E37

High Speed Rail (West Midlands - Crewe)

Environmental Statement

Volume 5: Technical appendices

Cultural heritage

Route-wide geoarchaeology desk study report (CH-006-000)

July 2017

ES 3.5.0.10.2

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Department for Transport

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1.1 Structure of the cultural heritage appendices

1.1.1 The cultural heritage Appendices for the Proposed Scheme comprise the following documents:

- a baseline report for each community area (Appendices CH-001-001 to CH-001-005);
- a gazetteer for each community area (Appendices CH-002-001 to CH-002-005);
- an impact assessment table for each community area (Appendices CH-003-001 to CH-003-005);
- a route-wide historic landscape character report (CH-005-000); and
- a route-wide geoarchaeology desk study report (this Appendix).

1.1.2 In addition, survey reports, incorporating geophysical survey and remote sensing studies for each community area are available in the Background Information and Data document[1].

1.2 Scope and coverage

1.2.1 This document presents a route-wide Geoarchaeology Desk Based Assessment (GDBA) of the Proposed Scheme, involving a review concentrating on surface deposits and areas of geoarchaeological potential across the land required for the Proposed Scheme.

1.2.2 Particular attention is focused on deposits associated with existing and former river courses where Pleistocene and Holocene sediments are most extensively preserved.

1.2.3 The data detailed within this document relates to the following community areas:

- Fradley to Colton (CA1);
- Colwich to Yarlet (CA2);
- Stone and Swynnerton (CA3);
- Whitmore Heath to Madeley (CA4); and
- South Cheshire (CA5).

[1] HS2 Ltd (2017), *High Speed Two (HS2) Phase 2a (West Midlands - Crewe), Background Information and Data, Cultural heritage survey reports*, BID-CH-004-001 to BID-CH-004-005, www.gov.uk/hs2

2 Aims and objectives

2.1 Aims of the geoarchaeological review

2.1.1 The aim of this review is four-fold:

- to provide an outline of the principal superficial geological deposits occurring within the route of the Proposed Scheme;
- to highlight the geoarchaeological potential of the principal superficial geological deposits;
- to consider the relevance of these deposits within regional and national research frameworks in archaeology; and
- to provide a specific geoarchaeological breakdown of the proposed route into a series of Geoarchaeological Character Zones (GCZ), forming the basis of a Geoarchaeological Landscape Characterisation (GLC).

3 Overview of bedrock and superficial geology and topography

3.1 Geochronology

3.1.1 Geochronology concerns the dating of geological strata and is key to developing a chronological framework for geological deposits along the route the Proposed Scheme. Where age estimates are available these, are expressed in millions of years ago, thousands of years ago, years before present (BP), and within the Holocene epoch as years Before Christ (BC) and Anno Domini (AD). These dates are supplemented, where known, with the comparable Marine Isotope Stage (MIS) where odd numbers indicate an interglacial period and even numbers a glacial period.

3.2 Topography

3.2.1 The route of the Proposed Scheme between Fradley and Crewe (Figure 1) forms a corridor along the western margin of the Upper Trent Valley, across the low-lying and gently undulating landscape of Staffordshire and Southern Cheshire. The route varies in altitude from a low of approximately 45m above ordnance datum (AOD) at Crewe to the highest point of approximately 170m AOD south of Stoke-on-Trent, with much of the approximately 60km route undulating between 60m – 120m AOD.

3.3 Solid geology

3.3.1 The underlying bedrock geology (Figure 2) is dominated by sedimentary deposits of Triassic age (approximately 200 - 250 million years ago). These largely comprise mudstones, siltstones, sandstones and salt deposits (halites) of the Mercia Mudstone Group, but with deposits of Bromsgrove Sandstone Formation and interbedded sandstone and pebble conglomerates of the Kidderminster Formation, particularly around Stafford; all are part of the Sherwood Sandstone Group and form the remainder of the Triassic sequence. South of Stoke on Trent, Carboniferous siltstones and sandstones of the Warwickshire Group occur along the route, but these form a relatively small part of the overall mapped sequence of deposits.

3.4 Superficial geology

3.4.1 The superficial geology is more complex (Figure 2) reflecting the influence of glacial and riverine processes, which may extend over the last 400,000 years of geological time, though the majority of deposits are likely to be more recent.

3.4.2 The area is close to the margins of the last major ice sheet to affect mainland Britain during the Late Devensian (approximately 30,000 – 15,000 years ago), which on present evidence[2] probably reached a line from Lichfield to Wolverhampton. This last glaciation has largely removed evidence of earlier ice sheets and palaeodrainage. However, as its precise limits are still unrefined and the focus of debate, it is possible that earlier glacial and fluvial sediments, as well as associated Lower to Upper

[2] Bridgland, D.R., Howard, A.J., White, M.J. and White, T.S. (2014), *Quaternary of the Trent*, Oxford, Oxbow Books

Palaeolithic archaeology and palaeoenvironmental deposits, may form isolated remnants in the landscape or be buried beneath Devensian deposits.

3.4.3 Large expanses of glacial sediments deposited directly by ice (tills) are located along the route, particularly around Crewe, and are almost certainly of Late Devensian age, but more isolated deposits at Stone and north-east of Rugeley may well relate to earlier glacial stages. Understanding the age, extent and character of these tills is critical to understanding the potential of the proposed corridor to yield Palaeolithic cultural remains and associated palaeoenvironmental deposits. South of Stoke-on-Trent large deposits of glacial outwash sands and gravels are mapped by the British Geological Survey (BGS) and were probably aggraded during the last Cold Stage (Devensian).

3.4.4 Pleistocene river terrace deposits occur at three locations along the route; Fradley to the south, the confluence of the River Trent and River Sow east of Stafford, and to the south of Crewe. In places, these deposits are mapped along the contemporary river valleys at altitudinally low levels and these terrace deposits are likely to relate to the last Cold Stage (Devensian), although organic rich sediments relating to the last interglacial or subsequent interstadials may be interbedded within them[3]. Other, isolated terrace at higher levels may relate to earlier Pleistocene fluvial activity.

3.4.5 The route of the Proposed Scheme also crosses several deposits of post-glacial Holocene alluvium, twice crossing the River Trent east and west of Rugeley, along with alluvial deposits associated with several smaller brooks including the Moreton, Meece and Checkley Brooks, and the river Lea at Madeley. Peat deposits are recorded in several locations from along the route north from Yarnfield (west of Stone). These occur along the courses of rivers and brooks, perhaps infilling palaeochannels or as a component of floodplain alluvial sequences, and in areas of till and glacial outwash where the peat may infill glacial features such as kettle holes. The peat is likely to be predominantly Holocene in date, but the potential for longer sequences of sediment including late Devensian interstadial deposits should not be excluded (see Section 4).

[3] Schreve, D., Howard, A., Currant, A., Brooks, S., Buteux, S., Coope, R., Crocker, B., Field, M., Greenwood, M., Greig, J. and Toms, P. (2012), *A Middle Devensian woolly rhinoceros from Whitemoor Haye Quarry, Staffordshire (UK): palaeoenvironmental context and significance,* Journal of Quaternary Science 28 (2), 118-130

4 Geoarchaeological potential

4.1 Introduction

4.1.1 Within the study area for the Proposed Scheme, the superficial deposits of primary importance as regards cultural, archaeological and geoarchaeological potential span both the Pleistocene and Holocene (Figure 2). The main categories of deposit are summarised below, outlining their geoarchaeological and archaeological potential.

4.2 River terrace deposits (Pleistocene)

4.2.1 River terrace deposits are key contexts for archaeological and geoarchaeological investigation. They represent fluvially deposited sediments, typically sands and gravels, that have been subsequently incised through and preserved as evidence of former floodplains along the sides of current and former river valleys.

4.2.2 The terrace sands and gravels reflect deposition under cold climatic conditions in braided river environments, whereas organic silts and clays are associated with meandering rivers in temperate climates. Within individual river catchments evidence for several terrace deposits can usually be mapped representing successive phases of aggradation and incision covering multiple glacial-interglacial cycles.

4.2.3 In the Upper Trent Valley, the earliest river terrace evidence dates to the end of the Anglian glaciation, around 450,000 years ago[4]. River terrace deposits can contain tools indicative of human activity, although invariably in non-primary contexts. In many catchments of Southern and Eastern England, flint is widely available, both in the Cretaceous Chalk bedrock and river gravels and therefore it has been the primary material used to produce hand axes.

4.2.4 Plotting of Lower and Middle Palaeolithic find spots[5] has shown a concentration of Lower and Middle Palaeolithic hand axes south of an imaginary line from the Severn to the Wash, but this is now known to reflect the distribution of remains with respect to the Late Devensian ice sheet and scarcity of flint further north; in the Midlands, quartzite available locally from the Triassic bedrock would have formed a key resource for hunter gatherers[6], but individual worked clasts[7] abrade quickly and do not stand out within other superficial deposits.

4.2.5 River terrace deposits may also preserve floral and faunal remains that are instrumental in providing information on past climates and environments as well as developing secure chronostratigraphic frameworks through both relative and absolute dating. For example, at the confluence of the Rivers Trent and Tame, a low terrace revealed the remains of four woolly rhinoceri and organic remains indicative of an arctic climate attributable to the Middle Devensian[8].

[4] Bridgland et al (2014)
[5] Roe, D.A. (1981), *The Lower and Middle Palaeolithic Periods in Britain*, Routledge and Kegan Paul, London
[6] White, T.S., White, M.J., Bridgland, D.R. and Howard, A.J. (2009), *Palaeolithic and Quaternary research in the Trent Valley (UK): contributions by early collectors,* Proceedings of the Geologists Association 120 (4), 223-232
[7] Clasts are defined as fragments of geological material, which form the basis of material worked into artefacts
[8] Schreve et al (2012)

4.2.6 Pleistocene deposits are identified as key contexts for future investigation, particularly where there is the opportunity to reveal stratified sedimentary sequences and associated archaeological deposits.

4.3 Till

4.3.1 Tills are poorly sorted sediments deposited directly by ice sheets. The upper reaches of the Trent Valley and surrounding landscape were glaciated during the last Ice Age (Late Devensian, MIS 2), with the tills mapped from the vicinity attributed to this period on the basis of BGS mapping[9].

4.3.2 However, as mentioned previously, the southern portion of this area is close to the margins of this ice sheet and its precise extent is still the focus of debate; therefore, some of the tills at the southern end may relate to earlier glacial episodes between the Anglian and Late Devensian[10], which in turn, has implications for the potential for discovering Lower and Middle Palaeolithic archaeology.

4.3.3 Although the tills themselves have limited archaeological potential, they may seal and preserve underlying stratigraphy containing archaeological sites and associated environmental remains. For example, at Four Ashes, the type-site for the Devensian, which is approximately 16km south of Stafford, several organic lenses sealed by till were revealed during sand and gravel quarrying dating to a timeframe spanning the Middle Devensian to Ipswichian interglacial. Radiocarbon dates from the upper organic lenses demonstrate that the Irish Sea ice, which deposited the till, arrived in this area after 30,500 BP and receded prior to 13,500 BP[11].

4.3.4 Since this seminal study at Four Ashes[12], little progress has been made refining the precise timing of glaciations in this region of the West Midlands[13].

4.3.5 Furthermore, chronological work to date has been based entirely on radiocarbon dating, reflecting the era in which the research was undertaken. Now, established newer techniques such Optically Stimulated Luminescence and Amino Acid Racemization analyses offer additional opportunities to refine chronologies.

4.4 Sands and gravels

4.4.1 Sands and gravels are a lithostratigraphic unit mapped by BGS at the 1:50,000 scale, but in practice may often be difficult to distinguish from river terrace deposits without the aid of exposures.

4.4.2 Glaciofluvial sediments are deposited by seasonal meltwater outwash at the edge of the Devensian ice-sheet or as subglacial, englacial and supraglacial deposits of the ice sheet itself. Sands and Gravels are distributed widely within the region but occur

[9] Bridgland et al (2014)
[10] White, T.S., Bridgland, D.R., Westaway, R. and Straw, A. (2016), Evidence for late Middle Pleistocene glaciation of the British margin of the Southern North Sea, *Journal of Quaternary Science, Volume 32, Issue 2, February 2017 pp. 261–275*
[11] Morgan, A.V. (1973), *The Pleistocene geology of the area north and west of Wolverhampton, Staffordshire, England,* Philosophical Transactions of the Royal Society of London B, 265, 233-297
[12] Shotton, F.W. **(**1977**),** *A discussion on the changing environmental conditions in Great Britain and Ireland during the Devensian (Last) Cold Stage*, Philosophical Transactions of the Royal Society of London B, 280, 107-118
[13] Bowen, D.Q., Phillips, F.M., McCabe, A.M., Knutz, P.C. and Sykes, G.A. (2002), *New data for the Last Glacial Maximum in Great Britain and Ireland,* Quaternary Science Reviews 21, 89–101; Chiverrell, R.C. and Thomas, G.S.P. (2010*), Extent and timing of the Last Glacial Maximum (LGM) in Britain and Ireland: a review*, Journal of Quaternary Science 25 (4), 535-549; Clark, C.D., Hughes, A.L.C., Greenwood, S.L., Jordan, C.J. and Sejrup, H.P. (2012), *Pattern and timing of retreat of the last British-Irish Ice Sheet*, Quaternary Science Reviews, 44, 112-146

primarily within the northern section of the route of the Proposed Scheme, from Madeley to Crewe.

4.4.3 The sediments have little direct geoarchaeological potential but may contain archaeology eroded and redeposited from Lower and Middle Palaeolithic contexts, or seal stratified deposits of archaeological and geoarchaeological potential. In particular, kettle holes[14] associated with outwash sands and gravels and tills have been shown in cases to preserve deep deposits of Late Glacial and Holocene sediment (see Section 4.6 on peat below) and are thus of a high geoarchaeological significance.

4.5 Alluvium (Holocene)

4.5.1 Alluvium is a generalised term covering unconsolidated sediments transported by water in a non-marine environment (e.g. rivers and lakes). It has also been used as a banner term including other sediments such as peat, which form under different conditions, but that often occur as distinct bands or discrete features within alluvium. Pleistocene river gravels are technically alluvium, but the term here is applied to fine grained deposits of Holocene date.

4.5.2 Alluvium is recorded within the course of several river valley and smaller brooks that dissect the route of the Proposed Scheme, the most significant of these being the main valley of the River Trent, including sediment potentially preserved within floodplain and former channel courses (palaeochannels). Palaeochannels are key contexts for understanding the physical evolution of the landscape, but also act as effective traps preserving both artefacts and ecofacts indicative of the surrounding environment and human activity.

4.5.3 Mapping of the Trent Valley[15] indicates that palaeochannels are generally rare within the Upper Trent (i.e. upstream from Rugeley, north of the confluence of the River Sow and River Trent) because of preservation factors related to the higher energy fluvial regime and constrained width of the valley floor, but become more frequent downstream of this point. Although likely to be present infrequently within the route corridor, where preserved their rarity nonetheless makes them key contexts for geoarchaeological investigation and sites regionally, for example, Yoxall Bridge have yielded significant palaeoenvironmental information[16].

4.5.4 Floodplain sediments may also contain archaeological remains and structures (e.g. fish traps) or seal buried land-surfaces containing archaeology.

4.6 Peat

4.6.1 Peat comprises partially decayed organic matter preserved within waterlogged anaerobic (i.e. oxygen-free) conditions. Peats are ideal contexts for the preservation of plant micro- and macro-fossils and invertebrate remains that provide key data on past vegetation environments, climate, land-use and the long-term impact of human communities on the landscape.

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[14] Water-filled hollows left when a block of ice has melted

[15] Baker, S. (2007), *The palaeochannel record in the Trent Valley UK: contributions towards cultural heritage management,* Internet Archaeology 20, http://intarch.ac.uk/journal/issue20/baker_toc.html; Howard, A.J., and Macklin, M.G. (1999), *A generic geomorphological approach to archaeological interpretation and prospection in British river valleys: a guide for archaeologists investigating Holocene landscapes,* Antiquity 73, 527-41

[16] Smith, D.N., Roseff, R., and Butler, S. (2001), *The sediments, pollen, plant macrofossils and insects from a Bronze Age channel fill at Yoxall Bridge, Staffordshire.* Environmental Archaeology, 6, 1-12

4.6.2 Peat deposits preserved within lakes, bogs and along river valleys have often been the focus for past human activity, and may contain a wide range of finds and structures (e.g. worked wood, timber structures) of archaeological significance.

4.6.3 Recent research frameworks for the West Midlands emphasise the need for more palaeoenvironmental work, particularly on lowland contexts, primarily as a means for testing existing models of land-use and subsistence based largely on outdated pollen studies from upland areas located peripheral to the main concentrations of settlement activity[17]. Any peat deposits identified along the route, either interbedded within alluvium or as discrete landform deposits such as palaeochannels and kettle holes, are therefore of high geoarchaeological potential.

4.6.4 The possibility of identifying deep sequences extending back to the Late Glacial should not be discounted on the basis of work from the Kings Pool, Stafford, which revealed an approximately 21m deep sequence of organic sediments extending back to the late Windermere Interstadial[18]. Other Late Glacial organic rich localities have also been described from Penkridge Pillaton Hall and Rodbaston, all immediately south of Stafford[19].

4.6.5 Identifying similar sequences would be highly significant in the context of understanding climate and vegetation history and human activity over the late Pleistocene/Holocene transition, particularly in view of the dearth of artefactual evidence for late Upper Palaeolithic occupation in the area.

4.6.6 There is a paucity of palaeoenvironmental data from lowland contexts of all periods, including the Pleistocene. The Pleistocene/Holocene transition represents a key period of climate and vegetation change in Britain, with consequence changes in society and material culture. The palaeoenvironmental data provides an important wider environmental and landscape context for these changes. Additional sediment sequences also provide the opportunity to employ modern computer based modelling of vegetation and climate data, supported by more robust chronological frameworks not available at the time of the earlier studies[20].

[17] Brennand, M. ed. (2007), *Research and archaeology in North-West England: an archaeological research framework for North-West England, volume 2, Research agenda and strategy*, Archaeology North West 9; Watt, S. (2011), *The archaeology of the West Midlands: a framework for research*. Oxford, Oxbow

[18] Bartley, D.D. and Morgan, A.V. (1990), *The palynological record of the King's Poll, Stafford, England*, New Phytologist 116, 177-194

[19] Jones, R.L. and Keen, D.H. (1993), *Pleistocene Environments in the British Isles*, Chapman & Hall, London, p.174

[20] Bartley and Morgan (1990)

5 Research frameworks

5.1 Archaeological and geoarchaeological potential of Quaternary sediments

5.1.1 Existing regional and national research agendas[21] provide an outline framework for considering the archaeological and geoarchaeological potential of the Quaternary sediments encountered along the route of the Proposed Scheme.

5.1.2 Regional research frameworks for north-west England emphasise the paucity of well-dated environmental and geoarchaeological data of all periods from lowland landscapes[22]. Geoarchaeological analysis of lowland contexts is deficient and required to rebalance the existing upland focus of regional palaeoenvironmental studies on which models of settlement and subsistence are currently based. The majority of these studies come from adjoining areas of Cheshire and Shropshire as there are few comparable or recent studies from Staffordshire, through which much of the route passes.

5.1.3 An understanding of the Middle and Late Pleistocene and Holocene development of the alluvial landscape is critical to understand the preservation and visibility of the archaeological and geoarchaeological resource. River courses would have acted as key foci for human activity and important corridors of movement though the landscape and have a high archaeological and geoarchaeological potential.

5.1.4 Two separate surveys of the Trent River valley[23] have suggested that the geoarchaeological potential of the Upper Trent may be comparatively low compared to the Middle and Lower Trent. The high gradient of the Upper Trent results in a rapid stream flow and medium to high energy environments dominated by coarse rather than fine-grained sediments. Consequently, the valley floor is relatively narrow and the preservation of palaeochannel and other floodplain features is likely to be relatively poor.

5.1.5 Several palaeochannels have nonetheless been identified during recent aerial surveys at the confluence of the River Sow and River Trent[24] and might equally be present along some of the smaller tributaries feeding the River Trent, River Sow and River Lea south of Crewe, which were not included in the aerial surveys.

5.1.6 Floodplain deposits along the river valleys and associated tributaries may nonetheless preserve former Holocene palaeo land surfaces and contain both archaeological and environmental remains.

5.1.7 Several small peat deposits identified within the land required for the Proposed Scheme may also have acted as a focus for past human activity and preserve important sequences of past vegetation history and human activity. The peats are likely to be of Holocene rather than pre-Holocene date, though the possibility of

[21] Brennand (2007); Watt (2011)
[22] Brennand (2007)
[23] Howard, A.J. (2005), *The contribution of geoarchaeology to understanding the environmental history and archaeological resources of the Trent Valley, UK*, *Geoarchaeology* 20 (2), 93-107; Challis, K. (2006), *Airborne laser altimetry in alluviated landscapes*, Archaeological Prospection 13, 103-127
[24] Challis (2006); Baker (2007)

encountering interstadial/interglacial deposits should not be excluded, and may suffer from damage through later agricultural activity (e.g. peat wastage and truncation).

5.1.8 The Palaeolithic represents a significant challenge in the North-West region. Archaeological finds of Palaeolithic date are extremely rare, with only two unstratified finds of Lower and Middle Palaeolithic date known from Staffordshire[25], reflecting the general paucity of Palaeolithic material recovered from the region in general.

5.1.9 As mentioned previously, a combination of taphonomic factors and use of non-flint resources may be important considerations in understanding the Lower and Middle Palaeolithic potential of the region. Any finds and environmental material will therefore be highly significant, particularly within the context of current research strategies regarding the occupation and recolonization of Britain and the West Midlands region over the course of the Palaeolithic.

5.1.10 Pleistocene river terrace deposits may yield archaeological and associated environmental material of Lower and Middle Palaeolithic date, although the Pleistocene sequence is relatively modest with typically no more than two terraces in the Upper Trent and no known in situ, stratified Palaeolithic contexts from the Trent Valley as a whole.

5.1.11 Finding Upper Palaeolithic material presents a challenge equal to the Lower and Middle Palaeolithic, primarily because of the advance of the Devensian ice sheet from approximately 30,000 – 15,000 years BP. Currently the only sites with Upper Palaeolithic material derive from cave deposits within the Peak District. Any assessment of the potential for Upper Palaeolithic finds from within the land required for the Proposed Scheme depends on an understanding how far south the Late Glacial ice sheet extended.

5.1.12 However, the low overall quantities of Palaeolithic find spots known from the region are unlikely to represent an accurate picture of the distribution and intensity of past human activity. Compared to other regions with richer Palaeolithic collections, the North-West region has seen far fewer amateurs searching for and reporting Palaeolithic find spots, with the small number of artefacts from Staffordshire cave sites likely to be a product of chance discovery rather than deliberate investigation.

5.1.13 In rare cases, organic deposits of Ipswichian (last) interglacial, Middle Devensian and Late Devensian (Windermere Interstadial) date may be preserved within scour hollows or preserved below till and outwash sands and gravels. Where preserved they have the potential to produce nationally important records of climate and environmental change and may reveal evidence of human activity; the latter is relevant in view of the current absence of artefactual evidence for a Palaeolithic human presence in the area.

5.1.14 The focus of Holocene palaeoenvironmental work within the North-West region has tended to be on early Holocene, upland contexts, and as a consequence there is far less understanding of the environmental context of human activity within lowland landscapes during prehistory despite the lowlands often forming key elements of hunter gatherer and transhumance models. A greater focus on suitable lowland contexts, including riverine alluvium, peat and buried soils potentially preserved below

[25] Bridgland et al (2014)

archaeological sites, could provide a new perspective on prehistoric communities within the lowland landscapes of the Upper Trent and adjoining landscapes.

5.1.15 The river terraces of the region have provided a topographic template for human activity over at least the 10,000 years, and therefore have the potential to preserve a palimpsest of multi-period archaeological remains extending back in places to the Upper Palaeolithic.

5.1.16 Research strategies for the Mesolithic of the West Midlands[26] are largely focused on the analysis of lithic assemblages, with less consideration of the role geoarchaeology can play in providing a critical environmental context for the post-glacial hunter-gatherer occupation of the region, and the transition between hunter-gathering and farming lifestyles at the Mesolithic-Neolithic transition.

5.1.17 Two early Neolithic causewayed enclosures are located at Alrewas and Mavesyn Ridware, the latter associated with a possible cursus monument. Both are on low gravel ridges close to the River Trent and less than 2km and 1km respectively from the route of the Proposed Scheme. Along with the significant ceremonial complex nearby at Catholme[27], which is located at the confluence of the River Trent, River Tame and River Mease approximately 5km north-east of the connection of the HS2 Phase One with the Proposed Scheme on the Pyford South embankment, they suggest that the riverine landscape and in particular confluence zones, were an important focus for activity during the Neolithic and Bronze Age and very likely prior to this.

5.1.18 Archaeological works throughout the Trent Valley also emphasise the importance of the landscapes at the confluence of rivers, as in the case of the aforementioned Catholme. Consequently, both the Pleistocene terrace gravels and Holocene alluvium, and the landscape near the confluence of the River Trent and River Sow, have a high potential for the recovery of multi-period prehistoric remains, both structural and artefactual.

5.1.19 Deposits of Holocene alluvium, peat and buried soils offer the opportunity to provide a clear environmental context for the Neolithic monumental landscape of the area that has thus far been lacking, but may also mask remains, making them invisible to some traditional methodologies of geoprospection (e.g. air photography, field-walking).

5.1.20 An environmental context is similarly lacking for the Bronze and Iron Ages. There is a notable increase in the number and distribution of round barrows, which suggests a significant opening up of the landscape. Field-systems and evidence for land-division may become apparent in low-lying riverine areas along the route of the Proposed Scheme, though these are likely to cover a broad date range from the Bronze Age onwards. Iron Age land division has certainly been recognized at Fisherwick, close to Catholme[28].

[26] Myers, A.M. (2007), The Upper Palaeolithic and Mesolithic archaeology of the West Midlands, in Garwood, P (ed.) *The Undiscovered country, the early prehistory of the West Midlands,* Oxford, Oxbow, 23-38

[27] Chapman, H.P., Hewson, M. and Watters, M.S. (2010), *The Catholme ceremonial complex, Staffordshire, UK*, Proceedings of the Prehistoric Society 76, 135-163

[28] Greig, J., Osborne, P.J., Smith, C. and Williams, P. (1979), *Part IV – The landscape of the Fisherwick area during the Iron Age,* in C. Smith (Ed.), Fisherwick: The reconstruction of an Iron Age landscape (pp. 93-103), BAR British Series 61

5.1.21 The Romano-British period represents a significant change in the ownership, organisation and administration of the landscape and the development of a complex relationship between town and countryside. Although the route does not pass close to any significant Roman sites (e.g. towns, villas, forts) new questions can nevertheless be asked about the impact of military, industrial and urban activity on the rural landscape.

5.1.22 The route traverses well-defined historic landscapes, including areas with medieval and post-medieval water meadows. There has been little application of geoarchaeological analysis to medieval and post-medieval contexts and any suitable deposits provide a significant opportunity to investigate patterns of historic land-use and the development of rural landscapes, and in particular, to understand the links between rural and urban environments.

5.1.23 Increased flooding and large-scale channel migration has been recorded within the Middle Trent during the medieval period[29], but there is no indication as yet that this occurred or had a major effect on riverine geomorphology within the Upper Trent.

5.2 Broad research themes

5.2.1 The broad research themes can be summarised as follows:

- Quaternary (Pleistocene and Holocene) landscapes and environments: geomorphology, vegetation history and climate change;
- human modification of the landscape: the creation of monumental, ritual and agricultural landscapes;
- land-use and subsistence strategies;
- the environmental context of historic landscapes, from the Romano-British to Industrial Revolution; and
- linking rural and urban environments.

5.3 Broad period division

5.3.1 The broad period divisions as follows:

- Pleistocene and early Holocene hunter-gatherers (≥ 4000BC);
- early agriculturalists and monumental landscapes (4000BC – 2000BC);
- later prehistoric farming communities (2000BC – AD43);
- urban and rural landscapes (AD43 – AD1760); and
- industrial and modern landscapes (AD1760 – AD1945).

[29] Brown, A.G., Cooper, L., Salisbury, C.R. and Smith, D.N. (2001), *Late Holocene channel changes of the Middle Trent: channel response to a thousand-year flood record*, Geomorphology 39, 69-82

5.4 Research questions

5.4.1 More specific route-wide research questions including the following:

- what is the geoarchaeological potential of the Quaternary sediments preserved along the route of the Proposed Scheme;
- what range of archaeology and human activities is preserved, what is the sedimentary context and relationship;
- what is the chronostratigraphic framework of the study area and how does this impact on preservation and visibility of the cultural and environmental record;
- how has the natural landscape (i.e. physical, vegetation, and climate) evolved over the course of the Quaternary and how has this affected and presented opportunities for human communities;
- what role can the geoarchaeological resource play in forwarding Palaeolithic research agendas for the West Midlands region, specifically relating to the chronology and environmental context of human occupation and recolonization over the course of the Palaeolithic;
- what is the date, extent and character of Mesolithic occupation, subsistence and environmental manipulation within lowland landscapes in the West Midlands;
- define the development of agricultural landscapes over the course of prehistoric and historic periods;
- define an environmental context for prehistoric monumental/ritual/funerary landscapes;
- what is the wider landscape impact of military, industrial and urban activity during the Romano-British period;
- what role can geoarchaeology play in understanding the early medieval landscape;
- what was the impact of industrialisation and urban development on the post-medieval landscape; and
- determine whether statistical programs (e.g. landscape reconstruction algorithm) can be applied to modelling palaeoenvironmental data and past vegetation and land-use.

6 Geoarchaeological landscape characterisation

6.1 Introduction

6.1.1 The route of the Proposed Scheme has been divided into 42 separate zones, termed GCZ, in order to identify, classify and describe variations in the key geological and landform units that make up the landscape within the study area (Figures 3 - 5). The GLC works on the same principals as a Historic Landscape Characterisation[30] and Landscape Character Assessment[31], but in this case largely considers the shallow buried and outcropping superficial geological elements of this landscape.

6.1.2 The GLC is critical to providing an appropriate baseline in order to more precisely identify the specific geoarchaeological potential of the route at a scale that can most effectively inform future decision making, management and mitigation of impact to the buried historic resource.

6.1.3 The geoarchaeological potential of the proposed route has already been considered at a broad scale in Section 4, and builds upon the overviews of geology, topography and landform undertaken for each of the five community areas.

6.1.4 The GLC breaks this down into defined zones based primarily on variation in geological characteristics, but considers the following criteria, detailed below and in the accompanying Table 1, comprising:

- solid and superficial geology;
- principal soil types; and
- landform elements.

6.1.5 The superficial geological component of the GCZ are considered to be of primary importance and cannot take account at this stage the potential for archaeological excavation to reveal features containing deposits of geoarchaeological interest (e.g. ditches fills, wells etc.).

[30] English Heritage (2004), *Using historic landscape characterisation,* English Heritage and Lancashire County Council, https://content.historicengland.org.uk/images-books/publications/using-historic-landscape-characterisation/using-historic-landscape-characterisation2004.pdf/

[31] Natural England (2014), *An approach to landscape character assessment,* https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/396192/landscape-character-assessment.pdf

Table 1: Geoarchaeology Landscape Characterisation, listing the key geological, soil and landform characteristics for each GCZ. Fm = Formation

GCZ	Superficial geology						Solid Geology	Principal soil-types (see note at end of table)	Landform
	River terrace deposits	Fluvio-glacial sands and gravels	Till	Head	Alluvium	Peat / organics			
1	X						Mercia mudstone	1 + 2	Trent and Mersey Canal
2					X		Mercia mudstone	1 + 2	Pyford Brook
3	X						Mercia mudstone	1 + 2	Trent and Mersey Canal
4	X				X		Mercia mudstone	1 + 2 + 3	Bourne Brook and Trent and Mersey Canal
5	X						Mercia mudstone	2 + 3	Crawley Brook
6					X		Mercia mudstone	4	
7	X						Mercia mudstone	5	River Trent
8			X				Mercia mudstone	6	
9			X				Mercia mudstone and Bromsgrove Sandstone Fm.	5 + 7	
10			X				Mercia mudstone	4 + 6 + 7	
11					X		Mercia mudstone	4	Moreton Brook

GCZ	Superficial geology						Solid Geology	Principal soil-types (see note at end of table)	Landform
	River terrace deposits	Fluvio-glacial sands and gravels	Till	Head	Alluvium	Peat / organics			
12					X		Mercia mudstone	4 + 6	Moreton Brook
13					X		Mercia mudstone	4	Moreton Brook
14			X				Mercia mudstone	6	
15	X						Mercia mudstone	5	
16					X		Mercia mudstone	4	River Trent and Trent and Mersey Canal
17	X						Mercia mudstone	5	
18							Mercia mudstone	6	
19			X				Bromsgrove Sandstone Fm. and Kidderminster Fm.	5 + 6	
20			X				Mercia mudstone	6	
21			X				Mercia mudstone	6 + 7	
22			X				Stafford Halite Member	6	
23			X				Mercia mudstone	6	

GCZ	Superficial geology						Solid Geology	Principal soil-types (see note at end of table)	Landform
	River terrace deposits	Fluvio-glacial sands and gravels	Till	Head	Alluvium	Peat / organics			
24					X		Mercia mudstone	6	Filly Brook
25		X			X		Mercia mudstone	6 + 8	
26			X	X			Bromsgrove Sandstone Fm. and Kidderminster Fm. and Tarporley Siltstone Fm. and Wildmoor Sandstone Fm.	2 + 5 + 9	
27			X	X			Kidderminster Fm. and Butterton Sandstone Beds	2 + 5	
28			X				Wildmoor Sandstone Fm.	2 + 9	
29	X				X	X	Wildmoor Sandstone Fm.	2 + 4 + 5 + 10	
30							Wildmoor Sandstone Fm.	2 + 9	
31							Kidderminster Fm.	6 + 9	
32			X			X	Salop Fm	6 + 10	
33		X	X		X		Halesowen Fm. and Butterton Sandstone Beds	2 + 6 + 10	River Lea

GCZ	Superficial geology						Solid Geology	Principal soil-types (see note at end of table)	Landform
	River terrace deposits	Fluvio-glacial sands and gravels	Till	Head	Alluvium	Peat / organics			
34		X	X				Chester Pebble Bed Fm.	2 + 7	
35	X	X	X		X		Sidmouth Mudstone Fm.	5 + 7	River Lea, Checkley Brook
36		X	X			X	Sidmouth Mudstone Fm.	5 + 7	
37		X	X			X	Wilkesley Halite Member	5 + 7	
38		X			X		Wilkesley Halite Member	1 + 2	Swill Brook, Basford Brook
39		X			X		Sidmouth Mudstone Fm.	1 + 2	Swill Brook, Basford Brook
40			X				Sidmouth Mudstone Fm.	2 + 7	
41	X				X		Sidmouth Mudstone Fm.	7	Basford Brook
42			X				Sidmouth Mudstone Fm.	7 + 11	

Note: Soil types[32]: 1) naturally wet very acid sandy and loamy soils; 2) freely draining slightly acid sandy soils; 3) loamy soils with naturally high groundwater content; 4) loamy and clayey floodplain soils with natural high groundwater; 5) freely draining slightly acid loamy soils; 6) slightly acid loamy and clayey soils with impeded drainage; 7) slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils; 8) loamy soils with naturally high groundwater; 9) freely draining very acid sandy and loamy soils; 10) fen peat soils; and 11) urban area.

[32] Cranfield University (2016), *The Soils Guide*, Cranfield University, UK, www.landis.org.uk

6.2 Fradley to Colton area (Figure 3)

6.2.1 GCZ1: The superficial geology is classified by BGS as Mid-Pleistocene glaciofluvial sheet deposits comprising sands and gravels. These appear most likely to represent Pleistocene river terrace deposits associated with the River Trent. The sediments are of high geoarchaeological significance with the potential to reveal stratified sedimentary sequences with associated archaeological and environmental remains of Palaeolithic date. The river gravels themselves may contain artefactual and faunal remains, and although of an unstratified nature, they are nonetheless useful in establishing a chronostratigraphic framework for the sediments. Debate over the precise southern extent of the Devensian ice sheet also raises the possibility for the survival of sediments dating to the end of the Anglian glaciation (approximately 450,000 years BP). River terraces are also preferred locations for prehistoric and later settlement so there is a high likelihood for survival of multi-period archaeological sites.

6.2.2 GCZ2: This zone comprises a thin lateral spread of alluvium associated with the course of the Pyford Brook, cutting north-south through the Pleistocene sands and gravels. The course of the Pyford Brook subsequently heads east, but appears heavily canalised. Interestingly there are no indications that the alluvium extends through the adjacent deposits of river terrace gravels. It is uncertain if this suggests the course of Pyford Brook through GCZ2 represents part of the pre-Devensian palaeodrainage, or that later canalisation of the course has removed evidence of former alluvial deposits. Deposits of alluvium are relatively modest in extent, but may contain preserved waterlogged archaeology or sediment sequences of palaeoenvironmental significance.

6.2.3 GCZ3: The superficial geology comprises river terrace gravels (i.e. largely sands and gravels) associated with the River Trent, and are likely to date to the last Cold Stage (Devensian). The deposits may contain unstratified artefacts and faunal material dating to the middle and late Palaeolithic, but there is also the possibility of organic rich sediments of last interglacial or interstadial date stratified within the terrace deposits. Similar to GCZ1, there is a high likelihood for the survival of multi-period archaeological sites located on the slightly raised terraces, and the sandy nature of the soils will prove suitable for geophysical survey.

6.2.4 GCZ4: The superficial deposits within this zone comprise alluvium and Pleistocene river terrace deposits. The former is represented by a thin lateral spread of alluvium associated with the course of the Bourne Brook, a minor tributary of the River Trent, which cuts through the mid-Pleistocene fluvioglacial sands and gravels. The alluvium may contain preserved archaeological structures and deposits of palaeoenvironmental interest, with the adjoining river terrace deposits potentially containing both unstratified artefacts and ecofacts, or sealing stratified organic deposits of late or pre-Devensian date.

6.2.5 GCZ5: This zone comprises Pleistocene river terrace deposits associated with the River Trent. These deposits are mapped along the Trent valley at altitudinally low levels and are likely to date to the most recent Devensian glacial stage. The deposits may contain unstratified artefactual and faunal material or preserve stratified organic horizons of late Devensian or earlier date, both of geoarchaeology and geochronological significance. The terraces are also likely to have been a focus for

later activity and may contain multi-period archaeological sites detectable through geophysical survey. A Neolithic causewayed enclosure is located less than 1km west of the route of the Proposed Scheme, situated on the River terrace deposits of the River Trent at Mavesyn Ridware, along with two nearby Bronze Age round barrows.

6.2.6 GCZ6: Superficial deposits comprise Holocene alluvium associated with the course of the River Trent. The floodplain alluvium may contain preserved waterlogged archaeology or seal buried land surfaces containing archaeology. The wetland edge and adjoining dry ground is typically a focus for human activity and is likely to be a key area for preservation of archaeological remains. Holocene alluvial sediments may also contain interbedded peat deposits that can provide a key environmental and landscape context for human activity. There are no indications of palaeochannels preserved along this portion of the route of the River Trent, but their preservation is likely to represent a key context for the preservation of archaeological and palaeoenvironmental remains. There is a possibility the alluvium of the floodplain may mask archaeological sites not detectable through geophysical survey.

6.2.7 GCZ7: Pleistocene River terrace deposits are distributed along the northern Banks of the River Trent from the confluence of the River Blithe to Hill Ridware. The deposits are not as spatially extensive as those to the immediate south of the River Trent, and there is no indication currently if these deposits include more than one terrace deposit dating to the most recent Devensian Ice Age. Similar to GCZ5, the deposits may contain unstratified artefactual and faunal remains, or may seal stratified organic deposits of Late Devensian interstadial, or earlier date, of both archaeological and geoarchaeological significance. Moreover, as previously emphasised, the slightly raised terrace deposits adjacent to the River Trent are likely to have been favoured as locations for settlements and may contain multi-period archaeological sites detectable through geophysical survey.

6.2.8 GCZ8: This zone largely comprises slightly acid loamy and clayey soils developed on Mercia Mudstone solid geology. Superficial Quaternary sediments are relatively sparse within this zone, comprising till deposits confined to the northern edge of the study area. The tills are of little direct archaeological or geoarchaeological significance, but may seal and preserve underlying stratigraphy. Although the majority of the superficial sediments along the route corridor are likely to date to the most recent Devensian glaciation, debate over the exact southern extent of the Devensian ice sheet raises the possibility that some of the till deposits could date to earlier cold stages. Any preserved underlying stratigraphy will be significant in refining chronostratigraphic frameworks for glacial cycles in the region, with the possibility that these deposits may contain preserved Palaeolithic archaeology and associated palaeoenvironmental data.

6.2.9 GCZ9: Superficial deposits within this zone are similar to GCZ8, with roughly half the zone covered by till. The other half of the zone has no recorded superficial deposits, with topsoil on bedrock comprising freely draining slightly acidic soils on Bromsgrove Sandstone Formation, with slightly acid base-rich loamy and clayey soils developed on areas of Mercia Mudstone. Areas with till, as stated for GCZ8, may date to the Devensian or earlier cold stages. They are significant primarily for their potential to seal stratified interglacial or interstadial sediments that where highly organic in nature are geoarchaeologically significant, and may contain Palaeolithic archaeological remains.

6.2.10 GCZ10: This zone comprises a mixture of areas lacking superficial deposits with loamy and clayey soils developed on Mercia Mudstone, and areas with till deposits of archaeological and geoarchaeological significance comparable to GCZ8 and GCZ9.

6.2.11 GCZ11: This zone comprises a thin lateral extent of alluvium associated with the Moreton Brook running from south to north across the proposed route. The alluvium has potential to contain stratified waterlogged archaeology and may contain interbedded organic horizons (i.e. peat) of high geoarchaeological potential.

6.2.12 GCZ12: The majority of this zone contains no superficial deposits, with slightly acid loamy and clayey soils developed on Mercia Mudstone. A small area of alluvium is present along the southern edge of the proposed route, associated with the course of Moreton Brook, and has a geoarchaeological potential similar to GCZ11. The alluvium is sufficient in extent that it may locally mask archaeological sites.

6.3 Fradley to Colton area and Colwich to Yarlet area (Figure 3)

6.3.1 GCZ13: This zone comprises Holocene alluvium associated with the course of the Moreton Brook. The preservation potential for waterlogged archaeology and stratified organic deposits of high geoarchaeological potential is considered of similar likelihood to other GCZ containing alluvium.

6.3.2 GCZ14: Extending between the courses of the Moreton Brook and River Trent, this zone includes patches of till that, similar other GCZ comprises till, may seal underlying stratigraphy of geoarchaeological significance with the added possibility of retrieving Palaeolithic artefacts. However, the majority of the zone has limited or no geoarchaeological potential, with no recorded superficial deposits and instead a cover of slightly acidic loamy and clayey soils developed on the Mercia Mudstone bedrock.

6.4 Colwich to Yarlet area (Figures 3 and 4)

6.4.1 GCZ15: The proposed route runs to the north of Great Haywood where Pleistocene river terrace deposits are recorded associated with the course of the River Trent. The terrace deposits are relatively modest and are likely to date to the most recent (Devensian) cold stage. Nonetheless, the terrace deposits offer the potential for the recovery of unstratified Palaeolithic artefacts and associated faunal remains, and may also preserve stratified geoarchaeologically significant organic horizons of Devensian interstadial or earlier date. Similar to other terrace formations, they are likely to have been preferred locals for settlement and associated human activity, and may contain multi-period archaeological sites detectable through geophysical and/or aerial survey.

6.4.2 GCZ16: North of Great Haywood the proposed route makes a second crossing of the River Trent, with this zone comprising Holocene floodplain alluvium. Again, similar to other GCZ containing alluvium, there is similar potential to preserve waterlogged archaeology and organic deposits of geoarchaeological significance. The zone is located to the north of the Great Haywood and Shugborough Conservation Area that includes important archaeological and historic landscape components. Any environmental data from within this zone can therefore play an important role in providing a broader palaeoenvironmental context for this landscape. Pastureland is noted along the River Trent to the north of this zone, and it is possible that features related to agricultural use and modification of the floodplain may be preserved. The proposed route also crosses the line of the Trent and Mersey canal.

6.4.3 GCZ17: This zone comprises Pleistocene river terrace deposits associated with the course of the River Trent directly comparable with terrace deposits along the opposite bank in GCZ15. The deposits are likewise considered to be Devensian in date, and similarly may contain unstratified Palaeolithic archaeology and faunal material, or contain stratified organic horizons of high geoarchaeological significance.

6.4.4 GCZ18: No superficial deposits are recorded from this zone, with slightly acid loamy and clayey soils covering the Mercia Mudstone solid geology. This zone therefore has limited or no geoarchaeological potential.

6.4.5 GCZ19: This zone is largely devoid of superficial deposits apart from a small area of till adjacent to the A518 Weston Road north-east of Stafford. The zone therefore has little geoarchaeological potential other than the till that might seal organic layers of geoarchaeological potential.

6.4.6 GCZ20: Superficial deposits comprising fluvioglacial sands and gravels and till outcrop within the southern half of this zone, forming the northern extent of a large deposit of Pleistocene and Holocene sediments concentrated in and around Stafford. Neither sediment type has direct geoarchaeological potential, but may seal important stratified organic layers of geoarchaeological significance. Importantly, the Kings Pool is located only approximately 2km to the south of the route of the Proposed Scheme, where an earlier study identified a 21m deep sequence of organic sediments extending back to the late Windermere Interstadial[33].

6.4.7 GCZ21: Broadly extending between the lines of the B5066 Sandon Road to the A34 Stone Road north of Stafford, this zone is comprised largely of slightly acid loamy and clayey soils developed on Mercia Mudstone, with relatively small patches of till around Yarlet. The geoarchaeological potential of the till has already been well-emphasised, although the remainder of the zone has limited or no geoarchaeological potential.

6.5 Colwich to Yarlet area and Stone and Swynnerton area (Figures 3 and 4)

6.5.1 GCZ22: This zone is largely devoid of superficial geology except for a small patch of till with very similar geoarchaeological potential to the previous zone.

6.5.2 GCZ23: Extending north to the Filly Brook, this zone contains only small areas with till deposits along the fringe of the proposed route, with the majority of the zone containing no superficial deposits with loamy and clayey soils covering the Mercia Mudstone solid geology. The zone therefore has very limited geoarchaeological potential except that related to deposits of till to the south-west of Stone.

6.6 Stone and Swynnerton area (Figure 4)

6.6.1 GCZ24: This zone comprises deposits of Holocene alluvium associated with the course of the Filly Brook, a tributary of the River Trent, running south-west from Stone before heading to the north-east. The deposits are relatively modest in extent, but nonetheless may contain preserved waterlogged archaeology and/or organic deposits of geoarchaeological significance. The remainder of the zone is devoid of superficial deposits, with the soil cover instead developed on Mercia Mudstone Bedrock.

[33] Bartley and Morgan (1990)

6.6.2 GCZ25: Holocene alluvium associated with the course of the Filly Brook, along with fluvioglacial sands and gravels, occur within the central part of this zone. These superficial deposits have a well-established potential for either preserving or sealing organic deposit of possible geoarchaeological significance. The remainder of the zone is of limited or no geoarchaeological potential, with no surviving recorded superficial deposits.

6.6.3 GCZ26: This zone is largely devoid of superficial deposits apart from the northern end of the zone where there are deposits of till and head; the former sediment is defined as poorly sorted slope deposits, typically comprising gravels and sands, although they can locally include lenses of silt, clay or even peat.

6.6.4 GCZ27: This zone is similar to zone GCZ26, with outcrops of head and till, along the line of the A51 Stone Road, of well-established geoarchaeological potential, with the remainder of the zone containing no recorded superficial deposits.

6.6.5 GCZ28: This zone includes large areas with no recorded superficial deposits, but with deposits of till located to the south of Swynnerton Old Park near Beech. In addition, BGS records laterally restricted deposits of alluvium that relate to a former tributary of the Meece Brook, running parallel to Common Lane from the Hattons. Although the alluvium may preserve waterlogged archaeological remains and/or organic deposits, the possible extinct nature of the water course and restricted extent of the alluvium may limit their preservation and extent.

6.7 Stone and Swynnerton area and Whitmore Heath to Madeley area (Figure 5)

6.7.1 GCZ29: This zone comprises deposits of alluvium associated with the Meece Brook, with river terrace deposits distributed along the eastern bank, and a small deposit of peat on the western bank. The peat deposit may reflect part of the sequence of Holocene alluvial deposits preserved within the floodplain, perhaps within palaeochannel features, or infilling the natural topography adjacent to the floodplain. The peat and alluvium may preserve waterlogged archaeology and are likely to contain a range of palaeoenvironmental remains of high geoarchaeological potential. The river terrace deposits are laterally restricted, but in common with similar deposits other areas, may contain unstratified artefacts and ecofacts of Palaeolithic date, or seal stratified organic deposits of geoarchaeological significance.

6.8 Whitmore Heath to Madeley area (Figure 5)

6.8.1 GCZ30: There are no superficial deposits recorded from this zone. The geoarchaeological potential of this zone is therefore considered negligible.

6.8.2 GCZ31: There are no superficial deposits recorded from this zone. The geoarchaeological potential of this zone is therefore considered negligible.

6.8.3 GCZ32: This zone includes extensive deposits of till and organic sediments extending north-west from Baldwin's Gate along the length of the zone. The organic sediments are likely to include peat deposits, infilling a possible former palaeolake of approximately 2km length by 400m width at maximum extent. The organic sediments have high potential for the recovery of waterlogged archaeological remains, dependent on the existing conditions of preservation, along with recovery of

sediments preserving a range of palaeoenvironmental proxies useful for providing a wider landscape context for any associated archaeology.

6.8.4 GCZ33: Superficial deposits comprise till, fluvioglacial sands and gravels, and alluvium associated with the course of the River Lea. The till and fluvioglacial sands and gravels are most likely Devensian in date, and although of little direct relevance, may seal geoarchaeological significant organic deposits of late Devensian interstadial or earlier date. The alluvium is relatively restricted in extent, only occurring along the northern fringe of the zone, although there is a still a possibility it may preserve waterlogged archaeological remains or preserve organic deposits of geoarchaeological significance. Roughly half the zone contains no recorded superficial deposits.

6.8.5 GCZ34: Till deposits comprise the majority of the superficial deposits in this zone, along with more modest fluvioglacial sands and gravels. Again, as with other areas with similar sediments, their geoarchaeological value rests on the possibility they may seal organic deposits of late Devensian or earlier date.

6.9 Whitmore Heath to Madeley area and South Cheshire area (Figure 5)

6.9.1 GCZ35: This zone comprises till, fluvioglacial sands, Pleistocene river terrace deposits and Holocene alluvium, the latter two associated with the courses and confluence of the River Lea and the Checkley Brook. The Pleistocene river terrace deposits are relatively modest in extent, and along with the till and fluvioglacial sands and gravels, most probably date to the Late Devensian. In all three cases, there is a possibility that these sediments may seal organic sediments of geoarchaeological significance, with the additional possibility that the river terrace gravels may yield unstratified Palaeolithic artefacts and ecofacts. The alluvium of the River Lea is relatively limited in lateral extent, with more substantial deposits associated with the Checkley Brook. Both deposits of alluvium may present conditions for the preservation of waterlogged archaeology and organic sediments of high geoarchaeological potential.

6.10 South Cheshire area (Figure 5)

6.10.1 GCZ36: The majority of this zone comprises till and fluvioglacial sands and gravels of Devensian age with an already well-established potential to seal geoarchaeologically important organic deposits of Late Devensian or earlier date. In addition to deposits of till and fluvioglacial sediments, BGS records a defined deposit of peat located approximately 250m south-west of Higher Den Farm. The deposit is approximately 300m in length by 50m in width and is likely to either infill a small former small palaeolake or kettle hole. The peat, dependent on local conditions of preservation, may contain waterlogged archaeological remains and other non-organic artefacts, whilst the sediment itself is geoarchaeologically significant as a means of providing a broader environmental context for any archaeologically documented occupation of the surrounding landscape. Additionally, any organic sediments of Holocene date may seal organic deposits of Late Devensian interstadial date.

6.10.2 GCZ37: This zone extends to Chorlton and, like GCZ36, includes extensive deposits of till and fluvioglacial sands and gravels with a defined deposit of organic sediments (approximately 400m by 300m in maximum extent) located to the south-west of Chorlton, again either infilling a former kettle hole or small palaeolake. These deposits

of sediment are considered to be of high geoarchaeological significance, as emphasised for previous zones with similar sediment types.

6.10.3 GCZ38: Fluvioglacial sands and gravels comprise the majority of the superficial deposits within this zone, with more modest deposits of alluvium associated with Swill Brook and Basford Brook running along the western and eastern edges of the zone respectively. The fluvioglacial sands and gravels date to the Late Devensian and have little direct potential, but may seal underlying stratigraphy of geoarchaeological relevance. The alluvium is relatively restricted but may contain waterlogged archaeological material or organic sediments of high geoarchaeological potential.

6.10.4 GCZ39: This zone is similar to GCZ38, largely comprising fluvioglacial sands and gravels and alluvium of the Basford Brook, with small deposits of till at the northern edge of the zone. These deposits have a similar geoarchaeological potential to those from GCZ38.

6.10.5 GCZ40: Located to the south of Crewe, this zone comprises till deposits laid directly by the Late Devensian ice sheet. As previously stated, the tills have little direct archaeological value beyond the possibility of sealing organic deposits of potential geoarchaeological significance.

6.10.6 GCZ41: This zone comprises the continued course of the Basford Brook, and as with other deposits of Holocene alluvium, may contain preserved waterlogged archaeology and other artefacts or preserve organic sediments of high geoarchaeological significance. Very minor deposits of river terrace deposits are present, with the potential to produce unstratified Palaeolithic artefacts and ecofacts, or seal earlier stratigraphy of geoarchaeological potential.

6.10.7 GCZ42: The final zone of the proposed route is composed entirely of till deposits, similar to GCZ40 and can be considered to have similar value with the potential of sealing Devensian or earlier sediments of possible geoarchaeological significance.

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Annex A
Further examination of key areas

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1 Introduction

1.1.1 The Geoarchaeology Desk Based Assessment (GDBA) identified deposits and landscape features along the proposed route that have an as-yet poorly defined potential in terms of archaeological, geoarchaeological and palaeoenvironmental remains. The GDBA further attempted to characterise specific areas of the route in geoarchaeological terms, and these areas were termed Geoarchaeological Character Zones (GCZ). These zones are used to inform this report.

1.1.2 This annex details the results of desk-based geoarchaeological works designed to enhance understanding of the archaeological risk to the project that these deposits represent, in order to facilitate the design of an appropriate evaluation and mitigations strategy. Risk is here defined as the potential for unexpected geoarchaeological deposits or archaeological remains to impose constraints or delays on the development/construction programme.

2 Aims and Objectives

2.1.1 The aims of the preliminary geoarchaeological investigation are to:

- ascertain the extent, depth, and nature of key superficial geological deposits and landscape features;
- determine the geoarchaeological potential of the landscape within the boundaries of seven borrow pits;
- establish the likely periods and environment types represented; and
- refine research questions if appropriate.

2.1.2 In order to achieve these aims, the following objectives have been identified:

- deposit modelling of all fourteen areas of alluvium, using existing BGS and site investigation geological data;
- deposit modelling of the Madeley palaeolake (CA4, GCZ32);
- deposit modelling of periglacial landform features such as potential kettle holes;
- assessment of light detection and ranging (LiDAR) and aerial imagery along the fourteen areas of alluvium to determine the presence/absence of potential palaeochannels not recorded by BGS mapping; and
- assessment of LiDAR and aerial imagery along the route within the Whitmore Heath to Madeley area and the South Cheshire area to identify potential periglacial and fluvial landform features not mapped by BGS.

3 Methods

3.1 Deposit modelling

3.1.1 Deposit modelling is required to map the lateral extent and depth of alluvium crossing the route of the Proposed Scheme (Figure 1). Each of the fourteen areas of alluvium is contained within a GCZ established during the GDBA.

3.1.2 Deposit records were entered into an industry standard software package (Rockworks™ v17.0). Each lithological unit (e.g. peat, alluvium) was given a colour and pattern allowing cross correlation and grouping of the different sediment and soil types. The grouping of these deposits is based on the lithological descriptions, which define distinct depositional environments.

3.1.3 Where suitable contexts were present a sequence of stratigraphic units representing certain depositional environments and/or landforms were reconstructed both laterally and through time. These were then displayed in the form of Digital Elevation Models (DEM), thickness plots or transects.

3.1.4 Borehole data were obtained from 3rd party ground investigation logs and each borehole assigned a reference number for the purpose of the assessment (e.g. borehole SK11SW297). The data considered most suitable and representative for modelling were selected to produce transects across the GCZ. It was not always possible to use boreholes from within the river floodplains, either because none were available or the data were unsuitable for confident interpretation. In those cases, suitable data were selected from outside the GCZ to build up a picture of the surrounding solid and superficial geology. This was considered an appropriate strategy to identify those rivers for which detailed information was lacking on the depth and extent of riverine sediments.

3.2 LiDAR and aerial imagery

3.2.1 LiDAR coverage of the route of the Proposed Scheme was visually inspected for signs of palaeochannels, palaeolakes and periglacial landform features. This used the 20cm horizontal cell resolution LiDAR coverage. This was captured during a series of flights between June and July 2014 specifically for the purpose of informing the design and EIA process for HS2 Phase 2a (West Midlands – Crewe). The LiDAR data is contained within the 250m buffer extending from the route of the Proposed Scheme and provides a broader landscape context for features crossing the proposed route. Inspection of the LiDAR data was restricted to the fourteen river crossings and to the Whitmore Heath to Madeley area and South Cheshire area. Shaded relief (also termed 'hillshade') was used to aid in visualisation of the data. Aerial imagery and historic maps were examined in ArcGIS to determine the surface visibility of features identified by LiDAR and deposit modelling.

4 Key Deposit and landform types

4.1 Alluvium

4.1.1 Alluvium is a generalised term used to cover unconsolidated sediments transported by water in a non-marine environment. Although any sediment transported by water is technically classed as alluvium, the term is here applied to fine-grained sediments of Holocene date. Alluvium is a key context for the preservation of sensitive waterlogged archaeology and associated palaeoenvironmental remains; both critical for understanding the physical evolution of the landscape and its exploitation by past human communities.

4.1.2 Alluvium is present in fourteen locations along the route of the Proposed Scheme, including crossings of the River Trent and River Lea and eight brooks. Although BGS have mapped the lateral extent of alluvium, currently there is a lack of detailed information about the depth and likely date of alluvium. For example, higher energy fluvial systems such as the Upper Trent may result in laterally constrained but more deeply incised river valleys containing significant depths of alluvium.

4.2 Palaeochannels

4.2.1 Palaeochannels are the former courses of rivers that have infilled with sediment, typically alluvium and peat, and ceased to be active channel courses. They act as traps preserving artefacts and ecofacts and are key contexts for the preservation of waterlogged archaeology and palaeoenvironmental remains critical for understanding the physical evolution of the landscape and its exploitation by past human communities.

4.2.2 The extent and preservation of palaeochannels has not been determined in detail for the route of the Proposed Scheme. Baker[34] and Howard and Macklin[35] largely focused on the lower and middle Trent where palaeochannel preservation was thought to be higher. They indicated that palaeochannels are likely to be generally rare within the Upper Trent because of preservation factors related to the higher energy fluvial regime and constrained width of the valley floor. However, assessment of LiDAR and aerial imagery may prove successful in determining the presence/absence of palaeochannels.

4.3 Palaeolakes

4.3.1 Palaeolakes are former lakes that have subsequently infilled with sediment and ceased to be active water bodies. These lake basins may include a variety of deposits, including lacustrine sediment, peat and colluvium (i.e. slope wash from dry ground). They are key contexts for archaeological and geoarchaeological investigation, with significant potential for preserving sensitive waterlogged archaeology and palaeoenvironmental remains.

[34] Baker, S. (2007), *The palaeochannel record in the Trent Valley UK: contributions towards cultural heritage management*, Internet Archaeology 20, http://intarch.ac.uk/journal/issue20/baker_toc.html

[35] Howard, A.J. and Macklin, M.G. (1999), *A generic geomorphological approach to archaeological interpretation and prospection in British river valleys: a guide for archaeologists investigating Holocene landscape,* Antiquity 73, 527-41

4.3.2 Mapping by BGS suggests the location of one potential palaeolake to the south of Madeley, running south-east to north-west for approximately 3km along the line of the West Coast Main Line (WCML) railway from Baldwin's Gate to Hey Sprink. Whilst the lateral extent of these deposits is known, there is no detailed information on the type, depth or date. This represents a significant unknown and therefore potential risk.

4.4 Kettle holes

4.4.1 Kettle holes are water-filled hollows left when a block of ice has melted, typically associated with outwash sands and gravels and tills. Kettle holes have been shown in cases to preserve deep deposits of late glacial interstadial and Holocene deposits, the former sediment often masked by later deposits of till. Although the till and outwash sands and gravels are of limited archaeological potential, any underlying late glacial and subsequent Holocene sediments are of significant geoarchaeological potential.

4.4.2 Mapping by BGS has identified four potential targets within the Whitmore Heath to Madeley area and the South Cheshire area that may represent kettle holes, or similar periglacial/glacial features (e.g. pingos) infilled with organic sediment, and perhaps sealing late glacial deposits beneath. Nothing is known about the depth, type and date of deposits within these kettle holes, particularly the possibility that some of these features may contain sediments of late glacial date important in understanding physical, climatic and environmental change during the latter stages of the last Ice Age.

5 Deposit modelling

5.1 Introduction

5.1.1 Deposit modelling was undertaken on fourteen areas of alluvium crossing the route of the Proposed Scheme, the Madeley palaeolake (GCZ32) and three potential periglacial landform features (GCZ36 and 37).

5.2 GCZ2 (CA1, Pyford Brook)

5.2.1 Transect GCZ2 comprises three boreholes, though none were located within the alluvium of the Pyford Brook (Figure 2). No comment can be made on the depth or date of deposits of alluvium associated with the Pyford Brook. The deposit records include Triassic mudstone bedrock, with boreholes SK11SW297 and SK11SW6 including gravel and sandy gravel mapped by BGS as Pleistocene glaciofluvial sheet deposits. These deposits may represent Pleistocene river terrace deposits although in practice this is difficult to determine without the aid of exposures.

5.3 GCZ4 (CA1, Bourne Brook)

5.3.1 Transect GCZ4 comprises three boreholes, although none are located within the alluvium of the Bourne Brook. Borehole SK11Sw6 is in the adjacent GCZ3 with boreholes SK11NW12 and SK11sW6 located in GCZ5 (Figure 3). The deposits comprise Triassic mudstone bedrock overlain by Pleistocene river terrace deposits (i.e. gravels and sandy gravels) recorded at an attitudinally low level and most likely related to the last ice age (Devensian).

5.4 GCZ6 (CA1, River Trent)

5.4.1 Transect GCZ6 comprises three boreholes, one of which (SK11NW14) is located within the alluvium of the River Trent (Figure 4). Boreholes SK01NE237 and SK01NE227 are located to north-west within GCZ7. The bedrock comprises Triassic mudstone, but is overlain in SK11NW14 by sandstone of the Bromsgrove Sandstone Formation, which is also Triassic in age.

5.4.2 Bedrock is overlain by Pleistocene river terrace deposits represented by approximately 15m of gravel and sandy gravel. In borehole SK01NE237 river terrace deposits are overlain by approximately 1m of silty sand with fine gravel and wood peat inclusions, in turn overlain by a silty clay also containing peaty inclusions. There is no indication whether the peaty inclusions represent fragments of eroded or redeposited material, or defined lenses likely to have formed in-situ. Borehole SK01NE237 is located approximately 250m north-west of the floodplain of the River Trent near to an area of water meadows distributed along the River Trent from Pipe Ridware to Nethertown.

5.4.3 Although only one borehole is located within the floodplain of the River Trent (SK11NW14), a borehole approximately 200m to the west (SK01NE220) includes a 0.7m layer of peat, and highlights the potential of the River Trent floodplain to produce deposits of geoarchaeological potential.

5.5 GCZ11 and 13 (CA1, Moreton Brook)

5.5.1 The route of the Proposed Scheme makes two crossings of the Morton Brook in GCZ11 and GCZ13 (Figure 5), which are here considered together because of their proximity. Transect GCZ11/13 bisects these areas, although the four boreholes are not located within the floodplain itself (Figure 5).

5.5.2 The deposits comprise Triassic mudstone bedrock overlain by a variety of superficial deposits, including gravelly clay (borehole SK02SW13), sand and sandy gravel (borehole SK02SW15), sandy gravel (borehole SK02SW21) and clay (borehole SK02SE18). At least some of these deposits may represent glacial till or patches of fluvioglacial sand and gravel.

5.5.3 The borehole records suggest superficial deposits may be more widespread than indicated by BGS mapping, which shows little or no superficial geology other than alluvium of the Moreton Brook and small patches of till (Figure 5).

5.6 GCZ16 (CA2, River Trent)

5.6.1 Insufficient deposit records are available for GCZ16. Consequently, no additional comment can be made on the likely extent, depth and age of deposits associated with the River Trent at this location.

5.7 GCZ24 (CA3, Filly Brook)

5.7.1 Two transects are presented for the Filly Brook, the first transect GCZ24 N-S (Figure 6) running south-north roughly parallel to the course of the Filly Brook and M6 motorway, and the second transect GCZ24 E-W (Figure 7) running east-west parallel to Yarnford Lane. The two transects intersect at borehole SJ83SE92 (Figures 6 and 7).

5.7.2 Transect GCZ24 N-S comprises six boreholes with two (SJ83SE17 and SJ83SE92) located near the course of the Filly Brook (Figure 6). The bedrock is recorded as Triassic mudstones. The superficial geology comprises a variety of deposits including silty clay (borehole SJ83SE9), sand (boreholes SJ83SE110, SJ83Se102, SJ83SE92, SJ83SE17), gravelly clay (boreholes SJ83SE110, SJ83SE9 and SJ83SE70), clay (boreholes SJ83Se102, SJ83SE92, SJ83SE17 and SJ83SE70) and gravel (borehole SJ83SE17).

5.7.3 Deposit logs for boreholes SJ83SE92 and SJ83SE17 are located close to the Filly Brook, and include clay, sand and gravel deposits interpreted as alluvium (Figure 6). Clays, sands and sandy clays recorded in adjoining boreholes are interpreted as glacial till.

5.7.4 The east-west transect (Figure 7) comprises five boreholes recording deposits of sand, sandy-clay and clay, similar to transect GCZ24 N-S (Figure 6). Deposits of clay in borehole SJ83SE92 are interpreted as alluvium along with sands and clays in borehole SJ83SE91. Surrounding deposits of sand, gravelly silt and clay may represent glacial sands and gravels and tills and would imply more extensive spreads of glacial sediment than currently mapped by BGS.

5.8 GCZ29 (CA4, Meece Brook)

5.8.1 Insufficient deposit records are available for GCZ29. Consequently, no additional comment can be made on the likely extent, depth and age of deposits associated with the River Lea at this location.

5.9 GCZ32 (CA4, Whitmore trough/Madeley palaeolake)

5.9.1 Transect GCZ32 comprises ten boreholes running south to north along the northern section of a large deposit of peat mapped by BGS (Figure 8). Extending from Hey Sprink in the north to Baldwin's Gate in the south, the peat and underlying minerogenic dominated sediment represent the location of a former palaeolake. Most of the boreholes are relatively shallow at only approximately 3m depth. The deposits comprise a thin layer of peat present in seven boreholes (SJ74SE75, 73, 72, 68, 66, 63, 61), varying between approximately 0.3 and 0.9m thick (SJ74SE61), typically underlain by a combination of sand, clay, sand and gravel. Two peats layers, each approximately 0.4m thick, were recorded in borehole SJ74SE73, separated by approximately 0.5m of sandy clay. Boreholes extending to the north of the palaeolake are dominated by gravelly sand, silty sand and sandy clays most likely representing fluvioglacial sands and gravels mapped extending to the north around Madeley.

5.9.2 None of the boreholes within either the area of peat or fluvioglacial sediment were bottomed, and as such there is no indication as to the likely depth of superficial deposits overlying bedrock. However, Yates and Moseley[36] report on deposit of sand up to 11m thick around Madeley, sealed by clay and peat each up to 1.5m thick.

5.10 GCZ33 (CA4, River Lea)

5.10.1 Insufficient deposit records are available for GCZ33. Consequently, no additional comment can be made on the likely extent, depth and age of deposits associated with the River Lea at this location.

5.11 GCZ35 (CA4, River Lea and Checkley Brook)

5.11.1 Insufficient deposit records are available for GCZ35. Consequently, no additional comment can be made on the likely extent, depth and age of deposits associated with the River Lea and Checkley Brook at this location.

5.12 GCZ36 and 37 (CA5, potential kettle holes KH1 - KH3)

5.12.1 No deposit records are available for KH1 - KH3 and therefore no additional comment can be made on the extent, depth and age of deposits associated with these potential periglacial landforms.

5.13 GCZ38 (CA5, Swill and Basford Brook)

5.13.1 Insufficient deposit records are available for GCZ38. Consequently, no additional comment can be made on the likely extent, depth and age of deposits associated with either the Swill or Basford Brook at this location.

[36] Yates, E.M. and Moseley, F. (1957), *Glacial lakes and spillways in the vicinity of Madeley, north Staffordshire*, Quarterly Journal of the Geological Society 113, 409-428

5.14 GCZ39 (CA5, Basford Brook)

5.14.1 Transect GCZ39 comprises eight boreholes crossing the course of the Basford Brook along the eastern edge of GCZ39 (Figure 9). BGS map glacial till across the entire zone along with alluvium associated with the Basford Brook. The boreholes contain a range of deposits including extensive silty sands, sandy clays, sandy silts and silty clays likely to represent glacial till. Borehole SJ75SW450, located approximately 20m east of the course of the Basford Brook contains an approximately 1.3m thick peat deposit.

5.14.2 Thinner peats (i.e. less than 0.5m thick) are also recorded in boreholes to the north of the A500 (SJ75SW475, 483 and 484) adjacent to the course of the Basford Brook and suggest widespread preservation of peat within the floodplain.

5.15 GCZ41 (CA5, Basford Brook)

5.15.1 Insufficient deposit records are available for GCZ41. Consequently, no additional comment can be made on the likely extent, depth and age of deposits associated with the Checkley Brook at this location.

6 LiDAR and aerial imagery

6.1 Introduction

6.1.1 LiDAR data and aerial imagery was assessed within the 250m buffer extending from the route of the Proposed Scheme for all fourteen areas of alluvium, the Madeley palaeolake, and the Whitmore Heath to Madeley area and South Cheshire area. No evidence of palaeochannels were observed in the LiDAR or aerial imagery associated with the Pyford Brook (GCZ2), Bourne Brook (GCZ4), the first crossing of the River Trent (GCZ6), both crossings of the Moreton Brook (GCZ11 and 13), Filly Brook (GCZ24), both crossings of the River Lea (GCZ33 and 35), Checkley Brook (GCZ35), Swill Brook (GCZ38) and Basford Brook (GCZ38, 39 and 41).

6.2 GCZ16 (CA2, River Trent)

6.2.1 LiDAR data shows a clear palaeochannel associated with the River Trent located north-west of the village of Great Hayward. The palaeochannel is visible within the floodplain to the west of the current course of the River Trent approximately 250m north of the Great Hayward Marina (Figure 10). The meander is approximately 550m long. The southern portion of the meander is clearly visible on aerial imagery by a change in the surface vegetation. The palaeochannel is visible on the National Grid 1:10,000 scale maps dating from the 1920s, but not from the subsequent 1930s-1950s maps where the River Trent assumes its present course. The map evidence would therefore suggest the palaeochannel is the former course of the River Trent prior to modification during the 1930s-1950s. A more precise date for the straightening of the course of the River Trent at Great Hayward may be present in the extensive records of the Engineering Department of the Trent River Authority.

6.3 GCZ29 (CA4, Meece Brook)

6.3.1 Aerial imagery shows a large area of scrubby vegetation growth distinct from the surrounding arable land and associated with the course of the Meece Brook (Figure 11). The area of scrubbier vegetation corresponds closely with deposits of alluvium and peat mapped by BGS and indicates the presence of soils with higher moisture content. Peat deposits are mapped in two locations, both situated within the 250 buffer to the south of the route of the Proposed Scheme (Figure 11); the most substantial of these is located to the immediate south of Baldwin's Gate, forming part of the wider palaeodrainage and including the Madeley palaeolake located to the north of Baldwin's Gate. The alluvium and peat are of high geoarchaeological potential (see Section 4).

6.3.2 Examination of several aerial photos indicates that this land parcel has been under cultivation as recently as 2010. It is likely therefore that the sediments at this location may have suffered truncation or damage from agricultural activities, including wastage and/or oxidation resulting from drainage or lowering of water tables, or truncation of sediments because of ploughing.

6.4 GCZ32 (CA4, Whitmore trough/Madeley palaeolake)

6.4.1 The Madeley palaeolake has very little expression in the LiDAR data, visible as a largely homogenous area of even relief (Figure 12). However, there are indications of

patchy scrub vegetation on aerial imagery suggesting higher soil moisture content, possibly reflecting the underling fluvioglacial sediments and peat within the Whitmore trough section of the Madeley palaeolake.

6.5 GCZ36 and 37 (CA5, KH1–3)

6.5.1 KH1 - KH3, mapped by BGS as areas of organic sediment, are considered to represent possible periglacial features such as kettle holes. KH2 and 3 are located in GCZ36 to the immediate north and south of Den Lane (Figure 13). Both K2 and 3 are visible as gentle even depressions on the LiDAR data, but otherwise have little expression on aerial imagery. KH1 is located to the north in GCZ37 but is not visible as a distinct feature on either LiDAR or aerial imagery.

6.6 Whitmore Heath to Madeley area and South Cheshire area (GCz35-42)

6.6.1 LiDAR and aerial imagery were assessed within the 250m buffer extending from the route of the Proposed Scheme across the Whitmore Heath to Madeley area and South Cheshire area. LiDAR imagery shows many small depressions, most in the order of tens of metres. Many of these are annotated on Historic Maps as 'old sand pits' – a generic term used to describe various types of used extraction pits that are most probably largely of medieval and post-medieval date.

7 Borrow pits

7.1 Introduction

7.1.1 Seven borrow pits are located along the route of the Proposed Scheme in two main areas; the first group of five borrow pits are located near Kings Bromley (Figure 14) with a second group of two borrow pits to the south and north of Madeley (Figure 15). The geoarchaeological potential of the superficial geological deposits is outlined for the land within each of the seven borrow pits. The borrow pits are discussed with reference to the corresponding GCZ. Multiple borrow pits are considered together for convenience where they occur in close proximity within the same area of superficial geological deposits.

7.2 Borrow pits in GCZ3

7.2.1 Two closely located borrow pits are located approximately 1.5km to the south of King's Bromley within GCZ3 (Figure 14). The superficial geology is characterised by mid-Pleistocene glaciofluvial sheet deposits comprising sands and gravels. The sands and gravels may represent Pleistocene river terrace deposits associated with the River Trent, although in practice it is difficult to distinguish between glaciofluvial and fluvial sands and gravels without exposures. These sediments are of high geoarchaeological significance, if they represent Pleistocene terrace deposits, with the potential to reveal stratified sedimentary sequences with associated archaeological and environmental remains of Palaeolithic date. The date of the terrace deposits is uncertain, but debate over the precise southern extent of the Devensian ice sheet raises the possibility for survival of sediments dating as far back as the Anglian glaciation (approximately 450,000 years ago). The river gravels may also contain eroded and reworked Palaeolithic artefacts from earlier formations. River terrace deposits are also favoured locations for prehistoric and later settlement, so there is a high likelihood for the survival of multi-period archaeological sites.

7.3 Borrow pits in GCZ5

7.3.1 Two borrow pits are located to the immediate south of Kings Bromley within GCZ5 (Figure 14). The superficial geological deposits comprise Pleistocene terrace deposits associated with the River Trent. These deposits are mapped at altitudinally low levels along the River Trent and are likely to date to the most recent Devensian cold stage. The deposits may contain unstratified artefactual and faunal material or preserve stratified organic horizons of late Devensian or earlier date, both of geoarchaeological and geochronological significance.

7.4 Borrow pit in GCZ7

7.4.1 One borrow pit is located approximately 1km to the north-west of Kings Bromley within GCZ7 (Figure 14). The superficial geological deposits comprise Pleistocene river terrace deposits associated with the River Trent. The deposits are not as spatial extensive as those to the immediate south of the River Trent, and there is no indication that they include more than one terrace dating to the recent Devensian Ice Age. Similar to the borrow pits in GCZ3 (Section 7.2), the deposits may contain unstratified artefactual and faunal remains, or seal stratified organic deposits of Late

Devensian interstadial, or earlier date, both of archaeological and geoarchaeological significance. The terraces are slightly raised above the River Trent and are likely to have been attractive locations for settlement and may contain multi-period archaeological sites detectable through geophysical prospection.

7.5 Borrow pit in GCZ33

7.5.1 One borrow pit is located between Madeley and Hey Sprink Wood, adjacent to the WCML within GCZ33 (Figure 15). The superficial geological deposits comprise glaciofluvial sands and gravels, forming part of the Madeley Late Glacial palaeolake[37]. The sands and gravels are of little direct geoarchaeological significance, but may contain archaeology eroded and redeposited from Palaeolithic contexts, or seal stratified deposits of archaeological and geoarchaeological potential.

7.6 Borrow pit in GCZ34

7.6.1 One borrow pit is located approximately 0.5km to the west of Wrinehall within GCZ34, running adjacent to the south-western edge of the WCML (Figure 15). The deposits are of similar geoarchaeological significance to those described for the borrow pit in GCZ33 (Section 7.5), comprising glaciofluvial sands and gravels, most likely of Devensian date. They are of little direct geoarchaeological significance, but may contained eroded and redeposited Palaeolithic archaeology, or seal underlying stratified organic deposits of archaeological and geoarchaeological potential.

[37] Yates and Moseley (1957)

8 Discussion

8.1 Introduction

8.1.1 The results of deposit modelling and analysis of LiDAR and aerial imagery represent a key stage designed to qualify and quantify the archaeological risk to the project represented by deposits associated with river valleys, palaeochannels, palaeolakes and periglacial landform features.

8.2 River crossings and alluvium

8.2.1 Deposit modelling has highlighted four main issues inherent with the current availability and quality of the deposit records with regards to areas of alluvium and associated superficial deposits:

- eight of the fourteen river crossings have no available deposit records, either from the floodplain or surrounding landscape (Table 1);
- where deposit records are available, they are often located adjacent to rather than within areas of alluvium. Of the 14 river crossings, only three, the River Trent, Filly Brook and Basford Brook, have boreholes located within the floodplain (Table 1);
- deposit records are of variable detail, often lacking detail on more recent Holocene sediment. For example, generalised descriptions of alluvium frequently take no account of the presence of discrete organic bands that are of high geoarchaeological potential; and
- areas mapped by BGS and showing no superficial deposits often include borehole logs with deposits that may represent surrounding spreads of glacial sands and gravels and/or till.

8.2.2 There is a lack of detailed information on the depth and extent of riverine sediments crossing the route of the Proposed Scheme. This inevitably limits the ability to qualify and quantify the archaeological potential that these deposits represent.

8.2.3 However, the presence of peat deposits along the floodplain of the Basford Brook (GCZ39, Section 5.14) highlights the potential for other relatively minor watercourses lacking adequate deposit records to preserve geoarchaeologically relevant deposits.

Table 1: Availability of deposit records from individual watercourses

Watercourse	GCZ	Comment
Pyford Brook	2	No boreholes located in floodplain
Bourne Brook	4	No boreholes located in floodplain
River Trent	6	1 borehole in floodplain
River Trent	16	Insufficient deposit records
Moreton Brook	11	No boreholes located in floodplain
Moreton Brook	13	No boreholes located in floodplain
Filly Brook	24	2 boreholes in floodplain
Meece Brook	29	Insufficient deposit records

Watercourse	GCZ	Comment
River Lea	33	Insufficient deposit records
River Lea	35	Insufficient deposit records
Checkley Brook	35	Insufficient deposit records
Swill Brook	38	Insufficient deposit records
Basford Brook	38	Insufficient deposit records
Basford Brook	39	Peat recorded in floodplain
Basford Brook	41	Insufficient deposit records

8.3 Palaeochannels

8.3.1 Assessment of LiDAR data and aerial imagery along the route of the Proposed Scheme has produced little evidence for palaeochannels. The only palaeochannel identified during this survey represents the pre-1930s-1950s course of the River Trent at Great Hayward (GCZ16).

8.3.2 The low incidence of palaeochannels may reflect the linear nature of the route and restricted area available for analysis, but is also likely to reflect the fluvial regime prevalent in the Upper Trent Valley and its tributaries. Where palaeochannels have previously been identified they primarily occur at river confluences, such as the Trent-Sow[38], which are largely avoided along the route. Moreover, the high gradient of the Upper Trent results in a rapid stream flow and narrow valleys with poor preservation potential for palaeochannels, compared to the Middle and Lower Trent where palaeochannels are more numerously preserved.

8.4 Palaeolakes

8.4.1 The Madeley palaeolake forms part of a system of periglacial features formed at the margins of the retreating Devensian Ice Sheet[39]. These palaeolakes generally take the form of flat bottomed depressions with linking channels. The most significant of these palaeochannels along the route of the Proposed Scheme is the Madeley Basin and Whitmore Trough, although it is a rather ephemeral feature on both the LiDAR and aerial imagery.

8.4.2 Yates and Moseley[40] interpreted the Whitmore Trough as a spillway[41] that, together with the Madeley Basin, formed part of a single large proglacial lake: Lake Madeley. Whilst the superficial deposits of the Madeley Basin are dominated by glacial sands, the Whitmore trough contains accumulations of glacial sands and clays overlain by peat. Peat is not present to the north within the Madeley Basin. Pollen analysis of the clay produced a pollen signature of possible Late Glacial/Pre-Boreal date[42].

[38] Challis (2006); Baker (2007)
[39] Yates and Moseley (1957).
[40] Yates and Moseley (1957)
[41] A deep valley created by the flow of large volumes of meltwater
[42] Yates and Moseley (1957)

8.4.3 Borehole logs show a sequence of glacial sands and gravels overlain by clay and peat. Yates and Moseley[43] record a maximum depth of peat of approximately 1.5m, although deposit records reviewed as part of this report record no more than 0.9m, and typically 0.3m - 0.6m. The variance in peat thickness may reflect subsequent shrinkage, wastage or truncation of the peat occurring since the 1950s.

8.4.4 However, it is possible that deeper peats may be present in areas not covered by existing deposit records that run lengthways along the route of the existing WCML. The date-range of the peat is unknown, but is likely to be Holocene based on early pollen work from the underlying clay that suggested a late glacial/early Holocene date[44]. The depth, extent and age of the sands underlying the clay are similarly unknown.

8.4.5 The Madeley palaeolake is also partially situated within the boundaries of Madeley Great Park, a deer park most likely created in the early 13th century under the ownership of the Earls of Stafford. Deer parks varied in their use dependent on their size and location, included hunting, pannage (e.g. pasture for pigs), the right to collect timber or wood, and turbary (i.e. cutting of peat). The latter is suggested for Madeley in early 16th century documentary sources, although the occurrence or scale of any peat cutting is unknown.

8.5 Periglacial features

8.5.1 Potential periglacial features in GCZ36 and 37 (KH1 - KH3) are mapped by BGS as areas of organic sediment, with KH2 and KH3 visible on LiDAR as gentle depressions. At present, there are no deposit records for KH1 - KH3 and they remain an unknown with respect to their origin and extent, depth and age of deposits.

8.5.2 However, they represent examples of small peat filled hollows of variable dimension that are widely distributed across the west Midlands, often in relation to the margins and limits of the last (Devensian) ice sheet.

8.5.3 Although we suggest KH1 - KH3 could represent potential kettle holes, they may equally represent one or more of a series of infilled periglacial features identified across the nearby Shropshire-Cheshire Plain[45], including:

- shallow meltwater lakes and small meres largely containing late/post glacial sediments;
- kettle holes, potentially preserving deeper accumulations of sediment and sealed by Holocene organic deposits;
- moraine-damned hollows: standing water left in depressions following the drainage of water formerly dammed by terminal moraines;
- plunge pools – created through meltwater draining directly off the edge of the ice sheet; and
- subsidence hollows – often occurring through recent dissolution and removal of salt deposits from underlying saliferous geology. The bedrock underlying KH1

[43] Yates and Moseley (1957)
[44] Yates and Moseley (1957)
[45] Reynolds, C.S. (1979), *The limnology of the Eutrophic meres of the Shropshire-Cheshire Plan: a review*, Field Studies 5(1), 93-173

comprises saliferous Halite deposits, although no evidence for salt working is recorded at this location in the Historic Environment Record.

8.6 Borrow pits

8.6.1 The seven borrow pits are all located in areas of Pleistocene sands and gravels, representing either Pleistocene river terrace deposits (borrow pits located near Kings Bromley), or glaciofluvial sands and gravels (borrow pits to the south and north of Madeley). River terrace deposits are key contexts for archaeological and geoarchaeological investigation, representing fluvially deposited sediment that have been subsequently incised through and preserved as evidence of former floodplains along the sides of current and former river valleys. These terrace deposits are associated with the River Trent, and are mapped at altitudinally low levels. They are likely to relate to the last Cold Stage, although organic rich sediments relating to the last interglacial or subsequent interglacials may be interbedded within them[46]. Isolated terraces at higher levels may relate to earlier pre-Devensian fluvial activity, although age controls on Pleistocene deposits along the route of the Proposed Scheme are poor.

8.6.2 Glaciofluvial sands and gravels are widely distributed across the region. These sands and gravels are most likely Devensian, either deposited as seasonal meltwater outwash at the edge of the ice sheet or as subglacial, englacial and supraglacial deposits. They have little direct geoarchaeological significance, but may preserve underlying stratified deposits of archaeological and geoarchaeological potential. This could include a range of periglacial features such as kettle holes, preserving deep sediments of potential Late Glacial and Holocene date.

8.6.3 In the case of the borrow pit in GCZ33, the sands and gravels correspond to the Madeley Basin, forming one of a series of broad basins and linking troughs in the region[47]. The glacial sands and gravels of the Madeley Basin are over 11m thick, resting on clays. Other parts of the basin contain flat topped ridges of sand and deeper troughs containing sand and clay, but lacking the peat deposits recorded from the Whitmore Trough to the south (see Section 8.4). Although the peat within the Whitmore Trough is likely to be of Holocene date, the age of the sand and clay deposits within the Madeley Basin is uncertain, and could reflect the effects both of last glacial meltwaters as well as the pre-glacial palaeodrainage of the region.

[46] Schreve, D., Howard, A., Currant, A., Brooks, S., Buteux, S., Coope, R., Crocker, B., Field, M., Greenwood, M., Greig, J. and Toms, P. (2013), *A middle Devensian woolly rhinoceros (Coelodonta antiquitatis) from Whitemoor Haye Quarry, Staffordshire (UK): palaeoenvironmental context and significance*, Journal of Quaternary Science 28, 118-130

[47] Yates and Moseley (1957)

8.7 Key findings

8.7.1 The key findings of the preliminary geoarchaeological work contained in this report can be summarised as follows:

- the age, depth and extent of alluvium within all the river crossings along the route remains unknown, with 11 of the 14 river crossings lacking any deposit records from associated floodplains;
- peat was recorded within the floodplain of the Basford Brook, and highlights the potential for other minor watercourses along the route, for which adequate deposit records are currently lacking, to preserve similar deposits;
- the age, depth, extent and formation process of potential periglacial features in GCZ36/37 remain unknown;
- the Madeley palaeolake/Whitmore trough preserves an extensive although rather thin peat overlying late-glacial glaciofluvial/glaciolacustrine deposits. The date-range of these deposits has not been precisely established;
- only one palaeochannel has been identified along the route (Figure 10, GCZ16) related to modifications of the River Trent in the 1930s-1950. The potential for survival of unknown palaeochannels along the route is considered low;
- borrow pits located within areas of Pleistocene sands and gravels (borrow pits located near Kings Bromley) have potential to produce eroded and redeposited archaeology and faunal remains of Palaeolithic date, or seal organic deposits of geoarchaeological significance. However, current age controls on Pleistocene deposits in the Upper Trent is poor, although altitudinally low terraces are likely to be Devensian in date; and
- borrow pits located within areas of glaciofluvial sands and gravels (borrow pits to the south and north of Madeley) have little direct potential, but may seal geoarchaeologically relevant deposits. The date of the sands and gravels of the Madeley palaeolake are currently unknown.

9 References

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Challis, K. (2006), *Airborne laser altimetry in alluviated landscapes*, Archaeological Prospection 13, 103-127.

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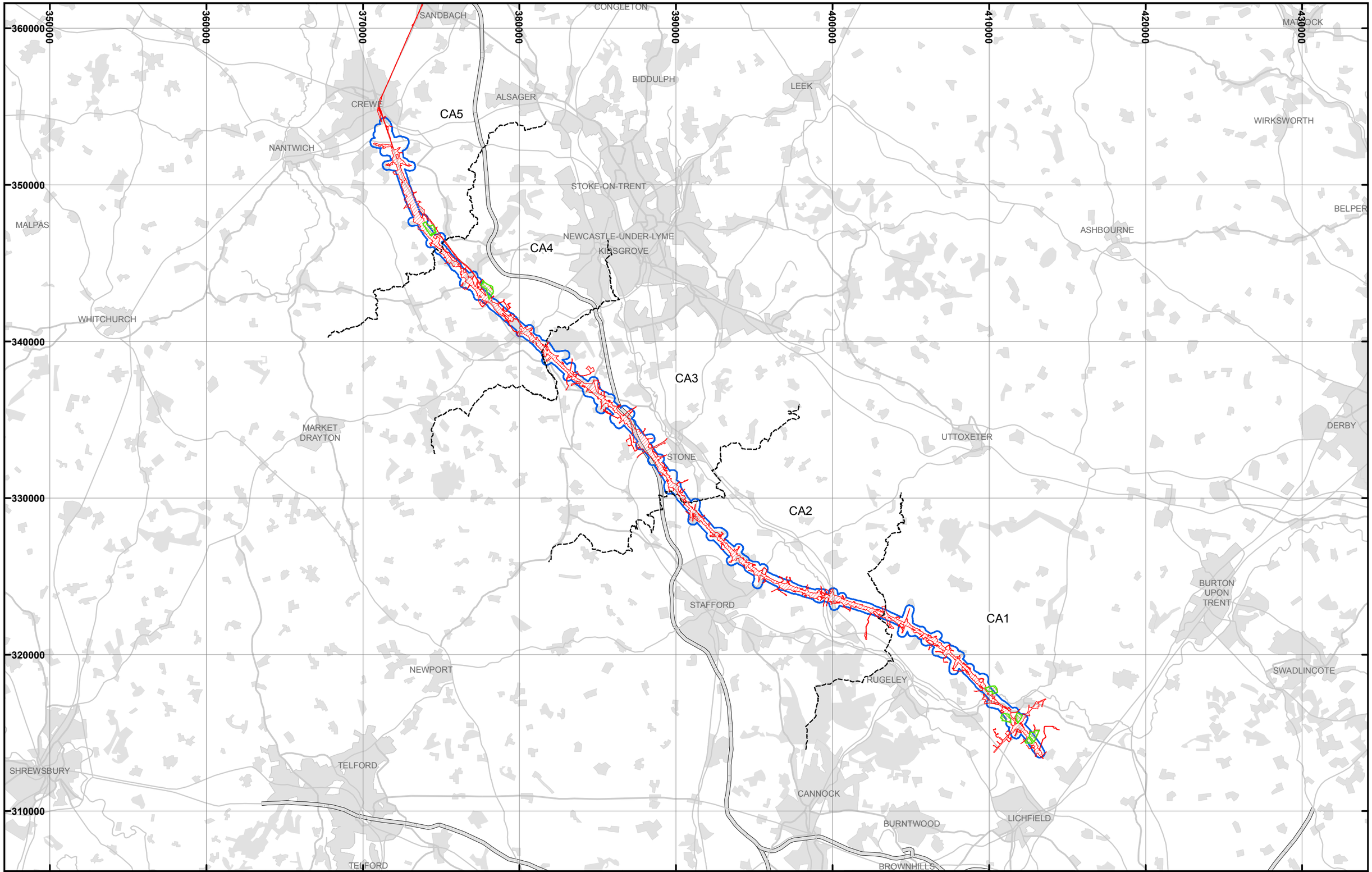
Reynolds, C.S. (1979), *The limnology of the Eutrophic meres of the Shropshire-Cheshire Plan: a review,* Field Studies 5(1), 93-173.

Schreve, D., Howard, A., Currant, A., Brooks, S., Buteux, S., Coope, R., Crocker, B., Field, M., Greenwood, M., Greig, J. and Toms, P. (2013), *A middle Devensian woolly rhinoceros (Coelodonta antiquitatis) from Whitemoor Haye Quarry, Staffordshire (UK): palaeoenvironmental context and significance*, Journal of Quaternary Science 28, 118-130.

Yates, E.M. and Moseley, F. (1957), *Glacial lakes and spillways in the vicinity of Madeley, north Staffordshire,* Quarterly Journal of the Geological Society 113, 409-428.



Legend

- Land required for the Proposed Scheme
- 250m Buffer
- Borrow pit
- ---- Community Area Boundaries

Map Number

Figure 1

Map Name

Route of the Proposed Scheme

Community Area:
1-5

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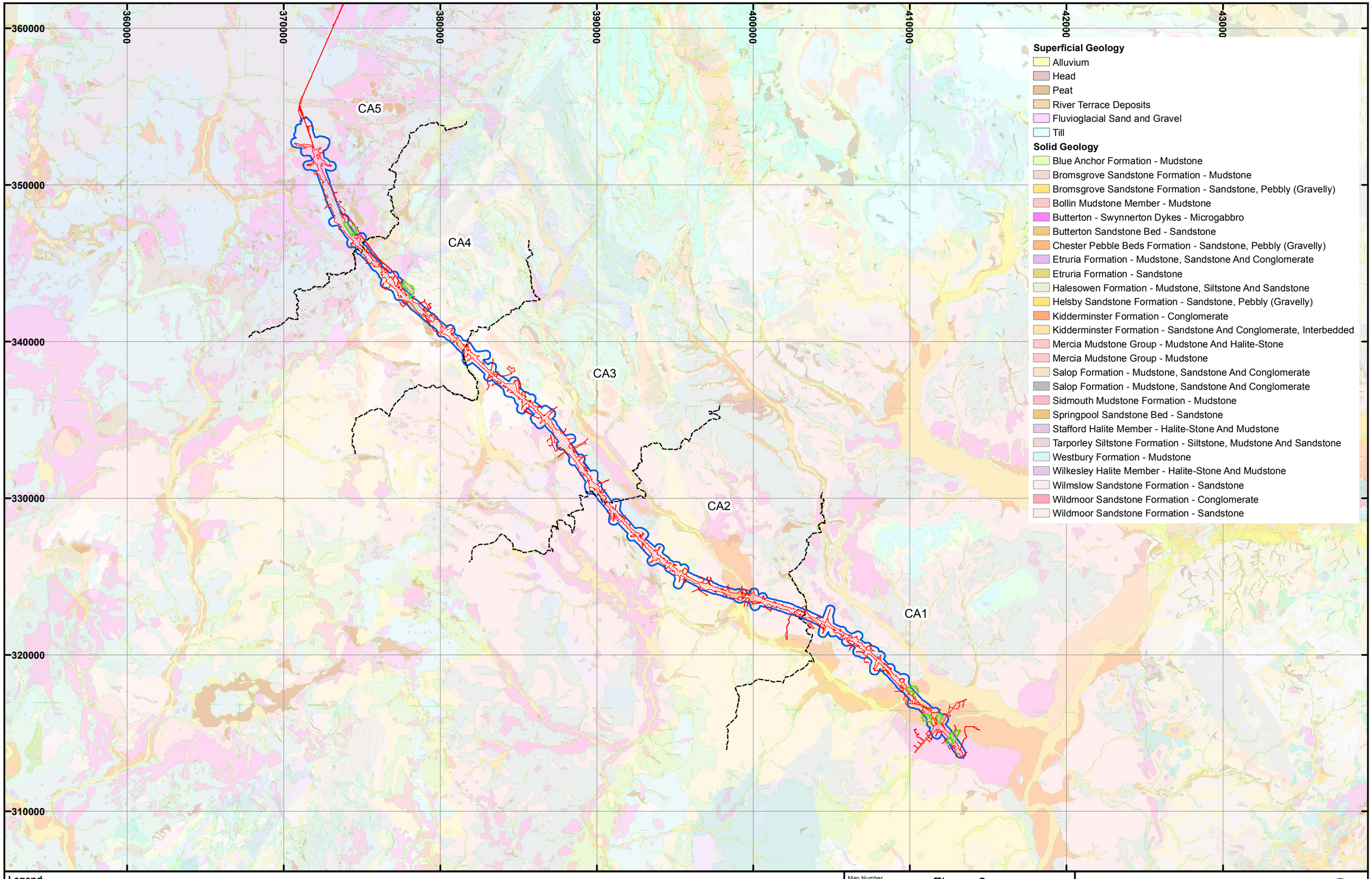
Metres

Doc Number:

Date: 27/04/17



Legend

- Land required for the Proposed Scheme
- 250m Buffer
- Borrow pit
- ---- Community Area Boundaries

Map Number

Figure 2

Map Name

Superficial and solid geology recorded along the route of the Proposed Scheme

Community Area:
1-5

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Date: 27/04/17

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400000
405000
410000
415000
420000
325000
320000
315000
310000
CA2
GCZ 18
GCZ 17
GCZ 16
GCZ 15
GCZ 14
GCZ 13
GCZ 12
GCZ 11
GCZ 10
CA1
GCZ 9
GCZ 8
GCZ 7
GCZ 6
GCZ 5
GCZ 4
GCZ 3
GCZ 1
GCZ 2
Borrow Pit

Legend

- Land required for the Proposed Scheme
- 250m Buffer
- Borrow pit
- Community Area Boundaries
- Geoarchaeological Character Zones

Superficial Geology

- Alluvium
- Head
- Peat
- River Terrace Deposits
- Fluvioglacial Sand and Gravel
- Till

Map Number: Figure 3

Map Name: Geoarchaeological Character Zones, Community Areas 1 and 2, showing visible superficial geologies

Community Area: 1-2

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Doc Number:

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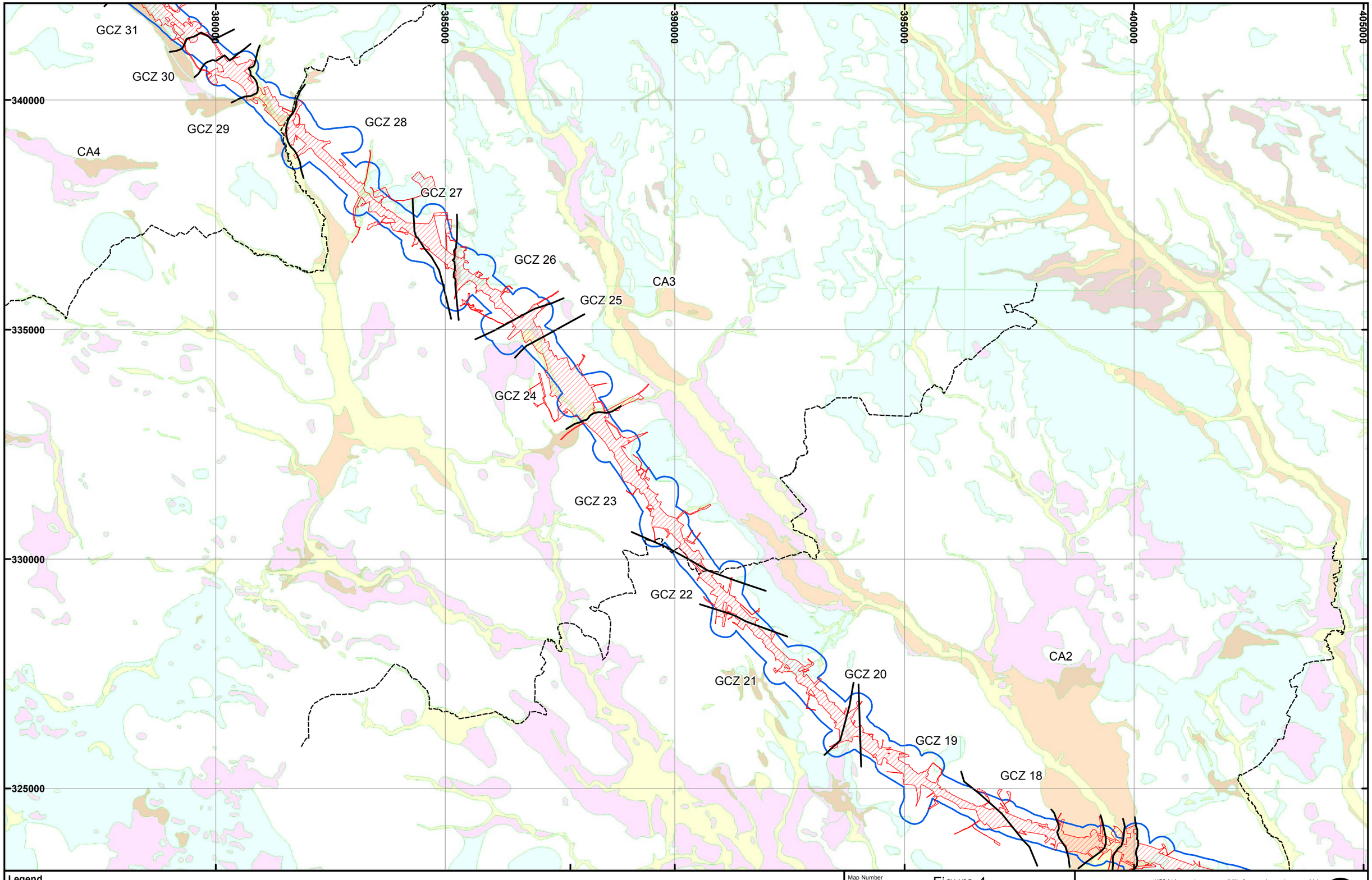

Legend

- Land required for the Proposed Scheme
- 250m Buffer
- Borrow pit
- Community Area Boundaries
- Geoarchaeological Character Zones

Superficial Geology

- Alluvium
- Head
- Peat
- River Terrace Deposits
- Fluvioglacial Sand and Gravel
- Till

Map Number

Figure 4

Map Name

Geoarchaeological Character Zones, Community Areas 2, 3 and 4, showing visible superficial geologies

Community Area:
2-4

Registered in England. Registration number 06791686.
Registered office: Eland House, Bressenden Place, London SW1E 5DU.

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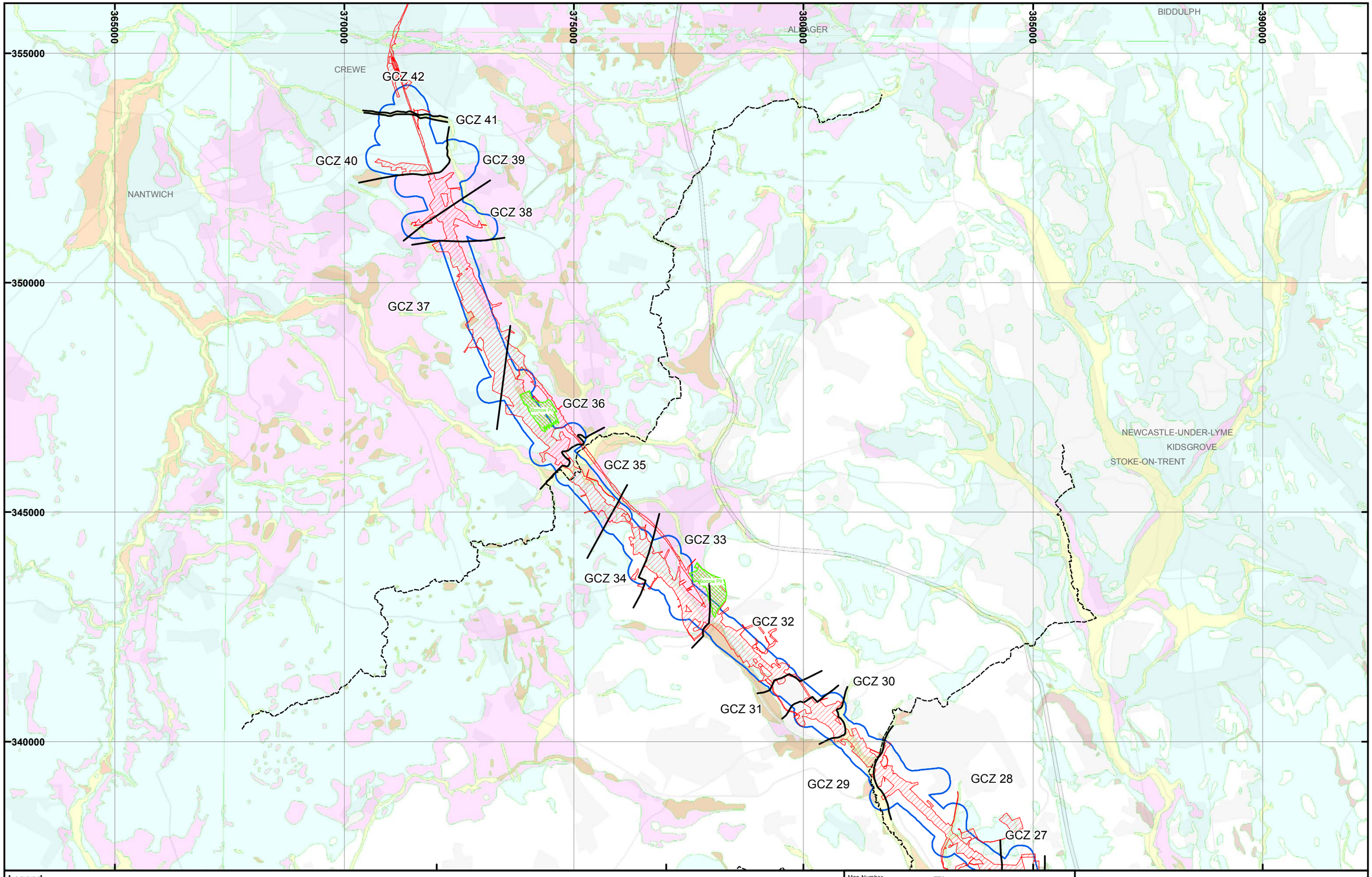
Doc Number:

Date: 27/04/17



Legend

- Land required for the Proposed Scheme
- 250m Buffer
- Borrow pit
- Community Area Boundaries
- Geoarchaeological Character Zones

Superficial Geology

- Alluvium
- Head
- Peat
- River Terrace Deposits
- Fluvioglacial Sand and Gravel
- Till

Map Number: Figure 5

Map Name: Geoarchaeological Character Zones, Community Areas 3, 4 and 5, showing visible superficial geologies

Community Area: 3-5

Scale at A3: 1:75,000

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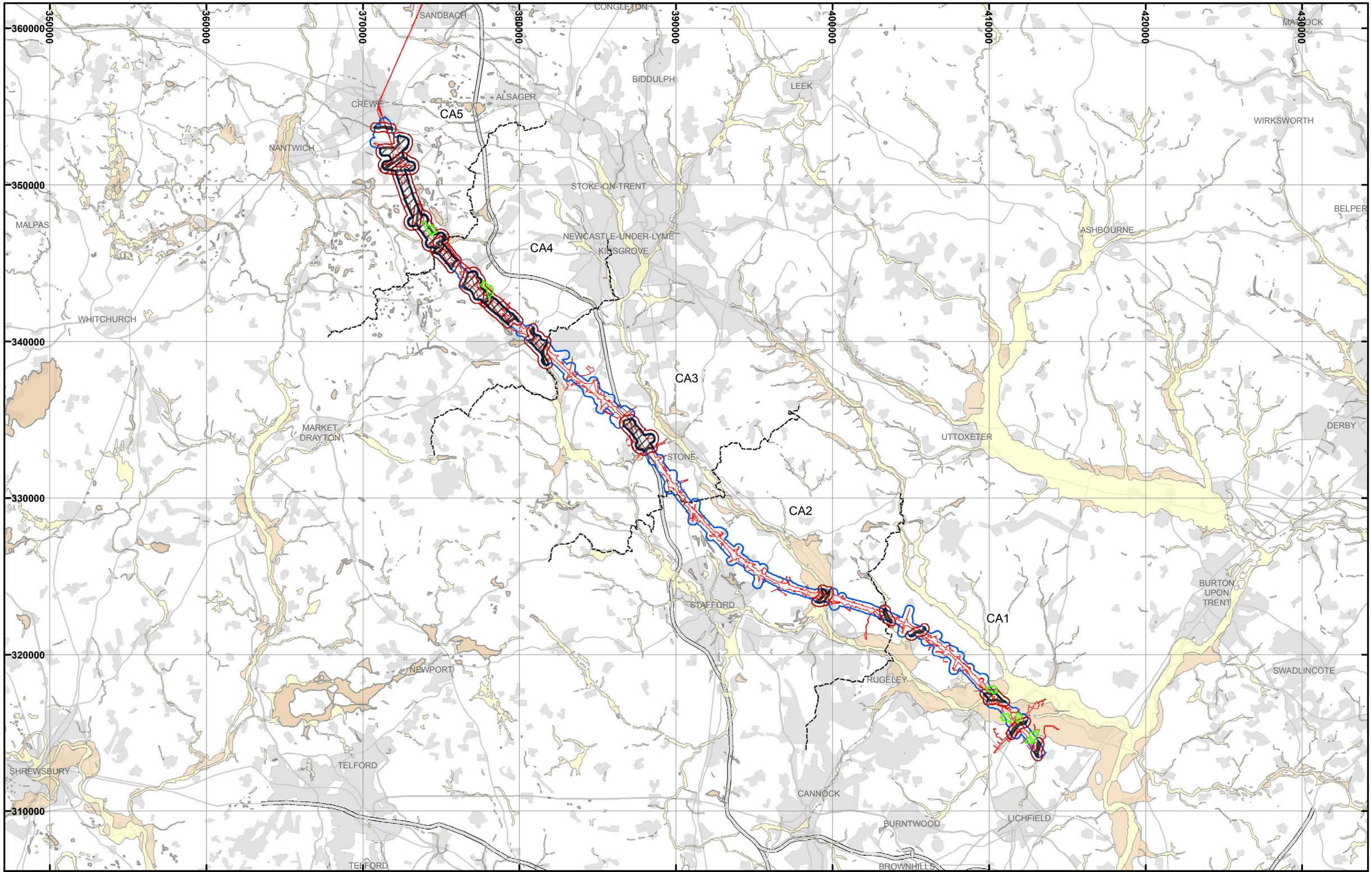
Doc Number:

Date: 27/04/17



Legend

- Land required for the Proposed Scheme
- 250m Buffer
- Borrow pit
- Community Area Boundaries
- Areas of Interest
- Areas of Interest: 250m buffer

Superficial Geology

- Alluvium
- Peat
- River Terrace Deposits

Map Number: Annex A - Figure 1

Map Name: River valleys, palaeolakes and potential periglacial features selected for deposit modelling and examination of LiDAR and aerial imagery

Community Area: 1-5

Scale at A3: 1:220,000

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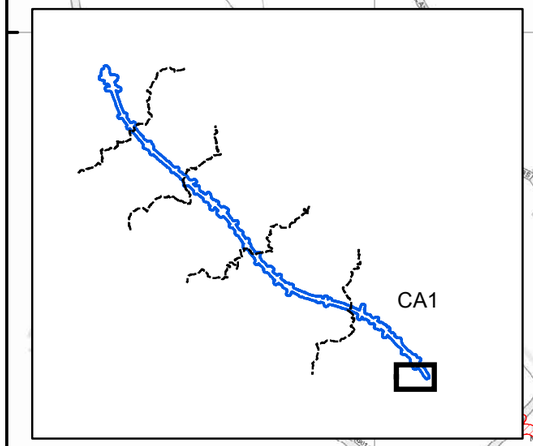
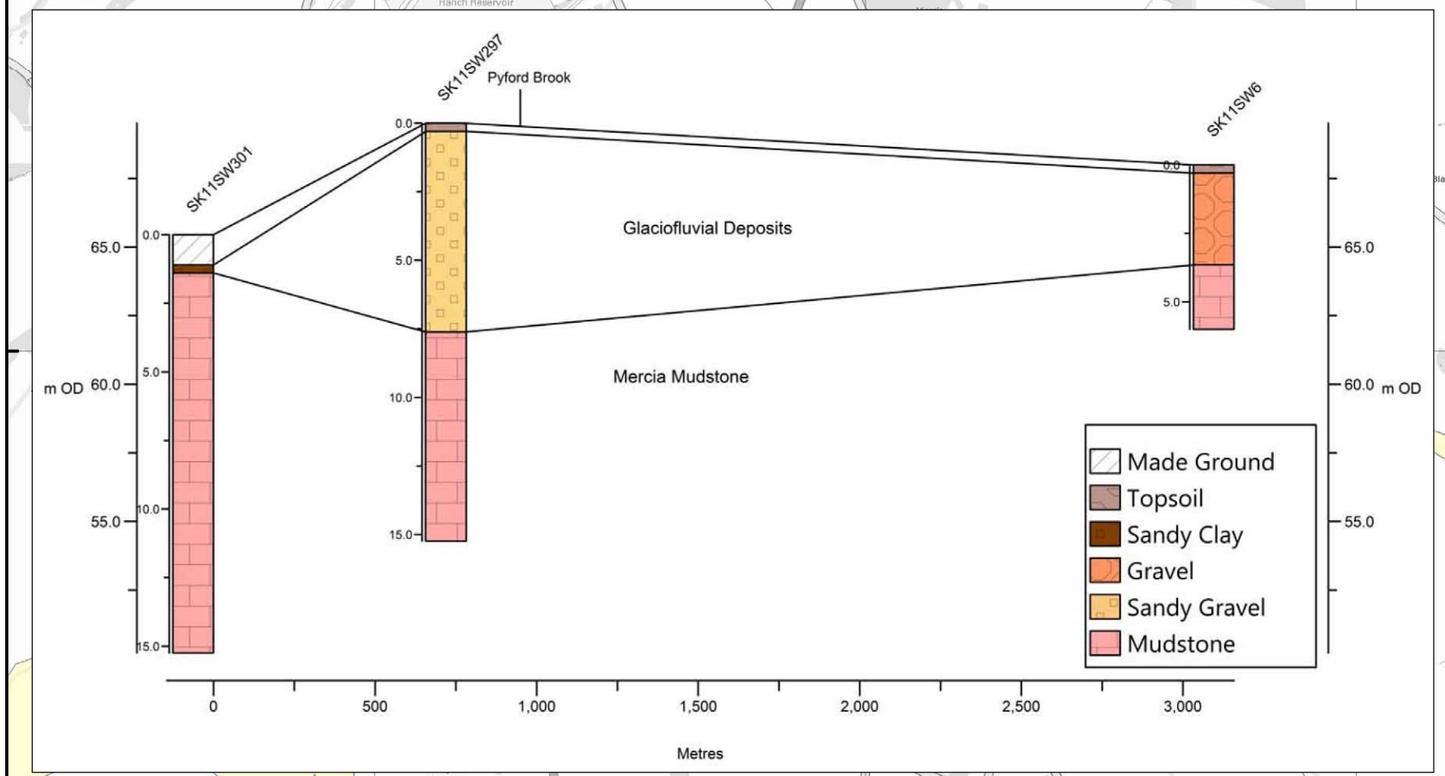
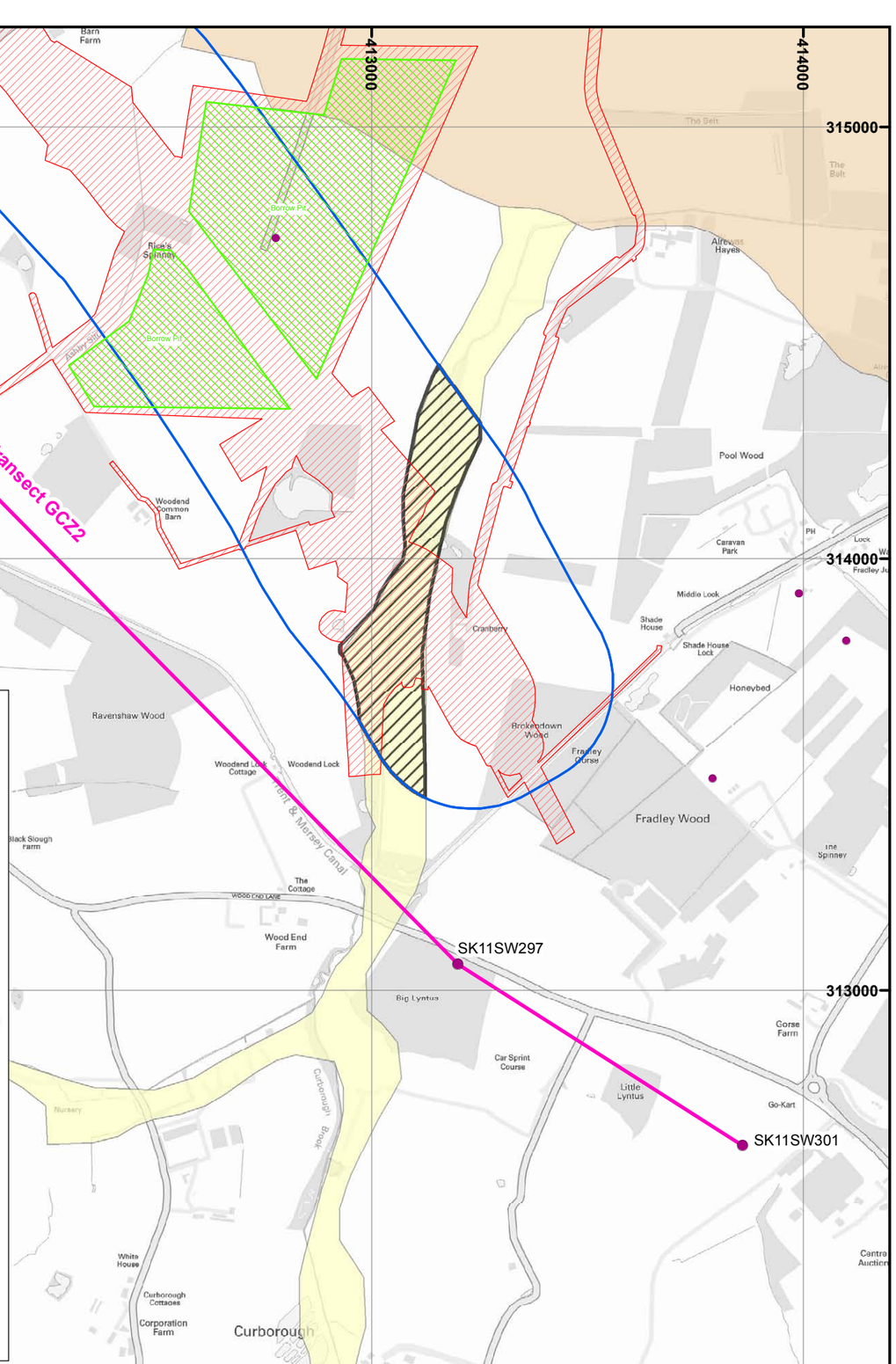
Date: 27/04/17







Legend

- Land required for the Proposed Scheme
- 250m Buffer
- Borrow pit
- Community Area Boundaries
- Areas of Alluvium
- Transect location
- Borehole location

Superficial Geology

- Alluvium
- Peat
- River Terrace Deposits

Map Number: Annex A - Figure 2

Map Name: Transect GCZ2 (Pyford Brook)

Community Area: 1

Scale at A3: 1:12,500

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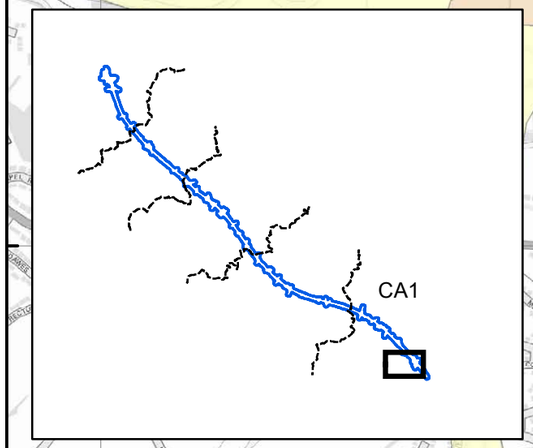
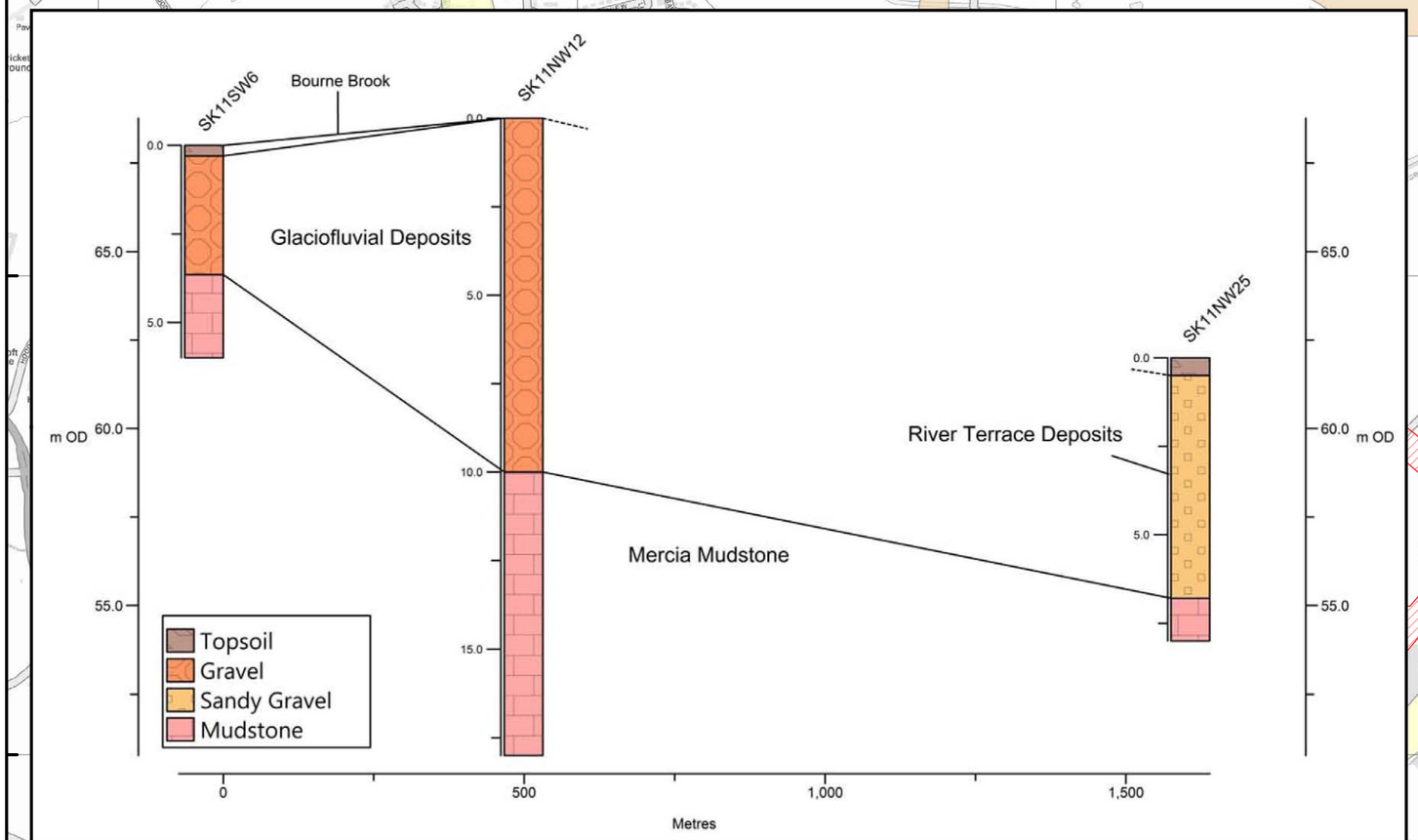
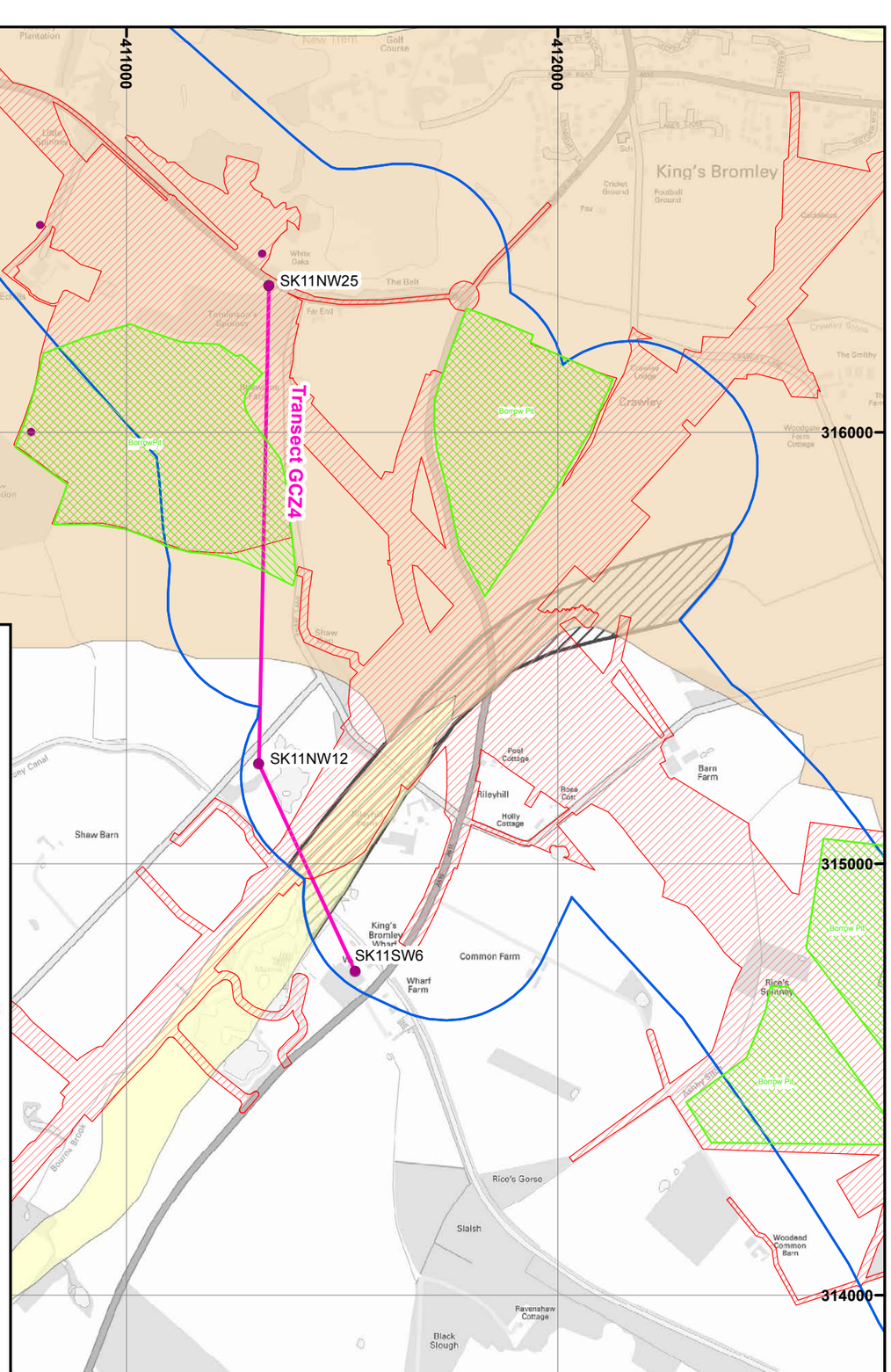
Doc Number:

Date: 27/04/17







Legend

- Land required for the Proposed Scheme
- 250m Buffer
- Borrow pit
- Community Area Boundaries
- Areas of Alluvium
- Transect location
- Borehole location

Superficial Geology

- Alluvium
- Peat
- River Terrace Deposits

Map Number: Annex A - Figure 3

Map Name: Transect GCZ4 (Bourne Brook)

Community Area: 1

Scale at A3: 1:12,500

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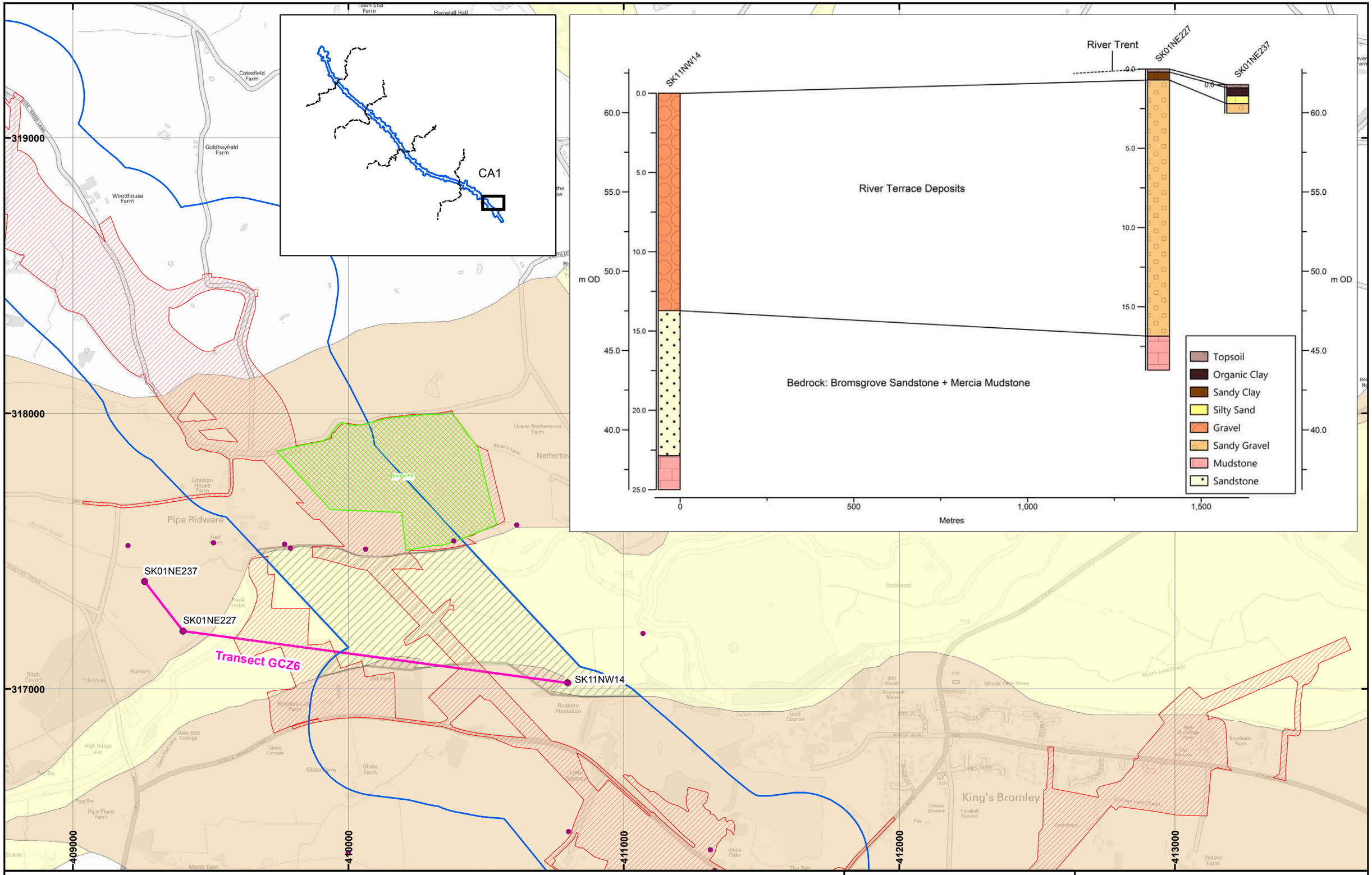
Doc Number:

Date: 27/04/17



Legend

- Land required for the Proposed Scheme
- 250m Buffer
- Borrow pit
- Community Area Boundaries
- Areas of Alluvium
- Transect location
- Borehole location

Superficial Geology

- Alluvium
- Peat
- River Terrace Deposits

Map Number: Annex A - Figure 4

Map Name: Transect GCZ6 (River Trent)

Community Area: 1

Scale at A3: 1:12,500

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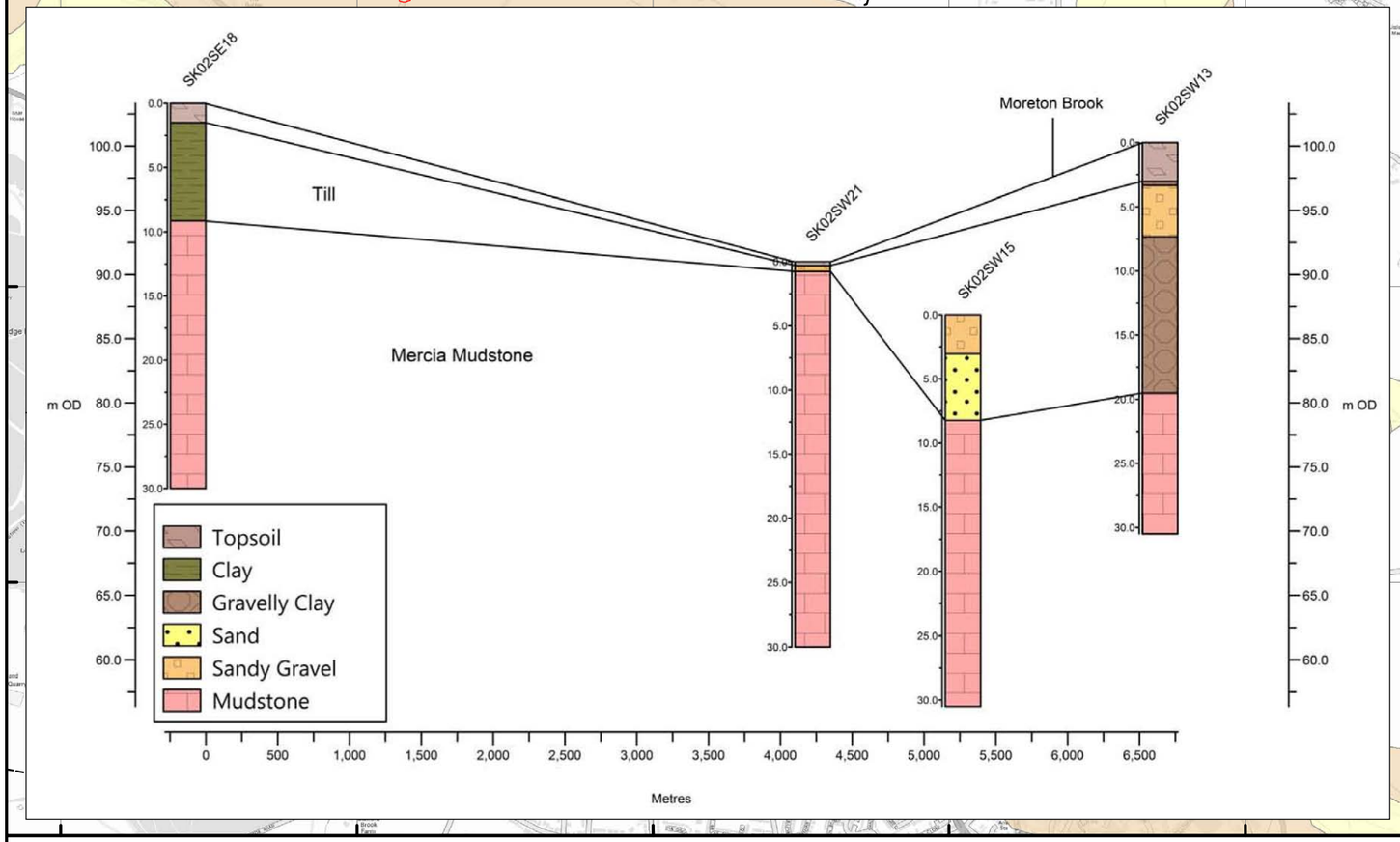
Date: 27/04/17



Legend

- Land required for the Proposed Scheme
- 250m Buffer
- Community Area Boundaries
- Areas of Alluvium
- Transect location
- Borehole location

Superficial Geology

- Alluvium
- Peat
- River Terrace Deposits

Map Number: Annex A - Figure 5

Map Name: Transect GCZ11 and 13 (Moreton Brook)

Community Area: 1-2

Scale at A3: 1:20,000

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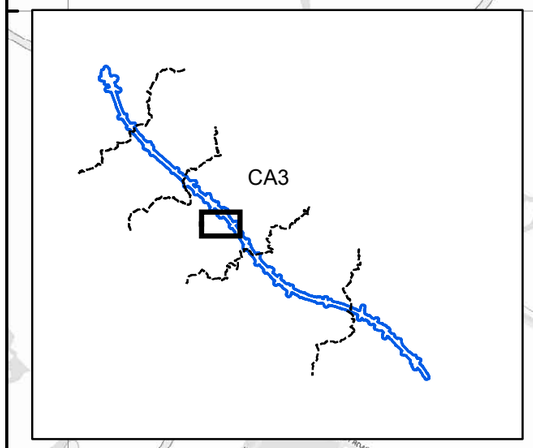
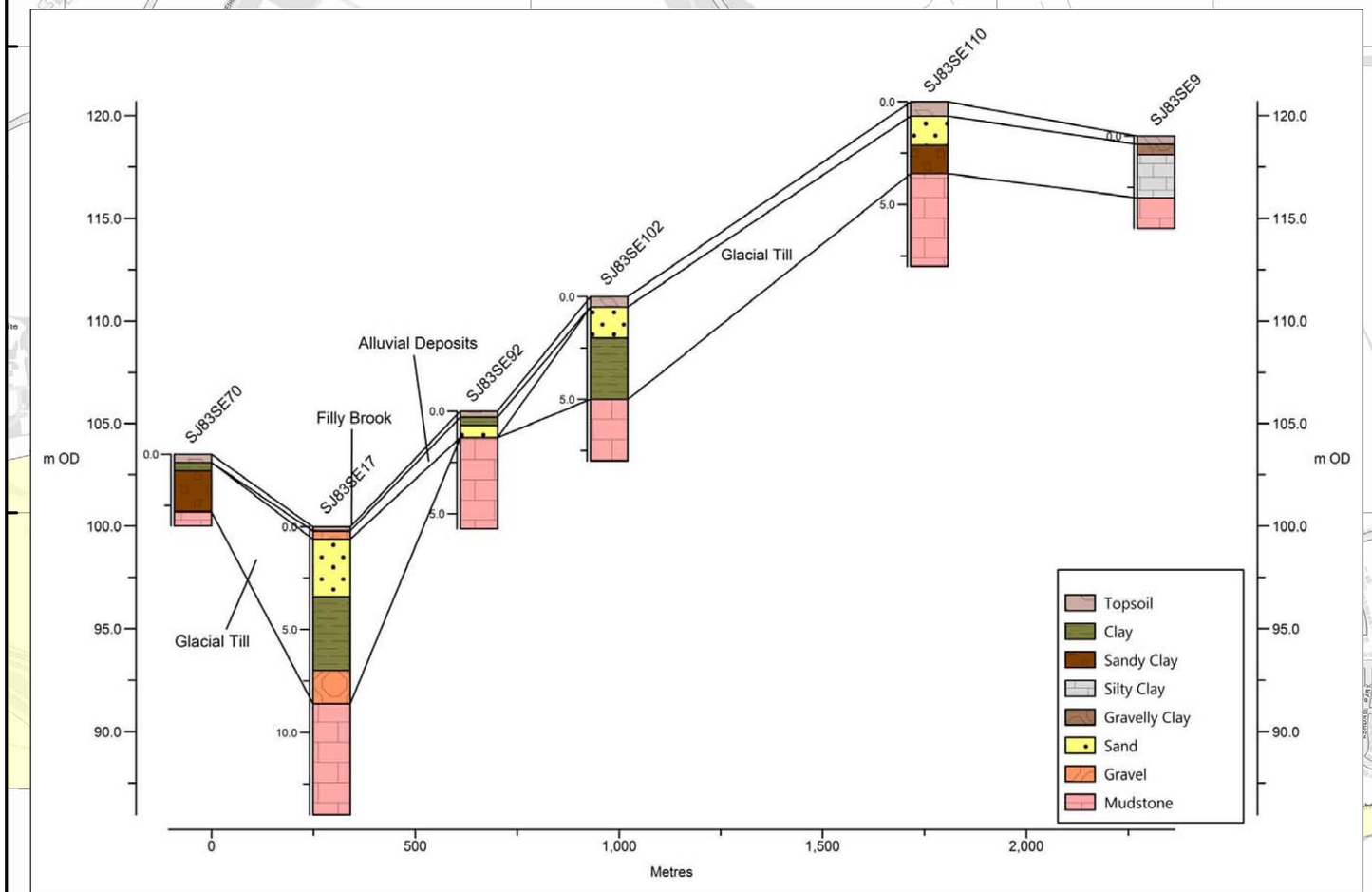
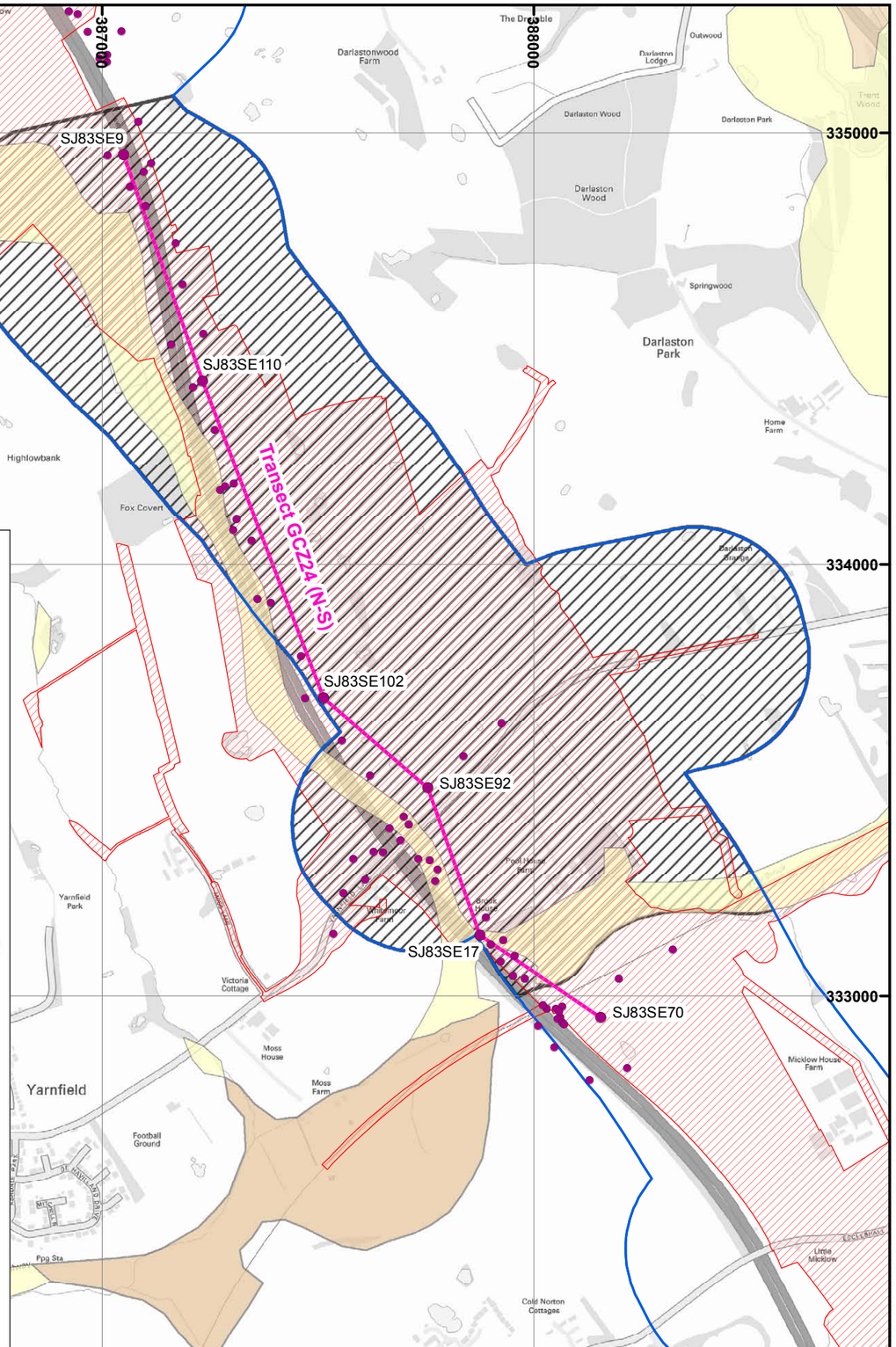
Date: 27/04/17







Legend

- Land required for the Proposed Scheme
- 250m Buffer
- Community Area Boundaries
- Areas of Alluvium
- Transect location
- Borehole location

Superficial Geology

- Alluvium
- Peat
- River Terrace Deposits

Map Number: Annex A - Figure 6

Map Name: Transect GCZ24 (N-S, Filly Brook)

Community Area: 3

Scale at A3: 1:12,500

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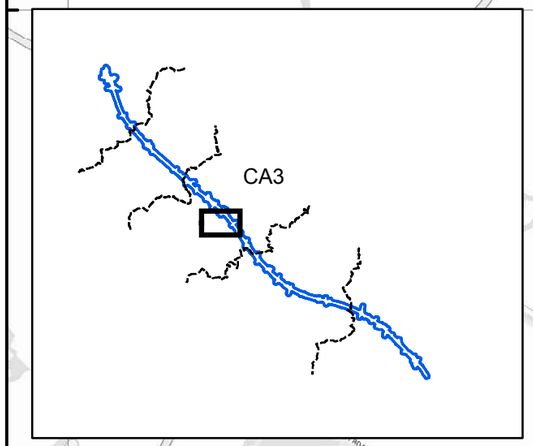
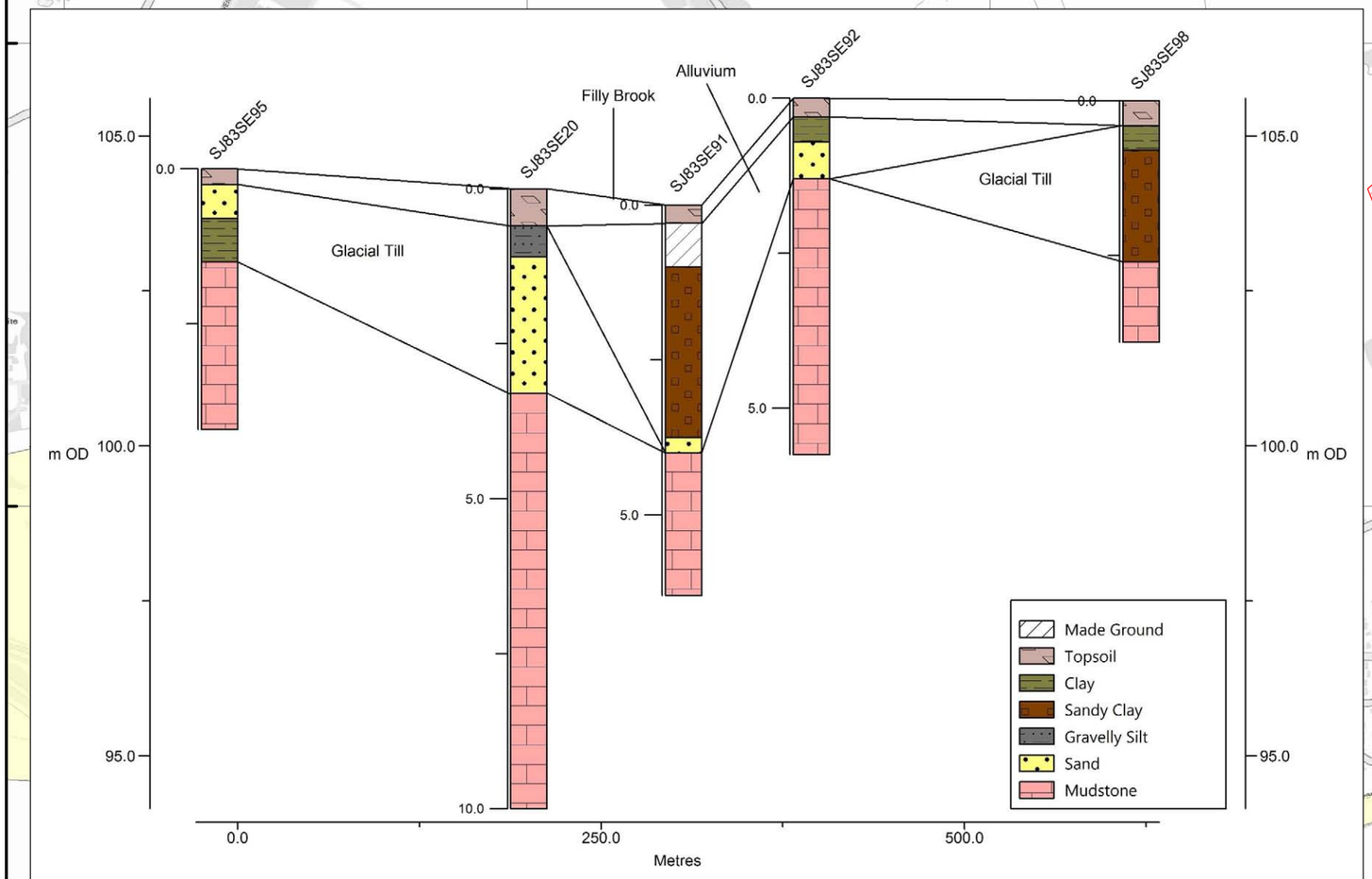
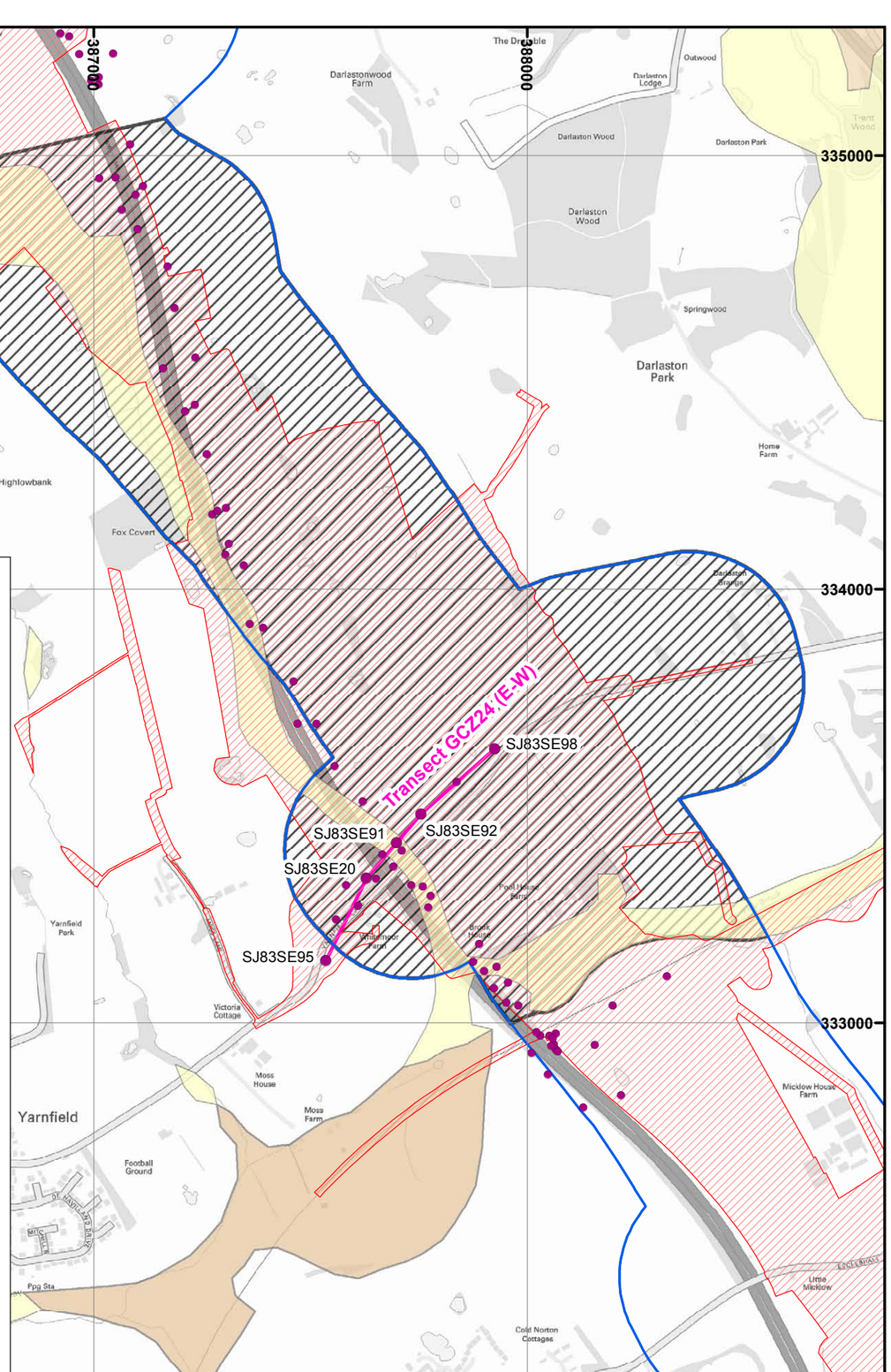
Doc Number:

Date: 27/04/17







Legend

- Land required for the Proposed Scheme
- 250m Buffer
- Community Area Boundaries
- Areas of Alluvium
- Transect location
- Borehole location

Superficial Geology

- Alluvium
- Peat
- River Terrace Deposits

Map Number: Annex A - Figure 7

Map Name: Transect GCZ24 (E-W, Filly Brook)

Community Area: 3

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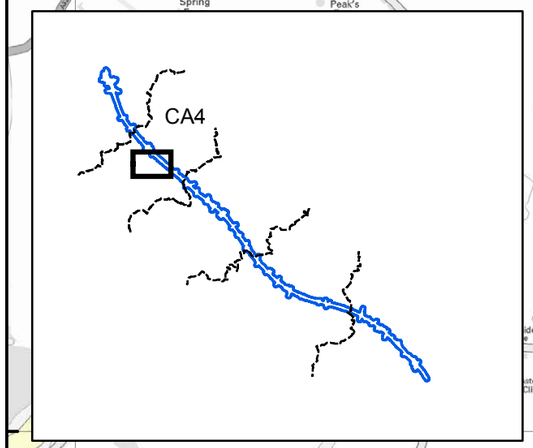

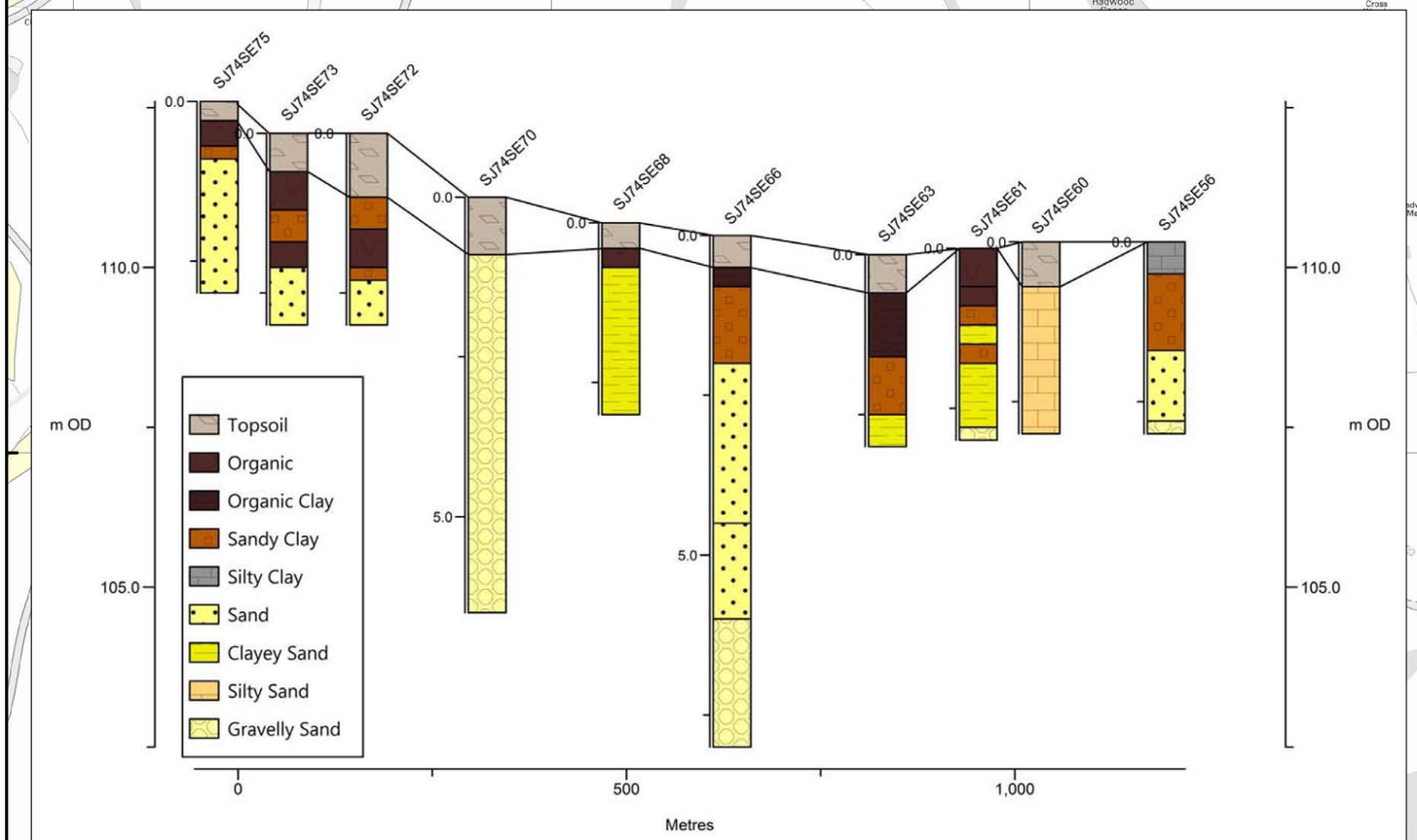

Legend

- Land required for the Proposed Scheme
- 250m Buffer
- Borrow pit
- Community Area Boundaries
- Areas of Alluvium
- Transect location
- Borehole location

Superficial Geology

- Alluvium
- Peat
- River Terrace Deposits

Map Number: Annex A - Figure 8

Map Name: Transect GCZ32 (Whitmore Trough/Madeley palaeolake)

Community Area: 4

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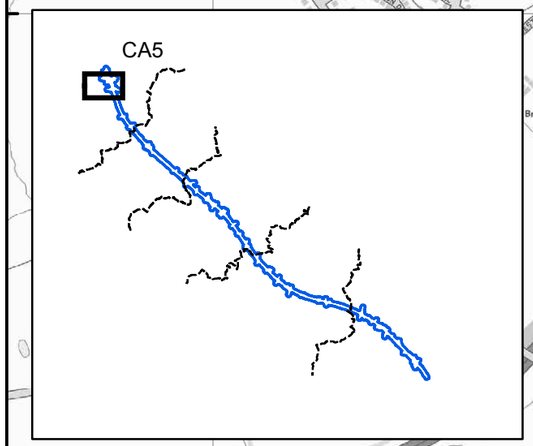
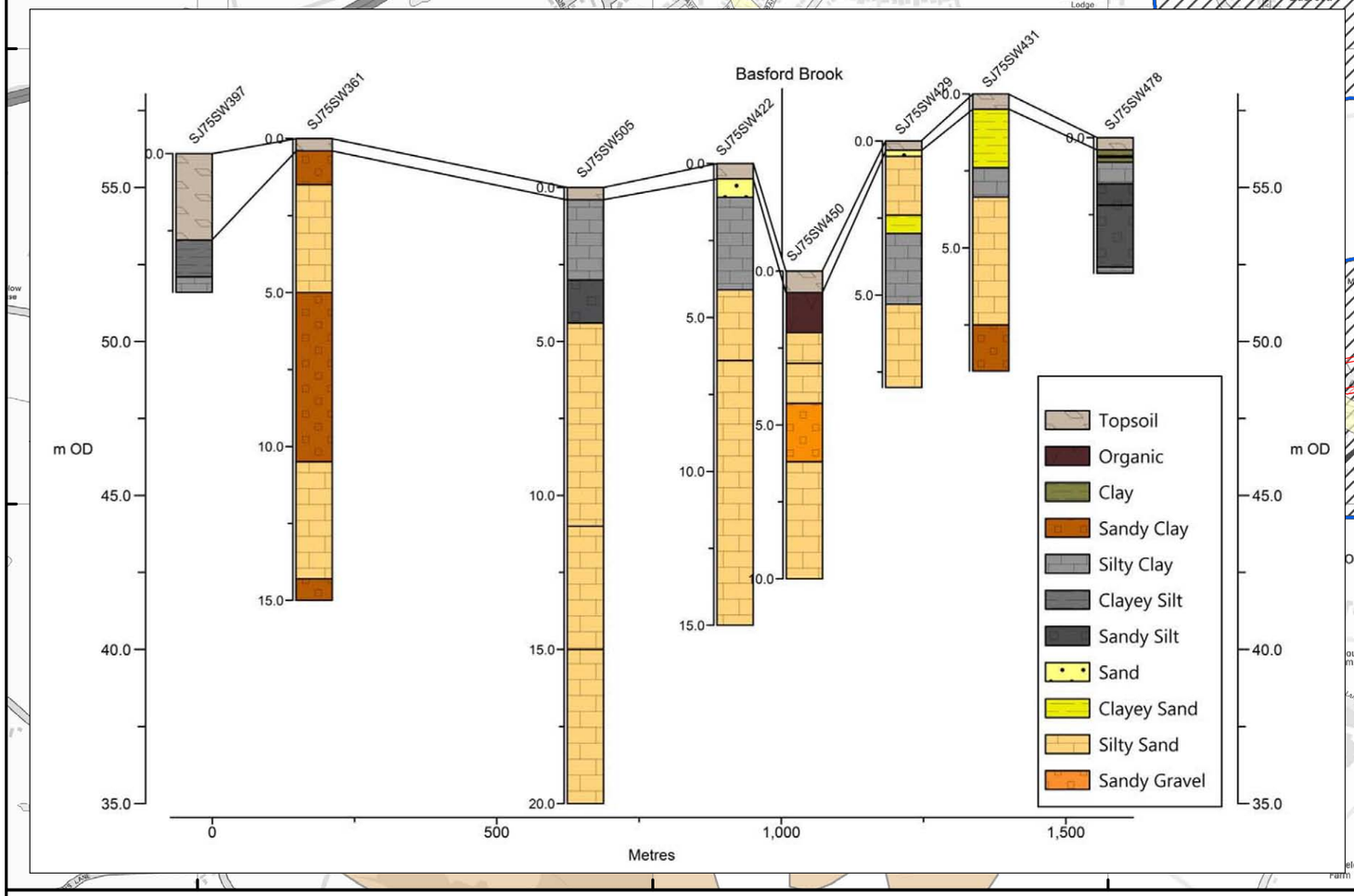




Legend

- Land required for the Proposed Scheme
- 250m Buffer
- Community Area Boundaries
- Areas of Alluvium
- Transect location
- Borehole location

Superficial Geology

- Alluvium
- Peat
- River Terrace Deposits

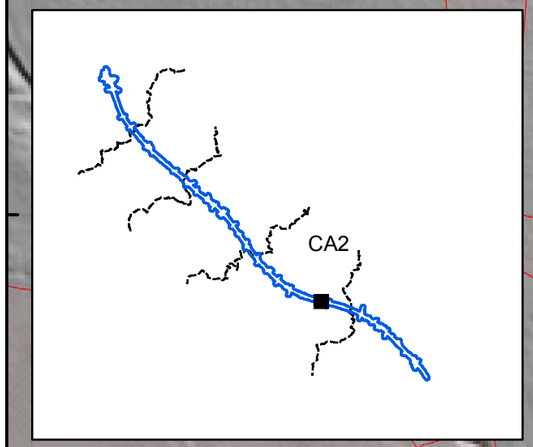
Map Number	Annex A - Figure 9
Map Name	Transect GCZ39 (Basford Brook)
Community Area:	5

Scale at A3: 1:12,500

0 125 250 375 500 Metres

Doc Number:

Date: 28/04/17



324000

323500

399000

399500

1920s County Series 2500 Map

0 80 160 240 320 400
Metres

1930s - 1950s National Grid 10k Map

Hoomill Cottages

River Trent

Middle Bridge

Lodge

0 80 160 240 320 400
Metres

Legend

- Land required for the Proposed Scheme
- 250m Buffer
- Community Area Boundaries
- Palaeochannel: 1920s County Series Map
- Palaeochannel: 1930s/1950s National Grid

Map Number: Annex A - Figure 10

Map Name: LiDAR image of palaeochannel within the floodplain of the River Trent (GCZ16)

Community Area: 2

Registered in England. Registration number 06791686.
Registered office: Eland House, Bressenden Place, London SW1E 5DU.

Scale at A3: 1:4,000

0 40 80 120 160
Metres

Doc Number:

Date: 24/05/17

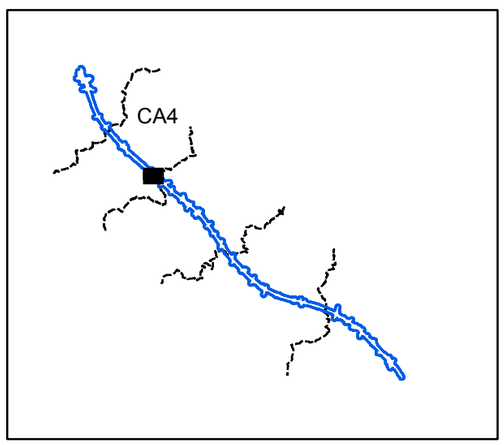
380500

381000

381500

340500

340000



Legend

- Land required for the Proposed Scheme
- 250m Buffer
- Community Area Boundaries
- Area of floodplain
- Current river course

Map Number: Annex A - Figure 11

Map Name: Aerial imagery GCZ 29 (Meece Brook)

Community Area: 4

Registered in England. Registration number 06791686.
Registered office: Eland House, Bressenden Place, London SW1E 5DU.

Scale at A3: 1:4,000

0 40 80 120 160 Metres

Digital data supplied by client.

Doc Number:

Date: 28/04/17

BGS Geological Mapping

20 cm LiDAR data

Aerial imagery

Borrow Pit

378000

379000

343000

342000

341000

340000

CA4

Legend

- Land required for the Proposed Scheme
- 250m Buffer
- Borrow pit
- Community Area Boundaries
- Palaeo-lake

Superficial Geology

- Alluvium
- Peat
- River Terrace Deposits

Map Number: Annex A - Figure 12

Map Name: LiDAR/aerial imagery comparison for GCZ 32 (Whitmore Trough/Madeley palaeolake)

Community Area: 4

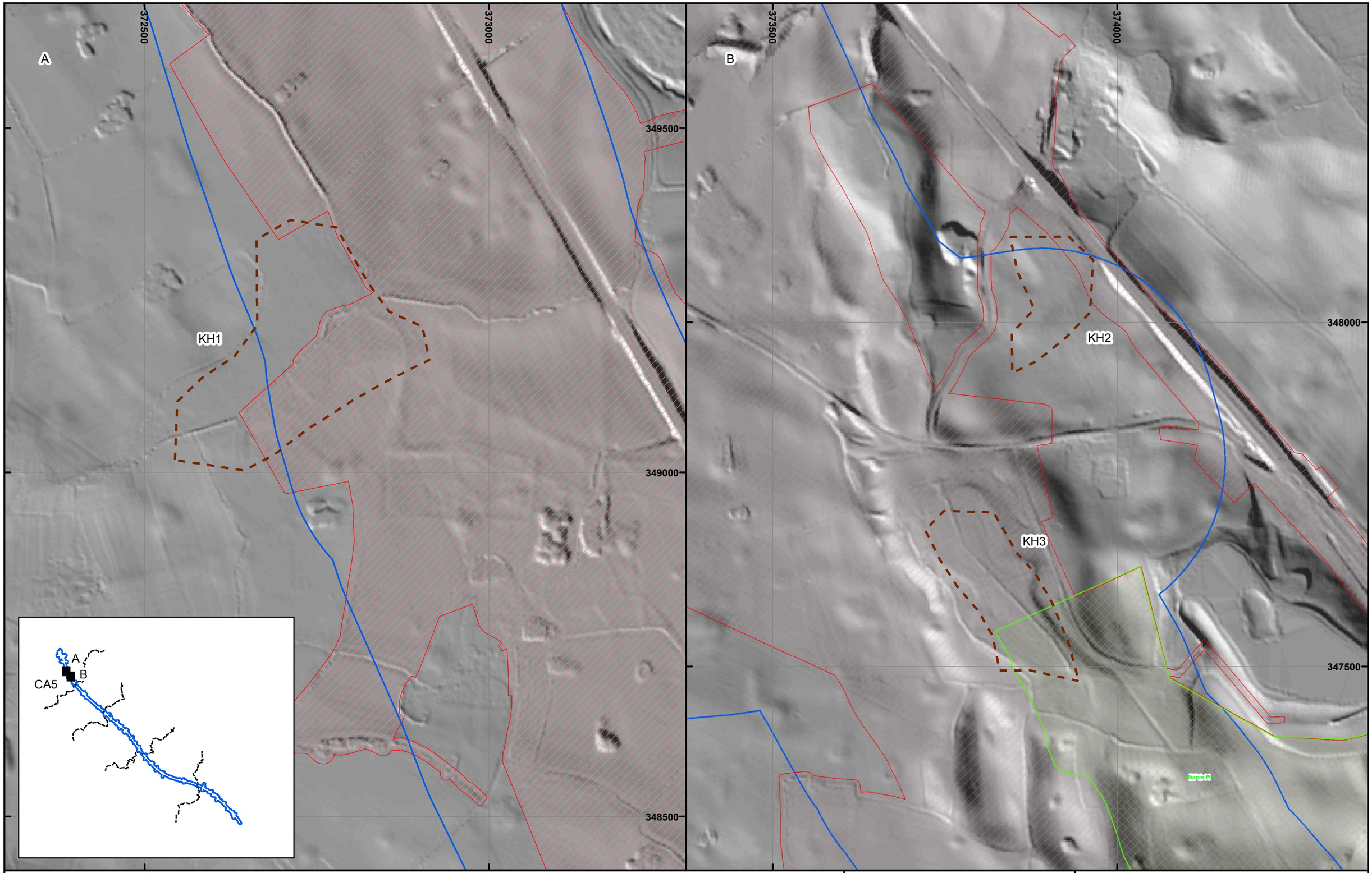
Registered in England. Registration number 06791686.
Registered office: Eland House, Bressenden Place, London SW1E 5DU.

Doc Number:

Scale at A3: 1:18,000

0 200 400 600 800 Metres

Date: 28/04/17



Legend

- Land required for the Proposed Scheme
- 250m Buffer
- Borrow pit
- ---- Community Area Boundaries
- Areas of Peat (potential Kettle Holes) as mapped by BGS

Map Number: Annex A - Figure 13

Map Name: LiDAR showing potential periglacial features GCZ 36,37 (KH1-3)

Community Area: 5

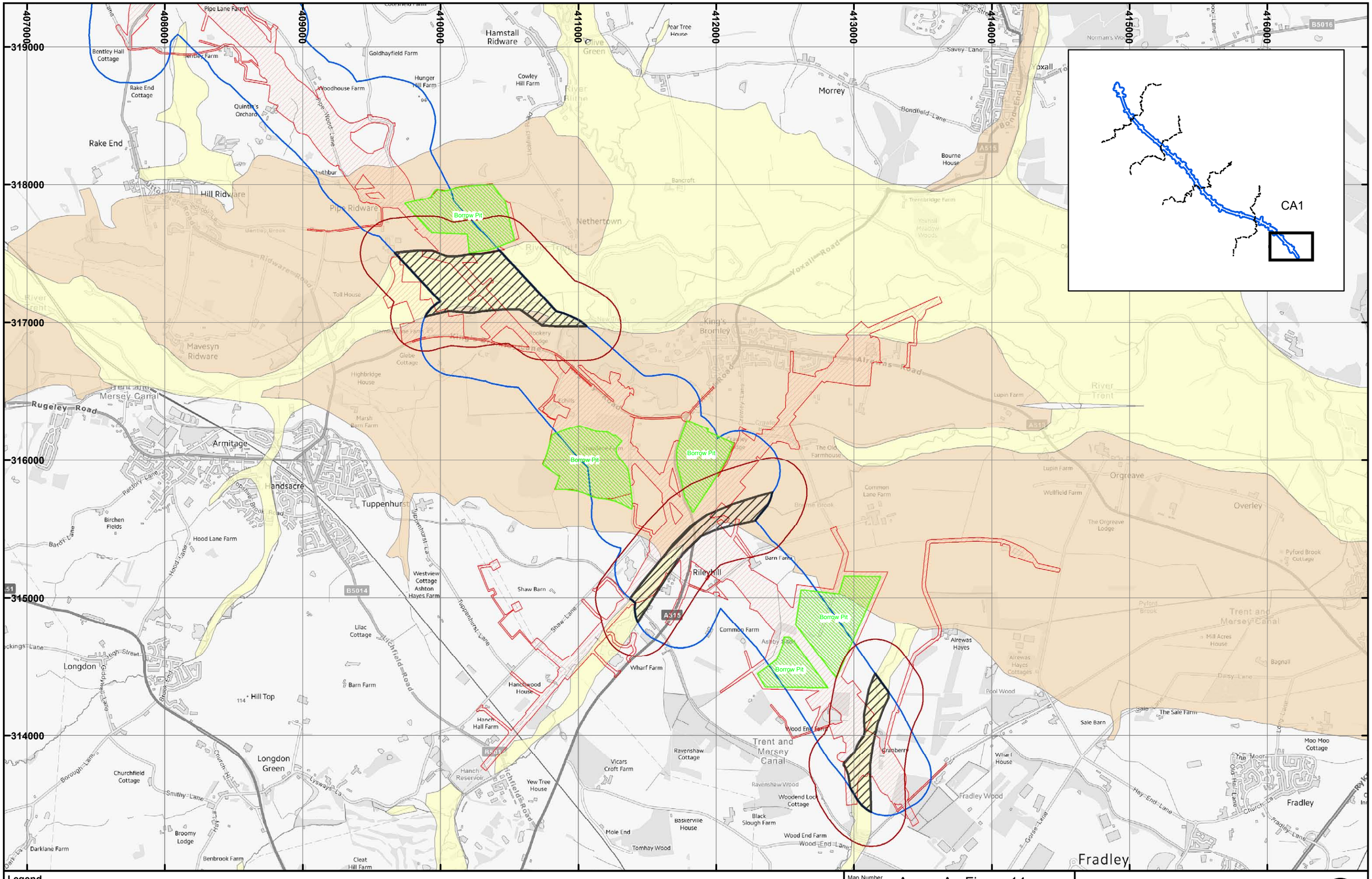
Registered in England. Registration number 06791686.
Registered office: Eland House, Bressenden Place, London SW1E 5DU.

Scale at A3: 1:5,000

0 50 100 150 200 Metres

Doc Number:

Date: 28/04/17



Legend

- Land required for the Proposed Scheme
- 250m Buffer
- Borrow pit
- Community Area Boundaries
- Areas of Interest
- Areas of Interest: 250m buffer

Superficial Geology

- Alluvium
- Peat
- River Terrace Deposits

Map Number: Annex A - Figure 14

Map Name: Location of borrow pits near Kings Bromley

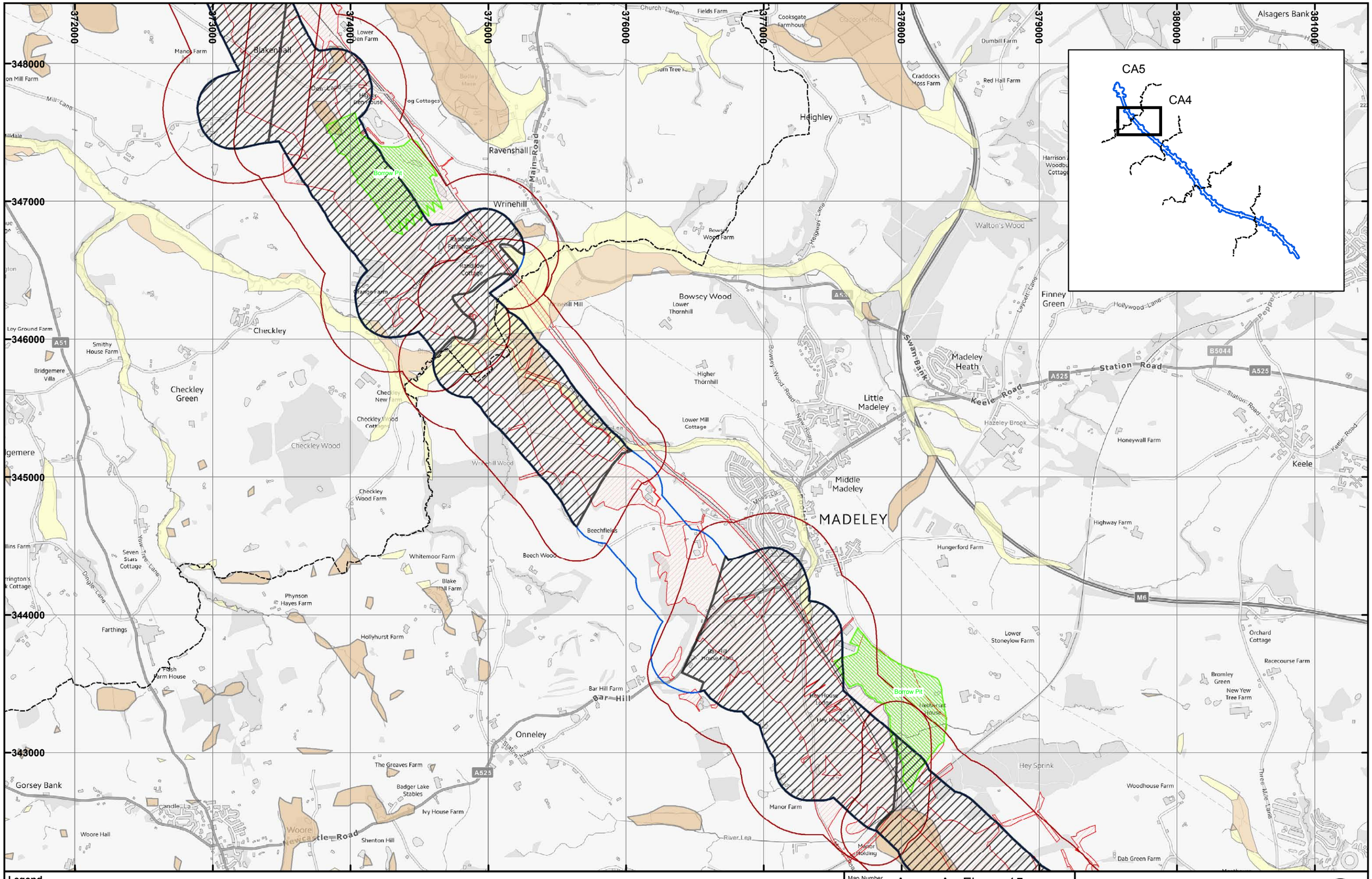
Community Area: 1

Scale at A3: 1:25,000

0 250 500 750 1,000 Metres

Doc Number:

Date: 28/04/17



Legend

- Land required for the Proposed Scheme
- 250m Buffer
- Borrow pit
- Community Area Boundaries
- Areas of Interest
- Areas of Interest: 250m buffer

Superficial Geology

- Alluvium
- Peat
- River Terrace Deposits

Map Number: Annex A - Figure 15

Map Name: Location of borrow pits to the south and north of Madeley

Community Area: 4-5

Scale at A3: 1:25,000

0 250 500 750 1,000 Metres

Doc Number:

Date: 28/04/17

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