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Herefordshire Archaeology
Conservation and Environmental Planning
Planning Services
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Lower Lugg Floodplain Archaeological Mitigation Review

Herefordshire Archaeology Report 243

Prepared for English Heritage with funding from the Aggregates Levy Sustainability Fund as administered by English Heritage for the historic environment (in accordance with ALSF Stage 2 Project Design PN 3336)

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Herefordshire Archaeology is Herefordshire Council's county archaeology service. It advises upon the conservation of archaeological and historic landscapes, maintains the county Sites and Monument Record, and carries out conservation and investigative field projects. The County Archaeologist is Dr Keith Ray MBE.

Contents of the Lower Lugg Floodplain Archaeological Mitigation Review

1. Introduction

1.1 About the Lower Lugg Floodplain Archaeological Mitigation Review

This document sets out the results of analyses aiming to improve and refine the effectiveness of archaeological mitigation of gravel quarrying in the floodplain zone of the Lower Lugg Valley, Herefordshire. Although conceived with intended relevance to the whole floodplain area, the project is specifically based on the cumulative results of archaeological mitigation which has been underway at Wellington/Moreton Quarry since 1986 (under the auspices of Worcestershire Historic Environment and Archaeology Service/WHEAS and predecessor organisations).

The analysis has been executed for English Heritage by Herefordshire Archaeology (working in close collaboration with WHEAS) with funding from Stage 2 of the Aggregates Levy Sustainability Fund (in accordance with English Heritage ALSF Updated Project Design PN 3336). The Herefordshire Archaeology project leader was Ian Bapty (under the overall direction of the Herefordshire County Archaeologist Dr Keith Ray MBE, FSA, MIFA). The WHEAS project contact and principal participant was Robin Jackson MIFA.

The work was undertaken between September 2007 and February 2008, and was in part designed to overlap with (and add value to) WHEAS execution of a PPG16 evaluation programme in connection with an active planning application by Tarmac Limited for a proposed southern extension of Wellington Quarry.

1.2 Background and research context

The 14 km long Lower Lugg river valley is located in central Herefordshire, and extends to the north and east of Hereford city. The valley, with its varied resources and good agricultural land, has long been a focus of human settlement, and is also underlain by extensive reserves of sand and gravel. There is a long history of commercial gravel extraction in the valley, and large scale quarrying in the valley bottom has been underway since the mid 20th century. Since 1986, archaeological work in mitigation of the quarry at Wellington/Moreton has emphasised the high archaeological and geomorphological value of the flood/plain area in particular. This work has revealed the extensive and deeply buried survival of regionally and nationally important alluvial and archaeological deposits within the floodplain.

Partly on the basis of the significance and complexity of the Wellington Quarry sequence, a detailed Archaeological Resource Assessment for the Lower Lugg Valley are as a whole was undertaken by Herefordshire Archaeology in 2006/7 (EH ALSF Stage 1 project for the Historic Environment, Project Number 3336). The assessment involved integrated multi-disciplinary collation and critical analysis of the known and potential archaeological, geological, geomorphological resource of the valley, and evaluated the significance of these assets within a regional and national context. The review process also included a critical analysis of the archaeological fieldwork methodologies which have been evolved to address deep burial of archaeological deposits in the Lower Lugg floodplain.

In addition, the Resource Assessment also examined the past and projected future development of gravel quarrying in the valley. The current planning framework (national legislation and guidance, West Midlands Regional Spatial Strategy, and Herefordshire Unitary Development Plan) was evaluated to predict the short to medium term pattern of future mineral extraction in the Lower Lugg Valley.

The conclusions of the assessment emphasised that:

- The valley bottom alluvial deposits preserve a highly significant combined archaeological and geomorphological resource with high local, regional and national significance. However, the detail of the potential resource is very poorly defined beyond Wellington/Moreton Quarry;

- Significant interpretative and site formation process questions remain even in those areas which have been subject to detailed investigation and recording. Because of these limitations, it is possible that the routine assumptions which have come to pragmatically inform fieldwork techniques and recording (such as received practical understanding of the 'typical' sequencing of archaeological deposits *vis a vis* observed alluvial units) are also inhibiting the full potential and recovery and analysis of archaeological data in the alluvium;

- Processes of archaeological evaluation within Lower Lugg alluviated areas present considerable technical and methodological challenges. Indeed, it has so far proved difficult via existing techniques to effectively identify and characterise alluvial/archaeological deposits at the archaeological field evaluation stage (i.e. prior to the granting of planning permission). Archaeological discovery/mitigation has consequently been fundamentally based on planning conditions linked to watching brief, excavation and recording work during the overburden stripping process;

- The current minerals planning framework (as defined by the incorporation of national legislation and regional guidance within the Chapter 11 of the Herefordshire Unitary Development Plan) does not allow rejection of a minerals planning permission to protect archaeological remains unless those remains are already known and described and of defined national or regional significance. These effectively means (given current knowledge/evaluation limitations) that the options for archaeological mitigation of quarrying in the Lower Lugg are limited to excavation/preservation by record.

In overall terms, these conclusions elucidated a fundamental management problem. On the one hand, the valley bottom zone of the Lower Lugg Valley demonstrably represents an area of high archaeological potential with deep burial of multi-period deposits, exceptional preservation, and important and complex interrelationships of archaeological, alluvial and palaeoenvironmental features and contexts. On the other hand, this also the area of the Lower Lugg Valley where the archaeological resource is least known in terms of spatial coverage, least understood in terms of site formation process, and least easy to assess and accurately model and characterise via standard archaeological field evaluation techniques. Since this is the same zone where future large scale gravel quarrying will take place, the assessment fundamentally emphasised the pressing need to address current practical and interpretative archaeological shortcomings if effective mitigation of quarrying (and especially mitigation other than preservation by record) is to be realised.

The Resource Assessment identified three interrelated research themes with respect to addressing this core mitigation agenda.

1. The need to systematically test the evolved understanding of patterns of stratigraphic, contextual and archaeological feature association across the whole area of existing archaeological investigation at Wellington Quarry (therefore checking/grounding the basic assumptions on which interpretative and fieldwork approaches are currently based).

2. The need to develop, implement and critically assess alternative techniques for archaeological evaluation in the Lower Lugg alluvium (therefore generating better pre-planning permission archaeological information and the potential for more directed and flexible engagement with the minerals planning process).

3. The need to pro-actively develop description and modelling of the geomorphological and buried landform detail of the Lower Lugg floodplain zone beyond the spatially limited 'known' areas associated with past and present quarrying (therefore improving both the contextual basis for understanding currently 'known' areas, and the potential for informed medium/long term strategic engagement with the minerals planning process).

1.3 Aims of the Lower Lugg Floodplain Archaeological Mitigation Review

The core objective of the English Heritage ALSF scheme is to reduce the impact on the historic environment of aggregate extraction. In particular, the scheme aims to:

- Develop capacity to manage aggregate extraction landscapes in the future.
- Deliver to public and professional audiences the full benefits of knowledge gained through past work in advance of aggregate extraction.
- Promote understanding of the conservation issues arising from the impacts of aggregate extraction on the historic environment.

Against these objectives, and the particular mitigation related research targets identified within the Stage 1 Resource Assessment, the *Lower Lugg Floodplain Archaeological Mitigation Review* has the following specific aims:

Improving archaeological evaluation methodologies in the Lower Lugg valley floor area

- To devise a revised methodology for archaeological evaluation in the Lower Lugg floodplain, based on best practice from recent national developments in alluvial archaeology, and utilising a staged GIS based predictive modelling and targeted fieldwork/trenching approach;

- To implement the strategy via PPG16 evaluation of the 2007 Southern Extension planning application for Wellington Quarry;
- To undertake preliminary assessment of the effectiveness of the approach in terms of the detection and characterisation of archaeological and geomorphological deposits vis a vis comparison with previous evaluation work at Wellington;
- To make recommendations for future archaeological field evaluation strategies in the Lower Lugg alluvium on the basis of the results of this analysis.

Improving practical understanding of the interrelationship of alluvial and archaeological sequences in the Lower Lugg Valley bottom area

- To systematically evaluate the vertical stratigraphic relationship of identified alluvial units, palaeochannel features and archaeological features across all the excavated areas of Wellington quarry using data derived from the primary excavation archives held by WHEAS;
- To construct an integrated overall stratigraphic model for Wellington Quarry presenting the combined vertical relationships of deposits across the site;
- To use the model to assess the consistency of the observed deposit sequence across the whole quarry area, with particular reference to the veracity of adopted practical assumptions about 'typical' relationships of alluvial and archaeological deposits, and received ideas/categorisations of 'anomalous' versus 'standard' deposits/alluvial units;
- To point up through this analysis elements of the Wellington stratigraphic sequence which may have been misunderstood or misinterpreted, or misrepresented in terms of their potential significance for the sequence as a whole;
- To identify possible deficits in potential recovery of archaeological data which may have resulted from received understanding of the Wellington sequence, and the way in which archaeological and alluvial deposits have been 'typically' supposed to interrelate;
- To assess if established fieldwork and recording methodologies need revision in the light of this analysis;
- To assess the value and practicality of undertaking refined deposit modelling (incorporating absolute three dimensional spatial and depth data) of the excavated areas at Wellington on the basis of existing archive information.

Improving archaeological mitigation of aggregate extraction in the Lower Lugg Valley

- To provide recommendations for realising more effective and sophisticated archaeological mitigation of aggregate extraction in the Lower Lugg valley;

- To suggest future research targets for further enhancing archaeological management potential in the Lower Lugg Valley.

1.4 Report content and partner contributions

Section 2: Revised Evaluation Methodology Analysis. This section assesses the revised evaluation methodology. It describes the basis and design of the methodology (as prepared by WHEAS in consultation with Herefordshire Archaeology through the PPG16 process), summarises the implementation results (as executed/coordinated by WHEAS and monitored by Herefordshire Archaeology within the PPG16 process), and discursively assesses the apparent success/effectivess of the methodology as judged against the previous results of conventional evaluation at Wellington.

The text was prepared by Ian Bapty (Herefordshire Archaeology) incorporating text and material prepared by Robin Jackson within the *Updated Project Design for an Archaeological Evaluation of the Proposed South Extension to Wellington Quarry, Herefordshire* (WHEAS proposal dated 17th July 2007, Jackson 2007c, Appendix 1 this document) and additional discussion and comment from Robin Jackson (WHEAS). Further revision and editing of the initial draft text was undertaken on the basis of comments by Robin Jackson (WHEAS) and Keith Ray (Herefordshire Archaeology).

Section 3: Wellington Integrated Stratigraphic Analysis. This section sets out the detailed rationale behind the integrated stratigraphic analysis, and the methodology used to assemble the stratigraphic model. The observed stratigraphic sequence for each spatially discrete area of investigation at Wellington Quarry is summarised. This information is combined within an integrated schematic stratigraphic model for Wellington Quarry. The model is used to analyse the consistency of overall stratigraphic relationships, and to assess the interpretative validity of the stratigraphic/pragamatic observational assumptions which have come to underpin established excavation and recording approaches at Wellington.

The stratigraphic model was assembled by Robin Jackson (WHEAS) from WHEAS archive material with the assistance of Ian Bapty (Herefordshire Archaeology). The text and analysis was prepared by Ian Bapty (Herefordshire Archaeology) incorporating initial discussion and comment from Robin Jackson (WHEAS). Further revision and editing of the initial draft text was undertaken on the basis of comments by Robin Jackson (WHEAS) and Keith Ray (Herefordshire Archaeology).

Section 4: Overall Conclusions And Proposals For Further Work. The findings of the Section 1 and Section 2 analyses are summarised, and proposals are outlined for further work to develop those findings.

Section 5: Bibliography.

Section 6: Appendices. Appendix 1 is the WHEAS Wellington Southern Extension PPG16 Updated Project Design (the latter inclusive of the results of the specialist remote sensing/geophysics work and deposit modelling work). Appendix 2 is the WHEAS Wellington South Extension Evaluation PPG16 Interim Report. For concise fulfilment of present purposes, both documents are selected to include only those sections relevant to the Section 2 analysis.

1.5 Constraints

Detailed methodologies and constraints are set out in Sections 2 and 3. In general terms, it should be noted that the project was devised and executed within the tight time window available for Stage 2 of the current English Heritage administered element of the ALSF programme for the historic environment (the Project Design was authorised in September 2007 for project completion by March 2008). The work reported here was also undertaken concurrently with a separate ALSF outreach project (incorporated into the same Project Design, and involving the same partners/personnel) aiming to present the results of the Stage 1 Resource Assessment to a local community audience. The technical research described here was therefore limited to analytical work which was deliverable within these time and resource/personnel availability parameters.

It should therefore be noted that:

- The commissioning of purpose designed fieldwork (excepting that separately delivered through PPG16 evaluation work) was not viable in the available timescale. Consequently the present project was only able to address the first and second of the mitigation review research targets identified in the Stage 1 Resource Assessment (see section 1.3 above). The third identified research target - that of developing alluvial/archaeological deposit modelling across the wider Lower Lugg valley bottom area - is not developed here, but is considered a potential project for submission for future ALSF funded research (subject to the continuation of the EH ALSF programme).

- The Section 2 analysis was designed to dovetail with and add value to PPG16 developer funded evaluation of a planning application for a southern extension of Wellington Quarry. The ALSF project was used to monitor and evaluate the revised evaluation methodology, but is entirely separate from the core PPG16 process. Documents produced through the PPG16 process and appended here are strictly the product of the developer funded PPG16 process, and are not to be seen as outputs of the ALSF project.

- Within the PPG16 process, the acceptance and implementation of the revised evaluation methodology was subject to acceptance and funding by Tarmac Limited (the Wellington Quarry operator).

- The conclusions of the Section 2 analysis derive from preliminary assessment of the results of the PPG16 evaluation as presented in the PPG16 Updated Project Design and Interim Report documents. As such, they are subject to the contents of the Final Report on the evaluation, and the results of subsequent mitigation work.

- As has been described above, the analyses presented here directly stem from the conclusions of the ALSF Stage 1 Lower Lugg Archaeology and Aggregates Resource Assessment, and should be read in close conjunction with the relevant sections of that document. Background information relating to the process of development of archaeological investigation at Wellington (Section 4,1 of the Resource Assessment), the alluvial and archaeological sequence at Wellington (Section 3.1 and 4.1 of the Resource Assessment) and initial assessment of fieldwork methodologies at Wellington (Section 4.6 of the Resource Assessment) has been not repeated here except in so far as it is strictly relevant to the present analayses.

1.6 Key conclusions

Evaluation Methodology

- The new structured and integrated approach - incorporating a GIS facilitated topographic/deposit modelling phase in order to differentially target trenching and geophysics sampling process - appears to have successfully identified and characterised key archaeological and alluvial sequences in the latest quarry extension. Features identified include dispersed and localised archaeological deposits (Neolithic/Bronze Age in this case) which had previously been resistant to evaluation;

- The methodology should be developed as a basis for all future quarry related archaeological field evaluation in the floodplain of the Lower Lugg Valley.

Integrated Stratigraphic Analaysis

- Stratigraphic patterning of alluvial units and archaeological deposits does appear to be consistent across the excavated areas of Wellington Quarry, and this analysis supports established fieldwork and recording methodologies which have been based on that understanding;

- Some 'anomalous' deposits may have additional significance, including the possible recognition of Early Medieval archaeological contexts which were not previously recorded as such.

Overall

- Archaeological engagement with the Lower Lugg Valley floodplain zone is well grounded and can deliver an improved range of archaeological mitigation options in the context of ongoing mineral extraction in the area;

- Further characterisation and predictive modelling of the archaeological potential Lower Lugg alluvium is technically achievable, and should be a key research target to enhance future resource management in the Lower Lugg valley, and strategic engagement with the minerals development process in particular.

2: Revised Evaluation Methodology Analysis

2.1 Introduction

2.1.1 *Purpose*

This section of the report evaluates the design and results of a 2007/8 PPG16 funded archaeological field evaluation of a 38.7 hectare southern extension to Wellington gravel quarry, Herefordshire. The PPG16 work, embodying a revised methodology aiming to significantly improve pre-planning archaeological detection in the Lower Lugg floodplain, was undertaken by the Worcestershire Historic Environment and Archaeology Service (WHEAS) on behalf of Tarmac limited.

The ALSF funded research exercise was designed to add value to the PPG16 work. It aimed to assist with the initial design of the methodology, and to assess the effectiveness of the results so as to ensure full 'best practice' input to the conduct of future quarry related archaeological field evaluation in the Lower Lugg floodplain. The overall objective is to deliver capacity for better quality of archaeological control at the evaluation stage of the minerals planning process in the Lower Lugg Valley. The project therefore also ultimately aims to facilitate significant potential benefits for local quarry companies and archaeological curators alike.

2.1.2 *Process*

The latest proposed Wellington extension is contiguous to earlier areas of significant archaeological discovery at the quarry. It was certain that the palaeochannel and alluvial sequence observed elsewhere at Wellington would continue into this area together with significant associated archaeological deposits.

Herefordshire Archaeology (as curators) and the Worcestershire Historic Environment and Archaeology Service (longstanding archaeological contractors for Tarmac Limited and previous quarry operators at Wellington) were very aware of the limitations of earlier archaeological field evaluation approaches, and these had been explicitly considered in the *Lower Lugg Archaeology and Aggregates Resource Assessment* (Bapty 2007). In the light of new techniques which had become available through recent archaeological experience in other comparable British river valley contexts, it was therefore proposed that – subject to the agreement of Tarmac Limited - an alternative archaeological field evaluation methodology should be developed for the latest Wellington extension.

Through discussion with Herefordshire Archaeology, and in appropriate consultation with Tarmac Limited, WHEAS Project Leader Robin Jackson prepared an Outline Project Design (dated 14th June 2007, Jackson 2007a) and Written Scheme of Investigation (dated 17th July 2007, Jackson 2007b) to take this project forward, and Tarmac Limited agreed to support and fund the new approach through the PPG16 process. Herefordshire Archaeology secured ALSF funding (via the PN3336 Stage 2 Project Design) to allow additional monitoring of the work, and to permit the production of the present report considering the success of the revised archaeological field evaluation approach against previous archaeological results at Wellington Quarry (Ian Bapty, Herefordshire Archaeology).

Specialist geophysics, LiDAR analysis and GIS/modelling work was contracted by WHEAS to the VISTA Centre, University of Birmingham (led by Dr Chris Carey, VISTA Centre). Initial data collation, LiDAR analysis, geophysics, gouge coring and GIS construction and modelling was undertaken during August and September 2007, and these results incorporated in an Updated Project Design (dated 24th September 2007, Jackson 2007c, appendix 1) within which the detailed trenching design and further geophysics work were specified. Archaeological trenching was undertaken during October and November 2007. The results were presented in the Interim Report (dated 20th February 2008, Jackson and Sworn 2008, appendix 2) and were used by Herefordshire Archaeology (Julian Cotton, Archaeological Advisor) to inform archaeological input to the planning proposal.

At the time of writing the planning proposal is awaiting determination.

2.1.3 *Limitations of this report*

It should be stressed that is not the purpose of the present ALSF supported report to restate the PPG16 results in full detail. Rather this document specifically seeks to review the design of the methodology, and to assess its apparent effectiveness. The detailed PPG16 Updated Project Design and Interim Report documents are appended (appendices 1 and 2), and the secondary analysis presented here should be read in conjunction with that information.

It should also be noted that this report obviously cannot take into account at this stage the results of future archaeological discoveries during mitigation in the evaluation area. That mitigation process will, of course, be the ultimate test of the success of the recent evaluation work. Nevertheless, it is argued here that comparison with the results of previous evaluations at Wellington Quarry, and the interpretative control provided by the cumulative archaeological understanding gained at Wellington Quarry over the last twenty years, does reasonably underpin the present exercise.

2.2 Background

2.2.1 *The archaeological field evaluation 'problem' in the Lower Lugg alluvium*

The particular nature of the archaeological deposits within the Lower Lugg alluvium poses special problems for the effective evaluation of archaeological remains in advance of quarrying. These constraints were discussed in detail in the *Lower Lugg Archaeology and Aggregates Resource Assessment* (Section 4.6, Bapty 2007), and may be summarised as follows:

- The poor level of current archaeological knowledge. Beyond previously excavated areas, existing knowledge of the archaeology of the Lower Lugg alluviated area for all periods before the Medieval is very limited. There is therefore little or no 'desk top' information to inform archaeological detection;

- Deep burial of alluvial deposits. Indications of buried archaeology in terms both of aerial photography and surface scatters of cultural material recoverable by field-walking are restricted because of the deep burial of most relevant deposits;

- Limitations of geophysics. Traditional geophysical techniques have been of limited use in the Lower Lugg alluvium. A geophysical survey was undertaken with some success by English Heritage in the 1986-96 area as part of a research project to define a site 'core' surrounding a Roman stone building at Wellington. Magnetometer survey detected a ditched enclosure of Iron Age or Roman date within an area of limited alluvial deposition (less than 1 metre). However, resistivity was unsuccessful, and magentometry survey subsequently undertaken during evaluation of the north and south extensions also drew a blank in an area where significant deeply buried archaeological deposits were later observed. More recent experimentation has suggested that the naturally low magnetic susceptibility of the Lugg Valley alluvium hinders effective application of magnetometry techniques in particular (Terra Nova 2002);

- Practical trenching limitations. The depth of the alluvium imposes considerable practical limitations on archaeological trenching strategies used in conventional field evaluation exercises. Small trenches/test pits are not practically viable in terms of safe and stable excavation in deep waterlogged/fine grained alluvial conditions where standing sections are prone to slumping and collapse. However, excavation of larger trenches effectively limits the spatial coverage which can be achieved within any given total sample area size;

- Scale of quarrying. Modern valley bottom quarrying in the Lower Lugg Valley impacts on large landscape areas creating a fundamental logistical challenge for effective evaluation and mitigation, especially in deeply buried contexts. The issue of commercial viability versus satisfactory archaeological coverage is therefore even more apparent in this situation;

- Nature of the archaeology. The character of the archaeology is complex and distinctively reflects the specialised use by human populations of the valley bottom zone. In some places and periods (for example, Early Neolithic pit groups, later prehistoric ritual deposition in the river or Early Medieval mills) the nature of that particular exploitation creates small dispersed features which are not obviously connected to broader patterns of archaeology, and therefore are difficult to predict and detect in advance of large area excavation;

- Specific circumstances of visibility of archaeological features in the alluvium. In the specific context of the Lugg valley alluvium, the visibility of archaeological features is closely associated with the character of the alluvium itself. At Wellington, archaeological features are generally only observable within the buff coloured Unit 2, essentially imposing a significant practical constraint on recognition and recovery of archaeological data.

2.2.2 *Established archaeological field evaluation methodologies in the Lower Lugg Valley*

Given these constraints, pre-planning evaluation in the Lower Lugg alluvial zone has been heavily reliant on direct sampling methods. The progressive learning process at Wellington Quarry over the last twenty years has informed the development of a range of approaches:

- Use of borehole data (where this is available commercially or where borehole survey can be undertaken for archaeological purposes) and auger survey. Analysis of groups of borehole and auger samples helps to develop understanding of subsurface alluvial sequences via simple modelling, and has been used to inform the probability that cultural material will be present in particular environmental contexts. It is also possible that cultural material will be directly recovered within core samples;

- Use of test pits (where viable) to supplement bore hole and auger data and to increase opportunity for recovery of cultural materials;

- The use of wide (4-5m) and long (30-50m) evaluation trenches. As well as allowing safe working, wide trenches facilitate sufficient exposure of areas of deeply buried horizons to maximise the chance of identification of cultural materials/features in a given trench. Larger areas also offer better opportunity for complementary sampling of palaeoenvironmental and geomorphological data. Similarly, sectional exposures in longer trenches have permitted more meaningful recording of alluvial sequences and features.

- Flexible use of this suite of methods has been used to maximise mutually informed results and increase sample area. Evaluation trenching at Wellington has typically featured a sample in the region of 2% of proposed development area.

- Use of additional specialist on site advice to inform palaeoenvironmental and geomorphological sampling procedures, ensuring these are an integral part of the archaeological field evaluation process.

2.2.3 *Effectiveness of established approaches*

In practice, these direct sampling approaches are limited by significant practical problems. In particular:

- Borehole and auger data are not easy to interpret. In isolation from larger sectional exposures, the subtle textural and colour transformations in the Lugg alluvium are difficult to analyse, especially where some of that detail may have been smeared and obscured by the augering/boring process itself. Practical cost constraints within standard evaluation provisions mean that it is not generally possible to undertake a sufficient density of auger and borehole coverage to allow detailed understanding of the interrelationship of observed sub-surface horizons, or to effect a degree of coverage which is likely to identify exiguous archaeological deposits (even if those can be recognised in core samples).

- Use of test pits is not practical/safe in deeper alluviated areas, and in any case does not necessarily add significantly to data from coring processes. Although vertical sections can be exposed and defined more clearly, and there is a marginally greater chance of recognition of archaeological features and materials, lack of area coverage (both within and between test pits) still means this is a very restricted form of archaeological observation in large scale alluvial environments.

- Wide trenching is more effective in terms of quality of observation and potential for recognition of archaeology within trench areas, but it has the obvious practical/cost constraint that it can only be applied to a very limited sample of total quarry extraction areas. In essence, the key issue is the constraint of absolute sample size (2%) in large areas *vis a vis* archaeological patterns which are typically associated with small and dispersed features.

- Specialist external geomorphological assistance and recording input is not always easy to organise in the timescales of planning evaluation, and potentially adds significant costs to the PPG16 client.

The specific consequences of these limitations in terms of actual patterns of archaeological identification at the evaluation stage at Wellington (vis a vis the subsequent outcomes of mitigation work) have recently been analysed by Jackson. The analysis is presented in the following table (from Jackson 2007b):

Early prehistoric activity

Character	Distribution/location	Detection
Pits and hearths (both isolated and in small groups). Dating from Early & Middle Neolithic & Beaker periods	Widely dispersed but restricted in area and typically isolated or present in small groups Mostly located on higher ground on west of site <u>or</u> on gravel islands within otherwise low lying areas	Poor-moderate Sporadically identified at evaluation but also often present at mitigation in apparently blank areas Widely dispersed character means that some are liable to encountered at evaluation but the restricted extent of areas of activity means that commonly applied sample levels are unreliable
Funerary monuments (ring-ditches and a Beaker grave)	Limited evidence Restricted to area of higher ground in north-west and west part of Wellington Quarry: 1986-96 area	Not determined Those identified to date have been detected at mitigation in areas not subject to prior evaluation. The restricted extent of some elements of the funerary deposits present means that commonly applied sample levels are unreliable
Localised deposition of material culture	Widely dispersed Within palaeochannel margins and 'wet' hollows	Poor-moderate Some areas identified at evaluation but also often present at mitigation in apparently blank areas Widely dispersed character means that some are liable to encountered at evaluation but commonly applied sample

Character	Distribution/location	Detection
		levels are not considered to be particularly reliable
Localised concentrations of flint and other artefacts	Widely dispersed Within alluvial deposits	Poor Some finds identified within alluvium at evaluation but insufficient to determine presence/absence of localised concentrations Widely dispersed character means that some are liable to encountered at evaluation but the restricted extent of areas of such activity means that commonly applied sample levels are unreliable

Later prehistoric activity

Character	Distribution/location	Detection
Middle Bronze Age burnt mound related activity comprising a substantial waterhole and an extensive spread of pits filled with fire cracked stone	Single example Located on higher ground in north part of Moreton Camp	Good Area identified as of high potential in evaluation and successfully earmarked for excavation Although correctly dated the preliminary interpretation was mistaken
Localised deposition of Late Bronze Age and Iron Age material culture (include disarticulated human remains)	Dispersed within palaeochannel margins and localised 'wet' hollows Associated with one particular palaeochannel, especially where is crossed north part of Wellington 1986-96 area and North Extension	Moderate Some areas located at evaluation and identified as of high potential Character was not understood at evaluation and additional areas were revealed at mitigation Widely dispersed character means that some are liable to encountered at evaluation but the restricted extent of areas makes commonly applied sample levels unreliable
Late Iron Age double inhumation Isolated skulls (x 2) within palaeochannels	Single example of inhumation. 2 isolated skulls Within channel margin and fill environments in 1986-96 area and southern extension	Not determined Inhumation and 1 skull detected at mitigation in an area not subject to prior evaluation. Other skulls detected at mitigation in area subject to prior evaluation The restricted extent of the inhumation and isolated

Character	Distribution/location	Detection
		presence of the skulls mean that commonly applied sample levels are likely to be unreliable
Field systems Not readily dateable Some ?Roman	Widely dispersed	Moderate Some elements detected in evaluation Due to widely dispersed and linear character evaluation trenching is liable to identify many but not all elements
Probable Iron Age settlement enclosure	Single example (pre-dating and underlying Roman settlement) On higher ground within 1986-96 core	Good Detected in Test pits and low % sample evaluation trenching supporting geophysical survey Areas affected are likely to be extensive and feature concentrated activity thus making these liable to detection through trenching

Romano-British

Character	Distribution/location	Detection
Settlement focus comprising a substantial stone building associated with several ditched enclosures and widespread activity (pits, corndrier, etc)	Single extensive area of settlement and associated activity Settlement focussed on higher ground within 1986-96 area but associated activity extends to encompass lower lying surrounding areas	Good Initial detection through single visit during topsoil stripping at outset. Very limited evaluation (based on 2x2m Test pits, geophysics and augering) broadly established a settlement 'core' although subsequent mitigation revealed the extent of activity to be wider than indicated. Recent trenching within this area has consistently encountered deposits Areas affected are likely to be extensive and feature concentrated activity thus making these liable to detection through trenching
Field systems Not readily dateable	Widely dispersed	Moderate Some elements detected in

Character	Distribution/location	Detection
Some ?Iron Age in origin; others may be early medieval		evaluation Due to widely dispersed, linear character evaluation trenching is liable to identify many but not all elements
Road or trackway comprising metalled surface with flanking ditches	Single example Located on western limits of 1986-96 permitted area	Not determined Detected at mitigation in an area not subject to prior evaluation Assessed as an extensive linear feature liable to be detected even through low sample level

Early Medieval

Character	Distribution/location	Detection
Watermills and associated channel management features (including possible fish traps)	Two locations Both present in southern extension along (managed) line of lesser palaeochannel	Poor Both identified at mitigation One was provisionally identified during evaluation but was neither accurately dated or fully understood The restricted extent of the features and activity associated mean that commonly applied sample levels are likely to be unreliable

Medieval

Character	Distribution/location	Detection
Ovens	Single group On higher ground towards north limit of 1986-96 area	N/A Area not subject to evaluation The restricted extent of the features and activity associated mean that commonly applied sample levels are likely to be unreliable
Ridge and furrow	Widely dispersed Ridge and furrow is present only on areas of moderate to higher ground but has been recorded	Moderate Some elements detected in evaluation Due to widely dispersed and

Character	Distribution/location	Detection
	within and sealed by alluvium	linear character evaluation trenching is liable to identify some elements
Field systems Not readily dateable Some may be early medieval or post-medieval	Widely dispersed Field boundaries have been have been recorded across much of the quarried area – some may survive as slight visible elements of the modern landscape	Moderate - good Elements detected in evaluation Due to widely dispersed and linear character evaluation trenching is liable to identify some elements Visible elements can be identified and recorded through surface survey

Post-Medieval

Character	Distribution/location	Detection
Water management features Not readily dateable	Widely dispersed within low lying areas Aerial photography and fieldwalkover has noted probably water meadow related earthworks across the original south extension and within the newly proposed southern extension indicating that much survives as a visible element within the landscape	Moderate - good Some elements detected in evaluation Due to widely dispersed and linear character evaluation trenching is liable to identify some elements Visible elements can be identified and recorded through surface survey
Field boundaries Not readily dateable Some may be medieval or modern	Widely dispersed Field boundaries have been have been recorded across much of the quarried area – many survive as visible elements of the modern landscape	Moderate - good Some elements detected in evaluation Due to widely dispersed and linear character evaluation trenching is liable to identify some elements Visible elements can be identified and recorded through surface survey
Sheep wash	Single instance	N/A Area not subject to evaluation The restricted extent of the feature means that commonly applied sample levels are likely to be

Character	Distribution/location	Detection
		unreliable

Alluvium and palaeochannels

Character	Distribution/location	Detection
Palaeochannels	Two main channels identified (A and B). Cross lowest areas of modern landscape	Good Both identified at evaluation. Main channel present at more than one location and relatively accurately plotted Due to multiple incisions and width of palaeochannels, understanding of the potential complexity of channel deposits is unlikely to be achieved within a 30-50m trench
Palaeochannel fragments	Widespread Focussed on ground to north and west of 1986-96 quarry but widely present including away from lowest parts of modern valley floor, though not present on high ground at north extent of Moreton Camp	Moderate Some identified at evaluation but not all – extents, understanding and dating poorly established
Alluvium	Almost universal except on highest areas of ongoing Moreton Camp extension	Good Understanding gained at evaluation has been comparable in many ways to that achieved through mitigation and in one case provided information otherwise not recorded

In summary, archaeological field evaluation at Wellington has:

- Had had some success in identifying extensive areas of intensive settlement activity;
- Been moderately successful in detecting key areas of later prehistoric and Roman activity (which success overlaps closely with the first bullet point above);
- Been moderately successful in identifying more dispersed areas of extensive settlement (such as Roman and later field systems) even where those features are relatively 'high' in the alluvial sequence;
- Been moderately successful in detecting the principal palaeochannel features.

However, the failings have been highly significant. On the negative side, archaeological field evaluation at Wellington has:

- Been of limited effectiveness in defining the parameters and character of identified settlement areas of any period;

- Been mostly unsuccessful in detecting more specialised deposits of restricted spatial extent (regardless of period and alluvial depth). That failure has included highly important archaeological features such as the two Saxon watermills, as well as alluvial features such as palaeochannel fragments;

- Been generally unsuccessful in detecting more deeply buried archaeological and alluvial features;

- Been generally unsuccessful in identifying earlier prehistoric deposits, some of which have transpired to be of regional importance;

- Been generally unsuccessful in detecting linear deposits of cultural material in the palaeochannel margins.

2.3 Developing a new evaluation approach at Wellington

2.3.1 *Addressing the preservation in situ issue*

As discussed in detail in the *Lower Lugg Archaeology and Aggregates Resource Assessment* (Bapty 2007, Section 4.5), one archaeological resource management response to the Wellington Quarry scenario which had been mooted by the Worcestershire Historic Environment and Archaeology Service would simply be to drop the archaeological field evaluation stage, and focus all resources on post planning mitigation through preservation by record. Archaeological resource managers/contractors would consequently have flexibility to identify and engage with the complex and dispersed archaeological sequences they know are almost certain to be present. The quarry company, for their part, would have some advanced definition of their liabilities/responsibilities, and avoid the up-front cost of archaeological field evaluation.

The basic problem with such an approach is that removal of the archaeological field evaluation stage effectively undermines any potential for consideration of archaeological issues in the determination of planning applications (i.e. the criteria for determining whether a planning application is granted or not), and specifically therefore the pre-planning option of preserving archaeological remains in-situ. The assumed archaeological resource (however potentially rich) has no value in terms of minerals planning assessment criteria which require demonstration of the regional and national significance of known archaeological deposits (see Bapty 2007, section 2.4). Only hard evidence of archaeology could (in principle at least) be used to facilitate rejection or significant modification of minerals extraction applications in the Lower Lugg for archaeological protection reasons.

In essence then, even though archaeological field evaluation at Wellington has previously been problematic – and many of the most important discoveries at the quarry have actually come through subsequent mitigation - the evaluation stage is still strategically essential. While localised preservation in situ may be possible at the post planning stage by agreement with the quarry operator (as happened in 1986 with the preservation of the Wellington villa 'core' area via Redland, the operator at that time), only accurate archaeological field evaluation at the pre-planning stage can certainly a strategic preservation in situ option. Given a scenario where quarrying is likely to be a continuing activity across well into the current century (see section 2.4, Bapty 2007), the retention of that option is crucial to realising a balanced approach to future historic environment conservation of the Lower Lugg valley floor area.

In summary, improving the effectiveness of archaeological field evaluation in the Lower Lugg floodplain is not just a matter of technical nicety – it is of fundamental importance for meaningful archaeological curatorial engagement with the quarrying process in the Lower Lugg Valley.

2.3.2 *Increased trenching sample option*

In the light of this pressing situation, the initial Herefordshire Archaeology curatorial response to the 2007 Wellington Quarry South Extension application was not just that the archaeological field evaluation stage should be retained, but that the total area trenching sample should be increased to 5% (doubling the 2.5% sample which had previously been typical at Wellington).

The 5% figure specifically reflected the outputs of the 2000/2001 English Heritage supported 'Planarch' research process (Hey and Lacey 2001). Planarch looked generally at the core issue of detecting dispersed and spatially restricted archaeological remains on large area sites at the archaeological field evaluation stage (whether in alluviated river valley environments or elsewhere). The resulting guidance was that, following desk based evaluation and remote sensing/fieldwalking, sample trenching should be undertaken at a level of 4-5% of the development area (or an initial sample of 3-4% followed by further targeted problem orientated trenching). Though not prescriptive, these recommendations have nevertheless been widely adopted in the last few years as a basic standard for the curatorial specification of archaeological field evaluation projects.

However, the increased sample trenching approach obviously comes with significant practical drawbacks, particularly with respect to developments of the scale of the Wellington Quarry South Extension. Unsurprisingly, the considerably higher costs are not welcomed by developers, and are not straightforwardly justifiable within the PPG16 process. In addition, within the specific context of quarry related archaeological field evaluation, the degree of additional disturbance caused by larger areas of archaeological evaluation trenching areas can create complications for subsequent 'overburden' stripping operations, and consequently is also unpopular with quarry companies for this additional reason.

It must also be stressed that there was by no means any guarantee that the 5% sample would in any case deliver significantly improved archaeological field evaluation results at Wellington Quarry. Planarch itself acknowledges that higher trenching ratios still have a less than 50% chance of detecting Neolithic, Bronze Age and Early Medieval activity, and are considerably less likely than that to define the extent of such deposits with any reliable predictive capacity. And that is before the additional complications of deep alluvial burial at Wellington are taken into account.

Through discussion between Herefordshire Archaeology, WHEAS and Tarmac Limited, it became clear that a wholesale trenching sample increase to 5% for the South Extension would be problematic to agree and deliver, and would not necessarily address the identified failings of previous archaeological field evaluation at the quarry.

2.3.3 *Recent techniques in the Trent Valley*

Fortunately, an alternative approach was suggested by the recent publication of EH/ALSF supported research which has aimed to develop a response to similar archaeological field evaluation issues in other deeply alluviated British river valley contexts. This research, developed in conjunction with the minerals industry, has focused on the use of an integrated suite of modelling, remote sensing and trenching techniques rather than just a more limited emphasis on direct sampling.

The assessments recently carried out by Trent Geoarchaeology are especially appropriate to the Wellington Quarry scenario. In particular, the work undertaken at the confluence of the Rivers Trent and Soar (English Heritage Project PNUM 3357, Brown et al 2005 and 2007) provides a closely analogous alluvial and valley bottom context to Wellington. The observed alluvial sequence, alluvial unit patterning and the depth and spatial disposition of the deposits is broadly similar in both cases, and both areas likewise share the site formation processes associated with a confluence zone (in the Wellington case, the confluence of the River Lugg and Wellington Brook).

In the Trent Valley work, 'traditional' data such as borehole and air photography evidence have been combined within a GIS with other kinds of information which have only become generally available/affordable in recent years (notably LIDAR survey data). Crucially, the GIS permits more sophisticated integration of these various data sources to produce predictive models based upon the direct link between the geomorphological evolution of floodplain environments and the potential distribution and survival of archaeological deposits.

The resultant understanding has allowed subsequent geophysics, trenching samples, and further geomorphological modelling and/or dating and palaeoenvironmental sampling to be more effectively targeted than can be achieved by a randomly sampling the whole development area. Importantly, prospection for areas of significant occupation and activity can employ relatively high trenching samples focussed within areas of higher ground ('islands') within the floodplain (up to 5%), including those buried and not visible at the present ground surface. Palaeoenvironmental and geoarchaeological deposit sampling, and prospection to establish the broad range of any other 'archaeological' activity present, can focus on areas of lower ground (palaeochannels and channel margins), where activity is often focused. Here a combination of a very limited trenching sample, boreholes and further geomorphological prospection and testing can be applied to selected areas (accompanied if required by selective dating of alluvial units and terrace deposits).

An added value is that the sub-surface modelling has the potential to allow better estimating of mineral and overburden volumes, which can be of practical benefit for minerals companies. In addition, the capacity to better predict and identify archaeological constraints in advance of quarrying also has the advantage of allowing minerals companies to restrict the cost contingency and practical risks associated with unexpected post planning archaeological discoveries.

The results and report produced from such a targeted, multi-disciplinary approach potentially provide the basis for well-informed design of archaeological mitigation strategies specifically reflecting the circumstances of alluviated landscapes.

2.3.4 *Developing an integrated approach at Wellington*

Although the application of similar techniques at Wellington appeared to offer a way out of the Wellington archaeological field evaluation impasse, it was nevertheless important to specifically take account of the particular Wellington circumstances in the design of the new approach.

Herefordshire Archaeology and WHEAS therefore worked together (in consultation with Tarmac Limited) to produce a methodology which tailored the Trent methodology to the Lower Lugg Valley context. For example, an important Herefordshire Archaeology recommendation was not just that differential trenching samples should be employed in particular areas, but also that alternative types of trenching should be used to further amplify that distinction. In particular, it was proposed that longer trenches should be employed in the topographically lower palaeochannel zones to maximise recording of spatially complex stratigraphic sequences in this context.

Overall, the following objectives were agreed for the new Wellington archaeological field evaluation (as set out in Jackson 2007a):

- To provide a predictive model for the archaeological and geoarchaeological deposits liable to be present in the proposed extension;
- To provide a high degree of confidence in the identification of the presence/absence of extensive and significant settlement (or other intensive activity) remains which may be present (especially those of Iron Age, Roman and medieval date);
- To provide a broad understanding of the extent, range and character of any such extensive and significant settlement (or other activity) remains which may be identified;
- To provide a broad understanding of the potential range, and likely circumstances for the location, of other elements of the archaeological record which may be present; namely identifying whether early prehistoric, early medieval and/or dispersed activity of other periods are present or are liable to be present, and identifying the circumstances and locations within which they may be predicted to survive;
- To provide an overall level of information which can support the development of an effective and justified mitigation design.
- To provide a broad understanding of the extent, range and character of sediment deposits that are liable to contain well preserved palaeoecological remains.

2.3.5 *Design of the revised Wellington archaeological field evaluation methodology*

To deliver these objectices, it was agreed by Herefordshire Archaeology and WHEAS (with the support of Tarmac Limited) that the 2007 Wellington South Extension archaeological field evaluation should involve a two stage process:

Stage 1 aimed to deliver a GIS based predictive model via an integrated process of Archaeological Desk Based Assessment (which in this case was already in place as a result of preliminary work undertaken in 2006), GIS preparation, LiDAR analysis, geophysical survey and review, and deposit modelling.

Stage 2 (following the collation of the Stage 1 results within the Updated Project Design) involved targeted trenching and additional geophysics as directed by the predictive modelling.

2.3.6 *Stage 1 process*

Initial GIS construction. The GIS was planned to incorporate:

- OS digital mapping utilising 1:10,000 scale OS digital basemap;
- Site boundaries and constraints (source: Tarmac Limited);
- Bedrock, drift and alluvium (source: BGS and WHEAS archives, Hereford Valleys Survey);
- Flood risk mapping (source: Environmental Agency);
- LiDAR at 0.25m vertical resolution (source: Environment Agency);
- Other existing topographical information and base mapping (source: Tarmac Limited and WHEAS archives);
- Moreton Camp borehole survey comprising borehole logs for 76 boreholes across the site of which 53 are within the bounds of the proposed extension, with the remainder in close proximity (source: Tarmac Limited);
- Existing borehole and trial pit survey from adjacent areas (source: WHEAS fieldwork archives and Tarmac Limited)
- Aerial Photographic mapping from the digital mapping undertaken in 2007 as part of the Lower Lugg Archaeology and Aggregates Resource Assessment;
- Historic mapping, principally 1st and 2nd Edn OS;
- SMR data (source: Herefordshire Archaeology and WHEAS Desk-based assessment for Moreton South);
- Existing detailed local archaeological data including palaeochannel mapping (source: WHEAS archives/previous archaeological work at Welington)

It should be noted that the process of GIS construction (in this case within Arcview 3.3) was intended not just to involve passive data collation, but active analytical engagement with that material. In particular:

- The LiDAR data was intended to underpin the creation of a topographic model of the proposed development area (using the 3-D Analyst Arcview extension package);

- The combined borehole data and relevant existing archaeological data from adjacent areas was intended to permit the construction of a preliminary sub-surface model (using a combination of Rockworks, ArcGIS and ArcScene software). The model was proposed to facilitate initial low resolution identification of larger floodplain components such as palaeochannels, terrace segments and geological islands within the framework of the alluvial stratigraphy;

- These analytical strands and supporting data from other GIS layers were planned to be combined within an interpretive mapping layer which would also be accompanied by an interpretative text.

Preliminary Geophysical Survey. Following the GIS construction and associated preliminary modelling/interpretation exercise, geophysical survey was proposed to test and refine the initial deposit predictions.

Given previous geophysics experience in alluvial contexts both in the Lower Lugg Valley and elsewhere (see section 2.2.1 above), it was decided that geophysics would be based on Electrical Resistance Ground Imaging (ERGI) as the most likely method to deliver substantive results in this context.

It was proposed that the initial ERGI survey would comprise a minimum of 3 east-west transects across the site (to give a minimum total survey length of 1200m) using an IRIS SYSCAL PRO electrical resistivity meter and a 2.00m electrode spacing (which has a potential depth penetration of 15m and can therefore support more accurate modelling of the gravel body as well as overlying sediment units).

In addition, it was proposed to undertake limited gouge coring along some of the ERGI transects to provide ground truthing of the ERGI depth sections, and give additional data on sediment stratigraphy and architecture. Final presentation of the data and its interpretation was to be in the form of images produced in ADOBE ILLUSTRATOR, with associated interpretative text.

Integrated Predictive Interpretation. An interpretative combination of the geophysics results and the GIS resource and deposit modelling was proposed to identify zones of predicted archaeological potential, and allow targeting of trenching and further geophysics on this basis. The detail of this targeting was to be set out in the Updated Project Design.

2.3.7 *Stage 2 process*

Trenching. Trenching was planned on the basis of a 2.5% sample of the whole site, (providing 9675m² of trenching in total). Based upon a typical 4m wide trench this allowed for just over 2400m of trenching (with a proviso allowing extension of the total trench length should 1.80m wide trenches be safe and archaeologically useful in some circumstances/conditions of limited overburden thickness).

The proposed trenching method was designed to flexibly engage with the Stage 1 predictions, meaning that the total 2.5% sample would be achieved by differential levels and methods of trenching in particular zones according to their predicted archaeological potential. In principle:

- Higher sample levels (3%+) were proposed for areas where the alluvial overburden depth is least and sand and gravel deposits area closest to the surface (gravel 'islands'). On the basis of previous archaeological work at Wellington (see section 2.2.3 above) such areas are considered to have the greatest potential for the presence of significant archaeological deposits liable to be detected through trenching (settlement enclosures, spreads of intense activity, etc). It was proposed to cover approximately 25% of the total site area at this higher sample level. Trenches in these areas were proposed to be 50m long.

- Lower sample levels (max 1%) were proposed in areas where the depth to sand and gravel is greatest and the alluvial overburden at its thickest (palaeochannels etc). Such areas may include significant archaeological deposits, but are not anticipated to include occupation or other deposits of a character and extent liable to be effectively detected through sample trenching. However, important palaeoenvironmental and other geoarchaeological horizons may be present. It was therefore proposed to cover a further 25% of the total site area at this lower sample level. Long trenches (100m+) were proposed in these areas and would be located so as to provide appropriate cross-sections across deeper sequences. This would also allow for investigation and sampling of palaeochannel fills and deeper valley floor accumulations.

- Moderate sample levels (approx 2%, and similar to those previously used at Wellington), were proposed across the remaining area (estimated to be approximately 50% of the total site area). These low sample areas were to provide evidence for the broad range and character of deposits liable to be present across much of the site. This level of sampling was also considered to provide a reasonable level of certainty of the presence/absence of any settlement enclosures, spreads of intense activity, etc in these areas (though further refinement of the character and extent of such spreads may be required).

- In addition, a provision based upon 0.5% of the total area (1935m^2 equal to approximately 485 x 4m of trench) was planned to be retained to allow for additional trenching to support results in any given area and refine understanding of extent or character of deposits identified.

Beyond this targeting methodology, implementation of trenching was naturally proposed to follow established industry guidance/'best bractice' procedures, and evolved site specific methods of operation at Wellington. Importantly these conditions included provison for site visits by a geoarchaeological/geomorphological specialist to give on site advice on sampling and interpretation matters (in addition to the use of existing evolved WHEAS geoarchaeological recording processes).

Additional geophysics. A minimum total of 400m of detailed ERGI survey was proposed. This was planned to be undertaken in transects of variable length according to the Stage 1 targetting results. To permit enhanced detail with this targeted research process, a 1m electrode interval spacing was proposed to provide a penetration of approx 6m. Use of an IRIS SYSCAL PRO was suggested, with transect locations and topography to be recorded using the LEICA RTK differential GPS.

Further gouge coring was also proposed to facilitate ground truthing of the ERGI transects, and to provide detailed information on sediment architecture and stratigraphy. It was also suggested that deposits suitable for the sampling of palaeoecological materials and radiocarbon dating might be identified through this process.

The planned output of the additional geophysics was detailed modelling of the deposits within the target transects (principally, potential palaeochannel fills), and refined cross-sections for these parts of the valley floor.

2.4 Assessment of the results

2.4.1 *Stage 1 Results - GIS*

GIS software is very widely used for spatially extensive manipulation and presentation of archaeological and other supporting data, and its application would now be expected as standard for a varied suite of archaeological resource management purposes (indeed, it should be noted that the 2006/7 *Lower Lugg Archaeology and Aggregates Resource Assessment* created a tailored archaeological GIS resource for the whole valley area, see Bapty 2007, Section 1.3). It is also, of course, a well demonstrated truism that GIS is only ultimately of as much use as the data entered into it allows it to be. In the Lugg Valley, that point was clearly illustrated when a GIS predictive archaeological model - based on statistical probabilities generated from overlaps in selected GIS data layers - was developed by the Institute of Geography and Earth Sciences, University of Aberystwyth as part of the *Lugg Valley Archaeology and Landscape Change Project* (Dorling 2008, see also Bapty 2007, Section 4.5). The resulting projections looked 'scientific', but really revealed much more about the uneven spatial coverage of the archaeological data and the coarse assumptions underpinning the analysis than any meaningful relative probability of past human activity in different landscape zones.

Before the present exercise, GIS had not previously been used with specific respect to organising archaeological data for evaluation of a quarry planning applications in the Lower Lugg Valley. It is then no surprise to discover that, judged against previous manual methods, GIS immediately proved to be an effective and essential tool for this purpose. Importantly, of course, the GIS linked capacity to analytically engage in statistically sophisticated ways with different spatial data layers was fundamental to the proposed predictive modelling process. But even without the aspiration to develop and test that predictive modelling component, it did not need this study to conclude that GIS applications should be used as a basic data collation and presentation device for future archaeological evaluation of large area planning applications in the Lower Lugg Valley.

However, it is equally obvious that much of the background material incorporated within the GIS – such as mapping (current and historic), SMR, geological and quarry related data – was similar (and similarly limited with respect to pre-figuring deeply buried archaeology) to that utilised in previous desktop evaluation exercises. As with earlier evaluations, superficial and chronologically late features were detectable. The most notable of these was an extensive grid of 'leader' and 'feeder' ditches associated with a Post Medieval water meadow system which covered much of the extension area. This would certainly have been recognised through 'traditional' desk top evaluation procedures, but the fact that this meadow system had been digitally mapped from air photo evidence within the *Lower Lugg Archaeology and Aggregates Resource Assessment* (Bapty 2007, Section 4.3) meant that it was immediately known and geo-referenced within the air photography GIS layer.

As far as sub-surface archaeology was concerned, the Desk Top Assessment (Miller and Jackson 2006) broadly concluded that significant alluvial and archaeological deposits would be present (including the probable extension of palaeochannel features partially recorded in contiguous zones). There was, of course, no immediate enhanced capacity to go beyond that generalisation just because existing background information was now within a GIS.

2.4.2 *Stage 1 Results - LiDAR*

The GIS based analysis of LiDAR data to identify palaeochannel and other features (such as archaeological earthworks) was a significant innovation against previous Lower Lugg evaluation processes, and is a core element of the recently evolved Trent Valley evaluation methodology. In practice, the LiDAR and additional geoarchaeological information (borehole modelling and ERGI data, see below) was initially assembled in a parallel GIS prepared by the VISTA Centre consultants.

It should be noted that, at the outset, there was some uncertainly as to the potential value of LiDAR in the specific circumstances of the Lugg Valley floodplain. Previous preliminary analysis of LiDAR data in the area had been undertaken by the Institute of Geography and Earth Sciences, University of Aberystwyth as part of the *Lower Lugg Archaeology and Aggregates Resource Assessment* (Bapty 2007, Section 3.2). This work, although based on the limited spatial coverage and the coarser resolution LiDAR data then available, had nevertheless concluded that relatively little alluvial topographic detail was present in the Lugg floodplain. It had been argued that this situation perhaps reflected a period of sustained stasis in late Holocene river development. In this scenario, limited dynamism necessary meant similarly limited evidence of past floodplain change, and such topographic evidence of earlier river development as did exist would in any case be concealed by progressive alluvial accumulation around the present river channel. It was therefore suggested that a stable and flat floodplain zone in the Lower Lugg Valley probably presented limited opportunities for observing features such as buried palaeochannels.

The results of the present LiDAR analysis, with finer resolution 1m posting data (within a Last Pulse Digital Terrain Model (LP DTM) analysed and presented by the VISTA Centre via topographic modelling in ArcGIS), in fact revealed significant archaeological and alluvial topographic evidence (Jackson and Sworn 2008, Figures 5-11, Appendix 2). In basis, the LiDAR allowed a subtle pattern of lower, higher and intermediate topographic areas to be differentiated.

The lower zone is mainly associated with three apparent palaeochannel alignments preserved as sinuous depressions crossing the proposed extension on a north to south alignment and coming together towards the south east corner of the area (Jackson and Sworn 2008, Figure 7, Appendix 2 this document). The westernmost palaeochannel (palaeochannel A) appears to be the continuation of a former watercourse identified in the 2003 Moreton Camp evaluation which was known to have subsequently been recut as a Roman drainage ditch. The other two palaeochannels (B and C) likewise seem to relate to a channel already recorded to the north-east which was known to have been open at least into Early Medieval period, and which may have originated in the early Holocene. Importantly, it was this channel which was associated with the two Saxon mills known from Wellington Quarry. At least one additional paleochannel fragment was also identified on the LiDAR, and this was interpreted as an isolated 'oxbow lake' meander feature.

The identified zones of 'higher' ground - and it should be emphasised that the distinction is slight in absolute terms - were interpreted as representing the flattened 'shadow' of higher points of the undulating gravel which would once have been rather more prominent gravel 'island' features within the early Holocene floodplain. Interestingly, the GIS combination of LiDAR and other data also confirms this pattern by the association with modern landuse, and the preferential use of the slightly higher areas for arable cultivation. These areas were also noticeably free of potential palaeochannel features. The intermediate zone was defined in the distinction between the high and low zones, and in the similar absence of palaeochannel features.

It should also be noted that the LiDAR also revealed significant cultural features, though inevitably relating to relatively late landuse phases. Most prominent was the 'known' water meadow system, but the LiDAR also picked up additional elements of the complex which had not been identified on the 2007 air photo mapping (Jackson and Sworn 2008, Figure 8, Appendix 2 this document). In the west and north of the site, fragmentary areas of ridge and furrow were identified which again had escaped detection through the air photo mapping work (Jackson and Sworn 2008, Figure 9, Appendix 2). Additional linear drainage and ditch features were also observed (Jackson and Sworn 2008, Figures 10 and 11, Appendix 2), and these did not seem to certainly correlate with the principal water meadow and ridge and furrow complexes.

In summary, the LiDAR analysis very adequately fulfilled its stated purpose of allowing the construction of a basic topographic model of the extension area. What is more, by identifying features which could be tied to previous archaeological and geomorphological understanding of the contiguous quarry areas, it immediately embedded within that topographic model a considerably enhanced capacity for archaeological prediction. Gravel high areas, for example, are well known from investigation of adjoining areas to be associated with the principal areas of settlement activity in the floodplain. Likewise, the identification and spatial linkage of the palaeochannel pattern to previously investigated channels also allowed informed conjecture about the sub-surface character of those features and their likely palaeoenvironmental and archaeological potential.

The analysis also demonstrates that, despite the relative stability of the Lower Lugg floodplain previously revealed by the *Lower Lugg Archaeology and Aggregates Resource Assessment* LiDAR analysis, local use of LiDAR is still a practical tool for 'geoarchaeological' characterisation and detection. The relatively limited pattern of palaeochannels identified in the extension (three principal channel features) does coincide with the earlier findings, and seems to confirm the interpretative picture of a stable Holocene floodplain environment associated with limited channel movement and an avulsive pattern of floodplain development. However, the present exercise has shown that the subtle and less pronounced alluvial topography that therefore exists is nevertheless still observable by refined LiDAR analysis, and is still directly relevant to predicting past human use of the floodplain area. Indeed, the upside of the scenario is, of course, that limited channel dynamism also means that the floodplain potentially preserves deeply buried and extensive archaeological deposits undisturbed by later river erosion.

It should also be stressed that specialist involvement in the LiDAR manipulation and analysis (via the VISTA Centre) was central to its success. Massaging of the data through differential projections, and the optimum statistical combination of different projections within the topographic model so as to maximise combined surface detail and feature visibility, was essential to making full use of the data. Such analysis requires appropriate computing power, software applications, technical competence and the specialist geoarchaeological understanding to facilitate informed interpretative presentation of the results (see Carey and Howard 2007 for technical detail in this case). At the present time, it is probably fair to say that such combined capacity would not generally be accessible through most independent archaeological contracting organisations.

2.4.3 *Stage 1 results – preliminary sub surface model*

It was originally proposed to add preliminary value to the LiDAR topographic model by correlating this with initial sub-surface modelling of alluvial deposits based on existing borehole data (using a combination of Rockworks, ArcGIS and ArcScene software).

In practice, this process proved to be of only very limited practical value, even allowing for the coarse results which had been expected.The limitations of the borehole data – derived from quarry prospection work, and therefore with limited recording of 'overburden' information not relevant to characterising the gravel - had already been recognised in previous archaeological evaluation at Wellington (see section 2.2.3 above). Although the modelling process theoretically had the capacity to amplify the value of such data by engaging with other data sources within the GIS so as to statistically 'interpret' broader predicted sub-surface patterns, the poor quality of the material combined with limited spatial coverage nevertheless frustrated any meaningful outputs. In effect, the modelling allowed no more than a basic projection across the extension of broad variations in the depth of alluvium/channel deposits over the gravel.

The preliminary sub-surface modelling did not therefore prove to be of real use in this case. On this evidence, the further use of quarry related borehole data for archaeological prospection purposes in the Lower Lugg Valley does not (however sophisticated the analytical manipulation) appear to offer significant information beyond that anyway obtainable by combined LiDAR and ERGI and gouge survey work.

2.4.4 *Stage 1 results – preliminary geophysics survey*

A total of nine ERGI transects were undertaken by the VISTA Centre (for detailed results see Jackson 2007c, appendix 1 this document). These were supported by coincident gouge core transects to 'ground truth' and enhance the ERGI results. The transects were aligned across palaeochannel features identified by the LiDAR topographic model, and were also extended to test the adjacent association of palaeochannels with higher parts of the floodplain.

In general terms, the combined ERGI and coring processes successfully facilitated significant modelling of transect detail, with interpretative anlaysis extending beyond the construction of basic profiles to include the sectional structure of some palaeochannel features. Perhaps unsurprisingly, the initial ER 2m electrode spacing proved to be insufficient to do much more than simply detect the presence of palaeochannels. A refined 1m spacing was adopted, and this allowed definition of section detail and facilitated the identification of potentially significant archaeological/alluvial contexts (such as, for example, as an unusual anomaly in the meander fragment which is recommended for further investigation). The gouge coring broadly confirmed the 'classic' Wellington three unit alluvial sequence (see Section 3 for detailed presentation of the Wellington alluvial sequence) across much of the extension floodplain. Perhaps more usefully, it also permitted considerable interpretative detail to be added to the ERGI palaeochannel sections. Direct recovery of organic material from some palaeochannel contexts also emphasised strong localised potential for palaoenvironmental analysis.

The results additionally helped to firm up some of the broader connections with previously excavated areas which had been implied by the LiDAR results. Two transects across Channel A confirmed a comparable depositional sequence to that observed in the presumed contiguous channel excavated to the north in 2003. A further two sections across channel C likewise revealed a leat like incision on its western side which immediately invited comparison with the similar re-incision in the channel which fed the Early Medieval mills, and strongly suggested that this was a continuation of the same feature.

2.4.5 *Stage 1 results - integrated predictive interpretation*

The LiDAR, ERGI and gouge coring data were interpretively combined to additionally add key areas of palaeoenvironmental potential and sub-surface alluvial detail to the LiDAR based topographic model (Figs 11 and 12, Appendix 1 Jackson 2007c, see appendix 1 this document). At its most basic level, this helped to confirm within the refined model that the predictions of alluvial depth which stemmed from the LiDAR results (such as thinner alleviation over higher presumed 'gravel island' areas) were broadly correct, and therefore that the proposed differential trenching strategy (designed with respect to such variables) was likely to 'work' in those terms. In addition, the detail sub-surface modelling from the ERGI and gouge coring process also helped to identify additional targets for specific testing of localised resource potential, notably with respect to palaeoenvironmental evidence sealed in palaochannel contexts

In line with the planned methodology, it therefore proved possible to design a differential trenching strategy based on distinct approaches in each of the three different topographical zones identified via the LiDAR based model (Figure 1, Jackson 2007c, appendix 1 this document). As had been proposed, within a total 2.5% sample, the highest 3% sample was targeted at the high points where expectation of *in situ* cultural deposits was greatest. The lowest 1% sample was undertaken in the intermediate zone where expectation of deposits of cultural and palaeoenvironmental significance was least. A 2% sample was applied to the palaeochannel areas, with this based on longer east-west trenches sited in terms of the ERGI results to maximise understanding of the palaeochannel sequence, while also allowing specific testing of paleoenvironmental potential. An additional ERGI and coring strategy (400m in total) was proposed to complement the trenches by evaluating intermediate areas, and also to complete survey of part of the site which had been inaccessible because of crop cover at the time of the initial work.

2.4.6 *Stage 2 results – archaeology*

The detailed Stage 2 results are presented in the interim report (Jackson and Sworn 2008, appendix 2 this document).

Important cultural deposits were exclusively identified within the higher density trenching on the main gravel island/ridge which runs on a north/south alignment between Palaeochannels 2 and 3. Interestingly, the identified contexts were all of a dispersed and localised character, and no larger area spreads of material/settlement were identified.

Scatters of pits, postholes and ditches indicated significant Neolithic and Bronze Age activity. Among the most notable discoveries was a single large pit containing Neolithic plain bowl pottery, axe fragments, flint tools and burnt stone (which can be closely compared with other known pits of this kind from Wellington), and a Middle Bronze Age cremation cemetery comprising 21 cremation deposits within a sequence of inter-cutting pits stratigraphically fossilising the sequence of development of the complex. A further intriguing feature of potential high significance was a bank and ditch stratigraphically sealed by alluvial Unit 2 (into which all the other prehistoric features are cut) and therefore of suggested Mesolithic or very early Neolithic date.

Only a few later features were recovered. These included undated ditches which are provisionally thought to be Roman on stratigraphic evidence, and a larger group of Unit 1 red alluvium filled ditches of a kind similar to those known from many parts of Wellington Quarry. These are generally considered to be post Roman, and in this case some are probably associated with the water meadow system which had been recorded by the LiDAR and air photo mapping.

In essence, the trenching strategy successfully located significant archaeological deposits of generally limited spatial extent. On the face of it, these results fit very neatly within (and validate) the initial modelling predictions. What is more they do seem to take understanding of the site beyond those predictions by illuminating not just the specific detail of the contexts, but also the more general patterning of past landuse across the extension area. In particular, it does seem that there was a preferential earlier prehistoric targeting of the main gravel 'ridge' location at the expense of the more 'isolated' terrace east of Channel 2 (which so far appears blank in terms of contemporary activity).

2.4.7 *Stage 2 results - alluvial deposits*

The trenching, and the additional ERGI and gouge coring results, also allowed significant additional detail to be added to the understanding of the alluvial and palaeochannel sequence, and its potential for recovery of palaeoenvironmental materials. This included the more detailed description of the 'standard' Wellington alluvial unit sequence (see Jackson and Sworn 2008, appendix 2 this document), including the recognition of particular local details within the extension. For example, zones were identified where the humic Unit 5 buried soil (known elsewhere at Wellington) was present within Unit 2. In addition, a deposit of compressed organic material identified within Unit 1 in the eastern part of the extension seems to be associated with a major flooding episode, and could be important in dating and interpreting the later alluvial history of the floodplain. Additional recording of palaeochannels supported by targeted ERGI transects in intermediate locations also allowed more detailed modelling of the development sequence, and the chronological interrelationships between the channels.

While, at one level the results of the further alluvial deposit investigations were less significant in testing and going beyond the initial model than the archaeological results, they nevertheless 'ground truthed' that exercise and facilitated more sophisticated characterisation which will directly inform subsequent mitigation processes.

2.5 Effectiveness of the evaluation strategy

2.5.1 *Fulfilment of stated objectives*

The preliminary assessment of the results must be that the original objectives (as set out in section 2.3.4 above) have been fulfilled, and that the overall methodology combining Stage 1 GIS based modelling and Stage 2 targeted trenching and geophysics has been a highly effective procedure in the context of the latest Wellington extension.

2.5.2 *Stage 1 overall assessment of effectiveness*

Clearly it was the 'new' data sources which underpinned the success of the initial modelling process. Given the previous observations about the specific character of the Lower Lugg floodplain (and its limited topographical variation resulting from a long period of floodplain stability), there was no certainty that the procedure would 'work'. However, the productive results of the LiDAR demonstrate the value of this approach in the Lower Lugg as elsewhere, and successfully underpinned the production of a predictive topographical model.

In similar contradiction to patchy previous experience, the Stage 1 (and subsequent Stage 2) work also demonstrated that geophysics (Electrical Resistance) is a practicable exercise in the Lugg floodplain zone, especially when tied to a wider GIS based modelling process incorporating LiDAR data. Some of that success naturally reflects ongoing technical advances in geophysics techniques and associated data manipulation and interpretative presentation since previous geophysics experiments in the locality.

One important caveat which should be added with respect to both the LiDAR and the geophysics is that overall alluvial thicknesses in the extension (circa 0.5m on the high points up to 2m in channels) were less than have been encountered in other parts of Wellington Quarry (where up to 3m alluvial accumulation over the gravels is recorded even in non-channel contexts). It could therefore be that such a suite of approaches would be less effective in areas of greater alluvial thickness (though even if so, that will only apply to relatively localised floodplain areas)

The more 'traditional' additional sources of data incorporated within the GIS had less influence on the predictive modelling (though the digital mapping of air photo evidence proved a useful supplementary resource within the GIS). Obviously, that does not mean that 'other' data should be ignored in the future, and they may prove of considerable predictive importance in particular local circumstance. Significant analysis of existing quarry prospection borehole information probably can, however, now be judged to be of little value in a scenario where other components of the evaluation process (ERGI/gouge coring modelling) supply much better controlled and defined data of that kind.

2.5.3 *Stage 2 overall assessment of effectiveness*

There needs to be some wariness in supposing that just because the trenching results seemed to confirm the predictive model in terms of zones of archaeological discovery, so the value of varied trenching against that predictive model is therefore automatically demonstrated. There is an obvious potential 'self-fulfilling prophecy' trap here – it is not necessarily an insight that things are found where most trenches are placed to find them. Perhaps too the process just 'got lucky' on this occasion. Alternatively, if it subsequently turns out that 'blank' evaluation areas also have significant archaeological deposits, then the present methodology will look a lot less 'smart' than it superficially appears at this stage.

However, it must be said that the very full understanding of previous patterns of archaeological discovery from Wellington Quarry (and the proven and consistent associations of archaeological deposits with particular alluvial and topographic contexts) does give significant control on these 'false finding' risks. What is most significant about the evaluation trenching in this case is not just that archaeological deposits were identified, but that within a total sample of only 2.5% it proved possible to identify precisely the kinds of dispersed and localised deposits (mainly of earlier prehistoric date) which had previously proved most resistant to pre-planning identification by blind sampling procedures (see section 2.2.2 above). Such deposits have also been among the most important mitigation discoveries at Wellington (e.g the 1996 Beaker burial, or the 2000 and 2002 Saxon mills). The current evaluation finds are no exception, and the Bronze Age cremation cemetery and the Mesolithic (?) ditch are unprecedented at Wellington, and certainly of regional importance. The difference in the present case is that mitigation recommendations can now proceed on the basis of specific prior knowledge of this potential.

The trenching, ERGI and gouge coring work has also demonstrably facilitated improved characterisation of palaeochannel contexts, though against the more satisfactory results of previous evaluation in this respect, the gain is less dramatic. Nevertheless, the more sophisticated sub-surface modelling achieved at the evaluation stage is clearly a significant advance for the identification of palaeoenvironmental potential in particular, and this information has fed directly into recommendations for post planning mitigation conditions and enhanced provisions for sequential C14 dating.

A closing caveat to this good news story is that it does need to be recognised that the differential trenching strategy is still by no means a perfect solution – a 2.5% sample is still only 2.5% however cleverly targeted - and some categories of material may be less well served by the variable approach. For example, significant cultural deposits (such as Beaker period linear middens adjacent to settlement areas) have been located at Wellington in topographically low palaeochannel contexts, and these are unlikely to be identified by the reduced percentage trenching ~~now implemented~~ used in the recent work (especially when that trenching was primarily oriented on long cross channel alignments to maximise recovery of floodplain sequence information). Moreover, other kinds of features – such as trackways and platforms – might also be expected in exactly these kinds of locations (see Bapty 2007, Section 5.2). At this stage it is impossible to tell whether such material has been missed in the present exercise.

There clearly is an implicit danger in too closely devising prospection techniques against criteria narrowly defined by previously known discovery at Wellington. The prescriptive assumptions within the predictive model concerning the relative archaeological interest of different topographical zones could yet turn out to be a significant over simplification with real consequences for the adequate characterisation of the resource. That will especially be the case if the evaluation results are treated with over confidence precisely because of their apparent efficacy in terms of the internal logic of the method.

2.5.4 *Overall conclusions*

- **The new evaluation methodology - incorporating a GIS facilitated topographic/deposit modelling phase in order to differentially target trenching and geophysics sampling process - appears to have effectively identified and characterised key archaeological and alluvial sequences in the latest Wellington quarry extension;**

- **The analysis of LiDAR data to generate the basic topographic model was a key innovation in the success of the evaluation process, and importantly demonstrated the applicability of this technique to the Lower Lugg floodplain context;**

- **The ERGI survey likewise demonstrated the practical application of geophysics in the Lower Lugg floodplain context, and indicate the potential future importance of this technique in the area;**

- **Features identified by the Stage 2 targeted trenching include dispersed and localised archaeological deposits (Neolithic/Bronze Age in this case) which had previously been resistant to evaluation;**

- **The methodology does have potential limitations, and issues such as sampling levels and strategies in different floodplain zones will continue to need revision and development to maximise recovery of evidence;**

- **The basic methodology should be developed and implemented as a basis for all future quarry evaluation work in the floodplain of the Lower Lugg Valley.**

3. Wellington Integrated Stratigraphic Analysis

3.1 Introduction

3.1.1 *Purpose*

This section of the report presents the results of a preliminary evaluation of the stratigraphic relationships revealed by progressive archaeological examination (1986 to present) of the Lower Lugg floodplain deposits within Wellington Quarry. The underlying objective is to support effective mitigation of quarrying work in the Lower Lugg Valley, and to maximise future recovery of data during archaeological work in the floodplain.

Understanding of the Wellington stratigraphy necessarily underpins evolved archaeological field techniques and interpretations within the floodplain zone. However, potential for significant oversight within embedded expectations of 'typical' stratigraphic relationships has long been recognised, and was summarised in the *Lower Lugg Archaeology and Aggregates Resource Assessment* (Bapty 2007, section 4.6). Problematic issues include the complexity of the alluvial sequence across the Lugg/Wellington Brook confluence zone, the uncertain transformational effects of post depositional change in the alluvial sediments, and the differential consequences of spatially variable recording over the last twenty years.

Given such issues, the analysis aims to test current received understanding against a combined review of the actual observed stratigraphic sequence in each past excavation area. The primary aim is to establish if existing assumptions about stratigraphic patterns – and particularly the stratigraphic situations in which archaeological features of different period are observed (and observable) – are consistently supported by the record. To this end, the analysis assembles and assesses an integrated model schematically combining all recorded stratigraphic relationships across the quarry.

3.1.2 *Process*

The work was undertaken between December 2007 and February 2008 by Ian Bapty (Herefordshire Archaeology) and Robin Jackson (Worcestershire Historic Environment and Archaeology Service/WHEAS). The analysis was based on review of data in the Wellington site archives held by WHEAS. The process of archival access and data gathering was led and guided by Robin Jackson with the assistance of Ian Bapty.

The present report, presenting and analysing the results of this work, was prepared by Ian Bapty and incorporates discussion with Robin Jackson.

3.1.3 *Limitations*

It had initially been proposed to tackle this research issue via construction of a detailed three dimensional deposit matrix employing absolute spatial and depth data. However, it transpired that this data could only be generated and presented by extensive secondary re-analysis of the WHEAS archive, and it became clear that this would not be achievable with the resources and time available through the ALSF Stage 2 process.

The analysis therefore offers a more limited schematic assessment based on readily available WHEAS Wellington excavation data which could be accessed without extensive reworking of the archival material. That restriction also meant that data from the recent work in the eastern part of the South Extension and Moreton Extension – which is still undergoing post excavation analysis and archival organisation – was not in a state which could be used for this work, and those areas are therefore excluded from the analysis.

The output is therefore an initial assessment of the validity of existing stratigraphic understanding at Wellington Quarry. As such, the analysis here is not an end point, but is a preliminary treatment of the stratigraphic 'problem' at Wellington, and is subject to clear identified constraints. The intention is therefore to 'scope' the issue, and, if appropriate, to preface a further research process.

3.2 Background

3.2.1 *Summary of the alluvial context at Wellington*

The archaeological investigations at Wellington Quarry since 1986 (see section 4.1.5 to 4.1.9 of the *Lower Lugg Archaeology and Aggregates Resource Assessment*, Bapty 2007) has facilitated spatially extensive recording of alluvial deposits across the part of the valley floor occupied by the quarry. This information has progressively informed an overall understanding of the character of the Wellington alluvial sequence, and an overarching geomorphological interpretation of how the Wellington valley floor has developed since the end of the last Ice Age.

This integrated description and understanding was recently summarised by Jackson in the *Lower Lugg Archaeology and Aggregates Resource Assessment* (Bapty 2007, Section 4.1.11, pages 90-92):

> The Devensian gravel being extracted at Wellington Quarry overlies and is largely derived from Raglan Mudstone. The Holocene deposits overlying these contain buried archaeological remains and at Wellington fieldwork has explicitly combined the study of archaeological deposits and of the sediments in which they are found. Previous work by Roseff (1992) and others has shown that the sediments are largely overbank flood alluvia laid down away from the main Lugg channel.
>
> The current model of valley development for the Lower Lugg in this area indicates that the late glacial Lugg Basin was crossed by a pattern of braided streams. These laid down deep gravel beds and resulted in an undulating surface to the natural gravels with an overall gradient that slopes across the quarried area gradually from north and west to the south and east. Dating of a palaeochannel fragment within the North extension has produced a date of between 18,000 and 14,000 yrs BP for the deposition of the terrace into which this palaeochannel was cut (Brown et al 2005). It is also suggested that the incision of the river that formed the Holocene floodplain occurred during the later Younger Dryas (Brown et al 2003) rather than the Holocene date implied by Dinn and Roseff (1992).
>
> Analysis of Holocene dated sediments overlying the gravels has provided a relatively clear picture of subsequent valley floor development in this part of the catchment. The valley floor would probably have initially consisted of multiple channels divided by constantly shifting gravel islands. However, the end of glacial conditions and the growth of the early Holocene

forest gradually caused the overland flow of water to be reduced because more water was able to infiltrate into the ground. As the fluvial energy dropped through the Holocene so did the particle size of the deposits and consequently the River Lugg gradually rationalised into fewer channels and, finally, into a single main channel which runs to the east of the quarry. This seems to have remained stable ever since because early Holocene deposits (at least in the centre and west of the valley floor) have not been reworked by movements of the river.

Within the area quarried to date, at least one major palaeochannel depression (Palaeochannel A), one well defined lesser palaeochannel (Palaeochannel B) and numerous channel fragments have been recorded (Figure 27). Some contain coarse deposits often concentrated to their sides or base and frequently including tufa, shell and organic material. These represent material deposited by fast flowing water. Bone and cultural debris are sometimes included within these and occasionally have clearly been specifically deposited into the channel margins rather than simply being material eroded and redeposited by the fast flowing water. The deepest of these include peat deposits formed as the channel silted up and choked with vegetation. For periods of time these would have survived as sinuous depressions and the deepest may have remained as seasonal streams for considerable periods of time. All were gradually filled by silt and clay deposited during periods of overbank flooding. Some of these depressions continued as watercourses because smaller channels were recut within them as a part of active water management during the Roman and later periods. Thus ditches and 'leats' have been identified lying within much earlier, natural channels – the most obvious place to keep the water flowing. Further, it has become increasingly evident that during phases of active channel incision on the floodplain, newly forming watercourses often partially followed the line of the depressions and softer fills left by their predecessors

The major palaeochannel (A) was at first understood to be a single broad channel incision but is now believed more likely to be a broad depression created by one or more meandering channel incisions related to the river Lugg. Dating of peat and organic rich sediments within the broad depression at various points shows that channels within the depression were filling with peat (ie starting to becoming inactive) and organic silts from the late Mesolithic onwards, while dates from organic debris in alluvial deposits towards the top of the depression fill sequence provided an Early medieval date. Smaller palaeochannels such as the one that runs north to south through site (Figure 27; Palaeochannel B) are considered most probably to represent former courses of the Wellington Brook. Artefacts recovered from these suggests that they date from the late Neolithic/early Bronze Age through to the early medieval period with Palaeochannel B being an active channel during the later prehistoric (Late Bronze Age onwards) and Roman periods and then being maintained as watercourse through the early medieval period prior to being abandoned to silt up sometime towards the end of the first millennium AD.

The alluvial sequence associated with these palaeochannels becomes increasingly complex towards the deeper sediments in the south-east part of the site, however, the typical alluvial sequence across much of the investigated area comprises three well defined deposits or alluvial units. At the base are the deep gravels above which are usually found a band of red-brown material, which varies greatly in texture (often including a substantial gravel component) and depth – although thicknesses greater than 30cm are not common. This is termed Unit 3. Above this is Unit 2, a silty clay deposit varying from yellow to grey in hue (often referred to as buff-coloured) and frequently more than 1 metre in depth. At the top is another red-brown layer, Unit 1, containing silt and clay, which can be up to a further metre thick though it is usually less than this.

Within the original permitted area, a brown, finds rich and apparently more humic deposit (Unit 4) has been extensively recorded between Units 1 and 2 in the area of the Roman settlement core. This is considered to represent a late prehistoric through to early medieval deposit, perhaps a buried soil resulting from a period of relative stasis in this part of the valley floor.

Darker bands have been commonly recorded in the lower half of the section (within Unit 2) and have been interpreted as former soil surfaces – the dark colour being the remains of humified organic matter. These are usually termed Unit 5. Fine sedimentary laminae have also been noted in patches over much of the valley floor in Unit 1 and Unit 2 deposits.

Rises in the gravel are overlain by deposits, which may entirely lack any of the alluvial units where the gravel is closest to the surface as towards the northern side of the Moreton Camp extension. Elsewhere, higher areas of gravel may lack the uppermost units while depressions may have an anomalous and altogether more complex sequence of units. Recent studies at the valley edge (Terra Nova January 2002; Terra Nova October 2002) have shown that the shallower deposits here may likewise lack the uppermost unit. This may indicate that, by the time the upper unit was deposited, the alluvium had already become deep enough that such higher points stood above most of the floods.

3.2.2 *Explicit interpretative issues*

Even in its own terms, this established view of the alluvial sequence raises a series of further questions. For example, it is unclear to what extent the alluvial build up has been relatively continuous and gradual, or – as certainly suggested by the Unit 4 and 5 horizons within the 'main' units - a more complex process combining periods of stasis with more dynamic episodes of river activity and flooding. Likewise, understanding of the formation of the main palaeochannel (Channel A) is not well developed. It could that the current model – presenting Channel A as a broad depression in the underlying gravel created by a series of meandering lesser incisions over a long period of time – conceals much additional complexity within that generalised rationalisation.

These uncertainties coalesce around the general problem of dating of the units (especially Units 2, 3 and 5). Because Unit 3 sits at the base of the sequence (presumably in a late Pleistocene/early Holocene context), it potentially dates the river channel incision that has led to the formation of the Holocene floodplain, and therefore the commencement of alluvial formation in the valley. Unit 5 is another important reference point in the sequence since it apparently forms a separate horizon within Unit 2, indicating at least two major phases for that deposit, and perhaps a need to divide Unit 2 into at least two separate events. However, Unit 2 seems to have little or no organic content, and therefore has not yet proved datable by conventional methods.

3.2.3 *Implicit interpretative issues*

These outstanding questions – and the impression they tend to give of a process of 'finishing off' an essentially known story – to some extent belie a number of more fundamental interpretative issues.

For one thing, it is important to stress that the overall evolved understanding of the Wellington alluvial sequence has been created out of a rolling programme of archaeological and geomorphological recording and observation over a twenty year period. That process was detailed by Jackson in the *Lower Lugg Archaeology and Aggregates Resource Assessment* (section 4, Bapty 2007), and incorporates the work of many different archaeologists, and many different circumstances of observation and recording across a very wide spatial area. Much of the area (especially in the earlier phases of work) was not observed or recorded at all, and specialist involvement in geomorphological recording only developed relatively recently as techniques have been progressively refined, and as PPG16 processes and planning conditions has supported more sophisticated multi-disciplinary investigation.

The consequence is that the understanding of the Wellington floodplain area is actually unevenly based on spatially limited windows of observation, and with uncertain consistency of recording control between those windows. Recent review of the written reportage for the 1986 to 1996 work by a specialist geomorphologist (Richard Payne, Appendix 1 in Jackson 2008b) has emphasised some of the ambiguities in the record, and the problems of trying to relate descriptions of disparate deposits which may or may not relate to broader patterns across the site.

There is therefore a real possibility that the 'feedback loop' of progressive learning/presumed understanding over the years has actually tended to reinforce dominant perceptions, subtly 'encouraging' further recognition and recording of the 'established' patterns. What is certainly clear is that 'anomalous' palaeochannel and alluvial deposits – not obviously fitting the established sequence - have often been noted. It is at least reasonable to ask how 'anomalous' all of these deposits really are, and to consider the possibility that some of them could turn out to be of greater interpretative significance if freed from that *a priori* 'anomalous' categorisation.

3.2.4 *Site formation process issues*

Even assuming the 'established' sequence is basically right, a further significant interpretative complication stems from the fact that it is not ultimately clear what the distinction between the recognised units really means in site formation process terms (see *Lower Lugg Archaeology and Aggregates Resource Assessment* Section 4.6 for detailed discussion, Bapty 2007).

Roseff (1992) argued that the contrast between Units 2 and 3 in particular primarily reflected differences in parent material, and that the discontinuity was therefore associated with a chronological point of significant change in erosion patterns in the Lugg catchment. However, more recent analysis (Terra Nova 2002) has argued the observed units may have more to with post depositional chemical alteration of deposits. Jordan has postulated that fluctuation in winter water levels in the alluvium causes cycles of oxidation and reduction resulting in mottling and gleying which create 'false' colour change effects. He suggests that the apparent Lower Lugg alluvial stratigraphy may be substantially an outcome of such secondary processes (Terra Nova 2002).

The most likely resolution of the debate is actually that both views are right to some extent, and the chemical changes differentially reflect and amplify real distinctions in parent material. In that sense, the observed stratigraphic pattern does, at one remove, have a connection to original depositional differences. Nevertheless that connection is not precisely understood, and the detailed understanding of the transformational process remains to be demonstrated. Clearly this situation could still have significant consequences for the accuracy of the secondary interpretative associations which have been built upon it.

3.2.5 *Archaeological associations*

This combined set of issues is of key importance to realising a full understanding of the archaeological deposits at Wellington Quarry (see Section 4.1 of the *Lower Lugg Archaeology and Aggregates Resource Assessment* for a full account by Jackson of this material, Bapty 2007). The stratigraphic and spatial associations of archaeological features within the palaeochannel and alluvial sequences are crucial to the interpretation of those archaeological features. Moreover, established understanding of these associations underpins the pragmatic fieldwork methodologies which have come to inform archaeological investigation in the particular circumstances of the Lower Lugg valley floor area.

In simple terms, there is an evident (and inevitable) relationship between archaeological features and the topographic detail presented both by the surface of the underlying gravels, and by the gradual accumulation of alluvial horizons across the valley floor. In essence, as Holocene alluviation has gradually 'filled' in the undulating topography of the Late Pleistocene gravels, a succession of different niches and surfaces for human settlement has been created. Prehistoric features such as the Neolithic pit groups are typically associated with slightly raised gravel areas which have been subsequently buried by the alluvial growth of the floodplain, while chronologically later features are necessarily higher in the stratigraphic/alluvial sequence. Spatial factors obviously also influence the scenario. While prehistoric contexts are deeply buried where the depth of the floodplain deposits is greatest, they may also be found more superficially (and in closer stratigraphic juxtaposition with later features) in marginal floodplain locations where the surface of underlying gravels are highest in absolute terms, and alluvial build up is therefore limited and more recent. In these latter situations, the earlier alluvial units (Unit 3 and sometimes also Unit 2) are typically entirely absent, and prehistoric and Roman features cut into the gravel may be closely juxtaposed stratigraphically, and both overlain by red alluvium (Unit 1).

The picture as a whole is also complicated by the systematic preference for human settlement of all periods to utilise particular natural environment niches for specific purposes. The Saxon watermills, for example, were carefully located to make use of Palaeochannel B which was artificially re-cut as a leat for the mill water management system. In addition, active human modification (such as drainage, and settlement and argricultural activity) has directly affected processes of alluvial change and accumulation, and significantly altered the character of the floodplain and its deposits. A good example seems to be represented by the humic Unit 4 in the vicinity of the Roman villa. This has generally been interpreted as a buried soil associated with a period of alluvial stasis, and as such probably represents deliberate drainage and management for agriculture which thereby interrupted 'natural' floodplain development.

The particular matter of post deposition chemical change in the alluvial deposits is a significant additional factor in observing and interpreting archaeological remains in the Lower Lugg floodplain (see also *Lower Lugg Archaeological Resource Asessment* Section 4.6, Bapty 2007). From the beginning of archaeological recording at Wellington Quarry, it has been observed that there is a practical relationship between particular alluvial layers and the potential to easily recognise archaeological deposits within them. Jordan has suggested that the mottling/gleying process which produces the alluvial colour changes also effectively 'strip outs' significant stratigraphic detail as a phenomenon visible in section to the naked eye, and in the process causes archaeological features to 'disappear' in some affected zones (Terra Nova 2002).

The most persistent manifestation of this pattern is that archaeological features are not generally visible until the yellow/buff coloured Unit 2 is reached. For example, across Wellington Quarry, the late linear boundaries ('red ditches') which were evidently dug through at least the lower part of Unit 1 have only been observed and recorded where the base of the ditches cut into Unit 2 . This does mean that loss of archaeological information (lost in the sense that that features cannot be seen and therefore cannot be excavated stratigraphically and recorded) in Unit 1 is extremely hard to quantify, except for the fact that since Unit 1 is shallower/later, the observed pattern evidently privileges the earlier over the later periods. The assumption has been that Unit 1, being stratigraphically younger, is associated with relatively late deposition, and consequently the 'wiping' of the archaeology within it is confined to recent periods.

However, even where the archaeological features are visible in Unit 2, post depositional change is probably still an influence on what is being seen and the extent to which it can be understood against the normal frames of reference used in archaeological fieldwork. Firstly, loss of stratigraphic definition in terms of the detailed alluvial horizons of Unit 2 means that all features/periods effectively sit in one stratigraphic unit (excepting where Unit 5 allows additional definition of Unit 2). As a result the relative interrelationship between features can only be shown where they directly intersect (essentially what cuts or overlays what), or where artefact associations or absolute dating techniques can be brought to bear on the chronological analysis of spatially disparate contexts.

Moreover, it may also be that some degree of differential selection of the relative visibility of different archaeological features is occurring even in Unit 2. One possible post-depositional process at work here is that stratigraphic boundaries which are sufficiently defined to form a marked hydrological discontinuity (such as some archaeological features) are paradoxically made more visible by superficial colour change in this particular context (Terra Nova 2002). However, if that analysis is right, it is not necessarily the case that such a process affects all Unit 2 archaeological features of all types and all periods in the same way. Moreover, it has been observed that archaeological features are visible at different levels within Unit 2, not necessarily with any clear stratigraphic inter-relation. The visible record in this horizon is therefore not a known quantity, and may actually be more incomplete than has generally been supposed.

In essence, while the visible alluvial units structure the appearance of the archaeological record in the Lower Lugg floodplain, the effect of this on differential visibility of the archaeology in separate alluvial contexts is not as yet satisfactorily understood. Consequently, however effective the detection and recording of particular features or groups of features, there is an outstanding uncertainty in evaluating the consistency and overall value of the recovered archaeological sequence.

3.2.6 *Interpretative issues summary*

Collectively , the combined complexity of the alluvial and archaeological sequences at Wellington Quarry raise important questions about the current state of understanding of archaeological deposits in the Lower Lugg floodplain, and the evolved assumptions which underlie that understanding. Those issues can be summarised as follows:

- The interpretative significance of the observed pattern of alluvial units at Wellington Quarry is not fully established, and it remains possible that post depositional change effects are creating uncertain differential alterations in the patterning of archaeological and alluvial deposits across Wellington Quarry;

- The practical fact that archaeological contexts are principally visible in Unit 2 may tend to erroneously confirm assumptions about the vertical relationships of archaeological finds across the site vis a vis observed stratigraphic zones, and the archaeological potential of other alluvial units;

- The patterns of progressive recording across the site may have tended to create incorrect interpretative elisions and separations of deposits from different spatial zones so as to confirm the 'standard' sequence, while downgrading the significance of 'anomalous' deposits.

3.3 Design of the analysis

3.3.1 *Terms of reference*

Against these identified issues, the present analysis was designed to answer three specific questions. Judged against the original site records:

- Does the observed Wellington alluvial sequence consistently conform to the established 'standard' description?

- What is the patterning of so called 'anomalous' units within the overall stratigraphic sequence, and does this suggest that that such contexts may have been underestimated in terms of their real importance?

- Is there a consistent relationship of archaeological deposits (features and artefacts) to the observed patterning of alluvial units and palaeochannels? In simple terms, are archaeological deposits always in the 'right' place in the alluvial sequence according to prevailing chronological assumptions and the received understanding of alluvial development?

3.3.2 *Methodology*

Records were interrogated relating to the eleven areas of Wellington Quarry archaeologically recorded by WHEAS and predecessor organisations between 1986 and 2002 (1986 evaluation, Salvage Recording areas 1 -9, South Extension). The primary source was the Wellington site archive currently held by WHEAS. The archive contains the localised stratigraphic matrices for particular stripping and trenching units which were prepared during ongoing fieldwork and post excavation processes. At various points over the last twenty years, broader combined notes on stratigraphic relationships have been prepared, and are also held in the archive. In addition, a specialist geomorphologist (Richard Payne) has recently produced an analytical description (based on primary archival information) of the character of the observed alluvial contexts recorded during the original evaluation and salvage recording phases (appendix 1 in Jackson 2008).

Led by Robin Jackson, this combined information was used to build a full account of the complete stratigraphic relationships across each larger area. To ensure, as far as possible, consistency and accuracy in the relationships identified, the analytical process was also informed as necessary by cross-checking with context records, section drawings and photographs. The combined stratigraphic patterns were collated in the form of a series of matrices representing each study area, and the key relationships revealed in those matrices are summarised below (see section 3.4.1).

In the final analytical stage, the collected area matrices were integrated and rationalised within a single schematic model representing the full sequence of stratigraphic relationships across Wellington Quarry (see section 3.4.2). The rationalisation involved 'cancelling out' repeated relationships (so that these were only shown once within the schematic model), while ensuring that all specific relationships were represented regardless of their apparent 'fit' to the 'standard' sequence.

The model was then assessed against the identified terms of reference to determine the specific conclusions of the analysis (section 3.4.3).

3.3.3 *Constraints*

There is an obvious 'in principle' limitation to this analysis in that it is, of course, based on records which already embody interpretative engagement with the data. It might therefore be argued that such an analysis will still be trapped within - and tend to confirm - the same assumptions which were there from the outset.

Given this significant implicit constraint, it should be understood that, strictly speaking, this analysis is about testing the consistency of the information in the record, not testing the alluvial relationships themselves. However, it is strongly suggested that this is still a worthwhile process with valid potential to inform fresh understanding. If the combined alluvial, channel and archaeological relationships within the recording of the Wellington stratigraphy are not consistent - either across different spatial areas and/or in totality with respect to the broader interpretations nominally based on that source material – then such irregularity is a real issue which does need to be addressed through future fieldwork and analysis. An output which appears to confirm existing perceptions is likewise useful (and potentially reassuring), but must be phrased as a preliminary finding.

It should also be noted that this analysis is explicitly concerned with relative vertical relationships within the alluvial sequence. Nevertheless, those patterns are, of course, tied to and informed by spatial associations (see discussion in sections 3.2.2, 3.2.3 and 3.2.4). For example, the interpretative linkage of separate deposits to the same stratigraphic context is closely informed by observed or implied spatial connections. This is perhaps most relevant to the classification of palaeochannels, where continuity of channels across contiguous zones is assumed in the delineation of the quarry wide channel A to F sequence.

As previously noted in section 3.1.3, the analysis does not incorporate the results of evaluation/mitigation in the eastern part of the original South Extension and the Moreton Camp extension.

3.4 Results

3.4.1 *Summary of alluvial sequences*

Note It should be stressed that the summaries are specifically linked to the present analytical exercise and are only intended to identify stratigraphic relationships to that end. A detailed descriptions of the archaeological sequence in these areas is provided by Jackson (2008), and in the relevant interim reports (see full Wellington bibliography in Bapty 2007). In addition, Payne (appendix 1 in Jackson 2008b) has specifically reviewed the available archive data from a specialist geomorphological perspective. The following should be read in conjunction with those accounts, and does not attempt to replicate the detailed context descriptions contained in those sources.

Original Evaluation

Alluvial units and channels: Core sequence of Topsoil, Unit 1, Unit 2, Unit 3 (in the form of a 'red gravelly unit' which may be equated with the subsequently categorised Unit 3.2), with the underlying gravel presumed but not reached/recorded.

Within the core sequence, Unit 4 (a humic horizon interpreted as a Roman period ground surface/buried soil) was sealed by Unit 1 and overlay Unit 2.

A channel deposit was sealed by Unit 4, and may have been open at the beginning of the period of formation of that unit. The vertical relationship of this channel to the lower stratigraphy was not positively established/recorded, but it is assumed to cut Unit 2.

Archaeological features: Roman features, including the 'villa' deposit were in direct association with Unit 4, and were sealed by Unit 1. Some undated features cut Unit 4 (and were sealed by Unit 1), and were presumed by the excavators to also be Roman from pottery in the fills.

Salvage Recording 1

Alluvial units and channels: Core sequence of Topsoil, Unit 1, Unit 2 (2a and 2b) and Unit 3 (here represented as as a fine mixed deposit), and underlying sand and gravel. Units 4 and 5 were also both locally present. Unit 4 was sealed by Unit 1 and overlay Unit 2.1. Unit 5 (a narrow gleyed humic horizon) was recorded within Unit 2, and Unit 2 was therefore locally divisible into Unit 2.1 (above Unit 5) and Unit 2.2 (below Unit 5).

Two 'anomalous' alluvial units were locally recorded. A brown alluvial unit was overlain by Unit 1 and sealed by Unit 2.1. In one locality, a red alluvium filled feature (natural depression or ditch?) was overlain by Unit 4 and 'cut'/overlay Unit 2.2.

A complex pattern of channels was recorded across at different locations across the area. Channel B was sealed/partially filled by Unit 1, and cut Unit 3; a re-incision (B1) cut into the underlying originary channel (B2). B1 was also locally incised into the brown 'anomalous' unit. Channel C was overlain by Unit 1, and incised into Unit 3. Channel F was sealed/partly filled by Unit 3, and incised into the gravel. An 'anomalous' channel fill was sealed by Unit 2.2 and cut into the gravel.

Archaeological features: Roman and later archaeological features were recorded in this area. Unit 1 sealed/ filled (post Roman?) 'red ditches', and these ditches cut Unit 4. A scatter of other features (considered to be Roman from pottery in the fills) were sealed by Unit 1 and cut into Unit 4. Roman features/artefact material were directly associated with Unit 4, and cut into Unit 2.1. In one place, a stone lined Roman feature was sealed by Unit 4 and cut into the 'anomalous' red alluvium filled feature.

<u>Salvage Recording 2</u>

Alluvial units and channels: Core sequence of Topsoil, Unit 1, Unit 2 and Unit 3 (the latter here described as a 'mixed' deposit) and sand/gravel, although Units 2 and 3 were not present on 'high' gravel/marginal floodplain areas. Within a depression, Unit 5 was present as a horizon within Unit 2 (thereby separating Unit 2 into Unit 2.1 and Unit 2.2 above and below Unit 5).

One 'anomalous' unit was recorded. This yellow/red alluvial horizon was sealed by Unit 5 and overlay the gravel.

Channel B was overlain by Unit 1 and was incised into the gravel.

Archaeological features: Roman features associated with the villa complex/landscape were overlain/infilled by Unit 1, and - given their spatial location on a thinly alluviated gravel high point - were cut directly into the gravel. Bronze Age ring ditches were overlain by Unit 1, and cut into Unit 3.

<u>Salvage Recording 3</u>

Alluvial units and channels: Core sequence of Topsoil, Unit 1, Unit 2 (2.1 and 2.2) and Unit 3, and underlying sand and gravel. Units 4 and 5 were also both locally present. Unit 4 was sealed by Unit 1 and overlay Unit 2.1. Unit 5 was recorded within Unit 2, and Unit 2 was therefore locally divisible into Unit 2.1 (above Unit 5) and Unit 2.2 (below Unit 5).

A complex sequence of channels A, B and C were all identified in this area. Channels B and C were sealed by Unit 4. Channel B cut Channel A and can be considered a re-incision of the large Channel A. It is conjectured that Channel C also partially cuts Channel A in a similar relationship, though this pattern was not demonstrated, and

Channel C was only certainly recorded as cutting Unit 3. The large Channel A was incised into Unit 3.

Archaeological features: Roman drains/ditches were sealed by Unit 4 and cut into Unit 2. Other spreads of Roman features were also sealed by Unit 4 and cut into Unit 2.1. Roman cultural material was also recovered from the fill of Channels C and B. Burials of Iron Age date were within Unit 2, but could not be spatially tied to the Unit 2.1/Unit 5/Unit 2.2 sub division.

<u>Salvage Recording 4</u>

Alluvial units and channels: Core sequence of Topsoil, Unit 1, Unit 2 and Unit 3 (here described as 'mixed gravelly and silty'), and underlying sand and gravel.

In addition, two 'anomalous' alluvial units were also recorded. An orange/brown alluvial unit was sealed by Unit 1, and overlay the gravel. The orange/brown unit also locally sealed a brown alluvial unit which (where present) overlay Unit 3.

No channels were recorded in this area.

Archaeological features: Medieval ovens, a Post Medieval sheepwash, Roman features and Later Prehistoric features were all associated with thinly alluviated areas where the 'core' sequence was not present. All these features were therefore immediately overlain by the Topsoil. The oven, Roman features (ditches) and later prehistoric features were all cut directly into the gravel. The Post Medieval sheepwash cut into the anomalous orange/brown Unit.

In addition, a scatter of Neolithic pits were cut into the gravel. The stratigraphy overlying the pits is not recorded.

<u>Salvage Recording 5</u>

Alluvial units and channels: Core sequence of Topsoil, Unit 1, Unit 2 and Unit 3, and underlying sand and gravel. Unit 3 was here divisible into an upper silty unit (Unit 3.1) and a lower gravely unit (Unit 3.2).

Channel D was entirely within Unit 2, being sealed by Unit 2.1 and cut into Unit 2.2.

Archaeological features: 'Red ditches' infilled and sealed by Unit 1 were cut into Unit 3.2. Roman features were sealed by Unit 1 and cut into either Unit 3, or else (where present) Unit 2. A group of Neolithic pits were sealed by Unit 2.1 and cut into Unit 2.2.

<u>Salvage Recording 6</u>

Alluvial units and channels: Core sequence of Topsoil, Unit 1, Unit 2 and Unit 3, and underlying sand and gravel. Unit 3 was recognisably divisable into an upper silty horizon (Unit 3.1) and a lower gravely horizon (Unit 3.2).

Channel E, with at least 3 incisions recorded, was sealed by the topsoil and cut into Unit 3 (3.1 or 3.2 not recognised/specified at this location).

Archaeological features: No archaeological features were recorded in this area.

Salvage Recording 7

Alluvial units and channels: A basic sequence of Topsoil, Subsoil, Unit 3 and underlying sand/gravel was recorded. Neither of Unit 1 or Unit 2 were recorded.

An anomalous alluvial unit recorded at one location was described by the excavators as a yellowish brown compact silty clay (context 4002). It was overlain by the subsoil and sealed a Roman ditch.

No channels were recorded.

Archaeological features: A Roman ditch (dated by pottery) was sealed by anomalous yellow/brown alluvial Unit (context 4002), and was cut into Unit 3.

Salvage Recording 8 and 9

Alluvial units and channels: Core sequence of Topsoil, Unit 1, Unit 2 (absent in SR8) and Unit 3, and underlying sand and gravel.

A brown 'anomalous' Unit (context 4503) was overlain by Unit 1 and sealed prehistoric features (see below).

No channels were recorded.

Archaeological features: Three Romano-British ditches were associated with/cut into Unit 2, although the precise interrelationships both between these ditches, and between the ditches and the alluvial context is not clear. A Beaker burial/ring ditch and a group of Middle Neolithic pits were sealed by the 'brown anomalous' unit and cut into Unit 3.

South Extension (West)

Alluvial units and channels: Core sequence of Topsoil, Unit 1, Unit 2 (2.1 and 2.2) and Unit 3, and underlying sand and gravel. Unit 5 was recorded, sealed by Unit 2.1 and overlaying Unit 2.2. A tufa spread was locally present sealed by Unit 1 and overlying Unit 2.1.

A yellow/brown 'anomalous' alluvial unit (context 10552) identified in one trench was sealed by Unit 1 and overlay Unit 3.

Channel B was sealed (and partially filled) by Unit 1. An upper incision (B1) overlay a dense brushwood horizon (dated to c. 600-685 AD) which sealed the lower (originary) incison (B2). B2 was incised into Unit 2.1.

Archaeological features: 'Red ditches' were sealed and filled with Unit 1, and locally cut into both the tufa horizon and the upper fills of Channel B1. Roman ditches (dated by pottery) were sealed and partially filled by Unit 1, and cut into Unit 2.1. Iron Age/Romano British cultural material and Neolithic/Bronze Age flintwork was recovered from within the fill of Channel B2. A complex of Middle Neolithic, Late Neolithic and Beaker period features were sealed by the tufa horizon and cut into Unit 2.1.

Two Saxon mills were identified in spatial association with Channel B1. Mill 1 was sealed by Unit 1 and cut into Unit 2.1. Mill 2 was sealed by Unit 1/the Unit 1 upper fills of Channel B1, and in one area by a 'red ditch'. A leat/mill channel had been into the lower fills of Channel B1, and was likewise sealed/filled by Unit 1. The Mill 2 complex overlay Channel B2, and the mill pit was additionally cut through Unit 3 and into the gravel.

3.4.2 *Integrated stratigraphic model*

Figure 1 (page 49) shows the integrated stratigraphic model, presenting the combined relationships from each area.

For ease of recognition, deposits are colour coded according to category: yellow box = alluvial unit, blue circle = paleochannel and orange box = archaeological deposit. Striped deposits indicate that the precise classification (alluvial unit, palaeochannel and archaeological deposit) is not certainly established. Dotted lines indicate presumed relationships which have not been certainly demonstrated by actual observation.

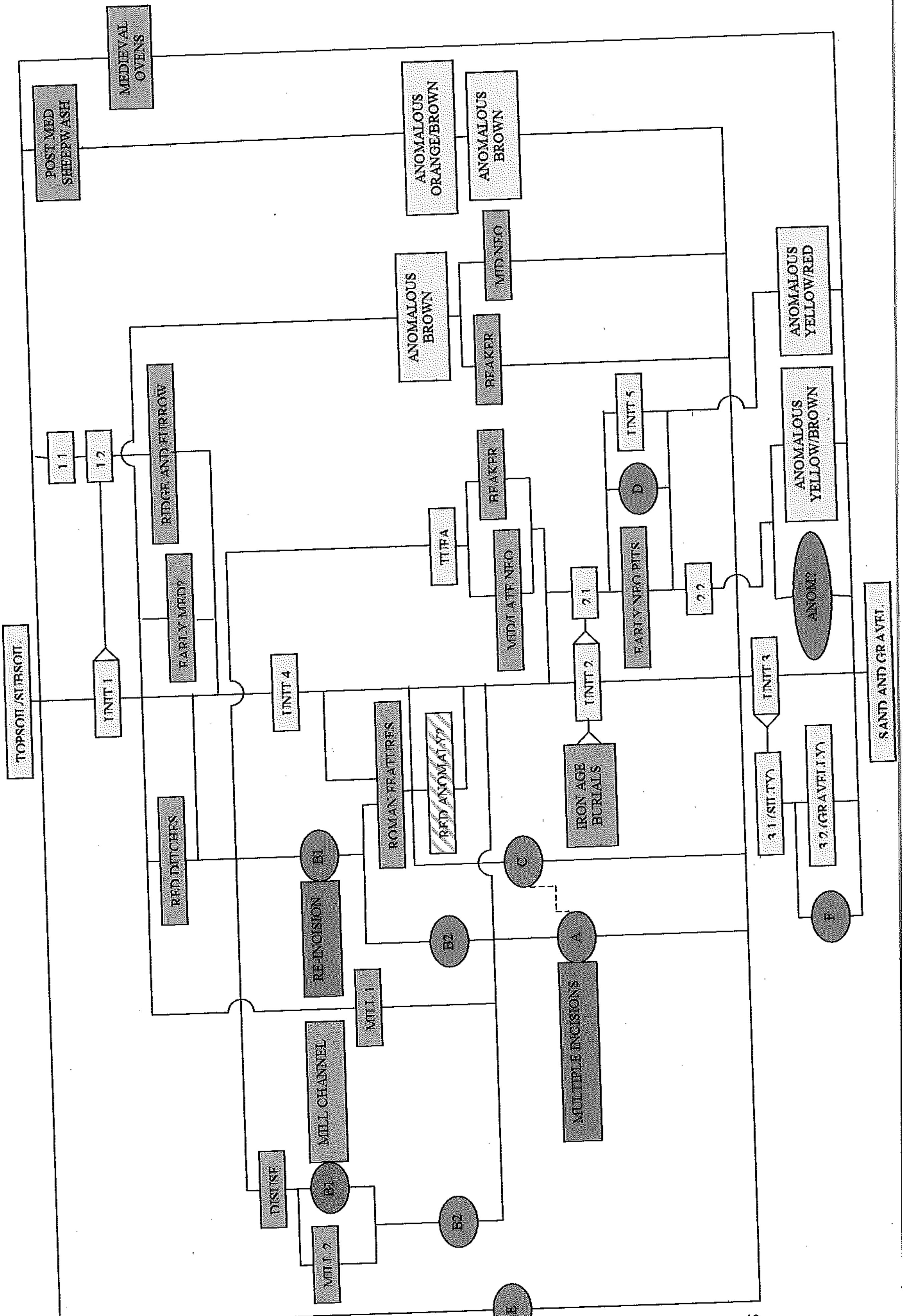
3.4.3 *Specific analytical conclusions*

Does the observed Wellington alluvial sequence consistently conform to the established 'standard' description?

The model clearly suggests that it does. Indeed, the very fact that it even proved possible to assemble the combined model, and to concisely but completely combine within it stratigraphic information from widely dispersed deposits, is a strong indication that the 'core' alluvial sequence – Topsoil/Subsoil, Unit 1, Unit 4, Unit 2.1, Unit 5, Unit 2.2, Unit 3.1, Unit 3.2, underlying gravel – does consistently obtain across the Wellington floodplain area. As has already been emphasised, spatial patterns combined with the relative height of the underlying gravel and the chronological 'growth' of the floodplain mean that very often elements of the sequence are missing. However, it is possible to be clear in the terms of the present exercise that elements of that sequence have never been found out of their 'correct' vertical place.

The channel sequence also appears consistent in its stratigraphic relationships. In terms of Channels D, E and F this is inevitable because each was observed in only one locality (Channel D in SR1, Channel E in SR5, Channel F in SR6). The more complex set of relationships connecting channels A, B and C clearly remain to be fully determined, but as currently described at the different locations they have been

Figure 1. SCHEMATIC MODEL OF COMBINED STRATIGRAPHIC RELATIONSHIPS AT WELLINGTON QUARRY
(see section 3.4.2)



identified, they do sit uniformly within a common stratigraphic sequence (Unit 1, Mill channel, channel B1, channel B2, Channel A, Unit 3 and Unit 4, Channel C, Unit 3). It is probable that Channel C is at least partially incised into Channel A, but this has not been certainly demonstrated.

What is the patterning of so called 'anomalous' units within the overall stratigraphic sequence, and does this suggest that that such contexts may have been underestimated in terms of their real importance?

On the face of it, the model does not suggest that the anomalous units 'threaten' the stability of the overall observed alluvial sequence, not least because they emerge as mostly late or early in the sequence.

For example, the anomalous orange brown alluvium and anomalous brown alluvium in SR4 (with the one overlaying the other) relate to a high and thinly alluviated marginal floodplain area. Consequently, they must be late, and are not relevant to the underlying 'bulk' of the sequence. Similarly, the anomalous brown alluvium which overlay Beaker and Middle Neolithic features in SR8 looks more significant purely in terms of its stratigraphic position sealing prehistoric horizons. Nevertheless, topography is again important here since the prehistoric occupation occupied a gravel ridge, and this deposit (which is sealed by Unit 1), however interpreted, probably again represents a relatively late (later prehistoric?) alluvial episode.

By contrast, two of the anomalous units (the yellow/brown alluvium in SR1, and the yellow/red alluvium in SR2) are demonstrably low in the sequence (sealed by Unit 2.2 and Unit 5 respectively). They could suggest significant additional potential for detailed study of the earlier period of floodplain development. It is perhaps interesting that the one observed 'anomalous' channel fill (in SR1) was sealed by Unit 2.2 and therefore also belongs in this primary floodplain phase.

Is there a consistent relationship of archaeological deposits (features and artefacts) to the observed patterning of alluvial units? In simple terms, are archaeological deposits always in the 'right' place in the alluvial sequence according to prevailing chronological assumptions and the received understanding of alluvial development?

In many ways this is the most important 'test' because it is perhaps least prone to implicit distortion by the 'self-fulfilling prophecy' caveat (see section 3.3.3 above); while an alluvial unit may be tacitly described by an excavator to satisfy existing presumptions, a Roman pot is a Roman pot pretty much regardless of where it is found.

The significant answer within the stratigraphic model is that archaeological materials, wherever found, have indeed been consistent in their relationship to wider stratigraphic patterns, and there are no exceptions to this. In essence this means, for example, that late archaeology has never been observed overlain by supposedly 'early' stratigraphic units (as defined by stratigraphic relationship to early archaeological features in other places). Similarly, Neolithic and Bronze Age features have never been observed within Unit 1, although they may be sealed by Unit 1 when located on gravel high points at the modern floodplain margins.

Given this general pattern of observation and consistency, the model does additionally imply that some contexts on the edges of their 'normal' stratigraphic position therefore have additional significance. Features in the original evaluation and SR1 areas which were sealed by Unit 1 and cut into Unit 4 (the Roman period buried soil) were at the time considered to be Roman on the basis of (residual?) pottery associations. Within the combined model, it can be seen that the other demonstrably Roman features are either directly associated with Unit 4 or overlain by it. There must be a significant possibility that the features *cutting* Unit 4 are in fact post Roman, and may well be Early Medieval. This is a potentially important observation which could link to improved understanding of the wider landscape around the Saxon mills, and the possible later continuation of the Roman estate in the guise of the conjectured Anglo-Saxon royal estate in the Marden area (Bapty 2007, section 4.2).

Another interesting case in point is the 'red anomaly' in SR1, which was cut by a Roman pit, with that pit overlain by Unit 4. It is not clear whether this feature should be interpreted as an infilled natural depression, or perhaps a ditch which the trench happened to section at a very oblique angle. In either scenario, it is tempting to equate the red alluvium fill with Unit 1, which would mean that the 'red anomaly' thereby represents a pre (or very early) Roman phase of initial Unit 1 deposition. If the feature is a ditch, it also suggests that the ubiquitous 'red ditches' also begin rather earlier than has otherwise been supposed.

3.4.4 *General analytical conclusions*

The stratigraphic model, and the specific analysis arising from it, has interesting relevance to the wider issues of Wellington floodplain interpretation (see section 3.2 above).

On interesting observation is, quite straightforwardly, the overall simplicity of the model which it proved possible to produce while accommodating all relationships within it. This also implies that the floodplain structure as so far observed is actually less complex that might have been expected. Channel numbers are limited and the channel sequence is apparently spatially restricted (one main interlinked group/corridor associated with channels A,B and C). The sequence of overbank alluviation is likewise apparently consistent across the area, also implying a stable process of gradual Holocene floodplain accumulation.

As it happens, this observation does sit alongside the findings of more recent LiDAR based research in adjoining areas (see Section 2, this document) which has also pointed to a relatively stable Holocene floodplain environment in the Lower Lugg Valley. This situation also suggests a high probability of complex patterns of past human activity in the floodplain zone, and, indeed, the likelihood of good preservation of the resulting archaeological deposits (which will not have been generally subject to subsequent river erosion)

The demonstration that the archaeological horizons are consistently located in period/stratigraphic relationship terms across the floodplain area also has wider significance. In effect, it independently supports the allied conclusions about the consistency of the basic alluvial sequence. If post depositional changes were entirely or partially scrambling the 'real' stratigraphic record (as suggested by Jordan, Terra Nova 2002), it is hard to see how such consistency of archaeological associations within the alluvial sequence would still obtain. In effect, there is a strong suggestion from this analytical process that the 'real' stratigraphy is, in a meaningful way, represented by the 'classic' observed Wellington alluvial sequence.

The additional implication is, of course, that significant data are not being 'lost' through current processes of archaeological engagement at Wellington (specifically the pragmatic method of stripping to Unit 2 where features become 'visible'). Although the reasons for the loss of visibility in Unit 1 (and indeed, the way visibility is created through post depositional change in Unit 2) are still not well understood, it does seem to be correct on the basis of the present analysis that only late features are potentially being 'missed' as a result of this circumstance, and even those only in more thickly alluviated areas.

3.4.5 *Overall conclusions*

It would be wrong to overplay the findings of this analysis. Even within its own frame of reference, the schematic Wellington stratigraphic model presented here says nothing about the practical complexity of floodplain/archaeological site formation process (which also relates fundamentally to spatial/topographic variables across the valley floor). What the model does achieve, at a certain level of abstraction, is an integrated representation of the restricted archaeological recording of the stratigraphic result of that complex set of interactions.

Nevertheless, at the level of a preliminary 'scoping' analysis, it can be concluded against the stated objectives that:

- **Stratigraphic patterning of alluvial units and archaeological deposits appears consistent in different areas of Wellington Quarry, and this seems to confirm existing rationalisations of the sequence;**

- **Some 'anomalous' deposits may have additional significance, including the possible recognition of Early Medieval archaeological contexts which were not previously recorded as such;**

- **The analysis supports established Wellington fieldwork and recording methodologies which have been based on adopted understanding, and does not suggest significant archaeological data are being 'missed' by that approach;**

- **The analysis suggests that, using the WHEAS excavation archive, there is further productive potential for more sophisticated modelling of the subsurface characteristics of the previously excavated Wellington floodplain area.**

4. Overall Conclusions And Proposals For Further Work

4.1 Summary findings

The analyses in this report were designed to improve the technical capacity for effective archaeological mitigation of quarrying in the Lower Lugg Valley. Both sections addressed weaknesses in understanding and methodology which had been identified in the *Lower Lugg Archaeology and Aggregates Resource Assessment.*

Evaluation Methodology

- The new structured and integrated approach - incorporating a GIS facilitated topographic/deposit modelling phase in order to differentially target trenching and geophysics sampling process - appears to have effectively identified and characterised key archaeological and alluvial sequences in the latest Wellington quarry extension.
- The analysis of LiDAR data to generate the basic topographic model was a key innovation in the success of the evaluation process, and importantly demonstrated the applicability of this technique to the Lower Lugg floodplain context;
- The ERGI survey likewise demonstrated the practical application of geophysics in the Lower Lugg floodplain context, and indicates the potential future importance of this technique in the area;
- Features identified by the targeted Stage 2 trenching approach include dispersed and localised archaeological deposits (Neolithic/Bronze Age in this case) which had previously been resistant to evaluation;
- The methodology does have potential limitations, and issues such as sampling levels and strategies in different floodplain zones will continue to need revision and development to maximise recovery of evidence;
- The basic methodology should be developed and implemented as a basis for all future quarry evaluation work in the floodplain of the Lower Lugg Valley.

Integrated Stratigraphic Analysis

- Stratigraphic patterning of alluvial units and archaeological deposits appears consistent in different areas of Wellington Quarry, and this seems to confirm existing rationalisations of the sequence;
- Some 'anomalous' deposits may have additional significance, including the possible recognition of Early Medieval archaeological contexts which were not previously recorded as such;
- The analysis supports established Wellington fieldwork and recording methodologies which have been based on adopted understanding, and does not suggest significant archaeological data are being ‘missed’ by that approach;

- The analysis suggests that, using the WHEAS excavation archive, there is further productive potential for more sophisticated modelling of the subsurface characteristics of the previously excavated Wellington floodplain area.

<u>Overall</u>

- Archaeological engagement with the Lower Lugg Valley floodplain zone is well grounded and can deliver an improved range of archaeological mitigation options in the context of ongoing mineral extraction in the area;

- Further characterisation and predictive modelling of the archaeological potential Lower Lugg alluvium is technically achievable, and should be a key research target to enhance future resource management in the Lower Lugg valley, and strategic engagement with the minerals development process in particular.

4.2 Proposals for further work

4.2.1 *The predictive archaeological modelling agenda in the Lower Lugg*

There is a clear opportunity in these very positive results for taking forward the process of archaeological predictive modelling of the Lower Lugg alluvial zone.

As was emphasised in the *Lower Lugg Archaeology and Aggregates Resource Assessment* (Bapty 2007) and reiterated in section 2.3.1 of this document, the issue of improving background archaeological knowledge of the Lower Lugg floodplain is not just an academic matter, but one crucial to the effective management of the archaeological resource in the area. Without good quality information, it will be impossible to influence strategic planning processes with respect to future quarry development. Over the next few years, the ongoing development of local minerals planning policy via the Herefordshire Local Development Framework (and, at a West Midlands regional level, the Regional Spatial Strategy) presents a significant opportunity for such engagement.

As well as providing specific information about the likely incidence of archaeological deposits in different parts of the floodplain, modelling work also has the capacity to better define the floodplain historic environment as a whole. Recent archaeological analysis focussed on Wellington Quarry may reflect just the particular circumstances of the Lugg/Wellington brook confluence locality, and other parts of the floodplain could of quite different character – this was certainly suggested by limited investigation in 1998 of a large peat deposit at the Lugg Bridge Quarry (see Bapty 2007, section 4.2). Such possible variation has important significance for archaeological predictive modelling work, and it remains to be seen of the archaeological assumptions built into the recent Wellington exercise will necessarily be relevant in other parts of the Lower Lugg Valley floor. Moreover, it will in any case be a valuable exercise to have a better integrated understanding of the detailed alluvial makeup of the Lower Lugg floodplain, and this in itself will directly inform understanding of the varied archaeological potential in the floodplain landscape.

It is proposed that future work would be anchored to these combined agendas and would aim to build better understanding of the archaeological value of the Lower Lugg floodplain *outside* the planning process precisely as the means to significantly improve protection of the archaeological resource *within* the planning process. Only when overall archaeological potential is better characterised will it be possible to make sensible curatorial choices, and to properly input to local and regional strategic minerals planning decisions

4.2.2 *Proposals*

Two proposals are suggested a this stage.

Proposal 1 – Refine and verify the preliminary stratigraphic analysis

Method: Develop sub-surface characterisation of the Wellington excavated area using similar modelling techniques to those employed in the south extension evaluation. The data presentation and analysis process used to manipulate the ERGI information would instead be applied to vertical and spatial deposit data derived from the Wellington excavation archive.

Outputs:

- More sophisticated three dimensional presentation of stratigraphic and feature relationships across the Wellington Quarry excavated area, testing the validity of the Section 2 findings in this document;
- Maximise the potential value of the Wellington excavation resource by unifying that information with the recently developed south extension deposit model;
- Create a large area of modelled/researched floodplain which has the potential to facilitate fresh interpretative understanding of floodplain and archaeological site formation processes in the Lower Lugg Valley at an unprecedented macro scale.

Proposal 2 – Refine the methodology and undertake predictive modelling of the wider Lower Lugg floodplain area

Method: Employ the established evaluation methodology to predictively model other parts of the Lower Lugg floodplain, and also use that process to further test and refine the methodology

Outputs:

- Assessment of current methodology limitations and its applicability to other local floodplain contexts;
- Address limitations of the new methodology (sampling percentage in
- Meaningful archaeological characterisation of the wider Lower Lugg floodplain zone;

- Enhanced capacity to engage with the strategic minerals development process.

It is envisaged that further work would be delivered through the partnerships involved in the present project. Proposals would potentially be submitted to Stage 3 of the ALSF programme (subject to the determination of the nature and scope of that programme)

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