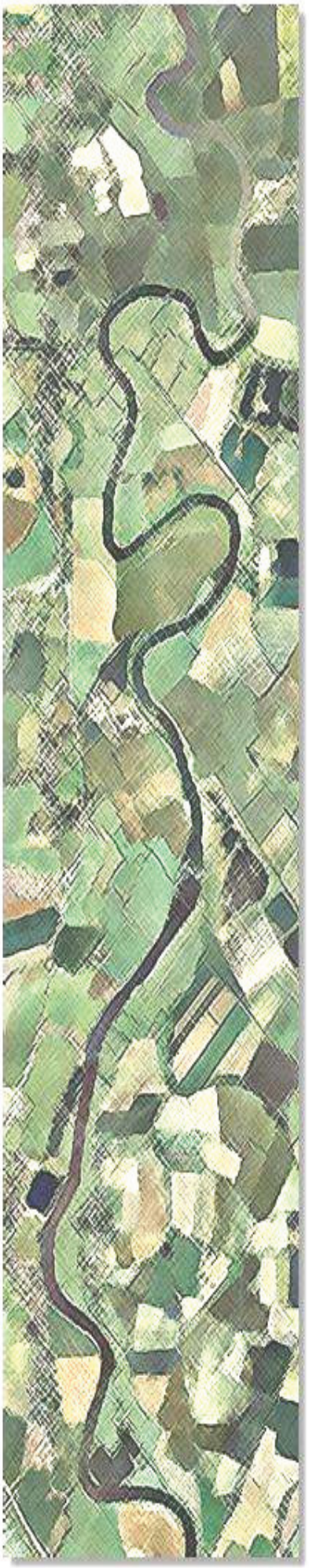

ASSESSING THE GEOARCHAEOLOGICAL DEVELOPMENT OF CATCHMENT TRIBUTARIES AND THEIR IMPACT ON THE HOLOCENE EVOLUTION OF THE RIVER TRENT

Project Design

For funding from the Aggregates Levy Sustainability Fund
Administered by English Heritage

Prepared by

Keith Challis and Dr Andy J Howard

Trent Valley GeoArchaeology

www.TVG.org.uk

ENVIRONMENT AGENCY

Supported by the Environment Agency

THE UNIVERSITY OF BIRMINGHAM

birmingham archaeology

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Principal Investigators

Keith Challis, Birmingham Archaeology,
University of Birmingham, Edgbaston, Birmingham, B15 2TT
(0121 414 5563, k.challis@bham.ac.uk)

Dr Andy J Howard, Institute of Archaeology and Antiquity,
Arts Building, University of Birmingham, Edgbaston, Birmingham B15 2TT
(0121 414 5497, a.j.howard@bham.ac.uk)

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PNUM 3850

EXECUTIVE SUMMARY

Summary Aims

- To describe and elucidate the known archaeological and palaeoenvironmental resource of the River's Idle and Dove, two principal tributary valleys of the River Trent that are affected by mineral extraction.

- To assess within a chronostratigraphic framework, the role that human activities such as deforestation and natural processes such as climate change have played in the evolution of these tributary valley floors.

- To use this information to help heritage managers assess how these human and natural factors may have influenced archaeological preservation and aid in the design of future prospection/mitigation strategies.

- To use our understanding of these tributary valleys to assess the role their evolution may have played in the development of the main valley floor of the River Trent; for example, increased flood frequency and magnitude resulting in incision and erosion, or the delivery of fine grained sediment resulting in alluviation. Conclusions with implications for heritage management will be disseminated to the relevant regional curators.

- Additional work will also be undertaken in two other smaller tributary valleys (the Doverbeck and Devon) with contrasting physiographic and hence hydrological regimes, which also contain sand and gravel deposits. Their study will provide the opportunity to test hypotheses developed during the more intensive survey of the two principal tributary valley floors.

Summary Objectives

- To build a robust georeferenced dataset that collates existing information describing, the archaeology, palaeoenvironments, topography, geology and geomorphology of the study areas within a digital GIS format.

- To undertake additional (georeferenced) field survey that will provide information describing the palaeoenvironmental character and sedimentary evolution of the valley floors, which allows the deposits to be placed within a chronostratigraphic framework.

- To interrogate this entire dataset at a number of spatial and temporal scales, thus allowing a greater appreciation of the evolution of these valley floors, which in turn will have implications for our understanding and prospecting of archaeology within these tributary valleys, but also the trunk system of the River Trent.

LIST OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

1.1 STATEMENT OF RELEVANCE TO ALSF CORE THEMES

This proposal has been developed to address themes, identified through discussion with contract, curatorial and academic archaeologists working in the Trent Valley, that are promoted as part of the research agenda of Trent Valley GeoArchaeology (www.tvg.org.uk), these are:

- To advise on the management of the archaeological and palaeoenvironmental resource in the floodplain of the Trent Valley and its tributaries.
- To establish a baseline of information for the Trent Valley and its tributaries.
- To publicise the archaeology and palaeoenvironmental resource of the Trent Valley and its tributaries.

In addition, the proposal addresses several ALSF themes, including the core theme of developing capacity to manage aggregate extraction landscapes in the future, and the objective two themes:

- The archaeology of the Quaternary Period: research to characterise the resource and to develop evaluation frameworks, predictive tools and mitigation strategies.
- Research to enhance understanding of the scale and character of the historic environment in aggregate producing areas in order to provide the baseline information necessary for effective future management.
- Methodological and technical development, in particular remote sensing and predictive techniques and the development of mitigation strategies.

1.2 SUMMARY OF AIMS AND OBJECTIVES

This proposal aims to elucidate the geoarchaeological development of two principal tributary valleys of the Trent (the rivers Dove and Idle) and to assess the impact of their evolution on the main valley floor. Study of the Idle and Dove will be complimented with supplementary study of two lesser valleys (the Devon and the Dover Beck; Figure 1) with the overall aim of identifying landscapes and resources in these tributaries that might elucidate key issues in the study of the main Trent Valley.

Study of these tributary valleys is considered important both because of the direct impact of past, present and future aggregate extraction on their cultural heritage and landscape and because research in other major river systems suggests that cultural and climatic signals are less blurred in tributary systems (Brown and Quine, 1999) and their study can therefore provide a detailed understanding of processes occurring upon the main valley floor.

For example, in the Trent river system study of human impact and environmental processes in tributary valleys might be expected to elucidate the apparent onset of large scale alluviation during the Romano-British period (*cf* Buckland and Saddler, 1985) or the reworking of large parts of the main valley floor from the Neolithic (Salisbury *et al.,* 1984). Overall, the study will contribute information to inform strategic management of the geoarchaeological resource in the tributary valleys and enhance understanding of the Trent Valley itself.

The proposed research, which is submitted under the *aegis* of Trent Valley GeoArchaeology, will be undertaken by the University of Birmingham (Institute of Archaeology and Antiquity, Dr Andy J Howard; Birmingham Archaeology, Keith Challis). The Environment Agency (represented by Mr Andrew Heaton) is a collaborative partner in the proposal and will contribute data, play a role in guiding the research so that anticipated results re tailored to the needs of the end-user community.

1.3 ANTICIPATED KEY BENEFITS

The proposed research is intended to generate materials and information of benefit to a broad swathe of the stakeholder community in the Trent Valley. Archaeological curators and others with a strategic management responsibility for the archaeology and landscape of the study areas will benefit from new GIS data (derived from analysis in the proposed project GIS) and supplied in a format suitable for inclusion in their corporate GIS. In addition, as part of phase two – the analysis stage of the project, a discussion document on geoarchaeological issues in the studied tributaries and their relevance to wider archaeological issues in the main valley will benefit both curators and the aggregates industry. The wider interested public will benefit from information imparted via the project web-site, information leaflets, lectures delivered by the project team and the publication of project results in a popular format. Publication of several papers discussing projects results in peer-reviewed journals will make a contribution to academic debate.

In summary, the proposed research will deliver:

- Comprehensive assessment of the geomorphological character, geoarchaeological and palaeoecological potential of the study areas.
- Information, including GIS data in appropriate formats, delivered to those with a strategic management responsibility, including SMRs and the Environment Agency.
- A major contribution to the academic study of the tributaries of the River Trent addressing key issues such as the timing and impacts of alluviation and the changing hydrological conditions triggering the reworking of the sands and gravels of the main valley floor.
- Approachable popular literature on the geoarchaeological significance of these rivers.

1.4 PROJECT BACKGROUND

Trent Valley GeoArchaeology 2002 (PN 3307) established a comprehensive benchmark in the understanding of the geomorphological character, landscape development and human settlement of the Trent Valley along its entire length (Knight and Howard 1994; Knight and Howard, 2004).

Tributary valleys have received less attention. However, a number of studies of confluence zones along the river (the Tame–Trent, ("Where Rivers Meet" by Birmingham Archaeology); the Derwent-Trent (Knight and Howard, 1994); the Soar–Trent (Brown *et al.,* 2004)) indicate that they contain landform assemblages and sediments which provide important archives for understanding changing patterns of river type, sediment supply and hydrological conditions on the main valley floor during the Holocene.

The proposed project compliments the on-going research by Birmingham Archaeology and the University of Exeter in the Trent – Tame and Trent – Soar confluences. Methodological experience, particularly gained in remote sensing (especially GPR, LiDAR and IFSAR) will inform the methods used in the present study. Discussion on results and interpretation will assist in developing understanding and models for tributary and main valley development that take in all available evidence. Close project collaboration is assured by the fact that key personnel are shared amongst the projects in question.

1.5 THE STUDY AREAS

The research will examine two of the principal tributary valleys of the Trent: the Dove (joining the upper Trent opposite Newton Solney: Figure 2) and the Idle (joining the lower Trent at West Stockwith; Figure 3). In addition, some supplementary additional study will be undertaken to investigate two lesser and physiographically contrasting valleys, the Dover Beck (joining the middle Trent at Caythorpe; Figure 4) and the Devon (joining the middle Trent at Newark; Figure 4). These valleys have been selected to provide contrasting physiographic contexts, land-use histories and geomorphological inputs and processes, which have all been demonstrated through empirical research to affect thresholds within the geomorphic system and hence the evolution of the valley floors.

1.5.1 Future Aggregate Extraction

The Idle and Dove Valleys are directly affected by aggregate extraction (at Misson, Sutton and Lound, Finningley, Blaco Hill, Tiln, Scrooby, Eggington and Leasowes Farm), the Devon and Dover Beck are not presently affected by aggregated extraction, but geological survey mapping shows the presence of river terrace sand and gravel deposits that are potentially of commercial value. Details of future aggregate extraction proposals within the study areas are contained within the Mineral Local Plans (MLP) produced by Nottinghamshire, Derbyshire and Staffordshire Councils which cover strategic planning up to 2006.

Pressure to win aggregate is greatest in the Idle Valley. Here the Nottinghamshire County Council MLP notes that:

> *If no further reserves are permitted then all four main quarries at Sutton & Lound, and Misson will be exhausted by 2007. These currently produce over 1 million tonnes per annum. In the Idle Valley, resource depletion is a major problem. This factor when combined with environmental constraints affecting what little remains, severely limits options beyond re-allocating land east of the River Idle.*

[…]

> *At Misson the lack of reliable geological information on this extensive, but unpredictable, resource precluded the allocation of specific sites. A number of planning permissions were … granted under that approach. However, recent geological investigations and environmental concerns suggest that no further significant acceptable options exist. This means that by 2007 a shortfall of around 500,000 tonnes per annum will occur. The Plan proposes to meet this shortfall in the short term by allocating a small extension to Finningley.*

In addition, reserves at Blaco Hill and Tiln are likely to be worked out by 2004/5. An existing allocation east of the River Idle, which contains an estimated 2 million tonnes of sand and gravel, remains to be taken up and would secure reserves until 2012.

The MLP notes that:

> *This allocation is believed to represent the limits of the economic sand and gravel resource east of the Idle. Further resources, totalling 3 million tonnes, have been identified to the west of the Great North Road and south of Barnby Moor. Whilst this land could follow on from the allocation east of the Idle, …[it]… is not without significant environmental constraints.*

At Scrooby, sand and gravel extraction has normally been very small scale and erratic, further reserves within an area of search are permitted to maintain historic levels of production and further extensions are possible.

In the Dove Valley the Derbyshire County Council MLP notes that:

> *Permitted sites together with the existing active sites should be capable of meeting anticipated production until around 2000; after this time, further areas of workable reserves will need to be made available. Assessment showed that the areas of the Upper Dove Valley are particularly constrained in terms of the quantity and quality of the mineral deposit, the quality of the landscape, and the relatively poor communication links with the major markets.*

The preferred area of search for additional sand and gravel provision is therefore the Lower Dove area. The Staffordshire MLP proposes restrictions to aggregate extraction in the Dove Valley west of Hilton, with extraction restricted to existing sites in the Lower Dove Valley.

1.5.2 Previous Studies of Tributaries of the Trent

In general, the geoarchaeological character of each of the tributary systems is imperfectly understood, although some limited work has been undertaken, for example, on the Dove (Dalton and Fox, 1988; Havelock *et al.*, 2004) and the Idle (Grattan, 1990; Howard *et al.,* 1999a). In addition, mapping by the British Geological Survey indicates that the Dover Beck and Idle Valleys both contain extensive peats. In the Idle, these deposits have yielded nationally important archaeology, often buried within and beneath the peaty sediments, such as the Late Mesolithic site at Misterton Carr (Buckland and Dolby, 1973) as well as significant environmental records (NAA, 2002). However, coring around Mattersey in the middle Idle has demonstrated the shrinkage and desiccation of these organic sediments (Howard, 1996) most probably exacerbated by down draw on the water table caused by water extraction for agriculture and by aggregate extraction (e.g. French, 2004). The potential to use these deposits to provide records of climate and land-use is decreasing rapidly. A new ALSF funded initiative by Dr Malcolm Lillie at the University of Hull is to investigate water table dynamics in relation to aggregate extraction sites in the Misson area (PN 3557) and co-operation and exchange of information with this initiative will be essential. Given the national and international significance of archaeological and environmental datasets recovered from similar deposits in the wider Humberhead Levels (Smith 1985; Boswijk *et*

al., 2001; Whitehouse *et al*., 2001), the opportunity to investigate these deposits now should not be lost.

1.5.3 Sub-surface Modelling, Remote Sensing and Computer-based Simulation

Three-dimensional sub-surface modelling, airborne remote sensing and computer-based modelling of landscape processes form key components of the proposed research. Work will build on previous ALSF funded research by the principal investigators and others (Challis and Howard 2003, Challis 2004a and b). In particular it is hoped to build on the innovative use of LiDAR for floodplain mapping developed by the project PIs as part of ALSF supported projects Trent Valley GeoArchaeology 2002 (PN 3307) and *Predictive modelling of multi-period geoarchaeological resources at a river confluence* (PNUM 3357; known colloquially as the Trent – Soar Project). Trent Valley GeoArchaeology proved the utility of EA 2m spatial resolution LiDAR for mapping floodplain features. The Trent-Soar project used 1m spatial resolution LiDAR from a specially commissioned survey flight to map floodplain and terrace features and included examination of reflected laser intensity data to examine soil moisture and hence palaeoecological potential, and comparison of LiDAR and IFSAR elevation data. The present project will build on the previous studies by using EA 2m resolution LiDAR to map floodplain features, principally in the Dove Valley using the methodology developed for TVG 2002. If possible the study will extend the use of EA LiDAR by examining reflected laser intensity data from the EA survey flights; a data source not normally made available as part of the EA LiDAR product.

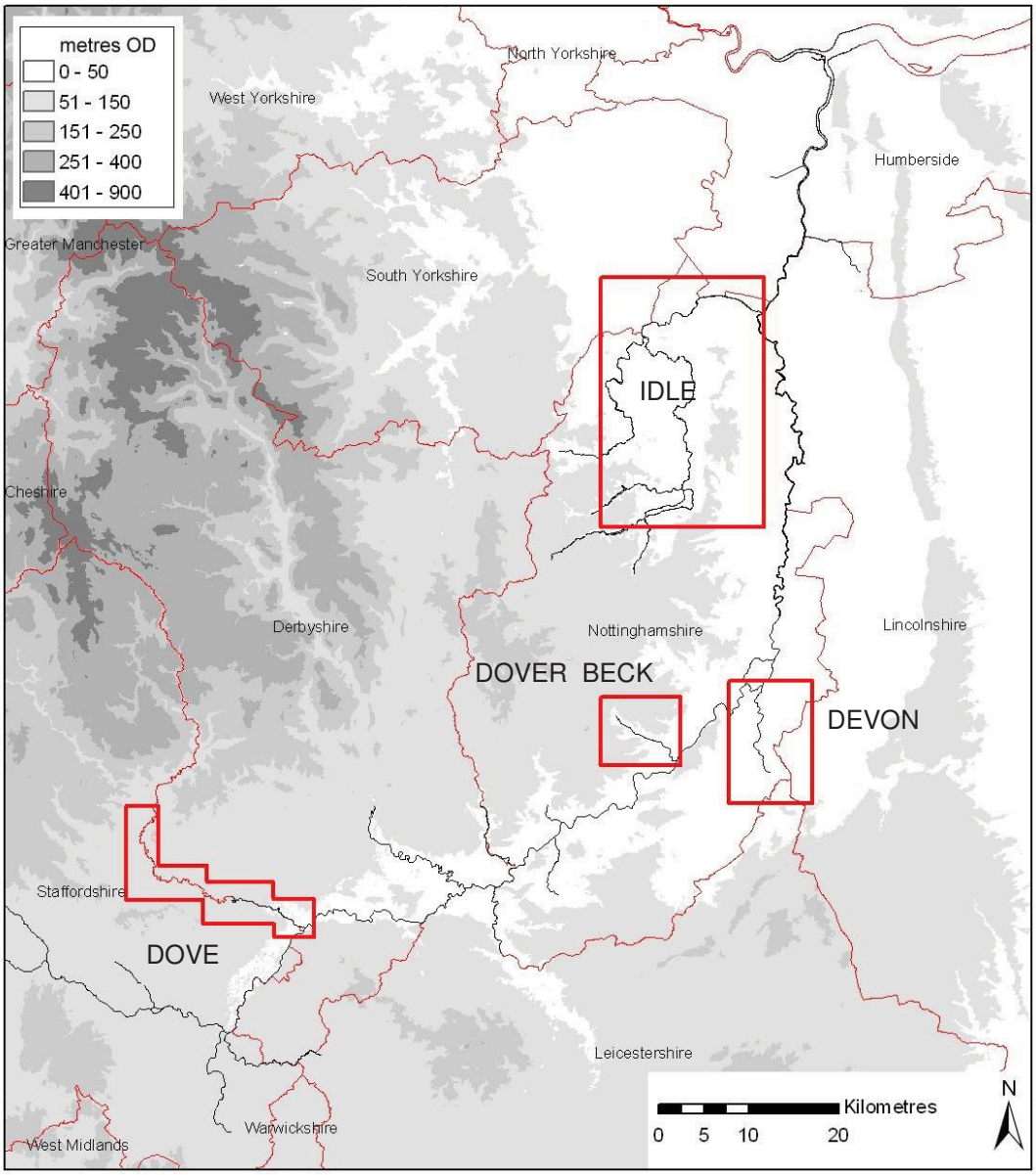

Figure 1. Topographic map of the midlands showing the Trent river system and the two principal and two supplementary tributary study areas.

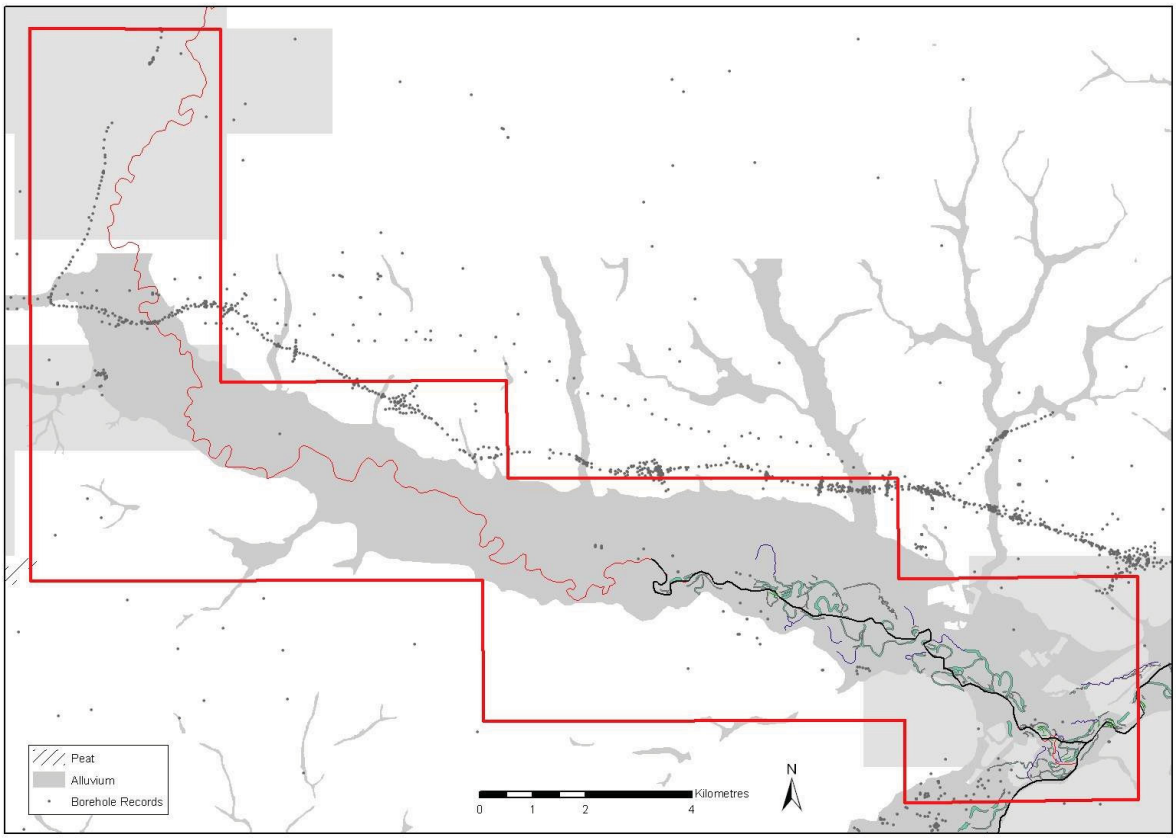

Figure 2. The Dove study area in relation to the upper Trent Valley. The map includes information from the TVG2002 GIS, including palaeochannels of the Trent. The maximum extent of the proposed study area is indicated by the red outline. Pale grey tone indicates the limited extent of LiDAR data available from EA.

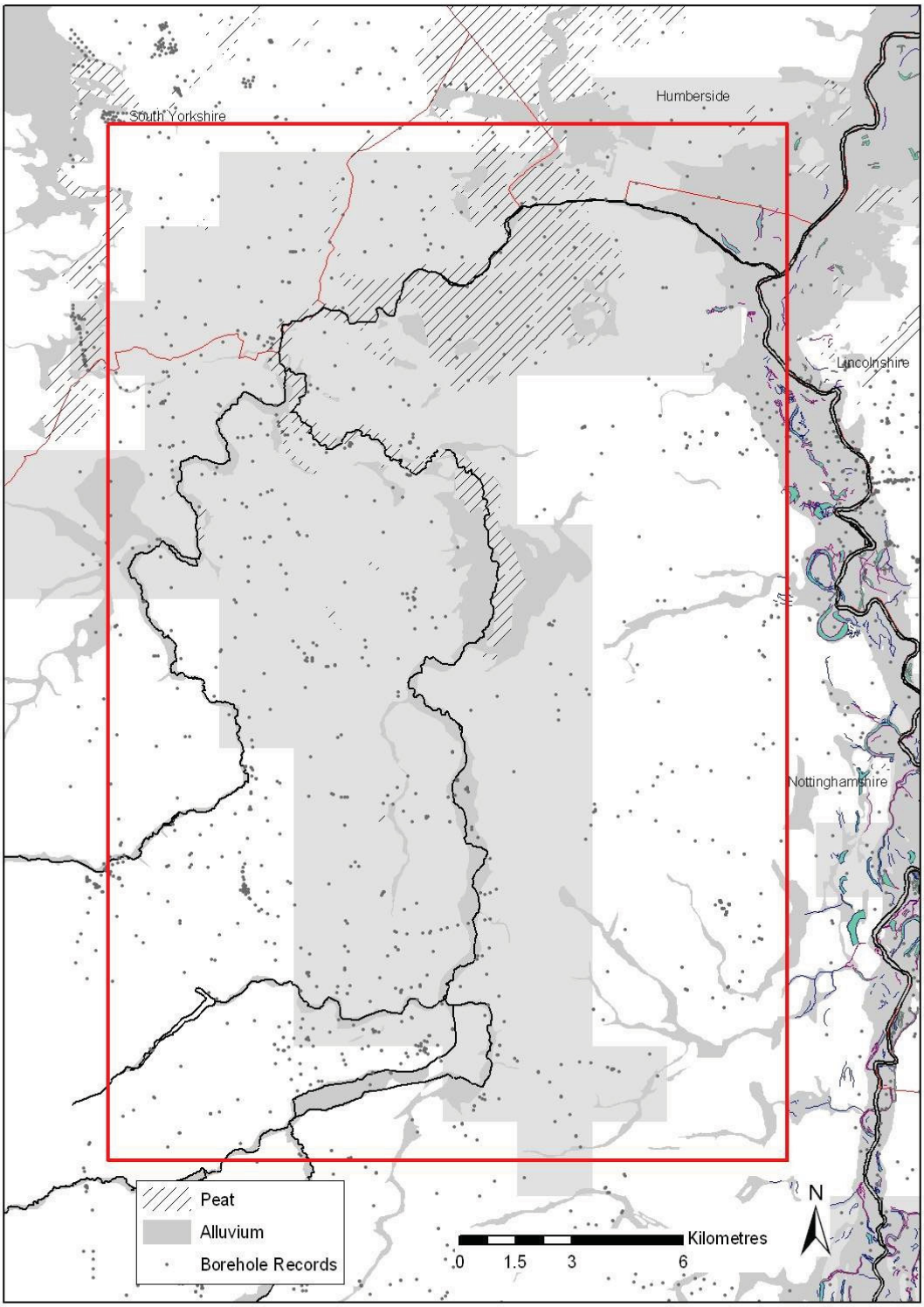

Figure 3. The Idle study area in relation to the lower Trent Valley. The map includes information from the TVG2002 GIS, including palaeochannels of the Trent. The maximum extent of the proposed study area is indicated by the red outline. Pale grey tone indicates the extent of LiDAR data available from EA.

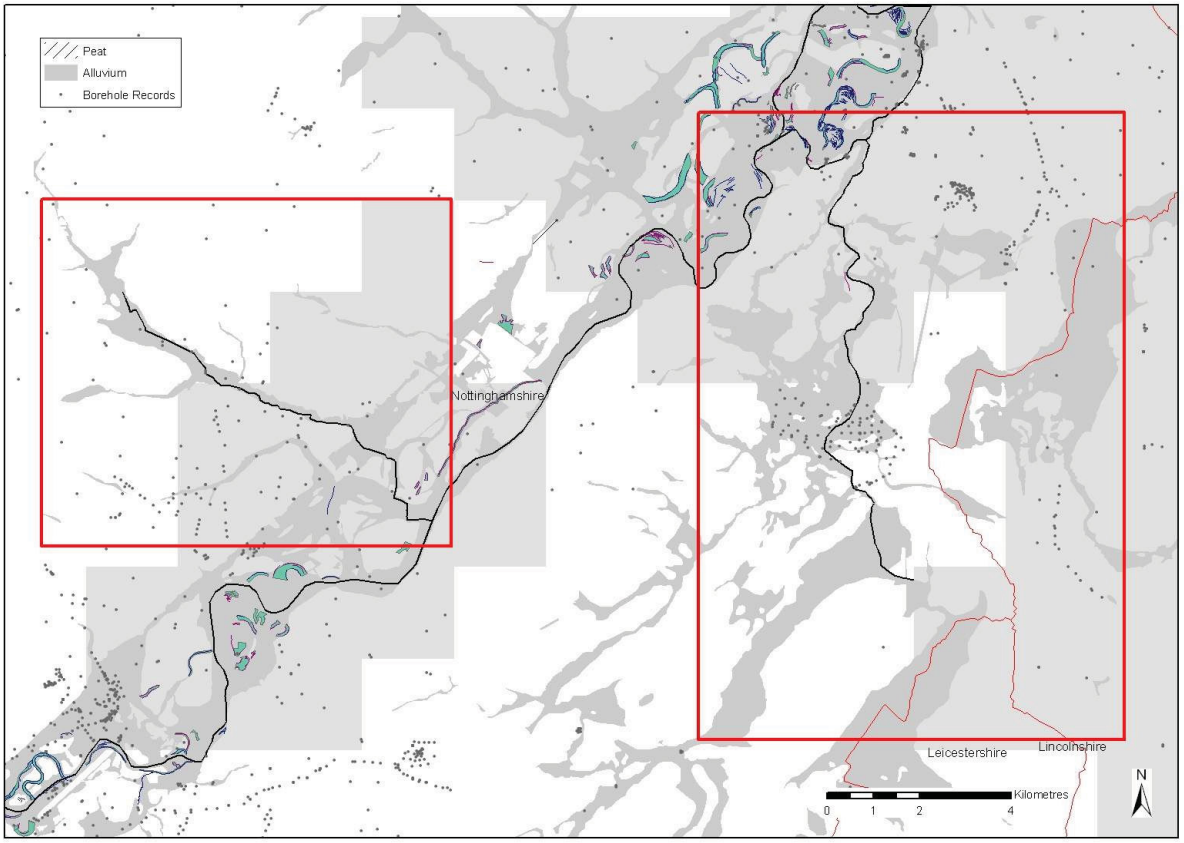

Figure 4. The Devon and Dover Beck study areas in relation to the middle Trent Valley. The map includes information from the TVG2002 GIS, including palaeochannels of the Trent. The maximum extent of the proposed study areas are indicated by the red outline. Pale grey tone indicates the extent of LiDAR data available from EA.

2 AIMS AND OBJECTIVES

2.1 INTRODUTION

This research aims to elucidate the geoarchaeological development of two principal and two lesser tributary valleys of the Trent (the rivers Dove, Idle, Devon and the Dover Beck) and to assess the impact of their evolution on the main valley floor. The results will inform strategic management of the geoarchaeological resource in these tributary valleys and enhance understanding of the Trent Valley itself.

The proposed work will compliment that undertaken as part of TVG 2002 through study of the Idle and Dove Valleys (with comparative study of the Devon and Doverbeck) to the same benchmark standards.

Aggregate extraction has a direct impact on the archaeology and landscape of the Idle and Dove Valleys and information derived from the study will inform future strategic management decisions in these valleys, in particular through identifying key landscapes and resources which are threatened by future extraction and in particular those which contribute significantly to the understanding of the archaeology of the main valley and so are worthy of special attention/protection.

A number of specific research and management questions are posed.

- Identification of key areas in which each studied tributary valley contributes to major themes in the archaeology and landscape development of the Trent river system.

- Identification and spatial isolation of areas of key significance so as to produce a landscape risk map of the tributary valleys (*cf* TVG 2002 component 4)

- Assessment of the impact of proposed future aggregate extraction in the study area in terms of areas of significant geoarchaeological resource.

- Review of how understanding of the geoarchaeological resource of individual tributary valleys and their catchment-wide significance and contribution to strategic management decisions in the main Trent Valley.

Research will develop empirical models of the geoarchaeological evolution of each tributary valley and will rely on the use of a comprehensive suite of field, laboratory and computational techniques already developed and tested extensively in the Trent Valley and elsewhere (Howard *et al.*, 2001, Howard *et al*., 1999b, Howard *et al*., 2004).

Discrete landform assemblages will be mapped in the field and by remote sensing (Passmore *et al*., 2002), alluvial architecture examined via borehole data and a programme of radiocarbon dating of material recovered from cores, temporary and natural exposures will allow the construction of a high-resolution chronology for valley floor evolution.

In order to address these broad objectives, the proposed research will comprises two interlinked modules focused around (1) mapping of landform assemblages, (2) alluvial architecture and palaeoenvironmental analysis. The research is programmed to take place in

two phases (following the guidelines set out in MAP2). Phase 1, data collection, integration, fieldwork and assessment will culminate in an assessment report, archive and project design for phase 2. Phase 2, will comprise comprehensive analysis of data gathered in phase one and lead to further archive, reporting, publication and dissemination of the results of the research.

The aims and objectives of each module of phase 1 are set out below in the form of objectives (labelled A1, A2, B1, B2, etc.) and their component tasks (labelled A1A, A1B, etc.). Section 3 contains similarly labelled explanatory method statements for each component task.

2.2 MAPPING OF LANDFORM ASSEMBLAGES

2.2.1 A1: Creation of a Project Geographical Information System (GIS) comprising baseline topographic, geological and archaeological data

A GIS will be developed as a tool for collating, managing and analysing topographical, archaeological and landscape data collected as part of the project. In this sense the GIS will serve as a research tool for the project team and it is not intended to create a stand-alone GIS for supply to end-users, particularly as data licensing issues and compatibility with end-users in-house systems would render this impractical. Rather, data derived from the project GIS will be supplied, as far as licensing permits, to end-users in a format suitable for incorporation into their own in-house systems. This follows the model successfully adopted in TVG2002, and end-users of data from that project report successful integration of supplied borehole and palaeochannel data into their various systems.

The GIS will comprise two principal elements: off the shelf data from third parties (such as Ordnance Survey and Geological Survey digital mapping) and new data generated by research undertaken as part of the project (such as field and remotely sensed landform mapping). The aim of this project component is to produce a durable geospatial information system able to operate at various scales (eg regionally to map catchment-wide landscape issues and on a reach level to map and analyse individual landscape elements). GIS creation comprises two tasks (below) described in greater detail in section 3.1.1

A1A GIS design and preparation
A1B Collection of HER data

2.2.2 A2: The reconstruction of valley floor palaeolandscape through the mapping of discrete landform assemblages

The aim of this project component is to produce comprehensive mapping of geomorphology and landscape of the study areas through a combination of remote sensing and fieldwork. Landform mapping will comprise mapping of palaeochannels and other plaeodrainage features using both conventional aerial photography and LiDAR/IFSAR (*cf* TVG 2002 component 2 and 3). This will be supplemented by field mapping. The landform maps will be further enhanced by incorporation of details of sub-surface alluvial architecture as part of component B1 and 2 (2.3.4 below).

Landform maps will be integrated into the project GIS and supplied to end-users as digital data. It is intended that analysis of these maps will eventually form the basis of digital

risk/alert mapping generated though analysis of the data in stage 2 of the project. This project component comprises five tasks (below) described in greater detail in section 3.1.2.

A2A LiDAR acquisition, input and assessment
A2B IFSAR acquisition, input and assessment
A2C Air-photographs acquisition, input and assessment
A2D Historic mapping acquisition, input and assessment
A2E Field mapping of geomorphology of study area

2.3 ALLUVIAL ARCHITECTURAL AND PALAEOENVIRONMENTAL ANALYSIS

2.3.1 B1: Mapping and modelling of three-dimensional sub-surface alluvial architecture

This component of the overall project aims to produce comprehensive three-dimensional character data for the alluvial deposits of the floodplains of the study areas in a durable Geographical Information System (GIS) format. This data will contribute to the landform mapping and provide a new data source for the Sites and Monuments Records (SMR) of participating local authorities. This component will comprise the collation, analysis and modelling of shallow geological borehole data within the context of a GIS. The aim of the component is to increase knowledge of the baseline geoarchaeological resource within the floodplain and to clarify the character and potential of that resource. The objectives are:

- A GIS-based catalogue of borehole data located in the floodplain of the study area that may be integrated with existing GIS data and data structures (for example the SMRs of participating local authorities).

- GIS derived maps showing the broad character of the alluvial deposits for the entire study area (at a catchment scale), including for example mapping the thickness of alluvial sand and gravel deposits and the distribution of peat deposits as a guide to the presence of palaeochannels.

- Production of sub-surface digital terrain models (DTM) of significant stratigraphic horizons at reach scale to attempt to identify and map key topographical features such as buried palaeochannels and gravel islands.

The component comprises two tasks (below) described in greater detail in section 3.2.3.

B1A Borehole acquisition and digitising
B1B Borehole data assessment

2.3.2 B2: Identification and palaeoenvironmental assessment of areas where organic sediments are preserved to determine the state of preservation and potential for buried landsurfaces and associated archaeology

The aim of this component is to identify and assess through sampling, areas where organic sediments are likely to be preserved. These areas, which will usually correspond with palaeochannel depressions and areas of backwater sedimentation, will be identified through a combination of field survey and analysis of remotely sensed imagery. This component will

provide a baseline assessment of the quantity and quality of palaeoenvironmental resource in these tributary valleys and their usefulness as proxy indicators of land-use and climate. The objectives are:

- To provide a baseline survey of the spatial distribution of palaeoenvironmental deposits across these valley floors

- To sample selected deposits and undertake palaeoenvironmental assessment to determine their suitability for providing proxy records of climate and land-use

The component comprises two tasks (below):

B2A Coring and sample recovery
B2B Core sample selection and palaeoenvironmental assessment

2.3.3 B3: Development of a high-resolution chronological framework through radiocarbon dating

This component is focused on using radiocarbon dating to provide a chronological framework for the stratigraphic units and hence allow detailed reconstructions of the development of these tributary valley floors (e.g. timing of episodes of incision, sedimentation, erosion). It is assumed that as in previous rounds of ALSF, the scientific dating team at English Heritage will provide this service 'in-kind' and will therefore, be closely involved in the development of a sampling methodology and selection of material for radiocarbon dating. However, broadly, the aim of this component is to:

- Identify deposits and sample materials suitable for radiocarbon dating to provide a chronological framework for the reconstruction of valley floor alluvial histories

The component comprises two tasks (below):

B3A Liaise with EH dating team over sampling methodology
B3B Select suitable samples for dating.

2.4 ASSESSMENT REPORTS AND UPDATED PROJECT DESIGN FOR PHASE 2, ANALYSIS AND PUBLICATION

2.4.1 C1: Prepare assessment reports and updated project designs

The aim of the first phase of the research is to gather, collate and assess comprehensive data for the archaeology, geomorphology and palaeoecology of the study areas. This data will be comprehensively assessed for its utility for future detailed analysis as part of this first phase. At the completion of the assessment it is intended to produce two stand alone documents reporting on the assessment of the two principal project components: landform and valley floor evolution; and alluvial architecture and palaeoenvironment. These documents will be supported by a project design for phase two, the analysis of the collated data leading to final reports and publication of results. This project component thus has three tasks (below) described in greater detail in section 3.3.1.

C1A Assessment report: mapping of landform assemblages and development of models of valley floor evolution.
C1B Assessment report: alluvial architecture and palaeoenvironmental analysis.
C1C Updated project design for phase 2 analysis and publication.

2.5 PROJECT REPORTS AND ARCHIVE

2.5.1 D1: Dissemination of Project Reports and Archive of GIS Data

Although substantial publication and final dissemination of project results is not envisaged until the completion of stage two of the project, it is recognised that the results of the assessment and the data gathered as part of phase one will be of use to Trent Valley stakeholder community and envisaged end-users.

In order to achieve as wide as possible dissemination of information about the project and its results a project website will be established at the outset as a part of the Trent Valley GeoArchaeology web (www.tvg.org.uk. This will contain an edited version of the project design and periodically updated interim accounts of project progress. At the completion of phase, project on-line versions of the assessment reports will be made available for download from the website.

Data, in particular GIS data, produced as part of phase one will be archived following the GIS data guidelines set out by the Archaeological Data Service (Gillings and Wise, 1998). Those GIS data that have been generated by the project team (principally palaeochannel plots, landform mapping and collated borehole observations) will be distributed to end-users in a format suitable for incorporation into their own GIS on CD-ROM (as was the case with TVG2002).

GIS data will also be made available for inspection (and perhaps download) via an on-line mini-GIS which will form part of the project website. This will be implemented using ArcIMS following the model developed by Birmingham Archaeology for the *Where Rivers Meet* project.

This project component has four tasks (below) which are described in more detail in section 3.3.2.

D1A Project Website
D1B On-line assessment reports and data archive
D1C GIS Data Archive
D1D GIS Data for End Users

2.6 CONCLUSIONS

This project aims to produce baseline information that will assist effective future management of the archaeological resource of two tributary valleys of the River Trent and through generating information for comparison with the Trent itself, contribute to the strategic management of the main valley floor. Research will include characterising the archaeological and geomorphological resource of the study areas and include methodological and technical development in remote sensing, in particular the use of LiDAR and IFSAR.

Anticipated results will be of wide benefit to the stakeholder community, including curators, and the aggregates industry. In phase two of the project published outcomes will serve both the academic and wider communities.

These aims contribute strongly both to key ALSF research criteria and to the research priorities for the Trent and its tributaries established by Trent Valley GeoArchaeology.

3 METHOD STATEMENTS FOR FIELDWORK, DATA COLLATION, AND ASSESSMENT

3.1 MAPPING OF LANDFORM ASSEMBLAGES

Comprehensive geomorphological mapping of the floodplain and terraces of the studied rivers will be undertaken through a programme of LiDAR and aerial photographic analysis and field mapping. Data will be collated in a geographical information system (GIS) developed using ESRI's ArcGIS and compatible with that devised for Trent Valley GeoArchaeology 2002. The Environment Agency will act as a project partner by providing access to LiDAR data. Where LiDAR is not available it will be substituted with nationally available IFSAR elevation data purchased from NEXTMap.

3.1.1 A1: Creation of a Project GIS comprising baseline topographic, geological and archaeological data

A1A GIS Design and Preparation

The GIS will be developed using ESRI's ArcGIS following the general data model and structure devised by the present authors for Trent Valley GeoArchaeology as part of the first round of ALSF funding.

Basic data layers will comprise Ordnance Survey (OS) 1:10000 and 1:50000 topographic mapping and 1:10000 digital terrain model (licensed via Edina), Geological Survey 1:50000 mapping (using the existing TVG license, but requiring extension to cover the lower Dove Valley) and palaeochannels maps produced as part of Trent Valley GeoArchaeology 2002, which cover parts of each study area close to the confluence of tributaries rivers with the Trent, but not the actual tributary valleys. These data will form part of the research GIS intended solely for use by the project team. It is not intended that Ordnance Survey or Geological Survey data be supplied to any third party (copyright restrictions prevent this). TVG2002 data is already widely distributed amongst the end-user community.

Additional data will comprise minerals allocation areas and existing quarries digitised by the project team from County Council MLP documentation, historic environment records (SMR, NMR, etc.), remotely sensed imagery, air-photographs, historic mapping, digitised field mapping and borehole data collected as part of the research by the project team. Thus the project GIS will serve both as a research tool for the project team and a source of data for end-users in the stakeholder community. It is not intended that the project GIS *per se* be made available beyond the project team, although an on-line version of aspects of the GIS will be developed for the website. However, data derived from the GIS will be supplied to end-users in appropriate formats.

Product

The principal product of this project component will be an ArcGIS based GIS comprising:

- Ordnance Survey 1:50000 and 1:10000 topographical mapping
- Ordnance Survey 1:10000 digital terrain model
- Geological Survey 1:50000 DigiMapGB50 geological mapping
- TVG2002 palaeochannel mapping

- Minerals allocation areas and existing quarries digitised from MLPs.

A1B HER data

Existing Historic Environment Records, principally Sites and Monuments Record (SMR) and English Heritage National Mapping Programme (NMP) cropmark data will be collected for incorporation into the GIS. Access to this data will allow understanding of past settlement, land use and exploitation of the floodplain, terraces and adjacent areas of each tributary. Digital SMR data will be obtained for relevant parts of Nottinghamshire, Derbyshire and Staffordshire and English Heritage National Mapping Programme air-photo plots will be acquired as scanned and georeferenced raster data for incorporation into the project GIS. These data will be vectorised to produce simple linework using the ArcScan module of ArcGIS, but no further manipulation of this data is anticipated. Vectorised NMP data will be returned to English Heritage at completion of phase one of the project. HER data will form part of the research GIS intended solely for use by the project team. It is not intended that HER data be supplied to any third party as copyright restrictions prevent this.

Assessment of HER data will be restricted to examination of data formats and structures, for example, it is anticipated that some level of comparison and reconciliation of SMR and NMR data will be useful and it may prove fruitful in the analysis stage to generate homogenised archaeological data for the study areas drawing from all existing HER. This onerous and time consuming exercise was examined as part of the Trent Valley GIS pilot study using only the NMR Monarch data and the Nottinghamshire SMR (Challis *et al* 1999). Since both Monarch (now Amie) and the various SMRs have undergone considerable revision and updating since 1999 (the SMRs for example having been updated to comprise vector polygons with attributes) provision has been made in the phase one project design only for a trial and assessment of the utility and effectiveness of merging and reconciling HER data. If it proves to be a useful and feasible goal, a method statement and time allocation will be included as part of phase two of the project.

Product

The products of this project component will comprise:

- NMR raster cropmark plots integrated into the project GIS
- Vectorised English Heritage NMP plots
- HER data (NMR and SMRs) integrated into the project GIS
- Trial reconciliation of SMR and NMR data with recommendations for future action

3.1.2 A2: The reconstruction of valley floor palaeolandscape through the mapping of discrete landform assemblages

Assessment of remotely sensed imagery and air-photo geocorrection will be undertaken using ERDAS Imagine image processing software. Imagine uses file formats that are directly compatible with ArcGIS and provides a powerful suite of tools for image analysis and three-dimensional visualisation.

A2A LiDAR acquisition, input and assessment

Airborne laser altimetry (often abbreviated to LiDAR from Light Detection and Ranging) uses the properties of coherent laser light, coupled with precise kinematic positioning provided by a differential global positioning system and inertial attitude determination provided by an inertial measurement unit, to produce horizontally and vertically accurate

elevation measurements. LiDAR is frequently used as a tool for examining aspects of the character of river floodplains, most often for geomorphological and flood modelling purposes (Lohani and Mason, 2001; Charlton *et al.,* 2003; Cobby *et al.,* 2001; Marks and Bates, 2000), but also for such varied applications as shallow water bathymetry (Guenther *et al.,* 2000) and mapping sand dune morphology (Rango *et al.,* 2000). Some archaeological uses of LiDAR have been examined in recent studies (Barnes, 2003; Bewley, 2003; Challis, in review b). The effectiveness of LiDAR for examining floodplain geoarchaeology was amply demonstrated in Trent Valley GeoArchaeology 2002 (component 2b; Challis 2004a).

An aircraft mounted laser, most often a pulse laser working at rates in excess of 30 MHz, projects a coherent beam of light at the ground surface, the reflection of which is recorded by a sensitive receiver. Travel times for the pulse/reflection are used to calculate the distance from the laser to the reflecting object. To enable coverage of broad areas, a swath beneath the moving aircraft is scanned by using rotating mirrors to direct the laser. The spatial resolution and scan swath width are determined by the frequency of the laser pulse and altitude of the aircraft at the time of survey. Typically, the receiver is able to record multiple returns for a single pulse, allowing recording, for example, of a partial return from the top of a semi-opaque object such as a woodland canopy (usually referred to as a first-pulse (FP) return) and from the opaque ground beneath the canopy (a last-pulse (LP) return). Other information, such as the intensity (amplitude) of the reflection may also be recorded. A detailed technical discussion of LiDAR may be found in Wehr and Lohr (1999).

LiDAR data for the project will be provided by project partners the Environment Agency as part of their contribution to the research. Data will comprise EA's standard 2m spatial resolution elevation product supplied as ArcGIS ASCII grid files. In addition; EA have agreed to supply access to raw point cloud data for the Idle Valley study area. This data will be reprocessed by Birmingham Archaeology to generate first pulse, last pulse and laser intensity data layers which will allow analysis beyond that possible using EA's standard data product.

LiDAR DSM

Assessment of LiDAR Digital Surface Model (DSM) data will be undertaken to extract significant landscape features such as palaeochannels from the DSM. This work will produce vector data to complement that generated from analysis of air-photographs (task A2C). This information will provide a basis for field mapping of geomorphology (task A2E) and the selection of coring sites (task B2A). In addition, the LiDAR DSM provides "elevation at surface" information for borehole assessment and three-dimensional sub-surface modelling (tasks B1A and B1B) and geomorphological modelling of landscape development (tasks C1A-C).

LiDAR Reflected Laser Intensity

This data provides an indication of the intensity of reflection of the laser pulse. Initial examination suggests that there is a fall-off in the intensity of the reflected light that corresponds with landscape features such as palaeochannels. Variations in the reflectivity of various earth surface materials to laser light of differing wavelength are quite well documented (for example see Wehr and Lohr, 1999: 74) and damp soil conditions are known to reduce reflectivity. It is possible that the increased soil-moisture associated with palaeochannels and perhaps other associated variations in soil and vegetation properties, are responsible for the reduced reflectivity of the laser pulse. This phenomenon is untested, but worthy of further examination as if reflected laser intensity is indeed related to soil moisture

it may provide a useful means to identify waterlogged features likely to be of greater palaeoecological significance, or even the slight variations in soil moisture that are responsible for the formation of archaeological cropmarks. Laser intensity data will be compared to the distribution of palaeochannels and other landscape features mapped using LiDAR and other techniques.

Further analysis of LiDAR data might be undertaken as part of phase two of the project and could comprise mapping of archaeological features of the landscape and the examination of the utility of LiDAR for mapping floodplain features as compared to conventional sources of information such as air-photographs and other remotely sensed data such as IFSAR. In addition the study of factors affecting laser intensity might usefully be undertaken. A method statement for this work will be included in the phase two project design if assessment during phase one indicates that it will be useful.

Product
The product of this project component will comprise:

- EA LiDAR DSM integrated into the project GIS.
- First pulse, last pulse and laser intensity data generated from reprocessed EA point cloud data and incorporated into the project GIS.
- Assessment of LiDAR data for the study areas including project method statement for further analysis.
- Vector digital data showing palaeochannel and other landscape detail digitised from LiDAR by the project team.

A2B IFSAR acquisition, input and assessment
Since LiDAR data are not available for the entire study area, in particular for most of the lower Dove Valley (Figure 4) it will be supplemented with IFSAR elevation data.

Airborne radar uses radio waves to measure the distance between an aircraft mounted senor and the ground surface. Interferometry relies on picking up the returned radar signal using antennas at two different locations. Each antenna collects data independently, although the information they receive is almost identical, with little separation (parallax) between the two radar images. Instead the phase difference between the signals received by each of the two antennas is used as a basis for calculating changes in elevation. The results are enhanced by using processing techniques during data collection to generate a synthetic aperture of much greater size than the physical antenna used and so enhance resolution (Intermap, 2003). Combining the principals of Synthetic Aperture Radar with Interferometry, Interferometric Synthetic Aperture Radar (IFSAR) is capable of producing both a radar image of the ground surface and calculating elevation changes to enable production of a digital surface model (DSM).

Intermap has undertaken IFSAR surveys of the entire of the UK. The results of the surveys are available as a commercial product in the form of 5m spatial resolution DSM with a vertical accuracy of between 0.5 and 1.0m and a 1.25m spatial resolution radar image. The project will acquire the DSM for selected parts of the study area where LiDAR coverage is incomplete, principally in the lower Dove Valley. IFSAR DSM data are available in ASCII raster format suitable for direct import into the project GIS for processing and analysis. Assessment of the IFSAR DSM will complement that for the LiDAR DSM (ie mapping of significant landscape features to support field mapping, provision of elevation data for

boreholes and geomorphological modelling of landscape development). The lower resolution of the IFSAR DSM when compared to LiDAR will inevitable limit its effectiveness in defining fine landscape detail. In general variations in resolution will not pose a problem in data processing as ArcGIS is able to integrate data on multi-scales, from regional to reach level in a single GIS view.

Further analysis of the IFSAR DSM might be undertaken as part of phase two of the project and could comprise detailed comparison with other remotely sensed data sources and conventional aerial photography. A method statement for this work will be included in the updated PD.

Product
The product of this project component will comprise:

- NEXTMap IFSAR DSM integrated into the project GIS.
- Assessment of IFSAR data for the study areas including project method statement for further analysis.
- Vector digital data showing palaeochannel and other landscape detail digitised from IFSAR by the project team.

A2C Air-Photographs acquisition, input and assessment

Conventional aerial photography will be used to map significant landscape features such as palaeochannels. In general, the project will follow the method adopted and proven by Trent Valley GeoArchaeology in 2003 (Baker, 2003), which used vertical photographs from two decdes (1940s and 1970s). Air photographs will be scanned (at 150dpi, 8bit, TIF format) rectified and georeferenced to real world co-ordinates by matching significant landscape features with those seen on OS mapping.

Photographs will be sourced from the collections of Nottinghamshire, Derbyshire and Staffordshire County Councils and from the National Monuments Record (Table 1). Photographs from the 1970s will be scanned *in situ* at Nottinghamshire and Staffordshire, and prints of 1970s photographs for Derbyshire purchased from the copyright holder, Simmons Aerofilms, with scanning and mapping rights to allow digitising and GIS use. After commissioning a coversearch for the study areas, selected photographs from the National Monuments Record collection will be viewed, and relevant photographs ordered as prints for digitising and incorporation into the project GIS.

	Notts	**Derbys**	**Staffs**
1970s Photos	Yes	Yes	Yes
1940s Photos	NMR	NMR	NMR
Nos 1970s	100	50	50
Nos 1940s	100	50	50

Table 1. Availability and estimated numbers of air-photographs from each county

Once rectified and georeferenced, topographical features of the floodplain surface will be digitized directly from the air-photographs within ArcGIS. GIS data will comprise a set of polygons and polylines with attached attributes recording information such as the source for the feature and related records (Table 2).

The end result of the module will be GIS data available to the project team for analysis and presented to the participating local authorities in a format suitable for inclusion in their corporate GIS.

Attribute field	**Example of value**
Unique ID	5935
Type	3
Notes	Positive crop mark associated with sinuous field boundary
Notes 2	Parish boundary (Elvaston/Draycott and Church Wilne)
NGR	SK48513735
Photosource 1	HSL UK 69 222_23_0917
Photosource 2	RAF 106G/UK/646_3120
Mapsource 1	OS 1" sheet 29 (1851); shown as active channel
Mapsource 2	
Borehole record	SK58NW/1-6
Palaeo potential	Peat
Date Years BP	1150 +/- 125
Date source	C14 Beta 12345
Comment	Investigated by TPAU (Howard 2008)

Table 2. Attribute fields for digitised palaeochannel data

- Unique ID: numbered from 5001 upwards.
- Type: 1-7 (after Baker, 2003). Where types overlap (for example a cropmark followed by a field boundary), the lowest possible number is given (in this case 3: cropmark). Where more than one type occurs within the length of a feature (for example a depression which continues as a cropmark in a ploughed field), a decision will be made as to which type constitutes the majority of the feature. In both cases the additional information will be recorded in the *Notes* attribute.
- Notes: additional descriptive information supplementing the *Type* category.
- Notes 2: additional descriptive information, generally relating to parish boundary data.
- NGR: an eight-figure National Grid reference given at a central point on the feature.
- Photosource 1: the primary photograph on which the feature was identified and plotted.
- Photosource 2: any other photograph which provided secondary information on the feature.
- Mapsource 1: reference to any historic map on which the feature is shown; text description of how the feature is depicted (e.g. stream course, active channel, relict channel).
- Mapsource 2: for use in future investigations
- Borehole record: for use in future investigations
- Palaeoenvironmental potential: for use in future investigations
- Date in years AD/BC: for use in future investigations
- Date source: for use in future investigations
- Comment: for use in future investigations

Creation of these data as part of phase one of the research is necessary to support field mapping of geomorphology (Task A2E) and assist in selection of sites for coring (Task B2A). If it is felt that useful further analysis of the air-photographic data might be

undertaken as part of phase two of the project a method statement and timings for this work will be provided as part of the phase two project design.

Product

- Geocorrected digital air-photographs incorporated into the project GIS
- Assessment of air-photographic data for the study areas including method statements for further analysis.
- GIS polygon/polyline/attribute data cataloguing geoarchaeological features of the floodplain surface (palaeochannels, etc.).
- Rectified vertical air-photograph mosaics (where the participating local authority has leant photographs in their ownership).

A2D Historic mapping acquisition, input and assessment

A limited selection of historic mapping will be purchased in digital format, or scanned, rectified and georeferenced from paper mapping, for incorporation into the project GIS. Historic mapping has proven of particular use in identifying aspects of floodplain topography that are the result of relatively recent river engineering and isolating recent channel changes. It is proposed to use Ordnance Survey first edition one-inch mapping (mid 19th century vintage) which covers the entire study area, supplemented by other maps of late 18th – early 19th century vintage (see below). OS one-inch data is already available for much of the study area, having been digitised during a Pilot Study in 1999 (Challis *et al.,* 1999) or during TVG2002; outstanding areas will be added. Additional mapping will comprise:

- George Sanderson, 1835 Survey of *twenty miles round Mansfield*, which covers the Idle, Devon and Dover Beck study areas. This map, at a scale of 2.5inches/mile, is available in a scanned version requiring georeferencing for the study areas.
- Burdett's survey of Derbyshire 1767, for the Dove survey area. The map requires digitising (from a 1975 reprint) and georeferencing.
- Yates' survey of Staffordshire 1775, for the Dove survey area. The map requires digitising (from a 1978 reprint) and georeferencing.

This selection of mapping has been chosen because it is readily available and provides good large to medium scale coverage of the study areas at an early date and with a high degree of cartographic consistency and reliability (important when geocorrecting to contemporary mapping). The Burdett and Yates maps have already been utilised for studies of the River Dove (Dalton and Fox, 1988).

Once digitised and georeferenced, use of these maps will be confined to areas considered as potential locations for coring, where their examination will assist in the selection of appropriate drilling sites. Further analysis of the maps might be undertaken as part of phase two of the research if it assessment suggest that it would be of benefit (for example comprehensive digitising of historic landscape features). Proposals for this work will form part of the phase two project design.

Product

The product from this project component will comprise:

- Scanned geocorrected OS 1-inch first edition mapping incorporated into the project GIS.
- Scanned geocorrected Sanderson 1835 map extracts incorporated into the project GIS.
- Scanned geocorrected Burdett 1767 map extracts incorporated into the project GIS.
- Scanned geocorrected Yates 1775 map extract incorporated into the project GIS.

- Assessment of map data for the study areas including method statement for further analysis if appropriate.

A2E Field mapping of geomorphology of study area

Field mapping of landform assemblages will be undertaken in the tributary valleys to validate the interpretational mapping derived from the analysis of remotely sensed imagery. Field mapping of discrete landforms (e.g. terrace edges, palaeochannels) will be undertaken using a carrier phase differential GPS to create digital data that can be imported directly into the project GIS. As well as providing a detailed record of floodplain morphology, field mapping will provide an opportunity to identify, record and sample natural exposures for environmental analysis and radiocarbon dating.

Field data will be incorporated into the project GIS in an appropriate format and will include digitally captured field data and digitised paper based and photographic records.

Product

The product from this project component will comprise:

- Field mapping of landform assemblages in the study areas.
- Incorporation of field data into the project GIS.
- Assessment of the data for the study areas including a method statement for further analysis if appropriate.

3.2 ALLUVIAL ARCHITECTURAL AND PALAEOENVIRONMENTAL ANALYSIS

Borehole records held by British Geological Survey and the aggregates industry will be inspected, digitised and analysed in order to map and model alluvial architecture and identify areas for field investigation. In addition, a limited coring programme will be undertaken to investigate palaeochannels, peat deposits and hitherto unexplored areas and to recover appropriate samples for palaeoenvironmental analysis and radiometric dating.

3.2.1 B1: Mapping and modelling of three-dimensional sub-surface alluvial architecture

B1A Borehole acquisition and digitising

Logs of boreholes within the study area are held at the National Geological Data Centre (NGDC), at the British Geological Survey, Keyworth, Nottinghamshire. Paper copies of the original logs are kept in box files, indexed by Ordnance Survey 1:10,000 quarter sheet. The NGDC also hold a digital index for the data, comprising national grid reference and other summary information for each paper log. In order to identify the borehole records required for the study, the digital index data (available as part of the TVG2002 GIS) will be spatially queried to list only those boreholes within the floodplain alluvium and terraces of the studied rivers. In addition, access to borehole records belonging to aggregate companies has been negotiated. This will provide additional borehole data for quarries in the Idle – Sutton-Lound complex and for Misson.

Where available the logs for both public boreholes in the NGDC and those held by aggregate companies will be examined and relevant details digitised for incorporation into the project GIS. The use of borehole data within a GIS requires the digitising of paper-based borehole records using a coherent and consistent data model. Where used for three-dimensional sub-surface modelling, digitising is followed by the interpolation of continuous surfaces from the data and the checking and analysis of the surfaces generated. In order to use such heterogeneous data a universally applicable data model, describing the stratigraphy of the study area, is required. The relatively diffuse spatial distribution of most borehole data means that it is generally necessary to adopt a relatively simple data model and to record for modelling only substantial, spatially contiguous stratigraphic elements. Within the Trent Valley the data model adopted (eg for TVG 2002 component 3, Challis 2004b) has usually recorded details of at least four stratigraphic units:

Unit 1: fine grained silt and clay alluvium
Unit 2: coarse grained sand and gravel alluvium
Unit 3: bedrock
Unit 4: organic deposits such as peat

Additional stratigraphic units, such as the lacustrine or aeolian deposits common in parts of the lower Trent Valley, or finer stratigraphic distinctions, such as local variations in the character of fine-grained alluvial cover, can be added where appropriate. The chief limitation of this approach lies in the simplistic data model adopted. In particular the need to impose a stratigraphic interpretation on the borehole data at the time of digitising, with no recourse to later amendment, is a severe limitation. As a result, the research proposed herein will follow the recommendations set out at the completion of TVG 2002 (Challis 2004b, 43) and borehole data will be digitised, modelled and visualised using software which is specifically designed for this purpose rather than through the use of the customised Access database developed for TVG2002 (we propose to use Rockware's Rockworks 2002; see Bates and Bates, 2000 and Bates, 2003 for a comparison and discussion of such software). This approach represents a change in methodology from that adopted for earlier studies in the Trent Valley, but reflects both the critical assessment of those studies and the conclusions of the English Heritage funded work undertaken by Bates (*ibid*) in the Thames and Lea Valleys. Rockworks 2002 has been selected for this task principally as it provides the ability to add and alter stratigraphic interpretations for borehole data both during and after digitising. It includes a suite of powerful deposit modelling tools, including tools for three-dimensional interpolation of solid objects from borehole observations and visualization. In addition data can be freely exchanged with ESRI products such as ArcGIS.

Product
The following products will be delivered at the completion of the component:

- GIS data comprising observations digitised from borehole logs.

B1B Borehole data assessment
Assessment of the borehole data will comprise the development of a lithostratigraphic model of the key alluvial units, production of GIS derived maps showing the broad character of the alluvial deposits for the study areas, including for example mapping the thickness of alluvial deposits and the distribution of peat deposits within alluvium as a guide to the presence of palaeochannels. This information will assist in field mapping of the study areas (task A2E) and is an essential component of the selection of sites for coring (task B2A). The assessment

will also examine suitability of borehole data for three-dimensional sub-surface modelling. If data prove suitable, a method statement for this work will be included in the phase two project design.

Product
The following products will be delivered at the completion of the component:

- GIS derived mapping showing the distribution and character of organic and alluvial deposits within the study areas.
- Assessment of borehole data for the study areas including method statement for further analysis if appropriate.

3.2.2 B2: Identification and palaeoenvironmental assessment of areas where organic sediments are preserved to determine the state of preservation and potential for buried landsurfaces and associated archaeology

B2A Coring and sample recovery
Depending of the nature of the superficial deposits, coring will be undertaken using a combination of hand augers (gouge, Dutch and Russian heads) or through using a vibro-corer with a window sampler. Samples will be transferred to monolith holders and kept under refrigerated conditions prior to analysis (component B2B).

Records of field observations of coring undertaken by the project team will be incorporated into the borehole record database developed as part of component B1A of the project.

Product
The following products will be delivered at the completion of the component:

- Completion of a programme of core sampling of alluvial deposits within the study areas.
- GIS data comprising observations digitised from borehole logs.
- Assessment of coring data for the study areas including method statement for further analysis if appropriate.

B2B Core sample palaeoenvironmental assessment
Environmental assessment will be undertaken by a combination of specialists. Drs David Smith and Wendy Smith (University of Birmingham) will undertake analysis for insects (including chironomids) and macroscopic plant remains respectively. Dr Ben Gearey (University of Hull) will undertake pollen analysis. As part of the initial assessment, organic-rich sediments will be analysed from the top middle and bottom of cores. Results from the palaeoenvironmental assessment will be added to the project GIS in an appropriate format including point records of basic assessment information and access to digital documents providing full text reports
The assessment reports will be supported by a rationale, method statement and costs for further, more detailed, analysis of the samples as part of phase two of the project should this prove appropriate.

Product
The following products will be delivered at the completion of the component:

- Palaeoenvironmantal assessment of organic deposits recovrd from core samples.
- GIS data reporting the palaeoenvironmental assessment
- Recommendations and method statement for further analysis if appropriate.

3.2.3 B3: Development of a high-resolution chronological framework through radiocarbon dating.

B3A Identification of strategy and samples for radiocarbon dating

As in the first round of ALSF, it is assumed that radiocarbon analysis will be provided as an 'in-kind' service by English Heritage. The presence of recycled 'old carbon' within sediments of the Trent catchment is a well established problem (A. Bayliss, pers. comm.), which can only be addressed through careful pre-treatment and selection of known materials for radiocarbon dating. Should this project be fully funded, discussions will be held with the EH dating team to identify suitable materials for collection and dating, and a procedural framework for this work.

Product

The following products will be delivered at the completion of the component:

- Summary report of dating including an assessment of their value
- Report describing valley floor evolution for each tributary valley (timing of episodes of fluvial incision, sedimentation and erosion) and assessing the implications for the archaeological record (e.g. increased alluviation in the main valley floor, erosion of sites etc).

3.3 ASSESSMENT REPORTS AND UPDATED PROJECT DESIGN FOR ANALYSIS AND PUBLICATION

3.3.1 C1: Prepare an assessment report and updated project design for analysis and publication of results

The principal products of phase one of the project will be two assessment reports reviewing the landform assemblages and alluvial architecture/palaeoenvironmental evidence for the study areas respectively. These will be accompanied by a project design for phase two of the project which will address analysis of data collected during phase one. It will also include proposals for publication, dissemination and archiving of project results.

C1A Assessment report: mapping of landform assemblages and development of models of valley floor evolution

This assessment report will consider the following themes:

- LiDAR analysis and digitising of landscape features
- IFSAR analysis and digitising of landscape features
- Air-photographs analysis and digitising of landscape features
- Historic mapping analysis and digitising of landscape features
- Field mapping analysis

C1B Assessment report: alluvial architectural and palaeoenvironmental analysis
This assessment report will consider the following themes:
- Borehole analysis and modelling
- Core sample analysis
- Radiocarbon dating

C1C Project Design for phase 2 analysis and publication
The project design will include rationale, method statement and costs for analysis of data collected during phase one of the project. In addition it will include proposals for publication and dissemination of final project results, likely to comprise at least:
- Project report for funding bodies
- Workshop for end-users
- Production of a Technical Bulletin for workshop
- Archiving of GIS and other data
- Presentation at international conferences
- Review and presentation to TVG group
- Academic papers
- Web presentation
- Popular publication

3.4 PROJECT REPORTS AND ARCHIVE

3.4.1 D1: Dissemination of Project Reports and Archive of GIS Data

D1A Project Website
The project web site will form a component of the Trent Valley GeoArcheology web presence (www.tvg.org.uk) which is maintained by the project principal investigators. Presently the TVG website is hosted by the University of Nottingham, but it will be relocated to the University of Birmingham server during the course of the project. This will have no impact on the appearance or functionality of the web site for end-users but will allow greater control over content, including the incorporation of an ArcIMS based on-line GIS.

Initially the web site will include a broad summary of the projects aims and objectives, contact details for staff and an edited version of the project design. It is intended that the website be updated at quarterly intervals during the project with short reports describing on-going project work and summary reports of results.

Product
The product of this component of the project will comprise:
- Project website initially including summary and edited project design.
- Quarterly website updates.

D1B On-line report and data archive
Digital versions of the two assessment reports will be made available for download in Adobe portable document format (pdf) from the project website at the completion of phase one of project research. Users will be required to complete a short registration process before downloading reports. This process will follow the model successfully implemented for TVG2002 reports. At present (November 2004) 42 registered users have downloaded

TVG2002 reports from the project website since the implementation of the facility in April 2004; this has included users from the UK, USA and continental Europe.

In addition, a trial on-line GIS will be developed using ArcIMS. The GIS will follow the model successfully implemented by Birmingham Archaeology for the *Where Rivers Meet* project (Wilkes and Barratt, 2004) and will provide view only access to geospatial data developed by the project team and for which the team holds copyright. Users will be required to complete a brief registration process, including a feedback form, to access the resource, which will be hosted on the Birmingham University map server within the tvg.org.uk domain.

Product
The product of this component of the project will comprise:

- Adobe pdf format versions of the assessment reports available for download from the project website.
- Implementation of an ArcIMS on-line GIS providing view only access to selected project data.

D1C GIS Data Archive
All data forming part of the project GIS will be stored in proprietary ESRI formats. All geospatial data will be projected to British National Grid (OSGB36). Data generated as part of the study will be archived on CD-ROM and/or DVD and accompanied by descriptive metadata following the format proposed in the Archaeological Data Service guidelines (Gillings and Wise, 1998). For each archive directory, an ASCII text file will be created as an index for the directory contents, following the format below:

Directoryname_Contents.txt Comprising a list of the files in the directory by name with brief description including the following information:

1. Filename
2. Computer software used
3. Date of data capture/purchase
4. Who created the file
5. Data source
6. Scale and resolution of data capture
7. Scale and resolution of data storage
8. Purpose of data set creation
9. Method of original data capture

So, for example, for a directory named cropmark_plots,

Cropmark_plots_contents.txt
1. Cropmarks.shp
2. ArcView 3.2 shapefile
3. 30/07/2001
4. KC
5. Derived from scanned NMP cropmark plots by converting raster image to shapefile within ArcView

6. Original source cropmark plots 1:10000, scanned at 600dpi
7. 1:10000
8. Provide vector cropmark plot of study area
9. Not known

In addition, information about the project and the spatial data generated as a result of project research will be submitted to the GIgateway (www.gigateway.org.uk/) supported by metadata in their format compiled using Metagenie software. This will ensure compliance with the aims of the National Geospatial Data Framework (NGDF) and allow the widest possible knowledge of project research and data availability. Copyright and licensing restrictions mean that it will not be possible for a full copy of the GIS data archive to be distributed beyond the University of Birmingham (for example to the ADS). Instead the archive will be held in the Institute of Archaeology and Antiquity HP Vista Centre at the University of Birmingham.

Product
The product of this component of the project will comprise:

- Compilation of ADS format metadata for all project GIS components.
- CD-ROM/DVD GIS data archive.
- NGDF format resource metadata and submission of resource to the GIgateway.

D1D GIS Data for End-Users
Where licensing permits end-users will be supplied with GIS developed as part of the project research on CD-ROM. Where end-users require data in proprietary formats other than ESRI's (eg Mapinfo), data exported from the project GIS will be converted into the required format by the project team prior to supply.

Product
The product of this component of the project will comprise:

- GIS data supplied on CD-ROM to end-users in their desired data format.

4 REFERENCES

Baker, S. 2003 *The Trent Valley: Palaeochannel Mapping from Aerial Photographs.* Research report for Trent Valley GeoArchaeology. Nottingham, Trent and Peak Archaeological Unit.

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