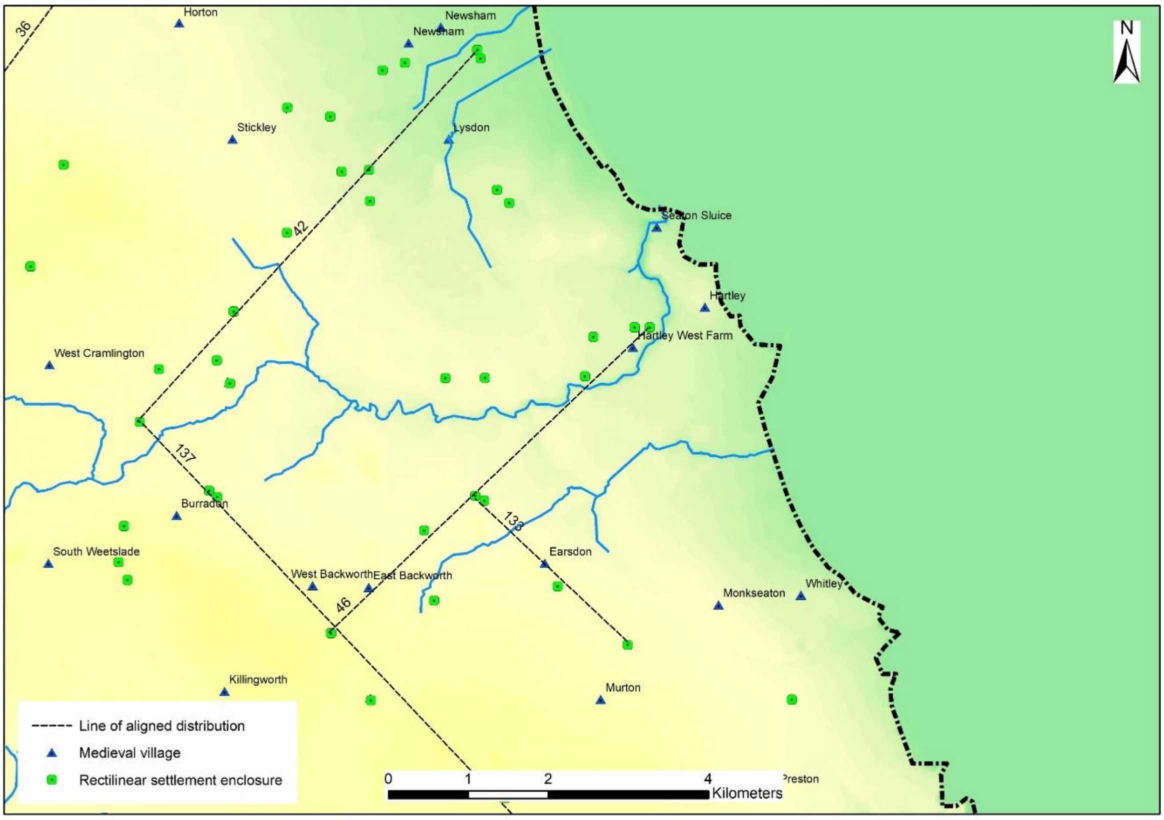

Figure 5.9 Hypothetical lines of aligned distribution relating to known rectilinear settlement enclosures in the North Tyneside area (50m DTM downloaded from Edina Digimap, 2017).

Two almost straight lines of rectilinear settlement enclosures, running at perpendicular angles of roughly 30 degrees and 120 degrees, is observable in the modern borough of North Tyneside, shown on Figure 5.9. The line of enclosures running 120 degrees includes one sub-circular enclosure north of Earsdon of unknown date. This perceived line skirts the ‘Shire Moor’ (now known as Shiremoor, an area of shared common land known to be in existence by the twelfth-century but which may have earlier origins than previously thought, which will be discussed in more detail in a later section. Taken with the line of settlements running on a roughly 30-degree orientation, these distributions appear to enclose a block of land between the settlements and the North Sea to the east. The character of one of these enclosures is somewhat speculative; but is rectangular and of similar dimensions to known rectilinear settlement enclosures in the area, although it was not included in the analysed dataset for rectilinear settlement enclosures. The area enclosed by the two lines of enclosures is now occupied by the modern settlements of Whitley Bay, Monkseaton and Hartley, all of which sit upon and extend from the cores of medieval villages. The hypothetical ‘annexed’ area in question does not contain any known pre-medieval archaeological features, despite archaeological investigations in advance of development (ASDU: forthcoming).

It is acknowledged that this absence of evidence is not evidence for absence; but at the time of writing the gap is apparent judging by the available data. If we are to assume that the area is indeed devoid of settlement or other remains dating to before the twelfth-century, when the medieval villages of Hartley, Whitley and Monkseaton are first recorded in documentary sources (Craster 1909), the Old English place-name elements within Hartley and Whitley (*ley* or *leah*, meaning a clearing, or field, in woodland) are clues as to how the landscape looked, and was used and experienced prior to this. Taken together, the evidence of place-names and lack of pre-medieval human activity in the area leads us to the assumption that this perceived annexed area contained woodland, possibly ancient, possibly managed; and the density of settlement enclosures surrounding it also implies the resource was shared. The Old English place-name element implies a wide date range for settlement of sometime after the end of Roman occupation in the early fifth-century, and before the Norman Conquest in 1066.

From this it could be suggested that the settlements of Hartley and Whitley have pre-medieval origins. Either way, the place-name element suggests that the area was under woodland until at least the post-Roman period or had re-wilded or used as managed woodland. Prehistoric settlement phases may have preceded the medieval villages at Whitley and Hartley, as was discovered at Shotton (Muncaster *et al.* 2014); and the inhabitants of these settlements within cleared areas had specific roles in the management of the woodland resource, and the animals which resided within it which represented a managed food source to nearby communities.

A further observation from this distribution pattern is the significance of the orientation on which they lie. The two predominant lines are oriented around 30 and 120 degrees, or north-east with the perpendicular south-east. It is the dominant axis of prehistoric field boundaries over large areas elsewhere such as the already mentioned Salisbury Plain (McOmish *et al.* 2006). These observed alignments of rectilinear settlement enclosures are also situated in an area which contains a relatively dense concentration of 1st edition Ordnance Survey boundaries and tracks which are also oriented at either 30 or 120 degrees. The areas of greatest density are, significantly, clustered close to the settlement enclosures, with very few in the area beyond towards the North Sea coast. Attempts were made to identify similar aligned distributions oriented differently, but no patterns of the numbers included in the 30/120 degrees axis could be seen on present evidence.

Critics of these ideas may argue that they imply large-scale landscape planning, which is not seen as tenable to some (for example Harvey 1976; Williamson 2016). The results of slope direction conformity analysis also sit in opposition to the idea of this type of land management, as will be shown later. These interpretations do not, however, assume that a complete coaxial system of field boundaries and tracks were laid out in relation to the distribution of these settlements. Instead, settlements could have been laid out on, or close to, resource linkage routes which were arranged along a north-east or south-east alignment to reflect the very general patterns in direction of underlying slopes close to the north-east coast, connecting communities to different natural resources, sometimes over long distances. Williamson (2013; 2016) argued that these initial routes were gradually infilled over long periods to form the field patterns present on 1st edition Ordnance Survey maps, which is likely to be the case throughout the current study area. Fields for arable and pasture relating to rectilinear settlement enclosures may well have projected from; or been influenced by the orientation and alignment of these linkage routes; but unpicking which ones were and which ones are later is something even excavation and scientific dating would struggle to achieve.

This theory cannot be supported by relevant evidence derived largely from transcribed roads, tracks and footpaths on 1st edition Ordnance Survey maps, despite many of these features depicted being oriented around 30 or 120 degrees, but only for short distances. It could be that these ancient tracks have almost completely disappeared from the landscape by the nineteenth-century, with fragments encased within later field systems which comprise the 1st edition Ordnance Survey data. It is also possible they were never there in the first place; and the alignments of settlements were more of a symbolic expression; and were connected by other routes. The purpose of resource linkage routes was to connect communities with a variety of natural resources and different topographic contexts in which different types of agricultural activity could be practiced. In the current study area, one or more settlements along the coastal plain, located within good workable arable land, would have required wood for fuel and building, and open moorland for seasonal grazing. Conversely, upland settlement communities may have required plots for arable in lowland contexts; or wanted access to acquire surplus crops from arable farming communities; resource linkage routes provided the means to do this (Williamson 2013; 2016).

Observed at a larger scale, more, albeit less obvious, patterns of alignments with similar orientations can be observed across the entire study area (shown in Figure 5.10), forming what could be perceived as ‘bands’ of settlement zones with considerable gaps between. Approximately 6km north-west of the line skirting the possible wooded areas of Hartley and Whitley is another alignment of rectilinear settlements on a very similar orientation, between Annitsford and Newsham, for example.

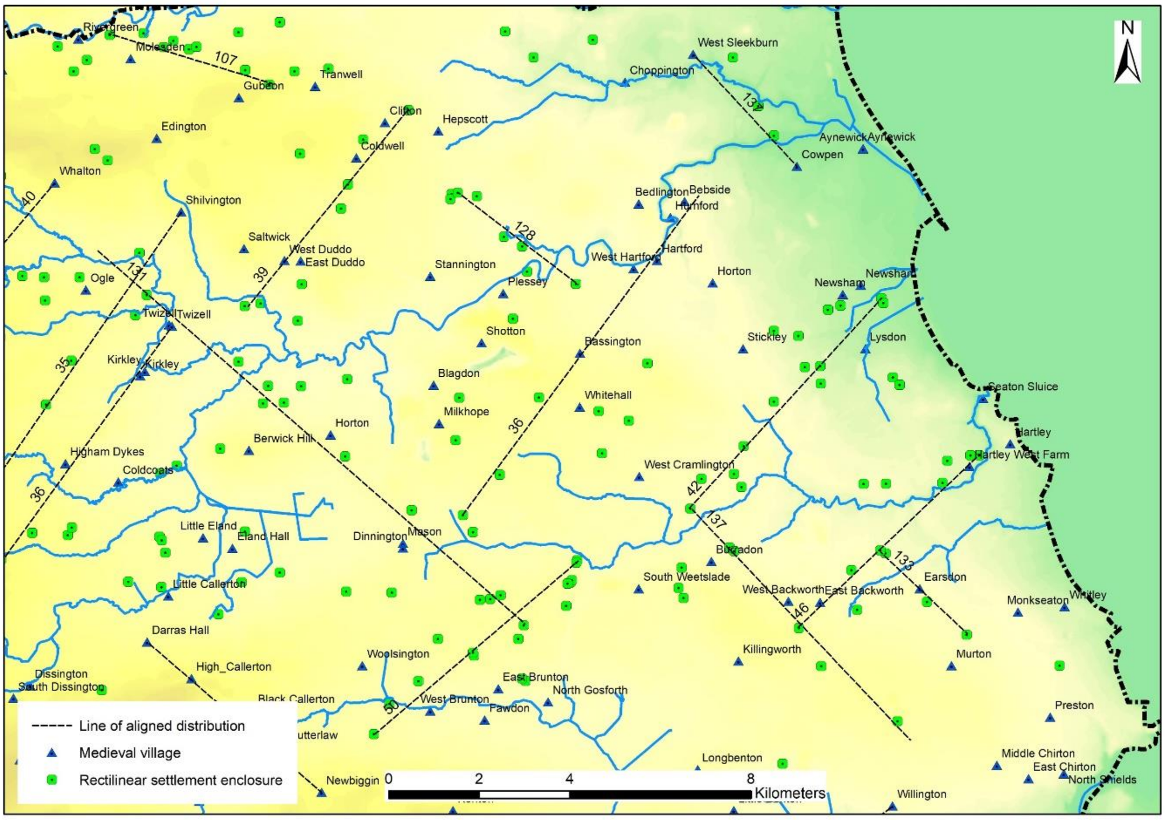

Figure 5.10 Further hypothetical aligned distrubutions in the study area, some of which incorporate medieval villages (50m DTM downloaded from Edina Digimap, 2017)

To the west of the Great North Road, the same distributions on similar alignments can be seen in large numbers. These alignments, again oriented roughly south-east or perpendicular north-east, are completely at odds with the prevailing direction of field boundaries and tracks present on 1st edition ordnance survey mapping; and with the most common direction of medieval-period ridge and furrow ploughing. Could these patterns simply be coincidental? If we follow a proposition by that at least some medieval villages overlie pre-medieval settlements (Roberts 2015: 41-44), which has been observed in excavations at both West Whelpington and Shotton, albeit with large gaps between occupation phases, the aligned distributions of both Iron Age/early Roman period settlement enclosures and medieval villages is more easily imagined.

The perceived aligned distribution of both Iron Age/early Roman settlement enclosures and medieval villages towards the west of the study area lies along the south-east flanks of the Swin burn and Dry Burn along the southernmost portion. This could be interpreted as a northern ‘extension’ of the alignment clustered along the River Wansbeck and the Crook Dean. Figure 5.10, above, shows these conjectural lines. The area between these two alignments is more sparsely populated on present evidence. This perceived aligned distribution is therefore probably not continuous, but two clusters which can be explained by a shared proximity to nearby water courses. The aligned distributions of settlements along the eastern coastal plain are more difficult to explain through topographic factors. The main rivers and streams in this area run predominantly west-east, whilst the aligned distributions are oriented either north-east or perpendicular south-east. Some settlements within the alignments are located close to rivers and streams, but others are not.

The idea of lines in the landscape is well established in prehistoric studies. Early interpretations of ‘fire pit’ alignments in Belgium and the Netherlands, consisting of depositional activity placed in a linear arrangement of pits, for example, stressed the association with topography, such as ridges and water courses. Many have recently been uncovered through archaeological excavations, the results of which have led to the proposition that the typological approach should be reconsidered; and that fire pit lines cannot be reduced to a single phenomenon or a single purpose (Løvschal 2014). Field patterns along the Denghie peninsular in Essex have been used to illustrate how resource linkage routes formed the origins of what have been termed fossilised prehistoric coaxial field systems (Williamson 2016: 271-277). The general topography here is similar to south-east Northumberland in that the main river valleys run west to east. Williamson showed how the longer linear boundaries and tracks ran west-east, whilst those running generally north-south were much shorter, and therefore believed to be a result of gradual ‘infilling’ over many centuries. If Williamson’s theory holds true, we might expect to find a similar pattern in the current study area; however almost all long linear units, present on 1st edition Ordnance survey maps as boundaries, tracks and footpaths, are generally more north to south in orientation, often traversing multiple watersheds.

The perceived combined aligned distributions of prehistoric/Roman and medieval settlements do not therefore conform with the routes of river valleys. The analysis of orientation of ridge and furrow in relation to underlying slope direction returned results which implied the latter was not an important consideration for the layout of the former. The apparent disparity in orientations between the grain of slope, aligned distributions; and field boundaries and ridge and furrow, suggests that many medieval settlements may indeed be located on the sites of earlier settlements; and the fields, furlongs and selions farmed by medieval communities were the result of a variety of considerations including conformity to slope direction.

The observations described here were initially part of a desire to explore the significance of a south-east orientation in the current study area. Although the above ideas should be taken with caution, they do offer clues on how the landscape may have been organised and used by individuals and communities during the period between the Iron Age and medieval period; and suggest a degree of endurance in the form of some boundaries and tracks, and settlement distribution.

5.4 Conformity to underlying slope direction

Although the importance of drainage to farmers in the past has been recognised in research contexts, it is rarely investigated in any detail. Peter Fowler’s wide-ranging account of farming in prehistoric Britain, for example, devoted relatively little space to the importance of drainage (Fowler 1983), despite the wealth of evidence for probable prehistoric ploughing in Britain including swathes of cord rig north of the current study area which in most cases appears to conform to underlying slope direction (Topping 1983; 1989). Logic would imply that achieving the free flow of surface water from fields in the past would have been facilitated by orienting fields and arable strips down or across a slope, rather than diagonally; but little is known about the relationships between people and the actual ground upon which they lived and worked in the past. The results of orientation and slope direction conformity analysis show that this dynamic cannot be dismissed.

5.4.1 Extents of conformity

The extent to which people in the past required features to conform to underlying slope direction inevitably varied. For example, 100% of pit alignments in south-east Northumberland conformed to within 30 degrees of underlying slope direction, as opposed to just 34% conforming to within 20 degrees; whilst the disparities are much tighter for later features. Although the pit alignment interpretations should be viewed with caution due to the small dataset, the upward trend in conformity from 20 to 30 degrees discrepancy permeates through all features. A thirty degrees threshold can still be seen to conform to underlying slope direction as was shown in a previous chapter; but at the edges of this threshold the practicalities of drainage, for instance, would be more compromised than if a feature conformed to within a narrower threshold.

The pit alignment conformity results, including those from the Milfield Plain, with so little conformity to within 20 degrees of underlying slope direction, suggests that conformity was perhaps a more general consideration at this time, with rivers appearing to be the pivots around which systems of pit alignments were laid out; and the more nuanced variations in slope direction were not deemed as important as the territorial boundaries which they may have demarcated. There may have been less need for drainage due to their purpose, which might have been to demarcate territory rather than enclosing fields. The gap between 20 and 30 degrees discrepancy shortens in the ancient boundary data, which may be the result of a greater need for effective drainage, suggesting these boundaries served a different purpose. Lower proportions of medieval and post-medieval ridge and furrow found to conform to 20 and 30 degrees of underlying slope direction suggests another change in the relationship with the grain of slope, where improved technology such as drainage and the widespread use of the mouldboard plough enabled other factors to play their part in the layout of linear human-made land-units. This development, and the importance of rivers, and other natural features, will be discussed in more detail later.

Total SEN_aspect_50m units: 399191

Orientation	Units	%
10_100	117518	29
20_110	79508	20
30_120	77148	19
40_130	99455	25
50_140	102367	26
60_150	83212	21
70_160	84413	21
80_170	80414	20
0_90_180	103367	26

Table 5.3 Proportions of 50m resolution aspect values within the current study area

As Table 5.3 shows, the largest proportions of slope orientations throughout the study area are around 10/100 degrees (29%), but 0/90, 50/140 and 40/130 all have over 25 percent representations. The lowest proportion are for slopes oriented around 30/120 degrees. This latter figure explains the low numbers of linear features oriented this way in the current study area if the results are interpreted according to conformity to slope direction. A surprising result is that slopes oriented around 80/170 degrees comprise the joint-second lowest proportions in the dataset. Initially, this does not tally with the results of so many linear features which are oriented this way; but thresholds overlap, so the high numbers of features oriented around 90 degrees should also be taken into consideration here.

Feature	% conforming to within 20 degrees of underlying slope	% conforming to within 30 degrees of underlying slope
Pit alignments	34	100
Ancient Boundaries	49	71
Rectilinear settlement enclosures	59	69
Early Medieval boundaries	48	78
Medieval nucleated villages	49	72
Medieval ridge and furrow	49	70
Post medieval ridge and furrow	50	70
1st edition boundaries and tracks	49	70

Table 5.4 Levels of slope direction conformity amongst all analysed features

The results of slope conformity analysis to within 20 degrees of underlying slope direction show in most cases a near 50-50 split between conformity and non-conformity. Rectilinear settlement enclosures showed the greatest conformity to underlying slope direction using these thresholds, with 59 percent of the dataset; whilst pit alignments showed only a 34 percent proportion. Changing the discrepancy threshold from 20 to 30 degrees showed a consistent change across all features, to a 70-30 split in favour of conformity. The results of the above analyses, shown together in Table 5.4, strongly suggest that respecting lie of the land was a serious consideration; but other things may also have been, such as land allotment and cosmological aspects. These factors had to be balanced when making decisions of land-allotment. Considering these other factors and variables probably explains the variance in conformity to underlying slope direction across all features, from some conforming to within 10 degrees; and others not conforming at all.

Settlement ditches in some cases probably served an important drainage function, keeping the occupation and work areas, including those for metalworking, textiles, food production, relatively dry. Ditches at Morley Hill Farm, for example, were thought to be used for managing water from around the settlement area (Headland 2018). The high levels of conformity to underlying slope direction of these features bolsters this interpretation. Issues with recess water around Morley Hill farm are still evident today, with large areas to the south and south east of the settlement enclosures submerged for much of the year. Only a small proportion of the Iron Age/early Roman settlement enclosures and associated boundary ditches at West Shiremoor conform to within 20 or 30 degrees of underlying slope direction which suggests they fulfilled a different function such as dividing areas of activity around the settlement which required less of an emphasis on drainage. This is still surprising though; as not conforming to slope direction to this extent would have probably led to drainage issues around the settlement site. It implies that other factors held precedence here, such as existing land tenure at the time the settlement and boundaries were laid out, or a push towards orienting to an axis, in this case around 105 degrees, regardless of underlying slope direction.

The ditches which characterise the remains of roundhouses along the coastal plain are termed ‘drainage gullies’ for a reason; and it would make practical sense to position entrances facing away from the prevailing wind and rain, which in the case of north east England is north-west. The fact that most excavated rectilinear settlement enclosures superseded unenclosed phases consisting of roundhouses with east or south-east facing entrances may explain the predominant east facing entrances of succeeding enclosures.

Most medieval village orientations cluster around 80/170-and 90/180-degrees, with 51 percent oriented between 80 and 100 degrees. Forty-nine and 70 percent of these conform to within 20 and 30 degrees of underlying slope direction respectively. Prevailing winds also had to be considered; and it would have made practical sense to orient medieval dwellings with the gable facing the wind direction. As most if not all peasant houses had thatched roofs, fire must have been a real concern, and changes in wind direction could have been disastrous (Roberts 2008: 235).

The boundaries of Parliamentary Enclosure of former waste or moorland, the straight, regular enclosures generally fit with existing field patterns in the vicinity, which in most cases conform to within 30 degrees of underlying slope direction. The Shire Moor was enclosed in the nineteenth-century, but although oriented differently to earlier field patterns in the vicinity, the straight boundaries still show a high degree of conformity to within 30 degrees of underlying slope direction. This reduces in terms of a 20 degrees threshold in the enclosed Shire Moor compared with the neighbouring field pattern to the east, within Murton township, illustrated in Figure 5.11. The two can be compared statistically using the Shiremoor and Murton township extents respectively as shown below.

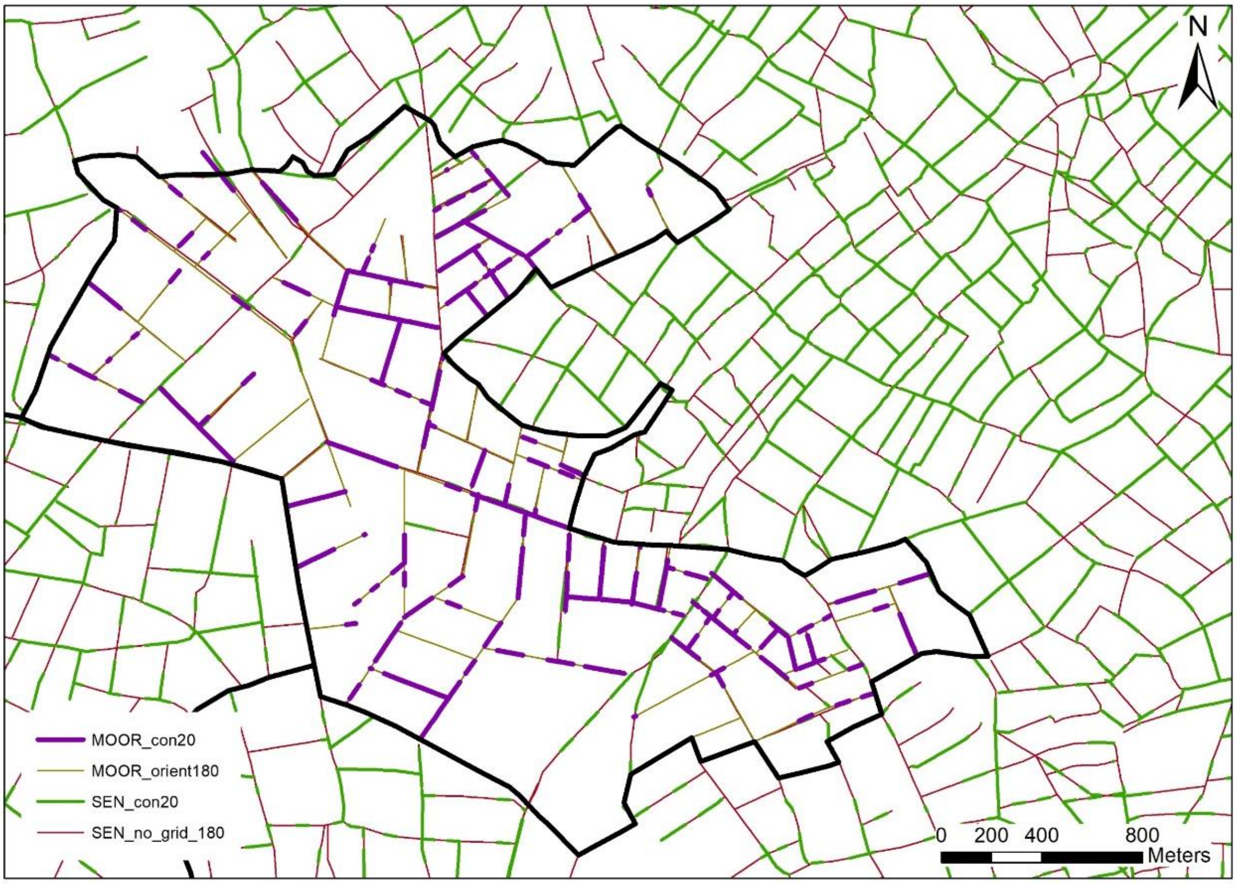

Figure 5.11 Levels of slope direction conformity within and around Shiremoor. Black line represents the extent of the Shire Moor in by the late eighteenth-century

- MUR_SEN: 22996
- MUR_SEN_con20: 13701 (60%)
- MUR_SEN_con30: 17806 (77%)
- MOOR: 28307
- MOOR_con20: 13126 (46%)
- MOOR_con30: 19615 (69%)

These results above show a clear difference in the amounts of units conforming to within 20 and 30 degrees of underlying slope direction between those in Murton township and those within the enclosed Shire Moor. The boundaries within Murton probably developed over a long period in relation to a framework based on a common orientation, which was in place as early as the medieval period if not before. The basis for this could be the 120 degrees boundary crossing through the township conforming almost wholly to within 20 degrees of underlying slope direction, from which numerous shorter, later boundaries project. This observation shows how underlying slope direction has led to the appearance of a common and enduring orientation amongst boundaries, tracks and settlements over long periods.

5.4.2 Slope direction and ploughing

Evidence for closely conforming cord-rig cultivation to underlying slope direction north of the current study shows the importance of respecting slope direction to farmers in prehistory. The narrow nature of cord rig morphology correlates with contemporary climactic trends broadly between the early Iron Age and the Romano-British period, when research has shown conditions of increased precipitation and a decline in temperatures (Topping 1989: 164). Ditched boundaries, for example, were often aligned at right angles to slope directions to improve drainage; and the same can be said for open field strips from which many enclosed fields developed in the late medieval and post medieval periods (Williamson 2016: 280). It is also easier to plough either along or at right angles to the slope direction. If the layout of fields and plough-strips was in large part dependent on enabling the free flow of surface water through respecting underlying slope direction, this could be suggested as a force for continuity in at least the ‘grain’ of the human-made landscape; and is evidence for the responsive dichotomy between the natural landscape and human-made features.

The practical and topographic contexts of prehistoric narrow-rigg ploughing have been compared with medieval ridge and furrow in the Kirknewton area, north Northumberland, in which the former was found to respect the lie of the land, whilst the latter was observed running diagonally to the hillslope. Ploughing along contours in the way demonstrated by the cord rig halts or slows soil erosion, helping to maintain the vital nutrients of the soil (Topping 1983: 22; 1989: 163-164). The evidence here for medieval ridge and furrow on the other hand was considered wasteful; and probably representative of a short-term form of agriculture, as its cross-contour nature would have promoted soil and nutrient erosion from exploited areas (Topping 1983: 23). In this instance the medieval ridge and furrow was probably a product of a short-term expansion of arable beyond the two or three field system medieval townships in this region often exploited more upland areas for arable for short periods, sometimes to enable the fallowing of one of the open-fields (described by Butlin 1964: 105; 113-114).

It was normal for strips to be ploughed flat in an anticlockwise direction during the fallow season in order to displace soil towards the edge of the furlong, as the regular ploughing in a clockwise direction moved soil to the centre of the strip; over a period of years this action led to the build-up of a marked ridge, which would result in very high, sloping ridges and furrows which would have cut deep into the infertile subsoil (Williamson 2003: 148-149). This must have been a difficult task given the deep furrows and high ridges; and it is hard to imagine the plough team negotiating the extremely undulating terrain. It does offer an explanation for instances where geophysical survey and excavation have encountered more than one direction of ploughing, for example the evidence contained in the geophysical plots at Choppington (AD Archaeology 2016), some of which clearly do not conform to the lie of the land; and at Highham Dykes (NZ 13374 75359) and Bradford (NZ 06605 79574) there are blocks of medieval ridge and furrow which do not conform to within 20 degrees of underlying slope direction, shown in Figure 5.12, where selions running diagonally across the slopes around Higham Dykes give the appearance that maintaining a common orientation was prioritised over conforming to the lie of the land. Examples such as this invoke the potential difficulties the plough teams involved in ploughing these areas experienced; and makes one wonder whether the tenurial layouts and arrangements of medieval open-fields held such importance that topographic constrains, which would have made certain furlongs difficult to plough, were not always given serious consideration. In some cases throughout the study area evidence for a lack of slope direction conformity might be echoing evidence in the Kirknewton area of short-term expansion of arable beyond the established open fields; whilst in others it could be the use of *solskifte* in organising furlongs in open fields which could be the case in the fields around Backworth medieval village in the current study area mentioned above (also see Astbury 2013).

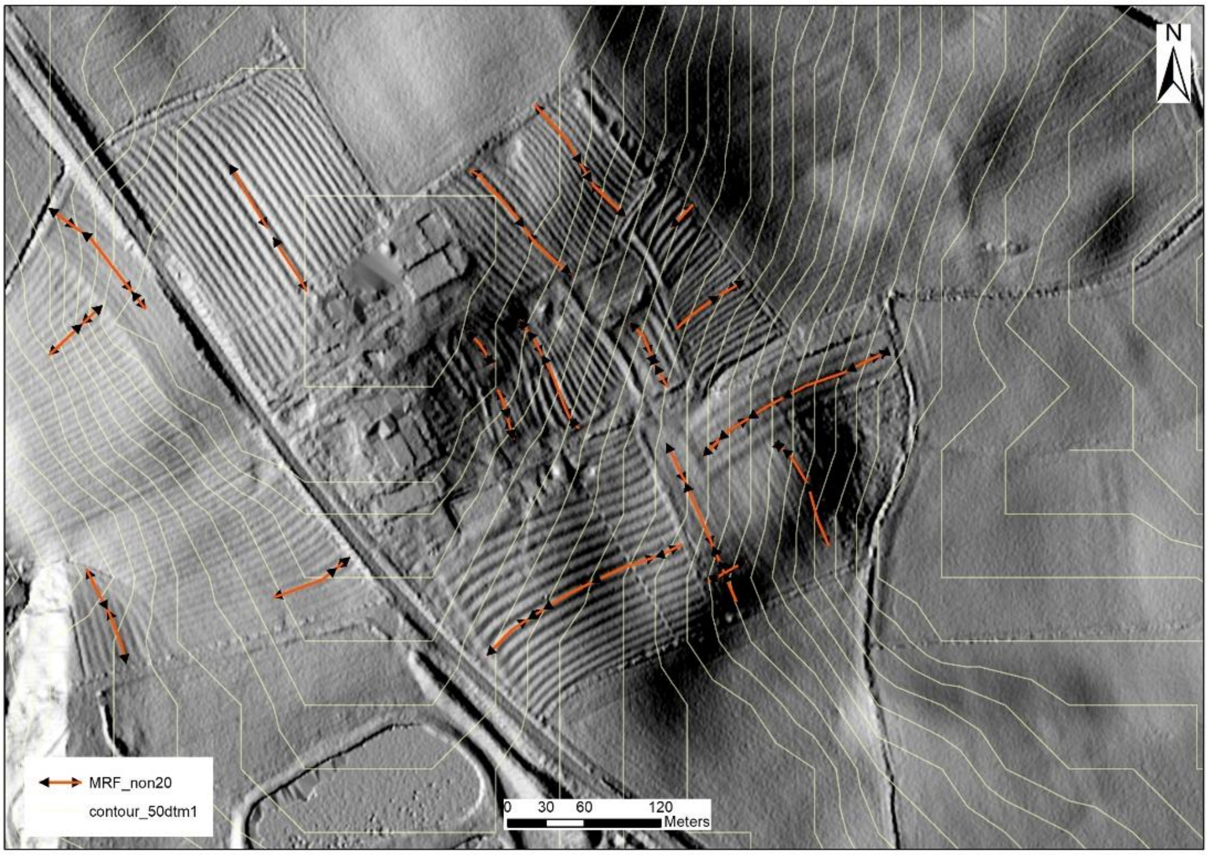

Figure 5.12 Non conformity to underlying slope direction amongst medieval ridge and furrow around Higham Dykes (LiDAR hillshade lit from 270 degrees, data downloaded from Environment Agency, 2016)

A return to warmer conditions in the period 1100-1300 entailed that excessive moisture was less of a problem to farmers. These conditions must have been influential, along with the uptake of the mouldboard plough, in the widespread use of ridge and furrow ploughing, which was much wider than cord rig, in some cases reaching 20m between ridges. Climactic deterioration occurred once again between 1300 and 1800 which explains a return to narrow ridged cultivation, around 2-6m wide (Topping 1989). Topping accepted that this was a general hypothesis, and that other factors should be considered when reconstructing early cultivation and systems, including the need to increase soil depth at higher altitude sites (Topping 1989: 164). Furthermore, the Northumberland coastal plain became the most progressive agricultural region in the country during the middle of the nineteenth-century (Williamson: 2002: 112-113). The advances in drainage technology could therefore account for the lower percentage (45%) of post medieval ridge and furrow which conforms to underlying slope direction than medieval examples (50%) in the region. Where field boundaries and ridge and furrow within them do not conform to grain of slope, it could be that one of the advanced drainage systems mentioned above was being employed; and this helps to date them to either the late medieval or post-medieval periods. The low numbers of units oriented around 30 or 120 degrees implies that the lower incidences of conformity were not due to a significant axis being utilised. It could also be that tenurial organisation had by this time overridden conformity to underlying slope direction as a factor behind the layouts of linear units. Judging by the high conformity to underlying slope direction amongst historic township boundaries, discussed earlier, this could be a later phenomenon.

The preservation of cord rig in the uplands shows these areas must have been used largely as pasture or moorland since then; but it also shows that some parts of the uplands were conducive to arable agriculture during the Bronze and Iron Ages. The lighter, shallower soils would have been more easily worked using an ard, once stones had been removed from the surface, compared with the heavy clays of the lowlands which would have posed many difficulties due to its composition. It has been argued that the development of the iron ard during the first millennium BC did enable heavier clay soils to be cultivated (Rees 1979; Jones 1981; Frodsham 2006: 139); but it is likely on current evidence, and what we know about the problems with ploughing clay soils (Williamson 2003: 150), that it was not until the mouldboard plough came into use that arable become the dominant form of agriculture in these areas. Excavations have shown that the main cereals consumed on lowland sites in the late Iron Age/early Roman period were spelt wheat and hulled barley (Hodgson *et al.* 2012: 203). The high frequency of arable weeds in environmental samples indicate the poor soil conditions characteristic of extensive, expanding cultivation in the late Iron Age (*ibid*), but it is not clear how successful these forays into arable agriculture along the coastal plain were. Considering the heavy, poorly draining soils along the coastal plain, and the probability that the mouldboard plough was yet to be introduced, we might imagine only limited success.

Limited animal bone assemblages on most sites are not seen to be a true reflection of the nature of the economy due to poor preserving soils; and it has been put forward that the emphasis was on cattle in both the late Iron Age and the early medieval period (Hodgson *et al.* 2012: 203-205; Banham and Faith 2014). There has been a tendency to take the concept of Anglo-Saxon farming for granted, and instead focus on the more powerful and educated sectors of society (Banham and Faith 2014: 6). The evidence for determining methods of ploughing, and the fields in which it may have been practiced, is patchy throughout Britain for the early Anglo-Saxon period; and environmental evidence suggests a strong bias towards animal husbandry and a move away from extensive crop cultivation (Banham and Faith 2014: 141), which was echoed by the findings at Shotton in the current study area (Muncaster *et al.* 2014).

Along with climatic considerations, soil and water management depends on the fundamental properties of the soil itself. Most land requiring drainage consists of 'intermediate clay' (30-50 percent clay) or 'heavy clay' (50-80 percent clay) (Cook 2009: 20-21). These are common to the current study region, deemed by soil surveys to be moderate or low-to-moderate fertility (Landis: no date). Drainage was probably not the sole purpose and benefit of ridge and furrow ploughing. Ridging increased the area of ploughsoil exposed to wind and frost, so may have been intended to increase flocculation (Williamson 2003: 150). Despite this, poor drainage was taken seriously by manorial courts, according to contemporary records. The water displaced by ridge and furrow had to be conducted to natural watercourses without causing flooding elsewhere. The banks of soil at the end of each furlong, known as 'headlands', generated from the process of ridge and furrow, often impeded the flow of water, so outlets were regularly dug using a trenching spade or trenching plough. Despite these measures, after long periods of rain the water often stood for long periods in the furrows (Williamson 2003: 150).

Ridge and furrow gains further importance as a tool for drainage when placed into the context of large, unhedged, open fields which characterise arable agriculture in the medieval period (Cook 2009: 24). Ridge and furrow ploughing using a mouldboard plough helped to remedy the problem of excess water in poorly draining soils, thus enabling land otherwise unsuitable for cultivation to be exploited. Ridges are normally higher on clay soils (Hall 1999: 33). The ridges provided a raised, warmer and drier growing area for crops, and the furrows acted as drainage channels. This could not be done using an ard, as it cannot turn the soil, it just cuts into it and stirs it. A mouldboard plough lifts and turns the soil in one direction, traditionally to the right (Banham and Faith 2014: 56-57). The soils along the coastal plain are predominantly heavy clay, not conducive to ploughing using an ard, and which are prone to puddling in winter and cracking in summer. It is likely therefore that any presence of arable fields associated with Anglo Saxon settlements such as

Shotton would be dependent on the mouldboard plough; and that arable was either very limited or part of an agricultural regime further west on lighter soils. The mouldboard plough may have continued in use in all regions from the Roman period onwards, but subject to relative wealth in certain areas (Oosthuizen 2006: 14-16). This may explain why livestock seems to have been the dominant form of agriculture during the Anglo-Saxon period, coupled with the wetter climactic conditions of the first millennium AD (Banham and Faith 2014).

5.4.3 Coincidental shared orientation

The evidence analysed so far sits between the conflicting views of those arguing for continuity of settlement and land-use (Bonney 1979; Jones 1979; Drury and Rodwell 1980; Rippon *et al.* 2015; Oosthuizen 2006; 2013; Roberts 2015); and those suggesting more change (Hodgson *et al.* 2012; Williamson 2016). Shared alignments and orientations are usually embedded in the theories for continuity (Rippon 2015; Oosthuizen 2006). These perspectives, in most cases regarding evidence from south of the current study area, have wider implications for our understanding of the character of social, economic and cultural change in the post-Roman period.

It has been said in studies based beyond the current area that long term continuity evidenced through similar orientations, especially in their more extreme forms, are misleading, and do not acknowledge either topographic contexts or practical functions of the field boundaries and their patterns in different periods (Williamson 2016: 264-265). The idea that shared orientation is evidence for continuity of land-use has been shown by this research to be less clear cut than was previously thought. An alternative reasoning can be put forward, that the shared orientations of settlements and boundaries from different periods is coincidental; and is due to the shared purpose of conforming to underlying slope direction over long periods of time, perhaps with long gaps between phases of occupation and land use and around a single site.

It could be the case that during different phases of activity, individuals and communities realised the importance, perhaps both practical and symbolic, of aligning their boundaries and tracks to conform to underlying slope direction, albeit to various extents. Common south-east orientations are present in large tracts of prehistoric field systems recorded on the Salisbury plain (McOmish *et al.* 2006: 51-

56); but it has been shown recently that this common orientation is coupled with a close conformity to the grain of slope (ENGLalD: no date). The same can be said of the ancient boundaries analysed in the current research, with 82 percent of those oriented around 30 or 120 degrees conforming to within 30 degrees of underlying slope direction.

The practical, economic and social factors behind the act of laying out large-scale field systems have been questioned (Williamson 2016); but their importance was recognised in interpretations of how coaxial fieldscapes may have developed (Rippon *et al.* 2015: 160). To give one example, Rippon *et al.* (2015) argued for continuity through alignment at a cropmark complex and nearby excavation at Linacres Farm in Claines, Worcestershire, where the linear features were found to share an orientation with extant field boundaries present on 1st edition Ordnance Survey maps (*ibid*: 260-262; fig 8.4). One axial field boundary shares an orientation with the cropmarks, whilst others in the vicinity do not. It was thought that by the time other later boundaries were laid out, the Romano-British enclosure complex had been ploughed flat and was no longer influential as a pivot. Furthermore, the Roman period ditch does not share an exact orientation with overlying ridge and furrow (*ibid*: 262). The excavated section of a ditch could well be contemporary with the cropmarks of field divisions; however, when the evidence is analysed from the perspective of slope direction, the argument could be made that these features are unrelated, and share orientation through the coincidence of adhering to topographic conditions in different periods, as may be the case in numerous examples in the current research.

To give one example in the current study area of the ideas put forward above, the orientations of cropmarks relating to a rectilinear enclosure at Holywell Grange Farm are similar to some 1st edition Ordnance Survey boundaries and tracks in the vicinity. Levels conformity to underlying slope direction are also consistent between the cropmarks and 1st edition Ordnance Survey boundaries: seventy-three percent of 1st edition Ordnance Survey boundaries in this area conform to within 30 degrees of underlying slope direction; and fifty-three percent conform to within 20 degrees. Local topography must therefore be considered an influence in the layout of boundaries over long periods; and where other factors were deemed more important, such as establishing large rectangular blocks of fields such as was done through

Parliamentary Enclosure, this is where the areas of non-conformity to underlying slope can most clearly be seen.

Relationships between boundaries and settlements from different periods are difficult to determine when a common orientation is observed between features of different dates, with both also confirming to underlying slope direction; but when other boundaries in the immediate area are oriented differently. If these latter features are found not to conform to underlying slope direction, the case for contemporaneity is strengthened, if not confirmed, as only excavation could prove or disprove any theories put forward here. Although it is tempting to draw hypothetical lines between 1st edition Ordnance Survey boundaries and tracks oriented to 30/120 degrees and the Iron Age/early Roman ditch complexes, there is often variance in underlying slope direction, which would hinder a continuation of this prevailing orientation if conformity to underlying slope direction was a key consideration.

Results have shown rectilinear enclosures were in many cases oriented to conform to within 30 degrees of underlying slope direction, which is reflected in the orientations of associated projecting boundaries and trackways. Furthermore, it would have made practical sense to position roundhouse entrances to 120 degrees to face away from prevailing wind. Positioning settlements on the east or south east face of slopes would have aided this. Research undertaken on other field systems elsewhere using NMP data have also shown that underlying slope direction is a significant factor in the orientations of boundaries beyond the current study area (Williamson 2016; EnglAID: no date).

Rectilinear enclosed settlements and medieval nucleated villages are most commonly oriented around 80 degrees. Within these thresholds 88 percent of the former, and 71 percent of the latter, are located within 1km of a known watercourse. Just 29 percent of these rectilinear settlement enclosures conform to within 20 degrees of underlying slope direction; and fifty one percent to within 30 degrees. Forty-nine percent of those medieval villages conform to within 20 degrees of slope direction, a figure which rises to seventy-two percent using a 30 degrees threshold. Interrelated reasons could explain this in both cases. The first is that situating settlements close to fresh water supplies would have been an obvious requirement for the survival of a settlement. This on its own should explain the high levels of closeness to rivers. But it could also be that the settlements were purposefully aligned with river valleys which generally dictate the lie of the land. The disparity in levels of conformity perhaps shows us that rectilinear settlement enclosures were not laid out with the same strict conformity to underlying slope direction as medieval villages; or that the landscape units into which both were inserted might have been more conducive to the lie of the land in the medieval period than in late prehistory. Some of the evidence for medieval ridge and furrow described above would suggest otherwise, however. Natural features did not wholly dictate the locations of settlements, but it is safe to say from the results of this research they were an influencing factor.

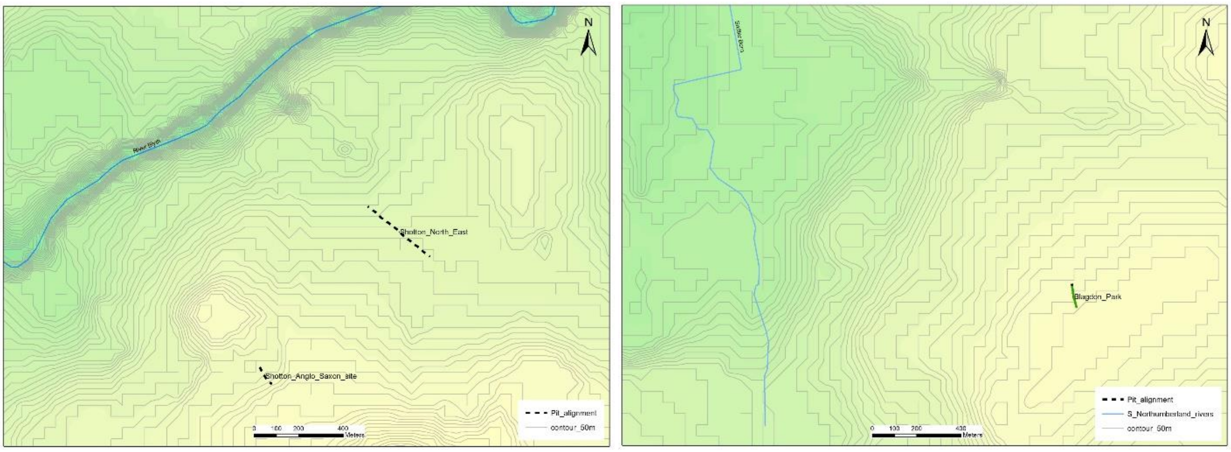

Figure 5.13 Relative orientations of pit alignments around Shotton, and the nearby River Blyth (left); and Blagdon and the Snitter Burn (50m DTM and contours downloaded from Edina Digimap, 2017)

The importance of river valleys as pivot points for prehistoric monuments is well documented (Bradley 2000; Richards 1996a; Williamson 2016); however, orientation analysis allows us to explore the extent to which people and communities in the past felt the need for the built structures which defined them to conform to the lie of the land; and how this might have changed over time. As Hodgson *et al.* (2012) stated, the pit alignments at Shotton run perpendicular to the river Blyth, and the pit alignment at Blagdon Park is roughly parallel to the Snitter Burn, 1.4km to the west, which can be seen in Figure 5.13. The orientation of the pit alignment at Fox Covert appears to be governed by its proximity to the now-drained Prestwick Carr. The pit alignments discovered at Blagdon Park also share a common orientation with later boundaries. These have all been found, as with the whole pit alignment dataset, to conform to within 30 degrees of slope direction. When viewed against the river valley, a general sense of conforming to the lie of the land is clear; but as the resolution is increased to a 20 degrees threshold of conformity, far less of these features respect underlying slope direction. A possible unexcavated pit alignment at Gardener's Houses Farm discovered through gradiometry survey (Biggins *et al*. 1997) lies on a parallel alignment to the one excavated at Fox Covert. On the evidence from this study, however, this is likely to be a result of respecting the lie of the land rather than consciously maintaining a common orientation in in pit alignments. Conformity to underlying slope direction is therefore a question of scale, and extent depending on the feature. This will be explored in more detail in the final two chapters.

Whether or not pit alignments were wholly or partially visible within later periods, the evidence suggests that the alignments along which they were constructed were in some cases retained at least into the medieval period. This perceived endurance of a common orientation could be at least partially attributed to topographic factors. Evidence for human-made linear features following the natural grain of slope can be seen throughout south east Northumberland; but the best examples lie within the townships of Horton and Whalton, which will form the basis of a case study in the next chapter. It is clear from the results that the grain of slope has influenced the layout of settlements, boundaries and tracks since prehistory.

Looking further afield for similar trends, an eighteenth-century map of central London (Rocque 1769) shows a large proportion of existing fields and tracks prior to the mass urban expansion of the nineteenth-century. Examining this alongside the locations of tributaries of the River Thames which are largely culverted even by the time of the Roque map, it can clearly be seen that linear human-made features are oriented according to these rivers which feed the River Thames. The rivers and their associated valleys represent the natural grain of slope in the landscape, but in this case they clearly also, like in the current study area, act as the pivots from which linear features project from and with which they are aligned. The Rocque map, like any historical map, is a representation of probably millennia of human activity and it cannot be discounted that some of the linear features depicted have medieval, Roman or prehistoric origins. A degree of caution is necessary, as the orientations and origins of some boundaries and tracks will have been borne out of other factors such as specific land tenure rights from various times in the past. It is striking, however, that a known Roman Road, Watling Street, which connected Roman London with Verulamium (now St Albans) to the north and beyond does follow the grain carved out by the river valleys north of the Thames; and is also the line from which numerous boundaries and tracks extend. This pattern can still be seen in the modern street layout.

At West Tilbury, Essex, cropmarks identified on Google Earth show probable ditches on a different orientation most present today. The cropmarks can be seen running parallel and perpendicular to a buried paleochannel (Figure 5.14). Some present-day boundaries and routeways are also oriented with the paleochannel and the cropmarks of ditches, including an old coal track depicted on the 1st edition Ordnance Survey map. It is unlikely that the cropmarks represent post-medieval enclosure boundaries due to the difference in orientation. As with some of the evidence presented above, this mix of orientations in a small area could be representative of the survival of elements of past land-use into the present. The paleochannel may not necessarily have been an active water course when these boundaries were laid out, but it was probably recognised as a wetter area which may have been used to dictate the layout of boundaries in this discreet area.

Figure 5.14 Relative orientations of now buried watercourses, probable ancient boundaries (white lines) and existing boundaries sharing near West Tilbury, Essex (Google Earth)

It appears that any similarities in orientation of medieval nucleated villages and 1st edition Ordnance Survey are only evident where the grain of slope enables it. Watersheds and natural ridges were also prominent pivots for land units (Williamson

2013; 2016). The following section will briefly explore whether digital methods can be used to compare calculated watersheds with the trajectories of possible early linear tracks and boundaries transcribed in the current study, using Horton township as a test-case. The exploratory methods used for this analysis can be found in Appendix B and Appendix C. The topography within Horton township is dominated by a prominent ridge which defines the western township boundary. From this the ground falls steadily away east-north-east, consistent with the 50 and 60-degree threshold in which most of the linear features are oriented. A high proportion of 1st edition Ordnance Survey features in this area conform to within 20 degrees of underlying slope direction (59%), with 79 percent conforming to within 30 degrees. These figures are significantly higher than the average across the study area. It is striking that to the west of Horton, within Cramlington township, the 50, or 160, degree orientation is almost absent. This evidence, shown in Figure 5.15, suggests that the grain of slope had a profound effect on the layout of linear features from prehistory through to the post-medieval period; and the extents of township boundaries in some cases were dictated by changes in grain of slope. Studying the orientation and conformity to underlying slope direction of 1st edition Ordnance Survey at Horton in relation to underlying soils may provide a reason for this concentration of conforming linear features. The dominant grain is clay throughout much of the coastal plain which does not change within Horton township; however, it does however lie on a geological 'boundary' separating heavy and medium clays. The soil group along the coastal plain is heavier than those to the immediate west of this line.

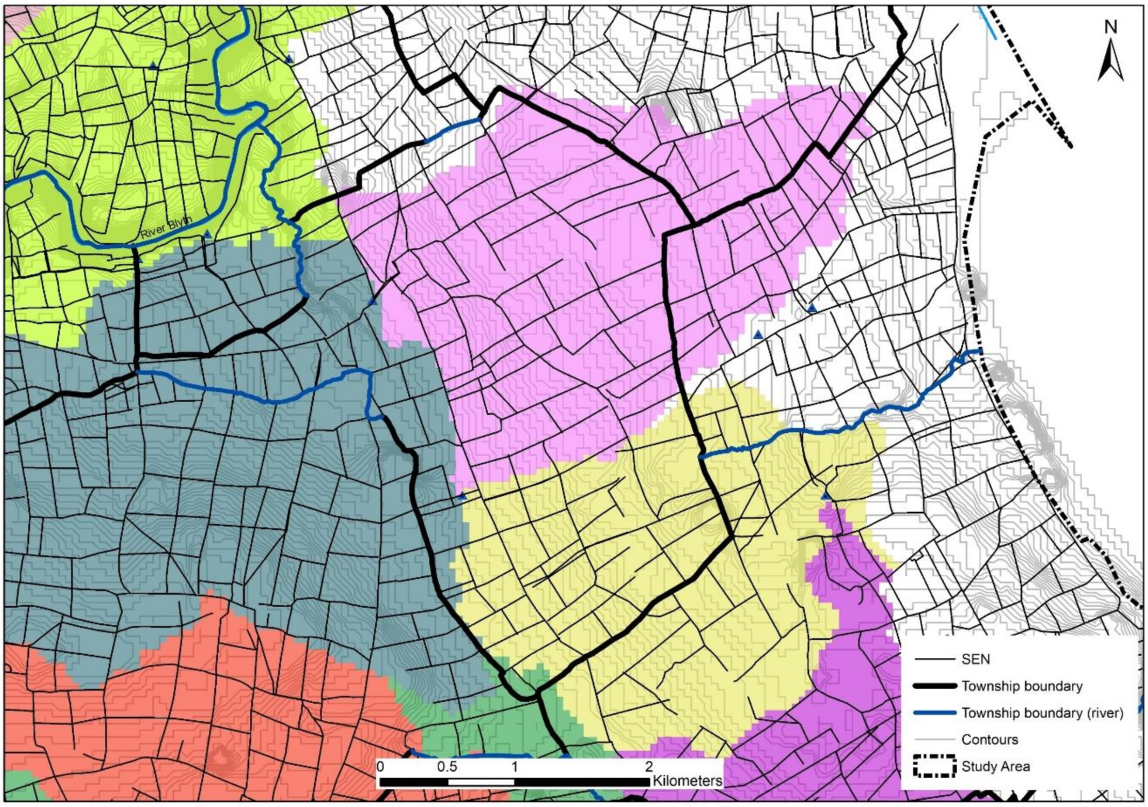

Figure 5.15 Watersheds around Horton township, the interfaces of which are marked where the colour changes

The fieldscape present on the 1st edition Ordnance Survey map is clearly anchored to the road which runs around 60/150 degrees along a distinctive ridge, which have been termed as 'watershed routes' (Williamson 2013: 89). The orientation of this road conforms to within 20 degrees of underlying slope direction for much of its course; and other, later tracks branch off this very close to perpendicular orientations (see Figure 5.16). From this the arrangement of boundaries and route-ways present by the nineteenth-century can be unpicked to reveal the genesis of boundary patterns in this area. The earliest datable linear features within the township are three rectilinear settlement enclosures of probable late Iron Age/early Roman date; all are oriented around 60 degrees. There is a fourth settlement enclosure (HER N11485) which is oriented quite differently, at 93 degrees; but all largely conform to within 30 degrees of underlying slope direction. Large portions of the township boundary are oriented to around 60/150 degrees and conform to within 30 degrees of underlying slope direction. The primary route-way through the township is oriented at 157 degrees; from which almost all boundaries present by the nineteenth-century are linked. Together this evidence shows a common orientation, governed by the lie of the land, for at least two thousand years in this discreet area.

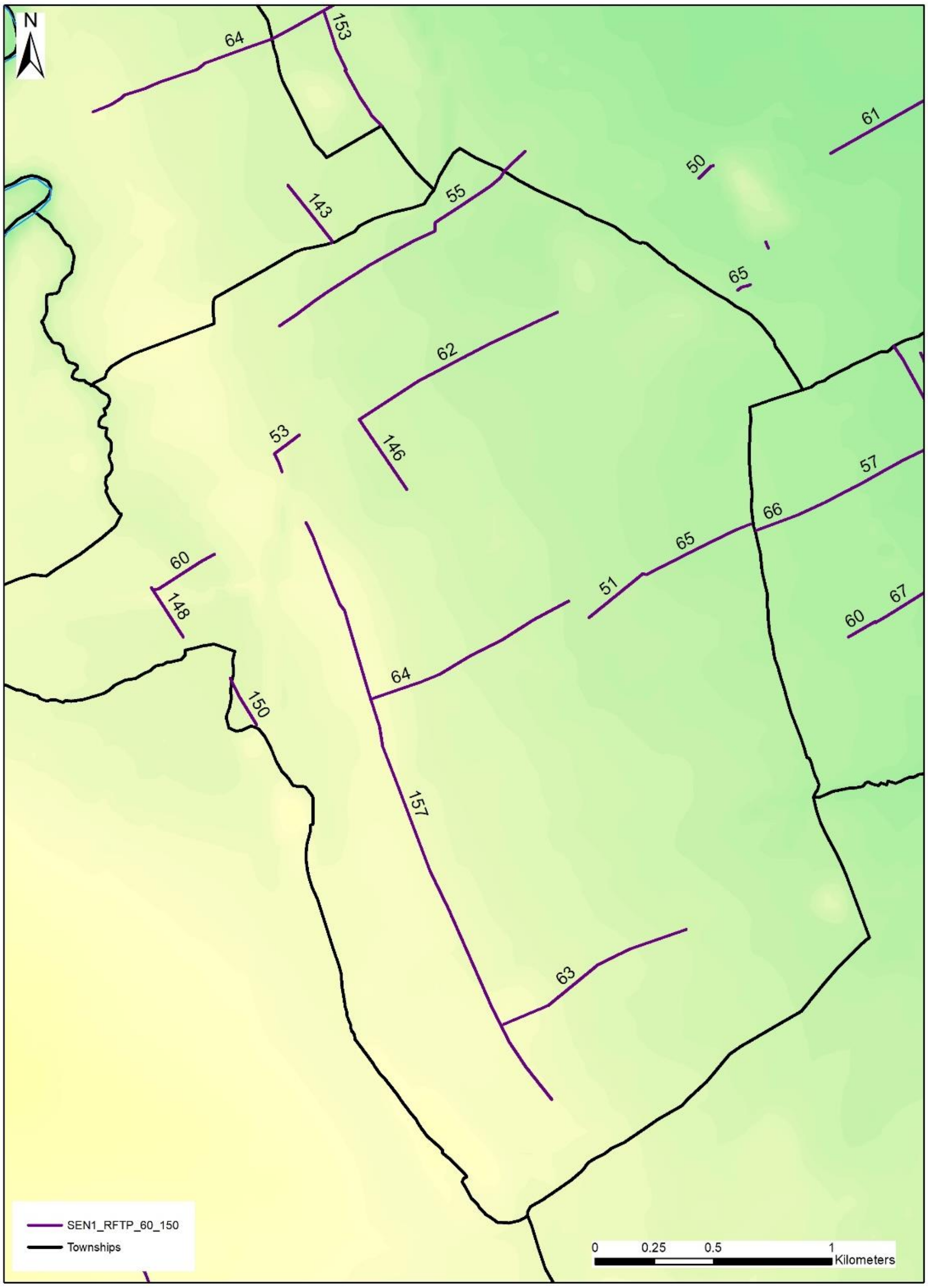

Figure 5.16 Roads and tracks depicted on 1st edition Ordnance Survey mapping whcih are oriented around 60 or 150 degrees within Horton township (50m DTM downloaded from Edina Digimap, 2017)

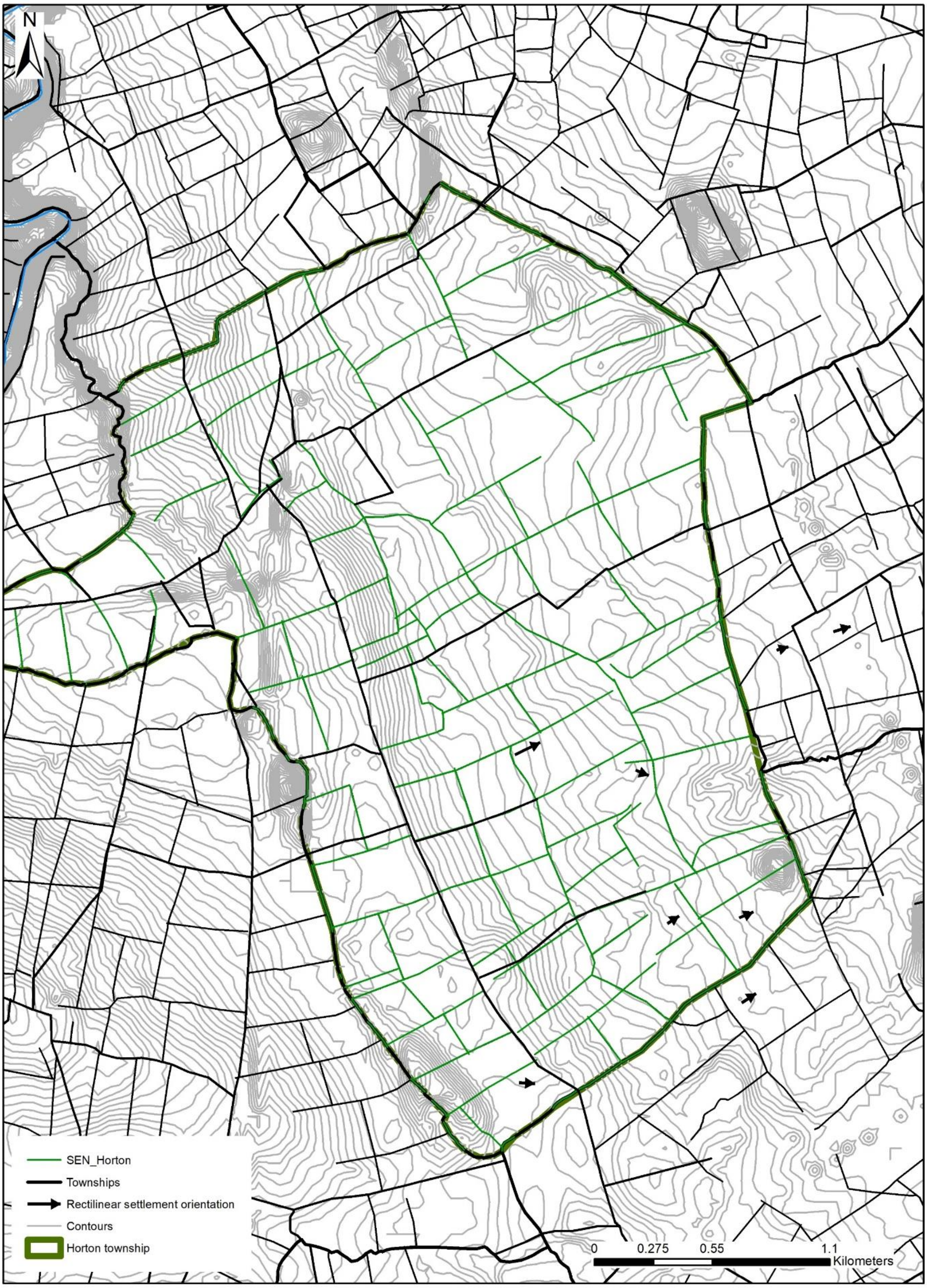

Figure 5.17 Orientations and the lie of the land in and around Horton township (contours derived from 50m DTM downloaded from Edina Digimap, 2017)

The watershed plot does show some correlation with the orientations of 1st edition Ordnance Survey boundaries at Horton. Figure 5.17 shows the collective evidence for rivers, contours, the levels of conformity to underlying slope direction of township boundaries and the orientation of 1st edition Ordnance Survey boundaries. All follow a similar pattern which, from a reductionist perspective, leads to the proposition for natural topography being the main influence over the layout of boundaries and tracks since at least the Iron Age considering that rectilinear settlement enclosures in the area share the same orientation.

A higher proportion of features excavated and dated to before the medieval period conform to the grain of slope than after. Why would a community need a common alignment over large areas, at the cost of facilitating drainage unless it was coming from above as some command; or from below as part of a received wisdom, tradition or cosmologically derived practice? Would it be easier to manage land-use in regular blocks? Would communities/tribes have had the means, or inclination to bother with this? Maybe in such a densely populated area as the coastal plain was in the late Iron Age, where space must have been at a premium, a level of common understanding and organisation must have been present in some form; and this might have led to the landscape being organised along regular linear alignments. The ‘Community Area’ theory, devised by John Bintliff, stressed that the apparent continuities in the placing of settlements over long periods may well have been the result of the convergence of natural conditions, or ways of using the landscape, rather than due to genuine continuities of local peoples (Bintliff 2001: 36-37); and the same may apply to the many examples of settlement and land units in the current study area which show high degrees of conformity to underlying slope direction.

The levels of conformity to underlying slope direction across most features, but especially those dated to prehistory, invites the proposition that communities were creating land-units as “microcosms of local topography” as described by Richards (1996a: 333) in his exploration of the links between henges and water. Entrances to henges, including those in the Milfield Basin, were mostly oriented to match the flow of water in nearby rivers and the general orientations of river valleys. That conformity to the lie of the land has been recognised from such early times, and through the current research showing that this prevailed over millennia, albeit becoming more diluted as the results show, suggests that human-made landscape features including individual and groupings of settlements, boundaries and tracks were created to embody a physical representation of local topography which created a series of homologies of how the landscape should be experienced and used over long periods.

5.4.4 The importance of the lie of the land

As it has been shown above, the results of this study imply the landscape as we see it at any one time is the result of a constant tension between natural and human actions. This aligns with recent ideas of landscape development discussed in the introduction. For example, on the surface lie the remains of past and present human activities, such as ridge and furrow ploughing; underneath this, however, lie the soils and geology, and directions of slope, that enabled these actions to occur in the way they did. This dialectic is largely borne out in the high conformity to underlying slope direction revealed by orientation analysis; and the examples which do not. Together, these represent the tensions between human will and the deep rooted constraints and enabling qualities of the natural landscape. Over time, human will has been shown to have found ways to bypass these constraints, through improved drainage technology for example. This leads to other human factors probably influencing the layout of boundaries for which human agency becomes more prominent in creating the variables relating to decisions about land use.

The possibility of both enduring landscape features and the presence of coincidental slope direction conformity could be applied to anywhere in current study area; and both could be present in some areas, with common orientations tied in with the lie of the land. The proposition of a common grain in the orientations of settlements and land units within the current study in prehistory is hard to uphold, however. Orientations changed regularly from place to place at numerous scales, as the results above show. The same can be said for elsewhere, such as Perry Oaks, Heathrow, where large-scale excavations showed the orientations of land units constantly changing through time (Framework Archaeology: 2006). If there was a common desire to lay out boundaries and tracks which conform to underlying slope direction, and some extant boundaries were still visible to successive and later generations; and if other circumstances allowed, such as rules of land tenure, then there is no reason to suppose that these existing boundaries were not incorporated into successive patterns. Conforming to underlying slope direction appears from this evidence to have been more important to people during the late Iron Age and early Roman periods than any push to a common orientation. The results challenge the idea of regularly oriented ‘Celtic’ fields being laid out in single acts on a regional scale in prehistory and Roman times in the current study area, which are thought to have been laid out regardless of underlying terrain in some cases (Field 2008). This is not to dismiss the idea of regular rectangular fields laid out around settlement enclosures, however, but conformity to slope direction entails that the orientation of regular fieldscapes would have been different from place to place depending on underlying slope direction.

The results of this research suggest a tension between conforming to underlying slope direction and creating coherent, regular land divisions. The importance of orienting boundary systems and settlements to conform with underlying slope directions would explain the local variation in orientation, from settlement to settlement, and field system to field system. We could from this viewpoint envisage a late prehistoric settlement, with field-system surrounded by common waste. This sounds very much like how the medieval landscape would have looked; and in some cases, nucleated villages have been found to have developed from single farmsteads which dated to the middle Anglo-Saxon period (Jones and Page 2006; Wright 2015). This may also explain why there are varying degrees of conformity to underlying slope direction; and localised uniformity of boundary layouts, rather than large coaxial systems with the same orientation across the landscape. In areas where uniformity is present, it looks to be the result of the consistent grain of slope. The variation in underlying slope direction across much of the study area meant uniformity was not possible at a regional scale. It seems that where it was possible uniformity was employed, such as is found in known earlier features, such as the pit alignments at Ewart and Redscar; and the Iron Age boundary systems at East Wideopen and at Pegswood. However, maintaining a common orientation over long distances irrespective of the lie of the land does not seem to have been practiced in the current study area. To bolster this theory, where uniformity is known beyond the current study area, such as the prehistoric fields along the Salisbury Plain, high conformity to underlying slope direction is also a common factor (EnglAID: no date).

On current evidence it appears that no sub-circular Iron Age settlement enclosures, common in the uplands, were present along the coastal plain. This distinction could reflect a deep relationship with the lie of the land and associated land allotment in place by the Iron Age. A sub-circular enclosure in upland areas by proxy is likely to be on a hill; and evidence from some sites shows that boundary systems ‘radiate’ outwards from these settlement enclosures, effectively wrapping around the hillside and thus conforming to underlying slope direction. Traces of cord rig, although not included in the analysis here, also suggest a high level of conformity to the lie of the land (Topping 1989). In this way the sub-circular morphology of the settlement enclosure, and the radiating boundaries fulfilled two things: they maximised productivity through effective drainage; and acted as a human-made reflection of the hill upon which it sat. The dialectic relationship between humans and the natural world is here brought into focus through practical and possibly associated symbolic gestures showing a deep respect for the natural world.

To a lesser extent this respect for the lie of the land can be seen at Shotton in the Iron Age and 1st edition Ordnance Survey boundaries north of the medieval village which lies on a prominent ridge; and in the cropmarks at Holywell Grange Farm which occupy a low hill. These observations further highlight the importance of underlying slope direction to the layouts of settlement and field systems. The terrain is obviously much flatter along the coastal plain, so linear features were not as bound by the ground upon which they were situated. Rectangular blocks of fields could be laid out where consistent slope direction permitted, perhaps strung along pre-existing routeways. These conditions are present with Whalton and Horton townships, to give two examples. Rectilinear settlement enclosures could easily be inserted into these regular axes, thus continuing the common trend in orientation. A caveat to this is that many rectilinear settlement enclosures are situated in upland areas, debunking the idea of a distinction between rectilinear in the lowlands and sub-circular in the uplands; however, there are examples of radial systems of boundaries projecting from these, such as the settlement enclosure (HER N9257) west of Dere Street (Figure 5.18).

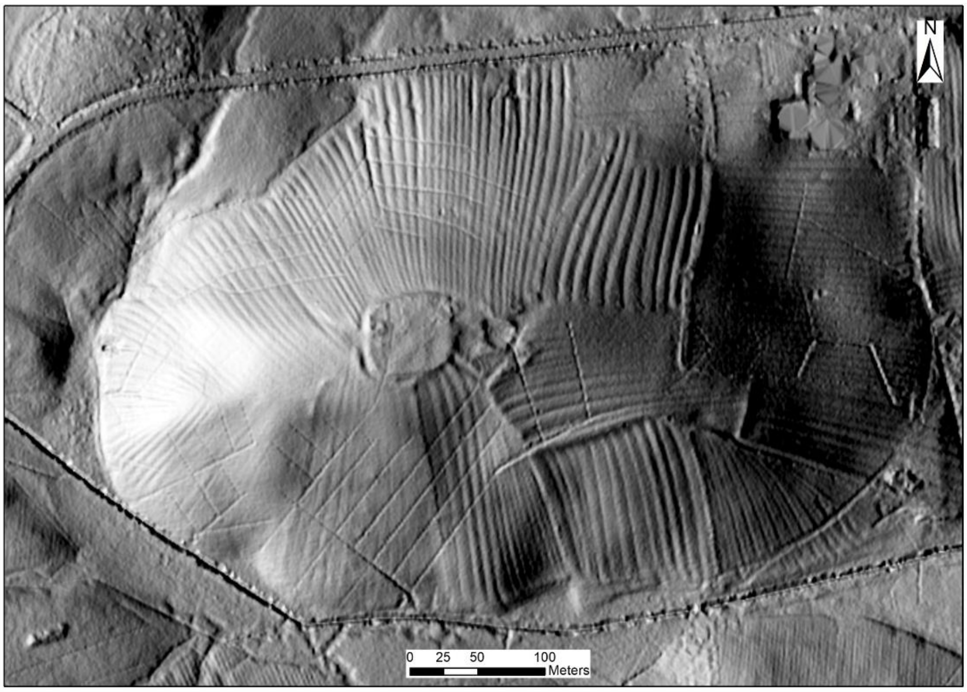

Figure 5.18 A probable Iron Age settlement and radial fields west of Dere St. Note the probable re-use of existing boundaries to bound blocks of medieval ridge and furrow. LiDAR hillshade lit fom 270 degrees, created from 1m LiDAR DTM downloaded from Environment Agency, 2016.

We need to question why large swathes of the prehistoric landscape had to be divided up into coaxial field systems: how was it managed; and what did it achieve? A level of top-down governance of landscape resources must be assumed for the period succeeding the Roman Conquest north of Hadrian's Wall, which would have entailed the need for large amounts of wood, quarried stone, and crops and livestock (Hodgson *et al.* 2012), but current evidence cannot tell us what this replaced. A plausible argument has been made for a regime of managed woodland in the period (Hodgson *et al.* 2012: 205), but to extend this to all elements of the productive landscape is problematic. For there to be evidence of a change in the grain in orientation of land units over time, the 30/120 degrees orientations relatively common in pit alignments would have to be widespread amongst ancient boundaries, but they are not, and where they are present in large numbers, such as at East Wideopen, they appear to be present only as a response to the lie of the land in a given area. The only 'grain' apparent is that of natural slope direction and river valleys which in most cases provide the pivots around which settlements, boundaries and tracks are oriented.

Together, in similar ways to evidence from the current study area, it can be suggested that elements of the ancient landscape were at least influential if not integral to the layout of later boundaries and fields. Findings from this research have shown that conformity to underlying slope direction was a common denominator amongst features assigned to different periods which shared the same or similar orientation; however common orientations may have been followed regardless in some instances as may be the case at East Wideopen and Holywell Grange Farm. An interesting point is that the proportions of conformity decrease over time. This might imply that the axes associated with the rectilinear enclosures led to other linear features being laid out the same orientation, even though some did not conform to slope direction to the same extent that earlier features did.

The importance of rivers in prehistory is well researched, as places of votive offerings (Bradley 2000); and as influencing the layout of ceremonial monuments (Richards 1996a 1996b). That so many prehistoric artefacts are found in rivers indicates the deep respect prehistoric societies had for the natural world. These offerings are connected to many different contexts, including ending the life cycle of an object, possibly connected with the death of its owner; making lavish gifts to the gods; and removing objects from circulation (Bradley 2000: 37). It is beyond the limits of the current research to expand on these actions further; but the importance of rivers to prehistoric societies took multiple guises.

Not all societies make a sharp contrast between the ritual and the everyday (Bradley 1987: 3). The same levels of symbolism between Neolithic henges and natural topography discussed by Richards (1996a) are not implied along all features studied in this research. It could be that pit alignments were the physical embodiment of the landscape in which they sat, which as a result led to early demarcations of land and territory. But the practical dimensions of reflecting natural topography by conforming to the lie of the land should be recognised. Without this, certain forms of agriculture and domestic life would be made harder, so the symbolic and practical could be read as a dialogue between the two. If we assume that henges, and possibly also pit alignments, especially given the suggestion that some held water for long periods (Spratt 1993), were highly symbolic representations of natural topography, the same can be said for later linear features including those analysed in this research. There is symbolism in respecting the natural world, and recognising the importance of rivers, but this symbolism was probably tied up with economic needs to maximise the potential of agricultural land amongst other things, so the deeper symbolic relationship with the natural world became mixed with practical necessity. Over time drainage technology developed, for example the introduction and uptake of the mouldboard plough and with it ridge and furrow, the deep symbolism behind respecting the land may have been gradually supplanted by other factors. We see this in the conformity to underlying slope direction results, with the levels falling through the different periods represented by analysed features.

Returning briefly to votive deposits, it has been suggested that over time they became increasingly ‘domesticated’, in that the almost exclusive associations with natural features including rivers later included built constructions such as boundaries and the ditches around settlements (Bradley 2000: 152). The presence of placed quern stones in boundary ditches at Pegswood is an example of this in the Iron Age (Proctor 2009). This practice of depositing domestic items has been evidenced in the Anglo Saxon (Hamerow 2006) and medieval periods (Hinton 1990); and could be evidence of ‘ground up’ traditions which persisted over many centuries and were resistant to changes from above.

5.5 The 2nd to 6th centuries gap along the coastal plain

Existing models for landscape change and continuity are somewhat juxtaposed in terms of the current study area. On the one hand some studies stress the continuity of land-use from prehistory into the medieval period and beyond (Oosthuizen 2006; 2013; Rippon *et al.* 2015); whilst on the other excavations in the current study area have shown some evidence implying dramatic change during the Roman period (Hodgson *et al.* 2012). Moving slightly away from the specifics of orientation and conformity to the lie of the land, the following paragraphs will revisit Research Aim 1 in addressing chronological gaps, particularly that between the 2nd and 6th centuries AD. Recent research based on developer-funded excavations has led to the idea of a stratified society characterised by site morphology and wealth creation and surplus along the south-east Northumberland coastal plain prior to the Roman advance in northern Britain (Hodgson *et al.* 2012: 206-207). Excavations have revealed various sizes of contemporary settlement enclosures and the presence of metal working and other production on certain sites such as those at West Brunton and Blagdon Park 2 which have not been found on other excavated sites such as those at East Wideopen (Hodgson *et al.* 2012: 206-207; NAA 2016; 2018). This entails some sort of economic structure was in place, where the management and organisation of goods and services was required. The density of rectilinear settlement enclosures suggests little primary woodland would have been left on the coastal plain by the Iron Age, even if not all identified settlements were in use at the same time; and the woodland attested to in the microfossil and macrofossil record is akin to secondary scrubland that will have followed the clearance of primary woodland (Hodgson *et al.* 2012: 205). This could explain why there are only a few Old-English woodland place-names in the current study area, and as a result implies that woodland had not been allowed to regenerate in through the Roman period. Despite this, there must have existed extensive woodland resources somewhere in the region to be able to build and maintain the settlement structures; and such a source must also have been readily available to the incoming Roman army. It has been proposed that a regime of woodland management was in place to ensure supplies were replenished and timbers of appropriate ages available when needed. This regime implies a degree of common authority in place by the late Iron Age (*ibid*: 205) or communal arrangement if following the framework of common property rights, or CPrRs (Oosthuizen 2013), more of which will be discussed later. Some of the gaps in the distribution of settlements may therefore have been the locations of managed woodlands. The Stamfordham area has long been noted as devoid of settlements likely to date to the late Iron Age. Chance factors could account for the dearth; and Jobey and McCord (1968: 53) noted that the area contains 'Chester' place names which have in the past misled antiquarians into thinking they represent Roman military installations but are in fact Iron Age rectilinear settlement enclosures. If the perceived dearth in settlement density in this area is real, it could have been an area of woodland; and may also have marked a boundary or neutral area between the region containing distinctive rectilinear settlements towards the coastal plain and the area west of the Devil's Causeway, where a dense scatter of Iron Age settlements lay, many of which are more sub-circular in form (Hodgson *et al.* 2012: 205-206). The aforementioned area around Whitley and Hartley may also have been wooded and thus used as a shared resource by local communities.

Evidence from excavated rectilinear settlements is also suggesting that within a few years the settlement pattern and economic and social systems associated with them may have been largely swept away following the building of Hadrian's Wall. If this was the case, it is hard to say what replaced this during the Roman period, as direct evidence for continuity in occupation and land-use is scarce between the late second and sixth centuries AD north of the River Tyne. If the abandonment of native settlements along the coastal plain between the Rivers Tyne and Blyth is in time shown to be a widespread phenomenon and economic and social structures collapsed with the abandonment, it would have had a significant effect on land-use and organisation in this period. It could be a bookending moment which separates practices and fieldscape morphology of the late Iron Age and early Roman period from the emergence of medieval nucleated villages and associated open fields for which the earliest references and current archaeological evidence places in the twelfth-century AD.

Evidence for settlement abandonment in the second-century AD comes from sites excavated between the Rivers Tyne and Blyth. Comparatively few rectilinear settlement enclosures between the Rivers Blyth and Wansbeck have been excavated. It is possible therefore that excavation of some of the latter could help to address the chronological gap created by the abandonment evidence towards the Tyne. Many excavated and dated rectilinear settlement enclosures between the Rivers Blyth and Wansbeck were found not to share orientation with 1st edition Ordnance Survey boundaries and tracks or traces of ridge and furrow, which implies their earthworks may have been greatly reduced and ditches backfilled by this time.

To the east of the Devil's Causeway the morphology of Iron Age settlements is almost exclusively rectilinear, whereas to the west it is more mixed. This change has been thought to be indicative of a western border of the Iron Age social unit (Hodgson *et al.* 2012: 211). It is not clear whether Hodgson *et al.* are referring to the Devil's Causeway as the actual boundary of a territorial unit, but if so, it could feed into the notion of an earlier date for the Roman road which is oriented similarly to numerous ancient boundaries along the coastal plain. However, the Devil's Causeway traverses an area which marks a change in the natural topography of the region, between the coastal plain and the uplands, which also has to be a consideration, as does the proposed use of the feature as Roman road which was quite distinct from boundaries, tracks and agricultural practices.

A different narrative during the Roman occupation in the area is gradually emerging in the area directly north of the River Wansbeck, through three excavated settlement sites, Pegswood Moor, St George's Hospital and North Seaton. The settlement and boundaries at Pegswood were found to have undergone a significant change in the second-century AD, again around the time of the Roman advance in the region (Proctor 2009). It is unclear how long this phase lasted, but it is clear that a significant change in how the land was used occurred, including a change in the orientation of boundaries and tracks. Dating evidence implies the late Iron Age/early Roman phase at St George's Hospital originated at the same time that settlements between the Rivers Tyne and Blyth were being abandoned; and that this phase included evidence for more intensive agricultural activity then the earlier Iron Age settlement (ARS 2016: 87-92). This was thought to reflect the need for more intensive agricultural output as a result of the Roman militarisation of the area. Four distinct orientations were present at the St George's Hospital complex including Bronze Age, middle Iron Age and late Iron Age/Roman enclosures, a medieval ditch; and post medieval ditch. Some of these features from different periods share orientation, such as a Bronze Age enclosure and post-medieval linear boundary; and the middle Iron Age and medieval orientations are also very similar. There was no evidence for occupation or land-use between end of the late Iron Age/early Roman phase and the medieval ditch, which suggests the site was abandoned in the post-Roman/early medieval period; and the medieval ditch was by no means indicative of settlement on the site in this period.

At North Seaton, dating evidence from excavations showed an almost unbroken sequence between the late prehistoric and early medieval settlement and land use phases (The Archaoelogical Practice 2015). The Iron Age rectilinear enclosure, early Anglo-Saxon settlement remains, and the later medieval nucleated village, all occupy an elevated ridge which demarcates a change in slope direction, with a north-east south-west direction to the north of the ridge, changing to both east facing and north facing slope directions to the south. Field boundaries to the north almost all follow the lie of the land. To the south some field boundaries are slightly at odds with it; and are generally oriented very differently.

The changes during the first- and second-centuries AD, including field systems and settlement at sites just north of the River Wansbeck, and the abandonment of settlements closer to the Tyne, strongly suggest there was a change in the way the landscape was settled and utilised at some point during and after the second-century AD. With discontinuity between the Rivers Tyne and Blyth, and continuity north of the Wansbeck, we are left with the area between the Rivers Blyth and Wansbeck, in which numerous unexcavated rectilinear settlement enclosures are known. The high density of rectilinear settlement sites in this region could be a result of translocation by community groups further south which were encouraged or forced to abandon their long-standing plots north of Hadrian's Wall. The agricultural landscape in this area, at least as far north as the river Blyth, would probably have undergone a high degree of change to support the Roman army along the frontier; and existing economic and agricultural systems would not have been suited to this. Would the economic and social frameworks in place during this time have accommodated this kind of translocation amongst the native population? And what is to say the area was not already densely populated, that the distribution is reflective of a long-standing pattern of settlement? The lack of excavation of these settlements south of the Wansbeck prevents this from being explored further.

5.6 Continuity in practice and tradition

The final part of this chapter will consider other strands of evidence and the social and economic practices behind the distribution of settlements, boundaries and tracks; and how these may have led to changes and continuities over long periods. Orientation and conformity to underlying slope direction remain important considerations in these discussions. By the final two centuries BC, against a backdrop of rising population, many long-lived unenclosed settlements are replaced by earthwork enclosures on the same sites along the with Northumberland coastal plain. There was probably a more complex subdivision of the landscape between arable and pastoral use; and a gradation of settlement was manifest in smaller, sometimes unenclosed, interspersed sites becoming dependent on the earthwork enclosures, perhaps serving them through a network of traditional obligations (Hodgson *et al.* 2012: 206). Despite growing evidence for complexes of boundaries projecting from Iron Age and early Roman period settlement structures, we still have little idea of what the landscape between occupational areas really looked like; or how it was managed in such a dense network of settlements. Fragments of evidence survive relating to land use, such as the supposed depositional practice of placing quern stones upside down in a ditch as a votive offering at Pegswood Moor, interpreted as a possible marker of change from arable to pastoral activity (Proctor 2009).

The evidence offered by Rippon *et al.* (2015); and Oosthuizen (2006) from beyond the current study area suggests continuity in the character of land use throughout the Roman period and into the Anglo-Saxon period and beyond. It has been argued elsewhere that regimes of land-use and management which began at least in the prehistoric period persisted into the medieval period, where they were manifested in open field systems (Oosthuizen 2013; 2016). In terms of judging whether some boundaries present in today's landscape, or at least those present by the nineteenth-century, have ancient origins, we need to consider the social and economic mechanisms which would have enabled this to happen; and why some boundaries survived whilst others did not. One model, mentioned briefly above, consists of a system whereby co-owners of land govern their rights over a common pool of resources such as woodland, arable and pasture, through collective institutions known as Common Property regimes or Rights (CPrRs hereafter) (Oosthuizen 2013; 2016). The longevity of such property rights is possible, but hard to predict; and such landscapes where CPrRs might have been deployed are highly susceptible to changes in ownership, subdivision and inheritance. Changes may not always be the result of governance, so it is hard to see these economic and social structures in a given area at a given time.

Areas devoid of archaeological features are regularly interpreted as shared pasture from at least the Iron Age (for example see Roberts 2015). There is debate as to whether these areas fulfilled the same function into the Roman period and beyond, however. Collective rights may have become more restricted before the Roman invasion (Millet 1990: 96-97); or were swept away completely after AD 43 by the imposition of Roman law which required a complete reallocation of rural property rights (Gerrard 2013: 143). This may apply to the current study area, considering the apparent abandonment of many settlements, and changes to others such as Pegswood. However, it has also been shown that the Roman administration rarely forced their own laws on its subjects (Stevens 1966: 108); and that CPrRs present in Iron Age society persisted into and beyond the Roman period; but may have been influenced by Roman law.

How would CPrRs work in the current study area? Resources would have had to be accessible for a start. Evidence from late Iron Age settlements at East Wideopen, Brenkley, Holywell Grange Farm and Shotton, and the results of this study, suggest localised agricultural fieldscapes which probably varied morphologically from farm to farm. Amongst these localised field systems there may have been routeways linking places and resources, some of which survived into the medieval period and beyond, with some incorporated into enclosure-period field systems. A retrogressive mapping exercise of Horsley and Harlow Hill townships just north of the River Tyne found that long linear boundaries, some of which related directly to possible Iron Age settlement enclosures, survived and were included on 1st edition Ordnance Survey mapping, and is still present in today's landscape. This showed that a common orientation had endured in the layout of boundaries over long periods, even in the immediate vicinity of Hadrian's Wall (Tolan-Smith 1997). The results of this study have shown, however, that this is not a common trend.

Elsewhere in southern Britain, where Roman military presence was not as pronounced as in the current study area following the initial conquest, it is easier to imagine rural communities retaining at least elements of CPrRs through the Roman period; but in the current study area, where Roman activity is dominated by Hadrian's Wall and numerous military installations associated with the frontier throughout the period, the changes are far more pronounced and must have had greater consequences on the rural population. The evidence for possible change on a large scale in the current study area during and after the second-century AD tests Oosthuizen's theory of continuing CPrRs throughout the Roman and early medieval periods. Population shift and settlement abandonment; and possible alterations to the dominant axes for linear structures in parts of the landscape make it difficult to imagine how CPrRs could survive from the Iron Age to the early medieval period and beyond. An event such as the supposed widespread depopulation of native settlements north of Hadrian's Wall in the mid-second-century AD would have had profound effects on both the physical landscape and the economic and social mechanisms embedded within this; which may have included CPrRs. The economic purpose of farms would have had to change to accommodate a surplus dimension to cater for the Roman Army along the frontier, including the outpost forts. This would have been a drastic change from existing regimes, even if there was a hierarchical system governing the use of space and resources.

The relatively sudden presence of the Roman army and associated installations would have had profound effects on property rights in the region, as the economic purpose of farms would have had to accommodate a surplus dimension to cater for the forts and *vici* on the frontier. The inability of existing systems to cater for the new consumers along Hadrian's Wall may account for the growing evidence for depopulation amongst settlements in the region. It could have been that a small number were maintained from which large areas were farmed, as 'ranches' (Hodgson *et al.* 2012: 217-218); and, as has been stated above, the later phases excavated at Pegswood and St George's Hospital could be evidence for this. Some rectilinear settlement enclosures further south could also be linked with this hypothetical system, such as the distinctively shaped scheduled settlement enclosure at Hazelrigg which shares orientation with some later field boundaries in the area, of around 80 or 170 degrees, whilst others in the vicinity do not and are oriented closer to 100 degrees. The common orientations shared by the settlement enclosure and surrounding boundaries present on 1st edition Ordnance Survey mapping could be evidence for endurance, which could also be the framework of continuity into which CPrRs could endure.

The Anglo-Saxon settlement at Shotton consisted of seven enclosures, a concentration similar in size to smaller later nucleated villages. The possibility of land held in 'common' can be entertained in this context; and may have paved the way for later systems associated with later regularly planned nucleated villages such as that occupying the ridge 400m to the north at Shotton. If more of these 'proto-nucleated' settlements like Shotton await discovery in the area, it is possible that systems of CPrRs would have been used to manage the way the land was used and divided around them. We cannot say on current evidence whether Anglo-Saxon settlements in the current study area show any prevalence from earlier occupation and land-use phases, but the fact that they can be identified in both Iron Age and Anglo-Saxon settings in the area leads to the tentative proposition that they may have endured.

Clusters of 1st edition Ordnance Survey boundaries and tracks bearing the characteristics of Parliamentary Enclosures, and orientated around 0/90 degrees, are often located in areas of former moor, or common, land. This is further corroborated by the presence on 1st edition Ordnance Survey mapping of place-names in farms or lands which contain the elements ‘moor’ or ‘common’. Matfen township contains the best evidence of this, but it has also been observed around Morley Hill Farm, Shotton, Brenkley and Cramlington amongst other places. The presence of Parliamentary Enclosure suggests in most cases, but not all, that these areas are former common land which was more resistant to enclosure and survived as such into at least the late eighteenth-century (Williamson 2002: 126).

Settlement distributions can be used to explore the longevity of common land. At Morley Hill Farm, for example, 83 percent of the rectilinear settlement enclosures, and 79 percent of associated boundary ditches, were found to largely conform to within 30 degrees of underlying slope direction. Almost all 1st edition Ordnance Survey boundaries and tracks in the vicinity appear to have little relationship with the rectilinear settlements and associated boundaries in terms of relative orientation; but were found to show 71 percent conformity to within 30 degrees of underlying slope direction. Evidence for post-medieval ridge and furrow ploughing at Morley Hill Farm largely corresponds with the Parliamentary Enclosure boundaries; and includes the furrows which overlie the upstanding earthwork rectilinear settlement enclosure (HER 1330) on a completely different orientation. Conversely, just 1km south-east of this complex, post medieval ridge and furrow both respects the orientation of a scheduled rectilinear settlement enclosure (HER 174) and even possibly reuses the north-south enclosure ditches. In fact, the rectilinear settlement enclosure shared orientation with most 1st edition Ordnance Survey boundaries in the immediate area. The area around Morley Hill Farm straddles two townships depicted on the first edition Ordnance Survey map, Dinnington and Mason, or ‘Merdisfen’ as it was originally known (Wrathmell 1975: 430). The original place-name element 'fen' helps to understanding the development of land-use in this area; and the issues with water management in this area have been discussed above. Furthermore, the area around Morley Hill Farm does not include a nucleated medieval settlement, which implies this area may have been used as common ground following the demise of the enclosed settlements in the early Roman period. The presence of ‘moor’ elements in farm names suggests the area occupied in the Iron Age and early Roman periods later lay unenclosed and possibly as common in the period between the demise of the settlements and the appearance of Parliamentary Enclosures by the nineteenth-century. Some existing 1st edition Ordnance Survey boundaries were found to be oriented in a similar way to the settlement enclosures and boundary ditches; but those that do are in most cases over 400m from the settlement complex, with numerous straight north-south and east-west boundaries in between. The survival of boundaries in this context could be attributed to the unsuitability to later arable agricultural use due to the very poor drainage around the site, which was remedied in the post-medieval period using more effective technology such as under-drainage.

Morley Hill Farm, and the area in the south of Shotton township, are examples of moorland which probably do not date back to prehistory; and were products of changes in the way the landscape was used during the Roman period and after. The following section will discuss an area of common land which probably did have its origins in prehistory, the Shire Moor (NZ 31737 71844), in what is now North Tyneside. Evidence for settlements or any other activity indicating prehistoric activity is sparse within the Shire Moor, aside from Bronze-Age cast of an axe head (HER 4619). A rectilinear enclosure (HER 750) was located on the boundary of the Shiremoor, but was not excavated prior to its destruction through development, and could relate to other, later activity. Possible roundhouses (HER 4848) were identified on a gradiometry survey plot, but these were never clarified, however, as the area in which they were found is yet to be developed. Nearby Killingworth Moor is also largely devoid of known prehistoric settlement sites; however much of this area has been developed since the 1940s, which prohibits the identification of further cropmark sites. Four rectilinear settlement enclosures form an 'arc' around the Shire Moor (West Shiremoor, HER 4836; HER4847; HER5012), shown in Figure 5.19. This can be extended further by HER 304 lies a little further away to the east; and HER16301 to the west. More may have existed to the south around Willington, and, also, to the east in the Whitley Bay area; but any evidence will have since been overlain by urban and industrial expansion from the late nineteenth-century onwards. If none were present beneath modern development in Whitley township, another gap could be postulated which has been discussed above. As has been hinted at above, the medieval village names of Whitley and Hartley contain old-English elements inferring woodland clearance (*ley,* or *leah*) which when coupled with the relative dearth in prehistoric settlements in this discreet area, could be evidence for shared resource-land, possibly woodland, prior to the establishments of Whitley and Hartley which are first mentioned in documents dating to the twelfth-century.

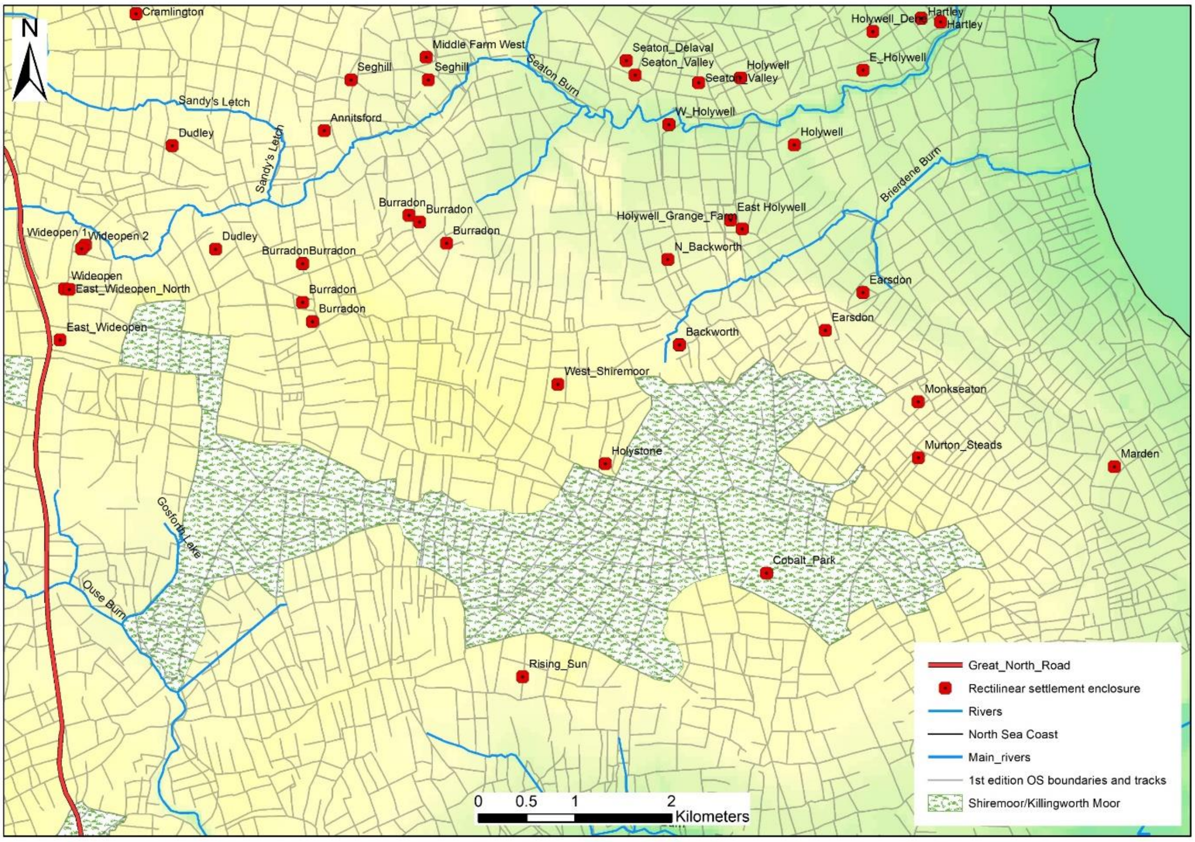

Figure 5.19 Spatial relationships between known rectilinear settlement enclosures and the Shiremoor (with Killingworth Moor to the west) as it was depicted on eighteenth-century estate plans

Considering the possible shared longevity of Killingworth Moor, which was probably a single entity along with Shire Moor, HER 16301 becomes more integral to the perceived system. It could therefore be suggested that the Shire Moor, and the associated Killingworth Moor, was common land governed through CPrRs well before the medieval period. The Shire Moor sits on clay soils which are less permeable and more seasonally wet than those in the surrounding area (Landis: no date), which may explain the lack of settlement from any period in this area, and the 'arc' of prehistoric settlements around it; and the fields depicted on the 1st edition Ordnance Survey map in the Shire Moor were laid out through Parliamentary act in the nineteenth-century, with improved drainage technology possibly enabling this. Similar distribution gaps can be seen around Stannington, Kirkley, and many more which may also representative of similar land-use but will not be explored further in this research.

The most likely agricultural model in the late Iron Age landscape between the Rivers Tyne and Blyth, based on this research and elsewhere, would be characterised by mixed pasture and arable, with more of the former arranged around one or more farmsteads in a densely distributed pattern which was punctuated by areas of common marsh woodland or further pasture. Some level of organisation is implied within this model, through perhaps the common rights of the open spaces to facilitate exchange between lowland and upland contexts along what have been termed resource linkage routes (Williamson 2016), and, also through seaborne trade with Western Europe.

5.7 Final remarks on region-wide observations and interpretations

The empirical approach to analysing the data gathered in this study has enabled observations on landscape development across the whole study area at a regional scale. Trends in common orientations can be observed at this scale, such as those within Whalton and Horton townships, in a way that would not be possible if only those areas were the focus of study. Studying landscape development through the lens of relative orientation and slope direction conformity at this scale has enabled case-study areas to be identified, particularly the township of Whalton which can be seen in the next chapter.

Analysing landscape development at this scale brings to mind theoretical issues around organisation and how the landscape was perceived, used and experienced. Landscapes are created and conceptualised by what is already there (Roymans et al. 2009: 338-339). They are always in process; and perceptions of landscapes are tied up in how we expect them to look and how they truly look when we encounter them (Tilley 2006: 7; 14). This latter statement was made in respect of modern perceptions of landscape, but it can be transposed to the perceptions made by scholars seeking continuity in the landscape over long periods. In the current study area at least, and aside from the possibility of aligned distribution of prehistoric and medieval settlements, there is no dominant prevailing orientation taken up by communities in the past at a regional scale. A deep-rooted respect for the lie of the land heavily influenced the layout of boundaries, tracks and settlements over long periods. In some cases, this coincidental respect leads one to assume that the dominant orientation was purely ideological, based on cosmological lines, for example; however, the inclusion of slope direction conformity analysis has shown a more nuanced picture, even at a regional scale. The following case-studies will now expand upon these observations at a regional scale.

6 Case-studies

The results and discussions above have highlighted trends in orientation and conformity to underlying slope direction across the region. The case studies presented below allow the data to be examined at a local scale which will be compared with those presented in the last two chapters to see whether different interpretations emerge. Research Aim 3 is to examine through the lens of orientation and conformity to underlying slope direction whether features dating to different periods relate to each other or not; and as a result, whether dating can be assigned to undated features, in particular those depicted on 1st edition Ordnance Survey mapping which in many cases survive in today's landscape. The following case-studies have been selected to address these things directly, based on the quality of evidence from different periods present in a given area, and the potential to produce meaningful results. The township of Whalton was chosen as most of the boundaries, settlements and routeways contained within it are oriented distinctly differently to those in neighbouring townships; East Wideopen, Shotton and Fox Covert were chosen for the amount and quality of excavated data, in the case of the latter, extending across multiple periods. The Devil's Causeway was chosen as, aside from Roman forts, and associated civil settlements, it is a rare linear feature in the current study area which can be dated to the Roman period beyond the Hadrian's Wall corridor.

Orientations and conformity to underlying slope direction will be compared across all available periods within a given area. This exercise is not just seeking explore aspects of the prehistoric landscape enduring into the medieval period. The breadth of data from different periods allows us to explore whether certain land-use elements or trends in orientation and conformity to underlying slope direction may have endured into the recent past through the inclusion of post medieval ridge and furrow; or in some cases the present where boundaries are still present in today's landscape. Distribution patterns from these comparisons offer the possibility of attributing a more secure chronology to field systems across the region. These case-studies will not be wide-ranging accounts of the history of the site in question; but where necessary to explain certain phenomena in the data and results of the analysis, the historical narrative surrounding the case-study location will be discussed. Appendix A contains a fuller version of the results from the following case-studies.

6.1 Shotton

The volume and scope of archaeological evidence from developer-funded excavations at Shotton make it an ideal case-study for addressing Research Aim 3 and Objectives 2, 6 and 7. The currently occupied but shrunken village of Shotton is located just south of the River Blyth, on a prominent ridge overlooking the coastal plain to the east and the low hills of South Northumberland to the west (Figure 6.1). Underlying geology consists of boulder clay with sandstone of the Pennine Middle Coal measures (Muncaster *et al*. 2014: 80); and prior to the recent open-cast mining which led to the creation of much of this dataset, the area sat upon predominantly loamy, clayey soils (Landis: no date).

Figure 6.1 Shotton village as seen from the south west (photograph: author)

Excavations between 2009 and 2010 uncovered evidence for settlement and land-use dating from the Bronze Age to the medieval period, including two pit alignments, Iron Age roundhouse gullies and linear ditches, a two-phase Anglo-Saxon domestic settlement; and part of a medieval nucleated village. These excavations have been discussed in detail elsewhere, focusing on architecture, social structure and economy amongst other things (Hodgson *et al.* 2012; Muncaster *et al.* 2014); but here the data will be studied in a different way, by exploring how features from different periods might relate to each other.

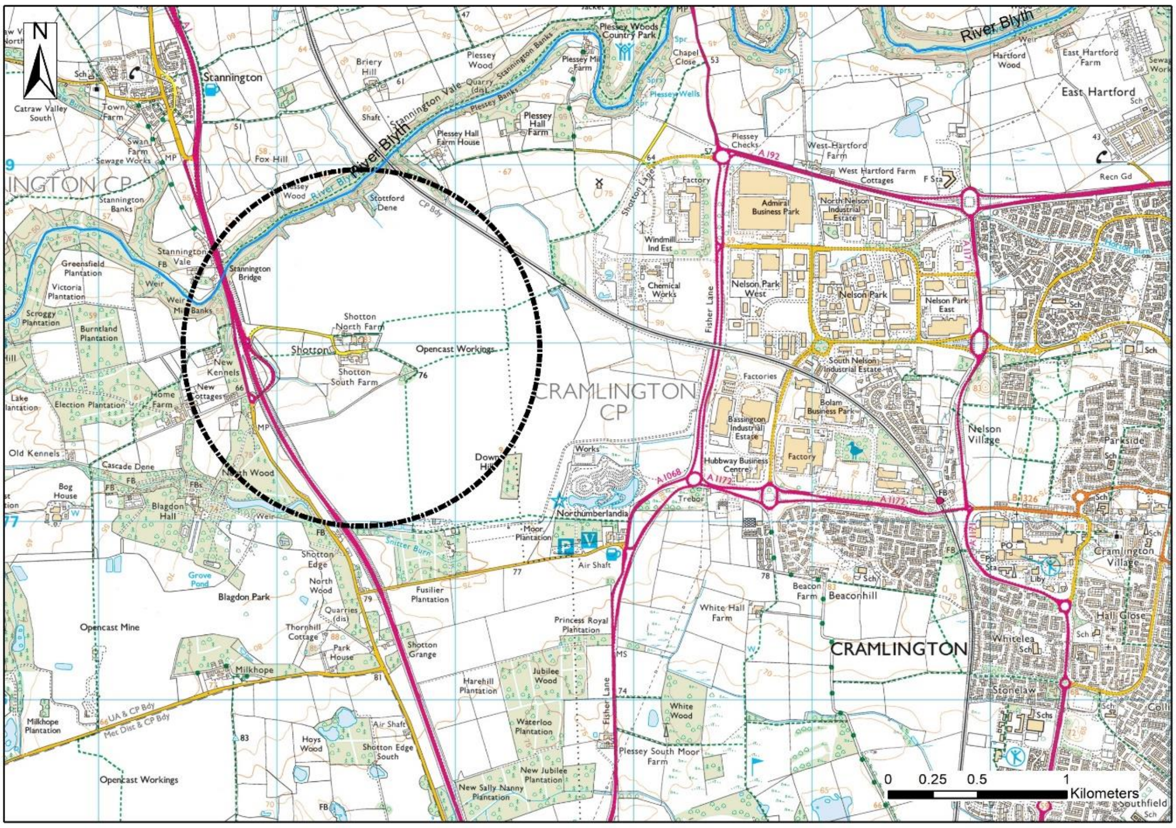

Figure 6.2 Shotton case-study extent (Ordnance Survey 1:250000 sheets downloaded from Edina Digimap 2019)

The earliest excavated features at Shotton were pit alignments, OSL dated to between the late Bronze Age and middle Iron Age. These were found to be arranged in roughly straight lines, with no evidence for other pit alignments branching off as if to form land parcels, which has been found elsewhere, such as the evidence discussed above at Ewart in North Northumberland. Evidence for Iron Age settlement and land-use comprised a linear curving ditch and fragmentary traces of two ring ditches representing probable roundhouses underlying the medieval nucleated settlement. An isolated roundhouse was discovered underlying the Anglo-Saxon settlement, situated probably by chance within one of the settlement enclosures, as no stratigraphic or scientific dating link could be established between the two phases of occupation at either the medieval village site or the Anglo-Saxon site. In addition, a cluster of roundhouse drip gullies, along with a rectilinear enclosure, was found adjacent to the pit alignment in the north-east of the site. The Shotton North-East Iron age enclosure was not thought to have a settlement function by the excavators (Hodgson *et al.* 2012: 100); but round gullies indicative of small stock enclosures or dwellings were present in the vicinity, suggesting some form of domestic activity.

A spatial and chronological gap of up to a millennium separates the prehistoric occupation and land use with early medieval activity, which comprised successive unenclosed and enclosed settlement phases of post built rectangular hall dwellings and sunken featured buildings (SFBs) There is a further chronological, and geographical, gap of at least two centuries between the demise of the enclosed early medieval settlement and the emergence of the medieval nucleated village, which was first documented in the twelfth-century; and was affirmed by ceramic assemblages and radiocarbon dating.

In addition to the excavated evidence, two unexcavated rectilinear settlement enclosures are situated within the case-study area. One survives as an earthwork 250m west of Plessey Mill farm; and was identified on LiDAR imagery by this author, shown in Figure 6.3. This enclosure occupies a prominent spur along the river Blyth, with steep slopes to the west. The other is a known cropmark in the southern portion of the township just south of the surface mine on relatively flat terrain. Farm names in this area, along with the prevalence of probable Parliamentary Enclosure boundaries, suggest this was an area of common, or moor, for some time in the post medieval period and possibly before. Medieval and post medieval ridge and furrow was also present across the site, captured on historic Google Earth and LiDAR imagery, and from excavation and geophysical survey plots. These were transcribed in the full dataset so could be clipped to the extents of Shotton township boundaries to provide the dataset for this case study.

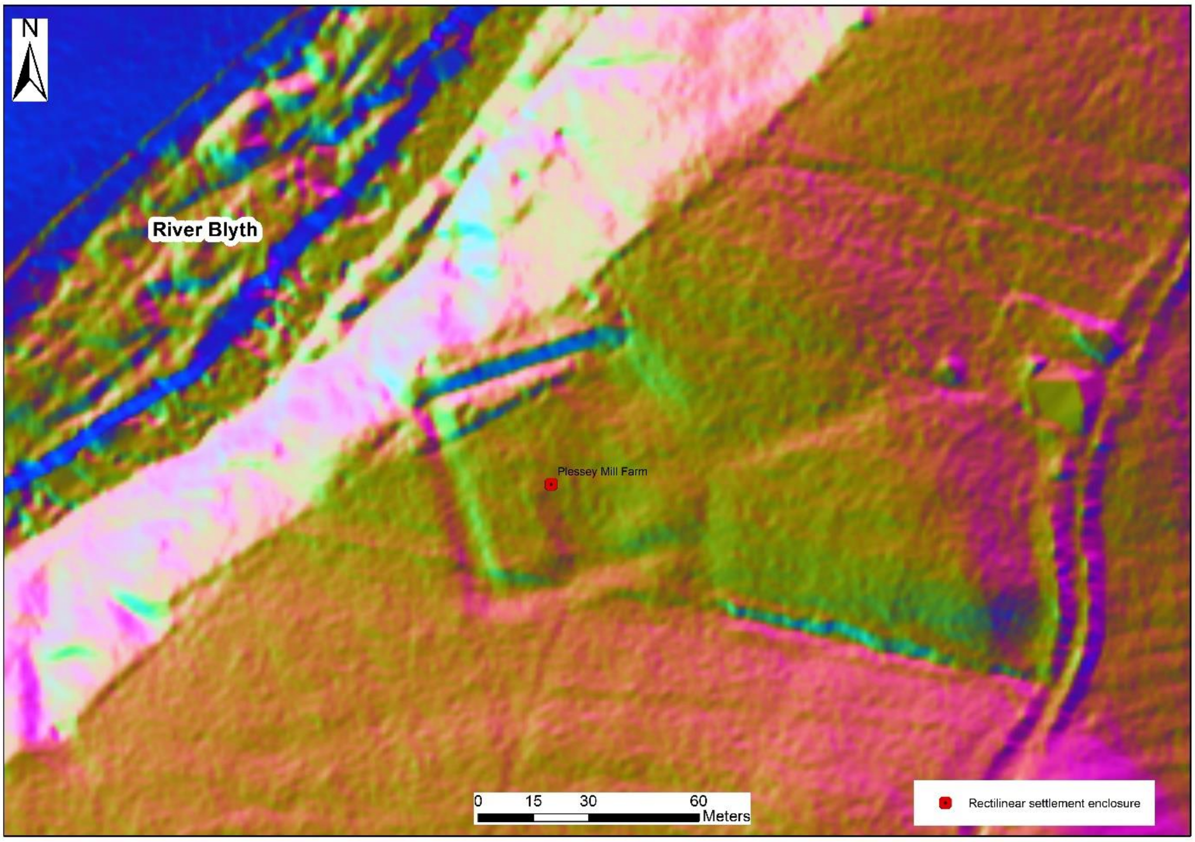

Figure 6.3 Newly discovered rectlinear settlement enclosure west of Plessey Mill Farm (Environment Agency LiDAR PCA imagery lit from 4 hillshades

There are areas where remote sensing imagery pre-dates the opencast, and around the Anglo-Saxon settlement this has led to some interesting discoveries. For example, much of the plantation to the immediate north of the Anglo-Saxon settlement remains was left unexcavated in this area; and analysis of LiDAR imagery led to the identification of surviving earthworks, shown in Figure 6.4, which whilst undated and now destroyed by open-cast mining, in some instances appeared to be continuations of excavated Anglo-Saxon settlement features. Some of these features may have contained evidence which extended the occupational sequence of the settlement; but this theory cannot be explored further due to the total destruction of the site by surface mining.

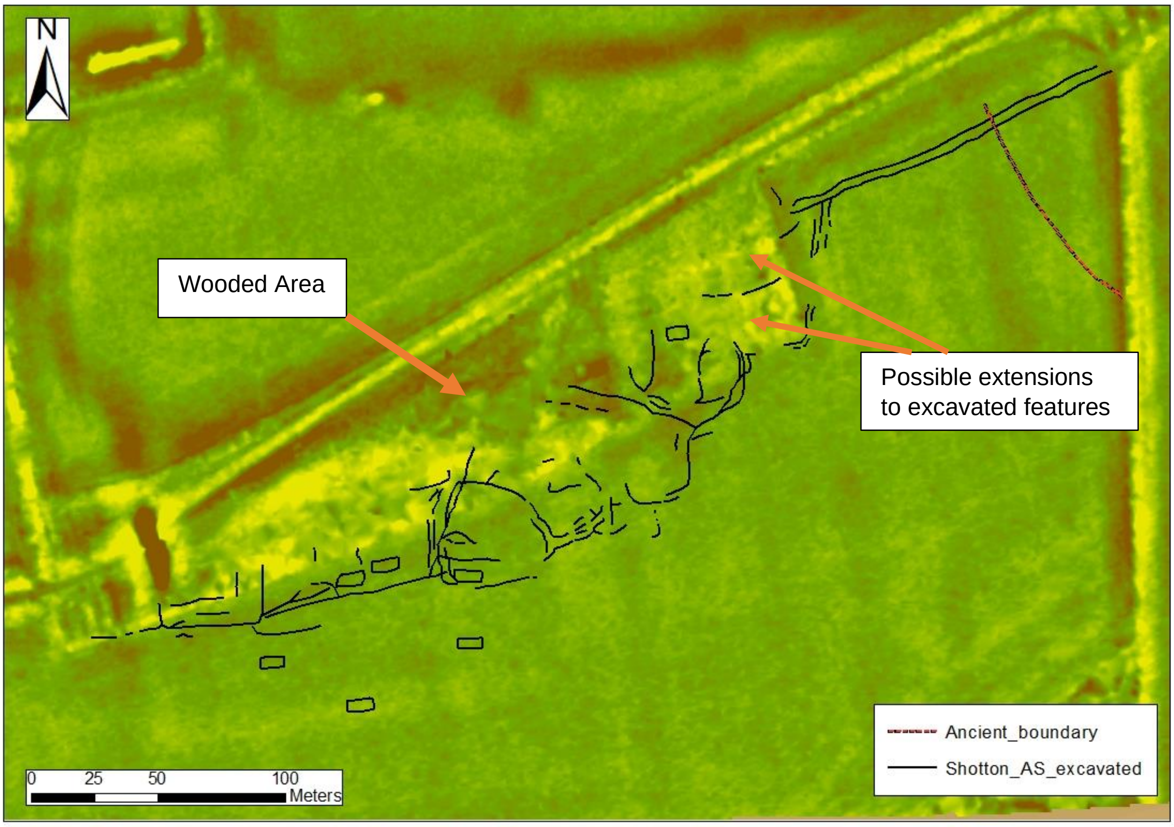

Figure 6.4 The wooded area north of Shotton Anglo-Saxon settlement excavated area, with LRM LiDAR imagery showing possible continuations of excavated features (LiDAR: Environment Agency, 2016)

Whilst there are speculative linkages between different phases of settlement and activity around Shotton, the main occupation and land-use phases are separated by long periods of apparent inactivity, echoing Research Aim 1 and Objective 2. The following results and discussion will explore whether common orientations or conformity to underlying slope direction can build an understanding of what was going on between these phases; or whether any similarities in orientation are representative of a common push to conform to underlying slope direction shared by many different generations of settlers in the area.

6.1.1 Results

Feature	Prevalent orientation (degrees)	Con20 %	Con30 %
SHO_PAL	130 (40)	38	100
SHO_ANC	30/120	57	65
SHO_RECT	76	22	58
SHO_SEM1	85	0	0
SHO_SEM2	80	64	88
SHO_MNV	88	49	74
SHO_MRF	80/170; 0/90	49	69
SHO_PMRF	80/170	52	67
SHO_SEN	80/170	50	70

Table 6.1 Proportions of orientations and slope direction conformity amongst linear features at Shotton

Shotton north-east pit alignment is oriented at 129 degrees; and the alignment adjacent to the Anglo-Saxon site is oriented 144 degrees. The most frequently occurring orientation for both is around 130 degrees. The most common orientations amongst the excavated Iron Age ditches was found to be around 30-40 degrees. A total of 57 percent conformed to within 20 degrees of underlying slope direction; and 65 conformed to within 30 degrees. The rectilinear settlement enclosure at Plessey Mill is oriented at 73 degrees and wholly conforms to within 20 degrees of underlying slope direction. The enclosure at Shotton North-East and the cropmark in the former Shotton moor are oriented at 35 and 110 degrees respectively, but neither conform to within 20 or even 30 degrees of underlying slope direction, which sets them apart from many rectilinear enclosures analysed across the study area, shown in chapter 4. Overall a comparatively low 22 percent of rectilinear enclosures in this study area conform to within 20 degrees of underlying slope direction; and 58 percent conform to within 30 degrees.

The hall structures representing the earliest phase of Anglo-Saxon settlement were oriented at around 85 degrees; and none conform to even 30 degrees of underlying slope direction. In all cases there were high discrepancies between the orientations of structures and underlying slope direction. The enclosures associated with the later Anglo-Saxon settlement were predominantly oriented at 80 degrees with the perpendicular 170 degrees for roughly rectangular enclosures. The double-ditched droveway extending east from the enclosed settlement was oriented at 65 degrees. A high proportion of 88 percent of the enclosure boundaries conformed to within 30 degrees of underlying slope direction; and all units oriented to the prevalent 80/170 degrees conformed to within 20 degrees. The entire excavated length of the droveway conformed to within 20 degrees of underlying slope direction, which implies that the lie of the land was an important consideration to the layout of linear units in this period. The results concerning the Anglo-Saxon settlement and droveway at Shotton therefore imply that the grain of slope around the ridge upon which they were founded had an influence on the orientation of the settlement layout, aside from the post-built halls. This is where the factor of scale is important. The results imply a general trend towards conformity to slope direction at the scale of the overall settlement and adjoining droveway; but at the scale represented by the settlement structures, this does not appear to have been followed with the same strict parameters.

The medieval village was oriented at 88 degrees, consistent with the predominant orientation of many features throughout the study area. Forty nine percent of the line of the village conformed to within 20 degrees of underlying slope direction; and seventy-four percent conformed to within 30 degrees. The most common orientations for medieval ridge and furrow around Shotton was also around 80/170 or 90/180 degrees, similarly to the nearby village. A total of 49 percent of medieval ridge and furrow was found to conform to within 20 degrees of underlying slope direction; and 69 conformed to within 30 degrees.

Post medieval ridge and furrow returned similar results, with 52 percent conforming to within 20 degrees of underlying slope direction; and 67 percent conforming to within 30 degrees. The prevalent orientation was 80/170 degrees. For this orientation, 56 percent conformed to within 20 degrees of underlying slope direction and 69 percent conformed to within 30 degrees. The most frequently occurring orientations amongst 1st edition Ordnance Survey boundaries in the Shotton area were also around 80/170 degrees. There is an even split between conformity and non-conformity to underlying slope direction amongst 1st edition Ordnance Survey boundaries and tracks; whilst 70 percent were found to conform to within 30 degrees of underlying slope direction. Of those oriented around 80/170 degrees, 49 percent were found to conform to within 20 degrees of underlying slope direction and 68 percent conformed to within 30 degrees.

The medieval village, along with the highest proportions of medieval and post-medieval ridge and furrow, and boundaries and tracks present by the mid-nineteenth-century, are all predominantly oriented around 80 or 170 degrees. This is a departure from the more frequent 30/120 and 40/130 degrees present in the pit alignments and Iron Age ditches.

6.1.2 Discussion

The question of how long pit alignments continued in use, and how they influenced later patterns of settlement is an important one in terms of this research. The pit alignment at Shotton North East site was found to conform to within 30 degrees of underlying slope direction for its excavated length, which could explain why it was reused to form part of the later enclosure (see Figure 6.5). OSL dating suggested that the pit alignment silted up gradually over a long period and was probably still visible in the late Iron Age, when it was used to form one side of the rectilinear enclosure during the fourth or third-century BC (Hodgson *et al.* 2012: 186).

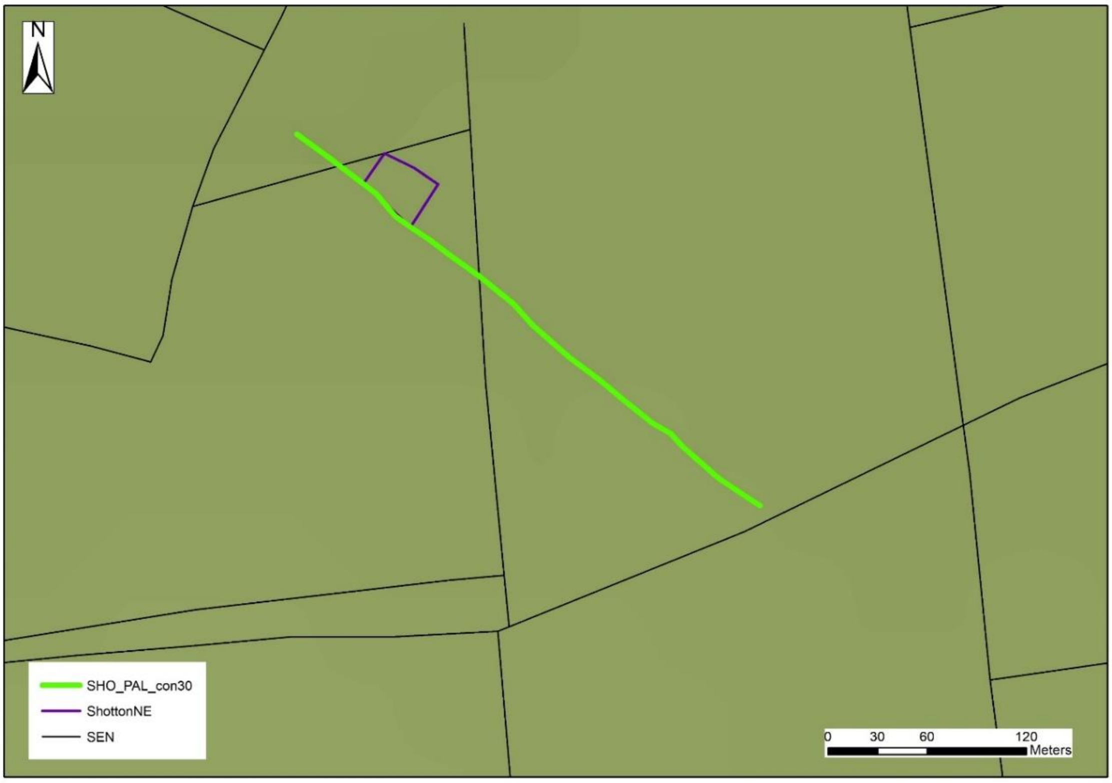

Figure 6.5 Shotton north east pit alignment (green) and Iron Age enclosure (purple), with surrounding 1st edition Ordnance Survey boundaries

Viewing the position of this pit alignment alongside contour data showed that it traversed a pronounced ridge. Most 1st edition Ordnance Survey boundaries to the immediate south of this pit alignment neither share the same orientation nor show the same levels of conformity to the lie of the land as the pit alignment; and look to have been laid out in roughly north-south blocks regardless of the natural topography shown in Figure 6.6. The appearance of these fields is indicative of Parliamentary Enclosure, which implies in the context of south east Northumberland that the land may have been unenclosed moor or common for some time before these boundaries were laid out.

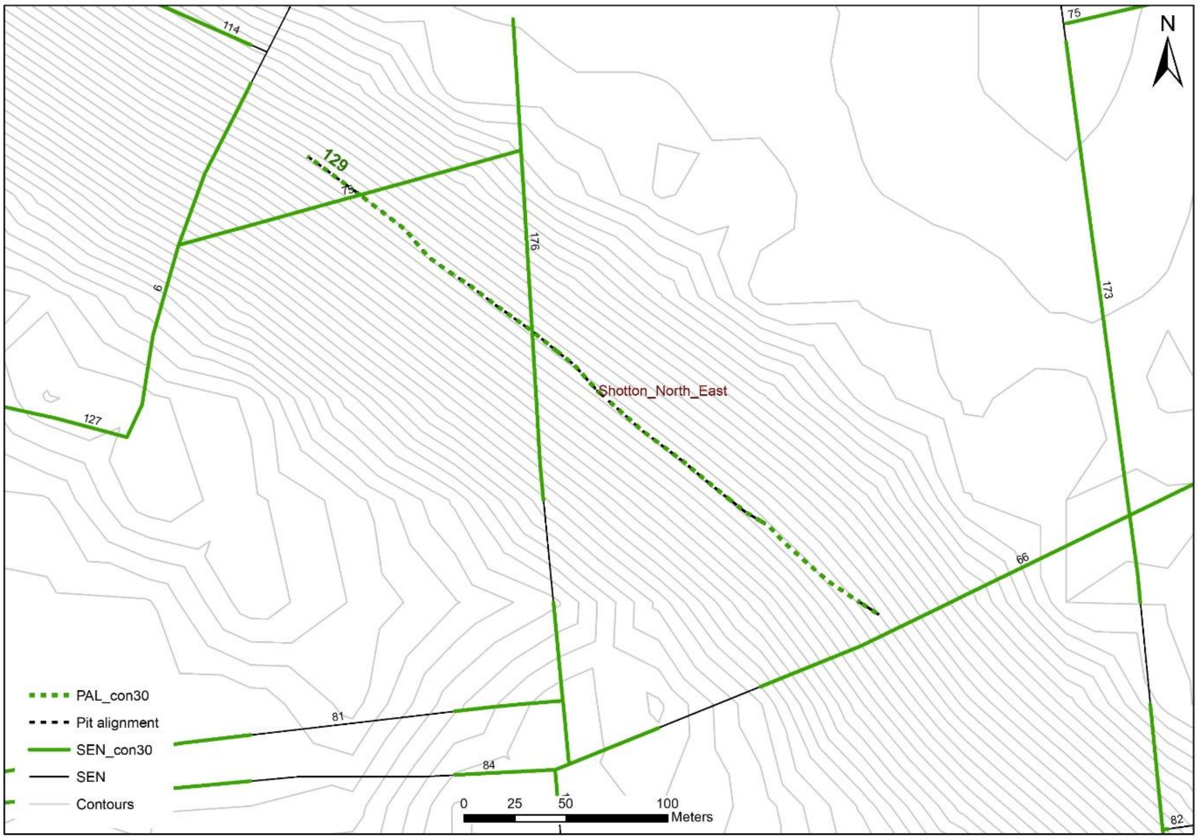

Figure 6.6 Relative orientations and slope direction conformities amongst Shotton north east pit alignment and surrounding 1st edition Ordnance Survey Boundaries (contours derived from 50m DTM downloaded from Edina Digimap, 2017)

Other boundaries which seem to have little or no link to historic patterns of land-use lay to the south of the medieval village, some of which overlay the Anglo-Saxon settlement. These were likely laid out in an area where all traces of past land division had disappeared. Medieval ridge and furrow cropmarks within these boundaries do not always follow the same orientation, so it may be that the medieval open fields to the south of Shotton village were quite unlike those which are depicted by the nineteenth-century, which are suggestive of Parliamentary enclosure of former common land. The tithe map of 1840 gives no indication of what the medieval open fields looked like in this area, so their character remains largely unknown aside from the fragments of ridge and furrow identified as cropmarks and earthworks.

The double ditches extending from the eastern limit of the Anglo-Saxon settlement do not appear to share orientation with any boundaries present on 1st edition Ordnance Survey maps. Excavations showed that the droveway ditches were deliberately filled at an unknown date but possibly at some point after the eleventh-century judging by the results of radiocarbon dating. This was probably done by levelling a bank which lay between them, an act deemed to be connected to a reorganisation of the landscape (Muncaster *et al.* 2014: 122). We do not, and now will not, know what this change looked like, but the presence of medieval ridge and furrow overlying the Anglo-Saxon settlement would suggest that the area around the droveway was possibly incorporated into medieval open field furlongs associated with the nucleated village at Shotton. Later, and evidenced through the presence of Parliamentary enclosures containing narrow ridge and furrow and the presence of 'Moor' place name elements in farms depicted on 1st edition Ordnance Survey maps in the vicinity, the area may have been allowed to become unenclosed common for some time. This may have taken the form of the medieval open fields being turned over to pasture or waste from the late medieval and post-medieval period. It had already been surmised that an earlier chronological gap between the end of the Anglo-Saxon settlement and the medieval village was a period when the land was farmed elsewhere, with the Anglo-Saxon settlement features gradually silting-up; and being erased from sight and memory (Muncaster *et al.* 2014: 138). It cannot be said on current evidence whether the drove-way was still visible at this time, but it may have still fulfilled a function after the demise of the settlement. The broad ridge and furrow overlying much of the Anglo-Saxon settlement would imply this, although the fills of the furrows were not dated. This is unfortunate, as OSL dating of these may have provided useful evidence with which to bridge some of the gaps present in the record at Shotton.

Whilst it is likely that cereals were consumed by the inhabitants of Shotton Anglo-Saxon settlement, it does not entail they were grown nearby. They could have been brought into the area as exchange for other resources such as cattle, wood, turf, metalwork, or goods brought in through land or seaward trade. Ancestral and trade ties with western Europe may have been strong at the time; and seaward trade was easier than land due to poor quality of roads, although it is likely that most Roman roads, apart from perhaps the Devil's Causeway, would still have been serviceable in this period.

In terms of later periods, orientation analysis has shown that medieval ridge and furrow overlay both the unenclosed and enclosed Anglo-Saxon occupation phases at Shotton on the same alignment. Within one furrow three gullies were detected, which were possibly associated with a boundary depicted on a survey plan of 1763-1784. If this is the case, the broad ridge and furrow (between 6.5 and 7.5m wide) post-dated the survey of the estate plan (Muncaster *et al.* 2014: 122). This would be quite unusual, as broad ridge and furrow is not commonly associated with post-medieval ploughing; and this observation bolsters the need for further detailed research into the chronology of ridged agriculture. Shared orientations between Anglo-Saxon boundaries and those depicted on 1st edition Ordnance Survey mapping may also in some cases be evidence of land units being used and maintained over long periods. The shared orientations and conformity to underlying slope direction across features from different periods, in this case including Anglo Saxon settlement and land use at Shotton, again brings the distinction into focus.

Shotton Anglo-Saxon settlement lay close to the nearby medieval manorial centre at Plessey. If this pattern of tenure extended back to the middle or even early Anglo-Saxon period, the settlement at Shotton might have been subordinate to a minor estate centre at nearby Plessey or perhaps was itself an estate centre in the pre-Norman conquest period (Muncaster *et al.* 2014: 138), which refers to ideas previously put forward (Jones 1979; O'Brien 2002). Areas within the present settlement at Shotton could be concealing evidence bridging the chronological gap in occupation between the Iron Age and the medieval village. If this was found, the argument for continuity through shared orientation and conformity would gain more traction.

The 1st edition Ordnance Survey boundaries to the north west of the pit alignment at Shotton show greater conformity to underlying slope direction; and some even share similar orientation with the pit alignment. Situated north of Shotton medieval village, this block of fields, which largely survived until the open cast mining, also contained some boundaries which shared the same orientation as the Iron Age ditches underlying the medieval settlement. The Iron Age ditches mostly conform to within 30 degrees of the slopes of the hill upon which Shotton medieval village lies, giving the impression of a radial boundary system projecting from a central nucleus on the ridge where the two roundhouse plots are also situated. This echoes ideas put forward in the previous chapter. A similar sequence can be seen around the pit alignment adjacent to the Anglo-Saxon settlement, where the droveway runs perpendicular to the pit alignment, suggesting the former had some bearing on the position of the latter or vice-versa. Small-scale gradiometry survey within paddocks at Shotton undertaken by the author revealed traces of possible features which are orientated similarly to the Iron Age ditches, but not the medieval tofts (shown in Figure 6.7). The features are dipolar responses; and could relate to buried fence posts containing ferrous materials, implying the features are modern; but it could also be speculated that the dipolar features are part of something which respected the same orientation as the Iron Age ditch; or was built with the same purpose, to conform to underlying slope direction even though the two features appear unrelated. The other alternative is that the orientation of the prehistoric ditch was re used for the same reason but with no other link, with the medieval tofts and their different orientation interrupting this shared orientation.

Figure 6.7 Results of gradiometry survey within the presently occupied Shotton village (OS mastermap downloaded from Edina Digimap, 2017)

Similar patterns of radial boundary systems can be seen elsewhere along the coastal plain, for example, the cropmarks and some extant boundaries at Holywell Grange Farm (NZ 31245 73411) appear to ‘wrap’ around the topography, in a similar way with most conforming to within 30 degrees of underlying slope direction. Excavations of the large settlement enclosure at Blagdon Park 2 revealed the beginnings of two ditches extending from the outer enclosure which also could be radial in appearance; and the same could be suggested for the external boundary ditches excavated at Morley Hill Farm. It is also common in more upland areas, for example the cropmarks of boundaries at Marley Knowe (NT 93590 32112) (Figure 6.8), and cord rig evidence present Trows Law in North Northumberland (NT 857135), which as Figure 6.9 shows has a different relationship with the lie of the land than medieval ridge and furrow which overlies the settlement remains.

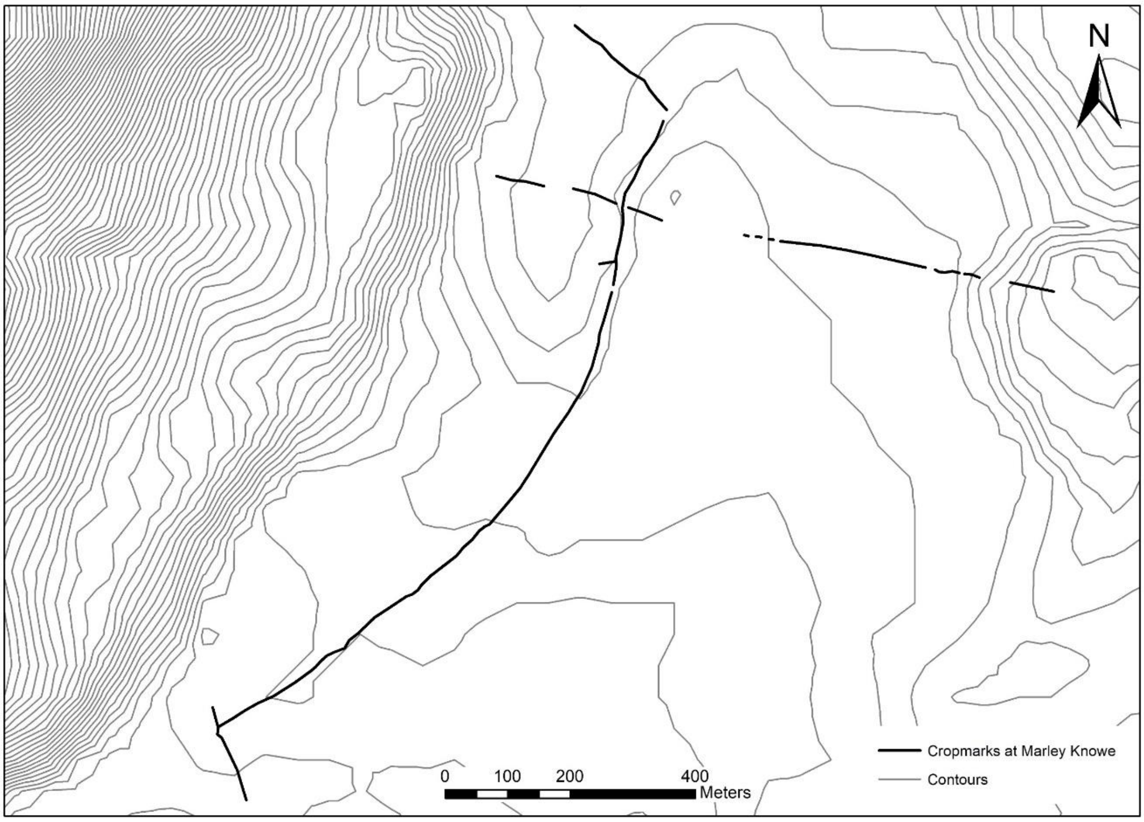

Figure 6.8 Probable Iron Age boundaries present as cropmarks around Marley Knowe (after Passmore and Waddington figure 4.17) (contours derived from 50m DTM downloaded from Edina Digimap, 2017)

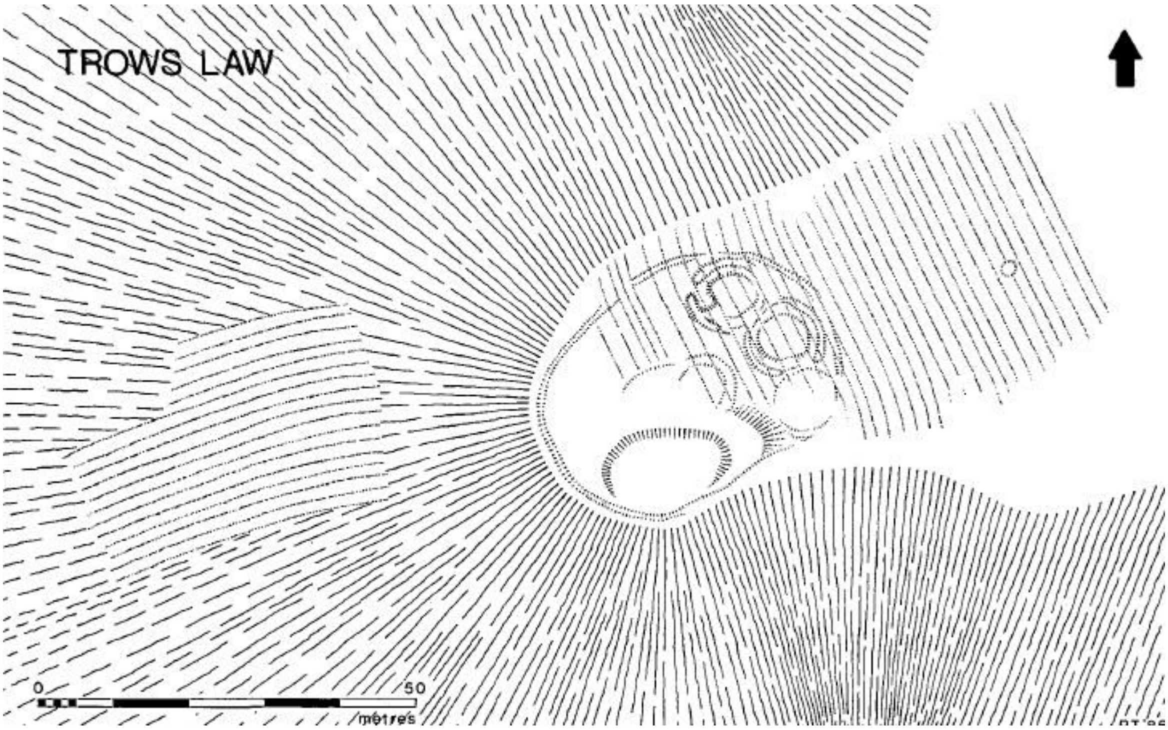

Figure 6.9 Cord rig radiating from an Iron Age palisaded settlement at Trows Law which is partly overlain by medieval ridge and furrow (from Topping 1983: fig.4)

The evidence presented above and in chapter 5 suggests that radial systems of boundaries were associated with some settlements from the late Iron Age and early Roman periods in the lowlands as a response to the lie of the land. This makes it difficult to imagine systems of coaxially arranged fields sharing a common orientation over very large areas around the time these settlements were occupied. It is easier from this evidence to imagine a more dispersed pattern of settlements, or sometimes groups of settlements in the late Iron Age and early Roman period, which each had their own associated plots which in some cases radiated from the settlement where the direction of underlying slopes made it a necessity. The fieldscape present until recently to the north and north-west of Shotton could have contained elements of ancient boundary systems which survived into the medieval period, evidenced in the form of medieval ridge and furrow which shares the same orientation and is encased within some boundaries in this area. The alignments created through ancient boundaries could have persisted into the very recent past, present some boundaries and tracks depicted on the 1st edition Ordnance Survey map.

From the evidence for shared orientation across different periods, it is tempting to suggest that linear arrangements of boundaries originating from at least the late Bronze Age continued to be used into the middle of the ninth-century AD; and in the case of the fields north of Shotton medieval village, up to the modern period. The shared conformity to underlying slope direction as a possible coincidence of reacting to similar conditions at different times makes it difficult to say whether there is a direct relationship between the Iron Age ditches at Shotton and those present on 1st edition Ordnance Survey maps, but the implication that some may be contemporary cannot be dismissed out of hand. By comparison, the different orientations of pit alignments, Anglo-Saxon settlement and medieval village in the Shotton area are likely the result of features in different parts of the site conforming to their local topographic conditions rather than a conscious effort to establish new boundary layouts on axes which were different from what came before. With the landscape around Shotton now completely transformed we cannot explore this any further, but the similar evidence at Holywell Grange Farm in the form of cropmarks remains unexcavated; and would be a good place to test this theory further.

Common orientations across features dated to different periods is linked to the common phenomena of conformity to underlying slope direction. Therefore, the same approach was probably being used over long periods. This still implies a lack of direct continuity in land use; but does not discount the endurance of certain land units over time. All three phases of settlement at Shotton are situated on the south-east sides of natural ridges, and would thus, like many other settlements in the region, may well have been specifically chosen for the favourable topographic conditions. We might therefore expect that previous individuals and communities also chose these locations for similar reasons, which explains why underlying remains of settlement were discovered at both sites. Why there appears to be gaps between these occupation phases on both sites, especially at the Anglo-Saxon site, is more of a challenging proposition. The enclosed phase of early medieval settlement at Shotton could be interpreted as proto-nucleated, characterised by a formal arrangement of homesteads situated within ditched enclosures. Radiocarbon dates showed this settlement was much longer-lived than the preceding unenclosed phase. The evidence in this period should be considered alongside the growth of territories and ownership that was taking place after the formalisation of kingdoms in the seventh-century AD. Stable, bounded settlements imply ownership of tracts of land. It can also be considered alongside ‘Butterwick’ settlements in the Yorkshire Wolds (Wrathmell 2012: 172-173), and other enclosed Anglo-Saxon settlements from beyond the study area (Reynolds 2003). The evidence at Shotton as it stands suggests the Anglo-Saxon settlement represents an isolated period of occupation, with no evidence for the re-use of earlier alignments or settlement remains, although these may have been lost through subsequent activity.

6.2 Fox Covert

The success of the case studies in identifying trends of change and continuity in settlement and land-use is dependent on the quantity and quality of data available for analysis. The plentiful evidence from Fox Covert is of very high archaeological value, and has the potential to address Research Aim 3. Located on the banks of the now-drained Prestwick Carr (NZ 19752 74773), developer-funded excavations at Fox Covert in 2005 uncovered a wealth of evidence for settlement and land-use including a Bronze Age/Iron Age pit alignment, early medieval and medieval boundary ditches, and a thirteenth-century grange complex (TWM Archaeology: 2007).

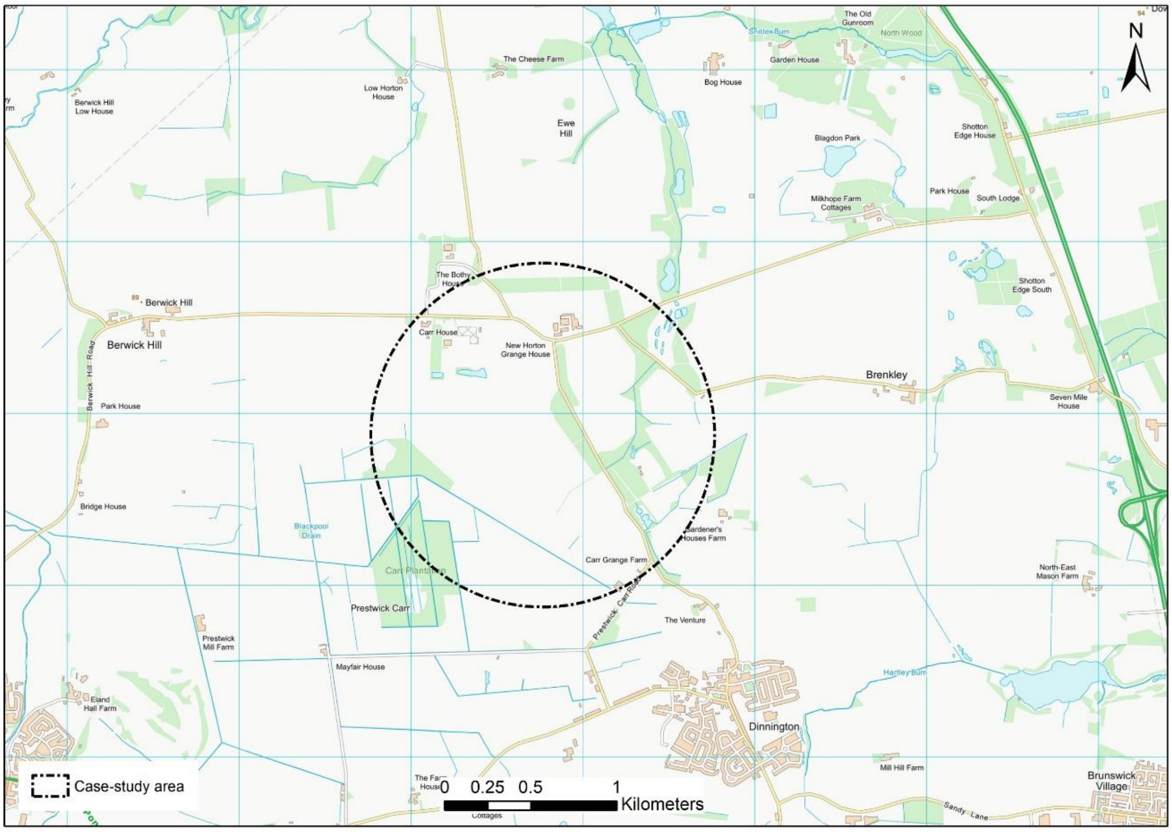

Figure 6.10 Fox Covert case-study area

Figure 6.11 Fox Covert and the now drained Prestwick Carr, seen from the north-east (Photograph: author)

The area is situated on a former basin mire drained in the nineteenth-century and which would have been an area of marsh and wetland in the medieval period (See Figures 6.10 and 6.11 for location and topography). The soils are loamy and clayey (Landis online). The southern portion of the excavation area contained a slight spur three metres in height on the western edge of a terrace overlooking the former Carr. Documentary evidence indicates that Prestwick Carr was exploited as a source of peat during the medieval period; and may have also been before this time.

There was activity on the site from Mesolithic times, evidences in flint scatters which were recovered during the excavations in 2005 (TWM). The pit alignment is the first discernible evidence for land-use available to us, however; and was dated using OSL dating of the fills from one of the pits. This returned dates of 920 BC ±430 for the lowest fill; and AD 280 ±130 for the upper fill (Hodgson *et al.* 2012: 108-109), suggesting the pit alignment may have been in use for many centuries. An early medieval boundary was dated to the tenth or eleventh-century through radiocarbon dating of a fragment of pig skull recovered from the primary fill of the ditch (TWM Archaeology: 2007). No settlement remains were discovered in the vicinity but as was discussed earlier, the presence of the pig skull, complete with butchering marks indicative of food waste, does imply that a settlement may have lain close by. A ditch thought to have been part of a probable field system dating to around the twelfth-century preceded the medieval grange complex, which was established in the thirteenth-century and lasted until around the middle of the fourteenth-century (TWM Archaeology 2007). The Grange was altered frequently over time, but the orientations of key boundaries remained throughout. The dates for these features were based on a combination of pottery finds, radiocarbon analysis and documentary evidence.

In addition to the excavated features, an Iron Age or early Roman period rectilinear settlement enclosure (N10963) is visible as a cropmark situated 250m west of Horton Grange Farm on the relatively flat crest of a ridge which stretches west to Berwick Hill. This has not been excavated but can be characterised on morphological grounds using the criteria set out in chapter 2. Historical accounts cite the discovery of bronze vessels dating to the Roman period by a local farmer in the 1890s which became known as the Prestwick Carr hoard (Harbottle 1995: 1). A linear cropmark situated close to the rectilinear enclosure, visible on Google Earth imagery, has also been included in the analysis as it could represent boundaries associated with the settlement.

Evidence for both medieval and post-medieval ridge and furrow was transcribed from excavation plots and Google Earth imagery; and boundaries and routeways present by the nineteenth-century were transcribed from 1st edition Ordnance Survey mapping. Together this data allows us to analyse possible relationships between features across the full chronological scope of this research using orientation analysis. A 1km buffer was generated around the centre of the Fox Covert excavation area, and all features within this area were analysed.

6.2.1 Results

The following table draws together the relevant results from the analysis of features at Fox Covert. From this the results and their implications can be discussed. Note that ‘Con 20’ and ‘Con30’ refer to the proportions of units conforming to within 20 or 30 degrees of underlying slope direction respectively.

Feature	Prevalent orientation (degrees)	Con_20 %	Con30 %
FOX_PAL	25	10	100
FOX_RECT	95	100	100
FOX_CRO	10/100	100	100
FOX_EMB	30/120	17	63
FOX_MED	20(110)	0	11
FOX_GRA	30(120)	44	73
FOX_MRF	30(120)	52	75
FOX_PMRF	80(170)	42	57
FOX_SEN	80(170)	55	73

Table 6.2 Results of orientation and conformity to underlying slope direction at Fox Covert

The following paragraphs present summaries of the results seen in Table 6.2 and the full results which can be found in Appendix A. The pit alignment was oriented at 25 degrees. Only 10 percent of its length conformed to within 20 degrees of underlying slope direction, but the entire length conformed to within 30 degrees. The rectilinear settlement enclosure is oriented at 95 degrees; and, like the pit alignment, wholly conforms to within 30 degrees of underlying slope direction. The two linear cropmarks situated adjacent to the rectilinear enclosure were oriented at around 10 and 100 degrees respectively; and both conformed to within 20 degrees of underlying slope direction. These results suggest that high levels of conformity to underlying slope direction were present during various times in prehistory, but that a common orientation did not persist over long periods in the Fox Covert area.

The early medieval boundary ditch does not take a straight course, so it had to be manually split into four parts for this analysis, which were calculated at 120, 29 and 52 degrees. Sixty-three percent of the whole ditch was found to conform to within 30 degrees of underlying slope direction, which included the whole of the section oriented at 29 degrees and around half of that oriented at 129 degrees. These results are illustrated in Figure 6.12.

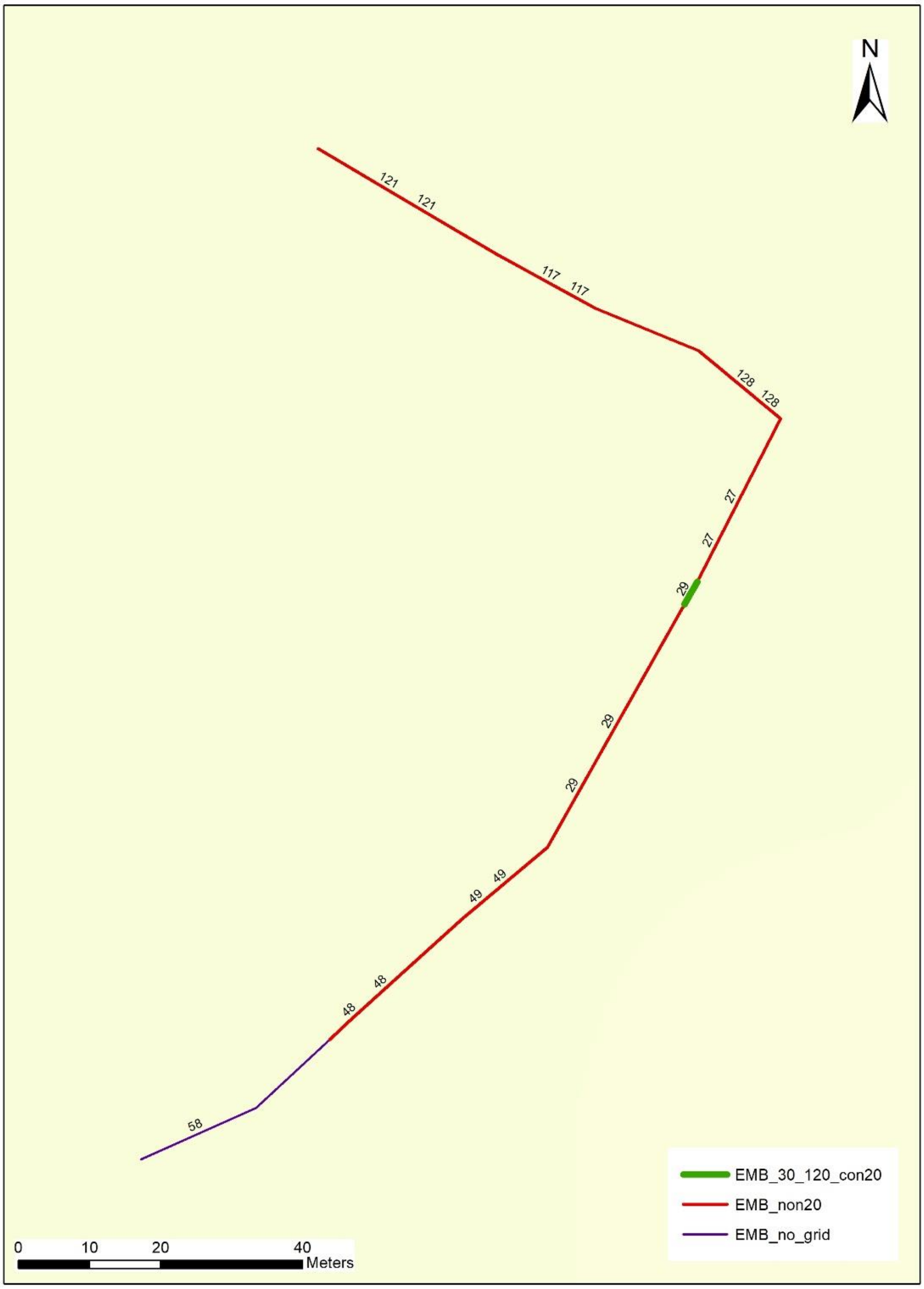

Figure 6.12 Orientation and slope direction conformity for the early medieval ditch at Fox Covert

The boundary ditch predating the medieval Grange was mostly oriented at around 10-20 degrees; and only 10 percent of this was found to conform to within 30 degrees of underlying slope direction, with no conformity to within 20 degrees. The prevalent orientation of the medieval Grange primary boundaries precinct boundaries was 30/120 degrees. A total of 44% of the outer boundaries conformed to within 20 degrees of underlying slope direction; and seventy-three percent conformed to within 30 degrees.

Medieval ridge and furrow was most commonly oriented around 30/120 degrees, with 52 percent conforming to within 20 degrees of underlying slope direction; and 75 percent conforming to with 30 degrees. The most commonly occurring orientation for post medieval ridge and furrow was found to be 80/170 degrees, with 42 percent conforming to within 20 degrees of underlying slope direction; and 57 percent conforming to within 30 degrees. A high proportion of 1st edition Ordnance Survey boundaries were found to be oriented around 80 or 170 degrees, shown in Figure 6.13. Boundaries and tracks present on 1st edition Ordnance Survey mapping oriented at either 30 or 120 degrees are almost completely absent, aside from a short (221m) footpath. Seventy-three percent of 1st edition Ordnance Survey boundaries were found to conform to within 30 degrees of underlying slope direction, shown in Figure 6.14.

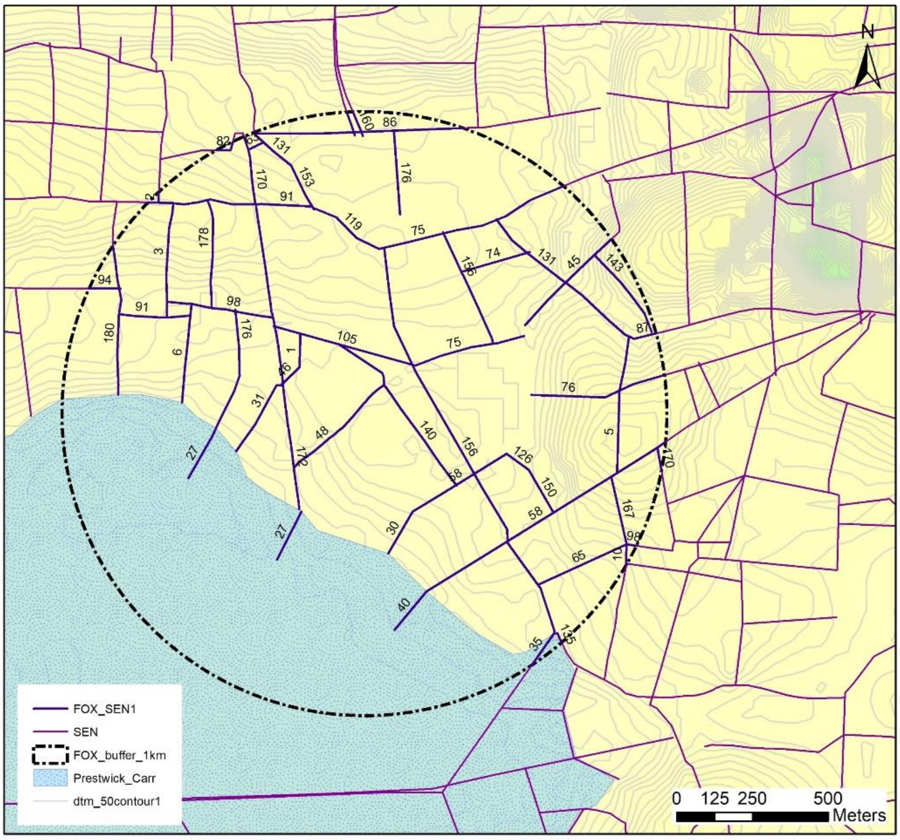

Figure 6.13 Orientations of 1st edition Ordnance Survey boundaries at Fox Covert (contours derived from 50m DTM downloaded from Edina Digimap, 2017)

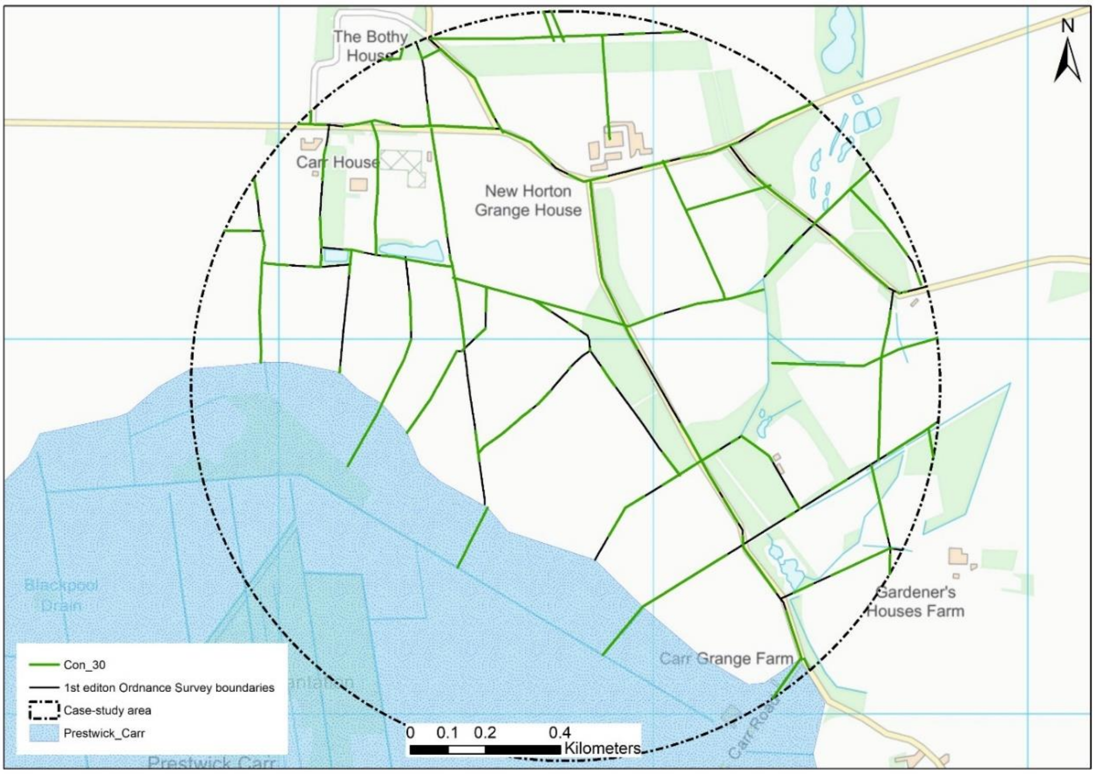

Figure 6.14 Levels of slope direction conformity amongst 1st edition Ordnance Survey boundaries at Fox Covert (OS district 1:15 000 mapping downloaded from Ordnance Survey, 2019)

6.2.2 Discussion

The pit alignment, two portions of the early medieval ditch, many of the Grange boundaries and some medieval furlongs are all oriented close to 30 degrees. The southern boundaries of the medieval Grange define the present field boundaries, so whilst the prevalent orientation for 1st edition Ordnance Survey boundaries is 80/170 degrees, there are possible remnants of orientations present in the area which may have associations with previous land-use.

The northern portion of the pit alignment skirts a small hillock; and to the south of this the terrain slopes consistently south west to Prestwick Carr. As the excavated portion of the pit alignment takes a straight course for its excavated length, it could be postulated that it continued to do so on the same alignment to the Carr, if the notion of natural features being the pivots for these systems is entertained. Excavations revealed that the pit alignment was cut by ditches and structures relating to a medieval Grange, so we cannot know this for sure; however, if the analysed pit alignment units included this hypothetical section, it would have run perpendicular to underlying slope direction; and conforming to within 20 degrees of it. This hypothesis is shown in Figure 6.15.

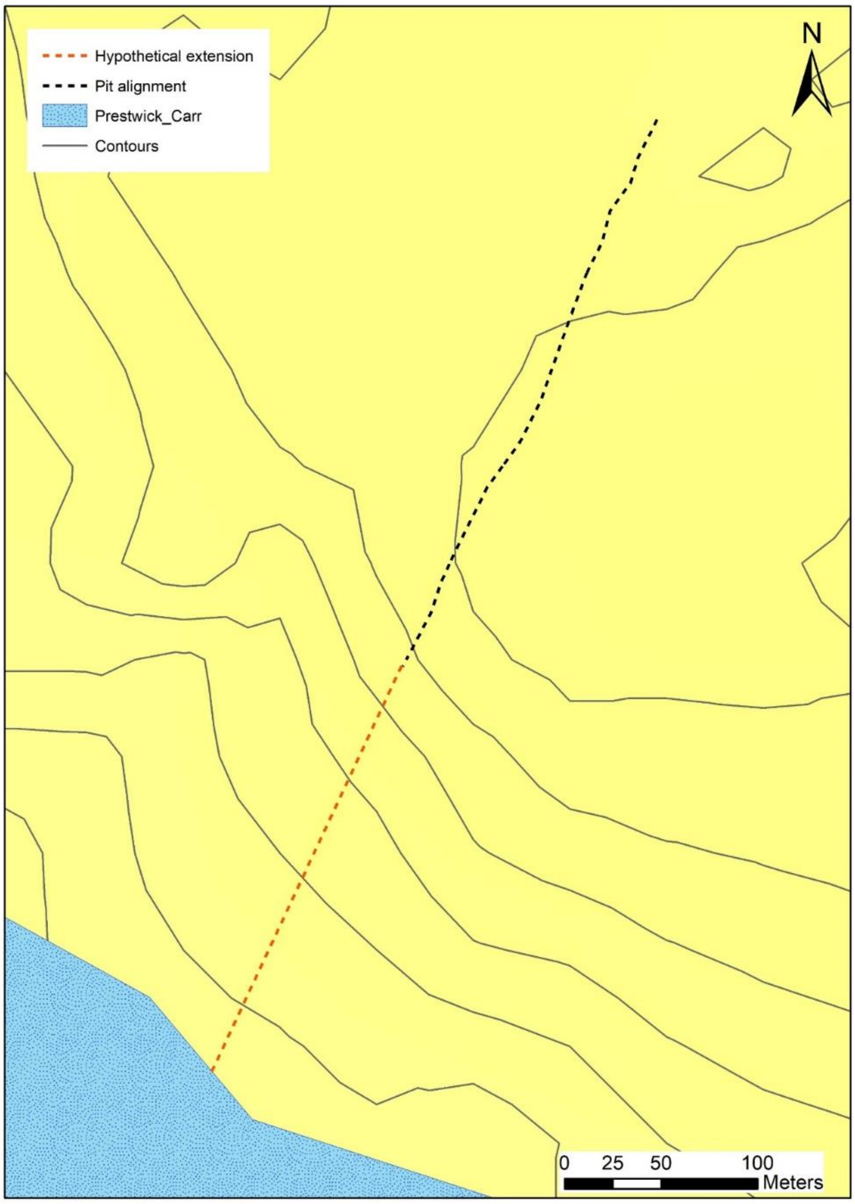

Figure 6.15 Hypothetical extension of the excavated pit alignment at Fox Covert (contours derived from 50m DTM downloaded from Edina Digimap, 2017)

Although the rectilinear enclosure and linear cropmark ditches conform to within 30 degrees of underlying slope direction, they are oriented differently than many of the surrounding boundaries and tracks present by the nineteenth-century, many of which also conform, although none overlie the cropmarks which were situated in the centre of an enclosed field. It is also difficult see links in shared orientation between the rectilinear settlement and the excavated features at Fox Covert, despite them being only 250m apart. This, however, would be to seek uniformity in the layout of boundaries, but if the main factor was conforming to the lie of the land at a local scale, then coaxial patterns for example would only be present where the terrain was conducive to this. These findings highlight the disparity in interpretations at regional and local scales.

The cropmarks of possible Iron Age ditches lying close to the rectilinear settlement enclosure are oriented around ten degrees differently from the nearby excavated early medieval ditch. The cropmarks wholly conform to within 30 and 20 degrees of underlying slope direction; but only sixty-three percent of the early medieval ditch conforms to within 30 degrees. With no dating for the cropmarks it is unknown whether the two might be contemporary, but the different orientations and lack of conformity to underlying slope direction for the early medieval boundary ditch compared with the cropmarks suggest that they are not connected following the logic that the boundaries associated with the rectilinear settlement were laid out in respect of the lie of the land. On the other hand, there is no direct evidence to say the rectilinear settlement and the cropmarks are in any way contemporary as the only thing linking them is close proximity and a high conformity to underlying slope direction.

A much higher proportion of medieval ridge and furrow conforms to within 30 degrees of underlying slope direction than post-medieval ridge and furrow in this area (75 and 57 percent respectively). Some medieval ridge and furrow underlay parts of the Grange complex, and the two were oriented in a similar way, as can be seen in Figure 6.16. The boundary ditch which predated the Grange is also oriented similarly to the ridge and furrow, suggesting the two could well be connected, especially as the ditch seems to separate two distinctive directions of ridge and furrow.

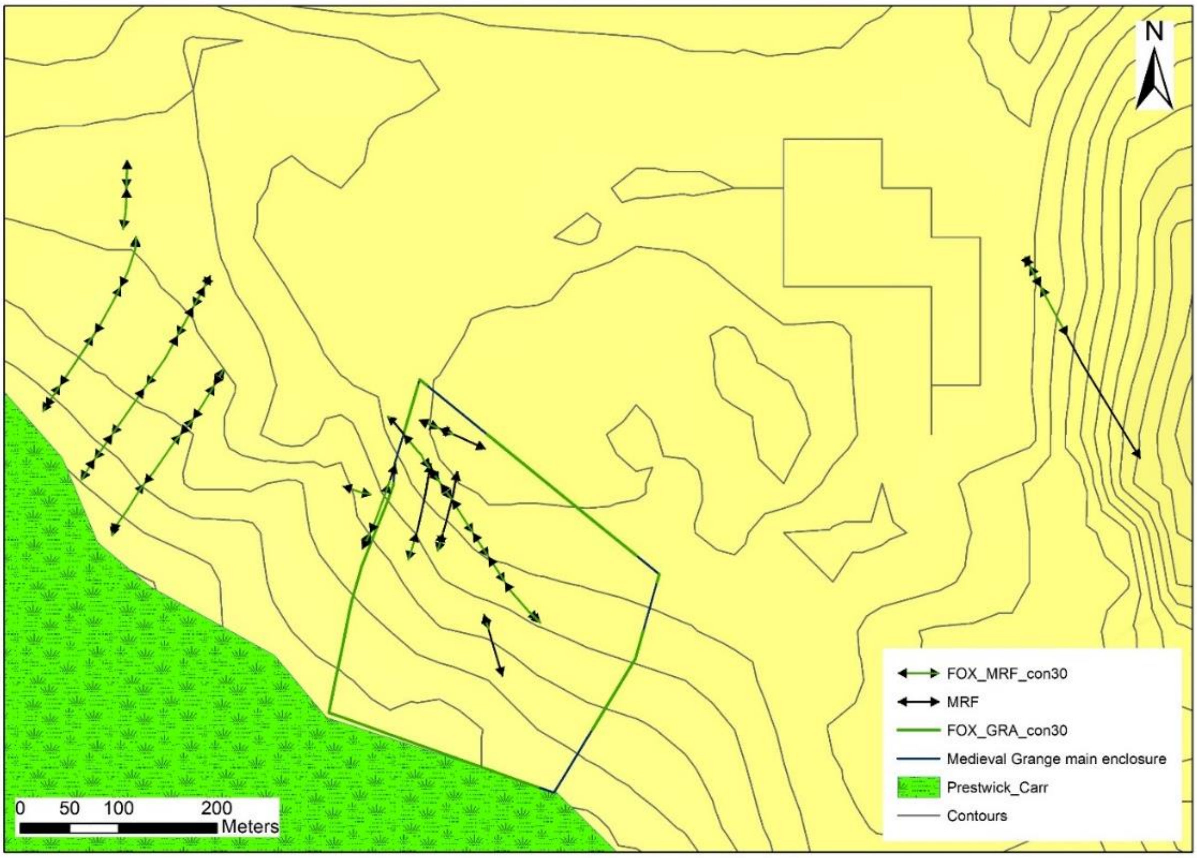

Figure 6.16 Orientations and slope direction conformity amongst medieval ridge and furrow and the medieval grange outer enclosure. Prestwick Carr may have been partially drained by this time, but this is pure speculation (contours derived from 50m DTM downloaded from Edina Digimap, 2017)

The 1st edition Ordnance Survey boundary units are in many cases closer to the 30 degrees limit than to 20 degrees in conformity to underlying slope direction. Some 1st edition Ordnance Survey boundary units are oriented similarly to that of the cropmark considered to be Iron Age in date (10/100 or 20/110 degrees), but do not conform to within 30 degrees of underlying slope direction, as is shown in Figures 6.17 and 6.18. These could, therefore, have been part of an earlier system of land division which endured into later times. Along with the shared orientation to post medieval ridge and furrow, this could be the result of improved drainage alleviating the need to conform to underlying slope direction. Under drainage would be a good candidate for this, which was the most common form of drainage technology in the post medieval period (Williamson 2002).

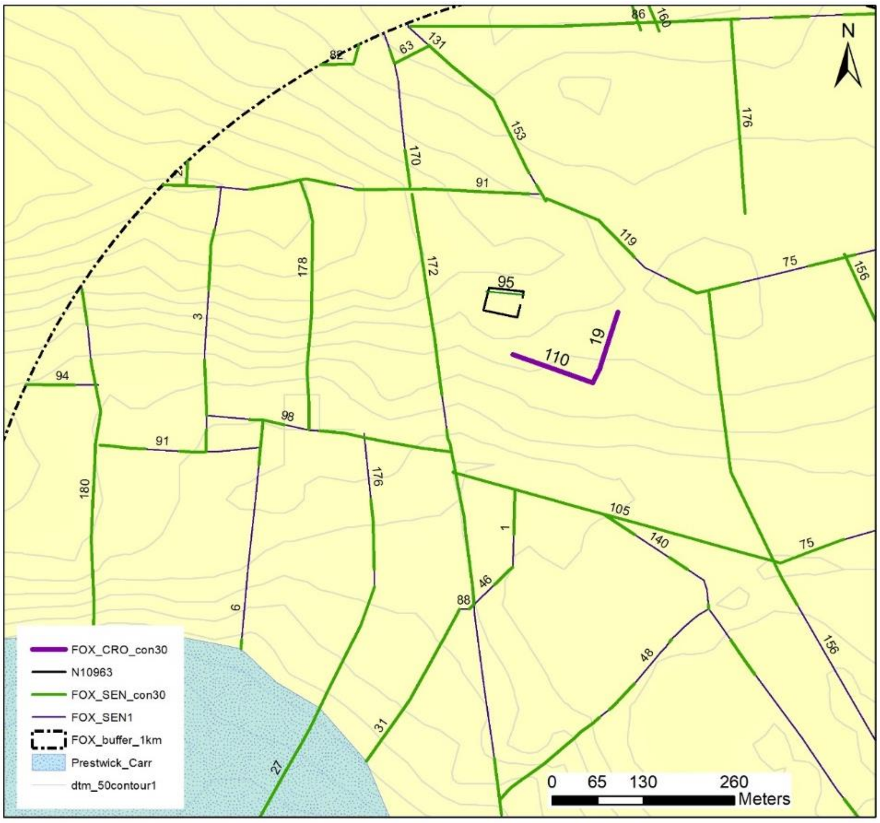

Figure 6.17 Orientations and slope direction conformity amongst Iron Age settlement and boundary traces and 1st edition Ordnance Survey boundaries (contours derived from 50m DTM downloaded from Edina Digimap, 2017)

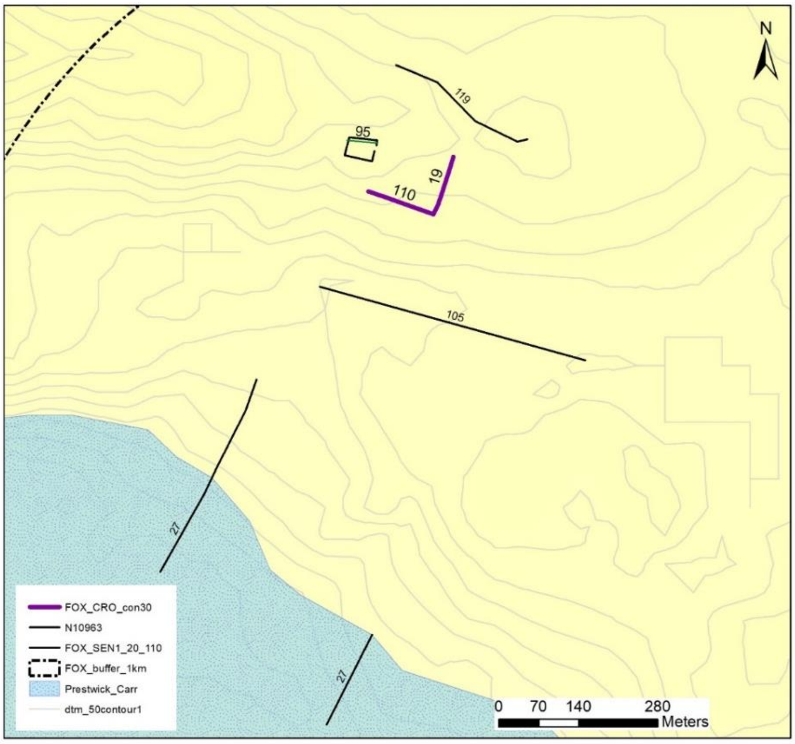

Figure 6.18 Orientations around 20 or 110 degrees amongst Iron Age settlement and boundary traces, and 1st edition Ordnance Survey boundaries (contours derived from 50m DTM downloaded from Edina Digimap, 2017)

The results show a clear shift in prevalent orientation between medieval ridge and furrow, predominantly oriented around 30 or 120 degrees, and post medieval ridge and furrow oriented around 80 or 170 degrees. The 30/120 degrees trend is also most common in the pit alignment and early medieval boundary ditch; whilst the 80/170 is also prevalent in 1st edition Ordnance Survey boundaries. The common orientations shared by post medieval ridge and furrow and 1st edition Ordnance Survey boundary units suggest the two are contemporary. It also implies a period of flux in land-use between the medieval ridge and furrow and post medieval ridge and furrow. At most places within the whole study area it has been found that medieval ridge and furrow and post medieval ridge and furrow share similar orientations which imply elements of open fields were used in the layout of post medieval enclosed fields layouts; and that enough of the open field layouts remained in place from which to do this. An example of this is Whalton, which will be referred to in a later case-study. This might not have been the case at Fox Covert; and what we could be seeing is a period in which former medieval arable land reverted to pasture before being brought back into cultivation as part of an enclosed field system. This could have occurred as part of the draining and enclosure of Prestwick Carr in the early nineteenth-century (Harbottle 1995). Whilst some medieval ridge and furrow units are oriented quite differently to the pit alignment, they still conform to within 30 degrees of underlying slope direction. Conversely, some shorter traces of ridge and furrow are oriented within 12 and 13 degrees of the pit alignment, but do not wholly conform to within 30 degrees of underlying slope direction. These anomalies are common throughout the medieval ridge and furrow dataset; and are reflective of the highly irregular layout of furlongs within medieval open fields.

In summary, the shared orientations of features assigned to different periods at Fox Covert is likely to be the result of unrelated and coincidental conformity to underlying slope direction rather than a conscious push to orientate features in the same way over long periods of time. The pit alignment had probably silted up completely by the tenth-century (TWM Archaeology 2007), so it is unlikely that it had any bearing on the orientation of the early medieval ditch or later medieval land-use. What it did leave was a legacy of orienting features to respect the lie of the land. The coincidence of conformity to underlying slope direction shows that the same orientation was adopted by different generations creating features to fulfil different functions, from land allocation to arable furlongs; and the common denominator for all was a requirement that the layout of linear features reflected the lie of the land. From at the least the Bronze Age until the medieval period, people appear to have understood the importance of demarcating land using boundaries which respected the lie of the land. From the prehistoric pit alignment and rectilinear enclosure, to the furlongs within medieval open-fields, being situated on the shores of the now-drained Prestwick Carr seems to have been a key factor in the orientation of land-use units at Fox Covert. It would have been an important resource in terms of fuel and food; and, also, a focal point to local communities.

6.3 A common orientation contained within the township unit: Whalton

The common orientation of boundaries and tracks from different periods are in some cases encased within territorial boundaries. Whalton is one of these; and is all the more distinctive when viewed against the contrasting orientations within neighbouring townships. This case study will address Research Aim 3 and Objectives 6 and 7 to explore whether underlying slope direction influenced the distinctive layout of boundaries and routeways encased within Whalton township; and will test the longevity of common orientations over long periods and distinctive phases of settlement and land use. Whalton is not the only example of a distinct orientation trend encased within a township unit. Horton, situated along the coastal plain, shares this characteristic; and will be analysed and discussed as a comparative township. The results from Whalton will also be compared with those from the neighbouring township of Ogle to the south, especially in terms of conformity to underlying slope direction.

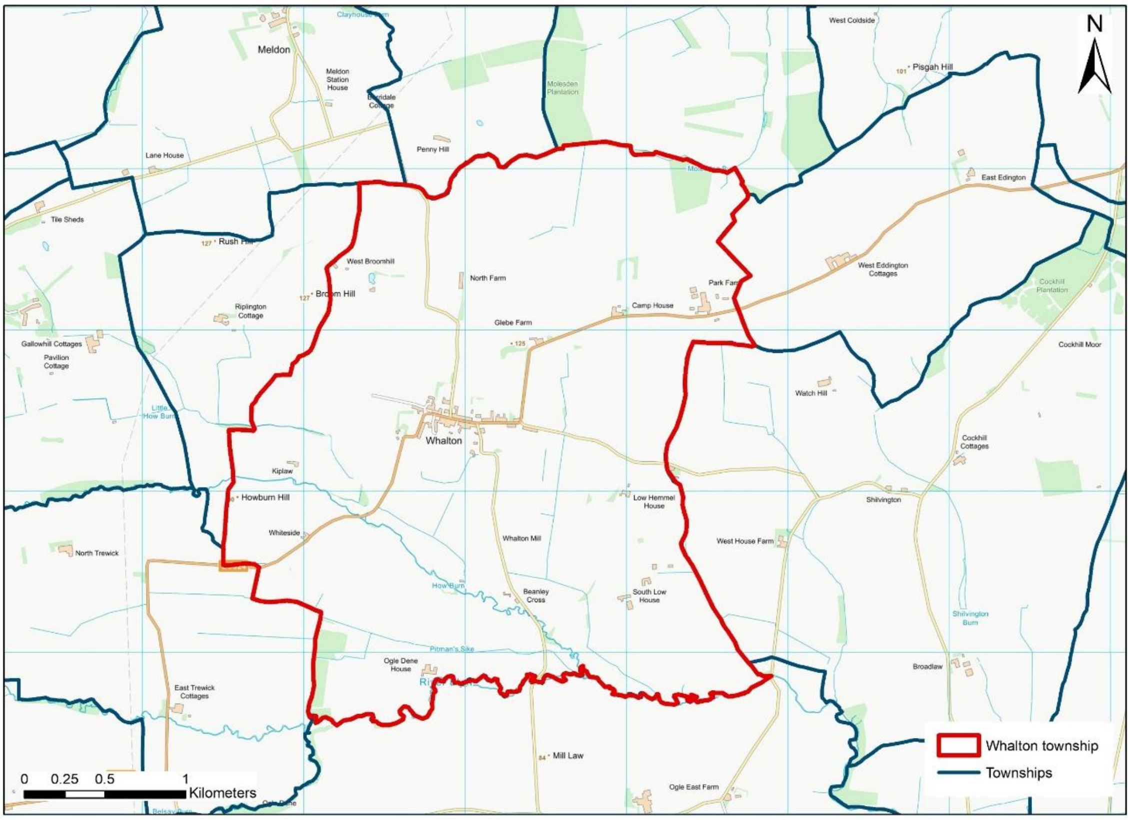

Figure 6.19 Whalton township

Figure 6.20 The currently occupied village of Whalton, looking west along the main road which formed the basis of the medieval village (Photograph: author)

Whalton township lies on the western borders of the coastal plain and at its centre lie the medieval village (Figures 6.19 and 6.20). The terrain consists of gently rolling hills falling into shallow river valleys, the most prominent being the River Blyth which separates Whalton township from Ogle to the south. The geology upon which Whalton sits consists mainly of boulder clays with areas of sand and gravels; and soils are loamy and clayey which suffer impeded drainage (Landis: no date).

The mixed agriculture of arable and pasture in this area entails that both cropmarks and earthworks of relict land units are present and identifiable on Google earth and LiDAR respectively. Along with historic maps, remote sensing provides much of the dataset for this study area, as no excavation has taken place comparable to areas further east along the coastal plain. Cropmarks identified within Whalton township include three rectilinear settlement enclosures, one of which is newly discovered through this research (see Figure 6.21). All are morphologically consistent with excavated examples in the region which have been securely dated to the late Iron Age and early Roman periods. There are also numerous other linear cropmarks present which cannot be dated with any precision. Two of these will be analysed and compared with existing boundaries to determine whether they might be contemporary with features in their vicinity through shared orientation or conformity to underlying slope direction. These are visible on the 2006 Google Earth image, 180m north-east of rectilinear enclosures at Whalton Hill Head farm (N11250); and east of N11249; and are illustrated in Figure 6.22.

Figure 6.21 Newly discovered Iron Age or early Roman period rectilinear settlement enclosure on 2015 Google Earth imagery

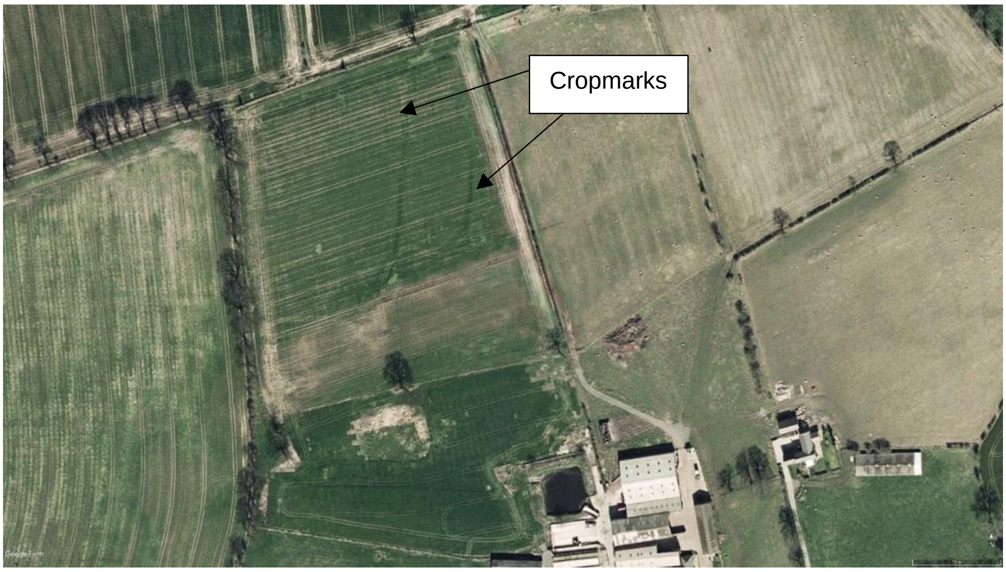

Figure 6.22 Linear cropmarks in the north east portion of Whalton townhip on 2002 Google Earth imagery

Addressing Research Aim 1, no evidence was found at the time of writing for settlement or land use during the intervening period between the probable decline of the rectilinear settlement enclosures in the late Iron Age or early Roman period, and the medieval nucleated village with associated evidence for medieval furlongs. Whalton appears to have held some considerable importance during the medieval period and beyond though, which could indicate a longer presence in the area preceding the nucleated village. Documentary sources record some *thanages* (areas of land held by powerful figures during the Anglo-Saxon period) in the region were absorbed into the ranks of the *socage* holdings (a feudal tenure of land) owing money rents. Whalton was one of these. Eight *socages* were recorded at Whalton in the inquest of 1242-3, the largest of any vill in Northumberland. They survived in the form of small freeholdings into the eighteenth-century; and were a decisive factor in maintaining the small village settlement which survives into the present (Wrathmell 1975: 59). Although only two medieval buildings remain standing at Whalton, St Mary's Church and a fourteenth-century tower-house incorporated into a later building, it can be assumed that the orientation of Whalton's medieval settlement core has not changed since the medieval period. The earliest known maps for Whalton are estate plans produced in 1768 for landowner William Middleton. These cover only the southern portion of the township but show that in this area the field system depicted on the 1st edition Ordnance Survey map was present by this time.

6.3.1 Results

Feature (Prefix)	Prevalent orientation (degrees)	% conforming to within 20 degrees of underlying slope	% conforming to within 30 degrees of underlying slope
WHL_RECT	100	76	88
WHL_GEL	10	100	100
WHL_MNV	99	59	100
WHL_MRF	10/100	57	77
WHL_PMRF	10/100	53	77
WHL_SEN	10/100	53	75

Table 6.3 Results of orientation and conformity to underlying slope direction at Whalton

The table above is a summary of the full results which can be found in Appendix A and Appendix B. The file prefix for linear cropmarks in Whalton is "WHL_GEL" (Google Earth Linear).

All three rectilinear settlement enclosures within Whalton township are oriented between 100 and 110 degrees. Kiplaw North, discovered through this research, is oriented at 107 degrees, Camp House (HER No. N11249) is oriented at 100 degrees; and Dead Men's Graves (HER No. N11250) is oriented at 102 degrees. A total of 76 percent of analysed units representing rectilinear enclosures conform to within 20 degrees of underlying slope direction; and 88 conforming to within 30 degrees. These figures are higher than those for rectilinear settlement enclosures across the study area.

The two cropmarks selected for analysis run parallel to a boundary defined by a natural water course. They are oriented at nine and four degrees respectively; and run roughly perpendicular to the nearby rectilinear settlement enclosures. Both cropmarks wholly conform to within 20 degrees of underlying slope direction. The orientation of the medieval nucleated village was calculated at 99 degrees; and the entire village conforms to within 30 degrees of underlying slope direction, with 58 percent of its length conforming to within 20 degrees. The greatest proportions of orientations for medieval ridge and furrow within Whalton are between 0/90 and

10/100 degrees. Fifty-seven percent of medieval ridge and furrow evidence conformed to within 20 degrees of underlying slope direction, with 77 percent conforming to within 30 degrees.

The most frequently occurring proportions of 10/100 degrees for post-medieval ridge and furrow echo those of medieval ridge and furrow. A total of 53 percent conform to within 20 degrees of underlying slope direction and 77 percent conform to within 30 degrees. The highest proportions of 1st edition Ordnance Survey boundary and track orientations in Whalton township are around 10 or 100 degrees and 0 or 90 degrees, confirming these were the dominant orientations over long time periods in this area. Fifty-three percent of 1st edition Ordnance Survey boundary and track orientations within Whalton conform to within 20 degrees of underlying slope direction, with seventy-five percent conforming to within 30 degrees. Overall, conformity to underlying slope direction is proportionately higher than the results for the whole study area.

6.3.2 Discussion

Using 50m aspect data, by far the most frequent orientation of slope direction within Whalton township is around 10 degrees, which, as is shown above, and taking perpendicular orientations into consideration, is shared by nearby rectilinear settlement enclosures, the medieval village unit, ridge and furrow dating to both the medieval and post-medieval periods; and boundaries and tracks depicted on 1st edition Ordnance Survey maps. There are exceptions to this trend, such as the blocks of ridge and furrow and 1st edition Ordnance Survey boundaries in the north east of the township, which are oriented roughly between 60/150 and 80/170 degrees. This could also have been a response to underlying topography. Aside from these small pockets, the consistency of 0-10 or 90-100 degrees and high conformity to underlying slope direction strongly implies long term continuity in orientation as a direct response to the lie of the land. The following discussion will explore this claim by comparing the results from different periods; and comparing them with those in Ogle township immediately to the south and Horton township further east.

It is likely that many of the boundaries and tracks present by the nineteenth-century are the result of the long process of enclosure which began at least by the fifteenth-century; however, it cannot be ignored that a common orientation of boundaries, tracks, settlements and ridge and furrow traces seems to have persisted since at least the late Iron Age, preserved the buried remains of rectilinear enclosures; and probably some boundaries and tracks, such as the road passing through Whalton village. This route could have been used as a pivot for the grain in orientation of settlements, fields and route-ways traversing the township, although none can be dated through absolute means at the time of writing. If the enclosure at Camp House (N11249) is indeed a hillfort as it has been postulated in the HER entry, a date of origin for this grain in orientation could be pushed back to the middle or early Iron Age.

The low amounts of post medieval ridge and furrow oriented around 30 to 50 degrees compared with medieval ridge and furrow is not too surprising. We should expect less variation in the amounts of orientation of post-medieval ridge and furrow, as it was laid out and used in fields morphologically different to medieval open fields, in long regular strips as opposed to complex systems of furlongs. Of those 1st edition Ordnance Survey boundaries oriented around 40 or 130 degrees at Whalton, a comparatively low 59 percent conform to within 30 degrees of underlying slope direction; and for those oriented around ±10 of 50 or 140 degrees, 55 percent conform to within 30 degrees. Boundaries oriented in these ways are most prevalent in the southern portion of the township, where, as Figure 6.23 shows, they do seem to conform to the grain of slope for significant lengths. In comparison with the most predominant orientations of 10 or 100 degrees (shown in Figure 6.24), of which 78 percent conform to within 30 degrees of underlying slope direction, these figures are quite low, and lead us to consider whether other factors were at play in these instances other than conforming to underlying slope direction, such as whether these boundaries are later additions to the fieldscape using more sophisticated underdrainage on the banks of the river which may previously have been unenclosed and put to other uses for long periods. No underlying traces of the boundaries oriented around 10 or 100 degrees could be identified to explore this further.

Figure 6.23 Levels of slope direction conformity amongst 1st edition Ordnance Survey bouondaries and tracks oriented around 40, 50, 130 or 140 degrees (50m DTM downloaded from Edina Digimap 2017)

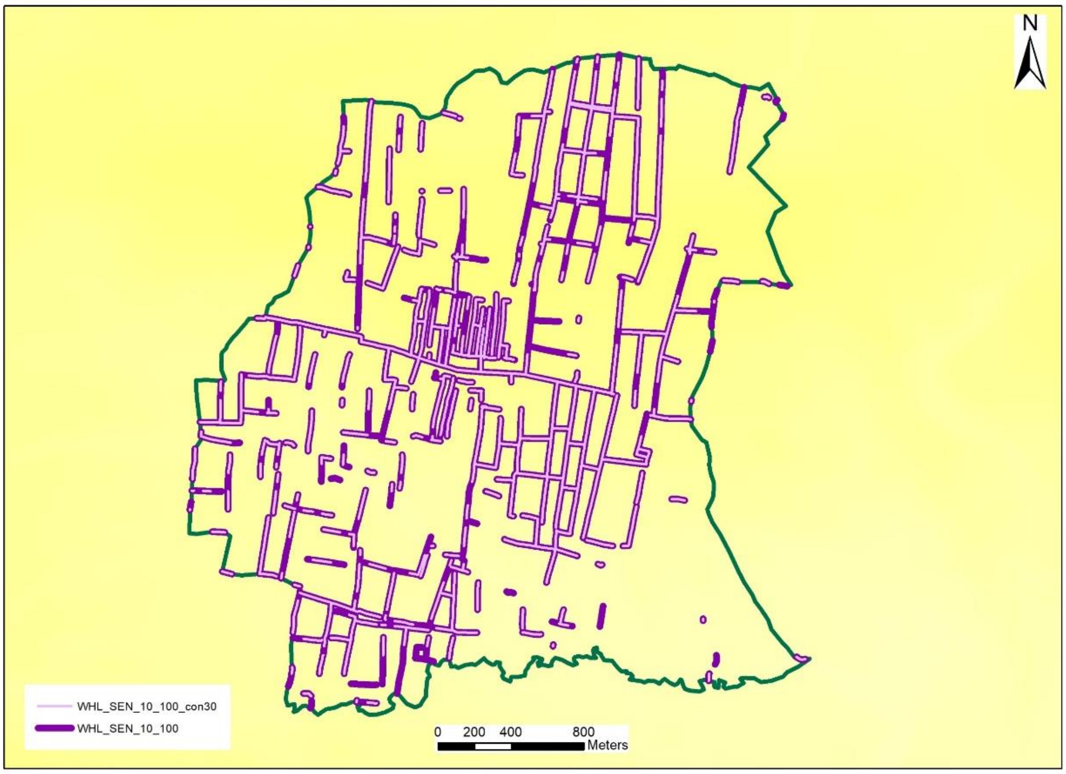

Figure 6.24 Levels of slope direction conformity amongst 1st edition Ordnance Survey boundaries and tracks oriented around 10 or 100 degrees (50m DTM downloaded from Edina Digimap 2017)

The newly discovered rectilinear enclosure west of Whalton shares the same orientation as some surrounding field boundaries and traces of medieval ridge and furrow. One furrow completely overlies western ditch of the enclosure, probably inserted after a long period of silting-up; but still using the same axis. This implies two possibly interrelated things: that the orientation of the rectilinear enclosure directly influenced the layout of medieval furlongs; or that conforming to underlying slope direction was a factor in the layout of two distinct landscape features separated by a chronological gap. This example illustrates the challenges of Research Objectives 6 and 7 with identifying continuity between distinct landscape features when conformity to underlying slope direction is present in both.

The medieval furrow reusing the probably partially silted-up western enclosure ditch of the Kiplaw North rectilinear settlement is repeated throughout the study area; and suggests that the enclosure was still upstanding and visible in the medieval period. The fact that both feature types largely conform to slope direction in this area means it cannot be assumed that the location and orientation of the enclosure influenced that of the furlongs; and it could simply be the result of a common need over long periods to conform to the lie of the land. It does invite us to consider how these surviving remains of settlement enclosures would have been perceived by medieval folk. A comparative example of this exists within Horsley township, with a probable Iron Age/early Roman periods settlement enclosure being used as a primary furlong within a medieval open field (Tolan Smith 1997: 77).

The prevalent 10/110 degrees orientations at Whalton differs from those within surrounding townships. For example, the average orientation within nearby Ogle township to the south is 80/170 degrees, which is more indicative of the prevalent 1st edition Ordnance Survey boundary orientations across the study area as a whole. Furthermore, a far greater proportion of rectilinear settlement enclosures conform to within both 20 and 30 degrees of underlying slope direction in Whalton (75% and 88% respectively) than those in neighbouring Ogle township (44% and 71% respectively). Taking the orientation of rectilinear settlement enclosures as an indicator for associated boundaries and routeways, based on excavated evidence elsewhere such as East Wideopen, Pegswood and West Shiremoor, this comparison suggests that ensuring landscape elements conformed to the lie of the land may have been more important in the Whalton area than around Ogle in this period. The average orientation of rectilinear enclosures within Ogle township is 94 degrees which is broadly reflective of the orientations of this feature type as a whole across the study area, but not too far removed from those in Whalton, with less than 10 degrees discrepancy between the two averages. The higher levels of conformity to underlying slope direction in Whalton could reflect the more pronounced terrain; or possibly a response to different soil conditions and their effects on drainage.

The results of later features continue this disparity, with 57 and 77 percent of medieval ridge and furrow in Whalton conforming to within 20 and 30 degrees of underlying slope direction respectively, compared with 50 and 72 percent respectively in Ogle township. The 53 and 77 percent of post medieval ridge and furrow in Whalton township conforming to within 20 and 30 degrees of underlying slope direction is also proportionately higher than the 53 and 68 percent within Ogle. The results for 1st edition Ordnance Survey boundaries conformity within Ogle township, with 48 percent conforming to within 20 degrees of underlying slope direction, and 68 percent conforming to within 30 degrees, are not as high as were found in Whalton (53% and 75% respectively). The most frequently occurring orientation amongst 1st edition Ordnance Survey boundaries in Ogle are around ±10 of 80/170 degrees, at 56 percent. The distinction between this and the 10/100 prevalence in Whalton can be seen in Tables 6.4 and 6.5.

WHL_SEN1 total length: 104413

Orientation	Length (m)	Percentage
WHL_SEN1_10_100	59033	57
WHL_SEN1_20_110	20273	19
WHL_SEN1_30_120	7659	7
WHL_SEN1_40_130	5524	5
WHL_SEN1_50_140	3399	3
WHL_SEN1_60_150	7362	7
WHL_SEN1_70_160	18409	18
WHL_SEN1_80_170	28541	27
WHL_SEN1_0_90_180	58091	56

Table 6.4 Prevalent orientations for SEN units within Whalton township

OGL_SEN1 total length: 67766m

Orientation	Length (m)	Percentage
OGL_SEN1_10_100	16467	24
OGL_SEN1_20_110	6971	10
OGL_SEN1_30_120	5439	8
OGL_SEN1_40_130	4927	7
OGL_SEN1_50_140	4225	6
OGL_SEN1_60_150	8793	13
OGL_SEN1_70_160	21300	31
OGL_SEN1_80_170	37893	56
OGL_SEN1_0_90_180	14999	22

Table 6.5 Prevalent orientations of SEN within Ogle township

The River Blyth forms the southern township boundary between Whalton and Ogle; and here there are some similarities in orientation between boundaries in the two townships, with blocks of fields either side sharing a 175-degree orientation, shown in Figure 6.25. Overall, however, the orientations of field patterns either side of the northern and southern township boundaries are very different. We would expect this due to the changes in terrain on either side of a river, which adds to the importance of the lie of the land in the layout of linear human-made features. Furthermore, Figure 6.26 shows the distinctiveness of Whalton’s linear units compared with those in surrounding townships. The idea of a common grain in the orientation of boundaries and tracks traversing large areas regardless of topography can be questioned from these results.

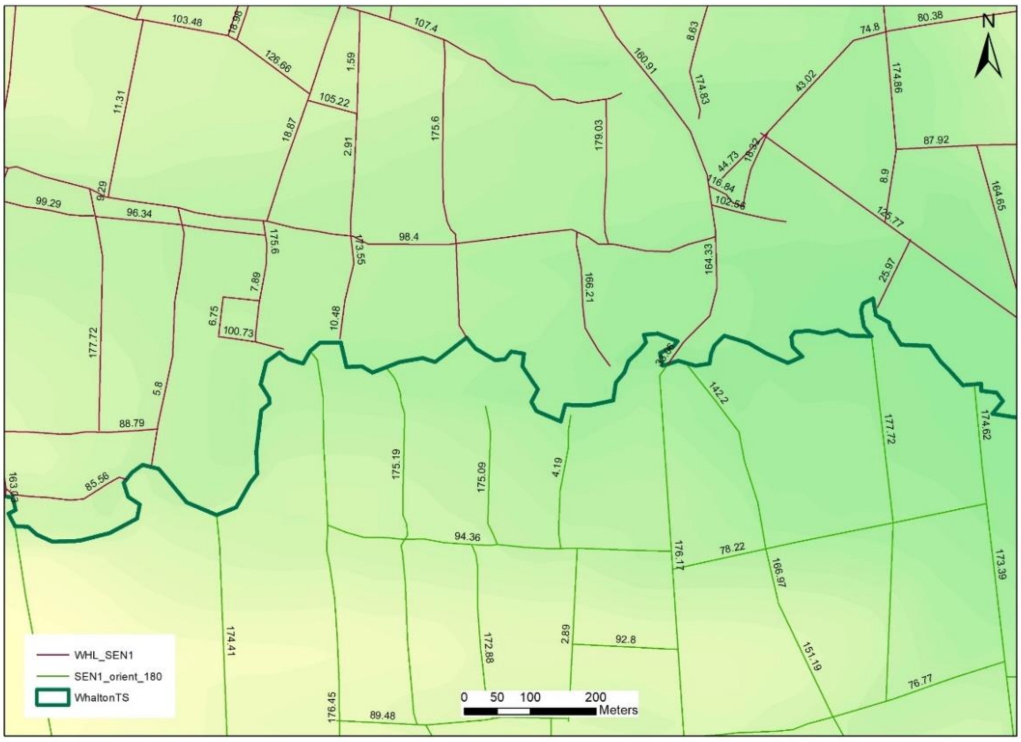

Figure 6.25 Relative orientations of 1st edition Ordnance Survey boundaries and tracks either side of the River Blyth (50m DTM downloaded from Edina Digimap, 2017)

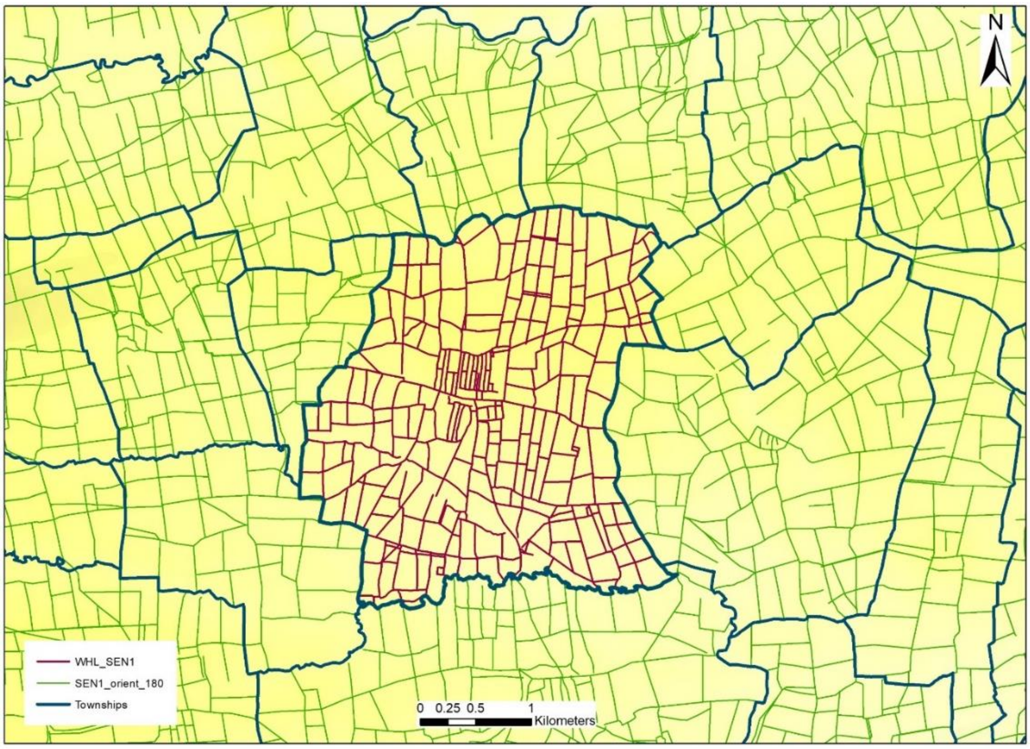

Figure 6.26 Orientations of 1st edition Ordnance Survey boundaries and tracks within Whalton and surrounding townships (50m DTM downloaded from Edina Digimap, 2017)

A similar situation to that in Whalton can be seen in Horton township, for which the boundaries differ significantly from adjoining townships to the west, such as those in Cramlington. The lie of the land appears to have influenced the layout of settlements and boundaries in a similar way to Whalton, but within Horton the dominant orientations of rectilinear settlement enclosures, ridge and furrow and 1st edition Ordnance Survey boundaries and tracks are commonly around 60 degrees; and where such features conform to underlying slope direction in large numbers. The 60/150 degrees orientation is more-or-less contained within Horton's township boundaries as depicted on 1st edition Ordnance Survey maps. The results for this can be found in Appendix A. Some boundaries share this orientation in neighbouring townships including Blyth and Seaton Delaval, shown in Figure 6.27; but territorial boundaries are often fluid; and can change over many centuries so it cannot be discounted that the units at one time did enclose discreet topographic units.

Within Horton township, proportionately more boundaries conform to within 20 degrees of underlying slope direction than do not; whilst in the neighbouring township of Cramlington, a greater proportion do not conform to within 20 degrees. The grain of the fieldscapes in both are also oriented on distinctly different angles, which may be significant. Boundaries and route-ways which conform to within 20 degrees of underlying slope direction also represent the grain within Wall township in the west of the study area; and within Murton and Monkseaton townships along the coastal plain.

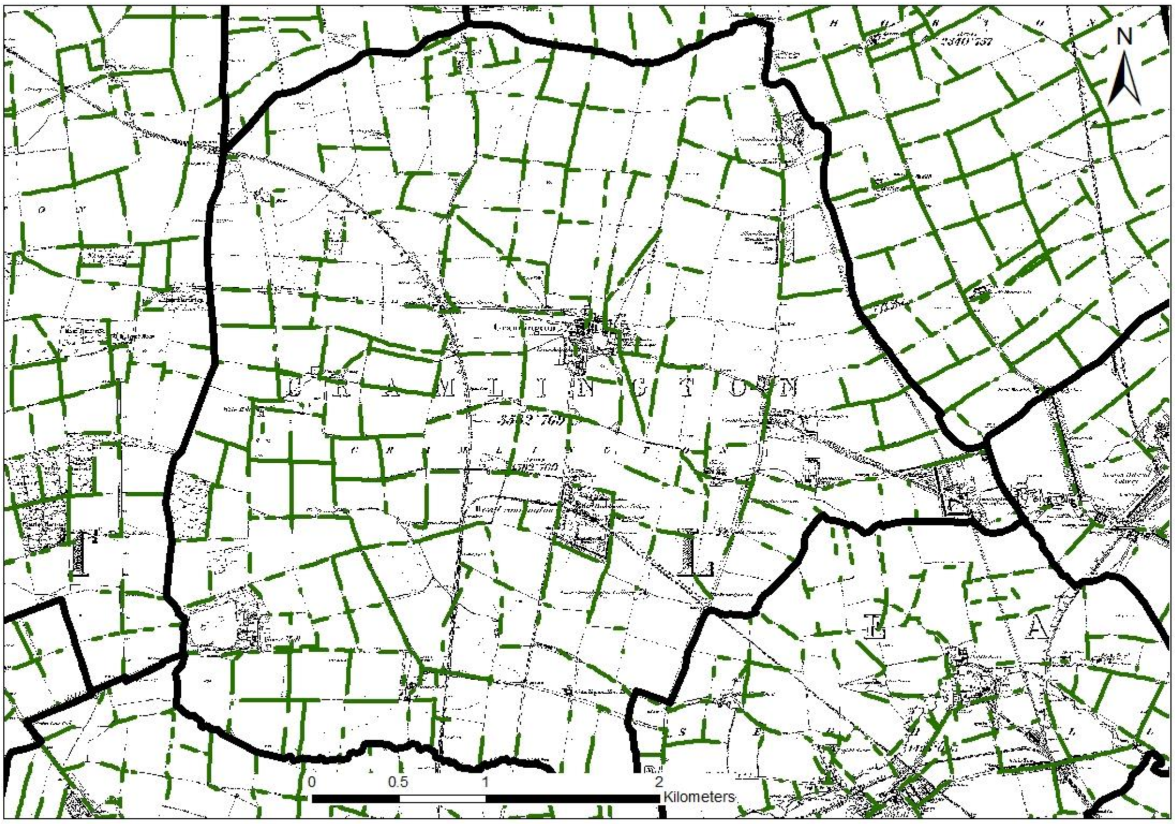

Figure 6.27 Common orientations around 10 or 100 degrees within Cramlington township, together with slope direction conformity to within 20 degrees, shown in green (1st edition Ordnance Survey mapping from 1865 downloaded from Edina Digimap, 2016)

The evidence from this case study implies the landscape of Whalton township as it we see it today developed in piecemeal fashion, perhaps beginning with a linear boundary or track such as the one passing through the middle of Whalton village, being used to lay out perpendicular boundaries and tracks, including perhaps some associated with rectilinear settlement enclosures. Over time the pattern may have grown and contracted; but the axis remained the same, maybe due to the long-standing presence of the road through the village. By the post-medieval period, following the enclosure of the open-fields, the coaxial appearance created by this was complete; but the original pivot remained even when early features, such as the rectilinear settlements, ceased to be occupied, although it would still have been visible. Therefore, the conformity to the lie of the land of the initial linear unit, the road for example, has led in this case to multiple phases of land-use sharing the same orientation. Later boundaries and tracks may have followed these orientations regardless as most conform to the lie of the land, but a legacy of orientation existed within this area which all later insertions followed. We cannot therefore say that the orientation of the rectilinear settlement enclosures and associated boundaries directly influenced the layout of medieval furlongs, for example. The link is indirect, through conformity to the lie of the land.

Tom Williamson (2016) stated that most post-medieval field patterns present by the time of 1st edition Ordnance survey mapping was the result of ‘infilling’ within longstanding linear boundaries and tracks which may well have originated in the prehistoric period. In the Northumberland lowlands we have a similar pattern of coaxial fields, usually laid out in a uniform pattern between rivers such as within Whalton. East Wideopen and Holywell Grange Farm and the rectilinear enclosures and field boundaries also show this phenomenon, where parts of the ancient landscape may have endured, whilst in the same area, post medieval changes in fields are apparent in their different orientations. These different orientations in later features showed comparatively less conformity to underlying slope direction, which is unsurprising considering the uniformity in orientation over a large area; but the improved technology such as under-drainage permitted this uniformity and control over the land. Doing the same in earlier periods would have compromised productivity through the possible drainage issues.

The evidence suggests a process of orienting settlements, boundaries and routeways which is first evident in the late Iron Age settlement enclosures; and possibly the route which passed through Whalton village, right through to post-medieval ridge and furrow and beyond, in a way which respected the lie of the land. This was all encased within specific boundaries, for example the townships of Whalton and Horton. These township boundaries therefore frame a long-standing trend to reflect the lie of the land in human-made features. The high proportion of linear units conforming to underlying slope direction within Whalton and Horton townships suggests that the need for boundaries to conform to the lie of the land was an important factor over many generations, even if the function of landscape elements did not always stay the same. It also implies that discreet topographic contexts dictated the extents of township boundaries at least by the medieval period, if not before.

Could these results be evidence of territorial units at Whalton, and Horton which stretch back to at least the Iron Age? This suggestion is tentative, but if the lie of the land was important in the layout of settlements and fields over long periods, then why not for whole administrative units? The notion that other neighbouring townships do not share the characteristic of encasing a common orientation of settlements and linear land units could be that they were later additions to the administrative and territorial composition of the landscape over time, and other factors were at play in setting the extents of these. Seen in this speculative light, Whalton township could have been a nucleus from which other territorial boundaries were laid out over time. It is bounded to the north and south by rivers including the Blyth in the south, which bolsters its situation as an early unit, as natural features were commonly used to define the first territorial and administrative units in the landscape from at least the Bronze Age judging by studies of pit alignments (Spratt 1993 for example). The use of a prominent ridge and watershed for the western extent of Horton which separates it from the distinctively different orientations in Cramlington township is another example of the use of natural topography being used to demarcate the first territories in the study area.

Whalton and Horton townships are rare examples where a common orientation and alignment appears to have been maintained over long periods, so it is possible that coaxial fields may have existed in some form in prehistory, perhaps associated with rectilinear settlement enclosures. The presence of two dominant alignments within these townships, represented by what is now the main road through Whalton village and the road straddling the ridge within Horton township, entails that even if co-axial fields were not present in pre-medieval times, the layout present on 1st edition Ordnance Survey mapping seems to have developed from these dominant axes. This echoes the argument for a piecemeal development of field systems, consisting of various phases of expansion and contraction made by Williamson (2013; 2016).

Not all townships present on 1st edition Ordnance Survey mapping contain dominant axes like those most visible in Whalton and Horton. Other township units consist of an irregular layout of boundaries and tracks, such as Bedlington and Birtley. The levels of slope direction conformity in these townships implies that this could be due to the variance in slope direction. Together the evidence suggests that regular coaxial fields are present in south east Northumberland; but crucially only where the lie of the land was conducive.

There is a correlation at Whalton between township area and pre-Conquest estate, although this is more by implication than evidenced directly. For example, contemporary court roll documents tell us the churches of several of the extensive parishes of southern Northumberland are located at baronial and shire centres, such as Bedlington, Bolam, Hexham; and importantly for this study, Whalton (Wrathmell 1975: 73). The common orientations in Whalton could to some extent be representative of this long history and act as a starting point for addressing the chronological gaps set out in response to Research Aim 1 and addressed in Aims 2 and 3.

6.4 The endurance of Iron Age boundaries into later periods at East Wideopen

Aim 3 of this research is to explore the endurance or not of ancient linear features through long periods. The concentration of excavated evidence for boundary ditches dating to the Iron Age and early Roman period sets East Wideopen apart from similar excavated sites between the Rivers Tyne and Wansbeck, where in most cases only fragments have so far been uncovered. By comparing the orientations and conformities to underlying slope direction of known ancient land units and those present in the recent past it is hoped insights will be revealed into the lives of those who made the decisions which shaped the way we see the landscape today. East Wideopen is situated on the coastal plain around 8km north of Newcastle-upon-Tyne, adjacent to the Great North Road (Figure 6.28). The site sits upon an area of Pennine Middle Coal Measures formation overlain by Devensian till (BGS 2017). The subsoils are slowly permeable, seasonably wet acid loamy and clayey which are regarded as having impeded drainage (Landis online). The excavated sites referred to below are situated on a low south east-facing ridge, with associated boundaries and tracks falling away down roughly south-east facing slopes.

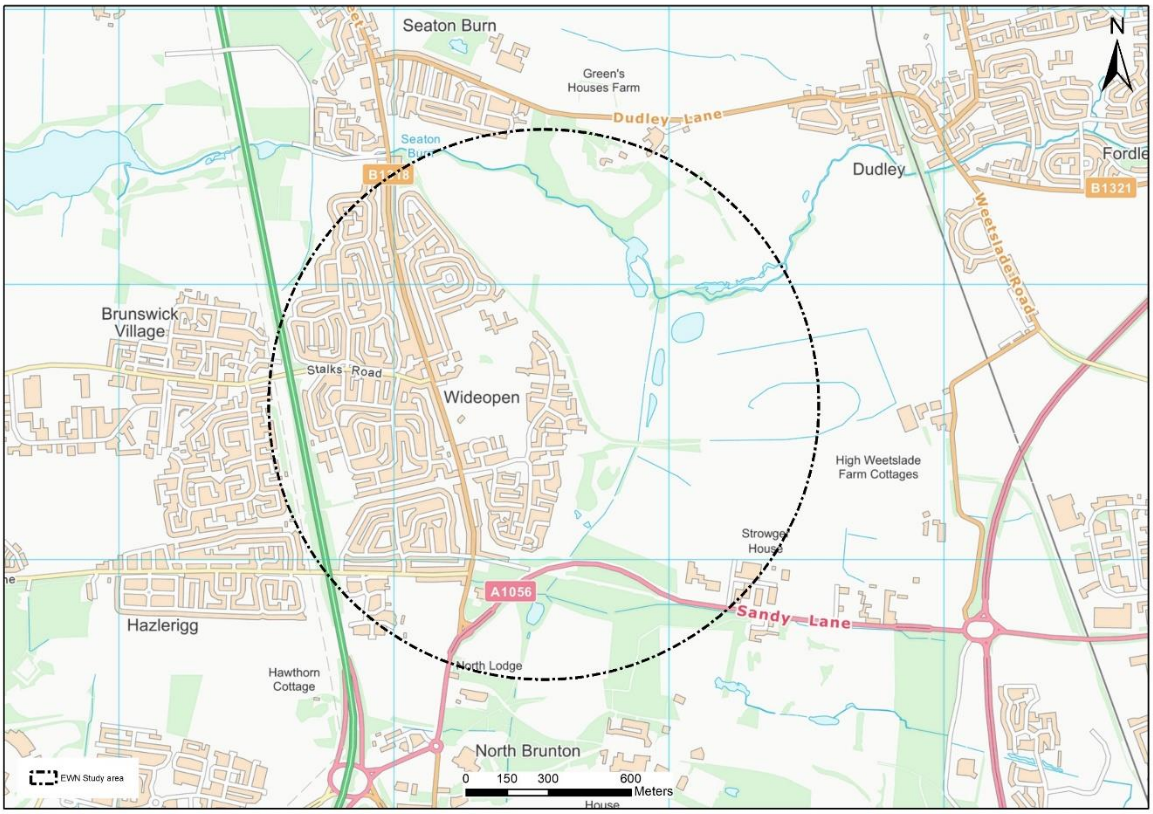

Figure 6.28 Location of East Wideopen case-study area

Recent developer-funded excavations at East Wideopen (ASDU 2014; NAA 2015; NAA 2018) uncovered three closely grouped settlement enclosures and numerous associated ditches dating to the Iron Age and early Roman period. The associated ditches were dated through association and by similar orientation with the radiocarbon dated enclosures rather than through direct scientific means. It is not certain, therefore, that the ditches and settlement enclosure were contemporary; and the ditches could be related to Roman or early medieval land use as they underlying medieval buried furrows; but the lack of associated evidence for this strengthens the case for them being associated with the Iron Age early Roman settlements due to the shared orientation. It is also possible that some ditches survived the demise of the settlement enclosures in the late Iron Age and second-century AD, something which the following analysis will seek to address. Two distinct rectangular fields were uncovered, with possible internal divisions separated by a trackway or droveway (NAA 2018: 8); these features will form the basis for analysis. Similar evidence for drove ways was found at Blagdon Park 2, Pegswood and Faverdale (Hodgson *et al.* 2012; Proctor 2009; Proctor 2012). The associated ditches at East Wideopen were thought to represent either associated outer enclosures for further occupation around the principal enclosure, or components of a wider network of boundaries associated with other uses. The complexity of intercutting gullies was thought to be typical of those associated with occupation rather than field boundaries (NAA 2018: 11). Aside from the excavated evidence, a further three cropmarks of probable rectilinear settlement enclosures lie in the immediate vicinity, taking the total to six within a 1km area.

Figure 6.29 Aerial image of excavations at East Wideopen, showing the southernmost settlement enclosure (from ASDU 2014: figure 51)

The excavated settlement enclosures and associated ditches are situated in the medieval township of Weetslade. The medieval settlement of Weetslade was first mentioned in 1242; and records show that seven taxpayers were recorded in 1312 which implies a relatively small settlement. The settlement cannot be accurately located in today's landscape; but is likely to have been situated around East Wideopen farm or possibly the site of the nearby mine, long since disused itself. Either way, nothing remains of the historic core, so the analysis could not be applied. Later references present in field names infer that the township of Weetslade had formerly contained open fields (Wrathmell 1975: 526); and cropmark evidence on Google Earth imagery has enabled traces of medieval and post-medieval ridge and furrow to be transcribed in the area. Buried furrows relating to medieval ploughing were also exposed across these sites during excavations, truncated in one area by post-medieval farm structures (NAA 2018).

Field boundaries within this area were transcribed in part from a 1780s estate plan, which was found to largely mirror the layout present on the 1st edition Ordnance Survey map. Georeferenced 1945 aerial photographs on Google Earth show the landscape before the onset of housing development which now overlies large parts of this case study area. By this time the area was characterised by a mixture of enclosed fields, some clearly parliamentary; and mining activity. Today, much of the area covered in this analysis is under modern housing.

6.4.1 Results

In the same way as was done at Shotton and Fox Covert, a 1km buffer was generated around the excavated ditches, and all relevant features to be analysed were clipped to this extent from the main datasets.

Feature	Prevalent orientation (degrees)	% con20	% con30
RECT	102	45	62
ANC_BOU	20/110	81	94
MRF	20/110	52	77
PMRF	10/100	51	70
SEN	10/100	52	72

Table 6.6 Orientation and slope direction conformity for features analysed at East Wideopen

Settlement	Orientation (degrees)
HER16222	94
HER5178	109
EWN_NAA	97
E_Wideopen	104
HER15298a	105
HER15298b	105

Table 6.7 Orientations of rectilinear settlement enclosures within EWN case-study area

The most commonly occurring orientations amongst rectilinear settlement enclosures were those around 100 degrees as Table 6.7 shows. Only 45 percent of these conformed to within 20 degrees of underlying slope direction, with 62 percent conforming to within 30 degrees. These figures are low compared with this feature type across south east Northumberland (69 percent). As shown in Table 6.7, the most frequently occurring orientations amongst ancient boundaries were within ±10 of 20/110 degrees (74%), with 66% oriented within ±10 of 30/120 degrees. Almost the entirety of the excavated ditches conformed to within 30 degrees of underlying slope direction (94%), with 81 percent conforming to within 20 degrees.

The prevalent orientation for medieval ridge and furrow was calculated at 107 degrees. A total of 52 percent was found to conform to within 20 degrees of underlying slope direction, and 72 percent to within 30 degrees. Post-medieval ploughing traces were found to be most frequently oriented around 10/100 degrees; and 51 and 70 percent conformed to within 20 and 30 degrees respectively. A total of 52 percent of 1st edition Ordnance Survey boundaries was found to conform to within 20 degrees of underlying slope direction, with 72 percent conforming to within 30 degrees. The 1st edition Ordnance Survey boundaries which were found to conform were predominantly oriented around 0/90 and 10/100 degrees.

6.4.2 Discussion

Total 50m aspect units: 1253

Orientation	Units	Percentage
10_100	475	38
20_110	281	22
30_120	260	21
40_130	332	26
50_140	248	20
60_150	176	14
70_160	216	17
80_170	231	18
0_90_180	367	29

Table 6.8 Proportions of 50m aspect orientations within EWN case-study area

As Table 6.8 shows, the most common slope directions around East Wideopen are oriented around 10/100 degrees. This is largely reflected in the orientation of rectilinear settlement enclosures (102 degrees); and the Iron Age/early Roman period ditches are also predominantly oriented around 110 and 120 degrees, with smaller units oriented around 0/90 or 10/100 degrees shown in Figure 6.30. It also reflected in the predominant orientations of ridge and furrow and 1st edition Ordnance Survey boundaries, but not to the extent of earlier features, as will be shown below.

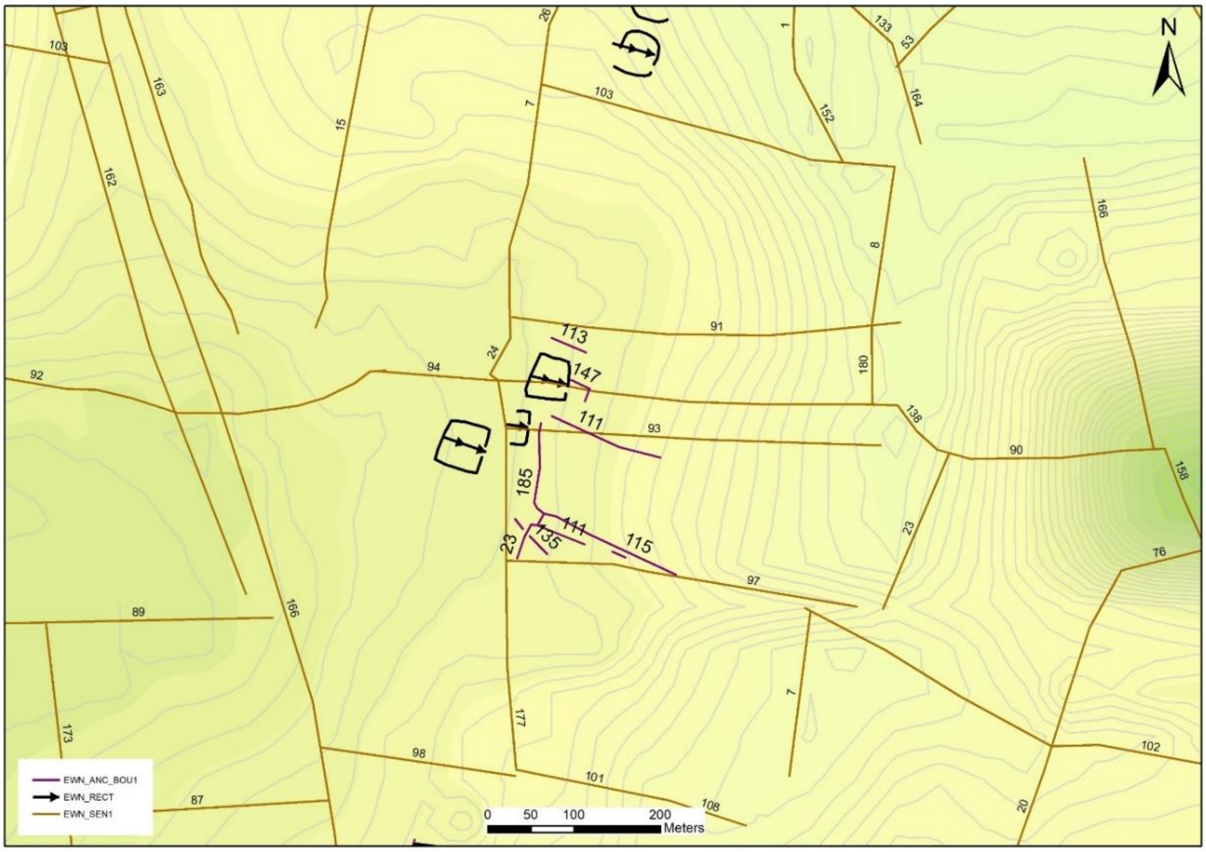

Figure 6.30 Orientations of settlement enclosures, ancient boundaries and 1st edition Ordnance Survey boundaries and tracks at East Wideopen (50m DTM dowloaded from Edina Digimap, 2017)

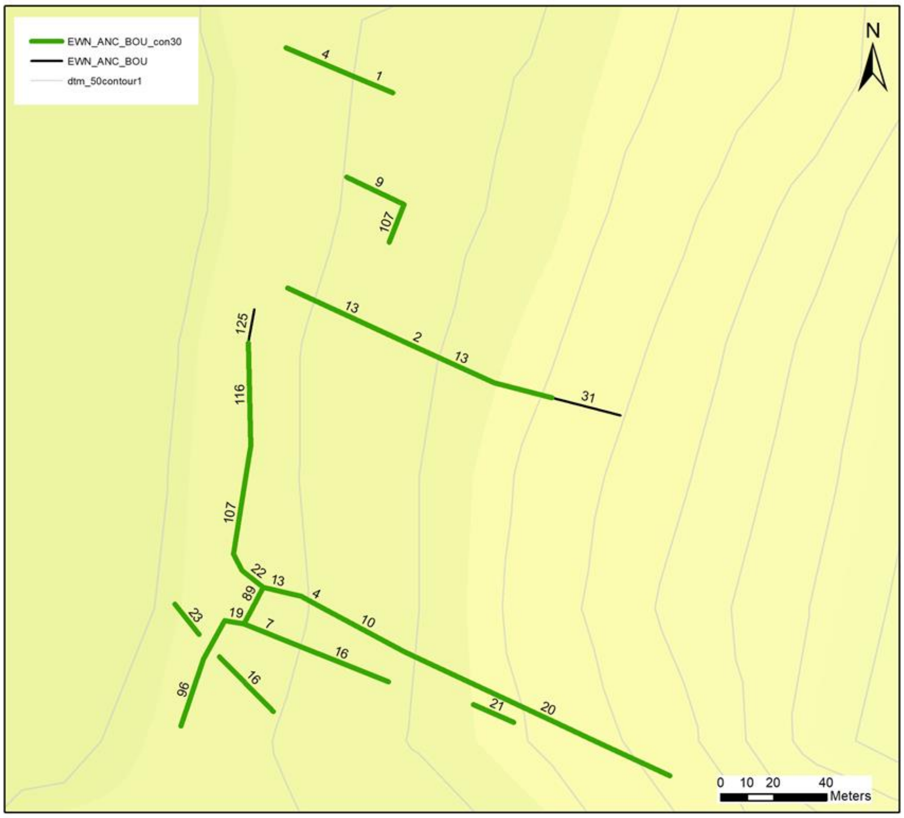

Figure 6.31 Levels of slope direction conformity amongst the ancient boundaries excavated at East Wideopen (50m DTM downloaded from Edina Digimap, 2017)

Apart from rectilinear settlement enclosures, conformity to underlying slope direction is relatively high across all features analysed at East Wideopen, as shown for the ancient boundaries in Figure 6.31. That only 62 percent of analysed rectilinear enclosure units conform to within 30 degrees shows most are situated on slopes facing different directions, which is illustrated in Figure 6.32. This is quite surprising in the context of this feature type as a whole; but similar evidence, albeit in the form of cropmarks, can also be seen at Holywell Grange Farm, where a higher level of conformity to within 30 degrees of underlying slope direction was found for the probable cropmark boundaries (58%) than the rectilinear settlement enclosure (HER 745) (43%) This distinction is illustrated in Figure 6.33. We therefore must consider the purpose of settlement enclosure ditches, and how different extents of conformity might relate to why they were laid out in particular arrangements.

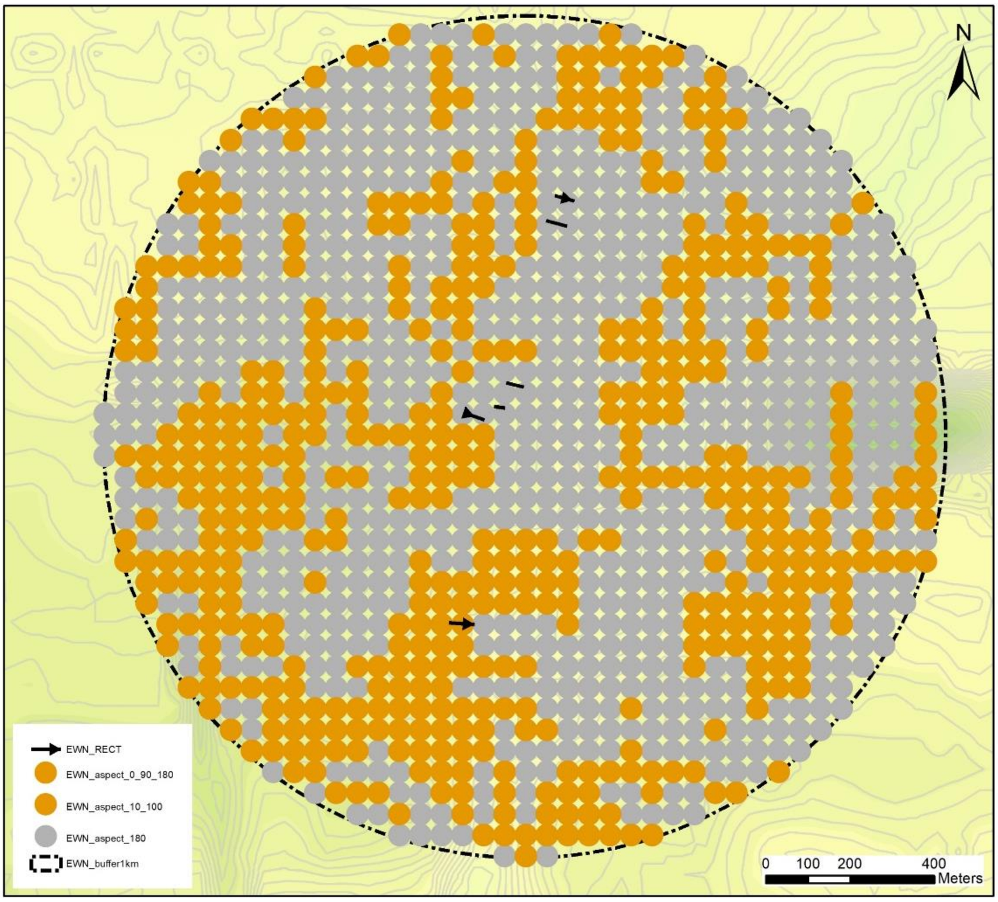

Figure 6.32 Orientations of rectilinear settlement enclosures compared within underlying slope direction calculated from aspect data derived from 50m DTM (downloaded from Edina Digimap, 2017)

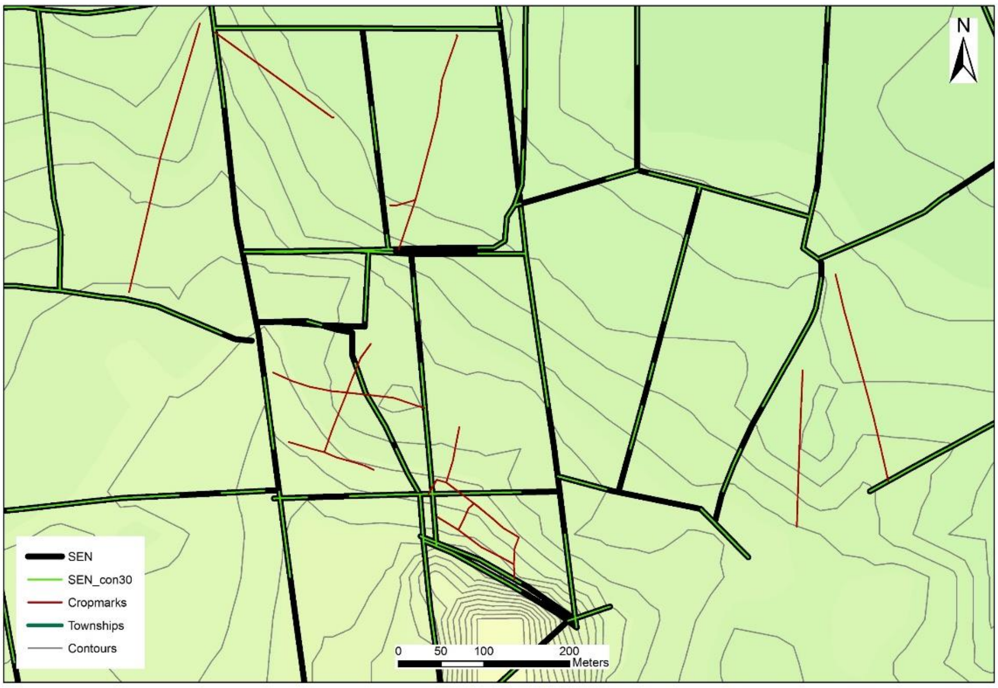

Figure 6.33 Levels of slope direction conformity to within 30 degrees at Holywell Grange Farm (contours and 50m DTM downloaded from Edina Digimap, 2017)

Despite the comparatively high conformity to the lie of the land amongst all analysed features at East Wideopen, the proportions conforming to within 30 degrees of underlying slope direction falls from 94 percent of ancient boundaries, to 72 percent of 1st edition Ordnance Survey boundaries. This could be evidence of both the higher importance of orienting prehistoric boundaries to slope direction which, whilst still important to later land-users, was less of an issue in later times, due perhaps to improved technology such as under drainage which enabled other factors such as land tenure to take precedence over the need to conform so closely to slope direction. This is also evidenced in the fact that slightly fewer post-medieval ridge and furrow units conform to within 30 degrees of underlying slope direction than medieval ridge and furrow traces, which could be the result of a push to plough strips in more a more orderly fashion coinciding with various enclosure regimes since the late medieval period.

Two of the 1st edition Ordnance Survey boundaries west of the excavated prehistoric complex are oriented similarly to many of the excavated ditches. The 1st edition Ordnance Survey boundaries oriented at around 120 degrees do not conform to within 30 degrees of underlying slope direction; and most other boundaries in the vicinity are oriented differently to the prehistoric complex. This could be fragmentary evidence of a common alignment being practiced in prehistory around a common orientation in this area, being in this case around 110-120 degrees; and irrespective of the lie of the land in some cases. One 1st edition Ordnance Survey boundary runs almost parallel with the north-south Iron Age ditch and the rectilinear settlement enclosure it bisects; and others share orientation with the average orientation of rectilinear settlement enclosures. This could imply that the few which share orientation with the boundary ditches might represent an earlier system of land management into which the rectilinear settlement enclosures were built, even though they do not share orientation exactly. The rectilinear settlement enclosures may therefore have been the pivots for later boundaries and tracks which evolved into the field patterns depicted on 1st edition Ordnance Survey mapping. These are predominantly oriented around 0/90 or 10/100 degrees but with fragments of an ancient pattern oriented around 30/120 degrees, or 20/110 degrees encased within. It is worth noting that both the 1st edition Ordnance Survey boundaries mentioned here are situated short distances away from the excavated complex with non-aligned boundaries in between. These non-aligned boundaries could be later insertions, with those that do share orientation with the excavated complex being examples of enduring boundaries in a complex and largely changing sequence of landscape development.

Analysis of similar evidence at Pegswood Moor, just north of the River Wansbeck, showed less conformity to within 30 degrees of underlying slope direction for both the excavated Iron Age and early Roman period ditches and boundaries and tracks present by the nineteenth-century than was found at East Wideopen. It is difficult to explain this disparity from features which are thought to be largely contemporary in date, but it could be that they lie at each end of the slope direction conformity scale. The ditches at East Wideopen largely conform to within 20 degrees; whereas those at Pegswood sit at the other end of the threshold, around and in some cases just outside the 30 degrees parameter. Both sets of ditches show varying levels of conformity, but other factors may have meant they do not conform to the same extents. For instance, the East Wideopen features lay on less well draining soils than Pegswood; or the slopes at Pegswood were steeper which facilitated a quicker run-off of surface water. The purpose of the ditches could also have been different as a result of these factors. Those around East Wideopen could have enclosed arable plots, comprising cord rig strips, for example, which would have required drainage to be effective in heavy clay soils; whereas those at Pegswood could have had different purposes. It was suggested that the late Iron Age enclosures at Pegswood were for corralling stock due to their association with a droveway (Proctor 2009). Any possible evidence for shallow cord rig ploughing would have been destroyed by more invasive medieval and later ridge and furrow; and later the destruction of the site by open-cast mining.

The presence of the Great North Road, now the modern A1 in this area, may have held influence over 1st edition Ordnance Survey field patterns in the southern portion of the case-study area, with two similarly oriented field boundaries projecting from it, shown in Figure 6.34. Once the orientation of the road changes, from eleven to 166 degrees, little relationship can be seen, however. Although the Great North Road does not appear to have a shared orientation with the excavated Iron Age/early Roman complex of ditches, the two may have coexisted at some point if we consider the importance to people in the past of local natural topography over the need to conform to a set orientation or alignment. A total of 69 percent of the Great North Road in this area conforms to within 30 degrees of underlying slope direction, which includes the portion closest to the Iron Age and early Roman settlement complexes. The presence of the Great North Road could also be a reason for the medieval settlement being located close by; and twenty prehistoric settlements dating to this period lie within 1km of the Great North Road including Shotton, Blagdon, and others visible as cropmarks towards and beyond Morpeth, as shown in Figure 6.35. From this evidence it could be argued that the Great North Road has much earlier roots, as has already been suggested in other studies (Heslop 2009; Hodgson *et al.* 2012: 192).

Figure 6.34 Distribution of 1st edition Ordnance Survey boundaries oriented around 10 or 100 degrees in relation to the Great North Road (GNR1) (50m DTM downloaded from Edina Digimap, 2017)

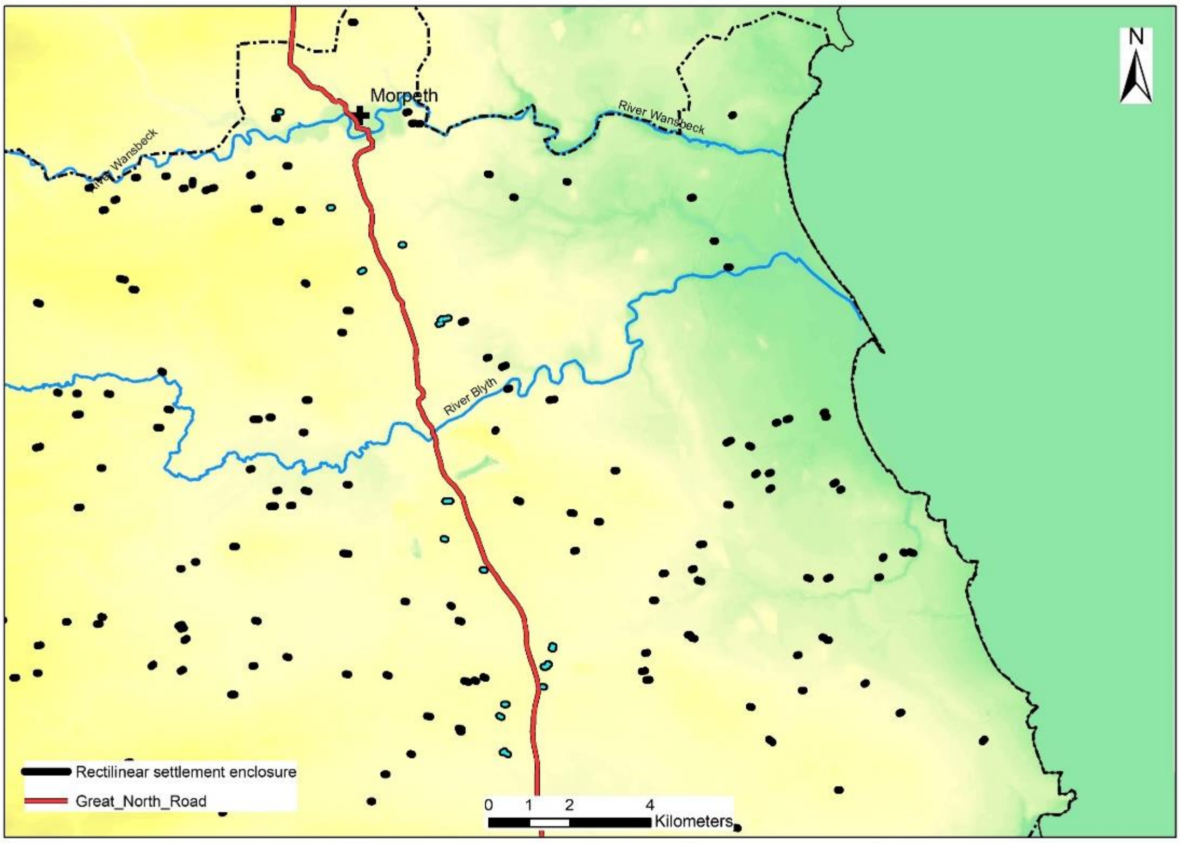

Figure 6.35 Distribution of rectilinear settlement enclosures within 1km of the Great North Road (highlighted) (50m DTM downloaded from Edina Digimap, 2017)

Interrelated questions arise from the changes in orientation in the same area at East Wideopen, for example: when did the fabric of the landscape radically change orientation; why did the change occur; and how did some boundaries survive these changes? These questions can only be definitively answered through detailed excavation. Comparing orientations between ancient and early modern features has enabled the identification of boundaries present in the landscape which share orientation with nearby Iron Age and early Roman period features. Excavating a sample of these would go a step towards answering some of the questions raised above.

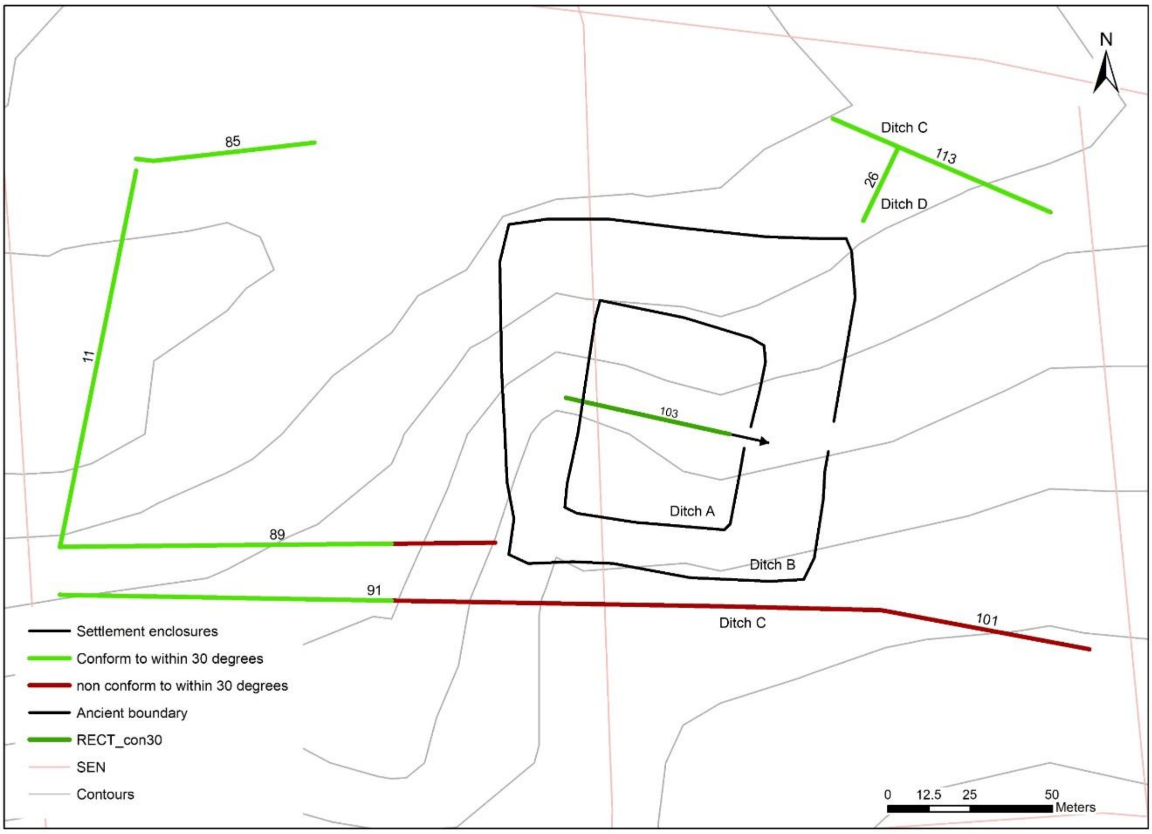

Figure 6.36 Brenkley excavation plan (after Headland Archaeology 2015: figure 5)

Excavations of an Iron Age/early Roman period settlement enclosure at Brenkley surface mine (NZ 21925 75907) also uncovered associated boundary ditches, some of which share orientation with surrounding existing 1st edition Ordnance Survey boundaries (see Figure 6.36). The rectilinear settlement enclosure is orientated 102 degrees, whilst the ditch to the south is oriented at roughly 90 degrees (ditch C); but at its eastern end changes orientation to 100 degrees, just two degrees difference with the settlement enclosure. The shared orientation and alignment of ditches A and B at Brenkley strongly suggests they were contemporary (Headland Archaeology 2015: 1-3). Ditch A at Brenkley shares alignment with a palisade trench which is likely to be an earlier feature, suggesting a common east-west axis over a long period (Headland Archaeology 2015: 14). The graded colour method described in chapter 2 allows us to see the extents to which excavated ditches conform to underlying slope direction without being confined to the thresholds used above. The evidence is too sporadic across the study area to view or interpret in this way as a whole; and offers little insight at this scale. It is, however, useful when analysing individual sites. At Brenkley, for example, the graded colour method illustrates greater conformity in the western portion of the site; and much less to the east

(Figure 6.37). Viewing this alongside underlying slope contours shows that the western portion of the site occupies a flat ridge which then slopes away to the south-east. If those who constructed this boundary wanted it to take a straight east-west course (which is of course a hypothetical proposition), then the eastern portion would obviously not conform to the south-east slope direction in the eastern portion. This dynamic is key to understanding the context in which linear units were built and used in the past: what was more important: maintaining a common orientation, conforming to macro or micro topography, or both?

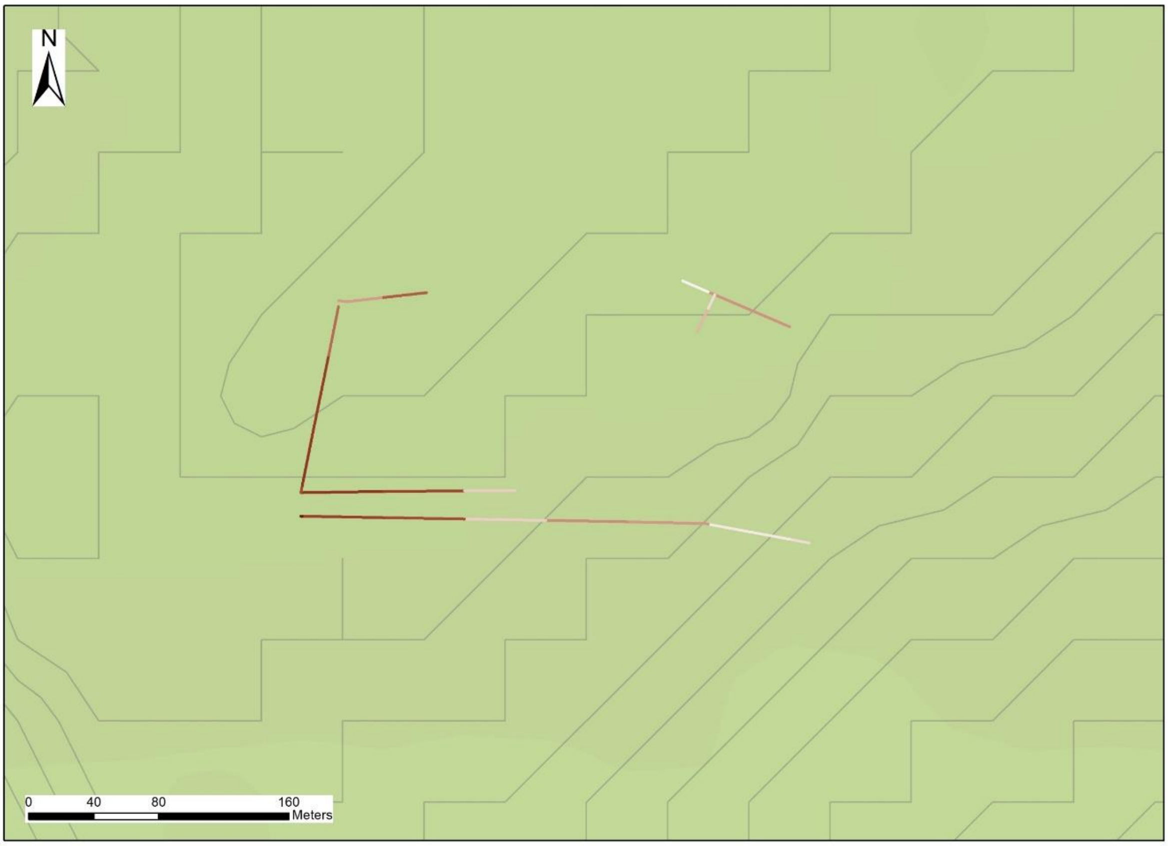

Figure 6.37 Using the graded colour method at Brenkley, where red signifies high slope conformity; and white represents low slope conformity. Contours are shown as grey lines

A complex of ditches to the north east of the enclosure are oriented at 25 and 113 degrees respectively, with just 7 degrees difference to the orientation of the settlement enclosure. An existing township boundary 120m north of the settlement is oriented at 96 degrees, six degrees different to the settlement enclosure. Immediately east of the settlement complex the field system is indicative of Parliamentary Enclosure; and could therefore previously have been moorland. Another existing boundary 440m south of the settlement enclosure is oriented at 98 degrees, just 4 degrees difference from that of the settlement; and only 2 degrees between the existing boundary to the north of the settlement. Around 1km south still, two parallel boundaries are oriented at 96 degrees. Most other existing boundaries present on 1st edition Ordnance Survey mapping in this area are oriented around 0-10 or 80-90 degrees. This is not a huge difference, but significant enough to set them apart from the common orientations of the settlement enclosure and the two boundaries mentioned above. This orientation is similar to the western portion of the excavated boundary ditch just south of the settlement enclosure. Both medieval and post medieval ridge and furrow can be seen within these 1st edition Ordnance Survey fields, sharing the same orientation as the boundaries, with the medieval ridge and furrow probably associated with medieval Brenkley medieval village's open fields. The township boundary to the north largely conforms to within 30 degrees of underlying slope direction; but there is also a high level of conformity amongst the 0/90 degrees oriented Parliamentary Enclosures. The 1st edition Ordnance Survey boundary to the south oriented similarly to the Iron Age ditch shows almost complete conformity to the lie of the land. The evidence at Brenkley is relatable to East Wideopen and Holywell Grange Farm in that possible traces for antecedent land-use can be seen within later field patterns; and these can be distinguished through distinctive orientations and the fact that some share orientation with excavated ancient settlement and boundary units.

As with other similar sites along the coastal plain, it is difficult to say whether the rectilinear settlement enclosure at Brenkley was the pivot for associated boundaries; or was inserted into an existing pattern of boundaries and tracks which were oriented around 95-105 degrees. The boundaries between those oriented in this way are probably the result of gradual 'infilling' over time; and the presence of medieval and post-medieval ridge and furrow in within these later insertions entail the process could have started at any point after the early-Roman period. The presence to the south of Brenkley medieval village suggests through its name element (*ley* or *leah*) that the area was wooded at the time of, or soon before, its inception. Alongside the 'moor' names of farms to the south of Shotton, 2km to the east, this suggests the area may have been used as common moorland and woodland over long periods; and could even have been so at the time of the prehistoric phase of settlement.

The suggested Iron Age/early Roman and 1st edition Ordnance Survey boundaries in the Brenkley area compared above may not be contemporary, and the external boundaries may post-date the rectilinear settlement enclosures and represent the re-planning of fieldscapes during and after the second-century AD. Another possibility is that the east-west excavated ditch is earlier and associated with the unenclosed roundhouse complex which pre-dated the enclosed phase. At the time of writing scientific dating was yet to be undertaken and interpreted; and the latest report warned that preservation of deposits was so poor that a stable chronological sequence may not be possible on a detailed level.

Returning to East Wideopen to conclude this case-study, the shared orientations of some ancient boundaries and 1st edition Ordnance Survey boundaries in this area suggests there may be fragments of earlier boundary systems embedded within later arrangements, thus adding weight to the idea that the 1st edition Ordnance survey map is a depiction of millennia of change, evident in the different orientations of boundaries in a particular area; and similarity through conformity to the lie of the land in the way the landscape was used and experienced. The results of slope direction conformity analysis have shown it to be a common thread through most analysed features, so it could be that any shared orientation is coincidental. This notion stands in opposition to some of the ideas put forward in the previous chapter from analysing the results at a regional scale. The issue of scale is something we will briefly return to in the following case-study.

6.5 The Devil's Causeway Roman Road

File prefix DCW

Roman roads such as the Devil's Causeway are specific landscape features which can be securely dated to the Roman period. Aside from Hadrian's Wall and associated structures, and forts north of the Wall, evidence for land use in the current study area is relatively poor for the Roman period after the second-century AD in south-east Northumberland. How Roman Roads relate to earlier and later land-use and occupation therefore carries the potential to better understand how it may have developed through this period and beyond; and offers a chance to analyse the dynamic of scale which has permeated through this and the previous chapter. The use of Roman roads is not confined to the period in which they are associated with, and some stretches have endured into the present. Although in the current study area the Devil's Causeway exists only as a low earthwork; or is only known from antiquarian accounts for some of its length, parts of it to the north between the river Wansbeck and Tweedmouth consist of modern roads. Furthermore, much of the original course of Dere Street, another Roman road further west in the study area, now comprises the modern A68.

The Devil's Causeway is believed to have been in existence as a Roman road by the mid-80s AD (Breeze and Dobson 2000: 11). It was probably a short-lived Trajanic (AD 98- 117) frontier between AD 105 and 122 connecting a possible Roman naval installation near Tweedmouth with Dere Street and Hadrian's Wall in the south (Hodgson *et al.* 2012: 212). A fort of Flavian date (AD 69-96) is known along the route of the Devil's Causeway at Low Learchild where the road crosses the River Aln. Limited excavation here indicates that the Devil's Causeway as a Roman military route ceased to be maintained following the building of Hadrian's Wall (Hodgson *et al.* 2012: 211). Other scholars have stated that the Devil's Causeway endured throughout the Roman period, facilitating the flow of trade from the western seaboard which helped to prolong the occupational sequence at the native settlement of Huckhoe located close to the road (Jobey 1959: 254). Its survival could also be linked with the fact that Hadrian's Wall as a frontier had changed after the third-century AD, with the major focus for defence of the province moving north of the Wall to outpost forts, at High Rochester and Risingham, so the Devil's Causeway became part of a broad zone of defence (Breeze and Dobson 2000: 142-143). Other work along the Devil's Causeway includes small-scale excavation which mainly confirmed the route of the road and its physical composition (Wright 1940); and the identification of marching camps along the route around Hartburn, Longwitton and West Thornton (Gates and Hewitt 2007: 15). In the current study area, a possible Roman fortlet has been identified on LiDAR data west of Bradford village by this author (NZ 05372 79119), shown in Figure 6.38. Poulter (2010) wrote extensively on the planning and surveying of Roman Roads in the region, including Dere Street; but is yet, to the author's knowledge, to address the Devil's Causeway.

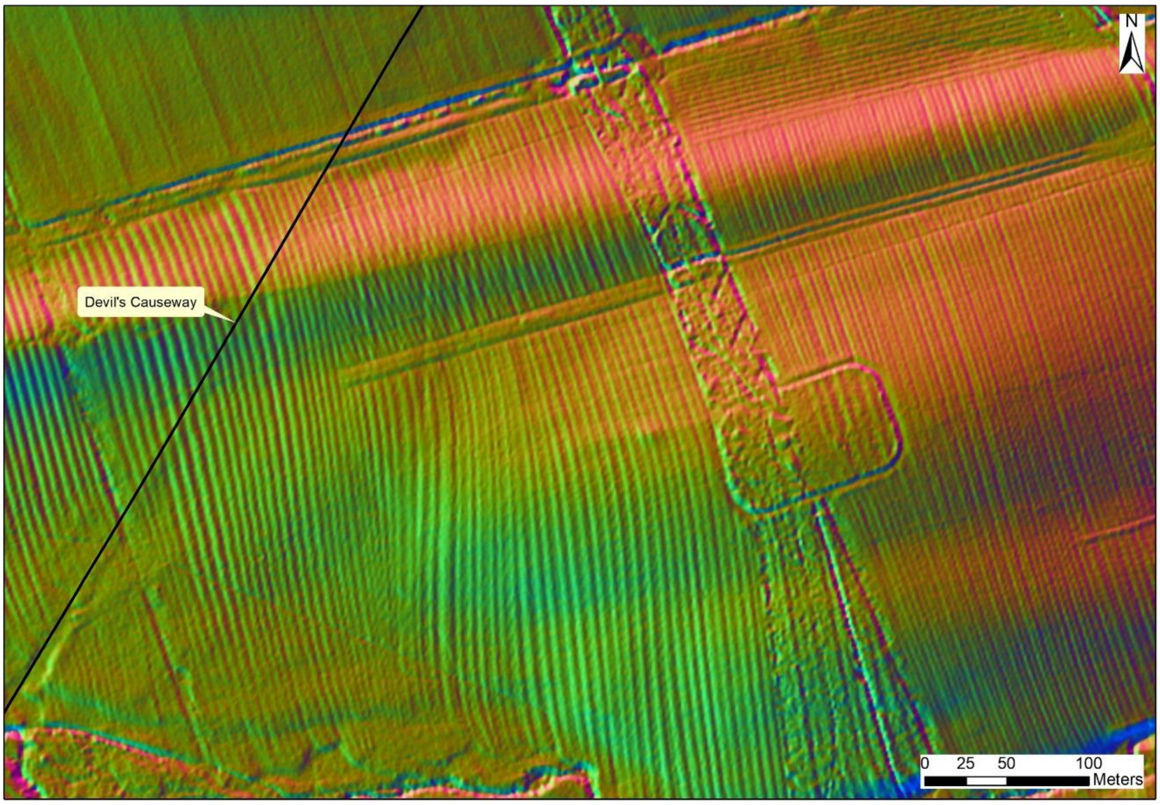

Figure 6.38 Possible Roman forlet identified on LiDAR imagery (PCA performed on 4 LiDAR 1m DTM hillshade images. Data downloaded from Environment Agency, 2016).

Environment Agency LiDAR data was patchy along the Devil's Causeway, which is unfortunate, as evidence for ridge and furrow was plentiful in the areas covered by this. Google Earth imagery and historic aerial photographs were used to fill these gaps where possible. The polyline created for the Devil's Causeway was clipped to the extents of the study area; and the split tool used at points where the direction of the road changed dramatically; although in the current study area these points were few as the road runs in a fairly straight course. Field boundaries and tracks transcribed from 1st edition Ordnance Survey maps within the buffer were also split and separated into the following categories for analysis: boundaries and tracks, and ridge and furrow traces which either a) run parallel or perpendicular with the Devil's Causeway within 200 metres; b) transect the Devil's Causeway at 90 degrees; or c) project directly from the line of the Devil's Causeway. A 200m buffer around the polyline for the Devil's Causeway was generated to clip the comparative units.

6.5.1 Results

As with all case-studies, detailed results can be found in Appendix A, and electronically accessed in Appendix B. The most common orientations found along the length of the Devil's Causeway were around ±10 of 30 degrees (81 percent), shown in Figure 6.39. It was found that a higher proportion of the road did not conform (58%) to within 20 degrees of underlying slope direction, whereas units conforming to within 30 degrees (68%) are similar with other features analysed in this study. These proportions can also be seen in Figure 6.39. Only forty-three percent of these sections oriented close to 30 degrees conform to within 20 degrees of underlying slope direction.

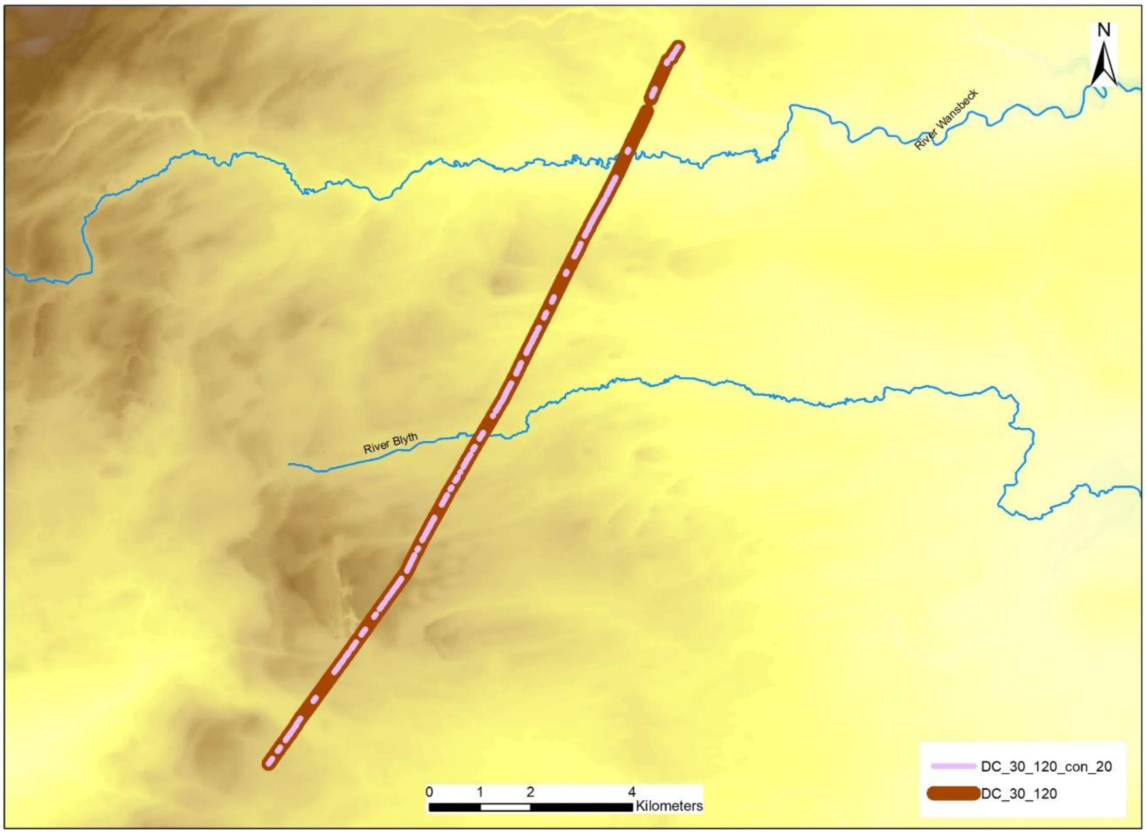

Figure 6.39 Orientation along the Devil's Causeway, alongside parts which conform to within 20 degrees of underlying slope direction (50m DTM dowloaded from Edina Digimap, 2017)

6.5.2 Relationship between Devil's Causeway and surrounding boundaries, tracks and ridge and furrow

Working from the results above showing that most of the Devil's Causeway length is oriented at ±10 of 30 degrees, the clipped medieval ridge and furrow and 1st edition Ordnance Survey boundaries and tracks were analysed to test the influence of the Roman Road on later features. Most medieval ridge and furrow evidence within 200m of the Devil's Causeway was oriented around 170-180 degrees, with only three percent oriented to ±10 of 30 or 120 degrees. For boundaries and tracks depicted on 1st edition Ordnance Survey maps, the highest proportion of orientations were around ±80 degrees, with large numbers also around 170 degrees. Just fifteen percent of 1st edition Ordnance Survey boundaries and tracks within 200m of the Devil's Causeway were oriented to ±10 of 30 or 120 degrees. In summary, the comparisons between the Devil's Causeway and surrounding field boundaries, tracks and ridge and furrow show very little relationship between the two, shown in Figure 6.40.

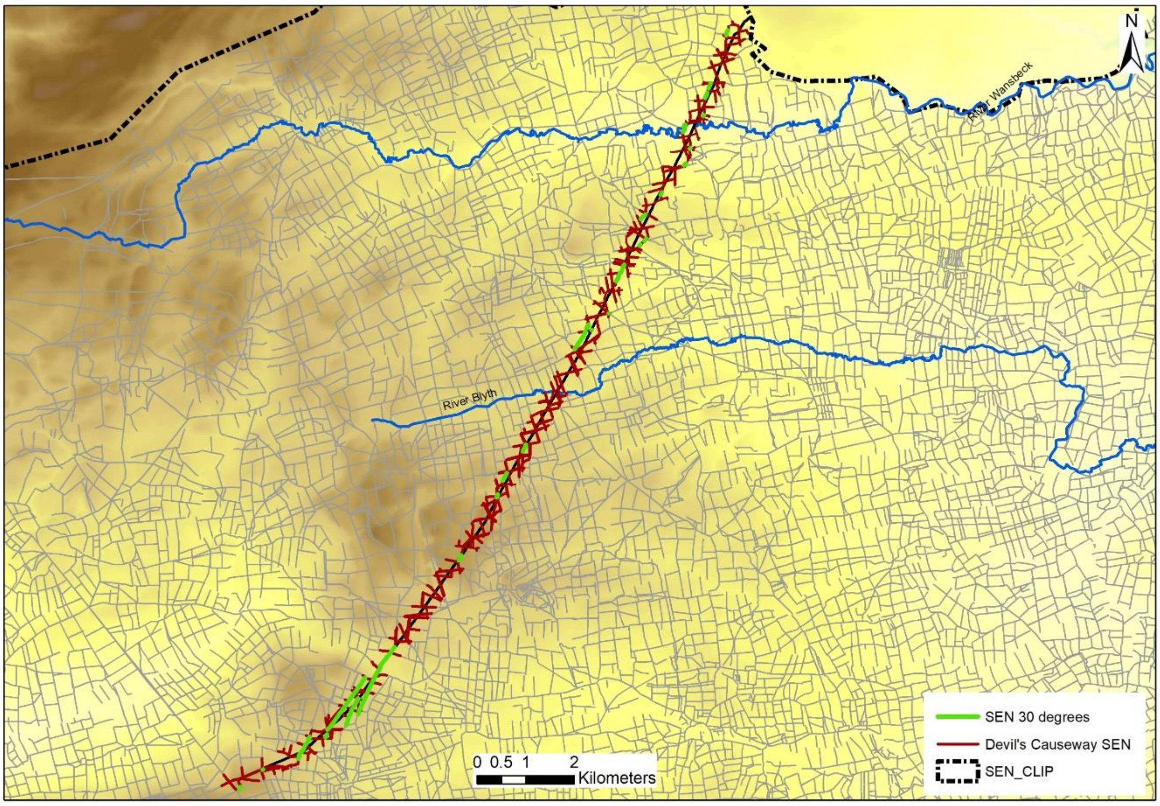

Figure 6.40 Surrounding 1st edition Ordnance Survey boundaries and tracks which share (green) or do not share (red) orientation with the Devil's Causeway (50m DTM downloaded from Edina Digimap, 2017)

6.5.3 Discussion

Traces of broad reverse 'S' ridge and furrow clearly overly the Devil's Causeway on completely different orientations in many places, as shown in Figure 6.41, suggesting much of the road within this study area had ceased to hold any importance by at least the medieval period (roughly post-1100). Chronological issues with broad ridge and furrow should be acknowledged (O'Brien and Adams 2016), but generally this type of ploughing is not thought to have been in existence prior to the early medieval period (Williamson 2003; Oosthuizen 2006). Boundaries and tracks depicted on 1st edition Ordnance Survey mapping show very little correlation with the road along its course in the current study area. As has been discussed, the 1st edition Ordnance Survey mapping is likely to represent millennia of former land units, so it is worth looking at this more closely.

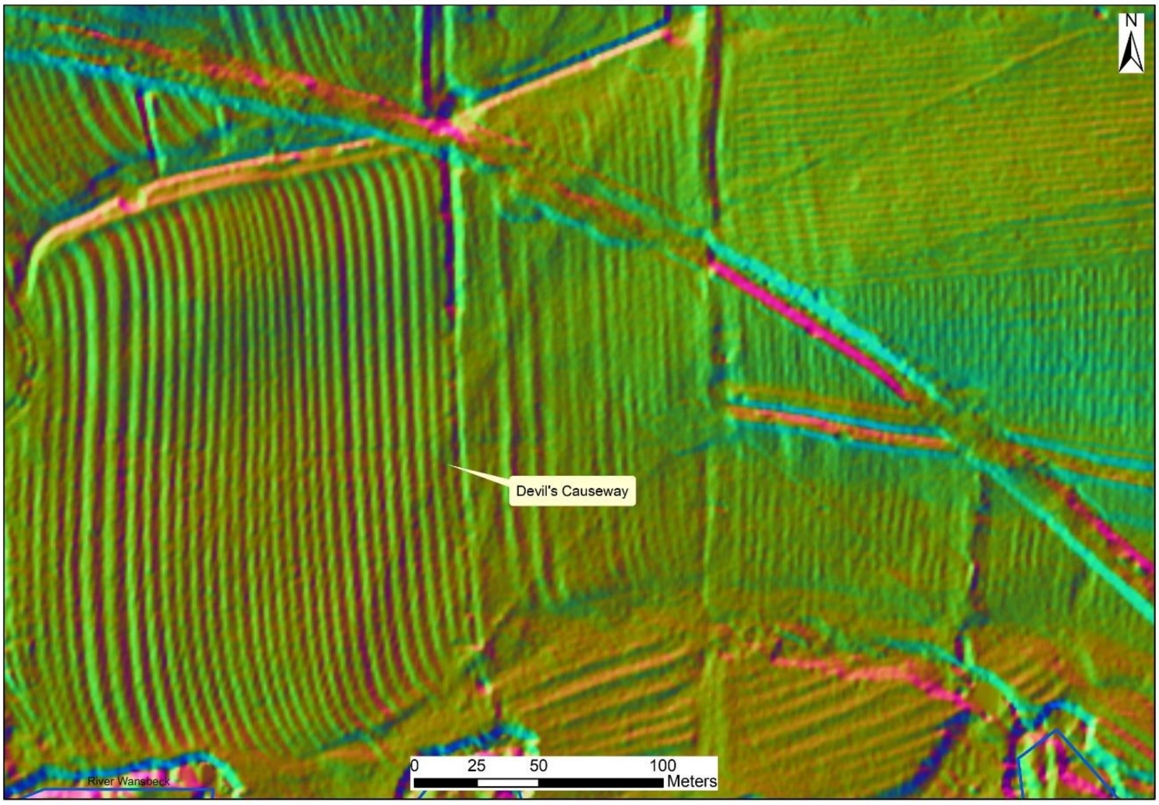

Figure 6.41 Medieval ridge and furrow overlying the line of the Devil's Causeway south of West Marlish. PCA performed on four hillshade images derived from 1m DTM data (downloaded from Environment Agency, 2016)

Results presented in the previous chapter showed that, at a regional scale, 30/120 degrees comprised the lowest proportion of roads and footpaths present on 1st edition mapping, which makes the fact that almost the entire length of the Devil's Causeway within the current study area is oriented to around 30 degrees quite striking. Some roads present by the nineteenth-century do show some correlation, such as the modern A696, which like the Devil's Causeway, shows little conformity in terms of orientation to surrounding field boundary orientations for much of its distance; and crosses the Devil's Causeway close to Edgehouse (NZ 05424 80491) and Bolam West Houses (NZ 06744 82560) at a perpendicular orientations (131 degrees). These roads, however, are likely to be later insertions into the landscape and do not appear on the Kitchin map of 1769; and are probably turnpike roads dating to the late eighteenth-century. A rectilinear settlement enclosure (HER N10568) lies adjacent to the aforementioned Edgehouse, which is oriented at 78 degrees. This orientation is shared by most 1st edition Ordnance Survey boundaries in the area; and could be further evidence of the Roman Road being inserted into a pre-existing layout of settlements, route-ways and boundaries which were oriented on a different axis. However, the 80/170 degrees to which the rectilinear settlement enclosure and surrounding 1st edition Ordnance Survey boundaries mostly conform to within 30 degrees underlying slope direction. The Devil's Causeway around Bolam West Houses also conforms to within 30 degrees of underlying slope direction, despite being oriented differently. The nature of any possible relationship between these features is hard to grasp, as it is clouded by the shared conformity to the lie of the land. The rectilinear settlement enclosure and 1st edition Ordnance Survey boundaries are clearly oriented similarly to a stream roughly 75m to the north which is also a township boundary. Stretches of the Devil's Causeway either side of that which conform can be seen not to, which could imply that the conformity to underlying slope direction of the Devil's Causeway in this area is coincidence; and when we consider the notion that getting from one place to another was deemed more important than respecting either the lie of the land or any or existing axes, the relationship between the two becomes a little clearer.

Apart from the later spurious examples, for most of its route through this study area the Devil's Causeway runs oblique to field boundaries and evidence for ridge and furrow. The Devil's Causeway Roman road traverses Great Whittington township on a 30 degrees orientation, with much of it conforming to within 30 degrees of underlying slope direction in this area. The Devil's Causeway in this township, as it does elsewhere, shows little commonality with the field boundaries through which it traverses.

Evidence of Roman roads which traversed an oblique route through field systems, such as Walden, Cambridgeshire, for example, which was deemed to have been surveyed from centuriated grid irrespective of topography and terrain as the already mentioned study by Peterson (2006). Research in the Bourne Valley, Cambridgeshire, showed that boundaries comprising existing so-called ‘cross valley alignments’ were bisected by a Roman road, and that the road was a later insertion (Oosthuizen 2006: 79-87). The Roman Pye Road in Norfolk mirrors this relationship with surrounding field systems (Williamson 2016: 268-270). If the same sequence occurred with the Devil’s Causeway route, it would suggest a hiatus in land-management, at least on a local scale. There is no definitive dating for the origins of fields in the current study area; and it cannot be discounted that the Devil’s Causeway may have been inserted over pre-existing fields during the early Roman period, some of which could comprise the layout depicted on the 1st edition Ordnance Survey map. It has been demonstrated elsewhere, however, that Roman Roads can sit comfortably within surrounding field systems, such as the course of Watling Street as it passes through western Northamptonshire (Williamson 2016: 282-284). Similarities in south east Northumberland can be seen in the way Dere Street has a far greater relationship with later field boundaries and tracks.

A comparatively large amount of the Devil’s Causeway was found not to conform to within 20 degrees underlying slope direction. There is plenty of evidence for Roman roads traversing in a straight line through landscapes irrespective of terrain; and we know that they were built in many cases with effective drainage, including cambering and roadside gullies. From this, what we might expect to see in today’s landscape is a Roman road bisecting a field system which largely conforms to the lie of the land and in some cases contains ridge and furrow. Considering the Devil’s Causeway has comparatively low conformity to underlying slope direction compared with other features studied; it begs the question of why would later fields and tracks use as a pivot something which does not share this requirement? Low levels of conformity to slope direction might be the reason the Devil's Causeway was not reused in later land use contexts. It has a lower proportion of conformity to both 20 and 30 degrees of underlying slope direction than medieval ridge and furrow, post medieval ridge and furrow and 1st edition Ordnance Survey boundaries and tracks in the vicinity.

This might explain why the Devil's Causeway failed to maintain its significance in a post-militarised context.

It could be that once the Devil's Causeway had ceased to be of military importance, elements of perhaps pre-existing systems of boundaries around the line of the road were re-used in the construction of medieval open fields and furlongs containing selions of broad ridge and furrow which are still visible as earthworks and cropmarks. The grain in orientation of boundaries and tracks in the landscape may have reverted to something like its earlier, pre-Roman character, with the Roman road being gradually lost beneath later land-use, with some stretches being incorporated into later fields and routeways. This is especially apparent to the north of the current study area. Blocks of straight, regular field boundaries suggests these originated long after the Roman road went out of use, most likely in the post-medieval period, echoing ideas suggested by Williamson (2016). This is visible particularly in Bradford township in the form of a network of straight, grid-like field boundaries which lie completely at odds with the Devil's Causeway. This layout is indicative of a post-medieval enclosure type, but probably incorporates internal piecemeal enclosure of a medieval or earlier open-field system.

Roman roads were built to fulfil the purpose of transporting soldiers and supplies from one strategic point to another as quickly as possible, so we might not expect the surveyors to be paying as much attention to respecting natural topography as those making decisions behind the layouts of field boundaries and medieval furlongs. This brings us back to the issue of scale, and in this case whether a shared orientation would be expected between two different land units fulfilling very different functions.

Roman Road	Prevalent Orientation (degrees)	% conforming to within 20 degrees of underlying slope direction	% conforming to within 30 degrees of underlying slope direction
Devil's Causeway	30	42	68
Dere Street	150	45	67

Table 6.9 Comparisons between Devil's Causeway and Dere Street Roman Roads

Comparing the results of the two Roman roads in the current study area, shown in Table 6.9, shows little variation in the amounts of conformity to both 20 and 30 degrees of underlying slope direction. The disparity is in the amounts of linear features along their route which share the same or similar orientation.

Dere Street appears to have a very different relationship with 1st edition Ordnance Survey fields and tracks along its route. The most prevalent orientation along the route of Dere Street in the current study area is 150 degrees, fifty-five percent of which conforms to within 20 degrees of underlying slope direction and 79 percent conforms to within 30 degrees. The highest proportions of 1st edition Ordnance Survey boundaries and tracks within 200m of Dere St are oriented around ±10 of 150 degrees (22%). Adding into these results the perpendicular orientations, ±10 60 degrees, returns forty-six percent. Twenty-eight percent of medieval ridge and furrow is oriented to within ±10 of 50 or 160 degrees which is the most common orientation along the line of Dere Street in the current study area, a much higher proportion than the two percent oriented similarly to the Devil's Causeway. Furthermore, thirty-six percent of 1st edition Ordnance Survey boundaries and tracks are oriented to within +-10 of 60/150 degrees. This is far higher than the fifteen percent of those oriented similarly to the Devil's Causeway.

Dere Street seems to have had far more influence over later field patterns than the Devil's Causeway, an obvious point as Dere Street is still in existence for much of its Roman route; whilst the Devil's Causeway has all but disappeared from the landscape in this region. Of particular interest is the evidence for medieval ridge and furrow, as the lack of this feature type showing any affinity in terms of orientation with the Devil's Causeway is a clear indicator that the road had ceased to hold any importance by the time medieval furlongs were being laid out. Stretches of the road can be traced beneath medieval furlongs, which carries the implication that the physical components of the road such as stone used for the drains on either side of the road had been robbed or largely cleared for practical purposes during the process of laying out and ploughing medieval furlongs.

The fact that so many more medieval and post medieval ridge and furrow units, and 1st edition Ordnance Survey boundaries and tracks conform to Dere Street than do with the Devil's Causeway suggests that the field and road patterns present by the nineteenth-century were established after the Roman roads were built. If the majority were there before the Roman period, we would expect more conformity to the line of the Devil's Causeway as well as Dere Street. This is not to say that none of the present roads tracks and boundaries have pre-Roman origins, however. Dere Street and the Devil's Causeway traverse quite different terrain. Dere Street climbs roughly north-east into the hilly region of upper Redesdale and Otterburn; whilst the Devil's Causeway follows less pronounced terrain in its roughly north-east course.

A total of eighteen medieval settlements lie within 500m of the Devil's Causeway along its entire known route. These figures are quite small compared with the twenty-seven medieval settlements located within 500m of the Great North Road (modern A1), but slightly higher than the thirteen within 500m of Dere Street. Overall, these figures do not suggest an intrinsic relationship between the major road network present by the medieval period. It could be seen to contradict the analysis of the relationship of field boundaries and ridge and furrow; but the proximity to the Devil's Causeway could also be coincidence. This does not solve the issue of whether the fields around it are earlier or later than the Roman roads in this region, but it does explain to some extent why they do not correspond to the line of the Devil's Causeway.

From the results of this case study it is likely that at least significant stretches of the Devil's causeway went out of use sometime after the fourth-century and the eleventh-century AD. It has also highlighted the different ways in which Roman roads were both perceived and used by subsequent generations, from seemingly being ploughed over in the case of the Devil's Causeway; to acting as the line from which later land-use was organised in the case of Dere Street. The issue of scale is of considerable importance to the interpretations of this data. It has to be borne in mind that a Roman Road and, for example a field boundary or medieval furlong were constructed with very different purposes in mind, in which scale was a key factor. This issue will be discussed further in the final chapter.

6.6 Case-Studies Discussion: Orientation and conformity to slope direction at a local scale

The following paragraphs will summarise the findings from the case-studies, along with observations from other specific sites worthy of note. The first of these is the excavated multi-period site just west of North Seaton village (NZ 29108 86392). A rectilinear settlement enclosure shares an orientation with the post medieval Lane End farm depicted on 1st edition Ordnance Survey mapping around 40m to the north. The existing road to the north, along which sits the medieval nucleated village and field boundaries present to the north is oriented only 12 degrees differently. This shared orientation does not apply to the 1st edition Ordnance Survey field boundaries in which the rectilinear enclosure is situated or fields to the south, apart from one, which lies at odds with the largely 0/90 degrees orientation in this area. As with the evidence discussed at East Wideopen, this could represent a fragment of a boundary system which has survived into the recent past. The evidence implies a degree of endurance in the area as orientations appear to have been maintained between at least the late Iron Age and the twelfth-century, and maybe up to the twentieth-century when modern development has largely overwritten the pattern of the landscape in this area.

An interesting sequence of landscape development exists within Backworth township (NZ 29558 71947). A 1757 estate plan depicts a system of boundaries to the south of the village which appear to have been replaced by a system on a different alignment by the time the tithe map was produced in the 1840s. The excavated later Iron Age/early Roman rectilinear settlement enclosure at West Shiremoor with external boundary ditches (ASDU 2018) occupied this area. Orientation analysis shows this to be closely oriented with the alignments in the 1757 estate plan but less so with the later boundaries, illustrated in Figure 6.42. This could represent a common orientation based on the Iron Age/early Roman settlement and boundaries which persisted for many centuries and were possibly incorporated into medieval furlongs which were then used in the relatively recent past to enclose former medieval open fields in the post-medieval period. These ancient alignments appear to have been replaced by a system of Parliamentary Enclosures at some point between 1757 and 1840. Why the earlier boundaries were replaced is unclear; and is not generally consistent with the pattern of Parliamentary Enclosure in

Northumberland, which were usually laid out to enclose areas of former common, such as the nearby Shire Moor. This aside, the distinction of conformity in orientation to one set of boundaries over a later pattern is striking. The evidence at Backworth shows the apparent complexity of landscape development at local scale, with pronounced changes to the grain of boundaries and tracks occurring in more recent times.

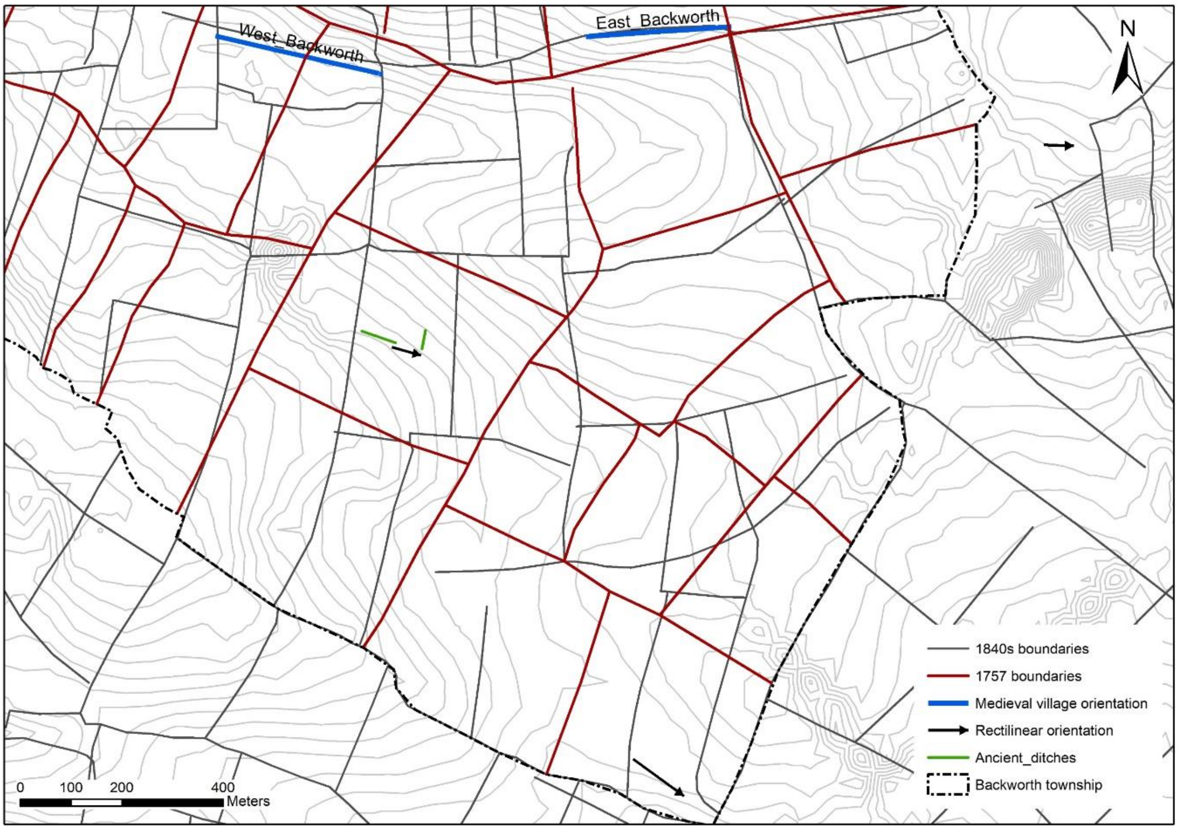

Figure 6.42 Orientations around the Iron Age and early Roman settlement and boundaries at West Shiremoor, in Backworth township (contours derived from a 50m DTM downloaded from Edina Digimap, 2017)

Similar evidence to that at Backworth is the clear distinction between the complex of linear cropmarks thought to be boundaries associated with a nearby rectilinear settlement enclosure and 1st edition Ordnance Survey boundaries around Holywell Grange Farm (NZ 31283 73330). Within the 1st edition Ordnance Survey boundaries and medieval ridge and furrow data there are some units which are oriented similarly to the cropmarks, again suggesting, as at Backworth, that the two could be contemporary. If Parliamentary Enclosures replaced an earlier field system on a different orientation, this would also echo the same occurrence at Backworth, and suggest that a portion of an earlier field system had been truncated by later patterns.

Again, this would be an unusual step to take; and no documentary records have been found which explain either occurrence.

At the Pegswood Moor Iron Age and early Roman settlement and boundary complex in the north of the study area (NZ 20272 88032) the general fabric of most boundaries from both phases conform to within 30 degrees of underlying slope direction, with a few exceptions. The 1st edition Ordnance Survey boundaries and tracks here also show high levels of conformity to within 30 degrees of underlying slope direction. The evidence could therefore be interpreted in the same way as at East Wideopen, Backworth and Holywell Grange Farm, that shared orientations are commonly found between ancient boundaries and 1st edition Ordnance Survey linear features; and in some cases, it could again represent some antecedent boundaries or tracks enduring into later periods.

Common 30, and 120, degrees orientations are present within Benwell township (NZ 21520 64380) maintained over a block of fields rather than just one or two isolated boundaries. A recent study has explored the possibility of continuous occupation at Benwell between the Roman *vicus* and the twelfth-century medieval village (Roberts 2015). The 'hallgarth' at the eastern end of the medieval village was thought to representing the capital messuage of the settlement; and the 'Hall Closes' associated with this area extended over a portion of the former *vicus.* This was categorised as the initial settlement focus, for which hallgarths are usually placed on better land, implying that activity in this area could fill the gap between the Roman *vicus* and the medieval village (Roberts 2015: 63-64). A block of fields is aligned with, and project from, Hadrian's Wall, shown in Figure 6.43. The possible endurance of settlement at Benwell, bolstered by these observations of possible shared orientation over long periods, could be the result of previous boundaries, some associated with Hadrian's Wall, and systems of tenure remaining in place throughout the period between the fourth and sixth centuries AD and beyond.

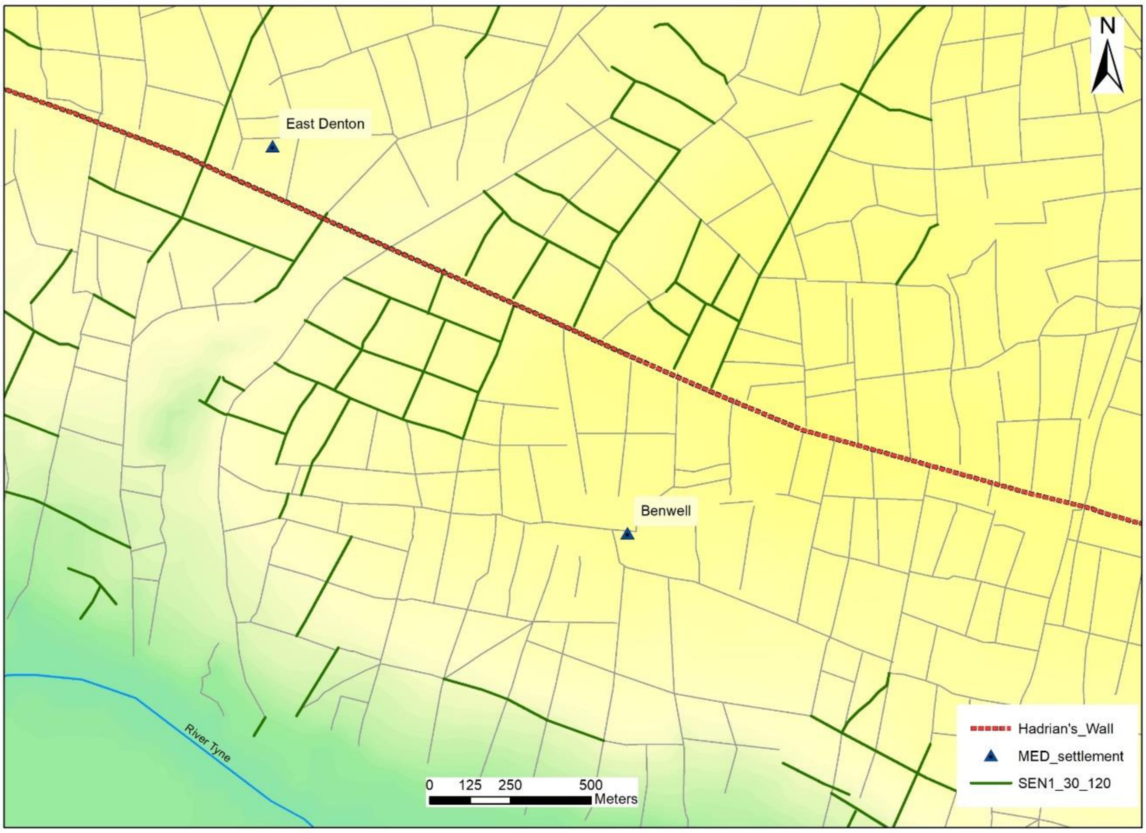

Figure 6.43 Orientations around 30 or 120 degrees amongst 1st edition Ordnance Survey boundaries and tracks in relation to the line of Hadrian's Wall (50m DTM downloaded from Edina Digimap, 2017)

The examples given above suggest a degree of long-term endurance amongst boundaries at a local level. As has already been stated, however, we must not forget the importance of the lie of the land in these observations and their implications. Clusters of 1st edition Ordnance Survey boundaries and tracks oriented around 30 or 120 degrees can be seen around Birtley and Chipchase townships, where four out of the five rectilinear settlement enclosures within Birtley township are also oriented to within 10 degrees of 120 degrees (Figure 6.44). These mostly conform to the south-west facing slopes on which they sit. Despite a relatively high concentration of 1st edition Ordnance Survey boundaries and tracks oriented around 30/120 degrees (25%) in the Birtley area, the most frequent orientations are around 80/170 degrees. This said, with orientations of most rectilinear settlement enclosures around 120 degrees, illustrated in Figure 6.45, it cannot be discounted that some nearby 1st edition Ordnance Survey boundaries and tracks with a similar orientation could relate to land-use contemporary with Iron Age or early Roman occupation in the area. Underlying slope direction appears from the results to be a key influence; and any common orientations between rectilinear and 1st edition Ordnance Survey mapping could be the result of both conforming to these conditions at different times. The medieval village-plan of Birtley is oriented at 54 degrees, which largely conforms to within 20 degrees of underlying slope direction. This adds further variation to the overall grain in orientation of linear features in this area; and suggests that local topography was highly influential in the planning and layout of settlements and boundaries in the past rather than trying to lay out land-units according to specific axes, such as 30 or 120 degrees. It is difficult to determine whether a change in orientation occurred in the Birtley area, or if it did, when, but as the results of slope direction conformity analysis show, it is most likely that the lie of the land was a significant factor in the layout of features over long periods; and this prevented any trend towards establishing a common alignment across large areas at a regional scale, if ever there was a plan to do this.

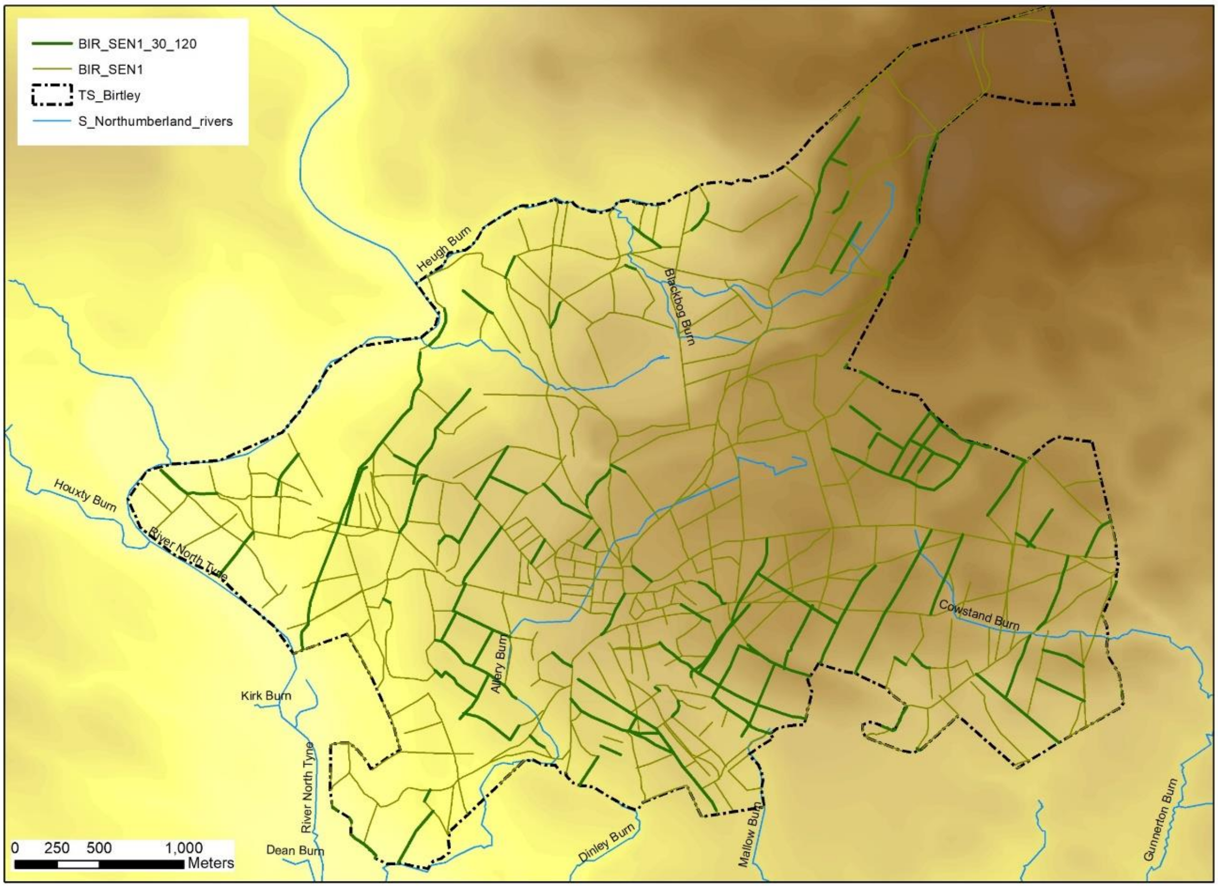

Figure 6.44 Distributions of 1st edition Ordnance Survey boundaries oriented around 30 or 120 degrees in the Birtley area (50m DTM downloaded from Edina Digimap, 2017)

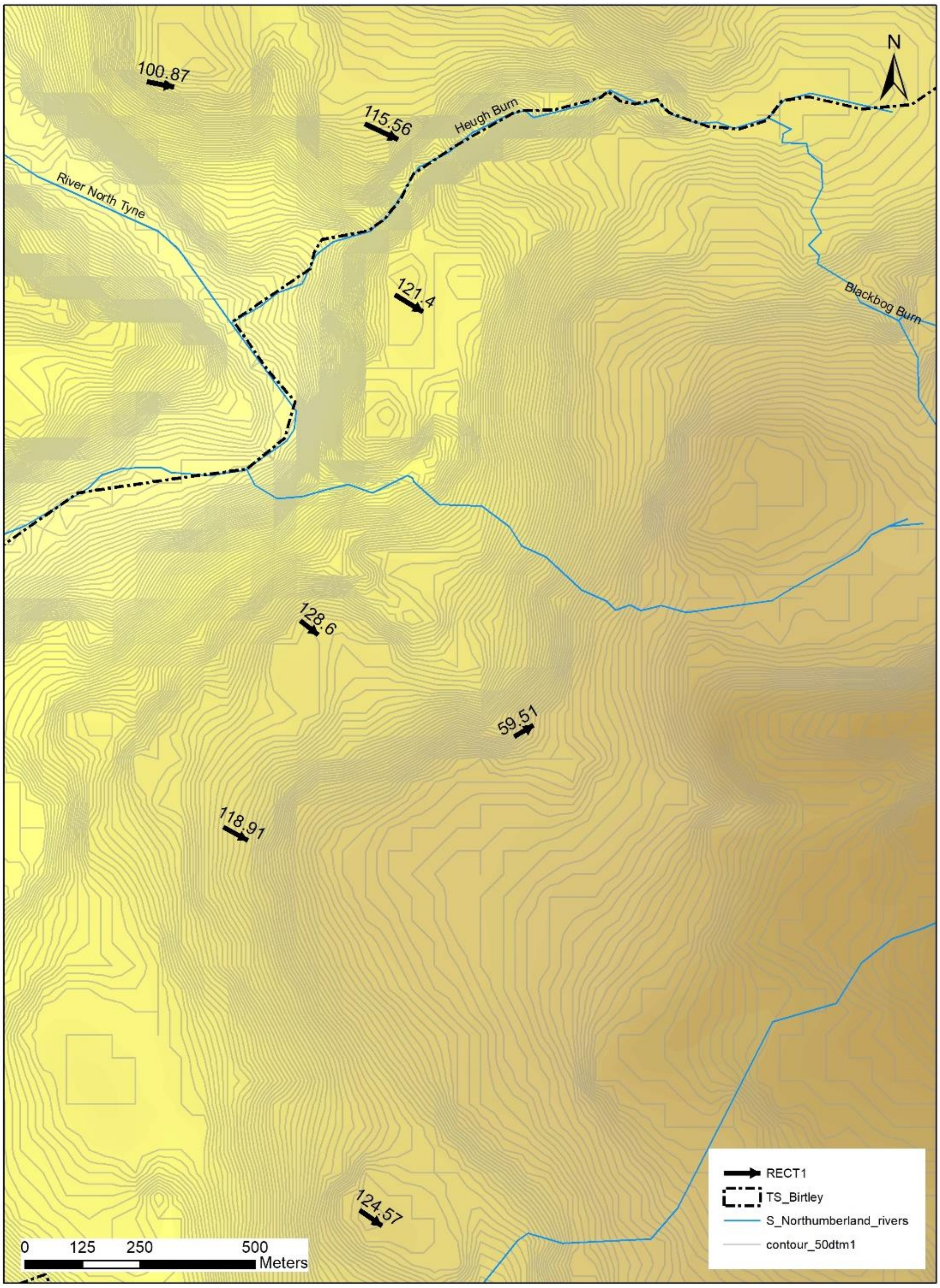

Figure 6.45 Orientations of rectilinear settlement enclosures in the Birtley area (50m DTM downloaded from Edina Digimap, 2017)

The orientations of three excavated enclosures and associated boundaries at Morley Hill Farm (NZ 22510 72283) are at odds with surrounding 1st edition Ordnance Survey boundaries. Evidence for post-medieval ridge and furrow ploughing here largely corresponds with the Parliamentary Enclosure boundaries; and includes furrows which overlie the upstanding earthwork rectilinear settlement enclosure (HER 1330) on a completely different orientation. Conversely, a nearby scheduled settlement enclosure at Hazelrigg (List entry: 1020703) shares its orientation with many 1st edition Ordnance Survey boundaries in the immediate area. Another scheduled settlement enclosure 350m to the south does not share this orientation; and is oriented similarly to the Morley Hill Farm enclosures and boundaries; but it should be noted that the southern settlement enclosure at Hazelrigg does share a similar orientation with 1st edition Ordnance Survey in its vicinity. The morphology of the northernmost Hazelrigg enclosure is also very distinctive in relation to others in the area with its regularly spaced double ditches and rounded corners. These relationships are illustrated in Figure 6.46. This evidence could tentatively be interpreted as a rectilinear settlement enclosure which either survived the apparent abandonment process in the second-century, or was possibly even built during this time as part of the reorganisation of the landscape to serve the changes wrought by the building of Hadrian's Wall and the needs of the Roman Army. Arguments have been made for the plantation of a system of 'ranches' at approximately regular intervals in the area apparently cleared of occupation after the building of Hadrian's Wall to provide a regular supply of agricultural produce for troops and their families stationed at the forts and within the surrounding civil settlements (Frodsham 2006: 167-168; Hodgson *et al.* 2012: 218-219). Unexcavated settlement enclosures could in some instances be elements of these ranches. This could also explain the changes to the Pegswood complex and the establishment of a new settlement at St George's Hospital just north of the river Wansbeck.

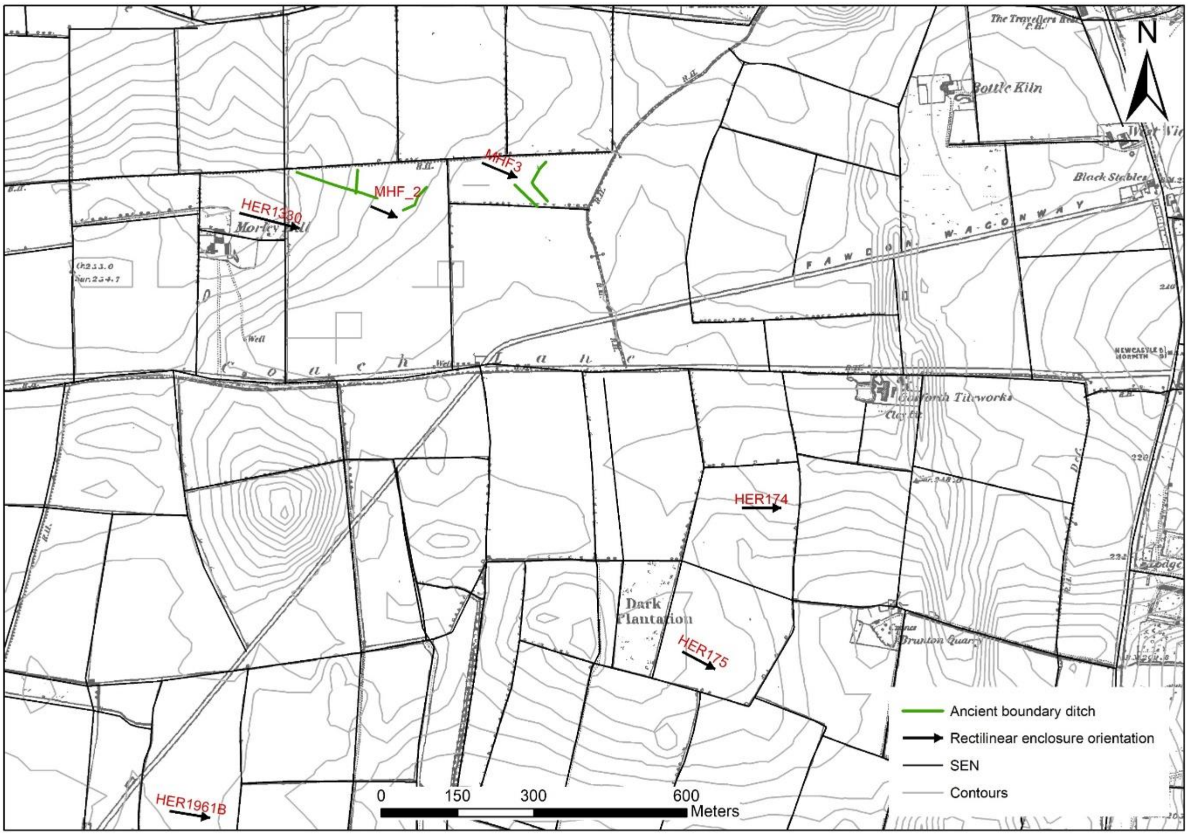

Figure 6.46 Relative orientations of rectilinear settlement enclosures, associated boundaries, and 1st edition Ordnance Survey boundaries and tracks around Morley Hill Farm (north), and Hazelrigg (south) (contours derived from 50m DTM downloaded from Edina Digimap, 2017)

At a regional scale coaxial fields with relatively high conformity to grain of slope can be seen. The case-studies highlight that these patterns which appear at a regional scale can be unpacked as local responses to the lie of the land (discounting Roman Roads). It therefore appears that the intention was always to construct coaxial patterns of fields where possible, but a dominant orientation was not part of this plan, and local topography should be seen as a significant factor in how the patterns we see today have developed over long periods of time.

The results lead us to consider whether certain features were constructed with sensitivity to micro-topography (changes apparent at 5m resolution), or macro-topography (changes at 50m resolution); and brings us back to the issue of scale discussed in chapters 1 and 2. The pattern of regular fields depicted in these examples and the case-studies above is most likely not an indication of large-scale planning but a series of local responses to the lie of the land. The dynamic between a desire to create regular field systems which respected the lie of the land upon which they sat. Therefore, regular coaxial systems can be seen where underlying slope direction allowed. This is where the concept of scale is important. At a regional scale there is no obvious dominant orientation in the results, but when viewed at the scale of a township trends become more apparent, such as Whalton and Horton; and more apparent still at an even more local level, such as the excavated boundary remains at East Wideopen. These local scale patterns create the framework of boundaries and tracks visible on the 1st edition Ordnance Survey map, where coaxial field systems are present at a regional scale; however, the orientation changes regularly depending on underlying slope direction.

If the study had included the orientation of roundhouses, which generally have a diameter of around 10-15m, then 5m resolution data would be more appropriate. The features comprising this study are in most cases much longer, to the point where they had to be manually split in some cases where they changed direction. These features were more likely built to respect macro topographic changes, reflected in the 50m resolution aspect data. In between these extremes of roundhouses and long linear boundaries are the rectilinear settlement enclosures and associated boundaries which are on average 60 long. Unfortunately, no other resolutions of data, such as 10m, could be found in any available repositories, so it was not possible to analyse using any other resolution to explore this issue further.

7 Conclusion

This study has devised new and original methods for managing and analysing very large amounts of data in a coherent manner, which was set out in Research Aim 2 and Objectives 4 and 5. Employing these methods has enabled the assessment of landscape development over long periods; and shows the scope of what can be done with transcribed linear units. A toolset has been assembled to address the research aims and objectives, comprising the transcription of linear features and the building of a coherent dataset (Research Objectives 3, 4 and 5), to the development and robust testing of the analytical methods (research objectives 6 and 7). Interpretation of the results addresses Research Aim 3 and Objectives 2, 6 and 7. It is hoped that these methods will be used in further research at different scales, using different data from elsewhere and asking different research questions of it. As long as the data is available in the form of linear units (polylines), and suitable DTM, the method can be used anywhere and for any time period, able to ask different research questions of the data.

7.1 Findings

The results and interpretations from the case-studies somewhat contradict those derived from the results at a regional scale. From the earliest evidence for pit alignments, it appears from the results of this research that the lie of the land was an important consideration in the laying out of linear units. The results suggest that over time the close dichotomy between human will and the natural landscape moved in favour of the former through improved technology, and perhaps also a wavering respect for the natural world. The results of slope direction conformity analysis have shown a more varied picture than perception by-eye analyses have suggested in the past; and offer the possibility that the results of other similar studies focusing on relative orientation may be open to question. As is exemplified at Shotton, specific locations appear to have been chosen by settlers at different times in the past based on topographic conditions; and the later settlement phases are unlikely to have been directly influenced by earlier phases, elements of which were no longer visible by the time later phases were begun. In some cases it is those units which do not conform to the grain of slope that are of most interest, such as the 1st edition Ordnance Survey boundaries west of the late Iron Age settlement and boundaries at East

Wideopen, where they share orientation with the excavated prehistoric ditches but do not conform to the grain of slope. Here lies a pocket of tentative evidence that a common orientation was being sought irrespective of the lie of the land.

Despite some pockets of evidence suggesting otherwise, such as East Wideopen, the results of this research have challenged ideas of prehistoric fields being laid out irrespective of the lie of the land, at least in the current study area. It has been put forward in the past that the general orientation of late prehistoric field boundaries in many cases were laid out oblivious of and sometimes in spite of underlying terrain, for various reasons, such as in accordance with some rule and with respect to an underlying cosmology; as a reflection of the prevailing north-eastern wind; to re reflect celestial alignments, in this case the sun, through its practical and symbolic importance; and it may even be that a form of ‘solskifte’ was responsible for the laying out of late prehistoric fields, and that all members of the community were allocated a reasonable share of the sun and shadow agricultural land, may have been respected by prehistoric communities (Field 2008: 213- 214). Recent research on the orientation and slope direction conformity of probable prehistoric fields systems along the Salisbury Plain showed that in most cases boundaries conformed to the lie of the land (EnglaID: no date) this is not to say the factors outlined by Field are irrelevant; but does show that respecting the lie of the land at least has to be considered alongside them in the suite of factors, of which many may be interrelated.

The findings of this research go some way to agreeing with Tom Williamson’s (2016) assertion that coaxial fields present on 1st edition mapping were not likely the results of single acts of planning. But at the same time the findings do not dismiss ideas of large scale planning out of hand as it cannot be proven either way at this time, and it is quite likely that many boundaries and tracks present by the mid nineteenth-century and beyond in some cases were and remain enduring elements of early systems of land management. Evidence for a dominant orientation in boundaries and settlements on a large-scale along the south east Northumberland coastal plain in any period has not been identified; and any high concentrations of orientations within particular areas recorded in this study appear to be responses to the ground on which they lie rather than conforming to a trend in orientation. This does not mean importance was not placed on orientations; but if a shared orientation across multiple phases of activity is the result of a push towards conformity to underlying slope direction, it makes it more difficult to identify actual continuity in land use. More detailed investigation would be able to explore this further; and will be outlined later in the chapter.

This study has found that using the term ‘continuity’ can be misleading in trying to explain developments in settlement and land-use over long periods. Continuity implies an unbroken sequence of land-use or settlement, whereas it might be more suitable to suggest the ‘endurance’ of some boundaries and routeways over long periods, in some cases despite other factors which could represent change. A good example of this is the presence of some boundaries depicted on 1st edition Ordnance Survey mapping at East Wideopen which share orientation with the long-disappeared prehistoric network of ditches which have recently been excavated. Most other boundaries in the vicinity do not share this orientation. Landscape change has most likely occurred in this area over the many centuries since the prehistoric settlement was abandoned, but despite this, some boundaries, or even the orientation of the prehistoric boundaries, may have endured into the recent past; and in some cases, into the present.

7.2 Potential for further work

Some areas of the discussion have had to be rather brief for logistical reasons, such as that concerning medieval land-use and technology at a site-specific level. An avenue for further work would be to adapt the methodology to allow for a detailed study of a smaller area. Logistical constraints prevented a larger dataset of ridge and furrow being transcribed for analysis, although it was ensured that evidence was included from across the different topographical zones of the current study area. A more comprehensive dataset including all known evidence for ridge and furrow may lead to different results in terms of both orientation and conformity to underlying slope direction.

Analysing the relationships between orientations of human-made linear features and underlying slope direction using 50m aspect data in the way this research has done allows assumptions to be made on a macro-scale. Applying the same approach using 5m aspect would allow interpretations to be made on a micro-scale; and as has been shown in chapter 2, using the two resolutions returns different results. This raises the issue of the extents to which people in the past were affected by the natural topography upon which they lived and worked; and invites further study with a focus on this.

As an exploratory exercise, undated cropmarks of linear features could be analysed with the aim of calculating an average orientation which can be compared with the results of excavated Iron Age or early Roman period ditches; and examining conformity to the direction of underlying slope direction. An assumption here is if a large enough percentage of dated boundary features were found to respect underlying slope, which is the case with the results of this study, a model could be tentatively put forward for undated linear features sharing this characteristic. The issue with this is that many boundaries and tracks depicted on 1st edition Ordnance Survey mapping also share this characteristic, which muddies the distinction to a degree.

It has been shown that the methodology behind orientation and slope direction conformity analysis devised through this research is robust and leads to meaningful results. It would be interesting to see how the trends found in the current study area compare with other places, particularly where larger datasets are present, such as the Milfield Basin in north Northumberland, or the Stonehenge landscape, for example. This leads to the proposition that other archaeological features could be studied through orientation and conformity to underlying slope direction, such as Neolithic cursus monuments, which traverse large distances seemingly irrespective of underlying terrain. A cursus monument lies just a few miles south of the current study area, at Hastings Hill near Sunderland, and initial observations illustrate the disparity in orientation between the cursus and field boundaries present by the nineteenth-century. It would also appear not to conform to the grain of slope on initial inspection. A detailed study using a large sample of cursus monuments would be a worthwhile use of the analytical tools developed through this research; and would broaden the chronological parameters used in this study.

A wealth of cord rig has been identified north and west of the current study area within Northumberland. Much of this is dated on purely morphological grounds. Performing orientation and slope direction conformity analysis would be a useful exercise on this feature type, especially in areas where features dated to later periods, such as medieval ridge and furrow, was present; and would add further contextual detail to existing studies in the region, particularly those conducted by Peter Topping (1983; 1989). A focus on contextualising the wealth of evidence for ridged cultivation in the current study area and beyond would be a useful addition to research agendas.

Many previously unknown settlements, mainly prehistoric, have been identified through this research, which bolsters the suggestion that only a small percentage of this site-type has been investigated in detail through excavation. Whilst secure dating exists and is growing to support the hypothesis that native farmsteads were abandoned on a wide scale in the second-century AD, these still derive from a small proportion, around ten percent, of known rectilinear settlement enclosures. Further detailed investigation of more settlement sites, including the gathering of secure dating evidence, may reveal some anomalies to this proposition. Many more prehistoric settlements must surely await discovery, either buried beneath later settlements, or not identifiable on aerial photography. Blagdon Park 1 and 2 were only discovered through speculative excavation, for example (Hodgson *et al*. 2012: 191). Many more sites are likely to remain undiscovered due to factors such as destruction through later ploughing, urban and industrial expansion (as must surely be the case in the metropolitan areas of Newcastle and North Tyneside); and historic mining activity, including surface extraction in the twentieth-century.

Morphological trends in late prehistoric settlement enclosures have been recognised in this research, which could not be analysed in more detail due to logistical constraints, but the following preliminary observations act as a starting point. One recognised type is distinctive for the large ‘D’ shaped outer ditches enclosing a rectilinear settlement. The best examples of these are Tranwell (HER N11281), the newly identified settlement at Startup; and (HER N23318). These are all oriented close to 90 degrees; and wholly conform to within 30 degrees of underlying slope direction. Another type identified are characterised by strict regular ditches evenly spaced with slightly rounded corners and have been discussed in earlier chapters: the scheduled Hazelrigg and the newly identified Harestane Burn 1 (shown in Figure 7.1) are the primary examples of this type. The comparatively large size of the latter marks it out as a possible Roman fortlet. This site is hereby marked as one of special importance in the current study area due to its remarkable size, and morphology;

and would warrant further investigation, especially in its location in a regularly ploughed field.

Figure 7.1 The distinctive morphology of the newly identified enclosure at Harestane Burn, seen on Google Earth imagery

Most identified rectilinear settlement enclosures underlie the remains of later agricultural activity, including ridge and furrow earthworks and modern plough-land, so internal features such as hut circles and fenced partitions could not be identified in many cases. The generally poor state of preservation of many of the sites is a cause for concern, leading to the suspicion that some may soon be ploughed out of existence altogether, a concern already raised in the context of south-east Northumberland (Proctor 2009: 102; Hodgson *et al.* 2012, 222). The increasing threats posed to this fragile, but highly important archaeological resource serve to further emphasize the urgency and importance of this kind of landscape study, particularly if anticipated as a prelude to excavation. Research agendas need to place more emphasis on the hinterlands around settlements if we are to address the issues raised in this research. One area of study which has emerged through this research is exploring the chronology of ridge and furrow; for example, identifying when the reverse ‘S’ type ceased to be used in Northumberland and elsewhere. This could be done through a research project which identifies specific morphological trends in types of ridge and furrow upon which keyhole excavation and scientific dating through OSL profiling and dating would provide a more accurate chronology for this feature type. It would certainly have added extra chronological depth to the analysis in this research. At a smaller scale, when studying medieval furlongs for example, the results of slope direction conformity analysis imply a similar level of conformity as boundaries and tracks, some of which may be much longer in length. It would be an interesting extension of the study to analyse these smaller features using 5m aspect data, to examine the impact of very local levels of topography on the layout of these features.

A closer look at climactic conditions in the late Iron Age compared with those of earlier times could explain enclosures being adopted over earlier unenclosed settlement complexes which often occupied the same site. The boundaries which do conform very closely to slope direction, for example those within the 20 degrees threshold, could be interpreted as having an important drainage function, such as an arable plot. In addition to this, further work on watersheds in the region and their relationship with boundaries and tracks would add to and be comparative with the exploratory case of Horton. Boundaries need to be included more in excavation schemes rather than focusing solely on settlement enclosures. Our knowledge of Iron Age social and economic contexts is currently imbalanced through the disproportionate weight given to enclosures over the landscapes in which they sat.

Ultimately, the only way to truly test the results of this research is through careful targeted excavation and bespoke scientific dating methods. With small ceramic assemblages, techniques such as archaeomagnetic and OSL dating of deposits would be useful for establishing tighter chronologies (Petts and Gerrard 2006: 158). As has been discussed in an earlier chapter, this is already taking place through some research projects, including recently just north of the current study area (Vervust *et al.* 2020). The following areas and features have been identified as candidates for further study:

- East Wideopen and the field boundaries and ridge and furrow traces to the west of the Iron Age complex. The boundaries remain in situ as low banks and ditches with hedges despite encroaching housing development to the south (see Figure 7.2). At the northern extreme of this orientation lies a block of medieval ridge and furrow on a similar orientation which could be further explored through small scale excavations of the existing boundary 1km north west of the Iron Age/early Roman complex; and which shares the same 120 degrees orientation. Elements of the boundary could contain deposits which connect it chronologically with the nearby excavated features. There are also traces remaining of similarly oriented boundaries to the south-east of the prehistoric complex which would also be candidates for further inspection. If we are to establish secure chronological sequences for ditches relating to Iron Age/early Roman settlement enclosures it is vital that more intuitive dating techniques are utilised, including the OSL which was successfully done on many exciting and extent boundaries around Wallington recently (Vervust *et al.* Forthcoming).

- Holywell Grange Farm: the as-yet unexcavated cropmark ditches around the settlement enclosure, along with existing boundaries which are oriented close to the cropmarks contain many elements which could form the basis for a detailed study.
- Whalton: the relationship between the newly identified rectilinear settlement enclosure west of Whalton village and the ridge and furrow which overlies it on the same orientation is another candidate for assessing the relationship between linear units dating to the Iron Age and medieval period.
- Hazelrigg: exploring the relationships between the distinctive rectilinear settlement enclosure, buried ditches in the vicinity and an existing boundary which currently comprises a hedge with shallow ditch and low bank; and which bears the distinctive reverse ‘S’ indicative of a relict medieval furlong or selion, shown in Figure 7.3. This area could therefore be of extra importance in terms of the development of land use in the region.

Figure 7.2 A boundary west of East Wideopen, marked by a hedge and shallow ditch. Image captured from Google streetview, 2019.

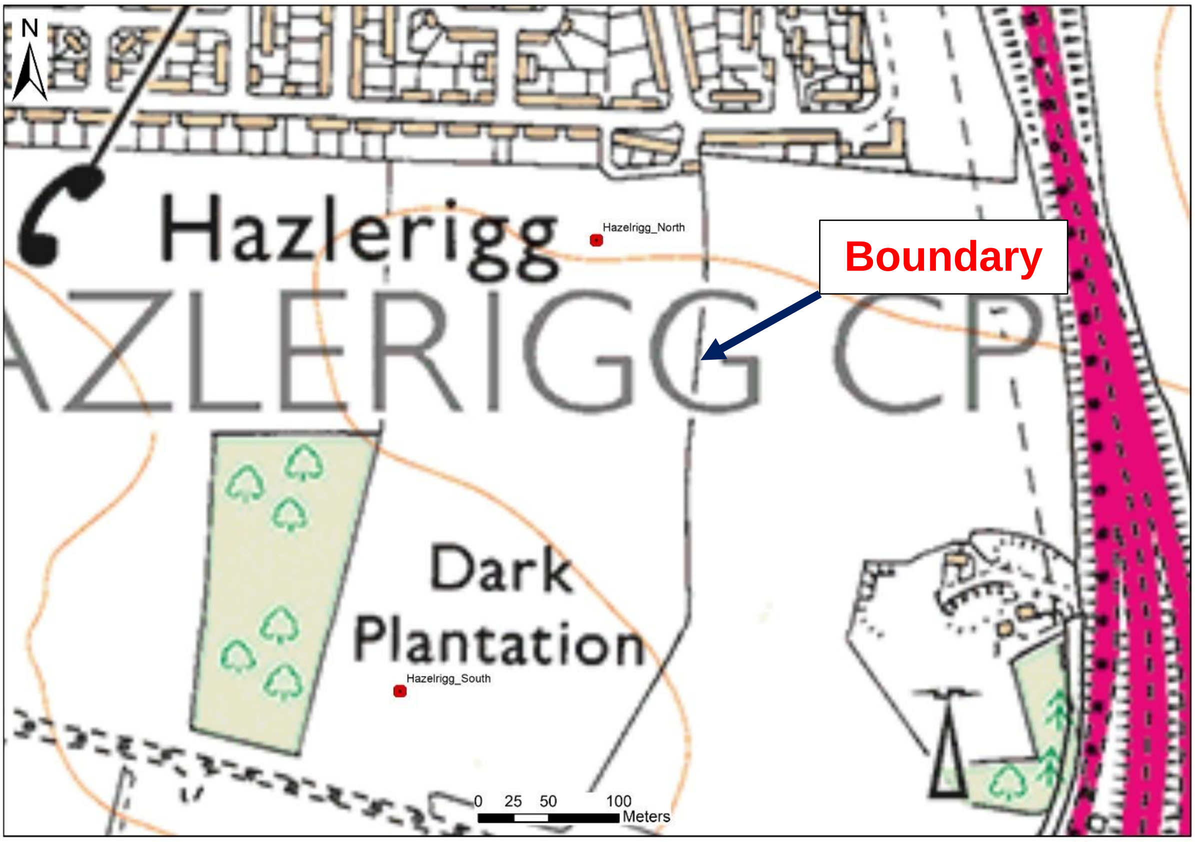

Figure 7.3 Existing boundary south of Hazelrigg, and proximity to nearby rectilinear settlement enclosures (1:250000 Ordnance Survey mapping downloaded from Edina Digimap, 2016)

Other sites have been identified as possibly holding key information regarding the development of settlement and land-use over long periods. The first is the upstanding remains of the rectilinear enclosure at Morley Hill Farm which is rare in an area where little survives above ground for this period, with most other sites only known through cropmarks or when excavated. With the issue of truncation by later activity, these remains hold great potential for the possibility of a longer occupational sequence. A small section of the enclosure bank and ditch was excavated prior to development (AD Archaeology 2015a), yielding dating evidence which could form the basis of further study. The notion of a late Anglo-Saxon core at the medieval village of Shotton could also be tested through research excavation (Muncaster *et al*. 2014: 138), expanding on the geophysical survey undertaken by the author through this research.

7.3 Filling the gaps

An absence of evidence is not evidence for absence in occupation or land use, and the notion that things stayed largely the same throughout the perceived gaps may be reflected in the lack of movement in the archaeological record. In addressing Research Aim 3 and Objectives 2, 6 and 7 the results are inconclusive in many cases, but the study has provided pathways in what to look for in terms of features enduring in the landscape over long periods. The past is, in Bradley's words, camouflaged: we only see it when something moves (Bradley 1984: 167). In this research, the movement is nudged by the analytical process, by omitting boundaries and tracks with a certain orientation to expose distinct features with certain orientations, or displaying a similar level of slope direction conformity, some of which could be contemporary. Gradual change is also harder to pin down archaeologically, such as the remains of the pit alignments or Anglo-Saxon track at Shotton silting up gradually over time. Gaps in knowledge are associated with change. Change did occur. The Anglo-Saxon settlement at Shotton, for example, ceased to be occupied at some point between the ninth and tenth centuries, and at some later date the area was used for furlongs containing medieval ridge and furrow. But can we pin this down to a single act? Probably not, even if we had better dating evidence. The medieval open fields associated with Shotton may have developed over time perhaps from a single furlong in a similar way to what was proposed nearby at Horsley (Tolan-Smith 2007). This research has shown that the ridge and furrow overlay the Anglo-Saxon settlement on the same orientation, with both largely conforming to within 20 degrees of underlying slope direction. It is possible that a much longer occupational sequence lies beneath the present buildings at Shotton, bridging the gap between the Iron Age and medieval phases. From this nucleus the land may have been managed throughout the perceived gaps in knowledge, which could lead to the proposition that some boundaries present in the recent past to the north of Shotton village did have much earlier origins. Change occurred at some point in the post medieval period, when the land was probably gradually converted to common for a time, evidenced in farm names around the southern portion of Shotton township; and similarly, around Morley Hill Farm. Again, with gradual change it is harder to see this in the archaeological record; but it can be postulated using some of the methods developed in this research.

There may not have been full depopulation of native settlements after the second-century AD in the current study area; and some residual occupation or re-establishment of sites cannot be ruled out, although so far apart from a few exceptions such as Hartburn and Huckhoe these are hard to detect archaeologically south of the River Wansbeck. Whilst only a small percentage of rectilinear settlements have been excavated, the evidence for large-scale settlement abandonment around the area north of what is now Newcastle and North Tyneside is growing, but there could still be other settlements in the area which contain evidence for some degree of continuity through the period, which facilitated the endurance of some landscape features.

Settlement evidence between late prehistory and the medieval period, such as West Whelpington and Shotton, shows that the same site was chosen on more than one occasion, but with a seemingly substantial gap in between. The gaps in evidence between the second and sixth centuries AD; and ninth and twelfth centuries AD imply that settlement locations were given up completely, evidenced at the numerous abandoned Iron Age/early Roman native settlements in the second-century AD and the Anglo-Saxon hall settlements at Shotton and further north at Felton in the ninth-century. Occupation of sites seems to move in a cycle when viewed this way, with medieval villages seemingly being situated where Iron Age settlements once stood; and the locations of late Iron Age and early Roman enclosed settlements, along with the known Anglo-Saxon settlements, being given over to the open-fields associated with the medieval villages. It is difficult to prove this last point entirely, as most lowland rectilinear settlement enclosures are overlain by post-medieval ridge and furrow, so we cannot say without excavation whether broad medieval ridge and furrow also overlay them. But once again the common denominator is place. Shotton and West Whelpington villages are situated atop prominent ridges which command strong positions in the landscape. It is hard to say without more evidence, but it could be that these places were left through the intervening period as settlements, or meeting places, whilst the surrounding areas were gradually filled-up with numerous enclosed and unenclosed settlements on areas which would eventually become integrated into open-fields associated with medieval villages. Some landscape elements probably did endure between periods; and some elements of land-use survived where settlements faded away, and these units were reused again and again by individuals and communities in different phases of occupation.

7.4 Forgotten and remembered landscapes

This research will conclude with a note on memory and its impact on practices over long periods. The ancient visual impact of the relict late Iron Age enclosures, many of which were still visible until the advent of the agricultural revolution of the late eighteen and nineteenth centuries, is key to understanding how pre-existing features were re-appropriated in later periods, both practically and conceptually (Chadwick 2013). The orientation of field boundaries directly north and south of Hadrian's Wall was markedly different in some areas, whilst in other areas it remained constant despite the dominant presence of the Wall. Both these trends could simply reflect local natural topography, which is apparent in some areas, but in others a link between the two cannot be gleaned. Township boundaries in most cases do not utilise the line of Hadrian's Wall between where the North and South Tyne Rivers conjoin and the North Sea, whereas further west it features regularly in township boundaries. East of the River North Tyne, it is almost as if Hadrian's Wall was invisible and forgotten in a symbolic sense, despite its dominant physical presence in the landscape along with the *vallum,* forts and other installations. This does raise questions around how the Wall and its purpose was perceived in later times.

Artefacts and memories are all processes, dynamic networks of lines of connectivity rather than static, fossilised fragments of the past (Chadwick 2013: 294). I would add the following to this: landscapes, artefacts and memories are therefore active, ever changing, sharing a dialogue with natural and human interactions. A Bronze Age barrow as perceived in the Anglo-Saxon period was active, not passive, or something that was 'just there'. We can see this in the way that such monuments influenced the locations of both ceremonial and domestic structures in the Anglo-Saxon period. Where things appear to us to have been disregarded, such as the perceived distance between prehistoric structures and medieval nucleated villages in south-east Northumberland (Astbury 2015), the former may have influenced the positioning of the latter in a way that created a certain order within the landscape at this time.

The past can serve a political role in the present. The strategic use of surviving features from the distant past and their incorporation in a different cultural landscape is a better framework than trying to explain it through the notion of ritual continuity (Bradley 1987: 4-5). Collective memory was, and can still be, practiced through ancestral ties based on the symbolic value of the lie of the land. People knew they were at the mercy of the natural world and that it had to be respected or they would face the consequences. Just like today really, but we are perhaps too self-assured in our collective abilities to manipulate the natural world to our own will.

8 Bibliography

AC Archaeology (2006) *Proposed Surface Mine at Shotton, Northumberland: Report on the archaeological evaluation by trial trenching.* Unpublished report lodged with Northumberland County Council.

AD Archaeology (2015a) *Land at Morley Hill Farm, Hazelrigg, Newcastle upon Tyne: Archaeological Evaluation*. Unpublished report lodged with Newcastle City Council.

AD Archaeology (2015b) *Mitford Estate, Land west of Morpeth, Northumberland, Archaeological Evaluation*. Unpublished report lodged with Northumberland County Council.

AD Archaeology (2016) *Shotton Triangle Site, Northumberland, Archaeological Evaluation*. Unpublished report. Lodged with Northumberland County Council.

AD Archaeology (2016) *Land at East Choppington Farm, Northumberland: Archaeological Geophysical Survey*, Unpublished report lodged with Northumberland County Council.

AD Archaeology (2018a) *Land North of Felton, Archaeological Strip and Record*. Unpublished Report. Lodged with Northumberland County Council

AD Archaeology (2018b) *Land at South Croft Stables, Ulgham, Archaeological Evaluation.* Unpublished report. Lodged with Northumberland County Council.

Archaeological Research Services and English Heritage (2008) *North East Rapid Coastal Zone Assessment Survey: Air Survey Mapping Report*, English Heritage National Mapping Programme, Historic Environment Enabling Programme: Project Number 3929.

Archaeological Research Services (2016) *An Archaeological Excavation at St. George's Hospital, Morpeth, Northumberland*. Unpublished Report. Lodged with Northumberland County Council.

AD Archaeology (2014) *Mitford Estate, Land West of Morpeth, Northumberland: Archaeological Geophysical Survey,* unpublished report lodged with Northumberland County Council.

ArcGIS Help (no date). https://pro.arcgis.com/en/pro-app/help/main/welcome-to-the-arcgis-pro-app-help.htm [date accessed 19/7/2019].

ASDU (2006) *Land at Seghill, Cramlington, Northumberland and Tyne and Wear: geophysical surveys,* unpublished report, lodged with Northumberland County Council.

ASDU, (2015) *East Wideopen, North Tyneside, Tyne & Wear: post-excavation full analysis*, unpublished report lodged with Newcastle City Council.

ASDU (2018) *West Shiremoor (North), Shiremoor, North Tyneside: post-excavation full analysis.* Unpublished report lodged with Newcastle City Council.

ASDU (forthcoming) *Murton Fields, archaeological evaluation.*

Astbury, D. (2013) 'West Backworth: a deserted medieval village and its wider context', *Medieval Settlement Research,* 28, 70-72.

Astbury, D. (2014) *Encountering the Past* (Unpublished Mlitt dissertation)

Aston, M. (1985) *Interpreting the Landscape,* London: Routledge.

Aston, M., and Gerrard, C. (2013) Interpreting the English Village: Landscape and Community at Shapwick, Somerset, Oxford: Oxbow.

Banham, D., and Faith, R. (2014) *Anglo-Saxon Farms and Farming*, Oxford: Oxford University Press.

Beresford, M. (1950) 'Glebe Terriers and Open Field, Yorkshire' *Yorkshire Archaeological Journal*, CXLVII, 349-362.

Beresford, M., and St Joseph, J K. (1958) *Medieval England an Aerial Survey*, Cambridge: Cambridge University Press.

Beresford, M., and Hurst, J.G., (1989) *Deserted Medieval Villages,* Stroud: Sutton.

Bidwell, P., and Speak, S. (1994) *Excavations at South Shields Roman Fort, vol. 1,* Newcastle-upon-Tyne: Society of Antiquaries of Newcastle Monograph 4.

Bidwell, P. (2010) 'A survey of the Anglo-Saxon crypt at Hexham and its reused Roman stonework' *Archaeologia Aeliana,* 5th series, 39, 53-145.

Biggins, J.A., Biggins, J., Coxon, R., and Watson, M. (1997) 'Survey of the Prehistoric Settlement at Gardener's Houses Farm, Dinnington', *Durham Archaeological Journal* 13, 43-53.

Biggins, A., Robinson, J. and Taylor, D. (2000) 'Vindolanda Roman Fort. A report on a geophysical survey at the Roman Fort at Vindolanda, July 2000 conducted by Timescape Archaeological Surveys, commissioned by the Vindolanda Trust', Unpublished Report held with Northumberland County Council.

Biggins, J.A., and Taylor, D.J.A. (2004) 'A geophysical survey at Housesteads Roman Fort, April 2003', *Archaeologia Aeliana,* 5th series, 33, 51-60.

Bintliff, J. (2001) 'Recent Developments and New Approaches to the Archaeology of Medieval Greece', *IV European Symposium for Teachers of Medieval Archaeology*, (Conference report) Sevilla: University of Sevilla, 33–44.

Birley, A. (2003) *Vol. I: The Excavations of 2001 and 2002: Civilian Settlement, second century forts, and the pre-Hadrianic occupation, with a report on the trial excavations at Carvoran,* Bardon Mill: Vindolanda Research Reports.

Blair, J. (2006) *The Church in Anglo-Saxon Society,* Oxford: Oxford University Press.

Blair, J. (2018) *Building Anglo-Saxon England*, New Jersey: Princeton University Press.

Blair, J., Rippon, S., and Smart, C. (no date) *Planning in the Early Medieval Landscape* http://humanities.exeter.ac.uk/archaeology/research/projects/planningintheearlymedievallandscape/ [date accessed 4/12/2018].

Bonney, D. (1972) 'Early Boundaries in Wessex', in P.J. Fowler (ed.), *Archaeology and the Landscape,* London: John Baker, 168-186.

Bonney, D. (1979) ‘Early Boundaries and Estates in Southern England’ in P.H. Sawyer (ed.) *English Medieval Settlement,* London: Edward Arnold, 41-51.

Bradley, R. (1984) *The Social Foundations of Prehistoric Britain,* London: Longman.

Bradley, R. (1987) ‘Time Regained: the creation of continuity’ *Journal of the British Archaeological Association* 140, 1-17.

Bradley, R. (2000) *An Archaeology of Natural Places,* Abingdon: Routledge.

Bradley, R. (2002) *The Past in Prehistoric Societies,* London: Routledge.

Bradley, R. (2012) The Idea of Order, Oxford: Oxford University Press.

Breeze, D., and Dobson, B. (2000) *Hadrian’s Wall,* 4th ed. London: Penguin

British Geological Survey (no date) https://www.bgs.ac.uk/ [date accessed 13/8/2019].

Brooks, C., Daniels, R., and Harding, A. (2002) (eds.) *Past, Present and Future: The Archaeology of Northern England*, Durham: Roger Booth Publications.

Brown, T., and Foard, G. (1998) ‘The Saxon Landscape: a regional perspective’ in Everson, P., and Williamson, T. (eds.) *The Archaeology of Landscape,* Manchester: Manchester University Press, 67-94.

Bruck, J. (1999) ‘Houses, Lifecycles and Deposition on Middle Bronze Age Settlements in Southern England’, *Proceedings of the Prehistoric Society,* 65, 145-166.

Bruck, J. (2008) ‘The Architecture of Routine Life’ in Pollard, J. (ed.) *Prehistoric Britain*, Oxford: Blackwell, 248-267.

Butlin, R.A (1964) ‘Northumberland Field Systems’, *Agricultural History Review* 12, 2, 99-120.

Butlin (1973) ‘Field Systems of Northumberland and Durham’ in Baker, A.R.H., and Butlin, R. (eds.) *Studies of Field Systems in the British Isles,* Cambridge: Cambridge University Press, 93-143.

Carlton, R. (2016) ’Archaeological Investigations at Well Hill, Stannington’, *Archaeology in Northumberland*, 22, 38-39.

Chadwick, A.M., and Gibson, C.D. (2013) ‘“Do you remember the first time?” A preamble through memory, myth and place’, in Chadwick, A.M., and Gibson, C.D. (eds.) *Memory, Myth and long-term Landscape Inhabitation,* Oxford: Oxbow, 1-31.

Citter, C. (2012) ‘Townscape – Landscape. The shaping of the medieval town of Grosseto and its territory (AD 600-1400)’, *Post-Classical Archaeologies* 2, 7, 189-226.

Collins R. (2012) *Hadrian's Wall and the End of Empire: The Roman Frontier in the 4th and 5th Centuries*. New York: Routledge.

Cook, H. (1999) 'Soil and Water management: principle and purposes', in Cook, H., and Williamson, T. (eds.) *Water Management in the English Landscape*, Edinburgh: Edinburgh University Press, 15-27.

Craster, H. (1909) *A History of Northumberland, vol 9*, London: Andrew Reid and Company ltd.

Crewe, V. (2008) 'The Appropriation of Prehistoric Monuments in Early to Middle Anglo-Saxon Settlements' *Medieval Settlement Research* 23, 1-8.

Crutchley, S., and Crow, P. (2009) *The Light Fantastic: Using airborne laser scanning in archaeological survey*, Swindon: English Heritage.

Curtler, W.H.R. (1909) *A Short History of English Agriculture*, Oxford: Clarendon Press

Davis, O. (2012) 'Processing and Working with LiDAR in ArcGIS: A Practical Guide for Archaeologists', Royal Commission on the Ancient and Historical Monuments of Wales www.rcahmw.gov.uk. [date accessed 4/8/2016].

Foard, G., and Deegan, A. (2013) *Mapping Ancient Landscapes in Northamptonshire*, Swindon: English Heritage.

Dixon, P.J. (1984) *The Deserted Medieval Villages of North Northumberland: a settlement history from the twelfth to nineteenth century,* Unpublished PhD thesis.

Dixon, P.J. (2014) 'Survey and excavations at Alnhamsheles deserted medieval village, on the Rowhope Burn, Alnham Moor, Northumberland' *Archaeologia Aeliana,* 5th series, 43, 169-220.

Doneus, M. (2013) 'Openness as Visualization Technique for Interpretative Mapping of Airborne Lidar Derived Digital Terrain Models', *Remote Sensing,* 5, 6427-6442.

Drury, P. and Rodwell, W. (1980) 'Settlement in the later Iron Age and Roman periods', in D. G. Buckley (ed.) *The Archaeology of Essex to AD 1500*, Council for British Archaeology Research Report, 34, 59–75, London: Council for British Archaeology.

English Landscapes and Identities (EnglaID) (no date) https://englaid.wordpress.com/ [date accessed 15/10/2018].

Field, D. (2008) 'The Development of the Agricultural Countryside' in Pollard, J. (ed.) *Prehistoric Britain*, Oxford: Blackwell, 202-224.

Fleming, A. (1978) The prehistoric landscape of Dartmoor: Part 1, south Dartmoor', *Proceedings of the Prehistoric Society*, 44, 97–123.

Fleming, A. (1998) 'Prehistoric Landscapes and the quest for territorial pattern', in P. Everson and T. Williamson (eds.) *The Archaeology of Landscape*, Manchester: Manchester University Press, 42-66.

Fleming, A. (2007) 'Don't Bin Your Boots', *Landscapes,* I, 85-99.

Ford, W.J. (1979) 'Some Settlement Patterns in the Central Region of the Warwickshire Avon', in P.H. Sawyer (ed.) *English Medieval Settlement,* London: Edward Arnold, 143-163.

Forlin, P. (2002) 'Airborne LiDAR Data analysis of Trentino Alpine landscapes: a methodological approach', *Post-classical Archaeologies,* 2, 247-268.

Fowler, P. and Taylor, C. (1978) 'Roman fields into medieval furlongs', in H. C. Bowen and P. J. Fowler (eds) *Early Land Allotment*, 159–62, Oxford: British Archaeological Report Britain Series 48.

Fraser, R. (2004) 'A Medieval Settlement at West Hartford, Cramlington', *Archaeology in Northumberland,* 26-27.

Frodsham, P. (2004) *Archaeology in Northumberland National Park,* York: Council for Archaeology Research Report 136.

Frodsham, P. (2006) *In the Valley of the Sacred Mountain*, Newcastle-upon-Tyne: Northern Heritage Publishers.

Gaffney, C., and Gater, J. (2003) *Revealing the Buried Past: geophysics for archaeologists*, Stroud: Tempus.

Gates, T. (1982) 'Farming on the frontier: Romano-British fields in Northumberland', in Clack and Hazelgrove, C. (eds.) *Rural Settlement in the Roman North*, Durham, 21-43.

Gates, T. (1997) *Air Photography and the Archaeology of the Otterburn Training Area,* Unpublished report for the Northumberland National Park.

Gates, T. (1999) *The Hadrian's Wall Landscape from Chesters to Greenhead: An Air Photographic Survey,* Unpublished report for the Northumberland National Park.

Gates, T. (2000) *The Archaeology of the College Valley Estate: An Air Photographic Survey.* Unpublished report for the Northumberland National Park.

Gates, T. (2004) 'Flying on the frontier. Recent archaeological air photography in the Hadrian's Wall corridor', in Frodsham, P. (ed.) *Archaeology in Northumberland National Park*, York: CBA, 236-245.

Gates, T. (2005) 'Yeavering and Air Photography: discovery and interpretation', in Frodsham, P. and O'Brien, C. (eds.) *Yeavering: People, Power and Place,* Stroud: Tempus, 65-83.

Gates, T., and Hewitt, R. (2007) 'Some newly identified Roman Temporary Camps in Northumberland and their Relation to the Devil's Causeway', *Archaeologia Aeliana,* 5th Series, 36, 11-30.

Gates, T. and O'Brien, C. F. (1988) 'Cropmarks at Milfield and New Bewick and the recognition of Grubenhauser in Northumberland, *Archaeologia Aeliana*, 5th series, 16, 1-12.

Gerrard, J. (2013) *Ruin of Roman Britain,* Cambridge: Cambridge University Press.

Gilchrist, R. (2009) 'Medieval Archaeology and Theory: a disciplinary leap of faith', in Gilchrist, R., and Reynolds, A. (eds.) *Reflections: 50 Years of Medieval Archaeology, 1957-2007*, Leeds: Maney, 385-408.

Giles, M. (2012) *A Forged Glamour: Landscape, Identity and Material Culture in the Iron Age,* Oxford: Oxbow.

Glover, P.W.J (2010) 'The discovery of an Anglo-Saxon Grubenhaus at New Bewick, Northern UK using Electrical Surveying and predictive deconvolution' *Archaeometry* 52, 2, 320-342.

Goransson, S. (1961) ‘Open-Field Pattern in England and Scandinavian solskifte’, Geografiska Annaler 43, No 1-2, Morphogenesis of the Agrarian Cultural Landscape: Papers of the Vadstena Symposium at the XIXth International Geographical Congress, 80-104.

Hall, D. (1999) 'The drainage of arable land in medieval England', in Cook, H., and Williamson, T. (eds.) *Water Management in the English Landscape*, Edinburgh: Edinburgh University Press, 28-41.

Hall, D. (2014) *The Open Fields of England,* Oxford: Oxford University Press.

Hamerow, H. (2006) ‘Special Deposits in Anglo-Saxon Settlements’ *Medieval Archaeology* 50, 1-30.

Hamerow, H. (2012) *Rural Settlements and Society in Anglo-Saxon England,* Oxford: Oxford University Press.

Harbottle, B. (1995) ‘Prestwick Carr: its draining and enclosure’, *Archaeologia Aeliana,* 5th series, 23, 1-15.

Harding, A. (1981) ‘Excavation in the prehistoric ritual complex near Milfield, Northumberland, *Proceedings of the Prehistoric Society,* 47, 87-135.

Harrison, S. (2002) ‘Open fields and earlier landscapes: six parishes in south-east Cambridgeshire’, *Landscapes*, 3, 35–54.

Harrison, S. (2005) *A History of Evolution and Interaction: Man, Roads and the Landscape to 1850*, unpublished PhD thesis, University of East Anglia.

Hart, C.R. (1997) ‘Excavations in Tynemouth, 1995’, *Archaeologia Aeliana*, 5th series, 25, 87-108.

Harvey, N. (1976) *Fields, Hedges and Ditches.* Oxford: Shire

Hawkes, J. (1996) *The Golden Age of Northumbria*, Morpeth: Sandhill.

Hazelgrove, C. (2002) ‘The Later Bronze Age and the Iron Age in the Lowlands’ in Brooks, C., Daniels, R., and Harding, A. (eds.) *Past, Present and Future: The Archaeology of Northern England*, Durham: Roger Booth Publications, 49-70.

Headland Archaeology (2015) *Brenkley Lane Surface Mine: Archaeological Excavations,* Unpublished report, lodged with Newcastle City Council.

Headland Archaeology (2018) *Enclosed Iron Age Settlements on land east of Morley Hill Farm, Hazelrigg, Newcastle upon Tyne: excavation*, unpublished report, lodged with Newcastle City Council.

Heslop, D. (2009) ‘Newcastle and Gateshead before A.D. 1080’, in Newton, D., and Pollard, A.J. (eds.) *Newcastle and Gateshead before 1700*, Chichester: Phillimore and Co.

Hill, J.D. (1992) ‘Can we recognise a different European past? A contrastive archaeology of later prehistoric settlements in southern England’, *Journal of European Archaeology* 1, 57-75.

Hingley, R. (2002) ‘Later Prehistory: Introduction’ in Brookes, C., Daniels, R., and Harding, A. (eds.) *Past, Present and Future: The Archaeology of Northern England,* Hassocks: Roger Booth.

Hinton, D.A. (1990) *Archaeology, Economy and Society: England from the fifth to the fifteenth century*, London: Seaby.

Hinton, D.A. (2010) ‘Deserted medieval villages and the objects from them’ in Dyer, C. and Jones, R. (eds.) *Deserted Medieval Villages Revisited*, Hatfield: University of Hertfordshire Press, 85- 109.

Historic England (2018) *Introduction to heritage assets: Field Systems,* Swindon: Historic England.

Hodgson, N., Stobbs, G.C., & van der Veen, M. (2001) An Iron-Age Settlement and Remains of Earlier Prehistoric Date Beneath South Shields Roman Fort, Tyne and Wear, *Archaeological Journal*, 158, 62-160.

Hodgson, N., McKelvey, J., and Muncaster, W. (2012) *The Iron Age on the Northumberland Coastal Plain: Excavations in Advance of Development,* Newcastle-upon-Tyne: TWM Archaeology.

Homans, G.C. (1942) *English Villagers of the thirteenth century*, Cambridge: Harvard University Press.

Hope-Taylor, B. (1977) *Yeavering: an Anglo-British centre of early Northumbria,* Swindon: English Heritage.

Hoskins, W.G. (1955) *The Making of the English Landscape,* London: Penguin.

Jarrett, M.G. (1962) ‘The Deserted Medieval Village of West Whelpington’, *Archaeologia Aeliana*, 4th Series, 40, 189-225.

Jobey, G. (1959) ‘Excavations at the Native Settlement at Huckhoe, Northumberland, 1955-7’, *Archaeologia Aeliana*, 4th series, 37, 217-278.

Jobey, G. (1960) ‘Some Rectilinear Settlements of the Roman Period in Northumberland’, *Archaeologia Aeliana,* 4th series, 38, 1-38.

Jobey, G. (1963) ‘Excavation of a Native Settlement at Marden, Tynemouth’, *Archaeologia Aeliana,* 4th Series, 41, 19-35.

Jobey, G. (1970) ‘An Iron Age settlement and homestead at Burradon, Northumberland’ *Archaeologia Aeliana*, 4th series, 48, 51-95.

Jobey, G. (1973) ‘A native settlement at Hartburn and the Devil’s Causeway, Northumberland, 1971’ *Archaeologia Aeliana*, 5th series, 1, 11-53.

Jobey, I. (1981) ‘Excavations at Middle Gunnar Peak, Barrasford, Northumberland’ *Archaeologia Aeliana* 5th series, 51-74.

Johnson, B., Waddington, C., Baker, P., Ramsey, C.B., Clogg, P., Cook, G., Cotton, J., Hamilton, D., Marshall, P. and Stern, B. (2008) ‘Prehistoric and Dark Age Settlement Remains from Cheviot Quarry, Milfield Basin, Northumberland’, *Archaeological Journal*, 165:1, 107-264.

Johnson, M. (2007a) *Ideas of Landscape,* Oxford: Blackwell.

Johnson, M. (2007b) 'Don't Bin Your Brain!', *Landscapes,* 2, 126-128.

Jones, G. (1979) 'Multiple Estates and Early Settlement' in Sawyer, P.H. (ed.) *English Medieval Settlement,* London: Edward Arnold, 9-34

Jones, M. (1981) 'The development of crop husbandry', in Jones, M and Dimbleby, G.W (eds.) *The Environment of Man: The Iron Age to the Saxon Period,* 95-127.

Jones, R., and Page, M. (2006) *Medieval Villages in an English Landscape: Beginnings and Ends*, Bollington: Windgatherer.

Jones, R. (2010) 'The Village and the Butterfly: Nucleation out of Chaos and Complexity', *Landscapes* 1, 25-46.

Kapelle, W.E. (1979) *The Norman Conquest of the North,* London: Croom Helm.

Kinnaird, T., Bolos, J., Turner, A., and Turner, S. (2017) 'Optically-stimulated luminescence profiling and dating of agricultural terraces in Catalonia (Spain)', *Journal of Archaeological Science* 78, 66-77.

Kluiving, S., and Guttman-Bond, E. (2012) 'LAC2010: First International Landscape Archaeology Conference' in Kluiving, S., and Guttman-Bond, E. (eds.) Landscape Archaeology between Art and Science, Amsterdam: Amsterdam University Press, 11-32.

Landis (no date) http://www.landis.org.uk/ [date accessed 20/8/2019].

Lewis, C., Mitchell-Fox, P., and Dyer, C. (2001) *Village, Hamlet and Field: changing medieval settlements in central England,* Bollington: Windgatherer.

Framework Archaeology (2006) *Landscape Evolution in the Middle Thames Valley: Heathrow Terminal 5 Excavations Volume 1: Perry Oaks,* Oxford: Framework Archaeology.

Lotherington, R., (2016). 'Iron Age settlement at St George's Hospital, Morpeth' *Archaeology in Northumberland,* 22, 22-23.

Løvschal, M. (2014) 'Emerging Boundaries: Social Embedment of Landscape and Settlement Divisions in Northwestern Europe during the First Millennium BC', *Current Anthropology,* 55 (6), 725-750.

McCarthy, M. (2002) 'The Archaeology of Roman Non-Military Sites', in Brooks, C., Daniels, R., and Harding, A. (eds.) *Past, Present and Future: The Archaeology of Northern England*, Durham: Roger Booth Publications, 105-112.

McCord, N., and Jobey, G. (1968) 'Notes on air reconnaissance in Northumberland and Durham', *Archaeologia Aeliana,* 4th series, 51-67.

McCord, N., and Jobey, G. (1971) 'Notes on air reconnaissance in Northumberland and Durham II', *Archaeologia Aeliana,* 4th series, 49, 119-30.

McOmish, D., Field, D., and Brown, G. (2002) *The Field Archaeology of the Salisbury Plain Training Area*, Swindon: English Heritage.

Miket, R. (1978) 'Two Early Anglo-Saxon brooches from Chesters and Chesterholme', *Archaeologia Aeliana* 5th series, 6, 177-180.

Miket, R. (1981) ‘Pit Alignments in the Milfield Basin, and the Excavation of Ewart 1’, *Proceedings of the Prehistoric Society* 47, 137-146.

Millet, M. (1990) *The Romanisation of Britain,* Cambridge: Cambridge University Press

Mills, J. and Palmer, R. (2007) ‘Introduction’, in Mills, J. and Palmer, R. (eds.) *Populating Clay Landscapes*, Stroud: Tempus, 7-15.

Muncaster, W., McKelvey, J., and Bidwell, P. (2014) ‘Excavation of an Anglo-Saxon settlement and of prehistoric features at Shotton, Northumberland’ *Archaeologia Aeliana* 5th series, 43, 77-141.

National Mapping Programme (2008) *North East Coast Rapid Coastal Zone Assessment Survey.* Online report available at: https://historicengland.org.uk/research/research-results/recent-research-results/north-east/north-east-rczas-nmp/ [date accessed 14/3/2018].

National Mapping Programme (2009) *Hadrian’s Wall World Heritage Site: National Mapping Programme Summary Report.* Unpublished report available at: http://research.historicengland.org.uk/Report.aspx?i=14809 [accessed 14/3/2018].

Northern Archaeological Associates (2016) *East Wideopen, Wideopen, Tyne and Wear: Post-excavation assessment report.* Unpublished report. Lodged with Newcastle City Council.

Northern Archaeological Associates (2018) *East Wideopen Farm, Wideopen, North Tyneside: post excavation assessment.* Unpublished report lodged with Newcastle City Council.

Novák, David. (2014). Local Relief Model (LRM) Toolbox for ArcGIS (UPDATE 2016-05 - new download link). 10.13140/RG.2.1.2010.1201/1. https://www.academia.edu/5618967/Local_Relief_Model_LRM_Toolbox_for_ArcGIS_UPDATE_2016-05_-_new_download_link_?auto=download [date accessed 8/8/2018].

O’Brien, C., and Miket, R. (1991) ‘The Early Medieval Settlement of Thirlings, Northumberland’, Durham Archaeological Journal 7, 57-91.

O’Brien, C. (2002) ‘The Early Medieval Shires of Yeavering, Breamish and Bamburgh’, *Archaeologia Aeiliana,* 5th series, 30, 53-74.

O’Brien and Adam O’Brien, C., and Adams, M. (2016) ‘The Identification of Early Medieval Monastic Estates in Northumbria’ *Medieval Settlement Research* 31, 15-27).s

Oosthuizen, S. (2006) *Landscapes Decoded: the origins and development of Cambridgeshire’s medieval fields,* Hatfield: University of Hertfordshire Press.

Oosthuizen, S. (2013) *Tradition and Transformation in Anglo-Saxon England: archaeology, common rights and landscape,* London: Bloomsbury.

Oosthuizen, S. (2016) ‘Recognizing and Moving on from a Failed Paradigm: The Case of Agricultural Landscapes in Anglo-Saxon England c. AD 400–800’, *Journal of Archaeological Research* 24, 179-227.

Opitz, R.S. (2013) 'An overview of airborne and terrestrial laser scanning in archaeology', in Opitz, R.S., and D. C. Cowley (eds.) *Interpreting Archaeological Topography: 3D Data, Visualisation, and Observation*, Oxford, 13-31.

Ordnance Survey Map Abbreviations (no date) https://www.ordnancesurvey.co.uk/resources/maps-and-geographic-resources/map-abbreviations.html [date accessed 20/6/2016].

O'Sullivan, D., and Young, R (1995) *Book of Lindisfarne: Holy Island,* Batsford: English Heritage.

Parker Pearson, M., and Richards, C. (1994) 'Architecture and Order: Spatial representation and archaeology', in Parker Pearson, M., and Richards, C. (eds.) *Architecture and Order: Approaches to Social Space*, London: Routledge, 38-72.

Passmore, D.G., and Waddington, C. (2009) *Managing Archaeological Landscapes in Northumberland*, vol.1, Oxford: Oxbow.

Passmore, D.G., and Waddington, C. (2012) *Archaeology and Environment in Northumberland*, vol.2, Oxford: Oxbow.

Peterson, J. (1988) 'Information systems and the interpretation of Roman cadastres', in Rahtz, S.P.Q. (ed.), *Computer and Quantitative Methods in Archaeology (BAR International Series 446 (i)).* Oxford: B.A.R, 133-149*.*

Peterson, J. (1990) 'Roman cadastres in Britain. II. Eastearn A. Signs of a large System in the northern English home counties', *Dialogues d'histoire ancienne* 16, 2, 233-272.

Peterson, J. (2004) 'Co-axial landscapes in South Norfolk and beyond: another view', *The Annual: The Bulletin of the Norfolk Archaeological and Historical Research Group* 13, 61-72

Pope, R. (2007) 'Ritual and the roundhouse: a critique on recent ideas on the use of domestic space', in Hazelgrove, C., and Pope, R. (eds.) *The Earlier Iron Age in Britain and the near Continent*, Oxford: Oxbow, 204-228.

Poulter, J. (2010) *The Planning of Roman Roads and Walls in Northern Britain,* Stroud: Amberley.

Proctor J. (2009) *Pegswood Moor, Morpeth: A later Iron Age and Romano-British Farmstead Settlement,* London: PCA.

Rackham, O. (1986) *The History of the Countryside,* London: Phoenix.

Rees, J. (1979) *Agricultural Implements in Prehistoric and Roman Britain.* Oxford: British Archaeology Reports 69.

Reynolds, A. (2003) 'Boundaries and Settlements in later Sixth to Eleventh Century England' in Griffiths, D., Reynolds, A., and Semple, S. (eds.) *Boundaries in Early Medieval Britain*, Oxford: Oxford University School of Archaeology, 98-136.

Reynolds, A. (2011) 'Debating Scale and Scale Change in the English Landscape: Four Case-studies from the late Roman-Period' in Escalona, J. and Reynolds, A. (eds.) *Scale and Scale Change in the early Middle Ages: exploring landscape, local society and the world beyond,* Turnhout: Brepols

Richards, C. (1996) ‘Henges and water: towards and elemental understanding of Monumentality and Landscape in Late Neolithic Britain’, *Journal of Material Culture,* 1, 3, 313-336.

Rippon, S. (1991) ‘Early Planned Landscapes in South-East Essex’, *Essex Archaeology and History,* 22, 46-60.

Rippon, S., Smart, C., and Pears, B. (2015) *The Fields of Britannia,* Oxford: Oxford University Press.

Roberts, B.K. (1987) *The Making of the English Village,* London: Longman.

Roberts, B.K. (2008) *Landscapes, Documents and Maps: villages in northern England and beyond,* Oxford: Oxbow.

Roberts, B.K. (2015) ‘Northumberland: reflections on prehistoric, Roman and Old English settlement’ *Archaeologia Aeliana*, 5th series, 44, 31-73.

Roberts, B.K., and Wrathmell, S. (2000) *An Atlas of Rural Settlement in England,* London: English Heritage.

Roberts, B.K., and Wrathmell, S. (2002) *Region and Place: A study of English Rural Settlement,* London: English Heritage.

Roberts, I. (2010) *Understanding the Cropmark Landscapes of the Magnesium Limestone,* Leeds: Archaeological Services WYAS.

Rocque, J. (1769) *A Plan of London on the same scale as that of Paris* https://www.rct.uk/collection/search#/3/collection/703117/a-plan-of-london-on-the-same-scale-as-that-of-paris [date accessed 15/9/2019].

Rodwell, W. (1978) ‘Relict landscapes in Essex’, in H. C. Bowen and P. J. Fowler (eds.) *Early Land Allotment*, 89–98, London: British Archaeological Reports.

Rollason, D.W. (2003) *Northumbria, 500-1100: creation and destruction of a kingdom*, Cambridge: Cambridge University Press.

Roymans, N., Gerritson, F., Van der Heijden, C., Bosma, K., and Kolen, J. (2009) 'Landscape Biography as Research Strategy: The Case of the South Netherlands Project', *Landscape Research*, 34:3, 337-359)

Semple, S. (2013) *Perceptions of the Prehistoric in Anglo-Saxon England,* Oxford: Oxford University Press.

Sentinel HUB (no date) https://www.sentinel-hub.com/ [date accessed 15/3/2019].

Sheppard, J.A (1973) ‘Field Systems in Yorkshire’, in Baker, A.R.H., and Butlin, R. (eds.) *Studies of Field Systems in the British Isles,* Cambridge: Cambridge University Press, 145-187

Smith, A., Allen, M., Brindle, T. and Fulford, M. (2016) *The Rural Settlement of Roman Britain,* Britannia Monograph Series 29, London: Society for the Promotion of Roman Studies.

Snape, M. (1992) ‘Sub-Roman Brooches from Roman sites on the Northern Frontier’, *Archaeologia Aeliana,* 5th Series, 20, 158-160.

Snape, M., Bidwell, P., and Stobbs, G. (2010) 'Excavations in the Military *vicus* south-west of the Roman Fort at South Shields in 1973, 1988 and 2002' *Arbeia Journal,* 9, 35-54.

Spratt, D.A. (ed.) (1993) *Prehistoric and Roman Archaeology of North-East Yorkshire,* CBA Research Report 87, London: CBA.

Stevens, C.E. (1966) 'The social and economic aspects of rural settlement'., in Thomas, C. (ed.), *Rural Settlement in Roman Britain*, CBA Research Report No. 7, Council for British Archaeology, York, 108–128.

Taylor, C.C. (1981) 'Archaeology and the origins of open-field agriculture', in Rowley, T. (ed.) *The Origins of Open Field Agriculture*, London: Croom Helm Ltd, 13-21.

Taylor, D.J.A., Robinson, J., and Biggins, J.A. (2000) 'A Report on a Geophysical Survey of the Roman Fort and *Vicus* at Halton Chesters' *Archaeologia Aeliana,* 5th series, 28, 37-46.

The Archaeological Practice (2015) *North Seaton, Ashington, Archaeological Evaluation in September 2015.* Unpublished Report lodged with Northumberland HER.

The Archaeological Practice (2017) *Excavations in Condercum Vicus (Benwell)* https://stjameschurchnewcastle.files.wordpress.com/2019/03/roman-excavations-in-pendower.pdf [date accessed 5/8/2019].

Tilley, C. (2006) 'Introduction: Identity, Place, Landscape and Heritage', *Journal of Material Culture*, 11: 7-30.

Tolan-Smith, C. (1997) *Landscape archaeology in Tynedale*, Newcastle upon Tyne: University of Newcastle upon Tyne.

Topping, P. (1983) 'Observations on the stratigraphy of early agricultural remains in the Kirknewton area of the Northumberland Cheviots' *Northern Archaeology* 4. (1), 21-31.

Topping, P. (1989) 'Early Cultivation in Northumberland and The Borders', *Proceedings of the Prehistoric Society,* 55, 161-179.

Topping, P. (2008) 'Landscape Narratives: The South-East Cheviots Project', *Proceedings of the Prehistoric Society*, 74, 323-364.

TWM (2007) *Archive Report, Fox Covert, OCCS, Dinnington, Tyne & Wear: Archaeological Excavation*, unpublished report lodged with Newcastle City Council.

TWM Archaeology (2006) *Seghill Landfill Site*, unpublished report lodged with Newcastle City Council.

TWM Archaeology (2008) *Shotton medieval village, Site 1: Archaeological Excavation,* Unpublished report lodged with Northumberland County Council.

TWM Archaeology (2013) *Shotton Medieval Village, Site 1, Shotton OCCS, Northumberland: Post-excavation archive report,* Unpublished report lodged with Northumberland County Council.

TWM Archaeology (2013) *Shotton Triangle Site, Archaeological Geophysical Survey*. Unpublished Report lodged with Northumberland County Council.

Vervust, S., T. Kinnaird, N. Dabaut and S. Turner. (2020) ‘The development of historic field systems in northern England: a case study at Wallington, Northumberland’. *Landscape History* 41 (2), 57-70.

Vince, A. (2007) ‘Anglo-Saxon and Medieval Pottery at Huckhoe, Northumberland’ AVAC report, http://www.avac.uklinux.net/potcat/pdfs/avac2007057.pdf. [date accessed 25/8/2015].

Vindomora Solutions (2018) *Land at East Sleekburn: archaeological excavation.* Unpublished report lodged with Northumberland County Council.

Waddington, C. (1997) ‘A review of pit-alignments and a tentative interpretation of the Milfield complex’, *Durham Archaeological Journal* 13, 21-33.

Wardell Armstrong (2017a) *Land at Station Road, Wallsend, Tyne & Wear*. Unpublished Report lodged with Newcastle HER.

Wardell Armstrong (2017b) 'Front Street, Dinnington, Newcastle upon Tyne: Archive Report' (unpublished report, record held at Newcastle City Council).

Webley, L. (2007) ‘Using and Abandoning Roundhouses: A reinterpretation of the evidence from late Bronze Age-Early Iron Age Southern England’ *Oxford Journal of Archaeology,* 26 (2) 127-144.

Webley, L., Vander Linden, M., Hazelgrove, C., and Bradley, R. (eds.) (2012) *Development-led Archaeology in North-West Europe*, Oxford: Oxbow.

Wilkinson, T. J. (1988) *Archaeology and Environment in South Essex*, East Anglian Archaeology Report, 42, Chelmsford: Essex County Council.

Williams, H. (2006) *Death & Memory in Early Medieval Britain*, Cambridge: Cambridge University Press.

Williams, M. (2003) ‘Growing Metaphors: the agricultural cycle as metaphor in the later prehistoric period of Britain and North-Western Europe’ *Journal of Social Archaeology*, 3 (2), 223-255.

Williams, E. (2015) *Northumberland Historic Landscape Characterisation* https://archaeologydataservice.ac.uk/archives/view/northumberland_hlc_2015/ [date accessed 9/7/2019].

Williamson, T. (1986) ‘Parish boundaries and early fields; continuity and discontinuity’, *Journal of Historical Geography*, 2(3), 241–48.

Williamson, T. (1987) ‘Early coaxial field systems on the East Anglian boulder clays’, *Proceedings of the Prehistoric Society*, 53, 419–31.

Williamson, T. (1998) ‘The ‘Scole-Dickleburgh Field System’ revisited’, *Landscape History*, 20, 19–28

Williamson, T. (2002) *The Transformation of Rural England: Farming and the landscape 1700-1870,* Exeter: University of Exeter Press.

Williamson, T. (2003) *Shaping Medieval Landscapes: Settlement, Society, Environment,* Macclesfield: Windgatherer.

Williamson, T., Liddiard, R., Partida, T., Foard, G., Hall, D. and McClain, A. (2013) 'A GIS aided study of agriculture and landscape in Midland England' http://archaeologydataservice.ac.uk/archives/view/midlandgis_ahrc_2010 [date accessed 8/8/2017].

Williamson, T. (2013) *Environment, Society and Landscape in Early Medieval England: Time and Topography,* Woodbridge: Boydell

Williamson, T. (2016) 'The Ancient Origins of Medieval Fields: A Reassessment', *Archaeological Journal,* 173, 2, 264-287.

Wilson, D.R. (2000) *Air Photo Interpretation for Archaeologists*, Stoud: Tempus.

Wrathmell, S. (1975), *Deserted village of South Northumberland*, University of Cardiff Unpublished PhD thesis, II, 295 (notes of which are stored by Newcastle City Council).Wrathmell 2012

Wrathmell, S. (ed.) (2012a) *A History of Wharram Percy and its Neighbours,* York: University of York Press.

Wrathmell, S. (2012b) 'Northern England: Exploring the Character of Medieval Rural Settlements' in Christie, N. and Stamper, P. (eds.) *Medieval Rural Settlement: Britain and Ireland, AD 800-1600,* Oxford: Windgatherer, 270-288.

Wright, R.P. (1940) 'The Devil's Causeway from Rimside Moor (Longframlington) to the Bridge of Aln', *Archaeologia Aeliana,* 4th series, 17, 65-74.

Wright, D. (2015) 'Shaping Rural Settlements: The Early Medieval Legacy to the English Village', *Landscapes,* 16, 2, 105-125.

9 Appendix A: Case study detailed results

9.1 Shotton

SHO_PAL1: 456m

Orientation	Length	Percentage
10_100	0	0
20_110	0	0
30_120	361	79
40_130	361	79
50_140	0	0
60_150	95	21
70_160	0	0
80_170	0	0
90_180	0	0

SHO_PAL: 456m

SHO_PAL_con20: 174m (38%)

SHO_PAL_non20: 282m (62%)

SHO_PAL_con30: 456m (100%)

SHO_ANC1: 511m

Orientation	Length	Percentage
10_100	0	0
20_110	0	0
30_120	361	79
40_130	361	79
50_140	0	0
60_150	95	21
70_160	0	0
80_170	0	0
90_180	0	0

SHO_ANC: 512m

SHO_ANC_con20: 290m (57%)

SHO_ANC_con30: 331m (65%)

SHO_RECT: 211m

SHO_RECT_con20: 47m (22%)

SHO_RECT_con30: 122m (58%)

SHO_SEM2: 456m

SHO_SEM2_con20: 291m (64%)

SHO_SEM2_non20: 165m (36%)

SHO_SEM2_con30: 403m (88%)

SHO_SEM2_non30: 53m (12%)

SHO_SEM2_80_170: 173m

SHO_SEM2_80_170_con20: 173m (100%)

SHO_MNV: 293m

SHO_MNV_con20: 143m (49%)

SHO_MNV_non20: 150m (51%)

SHO_MNV_con30: 218m (74%)

SHO_MNV_non30: 75m (26%)

SHO_MRF: 12340m

Orientation	Length (m)	Percentage
SHO_MRFa_10_100	2267	18
SHO_MRFa_20_110	1518	12
SHO_MRFa_30_120	1316	11
SHO_MRFa_40_130	1383	11
SHO_MRFa_50_140	1334	11
SHO_MRFa_60_150	1996	16
SHO_MRFa_70_160	4166	34
SHO_MRFa_80_170	6646	54
SHO_MRFa_0_90_180	6646	54

Table 11 Proportions of orientation for medieval ridge and furrow within Shotton township

SHO_MRFa: 12340m

SHO_MRFa_con20: 6008m (49%)

SHO_MRFa_non20: 6333m (51%)

SHO_MRFa_con30: 8469m (69%)

SHO_MRFa_non30: 3871m (31%)

SHO_MRF: 24322m

SHO_MRF_con20: 11397m (47%)

SHO_MRF_non20: 12924m (53%)

SHO_PMRF: 3978m

SHO_PMRF_con20: 2088m (52%)

SHO_PMRF_non20: 1890m (48%)

SHO_PMRF_con30: 2647m (67%)

SHO_PMRF_non30: 1331m (33%)

SHO_PMRF_80_170: 2651m

SHO_PMRF_80_170_con20: 1490m (56%)

SHO_PMRF_80_170_con30: 1841m (69%)

SHO_SEN: 91632m

SHO_SEN_con20: 46210m (50%)

SHO_SEN_non20: 45422m (50%)

SHO_SEN_con30: 64294m (70%)

SHO_SEN_non30: 27338m (30%)

SHO_SEN_80_170: 51144m

SHO_SEN_80_170_con20: 25258m (49%)

SHO_SEN_80_170_non20: 25886m (51%)

SHO_SEN_80_170_con30: 34800m (68%)

SHO_SEN_80_170_non30: 16344m (32%)

9.2 Fox Covert

FOX_EMB: 217m

Orientation	Length	Percentage
10_100	0	0
20_110	69	32
30_120	145	67
40_130	76	35

50_140	73	34
60_150	73	34
70_160	0	0
80_170	0	0
0_90_180	0	0

FOX_GRA: 1157m

FOX_GRA_con20: 506m (44%)

FOX_GRA_non20: 651m (56%)

FOX_GRA_con30: 846m (73%)

FOX_GRA_non30: 311m (27%)

FOX_MRF1: 1701

Orientation	Length	Percentage
10_100	288	17
20_110	588	35
30_120	824	48
40_130	452	27
50_140	522	31
60_150	522	31
70_160	163	10
80_170	67	4
0_90_180	71	4

FOX_PMRF: 1421m

Orientation	Length (m)	Percentage
10_100	0	0
20_110	232	16
30_120	232	16
40_130	0	0
50_140	385	27
60_150	385	27
70_160	0	0

80_170	803	57
0_90_180	803	57

FOX_SEN: 26176m

Orientation	Length	Percentage
10_100	5265	20
20_110	1839	7
30_120	2148	8
40_130	3244	12
50_140	5138	20
60_150	5576	21
70_160	8239	31
80_170	11259	43
0_90_180	9645	37

9.3 Whalton

WHL_RECT_: 309m

WHL_RECT_con20: 234m (76%)

WHL_RECT_non20: 74m (24%)

WHL_RECT_con30: 271m (88%)

WHL_RECT_non30: 38m (12%)

WHL_GEL: 231m

WHL_GEL_con20: 231m (100%)

WHL_MNV: 605m

WHL_MNV_con20: 354m (59%)

WHL_MNV_non20: 251m (41%)

WHL_MNV_con30: 605m (100%)

WHL_MRF: 24435m

WHL_MRF_con20: 13956m (57%)

WHL_MRF_non20: 10478m (43m)

WHL_MRF_con30: 18840m (77%)

WHL_MRF_non30: 5595m (23%)

WHL_MRF_con20: 13956

Orientation WHL_MRF_con20	**Length**	**%**
10_100	9041	65
20_110	4708	34
30_120	2401	17
40_130	2079	15
50_140	1992	14
60_150	1998	14
70_160	2642	19
80_170	4797	34
0_90_180	10439	75

WHL_PMRF: 18069m

WHL_PMRF_con20: 9550m (53%)

WHL_PMRF_non20: 8519m (47%)

WHL_PMRF_con30: 13850m (77%)

WHL_PMRF_non30: 4220m (23%)

WHL_SEN_180: 94002m

WHL_SEN_con20: 50162m (53%)

WHL_SEN_non20: 43840m (47%)

WHL_SEN_con30: 70403m (75%)

WHL_SEN_non30: 23599m (25%)

OGL_RECT: 704m

OGL_RECT_con20: 312m (44%)

OGL_RECT_con30: 497m (71%)

OGL_MRF: 17012m

OGL_MRF_con20: 8509m (50%)

OGL_MRF_con30: 12299m (72%)

OGL_PMRF_con20: 8340m

Orientation WHL_PMRF_con 20	Length	%
10_100	5431	57
20_110	2311	24
30_120	1103	12
40_130	837	9
50_140	175	2
60_150	407	4
70_160	1310	14
80_170	2485	26
0_90_180	5037	53

OGL_PMRF: 16041m

OGL_PMRF_con20: 8340 (52%)

OGL_PMRF_con30: 10959m (68%)

OGL_SEN: 67766m

OGL_SEN_con20: 32207m (48%)

OGL_SEN_non20: 35559m (52%)

OGL_SEN_con30: 45826m (68%)

9.4 East Wideopen

East Wideopen Aspect mean 50m: 85 degrees

EWN_RECT1

EWN_RECT: 284m

EWN_RECT_con20: 128m (45%

EWN_RECT_non20: 156m (55%)

EWN_RECT_con30: 177m (62%)

EWN_RECT_non30: 98m (38%)

EWN_ANC_BOU1: 746

Orientation	Length (m)	Percentage
EWN_ANC_BOU1_10_100	156	21
EWN_ANC_BOU1_20_110	553	74
EWN_ANC_BOU1_30_120	490	66
EWN_ANC_BOU1_40_130	46	6
EWN_ANC_BOU1_50_140	100	13
EWN_ANC_BOU1_60_150	54	7
EWN_ANC_BOU1_70_160	0	0
EWN_ANC_BOU1_80_170	0	0
EWN_ANC_BOU1_0_90_180	93	12

EWN_ANC_BOU: 745m

EWN_ANC_BOU_con20: 607m (81%)

EWN_ANC_BOU_non20: 138 (19%)

EWN_ANC_BOU_con30: 705m (94%)

EWN_ANC_BOU_non30: 40m (6%)

EWN_MRF: 3445m
EWN_MRF_con20: 1785m (52%)

EWN_MRF_con30: 2652m (77%)

EWN_PMRF: 3754

EWN_PMRF_con20: 1771m (51%)

EWN_PMRF_con30: 2630 (70%)

EWN_SEN: 24232m

EWN_SEN_con20: 12700m (52%)

EWN_SEN_con30: 17499m (72%)

Great North Road

EWN_GNR: 1854m

EWN_GNR_con30: 1283m (69%)

9.5 Dere Street

DS: 21303m

SEN_DS_con20: 9624.2m (45%)

SEN_DS_non20: 11782.6m (55%)

SEN_DS_con30: 14367m (67%)

SEN_DS_non30: 6936m (33%)

DS_60_150: 12325m

DS_150_con20: 6852m (55%)

DS_150_con30: 9736m (79%)

9.6 Devil's Causeway

DC: 19573m

DC_con20: 8301m (42%)

DC_non20: 11345m (58%)

DC_con30: 13244m (68%)

DC_non30: 6565m (32%)

DC_0_90_180: 128m

DC_0_*90*_180_con20: 128m (100%)

Using SEN_30_120

SEN_DC_30_120: 16951m

Using SEN_30_120_con_20

DC_30_120_con20: 7205m (42%)

DC_30_120: 16013m

DC_30_120_con20: 6978m (43%)

9.7 HGF Holywell Grange Farm

HGF_CRO: 2043m

HGF_CRO_con30: 1175m (58%)

HGF_CRO_non30: 868 (42%)

HGF_SEN: 14369m

HGF_SEN_con30: 10560m (73%)

HGF_SEN_non30: 3850m (27%) ****

9.8 Pegswood

PEG_ANC_BOU: 974m

PEG_ANC_BOU_con20:

PEG_ANC_BOU_non20:

PEG_ANC_BOU_con30: 626m (64%)

PEG_ANC_BOU_non30:

PEG_ANC_BOU_IA: 761m

PEG_ANC_BOU_IA_con20: 405m (53%)

PEG_ANC_BOU_IA_con30: 445m (58%)

PEG_ANC_BOU_IARB: 213m

PEG_ANC_BOU_IARB_con20: 110m (52%)

PEG_ANC_BOU_IARB_con30: 182m (85%)

9.9 MRF SPT CHO

MRF_CHO: 4871m

Orientation	Length	%
10_100	1800	37
20_110	578	12
30_120	1195	25
40_130	837	17
50_140	160	3
60_150	99	2
70_160	897	18
80_170	914	19
0_90_180	2505	51

MRF_SPT: 9030m

Orientation	Length	%
10_100	284	3
20_110	211	2
30_120	772	9
40_130	1308	14
50_140	5193	58
60_150	6947	77
70_160	2620	29
80_170	1426	16
0_90_180	321	4

MRF_CHO: 4871m

CHO_con20: 2041m (42%)

CHO_non20: 2830m (58%)

CHO_con30: 3501m (72%)

CHO_non30: 1370m (28%)

MRF_SPT: 9031m

SPT_con20: 2530m (28%)

SPT_non20: 6500m (72%)

SPT_con30: 4278m (47%)

SPT_non30: 4753m (53%)

10 Appendix C

10.1 Watershed analysis: an exploratory exercise

A DTM, or DEM was used for this purpose. To effectively undertake this exercise, it was found through testing that two approaches could be used. One was to include only major rivers, in this case the Wansbeck, Blyth and Tyne. This provides a general idea of the topographic conditions and flow accumulation over the major river valleys; and may indicate significant watershed routes which may have taken this trajectory regardless of more local variations dictated by secondary valleys. A second approach analyses all visible watersheds, from major rivers to small streams. This enables all topographic variations caused by river valleys, large or small, to be accounted for in the depictions of watersheds. In the flow accumulation plot, standard deviations were used to display the data, with a stretch value of 0.025 standard deviations; this enabled even the smallest of streams to be visualised and selected for watershed analysis; and was particularly useful along the coastal plain where the topography is less pronounced, but still dictated by low river valleys.

The plot depicts areas from the river or stream to the highest point at which water can run down into it. Vector points were snapped to all three major rivers in the region, the Rivers Tyne, Wansbeck and Blyth, along with numerous other tributaries and smaller rivers that were deemed to hold topographic significance. Using the generated plot of watershed areas, polylines could be drawn depicting the watersheds between river valleys (SEN_WS_line); these polylines were then be used as active analytical components to calculate the proximity between watersheds and various archaeological features. A brief preliminary analysis ‘by eye’ suggested numerous roads, tracks and footpaths depicted on 1st edition Ordnance Survey mapping ran along these watershed zones. It was also apparent from this exercise that one watershed traversed a large portion of the study area, traced roughly from Rudchester Roman fort in the south-west (NZ 11277 67353) to West Sleekburn in the north-east (NZ NZ 27905 85418), oriented roughly south-west to north-east for approximately 26km. This watershed appears by eye to have little or no influence over the location of linear archaeological features, an observation borne out by the statistical test below.

To calculate how many linear human-made features potentially traversed watersheds, the selection tool in ArcGIS was used to calculate various proximities between the watershed polylines (SEN_WS_line), and the SEN_no_grid dataset, the latter comprising transcribed SEN boundaries and tracks which had been split on points at which they contacted the 50m grid used in the underlying slope analysis. This dataset was more useful than the initial merged boundary polyline dataset which comprised linear polylines which ran for long distances, entailing that even if a small section was close to the watershed polylines, the whole polyline unit would be selected, most of which may not have been in close proximity. With an initial maximum distance threshold of 30 metres. This produced a dataset with very little correlation to the transcribed watersheds. Most boundary sections which conformed to underlying slope were either at odds with the direction of the watersheds, or at best perpendicular. Unsurprisingly, as the threshold was raised, a greater proportion of boundaries and tracks were found to conform with the watersheds. With a 50m threshold many more could be seen with a shared alignment to the watersheds; and more still using a 100m threshold. It is therefore necessary to define a meaningful threshold to these watershed units: how far from the watershed polylines can the results still hold meaning: but this will depend on the width of watershed, all of which are different. The problem with this approach is that there are so many boundaries and tracks that some of them are bound to have a degree of spatial correlation with watersheds; and if the same length of polylines were placed randomly across the study area, one might expect to find similar degrees of correlation.