1. INTRODUCTION

1.1 AGGREGATE EXTRACTION BACKGROUND

1.1.1 The Britain of the twentieth and twenty-first centuries is one that has been and is being subject to enormous change, be it from the expansion of urban centres, the improvement of its transport infrastructure, the reinvigoration of its industries, or even the pursuit of environmentally friendly solutions to our power crisis through wind farms. Change invariably entails construction, and construction almost always requires large amounts of aggregate, for road and building foundations, for tarmac, for concrete, or for mortar. Aggregate is relatively cheap to extract but costly to transport and so the development needs of an area require local sources of aggregate. The North West has seen a major upsurge in the scale of its developments, the city centre of Manchester has been extensively revamped, and now Liverpool, for some time the poorer cousin, is having its centre extensively remodelled; the current Paradise Street Development is currently the largest in Europe.

1.1.2 There is a recognised need for new sources of aggregate, and Lancashire County Council has commissioned studies (Entec UK Ltd 2005; Geoplan Ltd 2006) to identify areas for the future provision of high-quality mineral aggregates and high-grade sand (as a naturally accepted standard) in particular. These reports will eventually be incorporated into the *Lancashire Minerals and Waste Local Plan* (LCC 2006), identifying new Areas of Search. Policy 48 of the current adopted plan makes provision for release in 2006 of additional land for the extraction of 3.2 million tonnes of high-grade sand. The policy identifies three Areas of Search for aggregate: (1) the Lower Ribble Valley within the boroughs of Preston and south Ribble, with the others nearby; (2) north and west of Preston extending across the Fylde to the Wyre valley; and (3) the Leyland-Chorley area south of the Ribble but outside the West Pennine Moors. Notwithstanding the current provision for further extraction (landbank), it has been acknowledged that the current reserves of high-grade sand in the county will be exhausted towards the end of 2006, hence the motives behind the recent sand and gravel surveys (Entec UK Ltd 2005; Geoplan Ltd 2006).

1.1.3 This insatiable demand for sand and gravel comes into conflict with the aim to preserve the country's archaeological heritage, as river gravels, a common source of mineral aggregates, provide good, well-drained agricultural land and so have attracted considerable settlement activity throughout the millennia in which man has occupied this part of Britain. While these sand- and gravel-rich areas may contain a rich archaeological resource, since this is buried, such a resource is not necessarily documented, with incorporation in the county's Historic Environment Record, so there is an issue of the identification of the remains. The landscape itself has also considerable heritage value and the landform sequence contributes significantly to knowledge of environmental history and also an appreciation of the landscape. In any case, increasing an understanding of the archaeological resource through the planning process may typically provide for its excavation and preservation by record, but rarely does it provide for its actual preservation, which is the preferred option of the archaeological community (embodied within *Planning Policy Guidance* 16

(PPG 16). There is therefore a need to pre-empt the planning process and work with the sand and gravel extraction community to ensure that areas selected for such extraction do not include a significant archaeological resource.

1.1.4 English Heritage (EH) and the Aggregate Levy Sustainability Fund (ALSF) have sought to address the issue across the country by undertaking an extensive programme of research into areas where there is a potential sand and gravel mineral resource, coupled with research into areas of archaeological potential. The programme will result in the provision to the sand and gravel community of guidance on those areas that have enhanced potential for aggregate extraction, but which have a reduced archaeological potential.

1.2 CONTRACT BACKGROUND

1.2.1 As part of this ALSF programme, EH, acting on behalf of ALSF, invited Oxford Archaeology North (OA North) and the Department of Geography, University of Liverpool, to submit a joint tender for a programme of investigation into the potential impact of sand and gravel extraction on the archaeological resource of the Ribble Valley, in Lancashire and North Yorkshire (Fig 1). A project design was prepared by OA North and University of Liverpool Geography Department (2005) in accordance with a brief by English Heritage (2004), and following discussions with Peter Iles (Specialist Advisor (Archaeology) Lancashire County Council Environment Directorate), and Dr Susan Stallibrass, EH Scientific Advisor for the North West, and EH personnel. The project design provided for an investigation of the geology and geomorphology of potential areas of sand and gravel, undertaken by the Department of Geography, University of Liverpool, and for an investigation into the archaeological resource of the valley, undertaken by OA North. The project design was submitted in March 2005 and the project was commissioned in the same month.

1.3 THE RIBBLE VALLEY STUDY AREAS

1.3.1 The Ribble is the largest river system in Lancashire, covering some 1320km^2. The catchment extends from the headwaters of the Hodder in the Forest of Bowland to the headwaters of the Ribble in the western Yorkshire Dales. The current drainage network reflects the region's glacial legacy, with aggressive erosion perhaps accentuated by glacial meltwaters capturing the Hodder headwaters at the expense of the formerly westward-draining Loud Valley, and the Ribble headwaters at the expense of the eastward-draining Aire (Wharfdale) (Harvey 1985; 1997) (Fig 2). Carboniferous Limestones in the Ribble Valley, Carboniferous coal measures in the Calder Valley, and Carboniferous sandstones and gritstones in the Hodder Valley form the bedrock geology of the catchment headwaters (BGS 1991). Downstream the drainage basin is for the most part underlain by Carboniferous sandstone, gritstone and limestone before the Ribble flows across Permian and Triassic sandstones in the Lancashire lowlands downstream of Ribchester.

1.3.2 The study areas were selected so as to concentrate on areas of greatest soft aggregate (sand and gravel) mineral potential, to follow on from the *Lancashire Minerals and Waste Local Plan* (LCC 2006), which targeted the Post-Glacial river terraces of the Ribble as a principal Area of Search. The present study

defined two areas, the first comprising the river terraces of the Lower Ribble, between Preston and Sawley, and the second a substantially smaller area, to examine the terraces of the Upper Ribble, to the south of Settle, North Yorkshire (Fig 1).

1.3.3 ***Proposals for a Variation to the study area:*** once the programme was underway it became clear that the region included other areas and types of potential mineral aggregate. The project design (2005) provided only for areas of potential sand and gravel mineral within the region, and the study areas were defined accordingly. The landbank provision for crushed rock mineral aggregate is of greater duration than that for reserves of sand and gravel mineral (LCC 2006); furthermore, utilisation of new areas for crushed rock is typically achieved by expansion of existing sites. Consultation with the North Yorkshire County Council Minerals Officer (Chris Jarvis) and the North Yorkshire County Archaeologist revealed, however, that the *North Yorkshire County Council Minerals Plan* (1997) included a large area of search for crushed rock mineral aggregate. The reason for the discrepancy is that, in Craven District and the Yorkshire Dales National Park, hard aggregate, particularly magnesian limestone, is the dominant local mineral aggregate extracted. At present, the worked sources of aggregate are all limestone quarries within the Yorkshire Dales National Park, but it is North Yorkshire County Council and Yorkshire Dales National Park Authority policy to discourage further extraction of minerals in the National Park, and any applications for new quarries or extensions to existing quarries within the National Park will be rejected. In place of that, the *Minerals Plan* (NYCC 1997) has identified a search area for aggregate extraction between Long Preston and Skipton, bordered to the north by the National Park boundary and to the south by the Lancashire County boundary. The geology of this area is predominantly of Carboniferous mudstones and limestones (NYCC 1997), of which the mudstones have no potential for mineral extraction, but includes areas of limestone which have considerable mineral potential. It is inevitable that, as the existing quarries hit their planning boundaries, there will be a move to new quarry sites outside the National Park, which have good road communications, appropriate mineral reserves, and these will inevitably be within the *Minerals Plan* (NYCC 1997) Area of Search.

1.3.4 This project has focused on the sand and gravel aggregate, because that is the current need in Lancashire, but for other areas within the region, particularly the Craven lowlands, crushed rock is the principal source of aggregate. Accepting this aspect of local mineral extraction and the defined Area of Search in the *North Yorkshire County Council Minerals Plan* (NYCC 1997), there was a recognised need to extend the area of study for the present project to include other areas of potential aggregate extraction, particularly hard geology sources. As a consequence of this, a variation was proposed to extend the study area of the *Ribble Valley ALSF Aggregate Extraction Project* to encompass the *North Yorkshire County Council Minerals Plan* Area of Search (NYCC 1997), which would have encompassed an area between Skipton and Long Preston. In the event, the funding for a variation was not available in 2006/7 but there was some possibility that the funding would become available in 2007/8. In the meanwhile, analysis of the Upper Ribble dataset has been undertaken as far as possible, but not so as to require reworking if a variation is approved.

1.3.5 ***Remit of Present Report:*** while extensive work has been undertaken on the areas of soft aggregate in North Yorkshire, it was recognised that this study is substantially incomplete if it does not incorporate the areas identified by the *North Yorkshire County Council Minerals Plan* (NYCC 1997). It was therefore agreed with English Heritage that the work on the Upper Ribble should not be reported on at this stage, and that instead this should await the decision on funding in 2007/8. The present report, therefore, examines the archaeology and geology of the Lower Ribble study area in Lancashire, but also examines the sand and gravel mineral potential over a broader area to highlight potential zones of mineral and to inform future research of this nature within the wider region.

1.4 AIMS OF THE PROJECT

1.4.1 The Ribble Valley ALSF Aggregate Extraction Project has provided baseline data to assess the potential impact of aggregate extraction in the Lower Ribble Valley upon the archaeological and palaeoenvironmental resource, in accordance with Objective 2 of the Aggregates Levy Sustainability Fund (English Heritage 2005a). The following aims, defined in the *Project Design* (OA North and University of Liverpool 2005), have provided the foundations for the present project:

- to produce data that contributes to the needs of both planners, the minerals industry, and curators, and the archaeological community at large;
- to improve understanding of the quality, quantity and distribution of sand and gravel mineral aggregate within the region;
- to establish the effect that extraction has had and may continue to have on the archaeological and palaeoenvironmental resource;
- to enable a better understanding of the archaeological resource within the archaeological community and amongst the stakeholders;
- to allow better working practices to be developed, facilitating interaction and understanding between archaeologists and other professionals.

1.5 OBJECTIVES

1.5.1 The Ribble Valley ALSF Aggregate Extraction Project has highlighted those areas that are most likely to be affected by short-term proposals for aggregate and sand extraction, as defined by the *Lancashire Minerals and Waste Local Plan* (LCC 2006; Entec UK Ltd 2005; Geoplan Ltd 2006) mineral assessments, and also long-term potential for extraction, as determined by geological constraints. The following objectives, defined in the *Project Design* (OA North and University of Liverpool 2005), have served as the basis for the present project:

i) to collate, within a GIS, all available data on past, current and future aggregate extraction within the Ribble Valley, including British Geological Survey BritPits data and the Directory of Mines (BGS),

Lancashire County Council (LCC) or Regional Aggregate Working Party (RAWP) sources;

ii) to produce a GIS of the aggregate resources within the Ribble Valley, drawing upon BGS maps, the LCC-commissioned aggregate survey, and published and unpublished academic geomorphological and geological mapping;

iii) to assess the character and condition of the archaeological resource;

iv) to enhance the Lancashire HER by means of documentary and secondary sources, and by linking into the Environment Agency (www.environment-agency.gov.uk/subjects/conservation/) and National Rivers Authority historic environment databases, the *Historic Landscape Characterisation for Lancashire* (Ede and Darlington 2002), and the *Countryside Agency Joint Character Area Map* for the North West region (Countryside Agency 2005);

v) to undertake a comprehensive GIS-based survey of the late Quaternary and Holocene geomorphology, using a combination of field survey and LiDAR elevation data, and, expanding on previous work, thereby identify and clarify the fluvial and glaciofluvial landform sequence within the Ribble;

vi) to undertake an exhaustive survey of published and unpublished archaeological, geoarchaeological, palaeoecological and geo-morphological research to produce a greatly enhanced GIS database;

vii) to use LiDAR, aerial photography and other (Landsat) remote sensing sources to identify palaeochannels and other potential palaeoenvironmental archives;

viii) to examine the potential impact upon the archaeological and palaeoenvironmental resource of changes to the ground water levels, caused by aggregate extraction or other similar intrusions into the landscape;

ix) to undertake the modelling of surface and ground water levels and quality in response to scenarios of aggregate extraction, integrated river basin management, and climate change, with a view to quantifying the impact on the proven and potential archaeological;.

x) to identify research priorities for the future and highlight areas of urgency for research owing to threats from future aggregate extraction, changes in surface and ground water levels, and land use change;

xi) to create a Research Agenda for the Lower Ribble Valley, establishing the known resource, clear *lacunae* in the dataset, and research questions that might address these;

xii) to extend the outreach of the project to the stakeholders, and promote an understanding of the archaeological and environmental potential of the region and also the potential threats to the resource of continued aggregate extraction.

1.6 STRUCTURE OF THE REPORT

1.6.1 This report presents the results of the survey into the archaeology of the Lower Ribble study area only. The spatial coverage for the geological and geomorphological research is broader in scope to place the environmental history and the sand and gravel mineral resource in this regional context. The results of the work on the Upper Ribble will be submitted as a separate report and, subject to the commissioning of a variation to the present project, will embrace crushed rock aggregates of the Craven District as well as the sand and gravel.

1.6.2 This report examines the geology and geomorphology of the areas in relation to its archaeological resource. It opens with a background section (*Section 2*) which presents the wider geological and geomorphological context of the Ribble Valley and examines the archaeological and palaeoenvironmental context for the present study.

1.6.3 The methodology (*Section 3*) presents the traditional and new techniques that have been applied to examine the development of the terraces and to identify and characterise the archaeological resource. In particular, it highlights the value of the use of LiDAR, NextMAP and the GIS analysis. An assessment of the potential of all the archaeological and geological techniques is then made (*Section 4*), examining what has been learnt about the efficacy of such techniques in the course of the project. A series of recommendations is offered, which provide guidance on what techniques would be most appropriate if a similar study was enacted elsewhere in the North West.

1.6.4 ***Results:*** the results of the study are presented in *Sections 5-8*. *Section 5* examines the glacial and fluvial history of the valley in the light of the present work. The following section (*Section 6*) examines the distribution of the archaeological resource and examines the extent to which it is a real distribution of archaeological activity or a product of the differential archaeological investigations that have been undertaken in the valley. In the light of this, it presents a distribution of the archaeology based on an enhanced Historic Landscape Characterisation (HLC), which highlights both the actual observed resource and the archaeological potential.

1.6.5 *Section 7* highlights the sand and gravel reserves that have the greatest potential for extraction, and therefore the areas that present the greatest threat to the archaeological resource. *Section 8* presents the results of modelling changes to the valley floor as a result of present day and future fluvial erosion and deposition.

1.6.6 ***Conclusions:*** in *Section 9* the threats from fluvial erosion and aggregate extraction are considered in terms of areas of archaeological potential, examining the extent to which areas identified for potential extraction will have an impact on areas of known archaeology or areas of archaeological potential. The study examines the extent to which late fluvial deposition has buried and obscured archaeological remains, and highlights the risk that deep extraction will disturb as yet unidentified deeply buried archaeological deposits. Following on from this, *Section 10* makes recommendations for managing the risk to the archaeology, and highlights preferred options, including further research and mitigation.