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SID 5 Research Project Final Report

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Project identification

1. Defra Project code: BD1704

2. Project title: Conservation of Scheduled Monuments in Cultivation

3. Contractor organisation(s): Oxford Archaeology
   Oxford Archaeology, Janus House, Osney Mead, Oxford, Oxon

4. Total Defra project costs: £ £43,591

5. Project: start date .... 11 August 2003
   end date .... 01 June 2006

6. It is Defra's intention to publish this form.
Please confirm your agreement to do so...**YES** ☒ **NO** ☐

(a) When preparing SID 5s contractors should bear in mind that Defra intends that they be made public. They should be written in a clear and concise manner and represent a full account of the research project which someone not closely associated with the project can follow.
Defra recognises that in a small minority of cases there may be information, such as intellectual property or commercially confidential data, used in or generated by the research project, which should not be disclosed. In these cases, such information should be detailed in a separate annex (not to be published) so that the SID 5 can be placed in the public domain. Where it is impossible to complete the Final Report without including references to any sensitive or confidential data, the information should be included and section (b) completed. NB: only in exceptional circumstances will Defra expect contractors to give a "No" answer.
In all cases, reasons for withholding information must be fully in line with exemptions under the Environmental Information Regulations or the Freedom of Information Act 2000.

(b) If you have answered NO, please explain why the Final report should not be released into public domain

Executive Summary

7. The executive summary must not exceed 2 sides in total of A4 and should be understandable to the intelligent non-scientist. It should cover the main objectives, methods and findings of the research, together with any other significant events and options for new work.

This COSMIC project has developed, tested and delivered a robust and integrated risk assessment and mitigation model for archaeological sites in arable cultivation. The project has quantified the actual threat from arable cultivation to a sample of the archaeological resource in the East Midlands (Derbyshire, Leicestershire, Lincolnshire, Rutland, Northamptonshire and Nottinghamshire). It is the first project of its kind to have been funded by both Defra and English Heritage (EH), reflecting the responsibilities of both organisations for the conservation of the historic environment. The project was carried out between 28th July 2003 and the end of June 2005.

The main stated objectives of the project were to:

- develop an effective model for the assessment of risk to archaeological sites from arable cultivation
- develop an effective methodology for the wider application of the model
- look at the condition of selected sites and assess the implications of this for the East Midlands
- develop effective mitigation and management measures for the sites selected, tested against farmer reaction
- provide information to assist future targeting of resources by Defra and EH.

The development of a model which defines risk is intended to provide a reasonably straightforward framework for predicting, on a site-by-site basis, whether and where cultivation is likely to damage archaeological sites. Three models were developed and used for this project, culminating in the development of a fourth 'final' model towards the end of the project. The models are based on assessing characteristics that are intrinsic to the land, aspects of its management and the archaeological resource itself.

The basic project methodology was originally broken down into 9 stages: database construction, site selection, data collection, telephone interviews with farmers, stage 1 model testing - pre-fieldwork testing, field observation and recording, stage 2 model testing - post-fieldwork, stage 3 model testing - including management and mitigation measures and reporting.

Out of a proposed original sample of 159 Scheduled sites (identified by the East Midlands Scheduled Monuments at Risk survey (English Heritage 2003a) as being at moderate or high risk from cultivation damage and 39 non-scheduled sites (198 in total), permission was granted to undertake the survey and subsequent fieldwork on 77 and 39 sites respectively. In total, fieldwork investigations were carried out on 116 sites, covering 152 fields displaying different characteristics, with the variables represented resulting in the excavation of over 500 test pits.

Fieldwork was undertaken to assess the accuracy of the risk assessment models which originally used only desk-based data, and to provide data on the real risk to the archaeological sites from current agricultural practices. The test pits investigated the overburden over each archaeological site and did not explore the archaeological deposits themselves.

The fourth model proved to be very accurate in predicting risk, when compared against real risk on the sites tested. A risk assessment methodology was developed which, in conjunction with this final model, could be implemented on a national scale. This methodology includes an option for fieldwork, although the effectiveness of the model on its own means that fieldwork need not be undertaken for every site to be tested.

Key Results:

- on Scheduled sites, 37% of the farmers questioned believed that the archaeological site on their land was not of national importance
- 49% of landowners and farmers on Scheduled sites claimed never to have been spoken to about their sites by any archaeological body, including EH Field Monument Wardens
- scheduling and agri-environmental schemes do not always provide sufficient protection to the archaeological resource. Many farmers were found to be breaking the terms of their Class Consent as 25% of the Scheduled sites were being subsoiled
- 10% more Scheduled sites (22%) than non-scheduled sites (12%) were under root and tuber crops
- 3% more Scheduled sites (7%) than non-scheduled sites (4%) were subject to clod separation or de-stoning operations
- the majority of sites tested were at risk from cultivation, with Scheduled sites being at slightly higher risk (79% at moderate, high or serious risk) than non-scheduled sites (75% at moderate, high or serious risk)

The geographical spread of sites at risk has been looked at to highlight areas where at risk sites are particularly concentrated, therefore allowing future targeting of resources. Countryside Character Areas with a particularly high proportion of sites at risk are:

- Lincolnshire Wolds (CCA43)
- Fens (CCA46)
- Trent and Belvoir Valley (CCA48)
- Kesteven Uplands (CCA75)
- Bedfordshire and Cambridgeshire Clay lands (CCA88)
- Northamptonshire Vales (CCA89)
- High Leicestershire (CCA93)

The project looked briefly at the effectiveness of existing management strategies within these areas. The testing of the models has enabled the identification of variables which, on the basis of the sites tested, most often result in sites being at serious risk. These variables are:

- the presence of earthworks or vulnerable archaeological deposits (eg burials/mosaics)
- root and tuber crop cultivation
- particular vulnerability to erosion – e.g. locations on moderate to steep slopes with lighter soils or where root and tuber crops are grown
- any combination of the above variables

For each site, the project devised a series of management and mitigation options that could be adopted to reduce the risk from cultivation, tested against farmer reactions. On the majority of fields containing Scheduled and non-scheduled sites it would be possible to continue cultivation, but to a restricted depth, to provide sufficient protection to the archaeological resource.

One of the stated aims of the new Environmental Stewardship Scheme is to provide adequate incentives to farmers to ensure that archaeological sites in arable areas are managed so as to protect the archaeological resource, either through restricting cultivation depth or reversion to pasture. This means that for the first time there is an effective countrywide strategy available to farmers to protect archaeological sites, whether Scheduled or not, in arable areas. The means to identify sites at risk, and in need of changes in management, is therefore crucial to this process. It is envisaged therefore that the risk model developed here will provide the tool by which Defra and other advisors can aid farmers to assess which sites are at risk from cultivation.

Project Report to Defra

8. As a guide this report should be no longer than 20 sides of A4. This report is to provide Defra with details of the outputs of the research project for internal purposes; to meet the terms of the contract; and to allow Defra to publish details of the outputs to meet Environmental Information Regulation or Freedom of Information obligations. This short report to Defra does not preclude contractors from also seeking to publish a full, formal scientific report/paper in an appropriate scientific or other journal/publication. Indeed, Defra actively encourages such publications as part of the contract terms. The report to Defra should include:
    - the scientific objectives as set out in the contract;
    - the extent to which the objectives set out in the contract have been met;
    - details of methods used and the results obtained, including statistical analysis (if appropriate);
    - a discussion of the results and their reliability;
    - the main implications of the findings;
    - possible future work; and
    - any action resulting from the research (e.g. IP, Knowledge Transfer).

Introduction

This project is intended to develop, test and deliver a robust and integrated risk assessment and mitigation model for archaeological sites in arable cultivation. It reflects the concerns of recent studies which have highlighted the ongoing damage that arable farming techniques are inflicting on archaeological sites (OA 2002; Darvill and Fulton 1998; English Heritage 2003a). The project specifically looks to quantify the actual threat from these activities to a sample of the archaeological resource in the East Midlands (Derbyshire, Leicestershire, Lincolnshire, Rutland, Northamptonshire and Nottinghamshire), and considers how this risk can be assessed and managed. It is the first project of its kind to have been funded by both Defra and English Heritage (EH), reflecting the responsibilities of both organisations. The project was carried out between the 28th July 2003 and the end of June 2005 and was undertaken under the supervision of a Steering Group made up of members of both funding bodies and the Association of Local Government Archaeological Officers (ALGAO).

The impacts of intensive agriculture, and particularly arable cultivation, are widely recognised as the principal unmitigated threat to the buried archaeological resource (OA 2002). The processes that cause damage are well attested and include:

- the conversion to arable of previously uncultivated grassland which includes archaeological sites
- the encroachment of cultivation on archaeological sites surviving as 'islands' in arable fields
- the erosive effect of repetitive cultivation nominally "to the same depth"
- deeper than previous cultivation practices for the introduction of certain crops and to address problems with soil fertility and drainage.

Archaeological sites represent a unique and irreplaceable cultural asset. Unlike a threatened species or habitat, once damaged they cannot be subject to recovery or re-creation programmes. As well as being repositories of historic information and public interest, these sites make a major contribution to local diversity and landscape character, a point increasingly recognised by policy makers.

Background

The majority of archaeological sites are not protected from agricultural activities, only 4% of the known archaeological resource is protected under Scheduled Monuments Legislation (Ancient Monuments and Archaeological Areas Act 1979). Even this legislation does not currently provide automatic protection for Scheduled sites in arable cultivation because of the existence of a Class Consent for continued cultivation.

Class 1 of the 1994 Class Consent Order under the 1979 Ancient Monuments and Archaeological Areas Act exempts farmers from the need to obtain consent for normal cultivation of Scheduled Monuments if the site was already in cultivation when it was Scheduled, or if cultivation of the same kind had occurred lawfully in the same place within the six years beforehand. It may be noted that by definition this exemption recognises that cultivation falls within the type of damaging works that normally require consent under the Act. Those agricultural activities not exempted by the Class Consent provision are subsoiling, drainage works, or any other works liable to disturb the soil below the maximum depth affected by normal ploughing (defined as 0.30m).

Following EH's *Ripping up History* campaign in 2003 (English Heritage 2003b), in 2004 the government announced in its review of heritage legislation that it would "review the operation of the Ancient Monuments (Class Consents) Order 1994 in order to improve the protection of nationally important archaeological sites from the damaging effects of ploughing". EH has been charged with undertaking the preparatory work to deliver this reform, which has two key elements. The first is the possible removal of the automatic Consent to continue ploughing and its replacement by individual Scheduled Monument Consents on a case by case basis, underpinned by robust assessments of risk. This risk assessment has been provided by the COSMIC project. The second key element is discussed below.

DEFRA are obliged by Section 17 of the 1986 Agriculture Act to seek to achieve *'a reasonable balance'* between *a) the promotion and maintenance of a stable and efficient agricultural industry; b) the economic and social interests of rural areas; c) the conservation and enhancement of the natural beauty and amenity of the countryside (including its flora and fauna and geological and physiographical features) and of any features of archaeological interest there; and d) the promotion of the enjoyment of the countryside by the public'.*

England's Rural Development Programme (ERDP) was introduced to implement the 'second pillar' of the Common Agricultural Policy (CAP) and introduced in October 2000. As part of the ERDP schemes, only two, the Environmentally Sensitive Areas (ESA) scheme and Countryside Stewardship Scheme (CSS), included archaeological and historic landscape objectives within their targets. However, neither were totally effective in providing countrywide protection to archaeological sites at risk in arable areas.

The ERDP also made provision that all new beneficiaries of these schemes must meet the Good Farming Practice requirements in order to be eligible for payments. Good Farming Practice requires compliance with existing environmental legislation (including the 1979 Ancient Monuments and Archaeological Areas Act and

1994 Class Consents Order). It also encourages compliance with other standards including *'to protect all other areas and features of conservation value on your holding including:….historic and archaeological features…'* This was the forerunner of the 'Whole Farm' approach adopted by the new Environmental Stewardship Scheme (ES), introduced in 2005, which replaces and builds on the ESA and CCS schemes.

One of the main 4 primary objectives of the new ES scheme is to '*protect the historic environment and natural resources'*. It is made up of three parts, two of which are beneficial to the archaeological resource. The Entry Level Stewardship (ELS) Scheme rewards good land management using a whole farm approach, addressing wider issues such as reducing soil erosion, pollution etc. Specifically with regards the archaeological resource it encourages both the removal of archaeological sites (whether Scheduled or not) out of cultivation and the reduction of cultivation depth over archaeological sites. Such changes in management contributes to the overall points score for payment and once a farm has an ELS agreement all other known archaeological sites on the farm must be properly managed. The Higher Level Stewardship scheme incorporates the benefits of the ELS but also provides more resources in exchange for larger environmental benefits in high priority situations and areas. Specifically for archaeological sites it rewards changes in management, including arable reversion, direct drilling, management of water tables, and can include funding for capital works. This process is aided by the production of a Farm Environment Plan, identifying all environmental features present on the farm and any management concerns and solutions.

Therefore the second key element to enable reform is the introduction of much better incentives for farmers to appropriately manage monuments currently under cultivation, through reversion, minimum tillage or direct drilling. These have been provided by Defra's new Environmental Stewardship scheme as outlined above. EH will now be in a much better position to address the issue of plough damage in the ongoing Heritage Protection Review.

The project builds on and extends the work of three recently completed projects:

- the Monuments at Risk Survey (MARS) undertaken by Bournemouth University and EH, (Darvill and Fulton 1998)
- the Defra sponsored Management of Archaeological Sites in Arable Landscapes project (BD 1701) undertaken by Oxford Archaeology (OA 2002)
- the Scheduled Monuments at Risk pilot project in the East Midlands region, undertaken by EH (EH 2003a).

Objectives

The Objectives of the present project, as stated in the contract are:

- to develop and fine tune the broad risk assessment models delivered by BD 1701
- to develop a risk assessment model which fully integrates the approach developed by *Scheduled Monuments at Risk* with that developed by BD 1701 in order to allow risks from cultivation to be assessed alongside other sources of risk to archaeological sites
- to develop a clear "priority framework" for identifying sites requiring urgent management action in order to meet the requirement identified by Defra's *Review of Agri-Environment Schemes* (Defra 2002-3*)*
- to provide a series of clear, targeted, proportionate and pragmatic management recommendations, fully tested against land-manager reactions, for nationally important monuments in the East Midlands at risk from arable cultivation and for a sample of unscheduled sites
- to provide well-grounded feedback to inform the future targeting of agri-environment schemes for the region and to aid in the production of a regional scale plan for those sites perceived as requiring a management response beyond the scope of agri-environment schemes
- to inform a clear assessment of the requirement to deliver the approach on a national scale which will be fed into discussions concerning the EH funding agreement which, from 2003 onward, will be jointly produced by Defra, DCMS and Office of the Deputy Prime Minister.

Introduction to the Models

The development of a model which defines risk is intended to provide a reasonably straightforward framework for predicting, on a site-by-site basis, whether and where cultivation is likely to damage archaeological sites. Three methods were developed and used for this project, culminating in the development of a fourth 'final' model towards the end of the project.

All of the models tested are based on characteristics that are intrinsic to the land, aspects of its management and the archaeological resource itself. The three original risk assessment models tested as part of this project were the:

- adjusted model (developed by EH partially from BD1701) - model 1
- scoring model (based on the outputs of BD1701) - model 2
- decision tree/flow diagram model (based on the outputs of BD1701) - model 3.

The first model was developed by EH. The model works by feeding information into various lookup tables in order to establish risk levels. Each table brings together the results of research on issues like soil erosion, rainfall, drainage practices and crop regimes. These factors are linked together so that no variables are examined in isolation. An integrated risk value is established on the basis of a combination of the present risk (management practices) and the future risk (erosion potential) that define the hazard. This method has the advantage that it links factors like slope and soil type to establish a truly integrated approach.

The second model is a scoring method using weighting factors to define the overall risk. The principles of how to judge the effects of each category are the same as for the decision tree method (below), but are rather more explicitly linked to the standard definition of 'risk' as *the scale of hazard x the likelihood of occurrence*. Within this model the hazard is defined as damage to significant archaeological features and deposits, and the likelihood of occurrence is determined by other, non-archaeological intrinsic site characteristics and management practices. This method has the advantage of more explicitly incorporating management factors and archaeological significance and survival.

The third model is a decision-tree method based on working step-by-step through various site intrinsic and management factors that in turn lead through to a variety of scales of risk, ranging from effectively no risk, through to moderate and serious risk.

Methodology

The basic project methodology was originally broken down into 9 stages: database construction, site selection, data collection, telephone interviews with farmers, stage 1 model testing (pre-fieldwork testing), field observation and recording, stage 2 model testing (post-fieldwork), stage 3 model testing (including management and mitigation measures) and reporting. Two further stages were introduced towards the end of the project: identifying the 'real risk' to the sites tested and the development of a more accurate fourth model which was tested on a sample of sites.

Database construction

The project information management system consisted of a GIS linked to a database. The database was developed in Access 97 and the GIS element in Arcview 3.2. Any spatial data generated was stored in shapefile format. All data collected for the project were entered through a series of pro- formae linked to the main database.

Selection of sites

Both Scheduled and non-scheduled sites were targeted. Inclusion of both allowed examination of issues such as:

- whether the fact that less is usually known about the archaeological deposits on non-scheduled sites makes a difference in risk scores
- whether there are more incidences of subsoiling/pan busting/deep ploughing on non-scheduled sites, given that they are not protected from such activities by legislation
- ensuring that the final model is of equal applicability for both designated and undesignated sites
- whether land owners' knowledge and attitudes to archaeological sites is different, depending on whether they are Scheduled or non-scheduled

The Scheduled sites selected for the project included the 159 sites identified by EH's Scheduled Monuments at Risk survey as being at moderate or high risk from cultivation. In the case of non-scheduled sites, 'risk' had not been systematically assessed, therefore a series of criteria were developed and Local Planning Authority (LPA) Archaeologists were asked to identify 12 sites for inclusion in the project. It was intended that the nominations from each county would embrace as many of the variables outlined in the selection criteria as possible, mindful of the Scheduled sample (i.e. so that the combined sample together reflected as wide a range of site types, size and morphology etc. as possible). However, the LPAs were unable to pass the relevant ownership information to OA owing to their obligations under the Data Protection Act. These concerns revolved around the passing on of sensitive information, such as landownership details, to a third party, without the permission of the individuals involved. The identification of non-scheduled sites for inclusion in the survey had therefore to be revised. This resulted in an amended set of criteria to be applied to the selection of non-scheduled sites to be carried out as a second phase of site selection:

- sites covering any variables eg geology, topography, soils and crops, that are not encompassed within the Scheduled sample
- sites which are typical of those recorded in the Sites and Monuments Record (SMR) or Historic Environment Record (HER).

To enable the targeting of variables which were not already covered or where coverage was thin, a phase of analysis was undertaken of the variables covered by the Scheduled sites already confirmed as being included within the survey. Once the variables to be targeted were identified, information on non-scheduled sites potentially suitable for inclusion in the project was obtained in the following ways:

- LPAs identified a series of sites. They then contacted the landowners first to see if they were prepared to be a part of the project and asked permission for their contact details to be passed to OA
- Defra project officers, through their knowledge of the farms within agri-environment schemes (targeting the specific variables identified), passed on landownership details for post-2000 Countryside Stewardship Schemes (CSS), and a grid reference for known archaeological sites being cultivated. This information was sent to the LPAs to obtain detailed SMR/HER information on the archaeological sites within that area
- Archaeologists with knowledge of the geographical areas targeted were asked to identify both suitable sites (based on the targeted variables) and landowners. Tom Lane (Archaeological Project Services in Lincolnshire) provided information on sites covered by the Fenland Survey and Steve Parry (Northamptonshire Archaeology) provided information on sites covered by the Raunds Survey. Steve Parry sought farmers permission for contact details to be passed to OA. Tom Lane identified a series of sites on a map and OA visited local farmers in the area to find out who owned which site and, when identified, established whether or not they would be prepared to take part in the survey.

Combining sites identified by these means, the COSMIC sites therefore comprised 39 non-scheduled sites and 77 Scheduled sites; a total of 116 sites. In fact because many of the monuments spread over more than one field, in effect this means that detailed analysis was carried out on over 103 fields containing Scheduled sites, all showing different variables, and 49 fields containing non-scheduled sites, again showing different variables, giving a total of 152 sites/fields. Analysis showed that a sufficient coverage of the different variables selected had been obtained within the practical limits of the project and the Steering Group agreed that this was acceptable. Site selection was therefore determined by the number of available sites and their targeted coverage of variables rather than the number of sites required for statistical analysis of any particular factor.

Information gathering

The base information on all 159 Scheduled Sites identified by the East Midlands Scheduled Monuments at Risk project was supplied to OA by EH. Digital Scheduled Monument Constraint Area mapping was obtained from the EH Data Team, originally collated as part of the Defra Multi-Agency Geographic Information for the Countryside project (MAGIC). Digital base maps at 1:10,000 scale showing contours were obtained from EH as part of the MAGIC dataset. This mapping was obtained for all sites and a *c* 5km study area around each site.

Comparable information was collected for the non-scheduled sites. Where the LPAs identified sites and landowners they also provided digital mapping for the site location and SMR/HER details on the nature of the archaeological deposits. Where land ownership and location data were provided by Defra or through other individuals, this was mapped using the existing 1:10,000 base mapping and archaeological details were obtained from the LPAs. These data were then manually entered into the project database and the extents of each site digitised onto the digital base maps.

Soil survey data were obtained from the Soil Survey Map covering the East Midlands (Sheets 3 and 4). Geological information was obtained from the 1: 50,000 series solid geology maps produced by the British Geological Survey. Annual rainfall statistics were supplied by Meteorological Office as a digital plot of 30-year long-term monthly rainfall averages (1971-2000) on a 5 km GIS grid for the East Midlands. From these data sites were recorded as being in areas with more than or less than 800mm of rain per year, 800mm being the threshold for the onset of significant erosion events over susceptible sites (Unwin 1999).

Land manager interviews

Once a site had been identified and relevant details collated landowners were contacted by letter:

- explaining the project
- asking if they would be prepared to be included within the survey
- identifying the site(s) concerned, with a map showing their location, and giving notice that someone would shortly be phoning to discuss a range of issues outlined in the letter
- asking whether they wanted to give a telephone interview or would rather be sent the questionnaire to fill in themselves

Where telephone numbers were not known or where respondents indicated that a written response was preferred, written questionnaires and instructions were sent. These questionnaires and letters were drawn up in consultation with both Defra and EH and approval was obtained by Defra for their use. Where landowners were not actually farming the land themselves permission was obtained to approach the tenants, contact details requested and interviews carried out as above. All information from the interviews was added to the project database.

Where telephone numbers were known and responses to the initial letter indicated that a telephone interview was acceptable, landowners were interviewed to obtain information on:

- cultivation systems
- crops used currently and for the last ten years
- drainage/soil permeability enhancement measures
- current land management initiatives
- knowledge about the archaeological site
- awareness of arable impacts
- attitudes to management change
- preparedness to consider agri-environment schemes or S17 agreements
- suggestions for future management
- identification of any practical obstacles to improved management
- willingness to allow limited fieldwork on the site and any time/security constraints/preferences

Stage 1 risk assessment

Once all the data, including that from the interviews, had been collated and entered onto the database the three models were tested on all the sites, using the desk-based information obtained to date.

Field observation

This stage was designed to provide information to determine the degree of confidence that could be placed in the sources and/or inferences used in compiling the desk-based (stage 1) risk assessments and determine whether field observation would be necessary, either wholly or in part, in a future national programme. The fieldwork comprised a walkover, test pitting and auger survey.

Prior to fieldwork the location of each test pit was decided according to the variables represented within each site or field. The number of test pits varied from site to site and field to field depending on the type and number of variables present. Where numerous variables existed within a field these were all examined with test pits. All sites/fields had at least two test pits and those with multiple variables had up to 10. For example, where two geologies existed on a sloping field, a sequence of 6 test pits would be excavated testing ‘first geology’ where it coincided with the top, bottom and middle of the slope, and also ‘second geology’ where it fell on the top, bottom and mid slope.

The variables examined using the test pits were:

- Multiple Crops and Cultivation Systems - Where the monument or archaeological site covered more than one field, both the historical and current cropping regimes and cultivation systems were analysed for variation. When this occurred each monument was split into separate fields reflecting the cropping /cultivation differences and tested for the variables noted below
- Geology - The soil cover above different geologies on a site/field was tested. If no other test pits had been placed in the field or the field was large and therefore needed extra testing, control pits were placed to make sure that an even coverage over the site was obtained
- Change in Slope - Slopes were categorised as of one of three types: steep (greater than 7°), moderate (3-7°) and gentle (2-3°) using contour data on the OS 1:10,000 base map. Slopes were targeted separately and split into three zones; top, middle and bottom of the slope itself, with at least one test pit on each, unless the area of the monument on the slope was not large enough. In this case only two test pits, one at the top and one at the bottom, were used
- Presence of Earthworks - All earthworks recorded on the 1:10,000 maps were targeted with test pits. Each earthwork had a test pit at the top and bottom of its slope, while larger monuments also had a test pit in the middle of the slope. Those with a series of earthwork platforms had each level tested
- Soil Texture - Different soil types were determined from the Soil Survey maps and each one tested accordingly with a test pit

Proposed test pit locations were plotted onto the 1:10,000 digital base map of the site and co-ordinates derived from this mapping were used to establish the location of test pits in the field. A digital pro-forma used on a palm-top computer was developed to record all aspects of the fieldwork. This allowed the fieldwork results to be entered onto the palm-top in the field. These data could then be directly downloaded into the main project database at the end of the day/week. A paper version of this pro-forma was also developed which was filled in during fieldwork to act as a back-up and to assess which method of data capture was most effective.

A time-effective itinerary for the fieldwork was worked out, based on information collated during the questionnaire stage on when farmers wanted fieldwork to take place, and confirmed during a telephone call to each farmer in advance to arrange access. The relevant LPA archaeological curators were informed, for the most part, in advance of fieldwork. All staff working in the field were given training on the correct analysis and description of the soil type and texture, using a basic soil recording system.

The proposed methodology, site specific test pit locations and breakdown of variables per site were submitted to EH. For Scheduled sites Scheduled Monument Consent was required for works within the constraint areas. Consent was issued on behalf of the Secretary of State at the Department for Culture, Media and Sport by the Inspector of Ancient Monuments under Class 6 of the Ancient Monuments (Class Consents) Order 1994 once the project design was approved.

After respecting any access arrangements required by the farmer the sites were located and an initial walkover survey was carried out on each site. The walkover looked for evidence of recent disturbance in the form of artefacts with fresh breaks and those which were so delicate that they could not have survived for any length of time in the ploughsoil. Any such remains were recorded on the fieldwork pro-forma and the position of such material was established using a hand-held navigation-grade GPS (English Heritage, 2003c).

Each test pit was located using a hand-held navigation grade GPS system for a 2D location. This gave, as a worst case scenario, *c* 10m accuracy, although generally an accuracy of *c* 3-5m was achieved[1]. The intention of the test pits was to characterise the ploughsoil, rather than of the archaeological deposits, so this level of accuracy was sufficient for this purpose. Information on height (3D) was not critical to this process and was not used.

Ploughsoil depths and descriptions of the soils encountered were recorded through hand-dug, small test pits, *c* 0.3m square, excavated down to the top of the subsoil/natural (forming the natural drift/solid geology) or the top of the uppermost identifiable archaeological deposit. The nature of the subsoil/archaeological deposit at the base of the test pit was recorded in each test pit. An archaeological deposit was defined as one likely to contain archaeological artefacts or material and which has been deposited as a direct result of the phase/phases of archaeological activity on the site. This will include the upper fills of archaeological features, non-modern buried soils and the remains of earthworks. In most cases the test pits came down upon the subsoil or natural layer which lay beneath the current or any previous ploughsoils. These deposits consisted of the natural drift geology/solid geology of the area. It is this natural/subsoil horizon that is referred to as the potential archaeological horizon, as this is the horizon, in the absence of surviving archaeological deposits above it, through which archaeological features will be cut.

All test pits were backfilled immediately after recording. No finds were removed from any of the sites unless they were vulnerable to immediate damage.

Where greater soil depth made test pitting an unsuitable method for determining depth, an augur survey was carried out to record the ploughsoil depth and soils present. A program of augering was also undertaken at the same time as the test pit excavations on a number of sites so that the results of the two methodologies could be compared. This tested whether relevant changes in soils could be detected through augering and whether this methodology could be a useful alternative to the excavation of test pits in any future use of the methodologies developed. Decisions on when and where to use the auger were undertaken in the field, dependent on site conditions, and augering was undertaken alongside *c* 20% of test pits. The auger holes were located adjacent to the test pits and the results recorded on the pro-formae in the same format as the test pit results.

The fieldwork information was initially recorded using both a paper pro-forma sheet and via a palm-top computer in the field, which could be downloaded directly into the main project database. The idea of using the two methods was to judge which proved to be the most efficient and cost effective.

However, the original fieldwork methodology had to be changed during the progress of the project as a conflict occurred between the palm-top database (Handbase) and the main COSMIC database (Access) that eventually resulted in the abandonment of the palm-top as a data entry device. This led to some digital information being lost for a number of sites. However, this did not prove a particular problem as paper copies provided a backup for all the information. It also led to some corruption of the main database which had to be rectified as and when problems were identified. The remaining fieldwork information was therefore recorded on paper pro-formae and manually inputted into the Access database at a later stage. This provided a useful double check on the data entered into the database.

[1] Levels of accuracy defined by manufacturer of product

The fieldwork was undertaken over two years, mainly in the summer and autumn to fit between harvesting and sowing. At the end of the fieldwork stage, all the data were initially analysed and assimilated within the database. The detailed fieldwork results were submitted to EH at the completion of this stage.

Stage 2 revised risk assessments

After all the fieldwork data had been entered into the database the 3 risk assessment models were re-tested using this information and the results of both stages of testing (pre-and-post-fieldwork) compared to see which model was the most accurate.

Stage 3 model testing - including management and mitigation

This stage involved re-testing the post-fieldwork risk assessment models by re-calculating the risks after a hypothetical change in land management was implemented. If the models were sufficiently sensitive, the proposed mitigation would reduce the level of risk at the vast majority of sites to 'low' or 'minimum'.

The development of management and mitigation options involved assessing what practical measures were necessary to reduce the risk to the archaeological deposits from arable activities within the areas around each test pit. Such practical initiatives could include for example, taking the area out of arable, or cultivating it to a restricted depth eg 0.10m etc. The aim was to reduce the areas around all the test pits to low or minimum risk by hypothetically applying an effective management change. Once this was carried out for the individual test pits, the results for the whole field/site were taken into account and a final management option for the whole site/field was devised and recorded on a summary pro-forma sheet. The sheet also recorded whether the farmer had indicated that such a change would be acceptable. These sheets were submitted to EH East Midlands Region and the SMR/HERs for their management files.

Principles behind the Management and Mitigation Measures

If the protection of archaeological deposits was the only factor to consider and there were sufficient resources available, it would have been easy to recommend that all sites should be placed under pasture. This would have guaranteed that the sites were protected, but would ignore the practicalities of farm economics, which if not considered would make the application of these recommendations problematical. The mitigation proposals were therefore designed to provide a level of sustainable protection to each archaeological site whilst also trying to maintain the economic use of the land. The approach adopted, therefore, was to try to balance the archaeological and farming interests for each site and develop a management strategy that was tailored to suit both.

Farmers' and landowners' comments on the types of changes in management which they would accept (given the right incentives) were also taken into account, provided that they did not compromise the level of protection required to reduce the risk to the archaeological site. For example, restriction of cultivation depth might have been the most economic way to protect an archaeological site, but the farmer may only have been prepared to consider reverting the field to grassland. In this case reversion to grassland was recommended as it was recognised that archaeological sites are more likely to be protected if farmers are in favour of suggested management changes, rather than being presented with recommendations to which they would never willingly subscribe.

The aim of each proposed mitigation strategy was therefore where possible to allow the field to remain in cultivation but also to provide a sustainable level of protection to the archaeological resource. This was achieved either by limiting the depth of agricultural disturbance or, where this was likely to provide insufficient protection, by taking part or the whole of the field out of cultivation. Where cultivation might continue, at a reduced depth or otherwise, the aim was to create a deposit which would be a buffer between the archaeological deposits and the base of cultivation to provide a minimum, but sustainable level of protection to the archaeological deposits.

The basic assumptions to define a sustainable buffer deposit were:

- on a flat site with moderate soil (one where minimum problems would be expected in terms of drainage, compaction etc) the buffer would need to be a minimum of 0.10m thick
- for sites and fields on slopes and/or at high risk from erosion the buffer would need to be a minimum of 0.15m thick
- where these minimal buffer depths could not be achieved or where earthworks were present, then these sites should be taken out of cultivation.

Depths of buffer deposits greater than these minimum figures are preferable and where possible these were achieved by the proposed mitigation/management strategies. However, in many cases any further increase in the thickness of buffer deposits above the minimum level would have meant that a larger number of sites would have had to come out of cultivation.

One of the more difficult assumptions which had to be considered related to the archaeological value and likely state of preservation of ploughed mounds of long barrows and round barrows. The vast majority of these monuments were scheduled in the 1960s-1970s and ploughing has now removed any physical surface trace of the original earthworks. The assumption when scoring ploughed out barrows for the risk model, unless evidence suggested otherwise, was that any central or satellite burials or buried soils could survive just below the ploughsoil. This meant that these barrows were scored high in terms of significance (as they are all Scheduled) and also for their survival/vulnerability. The proposed management solution in all cases, unless the farmer wanted the field to revert to pasture, was that cultivation depths in these fields should be restricted to ensure that any surviving features are protected. This was thought more cost effective and practical than putting the site/field down to pasture. Only when the monument survived as an upstanding or low earthwork was it justifiable to suggest its removal from cultivation. This recommendation was usually used in conjunction with the recommendation that the rest of the field should be subject to restricted cultivation depths to ensure that any associated archaeological features are also preserved.

The management strategy options were:

- permanent grassland (whole field)
- part of field in permanent grassland
- restricted plough depth (0.10m, 0.20m, 0.25m, 0.30m)
- setaside
- no subsoiling
- none (no change in management needed).

Practicalities of restricting cultivation depth

Mitigation requiring a restriction in the depth of cultivation will only be successful when accompanied by effective systems and techniques to monitor compliance. Techniques for cultivation depth compliance monitoring have been successfully pioneered by EH (McAvoy 2002). These, and other techniques, are being further developed by OA as part of the current Defra/EH funded project, 'Trials' (Trials to Identify Soil Cultivation Practices to Minimise the Impact on Archaeological Sites (BD1705) and Effects of Arable Cultivation on Archaeology (3874).

All the above options include the caveat that no subsoiling or disturbance should take place below the depths specified. This is not a problem for the grassland or setaside options, but for the restricted depth options, particularly 0.10m and 0.20m, this would introduce a number of limitations to the types of crop which could be successfully grown.

Restricting cultivation to 0.10m would effectively mean cultivation could only occur using direct drilling as a means of reseeding grass and growing crops that can be combine-harvested (mainly cereals, oil seeds, peas and beans) with much reduced or even no soil disturbance (Christian and Ball 1994; Rasmussen 1999). Cannell *et al* (1979) defined and mapped three classes of soils and climatic factors to define the relative suitability or unsuitability of areas for direct drilling of cereals:

Soil Class	Soil Suitability Class for Direct Drilling	Soil and Climatic Factors
1	Suitable for spring and winter cereals	Stable structure, well drained, low rainfall
2	Suitable for winter cereals only	Stable structure, adequate drainage, medium rainfall
3	Unsuitable	Unstable structure, impeded drainage, high rainfall

The vast majority of the East Midlands area is covered by Class 1 and Class 2 soil. However, there are concerns that an entirely no-till cultivation system is not a long-term viable option, and that occasional subsoiling or panbusting would be needed. Nevertheless there have been some long-term trials where subsoiling has been restricted which have proved successful (MAFF 1998), especially if combined with good soil management techniques, such as avoiding working the ground in wet weather, thereby avoiding rutting and compaction and the subsequent forming of pans.

Reducing cultivation depth to 0.20m would effectively mean cultivation using shallow ploughing or non-inversion techniques. Once again such techniques are suitable for growing combine-harvested crops over the majority of the East Midlands and, as in the case of direct drilling, would, in the long term, give a better gross margin of financial profit for that field (less Horse Power required, less fuel consumption and time input for a similar return of crop yield). On the negative side, in common with direct drilling, these techniques may contribute to the build up of plough pans in wetter years. However, given the reduced depths of cultivation these pans would only form just below the 0.20m depth ploughed, and given the buffer allowed between the archaeological deposits and potential plough depths for the COSMIC sites, this pan could be broken up with only minimum intrusion into the buffer zone (this would have to be taken into account by any monitoring arrangements). Conversely actual ploughing could be restricted to 0.10m - 0.15m, allowing subsoiling to occur to a depth of 0.20m, therefore conforming to the recommendation: 'no disturbance below 0.20m'. However, given that less powerful (thus lighter) machines would be used for shallow ploughing as a result of reduced tillage depth, there would be less soil damage, especially if combined with the good soil management practices referred to above, therefore minimising the risk of plough pan formation. It would not be practically possible to grow root and tuber crops under this restriction.

There are other significant limitations and inhibitors which help to explain why, despite the economic and agronomic advantages, restricted cultivation systems have not been more universally adopted. The ability and willingness of farmers to adopt such methods are governed by a number of other factors, including farm size, ability to invest in new machinery, labour availability and skills, existing cropping and rotation patterns, future expansion plans, machinery running costs and the residual value of existing machinery (Park *et al* 1997; Monsanto 1999a; University of Cambridge 1998). The relative versatility of traditional cultivation techniques (eg for roots as well as combine-harvested crops), coupled with natural conservatism with regard to common, tried and tested techniques, represent further barriers to the acceptance of reduced tillage systems. However, the COSMIC survey interviews showed that a significant number of farmers might be prepared to accept restrictions in cultivation depths as a way to protect archaeological sites, although a number commented that the incentives would have to be right for them to do to this.

Report

Reporting was carried out in four stages: The results of the field observations were submitted as above (stage 1 1); a full and detailed account of the project was submitted to EH and added as an Annex to the SID 5 (stage 2); this Sid 5 summary report has been prepared for Defra (stage 3); a series of summary sheets has been produced, one for each site, summarising the risk and mitigation measures proposed, and submitted to EH's East Midlands Office (stage 4).

Introduction to Risk

The development of a model which defines risk is intended to provide a reasonably straightforward framework for predicting, on a site-by-site basis, whether and where cultivation is likely to damage archaeological sites. Three methods were developed and used for this project, culminating in the development of a fourth 'final' model towards the end of the project. Only by breaking down what goes into determining risk can a detailed understanding be achieved of how risk levels are established and what this actually means for the archaeological features and deposits on a site.

Defining the risk

The standard definition of 'risk' is *the scale of hazard x the likelihood of occurrence*. For this project the hazard is defined as damage to significant archaeological features and deposits, and the likelihood of occurrence is determined by other, non-archaeological intrinsic site characteristics and management practices. The risk therefore is defined as the likelihood of damage to significant archaeological features and deposits by arable cultivation and associated drainage practices. The risk is determined on a site/field by examining all the factors which may affect the degree to which agricultural activities may impact the archaeological horizons.

Risk levels are determined by three main factors:

- site intrinsic variables (slopes and soils)
- management factors (cultivation regime, depth and drainage)
- archaeological factors (significance and vulnerability)

The importance of each factor will depend on the area and individual circumstances of each site. These factors cannot be studied in isolation as one factor will ultimately have an affect on another. For example, a steep slope with a light soil will be at greater risk of erosion than a site on a more gentle slope, but if the field is being deeply ploughed for root and tuber crops for example, the risk is further increased. If this is taken a step further to include archaeological factors, for example, if vulnerable archaeological features such as burials or earthworks were present on the slope, the overall risk will also increase (Photo 5.13). Although this is a theoretical example of a worse case scenario of variables, the combination described is not uncommon and has been identified on a number of sites within the East Midlands.

Site intrinsic factors are part of the natural aspect of a site that include geology, soil type and slopes. These are important because they determine the rate at which erosion is likely to occur within a cultivated field. Erosion or the movement of soil can be a key mechanism by which the level of protection over an archaeological site decreases over time and risk increases as the soil protecting a site gradually thins. Any effective model needs to include an assessment of the likelihood of erosion and the rate at which it is likely to occur.

Erosion on a site can occur naturally by two main processes; wind action or water action. Water erosion is currently the main cause of erosion in the UK, with wind erosion usually confined to areas of peaty or sandy soils. Some areas are more prone to wind erosion than others, especially during dry periods; in the Fens significant wind erosion has occurred in the past to the extent of seriously denuding the once rich archaeological resource in this area.

There is more information collected about current rates of erosion on agricultural fields in the UK than in any other country in the world. The most important erosion process is the development of rills and ephemeral gullies on bare or cultivated slopes. This occurs through the process of rain splash which helps to mobilise soil particles and prepares them for transportation. Most research points to the rate of erosion being determined by rainfall variability, soil type, bare soil and slope gradient (OA 2002). These are key factors that have to be included and ideally studied together in any risk assessment model.

In recent years there has been considerable research into the effects of tillage erosion. This occurs through the turning of the soil by the plough causing net downward transportation of soil by gravity on a slope or movement of soil across a flat field. Govers *et al* (1993) believe that tillage erosion could be just as important in terms of soil movement as water erosion. The issues are still contentious and at present further research is needed into the effects of tillage erosion and how to measure it in the field.

Another potentially significant erosion issue is soil loss through harvesting. Less work has been carried out on this, but soil is often removed with crops from fields during the harvesting of crops such as sugar beet and potatoes. This soil is often washed and re-used at different locations; for example British Sugar offer the soil from beet washing free to farmers. The loss of this soil will cause the gradual lowering of the ploughsoil therefore leaving subsoil remains more vulnerable (OA 2002, Appendix F). Damage and compaction to the ploughsoil can also be caused by the harvesting of sugar beet, which is often done in wet weather, thus increasing the risk to archaeological sites. Therefore the basic assumption used for the models is that there will be an increase in risk caused by soil loss through the harvesting of specific crop types. Harvesting of root and tuber crops are more likely to lead to soil loss than the harvesting of combinable crops.

Management factors cover past, current and future crop regimes on a site, specifically the type of cultivation, depth of ploughing, drainage measures and type of crop rotation. These factors directly determine the likelihood of cultivation coming into contact with the archaeological horizon. Certain crop regimes will increase or decrease the risk to the archaeological deposits. For example, root and tuber crops are more likely to require deeper ploughing and frequent subsoiling than combinable crops, resulting in increased risk levels. In contrast, cultivation associated with long term grass land is significantly less likely to come into contact with an archaeological horizon than cultivation for root or combinable crops, and these sites are likely therefore to be at much lower risk.

The importance and vulnerability of archaeological deposits on a site is a key element in assessing the significance of risk to a site. Not all the models tested included this aspect within the risk assessment. However, by including these archaeological factors it is possible to prioritise certain sites that have been identified as being important and/or vulnerable and to demote sites where there is no indication that important archaeological deposits remain.

The majority of sites/fields in the study were Scheduled Monuments which are all, by definition, of national importance. There is therefore relatively little difference in the importance of the majority of sites that were studied. Under these circumstances the vulnerability/preservation of the archaeological deposit becomes an issue of greater significance as it helps to determine how susceptible a site will be to significant damage. For example, a complex site like a Roman villa, with preserved floor surfaces would be classed as at higher risk of significant damage to important deposits occurring than a small Romano-British farmstead; characterised by truncated cut features. Put another way the undamaged survival of the well preserved floor surface may be as equally at risk from cultivation as the truncated cut features but if both were to be equally damaged then the effect or potential loss of information would be far greater with the floor surface.

Enough information is often available for an individual site, whether Scheduled or identified from SMR/HER data, to establish a reasonably accurate idea of its importance and vulnerability, especially when local archaeological knowledge and experience of rural archaeological sites are taken into account. There is always a danger in assigning a level of importance or vulnerability to archaeological sites without any excavated evidence, but unless such an attempt is made it is more difficult to establish priorities. This is most applicable to earthworks and sites which are vulnerable to the 'threshold effect' where only one episode of slightly deeper cultivation could either destroy the last important remains of that site or irreparably damage important features (eg mosaic pavements, burials etc).

More detailed analysis and explanation of these factors can be found in the report on the Defra *Management of Archaeological Sites in Arable Landscapes* project (BD1701) (OA 2002).

Archaeological vulnerability and survival

Archaeological remains in arable landscapes display a wide variety of levels of survival, reflecting both their original form and subsequent modification by human or natural agencies. This affects both their vulnerability to further damage and their archaeological potential as a source of evidence. Sites often exhibit more than one form of survival. The following is a guide to how different types of archaeological site should be scored using the models, based on these factors:

- LOW RISK - a site which has been already significantly truncated, so that only deep negative features are likely to survive, for example ditches, deep pits and wells, cut into the subsoil. These are often first identified from aerial photographs and/or reflected in finds scatters. These are sites where much archaeological information has already been lost, and where further truncation will not destroy the site, but will only gradually remove fills and evidence of these features
- MEDIUM RISK - some early prehistoric activity areas, and occasionally later sites such as battlefields, are only (or principally) evident from artefact scatters left on the then ground surface and subsequently incorporated into (and dispersed in) the ploughsoil
- MEDIUM RISK - a site which has already been truncated by ploughing, but where shallow features such as pits, postholes and stakeholes, cut into the subsoil may survive, as well as the deeper features such as ditches, deep pits and wells. These are often first identified from aerial photographs and/or reflected in finds scatters. These shallow features can be of considerable value (many sites of this kind are amongst the largest (in terms of area covered) Scheduled Monuments in this country), but will be vulnerable to total destruction by continued ploughing
- SERIOUS/HIGH RISK Where human burials are present in shallow graves at the interface with the ploughsoil or not far below the ploughsoil, these are vulnerable to damage. Where the remains of stone walls have survived below the ploughsoil, they may resist destruction initially, but continued cultivation can lead to sudden collapse (especially after the introduction of new and more powerful machinery)
- SERIOUS RISK - on archaeological sites with deep stratigraphy, a build up of stratified layers can survive (eg successive floors, yard surfaces, occupation debris). Once these layers come within ploughing depth they will be successively eroded, and could be removed by one ploughing episode
- SERIOUS RISK The successive erosion of earthworks will occur when they are ploughed, as each year the plough flattens them out or encroaches upon their edges. Earthworks also often protect buried ground surfaces of importance for evidence of earlier landuse and environmental characteristics, which will become increasingly vulnerable as the earthwork is destroyed
- SERIOUS RISK In wetland and alluvial areas and in topographical situations where perched water tables occur, organic deposits and objects often survive, greatly enhancing the value of *in situ* deposits

Even sites already truncated by cultivation can be very vulnerable to 'threshold effects' where for example critical occupation levels, buried ground surfaces, human burials, or the last traces of shallow features (ie the archaeologically most critical features) are reached. These may easily be removed by one season's slightly deeper ploughing. Successive seasons of damage can culminate in a single episode which will destroy crucial evidence of this type. All cases where archaeological deposits are vulnerable to the threshold effect should be upgraded to SERIOUS RISK. In the risk models, where the type of archaeological site is unknown, the MEDIUM RISK category has been used.

Practical meaning of risk levels

The key to developing an understanding of overall risk levels is to first define the basic terminology being used within the models in simple practical terms that can be understood by specialists and non-specialists alike. To identify a site as being at serious risk is to classify it as being at greater risk than one at high risk and so on. The following section describes what this actually means in terms of the potential damage which could be caused to a specific site by cultivation. By defining these terms it is hoped to give real practical meaning to the results that can be easily communicated. The risk levels have been defined as the following:

- SERIOUS RISK – Sites classed as at serious risk are those where there is a significant chance that new damage is occurring or is very likely to occur in the future. These sites are at very real risk of disappearing from the archaeological record and/or will have significant remains destroyed if the management of the site remains unchanged. The rate of damage and likelihood of disappearance will vary from site to site, but the presence of a combination of extremes of variables like steep slopes, poorer soils and root and tuber crop cultivation, for example, can cause the total destruction of a site very quickly under certain circumstances, especially if the site is vulnerable to the 'threshold' effect or if earthworks are present.

- HIGH RISK – These are sites where there is a good possibility that new damage is occurring or is likely to occur in the future. They tend to be sites with extremes of one variable (eg steep slopes, the presence of root and tuber crops, drainage issues or the absence of a soil forming a buffer between the ploughsoil and the archaeological deposits), which are likely to lead to damage now and/or in the future. Mostly they differ from serious risk sites in that often only one of the extreme occurrences of the variables discussed previously is present, rather than a combination of them.
- MODERATE RISK – Sites classed as at moderate risk are those which are considered to be in stasis, in the sense that damage is continuing at the rate that it has been since the site was placed under modern cultivation. These sites do not have any extremes of variables (see above) that may rapidly accelerate damage, like steep slopes, poorer soils and earthworks, but the cultivation regime, if left unchanged, will result in steady attrition and ultimate destruction. Such sites could include ones where the buffer is almost non-existent and where the farmer is ploughing to a constant depth each year, but where compaction and erosion may gradually thin the soil, leading to incremental but consistent plough erosion of the site.
- LOW RISK – Sites classed as at low risk are those where damage is less likely to occur due to the current cultivation regime and which have variables that do not promote rapid erosion. Variables which may help protect the archaeological resource include flat ground where combinable crops are grown and those sites with buffer deposits. They can also include sites where minimum cultivation techniques are practised as part of the farming regime.
- MINIMUM RISK – Most sites that are classed at minimum risk are those where new damage is highly unlikely to occur now or in the future. These sites include those that are under long-term pasture or permanent setaside schemes and where there are no immediate future plans to return them to cultivation. These sites can have extremes of variables like steep slopes, poor soils and earthworks, but are not vulnerable to erosion through cultivation, and are therefore stable. Also included within this category are sites that may have sufficient buffer zones or have been subject to beneficial management changes (such as the introduction direct drilling techniques) to ensure that ploughing or drainage never impact upon the archaeological horizon.

Development of the Model

Comparison between pre-and post-fieldwork model testing

The accuracy of each model, ie the extent to which post-fieldwork assessments of risk replicated those based on pre-fieldwork data alone is as follows:

- Model 1: accuracy for Scheduled sites - 67%, accuracy for non-scheduled sites 73%
- Model 2: accuracy for Scheduled sites - 77%, accuracy for non-scheduled sites 88%
- Model 3: accuracy for Scheduled sites - 62%, accuracy for non-scheduled sites 88%.

The main reasons for variation between the pre- and post-fieldwork testing of the models are:

- landowners are understating the depth of ploughing (and the degree of risk of damage is therefore underestimated in pre-fieldwork assessment)
- the existence of buffer deposits like colluvium and old plough soil is hard to predict prior to fieldwork (this leads to the degree of risk being both over-and underestimated in the pre-fieldwork stage)
- soil maps are not detailed enough (this leads to the degree of risk being both over-and underestimated in the pre-fieldwork stage)
- if sites have been ploughed for a long time farmers will not necessarily know the depths to which this took place (this leads to the degree of risk being overestimated in the pre-fieldwork stage)
- some crop regimes had changed between the time when the initial interviews were conducted and when the fieldwork was undertaken (this leads to the degree of risk being both significantly over-and underestimated in the pre-fieldwork stage)

The models show reasonable consistency when the results of pre-and post-fieldwork testing are compared, demonstrating that the factors assessed within each model are on the whole being confirmed through fieldwork. They are also fairly sensitive to the application of mitigation measures, although, as seen previously, not perfect. The main problem however, is that each model, at all stages, shows different risk levels for many of the same sites tested, reflecting the different ways in which each model uses the information available to assess risk.

Therefore, in order to be able to produce a final, effective, risk assessment model, a method for establishing the real risk of damage to sites was required that could be used as a comparison to assess which of the models reflected this real risk most accurately.

Real risk for both the pre-and post-fieldwork models was ascertained by viewing all the data available at each stage of model testing and using that data to come to a conclusion on risk based on the underlying principals and knowledge of all the factors involved and their likely influences. The results of this sometimes differed from the risk category derived from the application of the same data to the models (eg the model may show that a site is at low risk when in fact looking at all the factors it is obvious that it is at high risk). It provides an objective way therefore to judge the accuracy of the results of each model. The real risk for each stage (pre-fieldwork, post-fieldwork and post-mitigation) was worked out using only the information which would have been available for each particular stage. The pre-fieldwork risk therefore is not necessarily the real risk to the site in question (that can only be judged 100% at the post-fieldwork stage) but is the risk for the site based on the information available at the pre-fieldwork stage. The use of this category is not therefore what it tells us about the real risk to the site in reality, over and above the results of the models, but it helps to judge which model is closer to the truth based on the information available at that time.

In contrast to the real risk identified at the pre-fieldwork stage the real risk for the post-fieldwork stage does reflect the actual real risk of cultivation damage to the site and is also helpful in judging the effectiveness of the models. In two cases none of the models accurately reflected the real risk, so a judgement was made using the evidence to assign risk to these two sites.

The effectiveness of each model (ie the extent to which they reflect the true risk of agricultural damage to a site) was assessed by comparing the models at each risk assessment stage with the real risk, allowing the strengths and weakness of each model to be identified.

The overall accuracy of the models against the real risk were:

- model 1 - 65% for the pre-fieldwork, 72% for the post-fieldwork, and 73% for the post-mitigation stage
- model 2 - 82% for the pre-fieldwork, 79% for the post-fieldwork and 92% for the post-mitigation stage
- model 3 - 74% for the pre-fieldwork, 65% for the post-fieldwork and 73% for the post-mitigation stage.

In addition to the establishment of real risk values a small number of key sites were studied in greater detail to explore in more depth the accuracy and ways in which each model responded in different circumstances, based on the way the data is used within each model. The need to develop a fourth model (final model) was borne out of the limitations of all the models tested. Model 2 was clearly the most accurate of all the models but still failed to elevate or reduce some sites into the appropriate risk category when compared to the real risk. The fourth and final model incorporated the best features of models 1 and 2, using model 2 as the template.

The fourth model was designed specifically to address the issues relating to the archaeological weighting and poor coverage of erosion factors in model 2. The solution developed in the final model was to clarify and simplify the archaeological weighting in model 2 and incorporate the better coverage of erosion in relation to other site factors from model 1.

In order to test the accuracy of the final model 30 COSMIC sites (comprising 34 fields and 108 test pits), thought to be representative of a range of different variables represented by all the sites, were selected for re-examination. These sites/fields were selected from both Scheduled and non-scheduled sites. A range of sites where the extremes of variables are present were also selected to ensure that the new model was sufficiently robust to identify the correct risk levels for some of the more threatened sites/fields and those which caused problems when testing models 1-3. These included sites that were under root and tuber crop regimes, those with earthworks, those on steep slopes and those under grassland. Sites tested also included a significant number where the risk assessment results for models 1-3 had changed significantly between the pre-and post-fieldwork stages.

Model 4 is divided into three main parts addressing:

Management factors

- buffer deposits
- cultivation method and depth
- crop regime
- compaction and drainage

Erosion factors (previously site intrinsic)

- likelihood of water erosion (slope vs soil type)
- likelihood of wind erosion (soil type)
- soil loss through harvesting (crop regime)

Archaeological factors

- survival and vulnerability (type of preservation)
- importance

Model 4: Final Model

Site Management factors						
Likelihood of Impact	**Serious Risk** ***Score 5***	**High Risk** ***Score 4***	**Medium Risk** ***Score 3***	**Low Risk** ***Score 2***	**Minimum Risk** ***Score 1***	**Score + confidence grade (CF)***
Buffer zones: previous cultivation depth/ extent in relation to archaeology	Cultivation of areas or encroachment on parts of sites not previously in cultivation (or proposed in the future); Evidence of new disturbance or earthworks present.	Present cultivation likely to be at interface with archaeology	Shallow buffer (eg. 0.10-0.20m); Previous cultivation has left differential cut and fill	Consistent moderate undisturbed buffer (of old colluvium or alluvium eg. 0.20-0.25 m)	Deeply buried (eg > 0.25m)	**A** .... **B**....... **C**.......
Cultivation method and depth	New significantly deeper ploughing with clear fresh disturbance eg. presence of fresh subsoil (>0.30m) (or proposed in the future)	Regular deep ploughing, deep rotavating, stone cleaning (0.26-0.30m) (or proposed in the future)	Normal ploughing, chisel ploughing (0.20-0.25m)	Shallow minimum cultivation methods (0.10-0.19m)	Continuous direct drilling with no subsoiling (<0.10m)	**A**....... **B**....... **C**.......
Cropping regime	Cropping includes sugar beet, potatoes, needing deep soils (or proposed in the future)		Cropping includes cereals, non-root crops		Cropping includes long term grass ley (or set-aside) > 5 years	**A** .... **B**....... **C**.......
Compaction and drainage	New regular subsoiling < 3 yrs old (or proposed in the future)	Regular or occasional subsoiling or pan busting required (3-6 years) wetland water table lowering (or proposed in the future)	Rare subsoiling required; moling and drains (7-15 years)	No subsoiling		**A**....... **B** .... **C**.......
Initial score **(In box to Right)**						
Intrinsic site factor. Weighting	**Any of above = Total score x 2.5**	**Any of above = Total score x 1.5**			**Any of above = Total score x 0.5**	

Probability of Occurrence score to be calculated in boxes a) and b) to right: **Initial score multiplied by any weighting derived from 'Serious' or 'High' and/or 'Minimum' columns as applicable (if Serious weighting applicable do not apply any High weighting as well).** Do not weight scores at this stage if no 'Serious' or 'Minimum' risk issues arise.	**a) Score above to multiply by Serious/High/Minimum weightings:** ………….. X …………	**b) Result = Final Score (may be graded A,B,C*)** A ………. B ………… C …………..

Future soil loss through erosion factors (site intrinsic factors)					
Susceptibility of cultivated soil to water erosion factors, Source : after Controlling Soil Erosion, MAFF 1999					
Slope > Soil texture	***Steep slopes***	***Moderate slopes***	***Gentle slopes***	***Level ground***	**Score + (CF)***
Light soils: *(Sand/loamy sand/sandy loam/silty sand loam/silt/silty loam)*	Serious Score 5 (High) (Score 4)	High Score 4 (Medium) (Score 3)	Medium Score 3 (Low) (Score 2)	Minimum Score 1	
Moderate soils: *(Silty clay loams/sandy clay/clay loam)*	High Score 4 Medium (Score 3)	Medium Score 3	Low Score 2	Minimum Score 1	**A**......... **B**......... **C**.........
Heavy soils: (Silty clay/clay)	Low Score 2	Minimal Score 1	Minimal Score 1	Minimum Score 1	

* Where average annual rainfall is less than 800mm, the likelihood of occurrence class in brackets applies

Susceptibility to deeper cultivation through soil movement by wind erosion						
Main soil group	Peats	Silts/sands	Loams	Sand clay/silt clay	Clay	**Score+ (CF) ***
Likelihood of occurrence	Serious Score 5	High Score 4	Medium Score 3	Low Score 2	Minimum Score 1	**A**......... **B**........ **C**........
Applied likelihood of occurrence result						

Susceptibility to deeper cultivation through soil loss during harvesting				
Crop type	Roots/tubers	Combinable crops	Not under cultivation	**Score + (CF) ***
Likelihood of occurrence	Serious (score 5)	Medium (score 3)	Minimum (score 1)	**A**........ **B**....... **C**........
	Any of above in highlighted grey columns = Total score x 2		**Any of above in highlighted grey columns = Total score x 0.5**	
Applied likelihood of occurrence result	**a) Score above to multiply by Serious/ Minimum weightings:** .... X	**Result = Final Score (may be graded A,B,C*)** A ………. B................ C.............		

Archaeological Weighting						
SCALE OF ARCHAEOLOGICAL RISK	**Serious Risk *Score 5***	**High Risk *Score 4***	**Medium Risk *Score 3***	**Low Risk *Score 2***	**Minimum Risk *Score 1***	**Score + (CF)***
Archaeological survival and vulnerability	Clear upstanding earthworks and structures; Low earthworks coupled with buried ground surface; 'Soft' horizontal stratigraphy, floor and occupation surfaces	Settlement activity; Shallow negative features with important contents (eg shallow graves)	Unknown archaeology or stratigraphy; Shallow negative features; Surface finds not reflected in underlying archaeology	Site already substantially damaged; Only deep negative features likely to survive	Site largely destroyed leaving very little potential	**A**....... **B** .... **C**.......
Archaeological significance	SM/national importance	Regional or County importance	County or Regional importance	Clear local importance	No obvious importance	**A** .... **B**....... **C**.......
Archaeological Risk Score						**Score**
Weighting to be applied for archaeological risk	For Archaeological Risk Score of **9-10** use weighting factor = **2**; For score of **8**-**7** use weighting factor = **1.5**; For score of **5** use weighting factor = **1.3**; For score of **5**-**4** use weighting factor = **1**; For score of **2-3** use weighting factor = **0.5**.					**Weighting**
TOTAL WEIGHTED SCORE FOR ARCHAEOLOGICAL RISK:	**Score above to multiply by weighting:** ………….. X …………			**Result = Final Score against Confidence grade*** **A** ………… **B** ………… **C** ……….....		

Scores to be given by quality of supporting evidence: A = Good evidence; B = Some evidence; C = Poor evidence, mainly assumption

Management factors (out of 50)	
Erosion factors (out of 30)	
Archaeological Weighting (out of 20)	
Total risk score (out of 100)	

The accuracy of model 4 was found to be high at all stages when compared to the data for real risk. The model gave 95% accuracy pre-fieldwork, 97% post-fieldwork (failing to reach 100% because 1 site just failed (by 1 point) to exceed the score which would have taken it from moderate to high risk) and 95% post-mitigation. The post-mitigation results were particularly gratifying since the model is clearly sensitive enough to reflect the changes brought about by the proposed mitigation measures, unlike the previous models. The higher than anticipated accuracy of the model may be partly to do with the types of site and field that were used for re-testing (although these were selected to be as wide ranging and to cover as many of the sites causing problems to models 1-3 as possible). A more realistic 80-85% accuracy level (ie better than that displayed by model 2) might be predicted for the model if it were to be re-tested for all the sites that were originally covered within the project.

There was however a significant difference between the pre- and post-fieldwork risk assessment results. This can be explained by the factors discussed above - ie the inaccuracies of data supplied pre-fieldwork. Once these inaccuracies are addressed for the final methodology the pre-and post-fieldwork assessments of levels of risk should show more correlation. The discrepancy between the two stages in this regard can also be explained by the fact that proportionally more 'problem sites' were used in the testing of the fourth model than in testing models 1-3.

The final risk is expressed as a numerical figure scored out of a total of 100 which can be further broken down into individual scores for the three main categories (management, erosion and archaeology). The maximum scores obtainable in each category are related to the overall importance of the variables in terms of their contribution to risk. Management factors can score a maximum of 50, erosion factors a maximum of 30 and archaeological factors a maximum of 20. Each group of factors could theoretically be studied separately or as part of the overall risk value, allowing for the identification of which category contributes most to the risk or whether the risk is based on a more widespread contribution from all categories. The model also provides for grading of the reliability of the information used, initially developed in model 2, indicating the degree of confidence placed in the final result.

The scoring system is translated into risk categories as follows: 0-29 = Minimum risk, 30-39 = Low risk, 40-49 = Moderate risk, 50-59 = High risk and 60+ = Serious risk. Sites scoring 40 or over should be considered for changes in management to reduce this risk.

Methodology for Model 4

Revised methodology

The methodology designed for the wider use of the model is different from that devised to undertake this project. Those who will be using the model will mainly, at least initially, be based at Defra, LPAs or EH and will have ready access to the resources which had to be collected for this project. There will also be differences in the methodology depending on whether Defra or EH use the models (see below), and whether Scheduled or non-scheduled sites are being assessed. The methodology for implementation also differs from the COSMIC project methodology in that it incorporates recommended improvements. The recommended revised methodology, outlined below, has therefore been devised specifically to be used by the above bodies, in close co-operation with each other, rather than being a methodology more suitable for use by an 'outside' body. Outside bodies can follow the methodologies below, but would need to consult with EH and/or Defra for key information such as archaeological details and landownership information.

The problems detailed above concerning the Data Protection Act should not arise if Defra, EH or the LPAs undertake the risk assessments as they will already hold much of the necessary landownership information.

The application of the COSMIC risk assessment methodology and fieldwork should be accompanied by training to ensure compatibility and accuracy of results. Detailed guidelines for using the model can be found in the detailed report submitted to EH and included as an appendix attached to this report.

Desk-based data collection

Desk-based data gathering at the initial stage of the process is necessary to provide the basic information on the archaeological sites, rainfall data and ownership. This can be done as follows:

For Scheduled sites:

- archaeological information - either direct from EH (WEBGIS and/or RSM (Record of Scheduled Monuments) mapping and description) or from the MAGIC website
- rainfall data - from the Met Office - ideally Defra or EH could obtain these data for the whole country, then they can be shared and consulted when needed
- landownership information - it is likely that all Scheduled sites will be assessed by EH, and perhaps by Defra. Ownership information for Scheduled sites is held by EH. Where this information is not up-to-date it will be held by Defra for sites on farms that are under agri-environment agreements or increasingly, those taking part in the new Defra Environmental Stewardship Scheme. The Land Registry can be contacted for sites for which ownership details prove problematic

For non-scheduled sites:

- archaeological information - this information is held by the County Sites and Monuments Record
- rainfall data - if purchased by Defra or EH this information could be made available to the LPA archaeological services
- landownership information - it is likely that either Defra or LPA archaeological services will be assessing these sites. Defra is likely to be able to identify ownership details for those sites which fall on farms with agri-environment schemes. The LPA archaeological services will hold ownership information for some or all sites.

Where site ownership is not covered by either body the Land Registry should be able to provide this information

Defra and EH will hold details of these sites which are currently under management agreements with Defra or EH.

Erosion and site management factors

The COSMIC project obtained details on these variables from a series of mapping sources (eg geological maps, soil maps, 1:10,000 mapping for topography). However, it became clear that, with the exception of the majority of the data on slopes, this mapping was too small-scale and generalised to provide information on specific sites. It is suggested, therefore, that once the desk-based data has been collected a visit is made to the farm to collect the rest of the pre-fieldwork data.

Land managers should be asked questions about past, present and future management of the site. Soil type should be identified in the field along with any earthworks and information on micro-topography and slopes recorded. The land manager will often know what geology underlies a particular field. One change incorporated into the guidelines for model 4 in the assumptions to be made when compiling the pre-fieldwork data, is that whatever the land manager suggests, no buffer should be presumed to exist unless there are very clear grounds for believing that one is present.

This site visit should collect of all the remaining data needed to complete this stage of the model. By visiting the site in this way, contact will be made with the farmer, allowing advice to be given and questions to be asked by both parties. If at all possible non-busy times of the farming year should be chosen to conduct these visits.

Use of fieldwork

Once the risk has been established and the degree of certainty calculated a decision can be made as to whether fieldwork is needed. It may be that a number of sites will need fieldwork, either to clarify the degree of risk or in the event of a farmer challenging the conclusions of the risk assessment (for example, he may claim that all archaeological deposits have been destroyed by 19th century steam ploughing). The farmer's potential aversion to any management change will have been gauged in the interview stage. Fieldwork may also be needed initially in other parts of the country away from counties sharing characteristics with the East Midlands, as a check on the national applicability of the risk assessment model.

The COSMIC fieldwork showed that test pits provided much more accurate data on the risk to sites than auger survey. The depth of modern ploughing could be easily established within the test pits through differences in texture, colour and compaction of the soil. Older plough soils and colluvium tended to be much more compacted. Differences in compaction proved to be the most useful way to identify the base of the ploughsoil, although factors like colour changes or textural differences were found to aid this process. The interpretation of deposits generally proved easier in test pits than in augered deposits. The test pits also provided much more detailed information on aspects such as the inclusion of coarse components, sorting of the soil and on the presence of artefacts. An instrument like a penetrometer may provide a useful tool with which the depth of plough soils, using compaction as a guide, could be identified without the need for test pits. This is being considered in the ongoing 'Trials' project.

Any fieldwork should include a walkover, ideally undertaken after the site has been freshly cultivated. The test pit location strategy and the excavation of the test pits should be implemented according to the presence of any differences in variables (eg differences in slope, soil, cultivation regime etc). In areas of deeper deposits, eg alluvium or colluvium, the auger could be used to investigate deeper deposits with greater efficiency after the basic build up of soils has been interpreted using test pits. Sufficient numbers of test pits therefore need to be dug within a site/field in order to address all the variables adequately. Some training may be needed to enable fieldworkers to distinguish between old and current ploughsoils.

Unless a reliable and cheap data logger can be identified, it is recommended that all data from the interview and from the fieldwork should be recorded initially on paper pro-formae. These pro-formae are robust in the field, quicker to fill in and will require less training than the use of a digital data capture system in the field. Entering data in the office, although slightly more time consuming, will enable a check on the information entered, allowing mistakes to be picked up and rectified.

The state of the archaeological resource in the East Midlands

The results presented here represent key findings of the work carried out for the project. Also included is information which helps to clarify why damage to archaeological sites is occurring, vital in trying to devise ways to remedy this in the future.

Key findings from interviews and fieldwork

Interviews with farmers/land-managers showed a lack of awareness of archaeological issues:

- the majority of landowners/managers indicated that they were aware that ploughing could cause damage, but said that they did not believe that damage was occurring to their archaeological sites. They often cited the explanation that the field had been cultivated for a long period of time and any damage would have already happened
- 20% of landowners/managers with Scheduled sites on their land did not know that the sites were Scheduled
- of those landowners/managers with Scheduled sites on their land, 37% believed that these Scheduled sites were not of national importance
- 49% of landowners/managers of Scheduled sites claimed never to have been spoken to by any archaeological body, including EH Field Monument Wardens.

The interviews revealed that 25% of Scheduled sites were subject to panbusting/subsoiling, which is not permitted under Scheduled Monument Class Consent. They also revealed that other potentially damaging activities were being carried out on both Scheduled and non-scheduled sites:

- 22% of Scheduled sites and 12% of non-scheduled sites were used for the growing of root and tuber crops
- 7% of Scheduled sites and 4% of non-scheduled sites were subject to clod separation/destoning practices
- 36% of non-scheduled sites were subject to panbusting/subsoiling.

Comparisons between the depths of cultivation over archaeological sites given during the interviews with the actual depths recorded in the fieldwork, revealed that many farmers/land-managers were underestimating these depths, especially over Scheduled sites:

- two-thirds of farmers of Scheduled sites underestimated the depth of their ploughing, with only 27% getting within 0.05m accuracy and 14% underestimating the depths by more than 0.20m
- for non-scheduled sites 40% of farmers were getting within 0.05m accuracy and just under two thirds underestimated the depth by between 0.10m and 0.20m, with 9% underestimating by more than 0.20m.

This caused some of the difficulties encountered in assessing the accuracy of the pre-fieldwork model as discussed above.

Actual plough depths recorded across the sites in the survey were:

- Scheduled sites - 0-0.10m 6%, 0.11-0.20m 2%, 0.21-0.25m 17%, 0.26-0.30m 53% and over 0.30m 22%
- non-scheduled sites - 0-0.10m 8%, 0.11-0.20m 4%, 0.21-0.25m 27%, 0.26-0.30m 47% and over 0.30m 14%.

This shows that for the majority of sites plough depths were recorded between 0.26m and 0.30m, with 22% of Scheduled and 14% of non-scheduled sites being cultivated to depths of more than 0.30m showing that non-scheduled sites are being cultivated to shallower depths than Scheduled sites.

Sites at Risk

Real Risk was calculated as discussed above. The results of this showed that the vast majority of Scheduled and non-scheduled sites are currently at high to serious risk from cultivation.
For Scheduled sites:

- 40 (39%) sites/fields are at serious risk
- 32 (31%) sites/fields are at high risk
- 81 (79%) sites/fields would require mitigation to reduce the current levels of risk (representing all sites/fields at serious, high and moderate risk).

For non-scheduled sites:

- 20 (41%) sites/fields are at serious risk
- 15 (30%) sites/fields are at high risk
- 37 (75%) sites/fields would require mitigation to reduce the current levels of risk (representing all sites/fields at serious, high and moderate risk).

By removing all those sites which are not being cultivated, effectively all those at minimum risk, it is possible to look at the percentage of risk for those sites under cultivation only. This shows that:

- 40 (46%) Scheduled sites/fields are at serious risk
- 32 (37%) Scheduled sites/fields are at high risk
- 81 (93%) Scheduled sites/fields would require mitigation to reduce the current levels of risk (representing all sites/fields at serious, high and moderate risk)
- 20 (48%) of the non-scheduled sites/fields are at serious risk
- 15 (37%) non-scheduled sites/fields are at high risk
- 37 (90%) non-scheduled sites/fields would require mitigation to reduce the current levels of risk (representing all sites/fields at serious, high and moderate risk).

Management and Mitigation

Only 6 Scheduled sites (out of the 77 Scheduled sites included within the COSMIC survey) and 6 non-scheduled sites (out of the 39 non-scheduled sites included within the COSMIC survey) are currently protected under either existing agri-environment schemes or EH Management Agreements. Of these, 5 sites are still at high or serious risk from cultivation damage.

Landowners/managers were asked if they would accept different, less damaging types of management over the archaeological sites concerned, if available as part of an agri-environmental scheme. Just over 50% said that they would. Given the choice between restrictions in cultivation depth, reversion to pasture and adopting setaside, restrictions in cultivation depths proved slightly more popular with farmers. Slightly more farmers of non-scheduled sites said they would consider beneficial management changes than those farming Scheduled sites.

For those Scheduled sites/fields which would require changes in management to protect the archaeological resource, the following recommendations were made:

- 33 sites/fields (32%) - no cultivation
- 28 sites/fields (27%) - limit cultivation to 0.10m
- 22 sites/fields (21%) - limit cultivation to 0.20m
- 4 sites (4%) - limit cultivation to 0.25m.
- (only 16 sites (16%) would not require any changes in management)

For non-scheduled sites at risk the management changes recommended were:

- 2 sites/fields - (4%) no cultivation
- 27 sites/fields (55%) - cultivation limited to a depth of 0.10m
- 8 sites/fields (16%) - cultivation limited to a depth of 0.20m
- 1 site/field - (2%) cultivation limited to a depth of 0.25m
- 1 site/field - (2%) no subsoiling.
- (only 10 sites (21%) would not require any changes in management)

Priority Frameworks and targeting strategies for the East Midlands

Specific variables to be targeted.

The testing of the models has enabled the identification of variables which, from the sites tested, often result in sites being at serious risk. By identifying these variables targeting of 'at risk' sites can be carried out where it is known that the most significant variables exist. These variables are:

- the presence of earthworks or vulnerable archaeological deposits (eg burials/mosaics)
- sites that are under root and tuber crops
- sites that are particularly vulnerable to erosion – eg on moderate to steep slopes with lighter soils or harvested for root and tuber crops
- any combination of the above variables

Specific areas to be targeted

Countryside Character Areas delineated by the Countryside Agency for the East Midlands (Countryside Agency, 1999) appear to offer a meaningful way of identifying areas of above average risk and enable the targeting of resources towards those areas in most need of more benign management. The distribution of sites at different levels of risk across the East Midlands shows that patterns can be identified within different counties. Certain Areas are at higher risk than others, reflecting the differences in the locations of key variables like slopes, heavier clay soils and areas that are suitable for the growing of root and tuber crops. The geographical distribution of different types of archaeological site can also have a significant impact on risk levels. For example, areas known to be rich in prehistoric monuments like the Lincolnshire Wolds are considered to represent unique prehistoric landscapes, considered as of special importance. Some Character Areas can also have unique forms of preservation of archaeological evidence, like the submerged prehistoric landscape of the Fenlands, representing a particularly significant but fragile resource.

The analysis suggests that the following Countryside Character Areas be given priority for targeting management changes to reduce the effects of agricultural operations:

- Lincolnshire Wolds (CCA43)
- The Fens (CCA46)
- Trent and Belvoir Valley (CCA48)
- Kesteven Uplands (CCA75)
- Bedfordshire and Cambridgeshire Clay lands (CCA88)

- Northamptonshire Vales (CCA89)
- High Leicestershire (CCA93)

Summary and analysis of Risk

The project revealed that the majority of sites tested were at risk from cultivation, with Scheduled sites/fields being at slightly higher risk (79% at serious, high or moderate risk) than non-scheduled sites/fields (75% at, serious, high or moderate risk). The geographical spread of sites at risk has been examined to highlight areas where at risk sites are particularly concentrated. The project identified which Countryside Character Areas contained sites which were most at risk and which variables most often led to sites being at high risk. This could aid future targeting of resources in terms of identifying priority areas for the application of risk assessments and the take up of management schemes.

On the majority of fields containing Scheduled and non-scheduled sites (52% Scheduled sites/fields and 75% of non-scheduled sites/fields) it would be possible to continue cultivation, but with restricted depths. This would allow continued productivity and also provide a sustainable level of protection to the archaeological resource. Reversion to permanent grassland for the whole field was recommended only for fields where vulnerable archaeology could be expected in the whole field, where pasture was the only effective way to preserve it and/or where the farmer stated that this was the only option he would accept (6 Scheduled and 3 non-scheduled sites/fields). Recommendations for setaside were only made if the farmer said that this was the only form of mitigation he would accept (3 Scheduled sites/fields). Setaside will offer a temporary solution but would need to be followed up with careful monitoring and ongoing discussions leading to more permanent solutions.

One of the main points to emerge from the project is that Scheduling and agri-environmental schemes do not always provide sufficient protection to archaeological sites. Many farmers were found to be breaking the terms of their Class Consent as 25% of the Scheduled sites were being subsoiled. It is possible that farmers of the 22% of Scheduled sites which were being ploughed >0.30m were also breaking the terms of their Class Consent if they were not ploughing to this depth 6 years prior to Scheduling, but this would be impossible to prove. In addition 10% more Scheduled sites (22%) than non-scheduled sites (12%) were under root and tuber crops and 3% more Scheduled sites (7%) than non-scheduled sites (4%) were subject to clod separation or de-stoning.

The risk to all archaeological sites is compounded by the fact that many farmers are not aware of (or will not admit to awareness of) the damage that cultivation can cause to archaeological sites. They commonly assumed that all significant damage had been done in the past or they were unaware that archaeological deposits can still exist even if buried. In the case of Scheduled sites, an historic lack of contact with the regulatory bodies has compounded this problem.

The risk to other sites in the East Midlands is likely to be more extensive than that identified for those sites included within the project. The farmers who agreed to take part in the survey are those likely to be more sympathetic to or interested in archaeology, and the fact that they agreed to participate suggests that they do not feel that they are actively damaging the archaeological sites on their land. It is likely that at least some of the farmers who refused to participate in the survey may have less sympathetic views towards the historic environment and the risk of damage to archaeological sites on these farms may be higher.

At present some 3000 Scheduled sites have been reported within the *Ripping up History* campaign to be under arable cultivation. If the results from the East Midlands are used as a direct parallel, *c* 79% of these sites could be at serious, high or moderate risk of damage from agricultural activities, a total of *c* 2,370 Scheduled sites. Some 39% of the Scheduled sites in the COSMIC survey are at serious risk: if projected this percentage would mean that *c* 1170 out of the 3000 sites could be at serious risk. This risk to the Scheduled resource is much higher than any other form of risk to Scheduled Monuments (Darvill and Fulton 1998).

Conclusion

The project was able to address all of its objectives:

- it developed and delivered an effective risk assessment model and associated methodology
- it identified individual sites and both geographical areas and site specific variables which should be prioritised for management action, therefore providing a clear 'priority framework' to Defra as recommended by the Review of Agri-environment Schemes
- it compiled sheets for all the COSMIC sites summarising the management options recommended for each site, fully tested against land-manager reactions
- it provided well-grounded feedback on the levels of risk and the areas most vulnerable to risk, to inform both EH and Defra strategies for the future targeting of initiatives to reduce this risk.

The project therefore achieved its main aim, to deliver an effective risk assessment methodology and model suitable to assess risk to archaeological sites in cultivation. Three models were originally tested, each analysed to identify their key weakness and strengths, including comparison with the identified 'real risk'. This led to the development of a fourth model, based on the best attributes of two of the original ones. The eventual model was successfully tested on a diverse range of different types of sites, covering both a wide range of variables and geographical distribution.

The final model proved to be very accurate when compared against the real risk. A risk assessment methodology was developed which, in conjunction with this final model, could be implemented on a national scale. This methodology includes an option for implementation for the fieldwork developed in conjunction with the desk-based stage of the model, although the effectiveness of the model on its own means that fieldwork need not be undertaken for all sites tested.

For each site, the project devised management and mitigation options which could be adopted to reduce the risk from cultivation, tested against farmer reactions. Management options were also discussed in relation to Countryside Character Areas, to help the targeting of these strategies. The project also looked briefly at the effectiveness of existing management schemes within these Areas.

One of the stated aims of the new Environmental Stewardship Scheme is to provide adequate incentives to farmers to ensure that archaeological sites in arable areas are managed so as to protect the archaeological resource, either through restricting cultivation depth or reversion to pasture. This means that for the first time there is an effective countrywide strategy available to farmers to protect archaeological sites, whether Scheduled or not, in arable areas. The means to identify sites at risk is crucial to this process. It is envisaged therefore that the risk model developed here will provide the tool by which Defra and other advisors can aid farmers to assess which sites are at risk from cultivation. It will also provide a framework in which theoretical changes in management can be applied to each site in question to allow the effectiveness of the mitigation to be judged prior to implementation. This process can occur during the completion of the Farm Environment Plan or during the subsequent Defra visit.

Further work

Some of the key issues identified as part of this study are that farmers:

- are often unaware of the restrictions required by Scheduled Monument Class Consents
- do not have regular contact with archaeological bodies, including EH, who would be able to explain their responsibilities
- are unaware of the damage they can cause to buried archaeological remains.

Owners receiving payments from the Single Payments Scheme (under cross compliance, specifically Good Agricultural and Environmental Condition 7) are required to be familiar with not only the location and extent of their Scheduled Monuments but also their management responsibilities towards them. However, there is still much room for improvement, part of which could be addressed through more intensive and effective monitoring and visits by EH and Defra.

The study has identified the need to develop better relations between archaeologists and the farming community. This project's success owes a great deal to the help and goodwill of the farmers and landowners who participated in the study. Many farmers who agreed to be involved in this study are interested in the archaeological sites on their land and would like to do more to protect them. A number of them have problems with EH and Defra. One of the ways to foster the good will of the farmers who participated and improve their relations with Defra and EH would be to supply them with information packs. These could include the new EH, Defra, ALGAO and Oxford Archaeology guidance leaflet `Caring for archaeological sites on arable land', providing information on the identification of archaeological sites and how to conserve them, a summary on the overall results of the COSMIC project and information to individual farmers about their own site(s) studied as part of the COSMIC survey.

Having now developed a method of risk assessment, it is important that a strategy is devised in order that it can be rolled out nationally, for use by EH Field Monument Wardens, Countryside Officers and Defra advisors. It is suggested that both a selection of EH and Defra staff are given training and sent out to a cross-section of the same COSMIC sites in the East Midlands to do their own risk assessments. It is important that the results should be the same for each site, whoever is using the model. The results of these risk assessments can then be compared with the results from this project. If the results of these assessments are the same then it can be assumed that the instructions and methodology accompanying the models are clear enough for both non-archaeologists and non-farming specialists to use. If the results are radically different then revisions will be required. Once this trial run has been completed satisfactorily then a strategy can be devised for a national roll out.

One of the aims of the 'Trials' project, is to look at the most effective ways to mitigate and monitor sites at risk. All results from the 'Trials' project should be taken into consideration during decisions on both management and mitigation undertaken as part of future risk assessments.

References to published material

9. This section should be used to record links (hypertext links where possible) or references to other published material generated by, or relating to this project.

Cannell, R Q, Davies, D B and Pigeon, J D, 1979 The Suitability of Soils for Sequential Direct Drilling of Combine-harvested Crops in Britain: a Provisional Classification, in *Soil Survey Technical Monograph* **13,** Soil Survey Applications

Christian, D G and Ball, B C, 1994 Reduced Cultivation and Direct Drilling for Cereals in Great Britain, in *Conservation Tillage in Temperate Agroecosystems* (ed Carter)

Countryside Agency 1999 *Countryside Character. Volume 4: East Midlands*. CA 10. Countryside Agency, Cheltenham

Darvill, T and Fulton, M 1998, *Monuments at Risk Survey (MARS)* EH/Bournemouth University

Defra Aug 2003 - 2003 *Review of Agri-Environment Schemes www.defra.gov.uk/corporate/consult/agri-envevhls*

English Heritage 2003a *Scheduled Monuments at Risk! - a pilot project in the East Midlands* - Kate Fearn & Jon Humble, 2003 (EH internal report)

English Heritage, 2003b *Ripping up History: Archaeology under the Plough*

English Heritage, 2003c *Where on Earth are We? The Global Positioning System (GPS) in archaeological field survey*

Govers, G, Quine, T A and Walling, D E, 1993 The effect of water erosion and tillage on hillslope profile development: a comparison of field observations and model results, in *Farm Land Erosion: In Temperate Plains Environment and Hills,* (ed S Wicherek) Elsevier.

MAFF 1998 *Code of Good Agricultural Practice for the Protection of Soil*

MAFF 1999 *Controlling Soil Erosion*

McAvoy F, 2002 Archaeology beneath and within the ploughsoil, a case study, in The Management of Archaeological Sites in Arable Landscapes project (BD 1701), Oxford Archaeology, Defra

Monsanto, 1999a *Progressive Crop Management- ECO tillage reduces inputs and maximises crop yields*

Monsanto, 1999b *A guide to the progressive adoption of reduced tillage.*

Oxford Archaeology 2002, *Management of Archaeological Sites in Arable Landscapes project* (BD 1701), Defra
http://www2.defra.gov.uk/research/project_data/More.asp?I=BD1701&M=KWS&V=Land

Park J *et al.* 1997 Integrated Arable Farming Systems and their Potential Uptake in the UK, *Farm Management* **9** (10), 483-494

Rasmusssen, K J, 1999 Impact of ploughless soil tillage on yield and soil quality: A Scandinavian review, *Soil and Tillage Research* **53**, 3-14

University of Cambridge, 1998 *Report on Farming in the Eastern Counties of England 1996/97*

Unwin, R. J 1999 *New Initiatives to Control Soil Erosion in England. Ministry of Agriculture*, Farming and Fisheries Publications.