National Implementation of the Conservation of Scheduled Monuments in Cultivation Assessment (COSMIC 3)

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Acknowledgements

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Executive Summary

Cultivation damage continues to be the single most significant reason for placing monuments on the Heritage at Risk Register. In 2013 1,977 monuments (43% of those on HAR) were directly threatened by cultivation - 1,571 by ploughing and 405 by arable clipping. Without further concerted management action on this category of sites HAR targets for Scheduled Monuments will become increasingly difficult to meet. The national COSMIC assessment (COSMIC 3) is not simply a point in time exercise: the fundamental purpose of the survey and the database it has generated is to provide a tool that can be used to manage this class of sites, now and in the future. It is specifically intended to provide much of the information needed by English Heritage's NPCD local Heritage at Risk and Development Management teams to assist them in refining current and future HAR assessments, and in targeting future management intervention (that is, the mitigation required to bring monuments down to low/vulnerable condition, and therefore off the HAR Register).

During the Ripping up History campaign of 2003 - which sought to persuade government that there was a greater need to incentivise farmers to appropriately manage archaeology subject to arable, and in parallel to reform the Ancient Monuments (Class Consents) Order 1994) - it was apparent that existing English Heritage datasets (such as the Record of Scheduled Monuments) contained little reliable information on the extent to which monuments were affected by cultivation - the first major obstacle to taking a more strategic approach to managing such sites - and was overcome through the Scheduled Monuments at Risk initiative (completed nationally in 2008). However, both Scheduled Monuments at Risk (and now HAR) were based upon the precautionary principle and automatically identified any monument under cultivation as being "at risk". In parallel, in their response to Ripping Up History DCMS tasked EH with undertaking preparatory work to enable reform of Class 1 Consent (by exchanging the general "one size fits all" consent for agricultural operations with individual SMCs tailored to the individual circumstances of each monument). As part of this research (the Trials Project) gave an improved, scientific understanding of the effects of tillage and other agricultural operations on surface and sub-surface archaeology. A key result of the project (funded jointly by Defra) was to indicate that – rather than cultivation always being incompatible with the management of a monument – in the majority of cases sites in fact remain in cultivation and not be at significant risk of degradation or loss, as long as the method of cultivation was modified (the so-called mitigation). These findings were further supported by the results of the COSMIC and COSMIC 2 pilots (see below), which field-tested a series of risk assessment methodologies in the E Mids region. Whilst in many ways COSMIC 3 represents the culmination of this work, in key respects it will be the starting point for further management work over the coming years. Key results have been:

- COSMIC 3 assessed all monuments with a HAR arable vulnerability, irrespective of whether this placed them on the HAR register, or at vulnerable/low risk. It assessed the current risk and the mitigation required to bring the monument into favourable condition;
- For the purposes of assessment each monument was broken down into fields or land parcels, a separate assessment was produced for each;
- Assessments were carried out on 1,587 monuments covering 3,953 land parcels;
- Of the land parcels assessed, the archaeology in 51% was considered to be at low or minimum risk, and 24% at serious or high risk;
- The assessment identified regional variation in risk, with the South West and Yorkshire & Humber having the most fields at serious or high risk. As these areas also exhibited the highest numbers of low and minimum risk fields, this is merely a

reflection of the number of monuments in each region and the scale of arable cultivation within them;

- The assessment has suggested that nationally, up to 130 monuments currently on HAR are at low or minimum risk in their entirety, and that 50-99% of the fields relating to a further 166 monuments currently on HAR are also at low or minimum risk. A further 242 monuments currently on HAR are assessed under COSMIC 3 as being at moderate risk in their entirety.

In terms of regions, the above breaks down into:

East of England. 5 monuments currently on HAR were assessed under COSMIC as being at low or minimum risk in their entirety and a further 25 as being at moderate risk. Between 50 and 99% of the fields on a further 16 monuments currently on HAR were assessed by COSMIC as being at minimum or low risk, 11 at moderate risk;

London. 2 monuments currently on HAR were assessed under COSMIC as being at low risk in their entirety. Between 50 and 99% of the fields on a further monument currently on HAR were assessed by COSMIC as being at minimum or low risk;

North East. 2 monuments currently on HAR were assessed under COSMIC as being at low risk in their entirety, and a further 2 as being at moderate risk. Between 50 and 99% of the fields on a further 3 monuments currently on HAR were assessed by COSMIC as being at minimum or low risk, 2 at moderate risk;

South East. 10 monuments currently on HAR were assessed under COSMIC as being at low or minimum risk in their entirety, and a further 28 at moderate risk. Between 50 and 99% of the fields on a further 23 monuments currently on HAR were assessed by COSMIC as being at minimum or low risk, 19 at moderate risk;

South West. 61 monuments currently on HAR were assessed under COSMIC as being at low or minimum risk in their entirety and a further 81 at moderate risk. Between 50 and 99% of the fields on a further 80 monuments currently on HAR were assessed by COSMIC as being at minimum risk, 37 at moderate risk;

West Midlands. 8 monuments currently on HAR were assessed under COSMIC as being at low or minimum risk in their entirety, and a further 8 at moderate risk. Between 50 and 99% of the fields on a further 13 monuments currently on HAR were assessed by COSMIC as being at minimum risk, 7 at moderate risk;

Yorks & Humber. 26 monuments currently on HAR were assessed under COSMIC as being at low or minimum risk in their entirety, and a further 94 at moderate risk. Between 50 and 99% of the fields on a further 27 monuments currently on HAR were assessed by COSMIC as being at low or minimum risk, 15 at moderate risk;

North West. 6 monuments currently on HAR were assessed under COSMIC as being at minimum risk in their entirety, and a further 5 as being at moderate risk. Between 50 and 99% of the fields on a further 5 monuments currently on HAR were assessed by COSMIC as being at minimum or low risk, 1 at moderate risk.

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1 INTRODUCTION

1.1 Background

1.1.1 The National Implementation of the Conservation of Scheduled Monuments in Cultivation (COSMIC 3) project builds upon the work started by OA in 1999, written up as 'The Management of Archaeological Sites in Arable Landscapes Project' (OA 2002), which brought together the evidence on the differing damage arable farming can do to archaeological sites and how such sites could be more effectively managed to prevent this damage. The project developed the prototype of the risk assessment model used here. It was the first project to be funded by both the Department of Food, Farming and Rural Affairs (Defra) and English Heritage (EH), reflecting the concerns and responsibilities of both organisations. This project made a number of recommendations for further work. These included the development of the risk assessment process used here and it also recommended work that was eventually undertaken in the Effects of Arable Cultivation on Archaeology (Trials) project. This later piece of work was commissioned in 2005, again jointly by the two organisations. The results of the Trials project led to a series of agricultural and land management recommendations to avoid arable damage and to allow sustainable management of archaeological monuments in a series of arable situations (OA and Cranfield University 2010). The results of the Trials project have been used to inform the COSMIC management recommendations, ensuring that the recommendations are based on hard evidence about mechanisms, processes and timescales of damage, rather than assumptions, therefore leading to more effective and sustainable management actions.

1.1.2 The primary aim of COSMIC 3 has been to use the refined risk methodology developed in COSMIC 2 (OA 2010) and to undertake a national assessment of all remaining Scheduled Monuments identified on the Heritage at Risk Register as being vulnerable to arable cultivation. On the basis of this risk assessment, and informed by the results of Trials (OA and Cranfield University 2010), the model has then been used to identify suitable mitigation measures/management strategies for each monument. The detailed background to this project was outlined in the initial project design (OA 2011) and has not been duplicated here.

1.2 Original aims and objectives

1.2.1 The aims of this project are:

- Aim 1 - to assess the condition of Scheduled Monuments throughout the country identified at risk through the Heritage at Risk (HAR) Survey.
- Aim 2 - to identify and apply effective mitigation and management measures for each site identified at risk.
- Aim 3 - to provide information to allow targeting of resources to encourage landowners to take up agri-environment schemes to protect monuments at risk.

1.2.2 Its objectives are:

- Objective 1 - to define which Scheduled Monuments are at risk and the nature of that risk
- Objective 2 - to identify the mitigation measures which would be needed to reduce this risk using methodologies based on those developed for COSMIC 2 and informed by the results of the Trials project.
- Objective 3 - to reduce the number of assets on the 'at risk' register through enhancement and/or replacement of the HAR risk assessments using a more detailed and accurate assessment process.

- Objective 4 - by generating a national risk/mitigation assessment for all Scheduled Monuments under cultivation, to underpin future Heritage Protection Reform relating to the agricultural Class Consent 1.
- Objective 5 - to help further the aims set out in National Heritage Protection Plan (English Heritage 2011) 2011-15 under 2D1 (Agricultural and Forestry Impacts), the English Heritage Research Agenda 2005-10 under D3 (Measuring Threat: Studying the Reasons for Risk and Devising Responses) and Theme 3A of English Heritage's Strategic Framework for Historic Environment Activities and Programmes (Promote better legislation, policies, guidance and good practice to improve the system of protection).
- Objective 6 - to assist future targeting of staff and grant resources by English Heritage and Defra (principally through the Environmental Stewardship Scheme administered on behalf of Defra by Natural England).
- Objective 7 - to increase the number of Scheduled Monuments being appropriately managed through Environmental Stewardship or other incentivised schemes.

1.2.3 A further aim of the project which was developed through an agreed Variation to the original project design was to make the existing COSMIC database, and future COSMIC outputs fully compliant with the data standards required for the new Heritage At Risk (HAR) Information Technology system.

1.2.4 The original project design stated that:

> *A short 10-page summary report will be produced which will briefly discuss the effectiveness of the methodology, summarise the results on risk and mitigation, comment on the validity of the results and look briefly at any regional differences or bias. Whilst not a task specified in the brief, OA believes that it will help EH with disseminating the results of the project and help it judge the validity of its results.*

1.2.5 The main report follows this format. However, it was also considered important that given the fact that the database would also be submitted, which would go on to be used by English Heritage and Natural England, a more detailed section on the methodology used and assumptions made should be included. This has been included as Appendix 1 and is not a comprehensive guide on using the model within the database but can form the basis of such a document if necessary.

1.3 Introduction to the Risk Assessment Model

1.3.1 The information potential of a site is composed of the physical monument, artefacts and ecofacts, but with the exception of human burials, this risk assessment is confined to the physical monument. It does not look at the effects of arable activities, physical or chemical, on artefacts/movable heritage under cultivation. It does also not look at the micro biological nor chemical impacts of cultivation.

1.3.2 Work that has been carried out on physical damage to artefacts in ploughsoils includes that by Reynolds 1989; Pendleton 1999, 63; Clark and Schofield 1991; Richards 1985 and Dobinson & Denison 1995, 52. Further detailed experimental studies were undertaken as part of the Trials project (OA and Cranfield University, 2010) and the issue was summarised in OA's work looking at the problem of Nighthawking (OA 2009). Studies specifically looking at the effects of agriculture on battlefield artefacts include Foard et al 2010 and the damage power harrows can do to flint assemblages has been looked at in the Upper Avon Valley (Warwickshire) by Meredith (undated).

1.3.3 Work that has been carried out on ***chemical*** damage to artefacts in ploughsoils includes looking at the effects of:

- the influences of agrochemicals on copper artifacts by the Universities of Bradford and Oxford (Pollard et al 2006 and Wilson *et al* 2006 and Pollard *et al* 2004)

- the spreading of slurry on fields and the spraying of sulphuric acid after harvest (Waddington 2001)
- the decompoistion of crop residues affecting its chemical make up and changing humidity (Wranglen 1995; Reynolds, 1989 and Malim and Hines 1998)

1.3.4 Biological and chemical impacts are also being addressed by work undertaken by Forestry Research (see Section 3.10 below).

1.3.5 The standard definition of 'risk' is *the scale of hazard* and *the likelihood of occurrence*. Within the model the hazard was defined as damage to significant archaeological features and deposits, and the likelihood of occurrence was determined by other, non-archaeological intrinsic site characteristics and management practices. The risk therefore is defined as the likelihood that damage to significant archaeological features and deposits will be caused by arable cultivation and associated drainage practices. The level of risk is determined on a site/field basis by examining all the factors that may affect the degree to which agricultural activities could affect the archaeological horizons.

1.3.6 Risk levels within the model are determined by three main factors:

- management factors eg length of cultivation, cultivation method and depth, buffer [1]deposits, crop regime, compaction and drainage
- site intrinsic variables – eg likelihood of water erosion (slope in relation to soil type), likelihood of wind erosion (soil type), soil loss through harvesting (crop regime)
- archaeological factors – eg significance and survival and vulnerability of deposits (type of preservation)

1.3.7 The importance of each factor will depend on the individual circumstances of each field/site. These factors cannot be studied in isolation as one factor will ultimately have an effect on another. For example, a site on a steep slope with a light soil will be at greater risk of erosion than a site on a gentler 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 are present on the slope, the overall risk will also increase.

1.3.8 *Management factors* cover aspects of past, current and future crop regimes on a site, length of cultivation, specifically the type and depth of cultivation, 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 cultivation and frequent subsoiling than combinable crops, resulting in increased risk levels. The Trials project has shown that all forms of cultivation requiring inversion will lead to the plough coming closer to buried remains over time and that non-inversion tillage is the only form of tillage which carries a minimal risk. For the purpose of populating the model on information on past and current management, information was collected from the farmers themselves through a questionnaire, or where this failed, from aerial photographs of the monument.

1.3.9 Based on the results of the Trials project, the length of cultivation also has a key part to play in the survival of archaeological deposits. This information has been collected from either the farmer survey or from aerial photographs. The level of risk from cultivation over time will depend on whether the site survives as an earthwork or not. For example, earthworks are the most visible, vulnerable form of archaeological site in cultivation and those that exist should be protected both for the earthworks themselves and also for the archaeological features they may have within or beneath them. If such earthworks have only just been brought into cultivation then this cultivation should be halted before damage removes the high potential these earthworks have. Similarly, earthworks that are just about to disappear, or may have just

[1] A buffer deposit can be both vertical (where a depth of soil lies between the bottom of the plough depth and the top of the highest archaeological deposit) and horizontal (where an uncultivated area has been left between the monument and cultivated area within a field). The two types of buffer have been distinguished in the report.

done so, should also be protected as these could still be offering protection to features and buried soils beneath, but that this protection could be coming to an end leaving sites vulnerable to the threshold effect. The same principle has been applied to flat sites. Where they have only just been brought into cultivation then it is likely that these sites will have suffered less truncation, so there will be a higher potential for archaeological remains to survive higher up in the original archaeological profile than those that have been in cultivation for many years. Those sites in cultivation since the 1940s are likely to be truncated, perhaps to depth of *c* 0.20 m based on the levels of truncation seen in Trials. Depending on the nature of the archaeological site, such truncation could have significantly compromised the significance of a scheduled site. Those sites cultivated the longest, unless other evidence suggests otherwise, have been scored in the model as being at lower risk.

1.3.10 *Site intrinsic factors* are part of the natural aspect of a site that includes 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 the 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 can cause soil to thin over archaeological sites on upper slopes, leaving them more vulnerable to destruction, while soil may accumulate on lower slopes and at their bases, therefore protecting sites. This is a simplistic summary as micro-topography plays an important part in archaeological survival and is explored more fully in OA 2002 and 2006.

1.3.11 *The importance and vulnerability of archaeological deposits* on a site is a key element in assessing the significance of risk to a site. By including these archaeological factors it is possible to weight monuments that have been identified as being particularly important and/or vulnerable to having a higher risk or lower risk where there is no indication that important archaeological may deposits survive.

1.3.12 For example, a complex site like a Roman villa, which might have preserved floor surfaces, or a cemetery with *in situ* skeletons, would be classed as at higher risk of the occurrence of significant damage to important deposits than a small Romano-British farmstead, characterized by truncated features cut into the subsoil. The risk of damage to the well-preserved floor surface and the truncated cut features might theoretically be equal, but if both were to be equally damaged by cultivation the effect or potential loss of information would usually be far greater in relation to the floor surface. The Archaeological Weighting score requires judgement based both on experience of monument types and from looking at all collated information for the monument. Many of the assumptions looking at Survival and Significance outlined in Appendix 1 relate to this.

1.3.13 Additional weighting is used in the model to take account of key factors that may override all other issues in determining the likelihood of whether or not damage is occurring. Weighting is applied to increase the risk factor, for example where earthworks exist, for areas of new cultivation, new significantly deeper cultivation and where soils are at risk from erosion according to the definitions within the model. Similarly, weighting (see Appendix 1) to decrease risk is applied where the site is deeply buried by deposits such as alluvium or colluvium or where long term grassland is proposed.

1.3.14 Using the model, those archaeological sites that may be undergoing cultivation damage will score above a numerical threshold. Where ongoing cultivation damage is predicted this will act as a trigger for the consideration of management procedures to prevent cultivation damage continuing. Those with damaging scores were then rescored using the appropriate mitigation option chosen, developed during the Trials project, to reduce the risk to low or minimum (in most cases).

1.3.15 The model also introduces the idea of grading the reliability of the information used, and hence the confidence of the judgement reached. This is done for each element scored, overall for each of the three main elements and also overall for the Overall Confidence in the pre-mitigation and post-mitigation scores. If there is reason to believe that the information is

accurate for each of any component element of the score then that element will be graded A; if there is some uncertainty, it will be graded B; and if only a best guess is made from minimal evidence then the score will be graded C. Some confidences are automatically generated, others manually. However, the overall confidence score uses judgement and is not based on numerical occurrences and provides the most accurate reflection of confidence based on all the factors assessed, with the proviso that some factors are more significant than others in determining confidence.

2 SUMMARY OF OUTLINE METHODOLOGY

2.1 Introduction

2.1.1 This section summarises the overall methodology as set out in detail in the project design (OA 2011a), more detailed information can also be found in Appendix 1. It also discusses where the methodology evolved from that originally submitted in the original project design during the life of the project.

2.2 Task 1: Project set up and build new database

2.2.1 An initial steering group meeting was held with Vince Holyoak, Damian Grady, David Kenny (all from English Heritage), Jez Bretherton (Natural England) and the OA project team. Issues concerning the methodology and the best way to collate data were discussed.

2.2.2 The first stage of the COSMIC 3 methodology was to design a totally new database to replace the existing one which had been developed piecemeal to deal with all the different models and methodologies used, including fieldwork. This model looked as much as possible like the paper copy of the model used for all previous COSMIC projects. The database introduced a series of autoscores which quickened the risk assessment process for some monuments. A Report Form within the database has also been included which summarises the score and key variables for each field assessed.

2.2.3 During the project English Heritage's HAR teams felt that it would be advantageous to fully embed the results of COSMIC in the future work programmes of local teams. For this to happen a specific COSMIC module would need to be generated within the HAR IT system. EH therefore asked OA, as part of a Variation (OA 2013), to redesign the database so that it was in a format compatible with the HAR IT system, currently under development.

2.3 Tasks 2 and 3: Data collection from English Heritage and Natural England

2.3.1 EH supplied all up-to-date relevant details on Scheduled Monuments identified as being at Risk in the EH Heritage at Risk survey, that is, for all those monuments categorised as at low, medium and high risk from arable cultivation. Once this was obtained the data were added to the database and linked to GIS mapping. The Shapefiles for each monument were obtained together with detailed base mapping. Each field of each monument was the digitised so that each field could be given an unique ID and assessed individually. This was then added to Google Earth as a KMZ file for ease of reference. Further automatic links were added to the EH National Heritage List for England so that the description of each monument and PDF map were easily referenced. EH also supplied contact details and recent management information where available for each monument and a list of sites it wanted excluded from Stage 1 and/or the whole assessment process.

2.3.2 Natural England provided data on which Scheduled Monuments lay within Environmental Stewardship or Classic Scheme agreements. Natural England also supplied Soil Association data at a 1:1250 scale.

2.4 Task 4: Contact landowners and enter data

2.4.1 Once all this data had been received and entered into the database, the owners/tenants of the 'at risk' monuments were sent a letter explaining the survey together with a brief questionnaire based on that used for COSMIC 2. The questionnaire was designed to elicit responses on past and future management regimes, with the data used from it to populate the 'Site Management' part of the COSMIC model. The package sent contained:

- a pdf of the location of the monument on a map divided into its constituent labelled fields so that the area was recognisable to the farmer
- a link to the EH National Heritage List to enable them to access further details on the monument itself
- a letter introducing the project
- a questionnaire for each scheduled monument and for each of the fields owned
- a stamped addressed envelope

2.4.2 The recipients were given a choice of either sending back the completed questionnaire or phoning a named specialist at OA who could go through the form with them. Two EH regions, Yorkshire and Humber and the South East took the initiative for some monuments and helped/encouraged individual farmers to fill in the questionnaires.

2.4.3 Once received the data from the questionnaires were added into the database, and if enough data were generated to complete the Site Management section of the model, this section was scored. If, on consideration of the information supplied further data was needed, which could be provided by the aerial photographic analysis, then it was sent through to Stage 2 (analysis of the aerial photographs). Common reasons why fields were sent to Stage 2 were lack of information on whether earthworks were present or on the length of cultivation. Also there were a number of cases where the respondents rightly identified that the monument was under pasture, but on examination using Google Earth© (GE) it was clear that clipping was occurring. It was assumed that unless there was evidence to the contrary the information provided by the respondents was correct. There were however, obvious cases where there were errors, for example the claim that the monument had never been cultivated but where GE clearly showed that it had been.

2.4.4 Initially it was proposed that time would be set aside to chase up data on monuments where no responses were received. However, given that the contact information passed on by EH was so out of date, this time was out of necessity spent instead on making the EH contact data usable for sending out the questionnaire. It was also considered unwise, and would be seen as unprofessional given the inaccuracy of the dataset, to start phoning people who may have moved on or died.

2.4.5 An additional task included within the Variation (OA 2013) discussed above, was the updating of this contact information using any relevant information received back from the questionnaire survey. OA also used this Variation to continue the editing of the EH data sent so that it was in a more user friendly format for auto-populating address labels.

2.4.6 At this stage, as an additional task, OA supplied EH with an initial list of monuments where all the fields were preliminarily identified as at minimum and low risk from the returned questionnaires. Monuments on this list were then checked in the field by the EH HAR team to inform the 2013 Heritage at Risk Count. It was hoped that the results of the checking would be fed back to the COSMIC project as an indication of the effectiveness of the methodology, but this did not happen.

2.5 Task 5: Interrogation of aerial photographs and Lidar data

2.5.1 For those monuments where no or insufficient response was obtained from the questionnaire, information on past and current management was collated from the interrogation of aerial photographs and Lidar data held by EH in the National Monuments Record (NMR) at Swindon (now known as the English Heritage Archive). A more detailed methodology of this process has been provided in Appendix 1, with a summary only provided here.

2.5.2 Damian Grady from EH's Aerial Reconnaissance Team provided two and a half days training to the OA team on the identification of cropmarks and landuse using aerial images. This allowed the team to, where possible, distinguish between the growing of different root and combinable crops, and the identification of others where applicable. Training was also given in identifying the differences between pasture, short and long term ley. An understanding of what constituted an archaeological cropmark and those generated by other means and how damage could be identified were also taught. Mr Grady worked closely with the team for the five months they were using the aerial photographs at Swindon to ensure accuracy and consistency in identification.

2.5.3 Once training was complete a selection of historic aerial photographs, including a stereoscopic pair, was examined from each decade up to the present, including all available Google Earth© images. The photographs were examined:

- to see if the monument had undergone significant damage during a particular decade,
- whether (if upstanding) its shape has changed,
- for information on how long each monument has been in cultivation,
- whether earthworks were present or had been seen since 1990,
- what crops have/are being grown on and/or around it.

2.5.4 Lidar jpegs from the Environment Agency were also used to identify the presence of earthworks. The photographs were selected from the cover searches provided by the NMR using basic criteria such as scale, quality etc (see Appendix 1).

2.5.5 Data recorded from the aerial images were entered directly into the database at the NMR. A summary description of the events seen on the aerial photographs were also recorded as a free text field where appropriate for key changes or observations. This information was then used at a later date to populate the Site Management section of the model.

A new tick box was added to the model if dated additional management or condition data was spotted within the extracts of the EH management database sent, if this superseded all data from the aerial photographs.

2.6 Task 6: Collect data and enter information on Site Intrinsic data

2.6.1 The 'Site Intrinsic' part of the model was populated for steepness of slope, soil type and annual rainfall. These factors are the main indicators of the likelihood of soil erosion from wind, harvesting and water. These were entered on a per field basis. Natural England supplied Soil Association data based on the dominant soil type and this was then used to label and score the basic attributes of each field for use in the model, eg Peats, Silts/sands, Loams, Sand/clay/Silt Clay and Clay. Data on soils was readjusted if those filling out the questionnaire indicated a different soil type.

2.6.2 Rainfall data was bought from the Meteorological Office as a digital plot of annual rainfall averages on a 5km GIS grid. From these data fields were recorded as being in areas with more than or less than 800mm of rain per year[2]. Information on slopes were taken from the digital OS 1:10,000 base map supplied by EH where contours were used to assess slopes as: steep

[2] The threshold for significant erosion events in susceptible sites (Unwin 1999)

(greater than 7°), moderate (3-7°) and gentle (2-3°). This information was used to in part automatically populate and score the Site Intrinsic section of the model.

2.7 Task 7: Finalise models and write summary report

2.7.1 By this point all the data collated had been entered into the model for both Site Management and Site Intrinsic factors and overall scores for these factors, including weightings generated.

2.7.2 At this stage this information was checked and the final part of the Model scored; the Archaeological Survival and Vulnerability section. This was scored using the information contained within the description provided, in the EH National Heritage List, any useful information from th6e EH management database provided and from examination of the monument itself on GE and aerial photographs. A series of assumptions were generated to score the Survival of the archaeology which are set out in detail in Appendix 1. This ensured a degree of consistency and guided the scoring of what, without excavating a monument, can be a difficult judgement. The assumptions are based on the knowledge of the likely type of archaeology represented and its likely surviving form.

2.7.3 Completion of this third section of the model allowed a final score to be generated and an overall Confidence rating produced. Generally if a monument was scored from the questionnaire it was scored A as the main factor influencing risk (ie whether cultivated or not and what type of cultivation occurring) will be known. Generally, where a monument is scored from aerial photographs and Lidar then these are given an overall confidence rating of B, to reflect the fact that even if very recent images are used it is impossible to predict what the farmer will do next year etc. If further survey is required before a judgement on what if any mitigation should be applied (and perhaps whether the monument considered for descheduling), the field is scored C. There are of course exceptions to this based on the individual circumstances of each field.

2.7.4 Given that each monument was scored on a field by field basis a query was set up in the database to allow what percentage of each monument is at what risk to be calculated. This allowed, for example, to see where all fields within a monument are at low or high risk or whether only a small portion of a monument is at low or high risk etc.

2.7.5 Review of all the data within the model, in particular the Site Management and Site Intrinsic Factors, and informed by the results of the Trials project, allowed a suitable mitigation for each field to be recommended to reduce risk and therefore the score. Options used include the direct drilling or minimum tillage which allowed the rescoring of the Site Management part of the model to reduce risk. All other mitigation options, such as reversion, extend headland etc. were autoscored. Some general assumptions used to guide the mitigation options chosen are discussed below and in more detail in Appendix 1. Each mitigation option is simply stated in the model but in fact will come with a raft of assumptions which are also laid out in Appendix 1. For example, if minimum tillage is recommend then one of the caveats would be that subsoiling should not exceed the depth of previous cultivation.

3 SUMMARY OF RESULTS

3.1 General

3.1.1 The total number of monuments assessed for COSMIC 3 at the questionnaire stage was 1587 (this takes into account the 17 that EH excluded) with between them a total of 3953 (64 fields excluded) fields.

3.1.2 The overall number of fields assessed changes slightly at different stages of the project. For example, the numbers of fields in the statistics examined at the questionnaire stage of the project differed to those examined later as further monuments were added by various EH Inspectors and a few additional fields digitised. In addition, a number of monuments were

excluded by EH from the Stage 1 process so that contact with certain owners were avoided for various reasons. Five monuments were sent to the NMR for final checks after anomalies were identified at a late stage. The results of this checking had not been completed by the time that the statistics were generated, although they were returned in time to complete the models within the database for these monuments. They represent only 0.15% of the resource and their contribution/lack of contribution is not seen as statistically significant. Some monuments from the East Midlands have also been included, although the bulk of the East Midlands was assessed as part of the pilot project (OA 2006)

3.2 Results of questionnaire survey

Monuments Stage 1 status	**Total monuments (minus those excluded)**	**% of 1587**
Monuments fully returned allowing completion of the model	708	45%
Monuments partially returned allowing partial completion of the model	69	4%
Monuments with No Returns	810	51%
Total	**1587**	
Fields Stage 1 Status	**Total Fields (minus those excluded)**	**% of 3953**
Fields fully returned allowing completion of the model	857	22%
Fields partially returned allowing partial completion of the model	140	4%
Information sent back allowing amendment of contact details but with no management data	55	1%
Questionnaires sent back with no data filled in	484	12%
Post Office auto-returned	263	7%
Response sent back saying wanted to be excluded	83	2%
Reply sent back but with no questionnaire attached	22	<1%
Nothing received back	2049	52%
Total	**3953**	**100%**

Table 1: Questionnaire response

3.2.1 Table 1 shows the breakdown of different responses following the sending out of the questionnaire, broken down by both field and individual monuments. This shows that on a monument by monument basis, out of the 1587 questionnaires sent, 708 questionnaires were returned completed to a level which allowed the Site Management page be filled in, with a further 69 sent back which allowed partial completion of this section. Combining these scores shows that for 777 monuments farmers/owners responded with useful data, a percentage of 49% of the total contacted.

3.2.2 On a field by field basis it was possible to totally complete the Site Management page for 857 fields, with partial completion for a further 140 fields, a total positive response for 997 fields, 25% of the total. For a further 644 fields farmers/owners responded by sending back replies saying they do not own the field, asking to be excluded, or returning correspondence back with no covering message. This gives an overall response whether positive or negative for 48% of fields (1641) fields, 48% of the total.

3.3 Breakdown of Risk Scores

Risk	Summary of risk definition	Typical examples of variables	Final score range
Minimum	Grass		0-11.99
Low	Minimal tillage/direct drill	Direct Drilling and long term ley (2-5 years) Direct Drilling of earthworks for combinable crops Minimal tillage plus long term ley (2-5 years) Minimal tillage of flat site with combinable crops Normal cultivation and long term ley Normal cultivation with low other variables	10-35
Moderate	Normal cult – no big variables	Shallow ploughing Normal cultivation of flat sites with high other variables Minimal tillage and growing field vegetables Low value archaeological score	35.1-48.99
High	One big variable	Minimal tillage of earthworks Normal cultivation of earthworks Flat site with root crops Future subsoiling/ drainage/destoning	49-65.9
Serious	Lots of extreme variables	Including a combination of some or all: roots, high risk of soil erosion, earthworks, proposed destoning/moling/subsoiling, no buffer (vertical or horizontal) Flat site with root crops with high variables High scoring archaeological values	66+

Table 2: Breakdown of risk scores

3.3.1 Table 2 shows the breakdown of risk scores from Minimum to Serious, together with the typical circumstances which cause them. It also shows the average scores applicable to the key variables summarised. There will of course be variations either side, especially when the Site Intrinsic factors are very high or low. The numerical breakdown of scoring is slightly different to the original breakdown used in previous COSMIC assessments due to developments in both the methodology and the introduction of new elements such as the autoscores. However, the overall categories are still defined by the same definitions used in COSMIC 2.

3.3.2 **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 (ie serious risk factors), 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 or seen since 1990. Serious risk sites will also include those barrows only now emerging from the peats which even if not upstanding earthworks are at risk of being planed off by cultivation as they emerge.

3.3.3 **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 vertical 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.

3.3.4 **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 vertical buffer is almost non-existent and where the farmer is ploughing to a constant depth each year, and where compaction and erosion may gradually thin the soil, leading to incremental but consistent plough erosion of the site.

3.3.5 **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 vertical buffer deposits. They can also include sites where minimal tillage (on a non earthwork) or direct drill (on an earthwork) techniques are practised as part of the farming regime. Also included within this category are sites that may have sufficient vertical buffer zones or have been subject to beneficial management changes to ensure that ploughing or drainage never impact upon the archaeological horizon.

3.3.6 **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/permanent 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.

3.3.7 Sites and fields should be prioritised for beneficial changes in management based on score. Whilst the scores have been amalgamated into the five risk levels, they all have numerical individual scores which can be used to further refine the prioritisation if required. It is also possible to search the database for specific attributes, for example, earthworks which are being clipped, those cultivated with combinable crops and those cultivated using roots and tubes etc.

3.4 Overall pre-mitigation scores

Fields at risk	Numbers	Percentage of all fields
Serious risk	269	7%
High	696	17%
Moderate	952	24%
Low	298	7%
Minimum	1766	44%

Table 3: Overall risk levels per field

3.4.1 The number of fields at serious and high risk from cultivation is 965, 24% of the total assessed. This number represents nearly half those fields which have been assessed as at low or minimum risk, which number 2064, 51% of those assessed. The remaining fields, 952

(24%), are at moderate risk suggesting that approximately half the COSMIC fields are at risk and requiring management change.

3.4.2 Often different fields within a monument were assessed as being at different risk levels; for example, a site could be partially in long term ley, part cultivated and part pasture. A query was therefore added to the database which works out the different risk levels for each monument by percentage. For example, a monument which only has 25% of its fields at serious risk may be a lower candidate for action than that with 80% of its fields at serious risk. A form within the database summarises these different percentages per monument (*frmviewmonsummary*).

3.4.3 Queries have been set up for where 100% of fields for a site has the same risk and where between 50-99% of fields have the same risk. The two queries also show the original HAR score. Due to the analysis being Field based it was necessary to run these queries as an aggregate. Therefore the first query shows those sites where 100% of the fields have the same COSMIC risk, and the second shows those where the same risk occurs between 50% and 99% of the fields. The queries also contain the suggested mitigation option. Again, as this is broken down per site only those where all the fields have the same mitigation option are displayed. In those sites where this is not the case, text is displayed telling you there are multiple suggested options.

3.4.4 Using this query, Table 4 shows all monuments where ALL the fields for a monument have the same risk level. This gives more of an idea of the risk levels of the monuments themselves rather than just looking at the combined number of fields. This shows a fairly even spread across the risk levels.

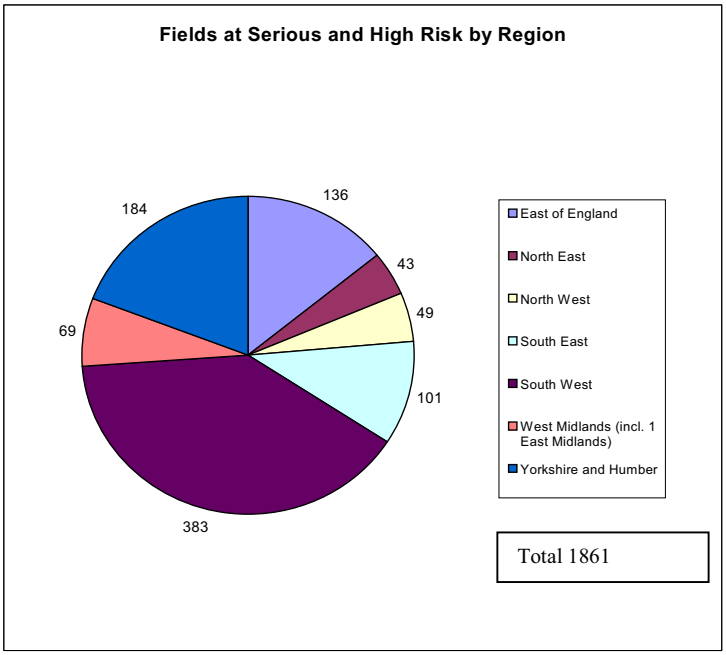
All of monument area at risk	Numbers	Percentage of all monuments
High or serious risk	371	23%
Moderate risk	342	21%
Low or minimum risk	385	24%

Table 4: Monuments where all of area under the same risk level

3.5 Regional variation in risk

3.5.1 Information on the different risk levels has been split by the different English Heritage Regions, to see if any regional variations can be identified. The pie charts (figures 1-3) summarise the risk levels between regions and tables 5-11 break down the risk within each region and shows what percentages of the region's fields fall into the different risk categories.

Figure 1: Fields at serious and high risk by English Heritage Region



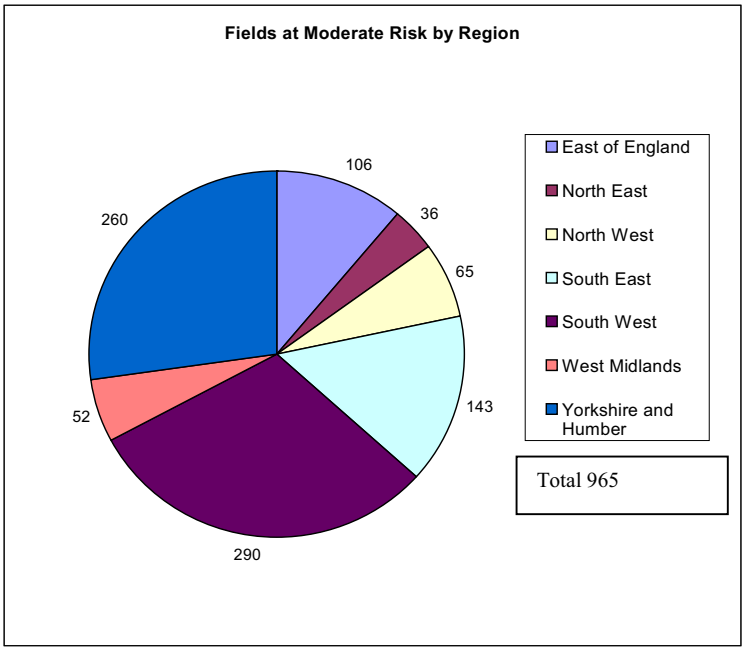


Figure 2: Fields at moderate risk by English Heritage Region

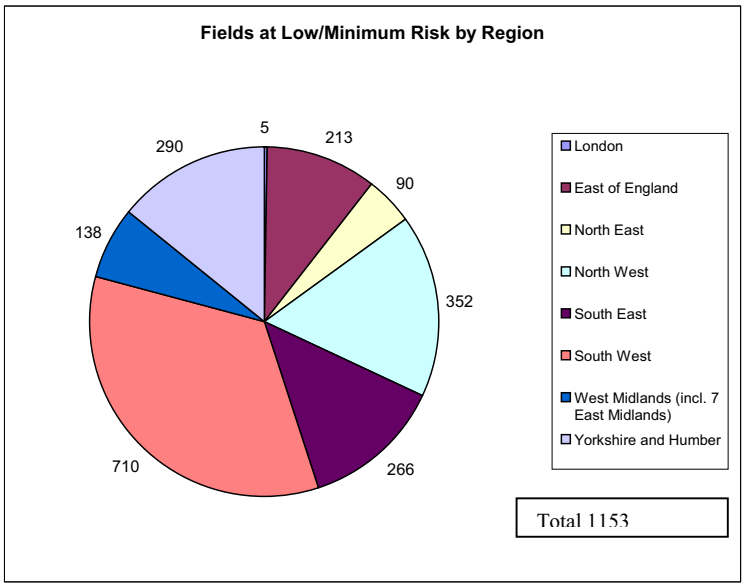


Figure 3: Fields at minimum and low risk by English Heritage Region

3.5.2 Tables 5-11 show the breakdown of risk by field within each English Heritage Region and what percentages of the region's fields fall into the different risk categories

Risk	Number of fields	Percentage of all fields
Serious	72	16%
High	64	14%
Moderate	106	23%
Low	23	5%
Minimum	190	42%
Total number of fields	**455**	

Table 5: Breakdown of risk per field in the East of England

Risk	Number of fields	Percentage of all fields
Serious	-	
High	43	25%
Moderate	36	21%
Low	10	6%
Minimum	80	47%
Total number of fields	**169**	

Table 6: Breakdown of risk per field in the North East

Risk	Number of fields	Percentage of all fields
Serious	10	2%
High	39	8%
Moderate	65	14%
Low	39	8%
Minimum	313	67%
Total number of fields	**466**	

Table 7: Breakdown of risk per field in the North West

Risk	Number of fields	Percentage of all fields
Serious	20	4%
High	81	16%
Moderate	143	28%
Low	40	8%
Minimum	226	44%
Total number of fields	**510**	

Table 8: Breakdown of risk per field in the South East

Risk	Number of fields	Percentage of all fields
Serious	78	6%
High	305	22%
Moderate	290	21%
Low	123	9%
Minimum	587	42%
Total number of fields	**1383**	

Table 9: Breakdown of risk per field in the South West

Risk	Number of fields	Percentage of all fields
Serious	32	13%
High	36	14%
Moderate	52	21%
Low	24	10%
Minimum	107	43%
Total number of fields	**251**	

Table 10: Breakdown of risk per field the West Midlands

Risk	Number of fields	Percentage of all fields
Serious	57	8%
High	127	17%
Moderate	260	35%
Low	33	4%
Minimum	257	35%
Total number of fields	**734**	

Table 11: Breakdown of risk per field in Yorkshire and Humberside

3.5.3 Out of all the EH Regions the North West has a smaller percentage of its fields at high and serious risk (only 20%), with the vast majority of its fields at low and minimum risk (75%). The EH Regions with the highest percentage of high and serious risk fields are the East of England (30%), the West Midlands (27%) and the South West (28%), with the North East and Yorkshire and Humber both with 25%. There is little variation between the EH Regions for moderate risk fields (all scores lying between 21-28%), apart from a lower value in the North West (14%) and in Yorkshire and Humber where it rises to 35%. Yorkshire and Humber also has a lower number of fields at low and minimum risk (39%) with the other regions apart from the North West scoring between 47%-53% which is remarkably consistent. What these scores show is that apart from the North West there is relatively little variation in the percentages of different risk scores between the regions.

3.5.4 These figures are in contrast to those seen from the initial COSMIC pilot study for the East Midlands, where 79% of scheduled monuments assessed were at serious, high and moderate risk from arable cultivation (OA 2010). This difference is thought to be due, at least in part, from refinements and improvements in the methodology resulting from several cycles of field testing and from the improvement of the veracity of the information fed into the model. This is particularly true in the case of the information which was retrieved from the aerial photographs and Lidar, as a result of training provided by Damian Grady (English Heritage, Aerial Reconnaissance Manager).

3.6 General facts and figures

3.6.1 Whilst a very detailed analysis of the different variables recorded for the COSMIC 3 monuments is outside the scope of this document, a few key statistics have been picked out.

3.6.2 The numbers and percentages of the main different crop types were:

- Roots and tubers – 232 fields (6% of all fields)
- Combinable crops – 1977 fields (50% of all fields)
- Not under cultivation – 1771 fields (44% of fields)

3.6.3 The number of fields which scored serious and high risk for compaction and drainage indicating regular or new subsoiling is 193. This is likely to be an under representation given that this information could only reliably be obtained for fields scored from the questionnaires, and this information will only presumably be given if the respondents are not aware that they should not be subsoiling their monuments.

3.6.4 Fields with earthworks present number 1180 – 61% of all fields, with a further 491 fields where earthworks have been seen since 1990 but are not visible on the latest aerial photographs[3]. Out of these 269, earthworks are being clipped by cultivation, 504 earthworks are being cultivated as are 283 earthworks seen since 1990 but not now visible or need their presence confirmed. Out of these cultivated earthworks root and tubers are being grown on 54

[3] Even if an earthwork has not been seen on the latest aerial photographs, but has been seen on any photo post-1990, it is still scored as if it does still exist. This reflects the fact that the latest aerial photograph may not be suitable for the identification of earthworks. This is why the earthwork flag was introduced.

fields. These clipped and cultivated earthworks (or those seen since 1990), make up the majority of the serious and high scores, with those affected by roots and tubers at the highest end of these risk levels.

3.7 Variations in results dependant on source

3.7.1 An impression was gained when filling in the model from the different sources that fields scored from the questionnaires were proportionally at less risk than those filled in from the aerial photographs. It was initially thought that those farmers/landowners who were looking after their monuments more benignly were more likely to feel they wanted to participate in the survey. However, the following table shows that this was not the case.

Percentages of risk from Questionnaires		**Percentages of risk from Aerial Photographs**	
Serious	9% (103)	Serious	<6 (166)
High	15% (162)	High	19% (534)
Moderate	16% (172)	Moderate	27% (760)
Low	14% (151)	Low	5% (147)
Minimum	46% (501)	Minimum	44% (1265)

Table 12: Comparison in percentages of risk according to source

3.7.2 One possible variation which was seen between the sources was that more low risk fields were scored from the questionnaires than the aerial photographs, reflecting the fact that information on minimal tillage and direct drilling is more likely to come from the questionnaire than from viewing the photographs.

3.7.3 A query was also set up to look at the receipt of questionnaires from the different regions, especially given that EH Inspectors were more proactive in some regions than others in trying to get farmers/landowners to fill in the questionnaire (data also includes fields where questionnaire partially filled in but had to go to Stage 2).

Regions	**Numbers**	**Overall number of fields in region**	**Percentage of overall number of fields within each region**
East of England	155	455	34%
North East	24	169	14%
North West	73	466	15%
South East	140	510	27%
South West	419	1381	30%
West Midlands	61	251	24%
Yorkshire and Humber	212	734	29%

Table 13: Comparison of responses between regions

3.7.4 On the whole the northern regions produced less questionnaires with the rest of the country producing broadly similar responses rates.

3.8 Overall post-mitigation scores

3.8.1 Once mitigation options had been applied the models were rescored, either automatically or manually depending on the mitigation option chosen.

Post-mitigation Risk	Numbers	Percentage of all fields
Serious	20	1%
High	12	<1%
Moderate	22	1%
Low	1158	29%
Minimum	2769	70%

Table 14: showing Post-mitigation scores

3.8.2 The majority of fields should at this stage after mitigation, score low (usually where minimal tillage/direct drilling have been recommended) or minimum (where reversion/expand horizontal buffer recommended), or where no mitigation was needed. However, there are a number of exceptions to this.

3.8.3 The numbers of fields still at serious and high risk from cultivation after the post-mitigation stage is 32 (<2%). This reflects the fact that in a couple of cases the risk could not be mitigated effectively, for example in fields where Christmas trees and/or Miscanthus are grown, where the risk from harvesting will always remain a serious future threat. The remnant high and serious risk fields also include those which would need further survey to see if the survival and significance of the monument is still at a level which is worth mitigating. For example, this may be the case where the field has a high Site Management score caused by long term destoning or subsoiling or growing of potatoes etc. which may have affected the survival of the archaeological significance. In these cases the pre-mitigation scores will come through and remain as a high post-mitigation score until questions on survival and significance are answered. This also explains the vast majority of fields still at Moderate risk (1%) but where the landuse has been less aggressive or where the archaeological score has been reduced considerably due to these survival concerns. This is discussed further in section 3.9

3.8.4 The breakdown of post mitigation options actually recommended can be seen in Table 15.

Mitigation recommended	Numbers	Percentage of all fields
Direct Drilling	274	7%
Expand horizontal buffer/headland	555	14%
Ley with Direct Drilling	24	<1%
Ley with minimal tillage	70	2%
Minimal tillage	653	16%
None	1866	47%
Other	7	<1%
Reversion	453	11%
Survey Required	80	2%

Table 15: Types of mitigation recommended

3.8.5 In general direct drilling was recommended where earthworks are present, or have been seen since 1990, and where the soils and slope allowed (ie where the water erosion risk scored minimal or low). This ensured that cultivation only occurred where there was a low risk of soil erosion. The one exception to this was where soils were classified as heavy – ie clay soils, where such techniques may not be practical. The same assumptions were applied with

minimal tillage, but this was not considered for earthworks after the Trials project showed the planing effects of this technique.

3.8.6 In the majority of cases 'Expand Buffer' was applied where the monument was located at the edge of the field or in a field corner, where often a small extension of an existing horizontal buffer/headland would protect the monument. It was also used where an earthwork was being clipped where an extension of an existing, ineffective horizontal buffer would prevent this and protect the rest of the monument. Where the monument was quite large with an earthwork being clipped within it, often two forms of mitigation was recommended: expansion of the horizontal buffer round the monument and reduced tillage away from it. In cases where an earthwork had a sufficient buffer but the rest of the monument was at risk, the field was scored as being flat, at risk and mitigation recommended accordingly.

3.8.7 Attempts were made to try and avoid the use of reversion, especially when it would mean creating grass islands in the middle of fields. However, where soils and slopes were not suited to long term cultivation this was unavoidable. However, it was possible to restrict the use of this option to only 11% of fields and using 'Expand buffer/headland' to 14% of fields.

3.8.8 Ley with direct drilling or minimal tillage was used on the few occasions where it appears that the field was already in long term ley (defined here as being grass between 2-5 years). Ideally it would stay in ley to become permanent pasture, but the idea behind this recommendation was that if it was brought back into cultivation or reseeded, then only reduced tillage techniques should be applied, with a stipulation that any subsoiling should not exceed the existing cultivation depth and that more of a soil loosening should be applied.

3.8.9 'Other' has been used nine times including the:

- Prevention of proposed moling
- Restriction of unsuitable cropping types where proposed
- Harvest impacts of Miscanthus and Christmas trees
- Impacts caused by creation of recent allotments

3.8.10 These mitigation options are discussed in more detail in Appendix 1 and would in practice contain caveats on subsoiling, soil management and other guidance as applicable.

3.9 Further survey

3.9.1 Three types of further survey were recommended, dependent on the stage that they are suggested. On the Site Management page where an earthwork has been seen since 1990, or identified from the Lidar image but which is not visible on the most recent images examined, these have been flagged via a tick box, separate to that ticked if an extant earthwork has been identified. These possible earthworks are referred to as having an earthwork flag. This flags up both their vulnerability but also acts as a trigger for further work to see if the earthwork actually does still exist on the ground, either by visiting the field or through work undertaken by the EH Aerial Reconnaissance Team. This is referred to as Further Survey Type A. The number of fields to which this refers to is 491.

3.9.2 The second area where further work has been recommended is on the Archaeological Scoring page where 288 fields were recommended for future research (Further Survey Type B). The tick box for further survey has been used where clarifications would be helpful on the survival and significance of the archaeological resource, but where enough information still exists to make informed decisions regarding the necessity for, and type of, mitigation required. Circumstances where this box is ticked include:

- where the area of scheduling does not correspond with the visible remains of an earthwork or cropmark
- where there is insufficient information within the National Heritage List. This was most applicable to monuments scheduled earliest and where often the only information to go on was 'Sites' or 'Cropmark site' or 'Enclosure'. These were scored with a default score and taken through to the mitigation phase. Those with no

data are usually those where scheduling took place early on in the process and there is no reason to think that these monuments are any less significant than those scheduled later which have descriptions, unless proven otherwise.

- other general issues needing clarification

3.9.3 The third area where further survey has been recommended is where further information is required to judge whether mitigation is necessary at all or even whether the field/monument should be considered for descheduling (Further Survey Type C). Where this is used and the field is cultivated the overall pre-mitigation score is accompanied by a C for confidence and this score and confidence is carried through to the post-mitigation stage. This score will remain until further survey work is undertaken to clarify the issues highlighted. Attempts were made to limit the number of these fields (79) so allowing as many monuments as possible to be taken through the whole risk assessment and mitigation process.

3.9.4 Further Survey Type C covers fields/monuments at all risks. In some cases they are low and moderate risk reflecting the fact that the evidence suggests that not much of archaeological significance survives, and reflecting that there may be nothing worth protecting. These fields/monuments may be those where earthworks were an integral part of their national significance when scheduled but where they have now disappeared. On investigation these monuments may well be candidates for descheduling. The higher risk fields/monuments are often those where important archaeological deposits may have been severely affected by past management.

3.9.5 Further Survey Type C to inform whether and what mitigation is needed is often therefore used for the following reasons:

- the national Heritage List mentions that the monument was scheduled as an earthwork feature but earthworks no longer survive suggesting that the monument may have lost its significance and may be a candidate for descheduling and no mitigation
- further information is needed specifically on survival in cases where previous management may have already destroyed much of archaeological significance

3.9.6 Further survey work for both types B and C could include a geophysical survey. This technique has been successfully applied to determining the localised impact of monuments threatened by cultivation and could be used to complement other forms of mitigation and survey discussed (Linford et al 2006). The use of buried glass chips just below plough depth and at the depth of archaeological deposits as used in OA's Trials project could also be used to complement the ongoing monitoring of plough damage on certain sites (OA and Cranfield University 2010)

3.9.7 It was considered whether to add barrows which were once scheduled as earthworks but are now flat to the Further Survey Type C category due to general concerns as to whether enough of these monuments still survive below ground to be worth mitigating. A decision was made not to do so, as both buried ground surfaces may survive or burials may still exist as central burials, on their periphery, or within the flanking ditches. This potential allowed them to retain their significance for the purposes of this assessment. It may be that at a later date EH will make a strategic decision to deschedule or just leave them unmitigated. This change in priorities could easily be accommodated in the database. Any such strategic decisions should be informed by further work on flattened barrows looking at issues of survival in relation to their historic arable regime. It could also perhaps look at the likely destruction caused by antiquarian investigations, of which there are many in certain areas, so that a series of informed assumptions can inform more generic decisions on the future of this monument type. Until then these monuments are usually being scored relatively low in the risk hierarchy (ie in the 30s) unless there are other high variables, so would not be amongst the highest scoring monuments requiring prioritised action. Those with remnant earthworks will of course continue to score high.

3.10 Effectiveness of methodology

3.10.1 Whilst accepted as a valid methodology, the COSMIC assessment of risk can only be 100% correct if the farmer has stated categorically what the monument is and will be used for in the future or if there is a confirmed management agreement in place for the monument. Only then can a totally robust risk assessment for the long-term risk to the monument from arable be produced. If aerial photographs are used then they will only be correct to the date of the latest one examined: some have photos taken as recently as 2012, others only 2005. Sometimes the EH management database supplied to OA will have management and condition data, but often these entries are undated so are of limited use. The accuracy and confidence levels indicated are therefore only relevant within these parameters.

3.10.2 The presence and identification of earthworks is key. An earthwork may still exist on the ground but not be identified from the latest aerial photographs as the photographs themselves may not be suitable for the identification of earthworks. For example, their non-identification may be due to the quality of the latest images, where the lighting conditions were too flat and not ideal for picking out earthworks. This will be true for the majority of Google Earth images that are taken in the summer around midday. These can also not be viewed in stereo. Earthworks may therefore may be under-represented. However, the methodology does compensate for this by the introduction of the earthwork flag, where even if an earthwork is not seen the latest images, if it has been seen on any image post-1990, it is given a flag to indicate that it may still exist in some form or another and should be treated as an earthwork until further survey proves otherwise. The project also used Lidar jpegs to identify earthworks, jpegs being the most accessible to EH and easier and quicker to use than original data. Original Lidar data is more detailed and would have allowed a more accurate identification of the presence or absence of an earthwork.

3.10.3 In many cases a complete set of aerial photos from every decade was impossible to obtain using the methodology applied. However, the vast majority of monuments did have good photographic records spanning most decades. The EH East, South East and South West Regions had some of the best coverage for this project. The Yorkshire and Humberside region, in contrast, had a poorer collection from which to choose from. GE imagery was very useful for looking at cropping and change since 1999. Again coverage was variable with poor coverage in the north of England with perhaps one or two flights presented with the latest often only dating to 2005. In the south over six image dates were often available to view with some dating to 2013, available during the later checking phase. However, overall, the aerial photos combined with the historic and recent GE imagery have given a good coverage from which to assess the monument's risk.

3.10.4 A series of detailed assumptions were made and recorded so that consistency could be achieved throughout the scoring process. These have been included in Appendix 1. It is possible that some of these may be disputed, if so then because they have been included, the assumptions and therefore the scoring can be changed accordingly. The assumptions have not always been followed where other data has been taken into consideration and where this is the case then the variance should be explained in the text fields. Some variance may also be caused by subtle details, variation in judgements and/or circumstances. Ultimately however, mistakes in consistency may have been made as ideas evolved or changed during the time taken to score nearly 4000 fields, and where not all fields which needed retrospective alterations were identified. It is also possible given the multitude of fields scored, that genuine errors have been over looked, despite the verification process. If these anomalies are picked up then they can be easily corrected within the database based on the assumptions outlined in Appendix 1.

3.10.5 The data on ownership provided by English Heritage were very out of date and certainly contributed to a proportion of un-returned questionnaires. Also this lack of up-to-date data in some cases drew criticism from a number of respondents who assumed that EH, being a national body, should hold up-to-date data. There were also unfortunate cases where the person the letter was addressed to was dead, and in one case had died 20 odd years ago. The

contact details themselves were also difficult to extract from the EH records in an automated way due to inconsistencies in recording which led to delay and inefficiency. Part of the Variation (OA 2013) enabled OA to rectify the formatting problem and amend the addresses where more up-to-date information was provided to OA, but this dataset is still not robust and efforts should be made to rectify this.

3.10.6 The National Heritage List for England was also often of limited use, especially for those monuments scheduled early in the process. In some cases the List contained no details on a monument other than its name. The List was useful in identifying earthworks, but only when the monument had been scheduled post-1990 enabling an earthwork flag to be recorded. It would also have been useful where a description existed to clarify what had been updated when. The same is true regarding lack of dated entries of the information available in the extract of the EH management database provided.

3.10.7 The results presenting the number of fields at minimum risk may be skewed by the inclusion of quite a number of fields with woodland and/or scrub. Woodland was included as often earthworks will survive within woodland which may be at risk from clipping from encroachment, by cultivation. Their inclusion also allowed a more complete overall picture of the monuments landuse and risk and will allow any changes in land management to be assessed in the future eg scrub clearance for arable. Impacts of woodland were not assessed here, but these have been researched in detail by Forest Research (Crow 2002; Yarnell *et al* 2010; Crow 2004; Crow 2008; Crow *et al* 2005).

3.10.8 Compatibility problems caused by using one version of Access at OA and another at the NMR in Swindon led to apparently random data losses. This meant that the aerial photographs for some monuments had to be reassessed and the monuments re-recorded. Some overall loss of aerial photographic coverage has occurred though, but where this would have led to uncertain scoring outcomes, then these monuments were reassessed as above. Similarly the transfer of data and queries and function from one database to another half way through the project also led to some losses and problems with the behind the scenes calculations/links, but we are fairly confident that all issues have now been picked up.

4 CONCLUSIONS

4.1.1 It is believed that the changes made to the model within the database will make it compatible with the HAR process. It has been set up so that new monuments and fields can be added and data on fields/monuments already scored can be changed as more information comes to light, perhaps from visits to the monument or changes in circumstance on a monument/field. Both a detailed instruction manual and training will be needed to facilitate this process.

4.1.2 The report shows clearly that there are still problems with scheduled monuments at risk from arable cultivation at a consistent level across all the EH regions, with the exception of the North West which appears to be less affected. Many of these at risk monuments, usually identified at moderate risk, will be those where cultivation has been occurring over long periods of time where probably much damage has already been done. Those fields identified at high and serious risk (24%) are those where the threat of serious ongoing damage is likely and these fields should be priorities for changes in management. Many of these fields contain earthworks which are being gradually being eroded leading to both their loss as part of the visual historic landscape and also potential loss of previously protected, well preserved archaeological remains. On a more positive note 51% fields were scored at low and minimum risk showing that progress has been made.

4.1.3 Mitigation proposals have been suggested for all fields at risk, except those fields where further survey is needed to decide whether there is enough of significance surviving to be worth protecting through changes in management. The majority of mitigation proposed is through reduced cultivation methods, 32%, 14% of sites could be easily protected by an extension of an existing headland or horizontal buffer and only 11% of fields have been

recommended for reversion where soils and/or slopes are unsuited to cultivation as a sustainable long term option.

4.1.4 As discussed above the COSMIC risk assessment is only as good as the data fed into it. Twenty five per cent of models for fields were filled in either in part or fully using results from the questionnaires sent back by land owners, a response rate of 49% of those farmers contacted. The confidence of the accuracy of the risk assessments scored from this source is high. Those scored by the aerial photographs are less robust as they will not be based on totally up-to-date information and they can not provide information on farmers future plans. However, given these caveats it is believed it is an effective way to assess risk or risk trends for each field assessed. Obviously all scores need to be validated on the ground and hopefully this validation process will be fed back into the risk assessment process perhaps leading to further tweaks in the methodology.

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Appendix 1
Detailed methodology and assumptions used when filling out the model and recording of data

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Detailed methodology and assumptions used when filling out the model and recording of data

Table List:

1 INTRODUCTION

1.1 *Purpose of Appendix 1*

1.1.1 It is important that the decisions used to score the risk assessment models for each field are recorded to show exactly how each field was scored and to ensure consistency in results. Where a score or record does not follow the decisions/assumptions laid out here, there should be an explanation in the appropriate text boxes. Whilst providing guidance on the methodology and the decision making process this appendix does not form a guide on using the model within the database as such but can form the basis of such a document if necessary.

1.2 *The model – changes since COSMIC 2*

1.2.1 The methodology used to score the model is the same basic methodology that has been used throughout the COSMIC assessment process. However, whilst the model is basically the same in how it works, a number of small changes have been made, including the introduction of a series of autoscores (see section 3.1 below), to save time and generated under certain circumstances, for example:

- When the monument is uncultivated
- When an earthwork is present
- When an earthwork has been observed since 1990 but has not been observed on the latest aerial photographs (new category)
- When an earthwork has been clipped

1.2.2 A number of new steps were also introduced to inform the scoring process. These included using the online EH National Heritage List for information to help score the Archaeological Variables and extracts from the EH management database supplied to OA and used to identify any dated information on condition, fieldwork and management schemes. If data from this source dated and the information supersedes the data from the aerial photographic assessment, then these data were also used to score the model and a tick box flags this up.

1.2.3 Earthworks seen on aerial photographs after 1990, mentioned in the EH description (if scheduled later than 1990), seen on Lidar or identified elsewhere, but not seen on the latest images, were identified, flagged and scored as if they were still present as discussed in the main text. These were not considered during the previous COSMIC assessments which were carried our prior to the Trials project.

1.2.4 Even if the earthworks flagged or extant are later than the monument itself they were still considered as they would still be offering protection to below ground remains eg ridge and furrow overlying a scheduled Iron Age settlement.

1.2.5 If woodland may be shielding known earthworks from view, these can also be scored with an earthwork flag, to flag up that further investigation would be needed to confirm this. However, given that these monuments are usually at low risk, unless clipping is an issue, then further investigation would be a low priority.

2 INITIAL METHODOLOGY

2.1 *Set up*

2.1.1 Where a monument extends over more than one field, each field was digitised using 'Get Mapping' and given its own letter in the database. The exceptions to this was where they were obviously:

- A garden or small non-agricultural enclosure
- Part of a larger non-agricultural complex, examples include uncultivated land which is part of sewage works, churchyards, cemeteries, farmyards, hotels etc.
- A sports field or golf course
- Well established parkland

2.1.2 A layer of monuments with their fields labelled was then added as a layer onto the Google Earth (GE) topographical mapping in the form of a KMZ file. A link from this to the English Heritage's online National Heritage List for England description for each monument was also established to allow ease of referencing.

2.1.3 In some cases the digitisation of the field boundaries whilst correct when digitised may appear not to be so as newer versions of the GE photos are uploaded and in comparison with the original Get Mapping© data. Similarly the boundaries of the fields may have changed over time, especially where fenced.

2.2 *Choosing the aerial photographs from the cover search*

2.2.1 The images were selected in order to assess monument condition and land use in each decade. Information on images available was supplied as frames within a geo-database in ArcGIS v10 format, each frame covering all or part of a COSMIC monument land parcel polygon. Aerial photographs were then chosen with advice from English Heritage, taking into account criteria such as time of year, quality of images and scale. The cover search data was worked through on an English Heritage locality basis, starting with the East of England. The photos were chosen in sets of 50 scheduled monuments per locality. The vertical dataset criteria focused on photos taken from the months of June, July and August and with a scale covering the suggested optimum of between 1:7,500 and 1:12,000. These criteria gave the best possible chance of identifying crop type and the presence of any earthworks. Where available, a sample of stereo-paired frames were selected for each decade from the 1940s to the 2000s that covered or mostly covered the scheduled area and were of reasonable quality. In the instances whereby frames were not available for any decade for a monument then the criteria for the time of year were ignored and frames selected from any available month. In a number of instances vertical photographs were not always available for a given decade.

2.2.2 Point data for oblique photographs was also supplied by English Heritage allowing a further set of images to be selected for each COSMIC monument. Again the criteria of time of year were paramount to consideration and images from June, July and August were prioritised to aid crop identification. Attempts were made to select photographs for every possible decade, but the majority of oblique images tended to be from the more recent decades.

2.2.3 EH also supplied digital Lidar jpegs where they covered COSMIC monuments. This was supplied rather than original Lidar data as it is easier to use and it is all EH had. Not all monuments were covered by this resource. This data was particularly useful to identify any surviving earthworks, although original Lidar data rather than jpegs

would have been more accurate. The accuracy of the resolution of the Lidar jpegs varied between 0.25m-2m. This data is recorded within a table within the database. The table records the minimum and maximum resolution of, and the number of, intersecting LiDAR jpegs to each of the Cosmic Fields. In some cases there will be multiple LiDAR tiles covering a site (especially for linears) each with a different spatial resolution. However, although each tile is a uniform OS square, it does not mean that there is actual LiDAR coverage across the whole of the tile. As such, although a site may intersect a tile, LiDAR data may not have been present.

2.3 *Filling in aerial photographic recording sheet*

2.3.1 The results of the aerial photograph assessment were recorded in a free standing form within the database at Swindon. The landuse from these photos were recorded per decade in a drop down list. Where more than one landuse was noted the most destructive was recorded. The latest photos looked at, including GE, or recent aerial photographs showing particularly significant information (eg where sugar beet was present), were recorded in more detail: eg. reference number (after the first two weeks), source, season, date, type of aerial photograph (ie oblique or vertical), landuse and type of cultivation (if obvious). The reference number and date for the Lidar and stereoscopic pair were also recorded separately. All historic GE images were utilised to inform this process, although the dating of these images is not always reliable.

2.3.2 Less recording took place if permanent pasture, scrub or other long term non-cultivation landuse was identified from the latest aerial photographs. This reflected the fact that these fields would be at low risk and time would be more profitably spent on assessing those which are at risk. If earthworks were present or flagged these were autoscored using tick boxes.

2.3.3 A free text box was used to add notes, or discuss any issues such as if other threats were seen, if clipping is occurring, whether there was anything unusual in the sequence of photos or anything else that may help assess risk to the monument.

2.3.4 At the request of EH, where cropmarks were seen outside the scheduled area or if a monument was seen to be extending outside its scheduled boundaries, then these were noted within the text box. The 2006/7 GE images were particularly good for this. The text box was also used if it was thought that a visit to the monument to resolve any uncertainties would be necessary.

2.3.5 Where no autoscores were generated then the model was scored using the data from the aerial photographs.

3 EXPLANATION OF SCORING PROCESS

3.1 *Initial stages, scoring and autoscores*

3.1.1 The COSMIC database is designed to hide the behind-the-scenes calculations of the model scores. The assessor is guided through a partly automated sequence of data entry forms for each field. These focus on the three scoring factors in the model: Site Management, Site Intrinsic, and Archaeology.

3.1.2 The Site Management factors are assessed either through manual scoring or by an auto-scoring system. The scoring method is determined through the answers to a set of core questions that the user is asked to give.

3.1.3 For the Pre-Mitigation stage these are as follows:

- *1) What is the source of the assessment?* - Each field is assessed using information from one of three sources. Questionnaires sent to the owner/occupier of the field (the preferred source of information), Imagery assessed by OA staff using Google Earth images and Aerial Photo analysis at English Heritage, or Both, where an incomplete questionnaire required further assessment using imagery.
- *2) Is the field cultivated?* - Ticked if the field is in cultivation, including ley.
- *3a) Have earthworks been seen on the latest imagery or on the ground?* - Ticked if the assessor has identified earthworks through aerial imagery or via the questionnaire or EH management database.

Or

- *3b) Have earthworks been seen since 1990 but are not seen today?*- Ticked as an alternative to 3a. Any field where known earthworks are considered to have 'disappeared ' since 1990, are flagged to allow further survey to take place[1].
- *4) Has clipping been identified on the monument?* - Ticked if the monument within the field shows evidence of having been 'clipped' by ploughing.

3.1.4 The combination of these answers provides the scoring workflow for the field within the model. The results of this for the Pre-Mitigation scoring are given in the table 1.

Source	Earthworks	Flagged	Cultivated	Clipped	Score	Confidence
Questionnaire	X		X		Model	
Questionnaire		X	X		Model	
Both	X		X		42.2	B
Both		X	X		42.2	B
Imagery	X		X		42.2	B
Imagery		X	X		42.2	B
Imagery	X				0.1	B
Imagery		X			0.1	B
Questionnaire	X				0.2	A
Questionnaire		X			0.2	B
Both	X				0.2	A
Both		X			0.2	B
ALL			X		Model	
Questionnaire					0.2	A
Both					0.2	A
Imagery					0.2	B
ALL	ANY TICKED			X	42.3	B

Table 1: Pre-mitigation scoring and autoscores used

[1] The presence and identification of earthworks is key. An earthwork may still exist on the ground but not be identified from the latest aerial photographs, as the photographs themselves may not be suitable for the identification of earthworks. For example, their non-identification may be due to the quality of the latest images, where the lighting conditions were too flat and not ideal for picking out earthworks. This will be true for the majority of Google Earth images that are taken in the summer around midday and can't be viewed in stereo. However, the methodology does compensate for this by the introduction of the earthwork flag, where even if an earthwork is not seen the latest images, if it has been seen on any image post-1990, it is given a flag to indicate that it may still exist in some form or another and should be treated as an earthwork until further survey proves otherwise.

3.1.5 Each of the Management choices are carried over to the Post-Mitigation stage (although hidden from the user) and can be further altered by the choice of mitigation option. The results of this for the Pre-Mitigation scoring are given in the table 2.

Option	Affect	Score	Confidence
Reversion or Expand Buffer / Headland	Overrides previous summary answers	0.1	A
Survey / Further Work or None	Previous answers are retained	As Pre-Mitigation	
All other options	Requires the model to be re-scored by the assessor	Model	

Table 2: Post-mitigation scoring and autoscores used

The users path through the database will be determined by these variables, meaning that the input forms will automatically alter based on the scoring method and score.

3.1.7 The Site Intrinsic section requires certain environmental details to be considered in the scoring. These are entered when creating the field entry within the database and consist of:

- *Soil Type* - Chosen from the list of Natural England soil descriptions or COSMIC variants. This dictates whether the soil is Heavy, Moderate or Light.
- *Slope* - Calculated within the records by using the value of the centre point in each field as determined from an interpolated 25m resolution elevation model. Future entries need simply select from one of the four slope classes.
- *Rainfall* - The model considers the average rainfall of a field as having a mitigating impact on the erosion risks of the site. These were determined through data received from Natural England. The criteria for the model is a simple toggle, of whether the average is above 800mm or below.

3.1.8 The archaeological factors are wholly scored by the assessor based on the information available.

3.2 *Score Weightings*

3.2.1 The COSMIC model uses a variety of weightings which multiply the given scores based on the answers chosen. As with the auto-score system these are hidden from the user. These are used in across the entire model in the situations outlined in Table 3:

Site Management : Weighting / Multiplier	**Circumstance – site management variables**
0.5	SM risk scores minimum
1	SM risk scores low, moderate
1.5	SM risk scores high
2.5	SM risk scores serious
Site Intrinsic: Weighting / Multiplier	**Circumstance – site intrinsic variables**
0.5	Where Harvesting risk minimum
1	SI risk scores minimum to high (except Harvesting minimum) - plus where water erosion scores minimum to moderate.
2	SI risk scores serious plus where water erosion scores high and moderate with the rainfall modifier

Site Management : Weighting / Multiplier	Circumstance – site management variables
4	SI weighting applied to Harvesting auto-score where Roots/Tubers are selected and where earthworks or those seen since 1990 present where autoscored from imagery
0.25	SI weighting for all fields not under cultivation
Archaeological: Weighting / Multiplier	**Circumstance – archaeological variables**
1	Where the archaeological total score is 5 or more
0.5	Where the archaeological total score is less than 5
0.25	Additional archaeological multiplier when the field is not in cultivation

Table 3: Weightings used within the database

3.2.2 These weightings have been developed further and differ slightly from those used in COSMIC 2, especially the archaeological weightings to prevent the fact that they are scheduled monuments over-riding the other scores, especially if the field is uncultivated. However, it is possible for both the weighting and the majority of the multipliers to be altered by an administrator if required using the Form *frmAdminDefaults*.

3.3 *Score Ranges and Risks*

3.3.1 Once the scores are tallied the final totals are given an overall field risk value. The focus of the COSMIC model on individual fields within a monument allows a single monument to have multiple Risk values for both Pre-Mitigation and Post-Mitigation. The ranges for these are given below.

Risk	Score
Minimum	0 - 9.99
Low	10 - 35
Moderate	35.1 - 48.99
High	49 - 65.99
Serious	66+

Table 4: Overall scores and risk

4 COMPLETING THE RISK ASSESSMENT MODEL

4.1 *Scoring the model - Site Management*

General

4.1.1 If an earthwork is clipped the clipping tick box should be ticked as well as the 'in cultivation' tick box. If an earthwork is present but has a sufficient horizontal buffer around it to prevent clipping, but where the rest of the scheduled area is cultivated, the monument should be scored as flat and cultivated.

Buffer[2] zones

Guidance (previous cultivation depth/ extent in relation to archaeology)

- **Serious** = Cultivation of areas or encroachment on parts of monuments not previously in cultivation (or proposed in the future); Evidence of new disturbance or earthworks present. If earthworks present include all cultivation as serious unless direct drilled
- **High** = Present cultivation likely to be at interface with archaeology: Use as default if not minimal tillage or direct drill (ie all inversion)
- **Medium** = Shallow vertical buffer (eg. 0.10-0.20m); previous cultivation has left differential cut and fill. Default if minimal tillage (non inversion). Also use as default if long term ley (2-5 years)
- **Low** = Consistent moderate undisturbed vertical buffer (of old colluvium or alluvium eg. 0.20-0.25 m) or just confirmed large vertical buffer. Use as default if direct drilled
- **Minimum** = Deeply buried (eg > 0.25m)

Further assumptions for filling in model

- If unclear use High [and confidence B) as a default, ie cultivation at the interface with the archaeological deposits.
- If potatoes/roots etc. have been grown in the past 10-15 years assume still in rotation and score High (B) and/or if grown on field in past and still seen in the rotation close by
- If potatoes/roots grown within 15 years and can be sure not still in rotation score a Medium vertical buffer (B) and say why this has been done
- If potatoes/roots grown over 15 years ago and not still seen in rotation but do not know when stopped do not score vertical buffer – score High
- If long term ley (ie 2-5 years) score Medium (B) - although would be serious risk if earthworks cultivated not using direct drill

Cultivation method and depth

Guidance

Earthworks (questionnaire) – (not used for sites scored from APs as this will trigger an autoscore)

[2] A buffer deposit can be both vertical (where a depth of soil lies between the bottom of the plough depth and the top of the highest archaeological deposit) and horizontal (where an uncultivated area has been left between the monument and cultivated area within a field). The two types of buffer have been distinguished in the report.

- **Serious** - Regular deep ploughing, deep rotavating, or stone cleaning (>0.30m) (or proposed in the future) or if in field: New significantly deeper ploughing with clear fresh disturbance eg presence of fresh subsoil (0.30m)
- **High** - Regular deep ploughing, deep rotavating, or stone cleaning (0.26-0.30m) (or proposed in the future)
- **Medium** - Normal or shallow ploughing and soil inversion techniques and minimal tillage
- Low – n/a
- **Minimum** - Continuous direct drilling with no subsoiling

Flat sites

- **Serious** - Regular deep ploughing, deep rotavating, or stone cleaning (>0.30m) (or proposed in the future) or if in field: New significantly deeper ploughing with clear fresh disturbance or presence of fresh subsoil (or proposed in the future)
- **High** - Regular deep ploughing, deep rotavating, or stone cleaning (0.26-0.30m) (or proposed in the future). Use if potatoes/roots grown in rotation
- **Medium** - Continuous normal depth (up to 0.25m) using ploughing and soil inversion techniques. Use as a default if no other clues visible from aerial photographs or if questionnaire does not state depth or method
- **Low** - Shallow inversion (up to 0.125m) or minimal tillage with subsoiling or if deep minimal tillage (or where not sure of subsoiling or depth), or direct drill with occasional ploughing to shallow depths. Use if long term ley (2-5 years)
- **Minimum** - Continuous shallow non-inversion ie minimal tillage and direct drilling with no subsoiling (0.10m)

Further assumptions for filling in model

- If can not tell what sort of cultivation score Medium (C) – default
- If potatoes/roots score high or serious (as there will be deep ploughing/stone cleaning) and B or A (depending on source)
- If long term ley (2-5 years) score low (B) – as it will be cultivated at some point but not very often
- If short term ley score as if cultivated (ie Medium)

Cropping Regime

Guidance

- **Serious** - Cropping includes sugar beet, potatoes, ie crops needing deep soils (or proposed in the future). Also includes Miscanthus
- **High** - Turnips, field vegetables, parsnips, carrots etc)
- **Medium** - Cropping includes cereals, non-root crops, short term ley ie one year (or ley where length not known)
- **Low** – Long term ley (2-5 years)
- **Minimum** - Cropping includes permanent pasture (ie over 5 years) (will be autoscored)

Further assumptions for filling in model

- Should be able to use B confidence rating as should be able to identify cropping from aerial photos (not A as cropping regime may have changed since aerial photographs taken) – use A if scored from questionnaire
- If Christmas trees etc score serious

- If potatoes/roots etc. have been grown in the past 10-15 years assume still in rotation (unless know otherwise) and score – serious but (C) and/or if grown on field in past and still seen in the rotation close by
- If normal combinable crop score Medium (B)
- If long term ley score (2-5 years) low to reflect cropping will change at some point as part of rotation but probably only to combinable crops
- If 1 year ley score Medium as normal cultivation – also if length of ley is unknown (If over 5 years will have been autoscored permanent pasture)

Compaction and Drainage

Guidance

- **Serious** - New regular subsoiling < 3 years old (or proposed in the future) or proposed new drainage system
- **High** - Regular or occasional subsoiling or pan busting required (3-6 years), wetland water table lowering (or proposed in the future). Use if roots/potatoes
- **Medium** - Rare subsoiling required; moling and drains (7-15 years). If questionnaire say sub-soiled in past assume even if they have not said either way that they will also do in future. Use as default when scored from imagery unless see otherwise
- **Low** - No subsoiling - default if not answered in questionnaire assume is none. Use if minimal tillage or direct drill or if long term ley (B) – as less chance of compaction and drainage issues whilst ley
- **Minimum** - Anything which suggests they are actively reducing compaction and wheelings

Length of Cultivation

Guidance

- **Serious – Earthworks** – recently in cultivation for first time – from 1980+, Unless Direct Drilled (if DD score Low)
- **High - Earthworks** still in cultivation from prior to the 1980s unless Direct Drill (if DD score Low). **Flat Site** in cultivation 10 years or less
- **Medium - Flat sites** in cultivation from 1980s onwards
- **Low - Flat sites** in cultivation from pre- 1980, Direct Drilling **earthworks**
- **Minimum** – n/a

4.2 *Scoring the model - Site Intrinsic factors*

4.2.1 Data on soils was obtained digitally from Natural England and consisted of Soil Association Survey data based on dominant soil type at a scale of a 1:1250. This was used to label and score the basic soil attributes of each field for use in the model, eg Peats, Silts/sands, Loams, Sand/Clay/Silt Clay and Clay. This allowed the scoring of wind erosion risk and, when combined with data on type of slope and rainfall, water erosion risk.

4.2.2 Rainfall data were purchased from the Meteorological Office as a digital plot of annual rainfall averages on a 5km GIS grid. From these data monuments were recorded as being in areas with more than or less than 800mm of rain per year[3]. Information on slopes were taken from the digital OS 1:10,000 base map supplied by

[3] The threshold for significant erosion events in susceptible sites (Unwin 1999)

EH where contours were used to assess slopes as: steep (greater than 7°), moderate (3-6.99°) and gentle (2-2.99°).

4.2.3 The questionnaire also asked what soil type was present on the assessed field. Where respondents confirmed the data from the soil survey an A confidence rating was given to both the wind and water erosion scores.

4.2.4 The likelihood of erosion during harvest score was based on whether the field was uncultivated, cultivated with combinable crops or cultivated with roots and tubers. If this information came from the questionnaires it had an A confidence grade, if from aerial photographs it was given a B confidence grade. If roots and tubers are chosen then the score is weighted to reflect the increased risk, if earthworks are also present and roots and tubers are grown and the site is autoscored from the imagery, a further weighting is also applied.

4.3 *Scoring the model - Archaeological score*

Archaeological Significance

Guidance

4.3.1 The Archaeological Significance/Importance scores are:

- **Serious** - Scheduled Monument or site of National Importance
- **High** - Regional or County Importance
- **Medium** - County or Regional Importance
- **Low** - Clear Local Significance
- **Minimum** - No obvious Importance

4.3.2 In most cases the monuments are scored as national importance as they are scheduled monuments. This should be given a B confidence score so as not to skew the overall Archaeological confidence grade and to reflect the fact that it is only assumed that the monument has retained its national significance. Exceptions to this are discussed below.

Archaeological survival and vulnerability

Guidance

- **Serious -** Clear upstanding earthworks and structures, low earthworks, likely buried ground surfaces. 'Soft' horizontal stratigraphy, floor and occupation surfaces
- **High –** Evidence of settlement activity, shallow negative features with important contents (eg shallow graves),
- **Medium -** Unknown archaeology or stratigraphy of shallow negative features, surface finds not reflected in underlying archaeology – use as default if no information,
- **Low -** Site already substantially damaged; only deep negative features likely to survive
- **Minimum -** Site largely destroyed leaving very little potential

Archaeological survival and vulnerability and Significance - further assumptions for filling in model

4.3.3 The information used to score archaeological survival was mainly gleaned from the National Heritage List for England (although in many cases no information was included within the records of this resource), from extracts from the English Heritage

management database provided and from clues in the description as to monument type (where no other information existed).

4.3.4 Without actually excavating a monument it is often difficult to judge survival and therefore whether a monument has retained its significance. Therefore, a series of assumptions have been worked out here based on OA's knowledge of archaeological monument types and their likelihood to contain certain deposits or types of features. This guidance need not be totally prescriptive in that if there is information available to refine this for a field then obviously this should take precedence. However, any information would need to be based on recent investigation/research as survival can change quickly on arable land, for example, where the Threshold Effect occurs.

General assumptions:

- If no information is available for a monument at all, survival was scored Medium as a default with a confidence of C. Where Medium is used as a default then the further work box would need ticking to imply that further information is needed to further inform the scoring. However, for the purposes of scoring despite this lack of information, it is assumed that these monuments still retain their national significance, therefore Further Survey Type C (see section 4.4 below) would not be required in order to be make decisions on mitigation. Those with no data are usually those where scheduling took place early on in the process and there is no reason to think that these monuments are any less significant than those scheduled later, which have descriptions, unless proven otherwise.
- Where there is some evidence of survival, whether high or low, and a reasonable assumption can be made, a confidence score B is used.

4.3.5 For some monuments scoring will be based on the type of monument unless there is evidence to the contrary. For example it is assumed that:

- Villas may have mosaics and floors therefore scored Serious and B (ie floor and occupation surfaces likely to be present)
- cemeteries will have 'shallow negative features with important contents' (ie burials and cremations) therefore will score High and B
- If earthworks present, or if earthworks seen post-1990, or standing stones ie if any upstanding remains are present, these are scored Serious and A – this will take precedence over any other score/type of survival option
- If only a ring ditch remains or ploughed out barrow these are scored for 'shallow negative features with important contents' ie High and B reflecting the fact that the central or satellite burials may still be present
- where a hillfort, fort, fortlets, moated sites (where no earthworks), some Roman Camps, rounds or settlements these are scored High to reflect that settlement activity is likely and B (if there is reason to think that this has gone or if soft horizontal stratigraphy likely, then scores should be adjusted accordingly)
- Hadrian's Wall – where it is likely that the wall survives as a buried feature along its length then score High and B
- Roman roads were scored as if the road surface itself survives underground so scored Serious and B - 'occupation surfaces' may survive. If only ditches survive then this would score Low – only deep negative features likely to survive and B (but still scored as National Importance and B). However, there may be cases where making a decision is difficult therefore further work (Further Survey Type B – see section 4.4) would be desirable. This would not mean that Further Survey Type C would be needed as part of the mitigation as it would still keep its national significance whether the road or only the ditches survive
- Enclosures could be scored High (settlement activity likely) if clear that they were used for settlement. If as was the case on a number of occasions the only

information available is that they were enclosures, then they were scored Medium C as default – see above

- Marching/temporary Camps - score Medium and B – ie may contain shallow negative features in the form of temporary buildings (may also include pits for latrines and refuse). They would retain their national significance and B.
- Vallum associated with Hadrian's Wall – score Low and B as just deep truncated ditch likely to survive but will retain its national significance and B.
- Boundary banks, ridges, lynchets, field systems etc where no earthworks or upstanding remains survive should be scored Low as 'site substantially damaged', or only deep negative features will survive (unless evidence suggests otherwise) and B as a valid assumption. If the description says that banks existed when scheduled but they are not there now then national significance is also dropped to Local C as one of the main features of their scheduling has gone. This would trigger National Survey Type C instead of mitigation to see if site is worth mitigating. If no banks when scheduled then significance will not have changed therefore kept as National B.
- Causeswayed enclosures or cursuses would score Low for survival and B as only deep negative features are likely to survive unless evidence to the contrary (eg could also score High if important contents have been found in the ditches). They would retain their National Significance (B)
- Dykes/Defensive ditches (ie no earthworks) would score Low B as only deep negative features survive but would keep their national significance (B) as will have been scheduled as being dykes without earthworks and in many cases are part of a larger defensive network
- Large-scale defensive systems scheduled as bank and ditch and no bank now survives scored Low as only deep truncated features would survive (B) but would keep National significance as they are part of a larger defensive network.

4.3.6 This section also contained a tick box as to whether fieldwork had been undertaken on the monument. Mostly this data was taken from the English Heritage National List description, although it is possible that not all incidences were picked up. Occasionally evaluation trial trenches or evidence of other forms of excavation was seen on aerial photographs, or the landowner/farmer may have provided this information. It was not usually clear on larger monuments where the work was undertaken so where a monument covered several fields the tick box was ticked for all. Much of the fieldwork undertaken, especially on barrows was undertaken in the 19th century, with varying degrees of record taking.

Assumptions for further survey

4.4.1 As discussed in section 3.9 in the main text, there are three forms of further survey recommended:

- Survey Type A – where earthworks have been identified post-1990 but not seen on latest aerial photographs – a tick box flags these monuments. Further survey could include further aerial reconnaissance under conditions which will maximise the potential to identify earthworks, or original Lidar data could be checked.
- Survey Type B – recommended at the Archaeological Scoring stage to provide further information on the monument but where there is still enough information available to score the risk. There is a tick box to indicate that this may be desirable. The type of survey will depend on the type of data lacking and it should be clear what is needed in the database entry.
- Survey Type C – this type of survey/further work is needed to be able to make a judgement as to whether mitigation is actually worth while due to a suspected

reduction in survival and therefore significance of the monument. An overall pre-mitigation score of C, if cultivated, acts as the trigger for this. The type of survey will depend on the type of data lacking and it should be clear what is needed in the database entry.

4.4.2 Survey Type B is often required:

- where area of scheduling does not correspond with the earthwork or cropmark
- there is insufficient information within the National Heritage List to make a considered judgement on survival and significance. This was most applicable to monuments scheduled earliest and often the only information to go on was 'Sites' or 'Cropmark site' or 'Enclosure'. These were scored with a default score and taken through to the mitigation phase
- other general issues needing clarification

4.4.3 Further Survey Type C to inform whether, and what mitigation, is needed for the following reasons:

- the National Heritage List mentions that the monument was scheduled as an earthwork feature but earthworks no longer survive suggesting that the monument may have lost is significance and may be a candidate for descheduling and no mitigation
- further information is needed specifically on survival in cases where previous management may have already destroyed much of the monument

4.4.4 The overall pre-mitigation score would be C (if cultivated) for these monuments as this uncertainty would over ride all other Confidence ratings and trigger the need for Further Survey as part of the mitigation. If the field is uncultivated then Further Survey would not be necessary and the pre-mitigation is scored A or B depending on the circumstances.

4.4.5 Sites requiring Further Survey Type C can have overall scores of high and low depending on the other variables scored. The vast majority of those requiring further survey are scored Low survival (B) and Local significance (C) reflecting the fact that from the evidence it is likely that the survival of deposits of significance is likely to have been compromised eg where earthworks are no longer present. Other scores and confidences will be different depending on the likelihood of survival, the type of archaeology and the nature of the questions that the further survey needs to address.

4.5 *Summary and Final Score*

4.5.1 Based on the confidence ratings used throughout the pre-mitigation model an overall confidence rating is manually inserted when all scores are complete. This confidence rating is not based on numerical values but a judgement given that some As and Cs are more significant than others. For example, if the questionnaire was filled out fully by the farmer/landowner then the overall confidence rating would probably be A unless discrepancies were noted. Where it was filled out from aerial photographs the overall Confidence would usually be B unless other factors over-ride this. Also, for example, if the Archaeological score was C leading to an overall pre-mitigation score of C, it is likely that further work would be needed to inform the mitigation stage, regardless of how many other As and Bs there were (see above).

4.5.2 The post-mitigation confidence score will be the same as the pre-mitigation score if no mitigation is recommended – ie no change is needed or if survey is required. If a positive change is recommended and mitigation applied, then the post-mitigation confidence will be A as it is assumed that if this change occurs then the change in risk or lack of risk, is certain.

4.6 *Mitigation*

4.6.1 The assumptions for applying the different forms of mitigation are based on the work of the Trials project and the main ones include:

- Clay soils would not be suitable for minimal tillage or direct drilling (although it is often suggested that this is checked on the ground as years of improvement may have changed the soil structure)
- If earthworks present only direct drilling would be recommended if soils and slope suitable (ie scores low and minimum for water erosion risk). If soils not suitable then reversion or extending headland/horizontal buffer would be only option
- Where possible mitigation that involved the creation of small grass islands in the middle of large fields was avoided, but sometimes this was unavoidable

4.6.2 The database allowed a suitable mitigation option to be chosen. If reversion or 'expand existing [horizontal] buffer/headland' is chosen this alters the pre-mitigation management score accordingly as long as the Site Intrinsic harvest score on this page is altered to No Cultivation'.

4.6.3 Normal plough depth has not been used as mitigation. Shallow plough depth could be suggested in exceptional circumstances but this would not offer sustainable protection over time as it has been shown in Trials that any techniques involving soil inversion will gradually erode the soil. Ley with minimal tillage/direct drill would be recommended where the field is already ley but where the recommendation would be to continue the ley but to use either direct drill and minimal tillage, depending on whether earthworks or not, if ever cultivated again or cultivated for reseeding.

4.6.4 Where possible the mitigation chosen would allow the monument to be kept in cultivation, unless an easier option presents itself. For example, the monument may lie within a small strip along the edge of a large field that would be suitable for minimal tillage. In this case however, 'expand the existing headland' option may be the more sensible option.

4.6.5 In some cases two forms of mitigation were suggested for example, if an earthwork is clipped then 'expanding the exiting horizontal buffer' will usually be used, perhaps with minimal tillage or direct drilling for the rest of the monument.

4.6.6 Whilst the mitigation option itself is kept simple there are a raft of assumptions/statements that also apply, for example:

- no subsoiling below the depth of the cultivation soil, especially important in fields which have been ley and are brought back into cultivation
- no roots should be grown
- the Defra Guide to Good soils management procedures should be followed to reduce harmful effects such as rutting and compaction (Defra 2011)

4.6.7 With regards subsoiling it should be clearly stated that soil "loosening" is a suitable alternative, especially where fields have previously been ley and for the removal of rutting, wheelings and compaction pans.

Appendix 2
Typical letter and Questionnaire

Address

9th May 2012 Ref No 1001880A/B

Dear

Re: Farmers are crucial to the management of our scheduled monuments and English Heritage needs your help.

We have been asked by English Heritage to assess the condition of all scheduled monuments which have been identified as 'potentially' being at risk from arable activities. The project is aimed ultimately to better target financial incentives for those sites that need it so that more benign management of these nationally important monuments can be encouraged where necessary. I have enclosed an article which I hope will shortly appear in your Regional NFU magazine which explains a bit about the background and aims of the project.

To contribute to this project we would like you to fill in a simple questionnaire on past, current and future management of the scheduled monuments (s) on the land that you own. This (these) are shown on the accompanying map(s). The questions will only relate to the field(s) identified on the enclosed map, but if the monument falls over more than one field then additional answers will be required for each field.

If you would like more detail on the monument(s) please follow this link (http://list.english-heritage.org.uk/advancedsearch.aspx#). If you type in the number in the bottom right hand corner of the accompanying map (minus any letters on the end) in the appropriate place this should take you directly to the description. If you are unsure what your obligations are regarding scheduled monuments and advice on how any damage may be minimised please follow this link (http://www.helm.org.uk/server/show/category.19665).

You can either fill in the paper copy of the questionnaire enclosed here or email or phone my colleague Jill Hind (j.hind@oxfordarch.co.uk, 01865 980756) for a digital copy. If neither of these options appeal then you could telephone Jill Hind who will fill it in on your behalf with you (on 01865 980756). Similarly if you have any queries or require further clarification then please do not hesitate to contact Jill.

We would be very grateful if you could complete your questionnaires within three weeks of receipt of this letter. If you feel strongly that you do not want to take part in this study, please let us know by return post and we will make no further attempts to contact you, otherwise we will send a reminder in a few weeks. Participation in the study is voluntary.

As the landowner, we will contact you in the first instance. However, if your farm is tenanted and you feel that it is more appropriate for the tenant to fill in the questionnaire, would you please pass this letter to him/her and at the same time send us their contact details.

Thank you for taking time to read this letter. We hope that you will agree to participate in this study.

Yours sincerely

Klara Spandl
Project Manager

The enclosed map(s) shows the monument(s), their overall numbers and the field numbers, if they spread over more than one field. For each monument and field can you provide information on the following:

No.		Monument	Monument
1	Is the monument indicated on the enclosed map (the hachured area in the map insert) under arable, part of an arable rotation or likely to be so in the next 5 years? If yes please fill in the questionnaire below. If no please say what landuse is practised on the monument.		
2	What type (inversion/non-inversion/direct drilling) and depth of cultivation is undertaken on this monument		
3	Has it been cultivated to a greater depth in the past - if so approximately how deep		
4	Has the monument a) recently been sub-soiled or pan busted or b) likely to be so in the near future	a) b)	a) b)
5	Have you a) recently or b) are you planning to insert/replace mole or pipe drains over the monument	a) b)	a) b)
6	Has the monument a) recently been de-stoned or b) do you have plans to do this in the near future?	a) b)	a) b)
7	Describe any bulking up of the soil you may have carried out		
8	What crops have you a) recently grown over the monument? or b) are planning in the future (combinable crops, roots, potatoes crops, energy crops, short term ley or permanent pasture)?	a) b)	a) b)
9	Have roots, or potatoes or energy crops been grown on the monument in the past - state which		
10	If none of the above crops are relevant state alternative here		
11	Do you treat the rest of the field away from the monument any differently - in terms of cropping/cultivation or any of the issues above? say how		
12	Does the monument consist of earthworks, if so how high are they approx.		
13	How long has the monument been in cultivation, approximately?		
14	Which of the following soil type occurs within the area of the monument (please tick which ever applicable)	Peat Silts/Sand Loam Sand/silt clays Clay	Peat Silts/Sand Loam Sand/silt clays Clay

Please reference the question number and fill in any extra details that wouldn't fit in the above table and continue overleaf if necessary.

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