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Measuring the minerals industry's contribution to biodiversity

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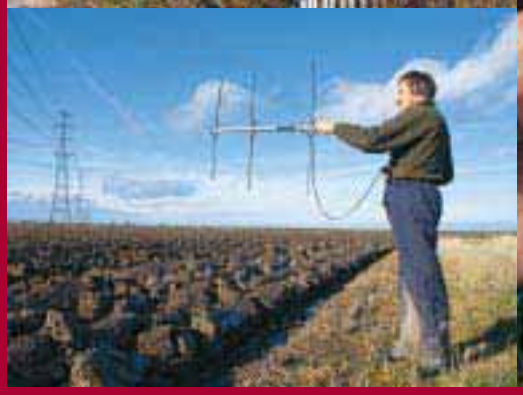

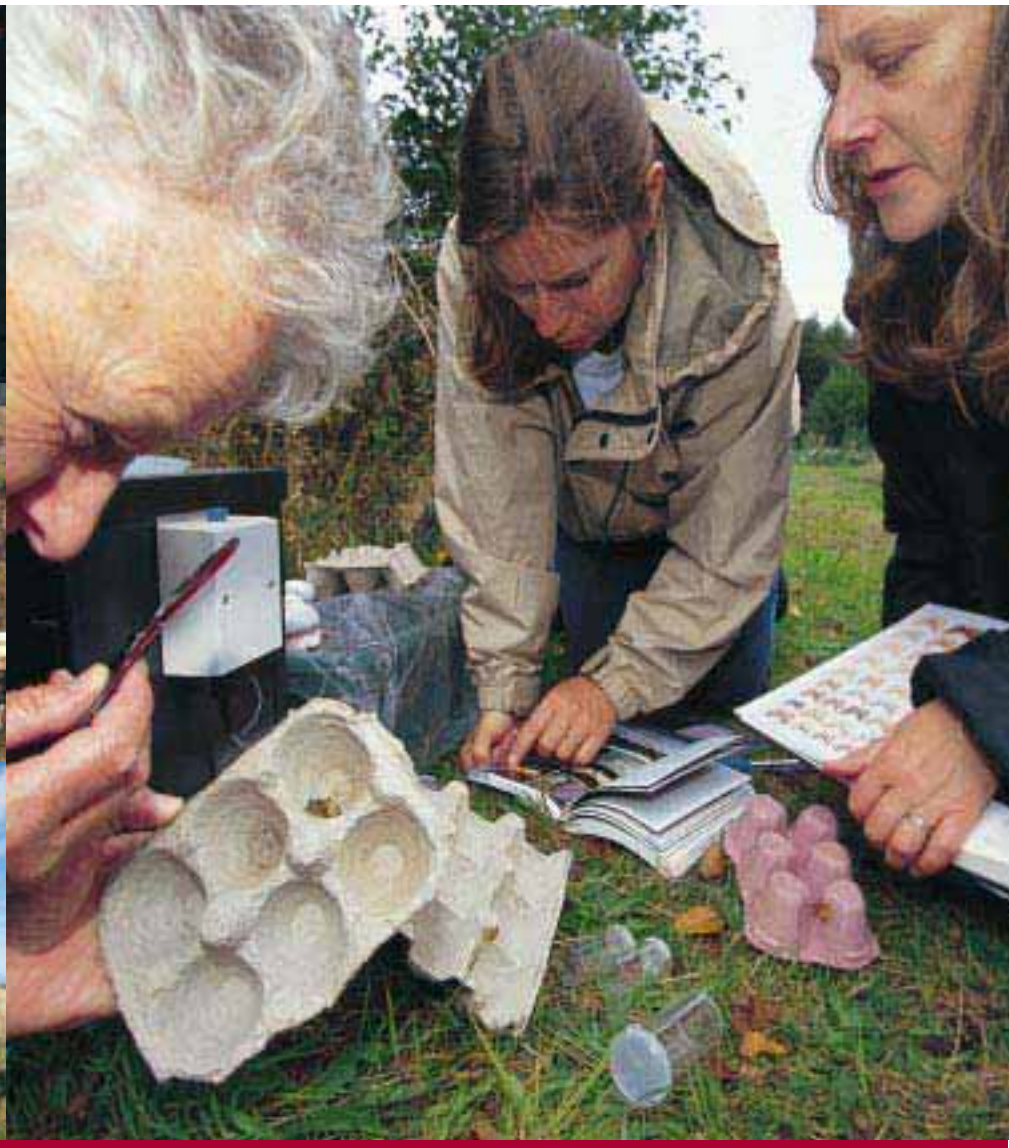

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English Nature Research Reports

Number 594

Measuring the minerals industry's contribution to biodiversity
Part A – Evaluation of techniques in pilot study areas
Part B1 – Biodiversity audit – White Peak
Part B2 – Biodiversity audit – Northamptonshire Vales

Prepared by
SLR Consulting
on behalf of
The Minerals and Nature Conservation Forum, comprising English Nature,
The Quarry Products Association and The Silica and Moulding Sands Association

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Foreword

This report has been prepared under contract to the Minerals and Nature Conservation Forum. Founded in 1994, the Forum, comprises representatives of aggregate and silica sand producers, through their trade associations, and English Nature. It works to raise awareness and promote action for biodiversity and geodiversity in England's minerals industry.

This report was commissioned by the Forum in recognition of a need to develop a methodology that could be used to assess the overall impact of aggregate/silica sand extraction in any given area. This product would be useful primarily at a strategic planning level, but also in directing more local decisions on quarry location and restoration schemes.

Quarrying has by its nature impacted on England's wildlife and biodiversity. Active quarries can provide habitats for wildlife populations, but in most cases, operational areas are likely to have significantly different and lower wildlife value than the original land. When quarrying ceases, land may revert naturally, or through designed restoration and re-creation schemes, to habitat capable of supporting a diverse wildlife population. In most cases however, this will be a different habitat or biodiversity value to the original land.

Previous studies have highlighted both the adverse impacts, and the actual and potential contribution of quarried land, both operational and non-operational, to the wildlife resource of a local area. However no studies have fully quantified the net biodiversity gains or losses arising from quarrying, or determined whether the activity was sustainable in wildlife terms. This pilot study aimed to identify a habitat and species 'balance sheet' for two mineralogically different areas, one dominated by hard rock quarries, the other by sand and gravel pits. The study also aimed to develop a GIS based approach, as the best way of capturing landscape-scale data.

The Research Report sets out the findings and views of the contractors, which are not necessarily those of the Minerals and Nature Conservation Forum. We do however believe this research is a useful first step toward a more developed product. Further research and development, to be carried out over the next year, will take forward the ideas in this report with the aim of providing a robust and widely applicable methodology that can be used alone, or in conjunction with, existing systems for assessing biodiversity value.

Dr Tom Moat
Chair of Minerals and Nature Conservation Forum

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Executive summary

The extractive industries have, in both positive and negative ways, undoubtedly influenced the biodiversity of this country over many centuries. As the scale of mineral extraction has increased so has the potential for positive and negative impacts. Previous studies, including those required through the planning process, highlight actual and potential impacts and potential contributions to biodiversity. However, to date there has been no attempt to fully quantify the true gains and losses across time. The industry and its regulators will only be able to clearly determine and predict the sustainability of their activities in biodiversity terms through a quantitative assessment.

Working closely with specialists at English Nature and practitioners from the aggregates industry (working together as the Minerals and Nature Conservation Forum) it has been possible to develop a methodology to assess the extractive industry's contribution to biodiversity. The method has been refined and tested through a pilot study of two contrasting areas of mineral extraction: the White Peak area that hosts the limestone hard rock industry in Derbyshire and Nene Valley, that hosts the sand and gravel aggregates industry in Northamptonshire. These studies are reported[1,2] separately.

There are many sources of biodiversity data that could be utilised for some form of analysis at the local or regional level. However, it was the aim of this project to establish a technique that can be adopted anywhere in the country and emphasis was placed upon the availability and consistency of data. The use of UK-wide standardised datasets allows analysis and comparison of the results of studies across regions and different sectors of the industry. Table 1, below, summarises the data that were considered suitable for the pilot studies.

Table 1 –data used for biodiversity assessment

Data Source	Biodiversity Feature Measured
Land Cover Map 2000 (CEH)	Broad habitat type
SSSI, NNR, SAC and SPA digital boundary data and citations (English Nature)	Sites recognised as of high biodiversity value and often supporting populations of notable species.
County-designated wildlife sites; collected and stored in different formats for each county.	Sites recognised as of high biodiversity value.
UK BAP Priority Habitat Inventories (English Nature, work in progress)	Areas of habitat recognised as of national biodiversity importance.
Species specific data, available from biological records centres and other sources	Used to describe the association of specific species with minerals sites

[1] Measuring the Minerals Industry's Contribution to Biodiversity Part B1: White Peak
[2] Measuring the Minerals Industry's Contribution to Biodiversity Part B2: Northamptonshire Vales

The assessment methods adopted in the pilot studies have made extensive use of geographic information systems (GIS) as a tool for collecting and analysing data. GIS is the obvious choice for analysis of this kind as it is capable of handling large quantities of spatially referenced data and is capable of making accurate area and distance calculations.

Within each pilot area, GIS datasets described in Table 1were interrogated to provide the following information:

- distribution and extent of all aggregates sites granted planning consent since 1947 within Countryside Agency defined Landscape Character Types;
- absolute figures for the cover (and proportion) of different broad habitat types within aggregates sites based upon satellite data (LCM 2000) for each pilot area;
- estimated figures for the change in broad habitats within consented aggregates sites, based upon a comparison with the surrounding landscape;
- distribution of statutory and non statutory wildlife sites and any overlaps with consented aggregates sites;
- distribution of priority habitat types (as available from English Nature) within or immediately surrounding consented aggregates sites; and
- distribution of selected species data in the study areas.

The quantitative information provided by GIS analysis was combined with a review of a number of restoration plans for consented workings and synthesised into a "balance sheet", showing a broad, qualitative overview of gains and losses to biodiversity over time, from pre-1947 to the next generation which has been taken to be 2033.

The balance sheets clearly show that both gains and losses to biodiversity have occurred in the past in both the Nene Valley and the White Peak Study Areas, when compared to a modern-day baseline, which represents a general decline in habitat quality in the post-1947 landscape. It is predicted that biodiversity gains will occur in the future as existing aggregates sites are restored and develop greater biodiversity interest.
The individual pilot study reports suggest that future losses to biodiversity can be minimised by:

- full consideration of biodiversity in the planning process;
- retention and appropriate management of remaining semi-natural habitats within aggregates sites; and
- the sensitive, nature conservation led restoration of existing aggregates sites.

With continued commitment to these points by both the industry and its regulators, it is considered that in the long-term, the industry can make a significant contribution to the biodiversity resources of the UK. The challenge remains for the industry to meet and exceed the predictions made for future biodiversity contributions.

The method described is seen as starting point for the long-term monitoring of the biodiversity contribution made by the aggregates industry. Monitoring biodiversity will be a key factor in determining the long-term sustainability of the industry.

Introduction

SLR Consulting Ltd (SLR) has been commissioned by English Nature, on behalf of the Minerals Nature Conservation Forum (MNCF) to undertake a study of the minerals industry's contribution to and impacts upon biodiversity.

Project outline

The extractive industries have undoubtedly influenced the biodiversity of this country over many centuries. As the scale of mineral extraction has increased so has the potential for positive and negative impacts. These effects may be negative, through the loss and disturbance to semi-natural habitats and populations of species, as extraction or waste disposal expands into new areas. Positive effects, resulting from habitat restoration or creation post-extraction; through the retention and management of high biodiversity areas; and the creation of geological exposures of conservation interest also occur. Previous studies, including those required through the planning process, highlight actual and potential impacts and potential contributions to biodiversity, but to date there has been no attempt to fully quantify the true gains and losses across time. The industry and its regulators will only be able to clearly determine and predict the sustainability of their activities in biodiversity terms through a quantitative assessment. Ideally, this assessment would have the ability to focus upon historical, current and future extractive activity.

This study aims to develop a robust methodology to assess the extractive industry's contribution to biodiversity. The method has been refined and tested through a pilot study of two contrasting areas of mineral extraction: the White Peak area that is occupied by the limestone hard rock industry in Derbyshire and Nene Valley, which is occupied by the sand and gravel aggregates industry in Northamptonshire.

Overall project bjectives

As set out in the brief for Contract No. PDD 119, the project has three main objectives:

1. to assess different techniques and data sources available and to develop a methodology suitable for future studies of this kind;

2. to follow and refine this method through a pilot study of two study areas; providing a comparison of losses and gains to biodiversity attributable to the extractive industry; and

3. to assess the actual and potential way in which the extractive industries in the study areas contribute to biodiversity and to identify wider messages for the industry and its regulators.

With these three main objectives in mind, the report has been split into two parts:

Part A describes the assessment methods and data sources that were considered for the study and provides a clear rational for the final assessment methods chosen. The findings of how practicable and effective these methods have been during the pilot studies is also discussed.

Part B presents the results of the pilot studies for the two study areas and discusses the implications for the industry and its regulators.

Report structure

The following methodology report has been divided into the following sections:

Section 2: Approach to Study
Section 3: Consultation
Section 4: Defining Study Areas and Minerals Sites
Section 5: Defining and Measuring Biodiversity
Section 6: Assessment Methods
Section 7: Evaluation of Techniques used in Pilot areas
Section 8: Summary and Conclusions

Approach to study

Background to approach

As set out in the brief, this study is to act as a pilot for future studies in other areas. As such, it has been important to examine the range of potential methodologies that are applicable, not only to the local resources of the two selected study areas but also to all areas throughout England. The brief also indicates that the methodology accepted should '*be as simple as possible and make maximum use of existing information/methodologies*'.

As there are currently no published methodologies or guidance for undertaking quantitative biodiversity assessments, such as the one required by this project, it was necessary that the variety of potential options were identified and their suitability assessed.

Defining the method

In order to design an effective, repeatable and clear methodology, it was important to consider and define the following key issues:

- What are the spatial and temporal boundaries to the study?
- What data will be used to define 'biodiversity'? and
- How will these data be analysed?
- How will it the data be presented?
- How will potential and actual effects be quantified?

Particular emphasis has been placed on developing a methodology that can be consistently used in different regions of England and potentially widened to encompass different sectors of the extractive industry. It was also important to design a method that allows analyses to be repeated in the future to monitor change and progress in each study area.

The methodology described has been developed through an iterative process; using two pilot study areas, it was possible to test both ideas and assessment methods. The final method presented has therefore been tested to ensure that it can deliver its key objectives.

Consultation

Consultation has played a very important part in defining the methodology and what types of biodiversity data would be used. Appendix 1, Table A1 lists those organisations and individuals contacted.

Individuals and organisations were consulted by telephone on a variety of topics. These included the availability of biodiversity data, background data used in defining study areas and mineral extraction sites.

In addition, the Steering Group, composed of English Nature staff and representatives from the mineral industry, has also played a vital role throughout the project. In particular:

- defining the scope of study;
- providing discussion on the variety of assessment methods;
- providing biodiversity data for the pilot studies; and
- commenting on drafts of the reports produced.

Defining spatial and temporal boundaries

Defining study areas

A key requirement of the methods chosen to answer the project brief was to provide a clear definition of the spatial boundaries of study areas. The project brief stated the method chosen should be compatible with national and regional biodiversity initiatives, which are set on a variety of spatial scales. It was also considered that a method that had the potential to highlight regional variations in the minerals industries contribution to biodiversity would also provide benefits for the study and therefore it was decided to split the country into discrete geographical-based study areas.

It is considered that there are a number of ways in which study areas can be selected, broadly defined as either administrative regions or biogeographical areas. A discussion of the relative merits of these two approaches is presented in Appendix 2.

A biogeographic approach has certain advantages over the use of administrative boundaries and for these reasons an approach based upon Natural Areas was recommended by the Steering Group. The approach based upon Natural Areas has been refined using the Countryside Agency's Landscape Character Typology because of the clear scientific and practical advantages this presents. In particular, geology and topography are key determinants of biogeographic area and therefore the dominant form of mineral extraction may well be defined by these same biogeographic boundaries. A further advantage is that biodiversity analysis can be targeted towards habitats and species characteristic of a particular biogeographic area.

Defining a minerals site

A clear definition of the spatial and temporal extent of a Minerals Site is essential for the study as it provides the basis for a repeatable and nationally applicable method. A full review of the process of defining a minerals site is presented in Appendix 2. For the purposes of this study a minerals site has been defined as "*an area of land with a current or expired planning permission for the extraction of aggregate minerals*".

Habitat classification systems

A wide variety of different habitat classifications exist and could potentially be used for this study. These include:

- UK Biodiversity Broad Habitat Classification;
- European CORINE[3];
- JNCC Phase 1[4] habitat; and
- National Vegetation Classification (NVC) Communities.

It was agreed to base the study upon a single classification system, wherever possible, to allow direct comparisons between study areas.

Through discussion with English Nature staff it was concluded that the measurable aspects of biodiversity to be included in such an assessment should be based upon the UK Biodiversity Broad Habitat Classification. This classification divides all terrestrial and maritime habitats in the UK into 28 broad types, including 18 terrestrial habitats. Further sub-divisions of these habitats has been undertaken to define the 45 UK BAP Priority Habitats.

Other habitat classifications were considered as alternatives. However, the UK BAP Broad Habitats provided advantages over these other systems. Significantly, they can be directly related to UK BAP Priority Habitat targets and, due to the existence of a UK-wide dataset based on this classification (LCM 2000, described below), can provide the basis for a UK-wide quantitative approach to measuring biodiversity. In addition, most reporting against BAP targets will use this classification, allowing direct comparison and quantification of any losses or gains against UK, England and local targets.

A disadvantage of the Broad Habitat classification is, however, its coarse habitat divisions. These divisions are too broad to differentiate between those habitats of nature conservation interest and those widespread and abundant habitats of lesser interest. For example, the Broad Habitat of Broadleaved, Mixed and Yew Woodland does not differentiate between ancient, species–rich upland ashwood and recent mono-specific sycamore wood, despite major differences in their contributions to biodiversity. Another example is the lack of differentiation between species-rich and species-poor neutral grasslands. It would also not be possible to tell whether a rock face supported a semi-natural cliff face community of biodiversity importance or was worked mineral face using the broad habitat divisions as a baseline. A similar situation may arise in the case of sparsely vegetated spoil heaps, such as

[3] CORINE Biotopes manual, Habitats of the European Community. EUR 12587/3, Office for Official Publications of the European Communities, 1991.
[4] See JNCC Handbook for Phase 1 Habitat Survey (1990) for a description of classification and survey message.

those that support metallophyte plant communities, which may be defined as bare ground or bare rock.

It was considered, therefore, that a further division of habitat type maybe required to ensure that habitats of biodiversity interest were picked up. It was decided that the definition of "priority habitats", defined under the UK BAP would be the most suitable finer scale division. Currently, there is no data source that has accurately defined the extent of UK BAP Priority Habitats, although this work is in progress by English Nature and due to be finished in Spring 2004.

Defining and measuring biodiversity

Background to biodiversity conservation

The Convention of Biological Diversity, signed by the UK at the Rio Earth Summit in 1992 was the starting point for the concept of biodiversity conservation,iethe protection of all life forms in the wider living environment. Since 1992, national, regional and local strategies have been developed to conserve biodiversity, through the identification of species and habitats that are rare, threatened or endangered. Nationally, this process was started by the UK Biodiversity Action Plan (UK BAP) in 1994. It has been the subsequent development of regional and local Biodiversity Action Plans (Local BAPs) that have driven efforts to conserve habitats and species that are important at a local level.

The Local Government Act 2000 establishes LBAPs in Community Strategies, so linking them clearly with what are now Local Development Frameworks. This links biodiversity action clearly within Minerals Planning. The 2002 England Biodiversity Strategy has taken this further by calling in all sectors of activity, including minerals, to embed biodiversity action into their work.

BAPs, at the national and local level, aim to achieve the following:

- to focus conservation action onto species and habitats considered to be most at risk at an international, national or local level;
- ensure that locally and nationally uncommon habitats and species are protected from unnecessary lost or damage;
- make provision through habitat creation to extend the resource of BAP habitats where there is not currently considered to be enough; and
- encourage appropriate management of BAP habitats, bringing unmanaged areas into management.

BAPs have specific, measurable targets which mean that value and success of BAP policies can be determined.

Definition of biodiversity

As the main aim of the study is to examine the losses and gains to biodiversity through the activities of the minerals industry it is essential that what actually constitutes 'biodiversity' is clearly defined.

Biodiversity, derived from the phrase 'biological diversity', is defined as all life forms on the planet, eg mammals, birds, amphibians, fish, insects and other invertebrates, plants, fungi and micro-organisms. It is obvious from such a broad definition that it is not possible to undertake a full "biodiversity" assessment of each study area.

In this instance, a range of options were considered as to what was practical in terms of measuring biodiversity for the purpose of this study. Consultation with relevant experts was undertaken to assist with this definition.

Measuring biodiversity

Due to the impossible nature of the task of measuring all 'biodiversity', it was decided that a suite of biodiversity indicators would be defined and measured. A major limit to the methodology being developed was that it should not require field survey to collect information. Therefore all biodiversity information had to be available from existing data sources.

The selection of biodiversity indicators

Biodiversity Action Plans (BAPs) have been prepared on a national and in most areas, local scale. National and Regional BAPs identify species and habitats that are conservation priorities eg are declining, threatened or rare; Local BAPs also include species which have particular local distinctiveness. The species and habitats selected for BAP therefore provide only a very limited picture of biological diversity as a whole. Through discussions with the steering group and biodiversity specialists at English Nature it was agreed that a more general approach be adopted that encompasses 'biodiversity' in the wider sense.

The aim was to develop a suite of biodiversity indicators that can be adopted nationally; but with enough flexibility to allow minor modifications (such as the removal of some indicators and addition of others) to reflect local priorities.

The availability of good quality information was considered a priority in the selection of biodiversity indicators and the following section discusses the availability of biodiversity datasets.

Biodiversity data

Biodiversity data are collected by a huge range of organisations for an equally diverse range of reasons. For the purpose of defining the methods of study, it was considered important to consider the widest possible range of data sources and select those which provided the most suitable data for analysis. A full description of the different data types available for the pilot study areas and a rationale for final selection is provided in Appendix 3.

Table 2 –Data types and sources available for the Pilot Studies

Type of data available	Specific datasets used for study
Comprehensive habitat inventories	Land Cover Map 2000
Designated site inventories	SSSI, NNR, SAC, SPA and Ramsar site boundaries
Minerals sites biodiversity inventories	Specific ecological survey for ES
Priority habitat inventories	EN priority habitat inventories for ancient woodland, lowland grassland, upland and lowland heathland.
Survey inventories and anecdotal records for species	Specific datasets for each study area from local record centres, English Nature etc.

Assessment methods

The methods of assessment recommended to measure the minerals industry's contribution to biodiversity have been developed through consultation and through a number of trials using the biodiversity information collected for the two pilot study areas, the White Peak and Nene Valley.

Assessment methods adopted have made extensive use of GIS as a tool for collecting and analysing data. GIS is the obvious choice for analysis of this kind as it is capable of handling large quantities of spatially referenced data and is capable of making accurate area and distance calculations.

Different assessment methods have been developed for each biodiversity feature described in Section 5 and Appendix 3. The following section describes the assessment method selected and, where appropriate, refers to Appendix 4 where a description of other methods that were considered as alternatives is presented.

Broad habitats

Two different approaches to the assessment of broad habitat losses and gains were considered. These are:

- estimated habitat analysis; and
- historical comparison analysis.

Following discussions, consultations and preliminary trials it was agreed that the estimated habitat analysis provided the most robust results. See Appendix 4 for a description of the historical comparison analysis.

Estimated habitat analysis

The broad habitat analysis was undertaken as a comparison of the current habitats present within minerals sites, as defined by the BGS minerals planning data) with the baseline proportion of broad habitats currently found in the surrounding Landscape Character Type (LCT). LCTs were thought to represent the closest biogeographic character to the typical character of extraction areas and therefore would provide the most useful comparison. This

analysis provides an indication of the current contribution that minerals land is making to the overall habitat diversity of the LCT.

The second part was to provide an estimate of the area of broad habitat that has been gained and lost as a result of the operation of the minerals site by calculating the percentage change in proportion of the broad habitat types present within a mineral site and the direction (increase or decrease) of that change. For instance, if the mineral site contains 2% woodland in 2000, and the surrounding landscape contains 4% woodland; 2% of the woodland cover that would have been present within the mineral site is deemed to have been lost.

The estimated gain or loss was calculated on the assumption that broad habitats occur in the same proportion throughout the landscape type, regardless of inter-type topographic, climatic and edaphic conditions. This calculation also assumes that all aggregates extractions contained the same proportion of habitats as the surrounding landscape prior to extraction. These generalisations of habitat homogeneity represent a potential short-coming of the technique. However, they do provide a benchmark to make general comments on the likely broad habitat gains and losses that have occurred as a result of aggregate extraction. In reality, the actual habitats gained or lost could only be calculated by a detailed analysis on a site by site basis.

This methodology ensures that habitat losses or gains arising from the mineral industry are compared to those losses or gains that have occurred in surrounding countryside of similar character.

Designated sites

The boundary data available for nationally and internationally designated sites (SSSI, NNR, SAC, and SPA) were analysed using GIS. The co-incidence of minerals planning area polygons with designated site polygons was assessed and the areas of designated sites within mineral planning areas were reported. In addition, the incidence of designated sites within a 100m buffer of minerals sites was also recorded to indicate other designations that have the potential to be influenced by minerals extraction.

Many SSSIs were selected between the 1960s through to the 1990s. SACs and SPAs have only begun to be identified in the last 10 years. A potential shortcoming of the use of designated sites to measure change in biodiversity is that it would be impossible to measure the area of habitat that was of SSSI, SAC or SPA quality that had been lost prior to the 1960s.

The analysis of this information provides an indication of the number and area of nationally designated sites that are under the influence of the minerals industry. Citations for SSSI and SAC sites were examined to assess whether any losses or damage to these sites had occurred as a result of the minerals industry, although this information was not consistently recorded. Citation and other ecological information for designated sites can also used to assess whether nearby minerals sites have had a positive effect upon these sites, either through management, exposure of rock strata, or protection from agricultural improvements or whether effects had been adverse, such as the direct loss as a result of mineral extraction or indirect effects such as dust deposition or disturbance.

Where digital polygon data is available for county-level designated sites, these can be analysed using the same methods described above. In the event that only point data,ieNational Grid References, are available then a simplified method is suggested, whereby the coincidence of points with minerals sites, or within a 100m buffer zone, are considered as being potentially effected by the minerals site. Supporting information about these sites is needed to assess whether effects of the extractive industry are positive, negative or neutral.

Priority habitat inventories

Priority habitat inventory data is available in GIS polygon boundary format and therefore an approach similar to the one described for designated sites was used. The coincidence of priority habitats with minerals sites boundaries was analysed and compared with the proportion of these habitat types within a Study Area as a whole.

The loss, gain or retention of priority habitats within mineral extraction areas can be inferred by this method. Where the boundary of a priority habitat has been curtailed by the extraction area, this would be stated and the amount of priority habitat lost would be determined. The inclusion of priority habitats of semi-natural origin within non-operational land within minerals sites would infer the retention of these sites and therefore would be interpreted as no net loss. Additional data and descriptions may be required for priority habitats to assess whether they are remnants of previously more extensive areas. Where priority habitats of secondary origin are identified within minerals sites, these would be interpreted as a net gain of habitat.

Species specific data

The approach taken with species specific data was to overlay this information with minerals sites boundaries and describe the presence of notable or indicator species within a minerals ownership boundary; where possible classified as present within active, restored or non-operational land. The areas which provide important habitats for notable species would also be described based upon an understanding of the habitat preferences of indicator species.

Where records of indicator species are sufficient to show the loss or gain of a species that is directly attributable to the presence of the minerals sites, this will be stated and the circumstances of loss or gain described or inferred. For instance, data for a Nene Valley gravel pit may show a population of marsh fritillary butterfly was known from records to be present prior to extraction, but as a result of a loss of meadow habitats to the industry, the population has not been recorded since. This would suggest local population extinction. In contrast, recent records of wildfowl and wading birds on restored gravel pit lakes and wetland habitats would represent a biodiversity gain to the site, following restoration.

Projected losses and gains

Making any predictions of future gains and losses beyond those operations that are already consented would be highly speculative as the industry is heavily influenced by changing policy, legislation and national and local economics.

It is, however, possible to evaluate, in each geographical area of study, the planning policies that apply to this area that relate to mineral extraction and biodiversity. This provides a broad outline of the potential impacts that could occur (positive and negative) through quarrying in this area. A review of such policy would provide a guide to what trends could be expected in the future.

Known future losses through detailed analysis of the habitats within consented areas of extraction that are yet to be worked could provide a projected figure for areas to be lost or impacted upon. Such detail would however require in depth analysis and data interpretation for each individual site which would be inappropriate for a study that is looking at broad trends across large geographical areas.

Future gains could be predicted through analysis of restoration plans for individual sites. This has been undertaken within the study areas through a review of documented restoration schemes for a small number of quarries within each study area. This review aims to provide an overview of the broad trends and types of restoration currently promoted by the minerals industry.

Conclusion

There are no suitable datasets available to make a direct comparison of losses and gains to broad habitats within minerals sites for the timescale set (1947). The use of the estimation method based upon the LCM 2000 data and described above, does however provide a statistical based method that concentrates on a single data set, of known accuracy (90%). The methods used for LCM 2000 are highly likely to be repeated in the future, with potential for future monitoring studies to be undertaken, using similar methods.

An analysis of designated sites and priority habitats described above will provide additional information on important aspects of biodiversity. These datasets lend themselves to a descriptive analysis, based upon their coincidence with minerals sites.

The variability in collection methods and lack of availability of species data for most of the UK means that assessing losses and gains quantitatively is not feasible at present. However, the coincidence of species records with minerals sites will be used in the pilot areas to provide a description of the species that are associated with these sites and the nature of that association.

Evaluation of techniques used in pilot areas

Through the trial of the methodology developed in two distinctly separate areas in terms of location and types of mineral extraction it has been possible to identify the strengths and weaknesses of the techniques adopted. In the following sections some of the implications of adopting these methods are set out.

Availability of data

One of the key aims of this project was to establish a technique that could be adopted across the whole of England and be comparable between study areas. As such it was necessary to consult widely to establish the nature of data that could be obtained to fulfil this requirement and how it could be interpreted.

Broad habitat data

As detailed, in earlier sections of this report, there is little consistency with the level of biological recording across the UK and therefore it was decided that the baseline data to be used for this project would be that provided by the Land Cover Map (LCM 2000), a habitat classification based upon satellite data.

These data are available for the whole of the UK and are compatible with a number of GIS packages. They are also held by English Nature which has used them as the basis of a number of habitat inventories such as lowland and upland heathland. Their adoption by English Nature and their use in determining land-use change across the UK by the government agencies ensure that they are likely to remain available and to be repeated in the future.

The pilot studies have highlighted some limitations to the LCM 2000 as the main source of habitat data for this study. LCM 2000 was collected as a national dataset, designed for interpreting macro-scale (Regional-National) levels changes in land use. However, some shortfalls in the accuracy of the dataset have been highlighted by this study, namely:

- the use of an "acid sensitivity" map to define grassland type, which may have led to misclassification of neutral and calcareous grasslands;
- the pixel size of 25m^2 which means that small habitat patches such as ponds and ribbon habitats are not classified;
- the misclassification of complex landscapes and habitat mosaics, such as small field patterns with dense hedgerow and tree cover as woodland and scattered scrub as calcareous grassland; and
- potential misclassification of habitats in areas of steep topography, eg dale sides, or cloud cover.

Results based upon the LCM 2000 should therefore be interpreted with these shortfalls in mind.

Other sources of biodiversity data

Details on the boundaries of statutory wildlife sites are also available in GIS compatible form from English Nature. Digital boundary data for non-statutory sites are increasingly available from local planning authorities, many of which use such systems in their land-use planning role.

Other biodiversity data tend to be limited and judgements on whether they are relevant or indeed useful to such a study needs to be made based upon the quality and format of such records in the locality.

Other sources of biodiversity data that may be useful to similar studies include:

- BSBI plant records;
- WeBS bird survey data;

- Hawk and Owl Trust raptor surveys;
- Bat Conservation Trust records;
- County Flora survey data;
- The Herpetological Society records; and
- county and national biological recorders for invertebrates, birds, mammals etc.

The usefulness of these different data sources will vary according to the level of recording effort that has occurred in the particular area and its storage as accurate geo-referenced data.

Though biodiversity data do exist from work undertaken for planning applications at mineral sites they tend to be varied in quality and format and are generally only available for more recent sites. Reliance on these data would bias a study of this kind towards more recent sites.

Mineral industry data

The collation of data on mineral sites could be carried out by mineral operators but this would require a large amount of co-ordination, time and effort on their part. Due to the commercial pressures of the industry, it is often not possible for individuals to spend large amounts of time pulling such information together. Further to this, the industry has been subject to many changes over the years in terms of mergers, take-overs and staff changes and, as a result, long-term records and staff involvement with individual sites is no longer guaranteed. Further to this, many of those sites within the study areas were controlled by operators that no longer exist meaning that any pre-existing biodiversity data and local knowledge may no longer be available.

Details of mineral site planning boundaries have been obtained from the BGS, which collates and holds such data for the whole of the UK in a form that is GIS compatible. This again, ensures that this dataset is likely to be available for future studies. This dataset is "work in progress" for the BGS and currently contains varied data from different planning authorities. For this study, data required extensive interpretation and consultation with minerals operators to ensure a consistent dataset was used. Despite the best efforts of the Steering Group, inaccuracies in the minerals planning source data remain, such as the misclassification of vein minerals as aggregates sites. It is therefore recommended that the aggregates industry develops its own register of all aggregates quarries for both past and current extractions.

Analysis technique

Once suitable biodiversity data has been sourced, and the boundaries of the study area and minerals sites have been defined, it is possible to interrogate them using GIS based analysis tools.

GIS provides a range of spatial analysis techniques suitable for handling and analysing large volumes of data geo-referenced data. GIS has the advantage that it also acts as a storage system for data sources, allowing further analysis to be undertaken using the same base data as new information is added. There is also potential for GIS-based techniques to be developed to provide statistically rigorous sampling methods. For instance, this may prove useful in a nationwide study based upon a sample of minerals sites.

Estimated time and data costs

Based upon the experiences gained from applying the methodology detailed in this report with those data sets available it has been possible to estimate the days required to undertake such work for similar sites with similar issues. Table 3 below breaks down the tasks and shows the estimated number of days required for the work. The estimate is based upon carrying out an analysis and providing a report similar to those shown in the pilot study areas based upon the data that are currently available.

Table 3A – Estimated time required for analysing biodiversity gains and losses through the minerals industry

Task	Days required
Data collection and consultation	1.5
Defining scope of study area and data to be used	1
Preparation and input of data into GIS	1
GIS Interrogation and Analysis	2.5
GIS Plan Preparation	2
Research and preparation of case study	2.5
Interpretation and reporting	5
Total	**15.5 days**

Table 3A estimates that a total of 15.5 days for a team of ecologists, mineral planners and GIS professionals would be typically required for the undertaking of such detailed data collection, analysis and interpretation studies. Table 3B estimates the charges made for datasets used in the study. Data charges are likely to be highly variable from region to region and dependant upon who is the owner or manager of the data. As an indication SLR incurred approximately £1500 of data charges for two pilot study areas, although many sources of data, including English Nature, Derbyshire Wildlife Trust, Derbyshire Records Centre and Staffordshire Ecological Record provided data free of charge.

Table 3B – Estimated data costs

Dataset	Source data owner/manager	Costs
Land Cover Map 2000	Centre for Ecology and Hydrology	£20,000 whole UK; or £4,500 per 100km^2; or £100 sub-contractor licence
Designated site data (SSSI, cSAC, SPA, NNR)	Country Agencies (English Nature, CCW, SNH)	Free (CCW may charge administration fee)
BAP priority habitat inventories	English Nature	Free
County Wildlife Site data	County Wildlife Trust, Local Authority or Biological Records Centre	Administration or consultation fee, usually approx. £200 per day
Species records	County Wildlife Trust or Biological Records Centre	Administration or consultation fee, usually approx. £200 per day
Specialist group species records (eg BSBI, Bat Conservation Trust, Hawk and Owl Trust)	Various	Highly variable. Estimated administration fee £200 per day
Aggregates planning permission data	British Geological Survey	Approximately £400 per Natural Area
Aggregate industry ecological information	Various aggregates operators	Free of charge

Following the experiences of the pilot studies, it is suggested that some components of this study could be reduced. The presentation of a separate case study, though useful in the trialling of the technique, is not necessary for the overall analysis and this could potentially be dropped from future studies, reducing the total time input to 13 days. Also, the use of standard GIS applications may reduce the time required for preparation of drawings, although it was noted that drawings generated directly from GIS required significant editing to aid interpretation and to provide a high quality image.

Interpretation of results

The results generated through the GIS interrogation should be interpreted with care. The use of LCM 2000 data is highly suited for large areas and strategic studies such as this but at the site specific level it can be relatively inaccurate as it uses large 25 x 25m pixels that can miss some of the fine details of smaller sites or linear habitats such as those associated with lake margins.

As LCM 2000 is based upon interpretation of the wider countryside it does not necessarily pick up some of the subtleties of vegetation cover in quarries that may have developed considerable interest. It is therefore essential that consideration be given to the potential biodiversity value of habitats such as 'Inland Rock' that may other wise be dismissed as being worthless. In addition, LCM 2000 has no facility to measure vertical or near vertical habitats, such as cliff-like quarry faces. The potential contribution of these habitats within the quarry environment is therefore underestimated. Due to the way in which LCM 2000 identifies land cover types it is possible that at the site level inaccuracies are magnified and some ground truthing may be required if detailed interpretation is proposed at this level.

As with all analysis of species data, it is essential that the constraints of the original data source, such as the extent of the survey and the methods used to collect and store information, are recognised.

The interpretation of nature conservation site information, eg SSSI, county-level wildlife sites, also requires care. Planning authorities and conservation agencies designate these sites upon the habitats and species present at the time of designation and therefore the historic extent of habitats of nature conservation importance cannot be directly measured. Designated site boundaries are revised to reflect current biodiversity interest in the event of loss of habitat, thereby preventing monitoring of changes in the extent of these sites over time.

Summary of study area pilots

The results of the analyses of both pilot areas are shown in detail in Part B of this report. In summary, and not unsurprisingly, there is a significant difference in the interpretation of biodiversity gains and losses between areas dominated by limestone extraction and sand and gravel extraction. Boxes 1 & 2 summarise the results of the research undertaken in each pilot area.

Box 1: White Peak Pilot Area

Limestone is the main aggregate extracted from within the White Peak pilot area (528 km^2) with much smaller amounts of dolerite. The area of permitted aggregate extraction since 1947 is 2802 ha, approximately 5% of the White peak itself. This comprises a total of 51 quarries, 24 of which are confirmed as being active. It is likely that many pre 1947 quarries have been amalgamated into more recent planning consents.

Analysis of change in broad habitats in the recent past (1947-2000) within aggregates minerals sites of the White Peak has shown that there has been:

- an estimated decline of 739 ha of low diversity agricultural land uses (improved grassland, arable and horticulture);
- an estimated decline of 320 ha of calcareous and neutral grassland;
- an estimated decrease of 67 ha of broad-leaved woodland; and
- increases in 1105 ha of quarry habitats (inland rock, built up areas and continuous urban).

The method used to estimate change is relative to a modern-day baseline,ieagainst the backdrop of general decline in habitat quality through agricultural intensification in the post-1947 landscape. It is estimated that other habitat types within minerals sites, including acidic grassland, dwarf shrub heath, bracken, standing water and coniferous woodland have undergone only minor changes in area in the recent past when compared to the surrounding landscape.

Approximately 4.6% of the consented aggregates minerals sites (as defined by the BGS minerals sites database) are designated as Biological SSSI. These 12 sites include three which have developed considerable biodiversity interest in former aggregate extraction areas. Many other sites are designated as geological SSSIs There are also, however, anecdotes of losses and damage caused to a number of such sites in the past. At the current time a number of mineral operators work with English Nature to manage these areas for biodiversity. A total of 13 county wildlife sites fall within the boundary of consented aggregate extraction sites. It should be noted that wildlife sites have not been designated within the Peak District National Park; although the National Park is considered to be a landscape of biodiversity importance. Some of these reflect the development of habitats in former mineral workings.

There are strong affinities between the distribution of great crested newt, and a number of rare plant species, with quarries in the White Peak. This is probably due to the range and rotation of temporary habitats that are suitable for these species in the quarry environment.

A shortfall of the analysis technique used is that it does not identify areas within the working or disused quarry such as undisturbed rock faces, scree and sparsely vegetated calcareous grasslands. Though these habitats form only a small component of an active quarry they predominate in abandoned sites and their value can in some instances be considerable, although the amount of time to develop such interest can also be considerable. Nevertheless, it is important that the value of such areas be recognised. For example, many active limestone quarries provide habitat for breeding peregrine falcon.

Due to the nature of modern limestone extraction many of the currently active sites have existed for tens if not hundreds of years in some form (initially as small quarries and borrow pits). Due to the volumes of rock being extracted, the life-cycle of a limestone quarry tends to be much longer than that of sand and gravel aggregates and in many cases old quarries become amalgamated into newer and larger ones, resulting in very old pre-1947 quarries still being active today. This is reflected in the LCM 2000 analysis that shows a high level of ‘active’ land.

Though the current ‘snap-shot’ of losses and gains in the White Peak currently suggests a negative balance, it is considered that, in the long term, as the industry ceases to operate in its current areas, the potential for a number of high value sites is significant as much of the restoration is likely to be towards habitats such as limestone grassland, scree and broad-leaved woodland. These habitats are priorities in the area and therefore the long-term biodiversity gain is potentially high.

Box 2 : Northamptonshire Vales Pilot Area

Extraction of aggregates, most notably sand and gravel, has probably occurred in some form for hundreds of years in the Northamptonshire Vales. It is estimated that a total of 3031 ha of land has been the subject of planning permissions for aggregate extraction since 1947. Sand and gravel extraction is by far the largest proportion of this industry, although limestone is also quarried. Only two active sand and gravel quarries remain in the study area.

Analysis of change in broad habitats in the recent past (1947-2000) has shown that there has been:

- an estimated decline of 822 ha of agricultural land uses (improved grassland, arable and horticulture);
- an estimated decline of 104 ha of built up areas and gardens
- an estimated increase at 605 ha of open water habitats;
- increases in calcareous grassland, estimated at 95ha; and
- increases in both broad leaved woodland and coniferous woodland, estimated at 191 ha and 75 ha respectively.

The balance between losses and gains is made up by small proportion of other land cover types with less significant cover.

Within inactive sand and gravel extraction sites, a large number of habitats of conservation importance now occur. Aggregate planning permission boundaries include 100 ha of SSSI designated land, comprising four sites, two of which are directly derived from former sand and gravel extraction. Disused quarries represent greater than 30% of the total area of county-level nature conservation sites, with over 900 ha of CWS and Northamptonshire Wildlife Trust Nature Reserves within former aggregates workings. This represents a significant proportion of the total biodiversity resource in the Northamptonshire Vales.

A wintering bird population of national importance has developed on the complex of flooded gravel pits in the area, including internationally important populations of gadwall and golden plover. The complex of flooded gravel pits that supports this bird population is being considered as a potential SSSI/SPA.

Wet woodland, a UK BAP Priority habitat, as indicated by the presence of alder is likely to make up a proportion of the broad-leaved woodland resource within aggregates planning permission boundaries. Skylark and common lizard records from within aggregates planning permission boundaries suggest that rough grassland habitats also make up a proportion of grassland habitats within these boundaries.

Whilst only a small number of current restoration plans have been examined, it appears to be the case that biodiversity-led restoration plans are popular. The focus of restoration plans appears to be open water, wetland, grassland and woodland habitats. This represents a shift from traditional restoration practices to return land to productive agricultural uses, which can be of only limited value for biodiversity.

It is clear, in the Northamptonshire Vales, that there has been a significant contribution to biodiversity resulting from the extraction of aggregates.

Whilst the appropriateness of the creation of large areas of man-modified habitats of open water and wetlands within a lowland river landscape could be questionable from a landscape character point of view, the biodiversity benefits are clear. Abandoned and naturally regenerated sand and gravel workings, and more recent restored extractions, support a range of species, including wildfowl, waders, dragonflies, butterflies, water vole and wetland plants, of at least regional biodiversity value. In the case of wintering birds, the valley is considered to be of at least national importance and may qualify as a site of international importance for wetland birds.

There are significant differences between the biodiversity gains and losses between the two pilot areas and it is considered that this is probably due to the typical 'life-cycle' of the quarries themselves and the length of the study period (ie 1947-2003).

In the Northamptonshire Vale, an elsewhere in the UK, the life of a "typical" sand and gravel quarry from start to finish, including restoration tends to be less than 15 years in total which means that in the period 1947 -2003 there are potentially three or four generations of quarries. As such there are only limited areas that are active at any one time. Furthermore, due to the relatively shallow depth of these workings, the potential for progressive restoration is much greater although the yield of mineral per hectare of worked land will be much lower than at a typical limestone quarry. In contrast, in the White Peak, a number of old quarries have become amalgamated into newer and larger ones resulting in very old pre-1947 quarries still being active today although they will, of course, be restored in the future when extraction ceases. In most cases, it is impractical to restore hard rock quarries, worked on multiple levels, although there is increased attention on treatment of upper faces to reduce interim visual impacts and this can provide some biodiversity potential during the active life of the site.

The analyses undertaken provide a snap-shot of the industry's biodiversity impact in the year 2000 (the date of the LCM data). Mineral extraction in both pilot areas has led to a change in the balance of biodiversity in the form of habitat structure and composition.

In the case of the Northamptonshire Vales there has been a shift in the composition of habitats from predominantly agricultural land (arable and improved grassland) to open water habitat. Though this habitat is not necessarily typical of the region, or a conservation priority, it has developed a high biodiversity value in its own right.

In the White Peak, there has been an apparent loss of significant areas of grassland habitat and broad-leaved woodland and major gains in land classifications that are characteristic of active mineral sites with limited vegetation cover. This is a reflection of the fact that large areas of land remain active for long periods of time and also possibly that the slow development of calcareous swards in old mineral workings are not picked up as calcareous grassland in the LCM 2000 analysis, which is incapable of making these kind of habitat quality distinctions.

Whilst it may take generations for the limestone quarries of the White Peak to complete their consented extraction and restoration schemes these quarries have the potential, where they remain above the water table in the limestone, to be restored to a typical mix of habitats for the area in which they are located,iecalcareous grassland and broad-leaved woodland. However, the potential for the largest limestone quarries, which can be worked to very significant depths, to intersect the water table could lead to a change in the composition of habitats with some water based restoration schemes which in the White Peak would not necessarily develop the same level of biodiversity interest as other terrestrial habitats.

Mineral resource comparisons

In comparing the findings of the pilot studies, the gross and real mineral yields from the study areas are worthy of consideration. The yields of some of the limestone quarries in the White Peak study areas will be measured in millions of tonnes per hectare whereas those from sand and gravel quarries in Northamptonshire will be at one or two hundred thousand tonnes per

hectare at most. Furthermore the gross contribution of the industry in both study areas to the national need for minerals is significantly out of balance with the White Peak being one of the UK's most significant aggregate and cement minerals production areas.

Future applicability of study findings

The adoption of a number of conservation related planning policies by local planning authorities ensure that impacts upon biodiversity in the form of existing recognised sites and features of importance (habitats and species) are considered when a planning application is determined and conditions are set. Further to this all mineral existing sites with planning consent are subject to review of their planning permission every 15 years under the 1995 Environment Act. During these reviews environmental impact assessments are generally undertaken and the restoration scheme is also reviewed.

In addition, many of those large mineral extraction companies that operate across the UK now have their own policies relating to wildlife and biodiversity conservation and they have established relationships with statutory and non-statutory wildlife organisations to ensure that their restoration schemes reflect the local biodiversity conservation priorities.

Recommendations

This report has examined the analysis techniques and datasets that have been considered during the development of the final methodology and there application through two pilot studies. The final methodology was chosen because it fulfilled a number of key requirements, namely:

- The method utilises UK wide datasets and GIS technology that have been adopted by a number of central government departments for data handling and strategic analyses. It is therefore anticipated that this technique shall have a long 'shelf-life' and improve with time.
- The analysis technique is suitable for comparison between administrative regions and different sectors of the minerals industry.
- The datasets used could also provide a baseline for habitat change which could be re-assessed in the future to track changes in land cover, which may prove useful for future biodiversity monitoring purposes.

A number of areas of the described method require refinement and further work. The key recommendation from the study is the ground truthing of results provided by LCM 2000. It is recommended that ground truthing of a sample of minerals sites is undertaken to identify how habitats typical of the quarry industry are being interpreted by LCM 2000. These habitats include:

- naturally colonising ground;
- inland rock, including natural and quarried outcrops;
- grassed screening bunds and soil storage mounds;
- recently restored habitats including grasslands, woodland, dwarf shrub and wetland; and

- other quarry habitats such as settlement lagoons, soil storage and sand faces.

Ground truthing of selected priority biodiversity habitats found within minerals sites, such as the occurrence of calcareous grassland within limestone areas, would allow the industry to clearly define the contribution that priority habitats within minerals workings are making towards the national resource of these habitats.

In addition to ground-truthing, the following refinements of the method presented are suggested:

- only species data that has been collected in a systematic way from a comprehensive dataset should be used in a study of this kind;
- fFurther development of the BGS minerals quarry database is recommended, with liaison between the BGS and the MNCF to ensure that the format of the database considers any future biodiversity studies;
- collect information relating to aggregates sites that fall outside the planning system, or were operational prior to 1947;
- application of National Biodiversity Network standards for recording and storing biodiversity data associated with minerals sites would encourage greater compatibility between different datasets and allow the industry to more effectively monitor its own biodiversity performance.

The main data source used for this analysis technique, remote-sensed land use data (LCM2000), is still in development. Subsequent attempts to define land-use through remote-sensing are likely to lead to a refinement of the current broad habitat definitions and lead to greater accuracy. Therefore this technique is likely to become more accurate in the future and could be used as a baseline upon which future studies can be based.

Conclusion

The techniques used for this study utilise UK wide datasets and technology that has been adopted by a number of central government departments for data handling and strategic analyses. It is therefore anticipated that this technique would have a long 'shelf-life' and improve with time. Though there have been a number of current weaknesses identified in the technique, it is considered that it provides information that would be otherwise difficult to compile. It is therefore recommended that further effort is applied to develop these, and other complementary analysis techniques, for future biodiversity monitoring purposes.

Appendix 1 Individuals and organisations consulted

Table A1 – Individuals and organisations consulted

Contact	Organisation
Dr Johnny Birks	Vincent Wildlife Trust
Nick Moyes	Derbyshire Records Centre
Kieran Huston	Derbyshire Wildlife Trust
Alan Smith	Northamptonshire Wildlife Trust
Tilly Tilbrook	Northants. County Council BAP Officer
Colin Wilkinson	RSPB WEBS Co-ordinator
Roger Catchpole	English Nature Spatial Ecologist
Gavin Measures	English Nature BAP Co-ordinator
Louise Brown	Northants CC Planning Dept.
David Newman	Northants CC Minerals Planning Dept.
Prof. Alice Coleman	Co-ordinator of 2nd Land Utilization Survey of Great Britain
Deborah Russell	English Nature Environmental Audit Team
Ben le Bas	English Nature, Peak District and Derbyshire Team
Ian Paterson	English Nature, East Midlands Team
Beth Gardiner	BAP Project Officer, Nottinghamshire County Council
Rhodri Thomas	Peak District National Park Ecologist
Rhys Cooper	British Geological Survey, GIS Team
Nigel Brown	Centre for Ecology and Hydrology, CS2000
Mineral Planning Officer	Derbyshire CC Minerals Planning Dept.
Annie Cooper	County Ecologist – Derbyshire County Council
Roger Hill	County Ecologist – Staffordshire County Council
Mineral Planning Officer	Staffordshire CC Minerals Planning Dept.
Mineral Planning Officer	Peak District National Park Minerals Planning Dept.
Phil Watson	Northamptonshire County Minerals Planning Dept.
Nick Richens	Countryside Agency

Table A2 – Steering group

Contact	Organisation
Tom Moat	English Nature
Tony Cosgrove	English Nature
Andy Butler	Tarmac
Miles Watkins	Aggregate Industries
David Park	Lafarge Aggregates
Tim Pinder	RMC
Nick Horsley	WBB Minerals
Andrew Denley/Andrew Roberts	Hanson Aggregates

Appendix 2 Defining spatial and temporal boundaries

Defining study areas

Administrative regions

There are a wide range of administrative boundaries that could be adopted to define such study areas; these could be political such as County, District or Unitary Authority boundaries or boundaries linked to the regional organisation of English Nature offices. There may also be some administrative boundaries set around distinct mineral planning zones, eg St. Austell China Clay Area in Cornwall. There are obvious advantages of using study areas based upon administrative boundaries, such as:

- the administrative areas often relate to budget allocations for the funding of such studies and strategies;
- their use means that the number of interested parties involved in a study would be reduced and that the study would therefore be likely to be more focussed;
- baseline data are often funded and collected on the basis of such boundaries;
- local BAPs are often drawn up on the basis of a county boundary; and
- policy decisions are often made at this level, making comparisons between study sites more meaningful and the recommendations made in such studies easier to implement.

However, such administrative boundaries rarely follow the boundaries that define and characterise the biological character of an area. For instance, within one county there may be a number of distinct and contrasting biogeographical zones, each with its own characteristic flora and fauna and different forms of mineral extraction. This may result in unnecessarily complex assessments and, importantly, the natural variations in biodiversity supported by extraction of different minerals could prevent comparison and conclusions to be drawn about individual minerals sectors.

Biogeographical areas

The selection of study areas based upon biogeographical criteria is another approach that has been considered.

English Nature developed the Natural Area approach to provide a consistent, ecologically coherent countrywide framework to focus national nature conservation targets to a local level. Natural Areas are defined as '*biogeographic zones which reflect the geological foundation, the natural systems and processes and the wildlife in different parts of England, and provide a framework for setting objectives for nature conservation*[5]'. The Natural Area approach taken by English Nature was complemented by the division of the country into landscape "Character Areas" by the former Countryside Commission and, in December 1996, a Joint Character Map of England was launched. The Countryside Agency has continued the work of dividing the country into discrete Landscape Character Types (LCT), based upon a mixture of biogeographic (including geology, soils and woodland cover) and cultural criteria,

[5] Biodiversity: The UK Steering Group Report, HMSO (1995)

through the Living Landscapes Project[6]. As a further advantage, both these datasets are available in digital format for the whole of England.

Pilot studies for the White Peak and Nene Valley showed that the refinement of the LCT information over Natural Areas provided a clearer definition of biogeographically similar areas.

Defining a minerals site

Quarries are defined in The Quarries Regulations 1999 (SI 2024) as "*an excavation or system of excavations made for the purpose of, or in connection with, the extraction of minerals (whether in their natural state or in solution or suspension) or products of minerals, being neither a mine nor merely a well or borehole or a well and borehole combined*". However, this definition is lacking in two important areas. Clearly the above definition would exclude the areas of non-operational land within a mineral operator's control. Due to the phased approach to extraction and restoration at many mineral sites it is possible that at any one time, within the area of consent, there can be areas yet to be worked and areas that have been worked but which have subsequently been restored. Non-operational land is the area that can often make the most contribution towards biodiversity within in a mineral extraction site. Therefore a more inclusive definition is required and used in this report, one that includes both operational and non-operational land.

Temporal extent

The extraction of minerals at varying scales has occurred for many hundreds of years and in some areas this has formed an essential part of the character of the land and, in the case of metallophyte plant communities for instance, habitats have developed that are specifically associated with old mineral extractions. Historic extraction sites can contribute a great deal to biodiversity in an area, but this is usually as a result of their natural recolonisation through time, rather than any specific management that may have been undertaken. In addition, the changing land use in surrounding land is also likely to have had an effect upon the biodiversity interest of historic minerals sites. These sites would benefit from a pool of greater biodiversity in the surrounding landscape and therefore would have the potential to draw upon this pool following abandonment, allowing habitats of greater biodiversity interest to develop in the intervening years than maybe possible at present, when much of the surrounding landscape has become impoverished agricultural land of lower biodiversity value. Historic, small scale extractions are often un-recorded and difficult to define except through detailed field survey. A temporal limit was therefore decided upon that clearly defines which mineral sites are to be considered in a study of the modern minerals industry.

A significant watershed for the modern minerals industry was the reformation of the planning system in Great Britain after the Second World War by the passing of the 1947 Town and Country Planning Act. After this time, all mineral extraction sites had to go through the planning process and therefore a formal record of each mineral extraction site was made. 1947 has therefore been chosen as the limit for sites' inclusion in this study. However, record keeping and implementation were not as thorough as today and many planning authorities

[6] Landscape Character Types, developed by the Countryside Agency by S. Warnock (in conjunction with the Living Landscapes Project and Entec Ltd.) 2001

had incomplete records of the areas covered by planning consents. The requirement to register Interim Development Order permissions and the subsequent regulations (Environment Act, 1995) requiring the review of old mineral permission (ROMPs) have been instrumental in determining which permissions are still valid but it should be noted that there will be uncertainty about the historic validity and use of some of the older mineral permissions.

Four minerals planning authorities within the White Peak and Nene Valley were consulted and found to keep plot sheets or some similar historic record of minerals sites; one authority has records from 1995 onwards. The reliability, completeness and access to these records varies greatly, with some authorities having separate file records for each site, that would take considerable time to access and analyse. The variability of record-keeping and availability between planning authorities was found to be as a considerable disadvantage.

A complete record of all permitted minerals sites is being created and maintained by the British Geological Survey (BGS). This database aims to collect the boundaries of all recorded minerals sites from the start of the planning process,ie1947. This work is currently in progress, although large areas of the country have now been completed. Whilst the original sources of these data are the minerals planning authorities, these data have been compiled and interpreted by BGS and possibly represent the most accurate record of permitted extractions. An additional advantage is that these data are currently available in digital format.

Definition of operational and non-operational land

All permitted minerals areas contain both operational and non-operational land. Operational land includes worked quarry faces, aggregate screening plant, buildings, etc. Non-operational land can include, for instance, screening bunds, inactive overburden tips, cliff top grasslands, disused quarries and restored areas. One major limitation of the BGS minerals boundary data is the lack of a boundary for the actual extraction area.

The Land Cover Map (LCM) 2000 (CEH, 2000) dataset identifies a number of cover types that appear to correlate well with active areas of limestone quarries in the White Peak Study Area. These include the broad habitat classifications of 16.1 Inland rock, 17.1 Built up areas and gardens and 17.2 Continuous urban. However, these habitat categories also apply to other non-operational areas such as disused/abandoned quarries that have not established a sward cover that fits the other vegetation classifications but could potentially have a high botanical value. As this is the case it is not possible to assume that all areas that do not fit into these classifications are non operational land. The only reliable means of splitting operational and non operational land is therefore through the interpretation of phasing plans and information provided by site operators or of aerial photographs. In either case, it would require detailed interpretation of each individual site and digitising of large amounts of data to allow any form of analysis.

Non-operational land may have a different and potentially higher biodiversity value than the operational land especially in an active minerals site. However, the biodiversity value of this land is likely to change as permissions are worked and restoration schemes implemented. Therefore, for the purposes of this study no distinction has been made between the two types of land.

Conclusion

The BGS minerals planning database has been used as the basic boundary for land under the control of the minerals operators. As it is not practical to define operational and non operational areas, and given these areas tend to shift around the consented site in the form of temporary features such as vegetated stock piles, un-worked land that will be worked in the future and restored land, it is considered appropriate that they are not split in the analysis. In this way it is possible to record the contribution or loss of biodiversity that occurs within the mineral operator's land at that 'snap-shot' in time.

Appendix 3 Measuring biodiversity

This Appendix provides details into the different sources of data that were considered for providing the measures of biodiversity. These datasets can be broadly classified into the following types:

- comprehensive habitat inventories;
- designated site inventories;
- minerals sites biodiversity inventories;
- priority habitat inventories; and
- survey inventories and anecdotal records for species.

Comprehensive habitat inventories

The UK has been collecting land use and habitat information for many decades. The first attempt to make an inventory of the land use across the country was made by Dudley L. Stamp in the 1930s. Most recently, remote-sensing has been used to produce a map of the broad habitat types that cover the country, through the Countryside Survey 2000. These comprehensive inventories provide coarse divisions and extent of habitats, providing a useful basic measure of biodiversity. However, due to their breadth, these studies rarely include any assessment of habitat quality, or what species may be supported by that habitat.

An assessment was made as to the usefulness of the range of comprehensive habitat inventories for the purpose of this study.

Land cover map 2000

Land Cover Map 2000 (LCM 2000) is a GIS-based land cover map for the whole of the UK, created through an analysis of spectral reflectance data from satellite. The data are based upon grid square "pixels" of approximately 625m^2, classified and constructed into land parcels using the UK Broad Habitat classification. Ground truthing of sample squares has allowed the data to be determined at 90% habitat accuracy.

This dataset has a number of advantages. Primarily, the data were collected in a systematic way over a single survey period and there is no inconsistency between regions. This allows quantitative analysis and comparison across the breadth of the dataset,ieUK-wide. The data were also classified according to UK BAP Broad Habitat types, an emerging standard classification, and compatible with UK BAP "Priority Habitats". English Nature is currently using the LCM 2000 data as the baseline to produce inventories for all UK BAP "Priority Habitats" across the UK[7]. It is highly likely that the methods used for LCM 2000 will be repeated in the future as an update or full survey as early as 2006, with the opportunity to monitor change.

[7] Deborah Russell, English Nature Environmental Audit Team, Habitats.

However, LCM 2000 has limitations, for example:

- LCM 2000 measures only broad habitats, and in many instances it is specific, priority habitats that are of interest, eg upland ash woods not all broad-leaved woodland.
- LCM 2000 has not mapped linear features, such as hedgerows and streams that provide potentially important habitats for a wide range of species, especially in intensively farmed landscapes.
- Small-scale habitat features that are less than $625m^2$ have not been mapped, which may make valuable contributions to biodiversity at a local level, eg ponds, flushes and springs.

County/district Phase 1 - habitat surveys

Following the establishment of a standardised system for classifying and mapping habitats[8] by the Nature Conservancy Council (English Nature's predecessor) many counties in England undertook full Phase 1 habitat surveys of their administrative area in the 1980s and 1990s. The earlier surveys tended to provide data in the form of hand coloured paper maps whereas later surveys utilised computerised mapping techniques and Geographical Information System (GIS) compatible data.

County Phase 1 datasets initially appear to be a suitable source of base data for studies into biodiversity losses and gains. However, Phase 1 survey has not been undertaken in every county and tends to be limited to those areas with larger resources of semi-natural habitats, eg Cumbria and Derbyshire. County Phase 1 data are therefore considered unsuitable for use across the country.

In this instance, there are full Phase 1 survey data available for the Peak District National Park and Derbyshire covering the White Peak study area. In contrast, the Nene Valley study area, in Northamptonshire, has not been surveyed to Phase 1 level. Therefore the use of Phase 1 data would be inappropriate for this study and comparison.

Second land utilisation survey of Britain

Between 1960 and 1968 a full, UK wide land use survey was undertaken by Professor Alice Coleman, of King's College London, as a follow-up to Dudley L. Stamp's Land Use Survey of Great Britain from the 1930s. The survey was mapped entirely in the field, using over 1000 surveyors. Colour field maps were produced at a scale of 1:10,560 (6 inches to 1 mile) using 70 categories of land use.

This dataset provides a useful insight into the historical land use of the whole of the UK and potentially provides the necessary information for an historic and modern day comparison.

The land use classification used in this survey is broadly compatible with the UK BAP Broad Habitat classification used as the basis for LCM 2000, the selected as the baseline standard for this study, although there is a major discrepancy between the datasets is the level of detail included in grassland recording. The Second Land Utilisation Survey (SLUS) did not attempt to separate types of grassland.

[8] England Field Unit – Nature Conservancy Council (1990) *Handbook for Phase 1 habitat survey – A technique for environmental audit*. Joint Nature Conservation Committee, Peterborough.

Only a small proportion of SLUS was ever published. The remaining field data are stored on paper maps. In order to include the SLUS as a historical perspective to the LCM 2000 data it would need to be available in digital format. The conversion of this dataset into digital format would be an enormous task and was considered beyond the scope of the present study.

Conclusion

Despite its limitations, the LCM 2000 data was considered to be the most accurate available comprehensive habitat inventory and has therefore been used as the basis for measuring broad habitats for this assessment.

Designated site inventories

Nationally and internationally designated sites (SSSI, NNR, SAC and SPA) are selected on the basis of clear national criteria following intensive field survey. Ecological information for these sites is detailed with habitat and selected species surveys often undertaken. These sites are recognised as the most valuable areas of nature conservation habitat in the UK.

County level designated areas are selected on criteria that vary from county to county and, in the case of the Peak District National Park, have not been designated at all. However, despite differences in selection and recording methods, county sites are identified as important sites for biodiversity and have an important role in nature conservation nationally.

Conclusion

An analysis of designated sites provides an indication of the land of current biodiversity interest that is within the control of the minerals industry. The number of sites designated post-mineral extraction is an indication of the biodiversity and geodiversity value of former minerals workings. In some instances, designations that have been made prior to mineral workings may have been compromised, either through direct land-take or the indirect effect of minerals operations. This would provide an indication of where minerals operations were having a negative effect upon areas that have been designated as important reserves of biodiversity.

Minerals site biodiversity inventories

Many mineral operators hold ecological data in the form of surveys undertaken for Environmental Impact Assessments or from survey work required by planning conditions (for example, habitat management plans or restoration monitoring). In addition to this, some quarries, on completion of restoration, and occasionally during operation, develop an ecological interest that attracts biological recorders. A good example of this is the study of flooded gravel pits by ornithologists, where notable assemblages of waterfowl may collect. Some mineral operators have also developed their own internal policies on data collection and have undertaken their own ecological surveys of each site in their control over and above the requirements of the planning system as part of an environmental management system (EMS).

These data are undoubtedly a useful source of information; however there are limitations to there value as detailed below:

- Ecological data have rarely accompanied planning applications prior to the Environmental Assessment legislation that came into force in 1988[9]. Therefore, judgements on the losses/gains of biodiversity to pre-1988 sites would need to be based upon a prediction or estimate of what was present at the site prior to extraction.
- The quality and level of detail within ecological impact assessments can be highly variable, particularly prior to 1995 when guidelines were published to set standards for the collection of baseline data for Environmental Impact Assessments[10].
- Ecological data from planning applications only describe the baseline at the time of survey, this being different for each application. The differences between data collection dates mean that a single 'current baseline' could not be used, making inter-site comparisons difficult.
- The collation of older reports and information for individual extraction areas can be made more difficult due to the complex planning history of some sites and the recent consolidation of the minerals industry where quarries have changed hands. Only where the current operator has a long association with a particular site are historical records likely to be available. It also appears to be common practise for local mineral planning authorities to archive documents that are more than three years old.
- Such site surveys rarely measure the wider ecological context of the site –iewhat the surrounding area contains, and the relative importance of the site within the surrounding area.

Conclusion

It is concluded that, though some biodiversity information held by operators or regulators on specific mineral sites could be of significant value to this study (particularly in augmenting or ground-truthing wider datasets), there are significant inconsistencies between sites and companies. More reliable data are inevitably linked to more recent studies, failing to give a historical perspective to any assessment. Therefore, these data sources cannot be relied upon to produce the regional overview of biodiversity in minerals sites that is required for this study.

However, in order to properly assess the usefulness of site specific information held by minerals operators, a number of case studies of individual quarries were undertaken during the pilot study. These case studies were nominated by minerals operators as sites where significant amounts of biodiversity information existed.

Priority habitat inventories

Priority habitats are those that have been identified through the UK BAP process as being of particular interest as habitats of conservation interest that have declined nationally in recent years. The UK BAP has set targets for halting losses, bringing unfavourable areas into appropriate management and creating new areas for all priority habitats.

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[9] Statutory Instrument 1988 No. 1199 The Town and Country Planning (Assessment of Environmental Effects) Regulations 1988

[10] Institute of Environmental Assessment (1995) *Guidelines for Ecological Assessment*. E & F N Spon.

English Nature is in the process of compiling databases of all UK BAP Priority habitats. The work to compile inventories of priority habitats is scheduled for completion by April 2004. Interim inventories for Lowland Grassland, Lowland Heathland and Upland Heathland were available for this project. Priority woodland habitat inventories have not yet been completed; therefore the Ancient Woodland Inventory (AWI), a dataset based upon a review of historical information, has been used instead. The AWI was compiled on different criteria to UK BAP inventories and does not differentiate between different woodland habitats.

Conclusion

Priority habitat inventories will provide a useful measure of biodiversity for the study. Priority habitat inventories have been completed based upon national standards and therefore it will be possible to make direct comparisons of losses and gains to these habitats between different areas using these data. Inventories are currently given provisional status, as ground truthing has yet to be completed; therefore any assessment based upon these inventories in their current state is likely to have an unknown margin of error.

Priority habitats represent the focus for biodiversity conservation outside designated areas. The retention of existing areas of priority habitats and the creation of new areas of these habitats through restoration would contribute in a tangible and measurable way towards biodiversity.

Species specific data

Local records centres, county taxonomic recorders and other special interest groups hold vast amounts of biodiversity information relating to individual species within a county or region. It was initially considered that data from these sources could be amalgamated and examined to assess where gains and losses to species had occurred.

However, these data were not considered suitable in isolation because:

- The data are largely anecdotal and rarely collected in systematic surveys, this would make comparisons and quantitative analysis impossible.
- No accurate baseline date for assessment could be set as data are recorded at wide range of different dates.
- Due to the patchiness of recording and the reliance of record centres upon volunteer recording, it cannot be assumed that the absence of a record from a location means the absence of a species.
- Often only records for protected, notable or rare species are collected and stored, skewing analysis.
- There is a possibility that any analysis would be skewed and misleading as more detailed recording inevitably takes place on sites that are proposed or have been consented for development or are recognised as publicly accessible wildlife sites, such as National Nature Reserves and local Wildlife Trust reserves.

Due to the limitations described above, measuring gains and losses for populations of species was not considered possible. A descriptive approach has therefore been devised, using

existing species records in and immediately around extraction areas to highlight where species are particularly associated with extractions.

It was not considered possible to examine all species records for individual study areas, as this could involve handling vast datasets from a range of sources. Collecting and analysing all these data would be both time-consuming and costly, as many data owners now charge for access to their records.

Therefore, for the pilot study areas a suite of indicator species were defined, based upon the availability of existing information and the criteria listed below. Due to variability in species occurrence, conservation importance and record keeping between regions different indicator species were defined separately for each regional study area. The criteria used to select indicator species for the pilot studies are presented below.

Criteria for the selection of protected species

1. The indicator species should be of "conservation concern", or directly associated with a habitat of conservation concern. Indicator species of habitats of conservation concern are likely to be common and well-distributed species with a strong affinity to a particular habitat. For instance, bilberry could be used as an indicator for acid grassland and dwarf shrub heath and common blue butterfly for calcareous grassland.

2. Species of conservation concern should be included on at least one of the following documents:

    a. Priority species in the UK BAP;
    b. Species protected under UK or European legislation[11];
    c. Bird species of conservation concern in the UK[12];
    d. Subject of either a local or regional BAP species action plan.

3. It should be a species that is potentially affected, either positively or negatively, by the minerals industry in each pilot area.

4. It should be a species sufficiently well-recorded within the pilot areas to provide a comparison between populations within and those outside extraction areas, the basis for a descriptive "balance sheet" analysis.

5. Ideally, the majority of records for the species should come from systematic survey data, rather than anecdotal records, to avoid problems associated with under-recording, localised recording effort, etc. that may confound analysis.

- Ideally, it should be a species that is not, or only minimally, affected by changes in surrounding land use or land management (eg agricultural intensification) and has not been subject to population crashes resulting primarily from influences other than habitat loss (eg disease, introduced predators).

[11] under WCA Act 1981, Habitats Directive 1992 or Birds Directive 1979
[12] RSPB Red and Amber List 2002

Conclusion

Due to regional variations in the quality and quantity of species data it is concluded that a different suite of indicator species are selected for each study area. The suite of indicator species should be selected based upon the criteria listed above. Consultation with local records centres and other data-holding organisations should be undertaken at an early stage to assist with the definition of indicator species lists. A pragmatic approach, where species are selected upon the basis of comprehensive recording, rather than the other criteria has distinct advantages.

Collecting species information for the pilot studies uncovered a number of issues relating to the availability of species data. It was noted that records for rare and protected species where more likely to be more comprehensive than for other species. Due to the range of organisations that hold records and the fact that many people record biodiversity on a purely voluntary basis, sufficient time should be allowed in a project timetable to contact all relevant sources and collect records. In areas where Biological Recording Centres have only been established for a short period, it is unlikely species records are comprehensive or consistent enough for detailed analysis.

Appendix 4 Assessment methods

Two different methods of assessing habitat change in minerals sites were considered when designing the method. A brief description of "historical comparison analysis" and the disadvantages of this method is described below.

Historical comparison analysis

The ideal scenario for assessing the losses and gains to biodiversity attributable to the minerals industry would be the comparison between historical and modern datasets of an identical suite of detailed ecological data. This method was explored, using The Second Land Utilisation Survey of Great Britain as a historic baseline to compare against the modern baseline defined by the LCM 2000.

The Second Land Utilisation Survey of Great Britain was undertaken in the 1960s and mapped habitats across the whole of England. This could be used to provide a historic baseline from which direct changes in the quantity of habitats within the actual mineral extraction boundaries can be determined. The 1960s data would be directly compared to that of the LCM 2000 data, giving an actual loss/gain of habitat within each area examined.

A number of disadvantages to this method were identified, notably:

- The technique limits the start date of the study to the 1960s rather than the desired start point of 1947. Pre-1960 effects cannot be assessed in this way.
- The interpretation of grassland communities in the 1960s land use survey is difficult as grassland habitats were not mapped with the same degree of accuracy as they have been in the recent LCM 2000.
- The 1960s data are stored on hand-drawn paper field maps, at 1:10,000 scale. Extraction of information from these hand-drawn maps would be time-consuming for the size of study areas under consideration and conversion of the data into a format suitable for quantitative GIS analysis would be extremely difficult, involving scanning and digitization of the field maps.

Due to the disadvantages associated with this dataset it was decided that it would not be pursued further.

Part B1 - Biodiversity Audit – White Peak

Executive summary

Extraction of aggregates, most notably limestone, has probably occurred in some form since Roman Times in the White Peak. Along with other changes in land use in the area there is very poor documentation to show what was present before the industry expanded to its current extent.

A method has therefore been developed (See Part A - Method for assessing Minerals Industry's Contribution to Biodiversity and Evaluation of Techniques in Pilot Study Areas) to assess losses and gains to biodiversity through the minerals industry and applied in the White Peak pilot study area. Data used to assess biodiversity are imperfect, and methodological assumptions and statistical inaccuracies in the main broad habitat dataset (Land Cover Map 2000) are highlighted in the main report.

It is estimated that a total of 2802 ha of land within the White Peak has been the subject of planning permissions for aggregate extraction since 1947. Limestone extraction is by far the largest proportion of this industry, although silica sand, dolerite and gravel are also quarried.

Analysis of the White Peak Study Area showed the vast majority of aggregate extraction occurs within four Landscape Character Type (LCTs), accounting for 90% of the total land within the Study Area. The high limestone plateau (52HLN); the limestone vales (52VLA); the wooded hills (53UPA) and unwooded upland vales (53VPD) LCTs account for 99% of the total extraction within the Study Area. Analysis of change in broad habitats in the recent past (1947-2000) within aggregate extraction areas in these four LCTs has shown that, when compared to a modern-day baseline which has shown a general decline in habitat quality since 1947, there has been:

- an estimated decline of 739 ha of low diversity agricultural land uses (improved grassland, arable and horticulture);
- an estimated decline of 320 ha of calcareous and neutral grassland;
- an estimated decrease of 67 ha of broad-leaved woodland; and
- increases in 1105 ha of quarry habitats (inland rock, built up areas, continuous urban and arable and horticulture (bare ground).

In addition to the estimated changes to broad habitats outlined above, analysis of biodiversity information for designated sites has shown that twelve sites, approximately 4.6% of the permitted aggregates sites by area, are designated as biological SSSI. These twelve sites include three which have developed considerable biodiversity interest in former aggregate extraction areas. Habitats such as mining spoil, limestone rock and scree support a number of species of interest, including rare plants. A total of 13 county wildlife sites fall within the boundary of consented aggregate extraction sites. Some of these reflect the development of habitats on former mineral workings, notably at Hopton Quarry and Hoffman Quarry. It should be noted that wildlife sites have not been designated within the Peak District National Park; although the National Park is considered to be a landscape of biodiversity importance.

In some respects these sites remain at risk from further development of aggregate extraction and there are anecdotes of losses and damage caused to a number of such designated sites in the past. However, at the current time, a number of mineral operators work with English Nature, Derbyshire Wildlife Trust and other nature conservation organisations to manage these areas for biodiversity. In addition, many operators and local planning authorities have specific policies that presume against aggregate extraction in areas of high biodiversity interest.

There are strong affinities between the distribution of a number of species of conservation importance and quarry habitats, notably great crested newt, peregrine, raven and a number of rare plant species. This is probably due to the range and rotation of temporary habitats and the existence of specific habitats that are suitable for these species.

The retention of habitats, especially calcareous grassland and woodland on the boundaries of current permitted aggregates extraction areas would represent a significant gain to biodiversity as these habitats have generally escaped agricultural improvement and will provide a colonisation source for habitats such as pioneer calcareous grassland when they come to be restored. Where these areas remain within the landholding of minerals operators, agreements securing these "pools of biodiversity" are likely to be necessary to ensure that future quarry extensions do not threaten them, either directly or indirectly.

The introduction of legislation and policy guidance concerning mineral extraction, has led to an increasing level of commitment on the side of the operator to restore and make good extraction areas following completion of works. Whilst only a small number of current restoration plans have been examined, it appears to be the case that biodiversity-led restoration schemes are popular and that, on the whole, locally appropriate habitats are being restored. The focus of restoration plans appears to be calcareous grassland, woodland, scrub and wetland habitats. This represents a shift from traditional restoration practices to return land to productive agricultural uses, which can be of only limited value for biodiversity.

A balance sheet, outlining the gains and losses to biodiversity in the past and looking towards the future, has shown that historical and more recent losses to biodiversity have occurred. However, some of the historical losses have now been mitigated through time, with the development of a number of man-made habitats of high nature conservation importance. A number of old quarry sites are have become important areas for metallophyte flora, calcareous grassland and great crested newt habitat. Some early extraction sites, including Bees Nest and Green Clay Pits, Stoney Middleton Dale and Millers Dale, are now recognised as of international importance, as a result of the habitats and species that these sites now support. More recent abandonment and natural recolonisation of quarry habitats, such as Hopton Wood Quarry, has led to the development of species-rich calcareous grassland of county importance for biodiversity, this site supports a number of nationally scarce species.

The balance sheet shows that the retention and appropriate management of remaining semi-natural habitats within aggregates quarries and the sensitive, nature conservation led restoration of existing quarries may mean that sites of up to international conservation importance are created in the distant future, representing a long-term gain to the biodiversity of the region from the present baseline. It is considered that completed, existing and future aggregates extractions within the White Peak can continue to provide habitats of high biodiversity value into the future through:

- continued avoidance of existing areas of biodiversity value, especially non-replaceable habitats such as ancient woodland and limestone dales;
- the focus of biodiversity led-restoration; and
- commitment to long-term management of restored areas and areas of high biodiversity value within the ownership of the minerals industry.

Introduction

SLR Consulting Ltd (SLR) has been commissioned by English Nature, on behalf of the Minerals Nature Conservation Forum (MNCF) to undertake a pilot study of the minerals industry's contribution to and impacts upon biodiversity.

This is the second (Part B1) of three documents that present the findings of the pilot study. The first report (Part A) describes and reviews sources of information available with which a biodiversity change audit can be carried out. It was found that there is no suitable single information source that could be used to make a direct comparison of losses and gains to biodiversity over the time period set by the project (1947-present day). The third report describes a pilot study of the biodiversity changes due to the sand and gravel extraction industry in the Nene Valley of Northamptonshire.

The most effective method was determined to be the use of a range of information sources, these were:

- "baseline" habitat data from UK-wide remote sensed land use/broad habitat data (Land Cover Map 2000);
- national and local nature conservation site inventories;
- national inventories for UK BAP Priority habitats; and
- survey and biological record data for a selection of indicator species relevant to each study area.

These various datasets were queried using a Geographical Information System (GIS) and were considered to represent the best available information to undertake a selective, yet representative, audit of biodiversity. The method chosen provides the additional benefit that the major data sources used are likely to be updated and repeated in the future, thereby providing a useful baseline for monitoring future change.

This report describes the results of the pilot biodiversity audit for the White Peak study area, providing a comparison of apparent losses and gains to biodiversity attributable to the extractive industry.

The final section of this report concludes with a review of the ways in which the extractive industries are contributing to biodiversity within the White Peak, which should be regarded as good practice that should be encouraged through the mineral planning process. Accordingly, the report identifies recommendations for the industry and its regulators within the White Peak.

Report structure

The following biodiversity audit report has been divided into the following sections:

Section 2: Data sources;
Section 3: The study area;
Section 4: Data analysis;
Section 5: Balance sheet; and
Section 6: Discussion, recommendations and conclusions.

Data sources

Introduction

Part A of this report has explained the rationale behind the selection of data types and the methods used to analyse them. Table 1 presents a brief summary of the data sources that have been used for the biodiversity audit of the White Peak and describes any constraints within those data that may have an effect upon the final analysis.

Table 1 – Summary of data sources, methods and constraints for the White Peak biodiversity and minerals study

Biodiversity Feature	Data Source	Analysis methods	Constraints on use and extent of data
Broad Habitats	Countryside Survey LCM 2000. CEH data in GIS polygons.	Estimation of broad habitats affected by minerals sites, based upon a baseline derived from the proportion of broad habitats within each Landscape Character Area.	LCM 2000 is estimated to be 80-90% accurate by CEH. Inaccuracies in classification become more apparent at small scales; habitats of limited extent, eg ponds, linear and boundary features are often under-recorded.
Designated Areas – National Inventories	SSSI cSAC, SPA and NNR inventories, English Nature data in GIS polygons. Citations for SSSI and SAC.	GIS calculation of the coincidence of minerals planning area polygons with SSSI polygons.	Boundary data for SSSI designated areas is definitive English Nature data and therefore of high accuracy. No data is available for areas of SSSI that may have been damaged or lost.
Designated Areas – County Inventories	Derbyshire Wildlife Trust County Wildlife Sites (Reference Point GIS and tables) and Staffordshire CC Sites of Biological Interest (GIS polygons and paper inventory)	GIS calculation of the coincidence of minerals planning area polygons with SBI polygons and CWS site centroid points.	Both Derbyshire and Staffordshire datasets have been recently updated (2000-2002) and are of high accuracy. No county-level wildlife sites have been designated within the Peak District National Park.

Biodiversity Feature	Data Source	Analysis methods	Constraints on use and extent of data
Priority Habitats	English Nature Priority Habitat Inventories for lowland grassland, lowland heathland, and upland heathland. English Nature Ancient Woodland Inventory. All GIS polygons.	GIS calculation of the co-incidence of minerals planning area polygons with Priority Habitat polygons.	Upland Heathland and Lowland Heathland Priority Habitats are provisional. Lowland Grassland Inventory data was compiled in 1990s through field survey. Ancient Woodland Inventory was compiled from historic maps and has not been ground-truthed.
Species data	Various sources, including English Nature, local records centres and Derbyshire Wildlife Trust.	GIS co-incidence analysis of species records and minerals planning area polygons	The unknown quality of anecdotal species data means that the absence of records for a species does not imply it is not present at a site.

Notes:

LCM 2000	Land Cover Map 2000, remote-sensed land use/broad habitat data
CEH	Centre for Ecology and Hydrology
SSSI	Site of Special Scientific Interest
cSAC	candidate Special Area of Conservation
SPA	Special Protection Area
NNR	National Nature Reserve
GIS	Geographical Information System
CWS	County Wildlife Sites (Second Tier Nature Conservation Sites)
SBI	Staffordshire Biodiversity Inventory (Second Tier Nature Conservation Sites)

The study area

Introduction

The following section outlines the work undertaken to define the scope of the study. The scope includes the definition of the Study Area and the types of extraction to be assessed.

Types of mineral extraction

It was agreed with the Steering Group that the biodiversity audit should focus upon above ground aggregates workings (ie quarries) that have continued or begun operating since 1947.

Other mineral extraction continues in the White Peak, notably fluorite and barite mineral vein extraction, often with some associated aggregates extraction. These workings have not been included in this study as their primary purpose is the extraction of vein minerals, which are not destined for the construction industry. These workings have therefore been screened out by a review of BGS minerals planning data, which include information relating to the type of extraction. Where a site had planning permission to extract aggregates in conjunction with mineral vein rights, these sites were included. However, it has been observed that a small number of quarries exist within the White Peak that do not have permission to extract aggregates, other than as removal of overburden, but actually remove sizable volumes of aggregates as by-product.

Historical aggregates workings, ie those completed prior to 1947, have been excluded from the pilot audit. This was for the following reasons:

- to prevent the introduction of what might be perceived as bias from long-abandoned workings that have had decades to develop biodiversity interest as a result of abandonment and low-intensity management;
- to ensure that the analysis only examines the industry that has been subject to planning regulations,ieit is the modern minerals industry; and
- to avoid logistical problems with identifying quarries that were active prior to the introduction of planning legislation.

Where areas of pre-1947 workings are included within the planning boundaries of current aggregates quarries, there was no method to remove them from the assessment. Where such older workings have been incorporated into a planning permission it is considered likely that their operation would then come under the same range of the planning policy guidelines as a post 1947 permitted site. Figure B1.1 shows the 51 aggregates quarries included within the study, of which 24 are considered active, 19 as inactive and eight have an unknown status.

Based on SLR's understanding of recent development in the quarry industry in the White Peak Study Area, it is apparent that some quarries have amalgamated and that others have closed, or been "mothballed" since the BGS collected the information used in this study. The information presented here therefore makes no differentiation between such quarries as they all have a recorded planning history.

Defining the study area

The study area of the White Peak was originally set as the Natural Area boundary, ie the biogeographic area of White Peak defined by English Nature in 1998. This boundary was further refined by sub-dividing it by the Landscape Character Types (LCT) that fall within the Natural Area. The definition of LCTs can be seen as a finer grain landscape-scale characterisation the English countryside.

LCTs have been derived by an analysis of soils, geology, woodland pattern and extent, settlement pattern and topography. The sub-division of the study area by LCT was assumed to provide a more accurate picture of habitat diversity than using the Natural Area boundary as a single unit.

An advantage of refining the study area by LCT has been to focus the study upon the LCTs where the majority of aggregates extraction has occurred. Table 2 clearly shows that for the White Peak Natural Area only a small proportion of its component LCTs, four out of a total of thirteen actually contain significant areas of current mineral extraction. This is likely to be because the LCTs on the fringe of the White Peak are often very small parts of larger LCTs in adjacent Natural Areas. Many of these LCTs are also within areas of differing geology.

With the exception of outlying limestone quarries, such as Shining Bank, which occurs in 51VPA landscape type, the greatest majority of aggregates extraction (99%) occurs within only four LCTs.

The four LCTs considered for further analysis include the White Peak Character Area landscapes of the high limestone plateau (52HLN) and the limestone vales (52VLA). The other two landscape types, 53UPA and 53VPA, are small sub-sections of the South West

Peak Character Area, which is characterised by unenclosed upland moorland. 53UPA and 53VPA contain the most southerly outcrops of the Carboniferous Limestone in the Study Area, in the Manifold and Dove valleys, and contain a small cluster of active quarries. The four selected LCTs account for 47,465 ha within the White Peak Study Area of a total of 52,680 ha and a total of 2772 ha of aggregates mineral planning permission area.

Table 2 - Analysis of total area of permitted aggregate quarries by Landscape Character Type

(Areas calculated from BGS Minerals Planning Data and Countryside Agency LCT data, using GIS, rounded to the nearest hectare). * Includes non-operational land within planning permission areas.

LCT	Landscape Character Type description	Total area of LCT in White Peak Natural Area	Total permitted aggregates sites*	% by area of permitted aggregates sites in White Peak
50RPD	A landscape type of intermediate dispersed unwooded heavy land restricted to the south-eastern margins of the study area	249 ha	0 ha	
50VPA	A landscape type of heavy land on ancient wooded upland vales restricted to the south-eastern margins of the study area.	1889 ha	5 ha	0.2%
51UDW	A landscape type of low hills, heath and moorland and wetland, restricted to the north-eastern margins of the study area.	14 ha	0 ha	
51UPA	A landscape type of ancient wooded low hills on heavy land restricted to the eastern margins of the study area.	302 ha	0 ha	
51VPA	A landscape type of ancient wooded upland hills and vales on heavy land covering extensive areas of the eastern margins of the study area, including Bakewell.	2033 ha	17 ha	0.6%
52HLN	A landscape type of unwooded high hills on limestone with nucleated settlements covering the majority of the central study area.	37651 ha	2340 ha	83.5%
52VLA	A landscape type of ancient wooded limestone upland vales, covering the Derbyshire Dales, including Monsal, Cressbrook and Dove Dale.	7510 ha	301 ha	10.7%
53HDO	A landscape type of open heath and moorland high hills, restricted to very small areas on the western margins of the study area.	114 ha	0 ha	
53HDW	A landscape type of wetland heath and moorland on high hills, restricted to the south western margins of the study area.	741 ha	8 ha	0.3%
53UPA	A landscape type of ancient wooded low hills on heavy land, restricted to the southern margins of the study area.	297 ha	54 ha	1.9%

LCT	Landscape Character Type description	Total area of LCT in White Peak Natural Area	Total permitted aggregates sites*	% by area of permitted aggregates sites in White Peak
53VPD	A landscape type of unwooded upland vales on heavy land with a dispersed settlement pattern, restricted to the western margin of the study area.	2005 ha	77 ha	2.7%
64RDA	A landscape type of intermediate ancient wooded heath and moorland, restricted to a very small area in the south of the study area	25 ha	0 ha	
68LWW	A landscape type of lowland wetlands, restricted to a very small area in the south of the study area	28 ha	0 ha	
TOTAL		**52860 ha**	**2802 ha**	

Data analysis

The data analysis for the biodiversity audit has been largely undertaken using GIS, a computer system capable of handling and analysing large quantities of spatially referenced data. The data analysis has been undertaken for each of the assessed biodiversity features separately. These features are:

- broad habitat type (LCM 2000);
- designated site inventories;
- priority habitat inventories; and
- species records.

Gains and losses of broad habitats

The broad habitat analysis, derived from the LCM 2000 dataset, provides an overview of the broad habitat types currently present within quarried areas and the broad habitats present in areas within the same landscape type that have not been quarried. This information is analysed further to provide an overview of the types of habitats that have been gained and lost from quarried areas.

This baseline information has then been used to compare between areas with consents for mineral extraction and areas outside this, and to make inferences as to the losses and gains of habitat that have resulted from the industry in these areas. Current baseline data have been used for the comparison because historic data were not available and because it allows a comparison with the current land use situation, not comparison with habitats that may have been present within extraction areas and the surrounding landscape prior to extraction.

Baseline broad habitat data, provided by the LCM 2000 dataset, was used to calculate the area and proportion of habitats that have been gained. As a single baseline date has been used the "gains" in actual fact represent a snapshot of the habitats within a quarry at the time LCM 2000 data were collected. This will include habitats that have been retained within the

non-operational areas of a quarry; habitats that have been either created or developed on previously quarried land; and habitats that have arisen through the operation of the quarry.

A comparison between the proportion of present-day habitats within aggregates quarries and the proportion of habitats in the surrounding landscape (defined as the LCT boundary) allows inference to be drawn on the type, proportion and ultimately area of habitats that may have been lost as a result of aggregates extraction within the Study Area.

Figure B1.2 shows a summary of the broad habitat types within the four selected LCTs of the White Peak Study Area; compared against the broad habitat types found in permitted aggregates minerals operations.

Table 3 shows a summary of the proportion of broad habitat types within the four selected LCTs of the White Peak Study Area; compared against the broad habitat types found in permitted aggregates minerals operations.

Table 3 - Proportion of broad habitat types within landscape character types and within permitted aggregate quarries

LCM 2000 habitat type		High limestone Plateau 52HLN		Limestone Vales 52VLA		Wooded Hills 53UPA		Unwooded Upland Vales 53VPD	
		Base line (%)	Aggr. Quarry (%)	Base line (%)	Aggr. Quarry (%)	Base line (%)	Aggr. Quarry (%)	Base line %	Aggr. Quarry %
Broadleaved, mixed and yew woodland	**1.1**	2.7	0.7	16.9	11.2	4.1	5.3	8.1	3.6
Coniferous woodland	**2.1**	0.1	<0.1	2.4	1.1	0.1	0	0.1	0
Arable and horticulture*	**4.1**	2.5	0.1	1.3		1.7	0	1.4	0
Arable and horticulture*	**4.2**	3.4	9.4	3.6	12.8	3.2	5.3	2.6	27.8
Arable and horticulture*	**4.3**	0	0	0	0	0	0	0	0
Improved grassland	**5.1**	42.2	19.2	46.9	9.9	66.6	47.9	57.0	33.9
Set-aside	**5.2**	0	<0.1	0	0	0	0	0	0
Neutral grassland	**6.1**	0.2	0	0.3	1.4	1.2	1.9	4.9	0.1
Calcareous grassland	**7.1**	42.0	29.0	20.9	22.8	21.8	0	17.9	9.8
Acid grasslands	**8.1**	0.0	0.2	0.1	0.8	0.2	9.5	0.0	<0.1
Bracken	**9.1**	2.3	3.1	2.0	3.8	0	0	4.9	0.9

LCM 2000 habitat type		High limestone Plateau 52HLN		Limestone Vales 52VLA		Wooded Hills 53UPA		Unwooded Upland Vales 53VPD	
		Base line (%)	Aggr. Quarry (%)	Base line (%)	Aggr. Quarry (%)	Base line (%)	Aggr. Quarry (%)	Base line %	Aggr. Quarry %
Dwarf shrub heath	**10.1, 10.2**	0.3	0.2	0.2	0.2	0	0	0.2	0
Fen, marsh and swamp	**11.1**	0	0	0.2	0	0	0	0.0	0
Standing open water and canals	**13.1**	0	0	0.5	0	0	0	0.1	0
Inland rock	**16.1**	2.6	32.1	0.4	16.2	0.0	16.4	0.4	0.8
Built up areas and gardens	**17.1**	1.5	1.8	4.2	10.6	1.2	0	2.4	8.0
Continuous urban	**17.2**	0.2	4.2	0.2	9.0	0	13.7	0	15.1
TOTAL Hectares		37651	2340	7510	301	297	54	2005	77

*There are three categories of arable and horticulture classified by the LCM 2000: 4.1 Cereals; 4.2 Bare ground, non-cereal or unknown; and 4.3 Not annual crop.

Table 3 clearly shows that the broad habitats supported by aggregates quarries are different to the habitats found within the surrounding landscape. This difference can be partially attributed to the size differences between the whole landscape type and the area of consented mineral development. This proportional difference in size is likely to account for the small or zero amounts of certain habitats within mineral workings. However, the information presented in Table 3 does show some clear differences in grassland and broad leaved woodland habitats.

The White Peak is a predominantly pastoral landscape with enclosed fields, supporting good grazing land and small areas of arable land. Throughout the White Peak, the two predominant habitat types are improved grassland, which varies from between 66-42% of the total land area of the four LCTs studied; and calcareous grassland, which varies from between 18-42% of the total land area of the four LCTs studied. Calcareous grassland and improved grassland show the biggest change in habitat area within permitted aggregates sites.

Decline in the total area of improved grassland is estimated to have occurred throughout the four LCTs studied. Estimated declines in calcareous grassland are more variable between the different LCTs studied, with a small increase estimated within the Limestone Vales (52VLA) together with declines across the other three landscape types.

Cover of broadleaved and yew woodland is variable across the White Peak, with the Limestone Vales being significantly more densely wooded, with nearly 17% of the area recorded as wooded. A decline in woodland habitat is shown in three LCTs, including the Limestone Vales. This can be explained in a number of ways, either:

- new plantations have yet to develop sufficient canopy cover to be classified as woodland habitats by LCM 2000;
- the extraction industry has cleared areas of woodland prior to development; or
- aggregates quarries are located in areas where there is a significantly smaller proportion of woodland.

An increase in arable and horticulture - bare ground is recorded within all four LCTs. Inland rock habitat also shows an increase in all four LCTs. These habitats and the probable mis-classification of continuous urban habitat within permitted aggregates sites are likely to represent the current extent of operational areas of quarries.

Neutral grassland, dwarf shrub heath, fen, marsh and swamp and standing water are not measured by the LCM 2000 as abundant habitats within the White Peak and the change that is estimated to have occurred within permitted aggregates sites is only small. This is likely to be due to the fact that these habitats occur in very small patches that may not be differentiated within LCM 2000. A recent Derbyshire Wildlife Trust survey (2003) estimated that 433 ha of semi-natural grasslands in Derbyshire are neutral unimproved or semi-improved. This total far exceeds the classification of neutral grasslands made by LCM 2000. A possible reason for this discrepancy is the way in which the classification of acidic, calcareous, neutral and improved grasslands were made. The LCM 2000 definitions for grassland types states "Neutral, calcareous and acid components are distinguished at subclass level using a soil 'acid sensitivity' map. Grassland management may obscure distinctions from Improved grassland." (CEH, 2000). As the majority of the Study Area occurs on limestone, it is likely that the discrepancy lies in the misclassification of neutral grassland as calcareous grassland. However, only detailed ground truthing would be able to test this assumption.

Gains and losses of broad habitats through the aggregates industry

Table 4 below shows the estimated area and direction of change (gain or loss) in broad habitats within aggregates sites in the White Peak landscape types.

Methodological assumptions

The estimated gain or loss has been calculated on the assumption that broad habitats occur in the same proportion throughout the landscape type, regardless of inter-type topographic, climatic and edaphic conditions. This calculation also assumes that all aggregates extractions contained the same proportion of habitats as the surrounding landscape prior to extraction. These generalisations of habitat homogeneity represent an obvious short-coming of the technique. However, it does provide a benchmark to make general comments on the likely broad habitat gains and losses that have occurred as a result of aggregate extraction. In reality, the actual habitats gained or lost could only be calculated by a detailed analysis on a site by site basis.

The LCM 2000 dataset has been extensively ground-truthed at a national scale and shown to be broadly 90% accurate. However, some shortfalls in the accuracy of the dataset have been highlighted by this study, namely:

- the use of an "acid sensitivity" map to define grassland type, which may have led to misclassification of neutral and calcareous grasslands;

- the pixel size of 25m^2 which means that small habitat patches such as ponds and ribbon habitats are not classified;
- the misclassification of complex landscapes and habitat mosaics, such as small field patterns with dense hedgerow and tree cover as woodland and scattered scrub as calcareous grassland; and
- potential misclassification of habitats in areas of steep topography, eg dale sides, or where areas were covered in cloud during the original satellite survey.

Results based upon the information provided by the LCM 2000 should therefore be interpreted with these shortfalls in mind.

Table 4 – Estimated area and direction of change in broad habitats through the aggregates industry in four studied LCT (52hln, 52VLA, 53upa, 53vpd)

LCM 2000 habitat type		Direction of change	Estimated change in habitat in ha
Broadleaved, mixed and yew woodland	1.1	decrease	-66.8
Coniferous woodland	2.1	decrease	-4.0
Arable and horticulture - cereals	4.1	decrease	-62.0
Arable and horticulture – non-cereals and bare ground	4.2	increase	188.6
Improved grassland	5.1	decrease	-677.4
Neutral grassland	6.1	decrease	-4.7
Calcareous grassland	7.1	decrease	-316.5
Acid grasslands	8.1	increase	11.8
Bracken	9.1	increase	21.1
Dwarf shrub heath	10.1, 10.2	decrease	-2.5
Fen, marsh and swamp	11.1	decrease	-0.6
Standing open water and canals	13.1	decrease	-1.6
Inland rock	16.1	increase	747.0
Built up areas and gardens	17.1	increase	29.9
Continuous urban	17.2	increase	139.1

The analysis above suggests that by far the greatest change is the decline in grassland habitats. It is estimated that 677.4 ha of improved grassland habitats and 316.5 ha of calcareous grassland habitats have been lost within the four LCTs studied. Variation between the landscape types is apparent, with the Unwooded Upland Vales (53VPD) and the Limestone Vales (52VLA) losing a much lower proportion of calcareous grassland. This is perhaps a reflection on the more varied geology of these LCTs, an artefact of the smaller area of LCT used to calculate the baseline habitat proportion or it could be due to the fact that there is a relatively large proportion of disused quarries in this area that may have developed such a habitat cover.

70.8 ha of woodland habitats are estimated to have been lost in total, with the largest proportion from 52VLA, the limestone vales character type, which is noticeably the most wooded of the four LCTs examined.

Increases in broad habitats are largest for those habitats considered to be associated with the extraction areas of quarries, notably limestone quarries, which make up the largest proportion of the aggregate industry within the White Peak. These habitats are the inland rock, bare ground (recorded as arable and horticulture by LCM 2000) and urban habitats. There has been an estimated net increase of 1104 ha of these four habitats within the four LCTs studied.

Nature conservation designated sites

Analysis of the coincidence of nature conservation designated sites with the planning boundaries of aggregates workings within the White Peak Study area provides an indication of what effects the extractive industry may be having upon those areas that are identified as important reserves of biodiversity. These effects may be positive, through the retention of important habitats within quarry boundaries and through protection of them from other types of modification. However, negative effects, whereby quarrying activities damage or disturb the protected site, may also occur.

Nationally and locally protected sites have been dealt with in separate sections as the information available for each is not compatible. Figure B1.3 shows the distribution of designated land within the Study Area.

Nationally designated nature conservation sites

Table 5 below indicates that a smaller proportion of nationally designated nature conservation sites (SSSI) fall within the planning boundaries of aggregates sites in the White Peak (5.8 %) than would expected from the average (9.4%).

Table 5 – Areas of protected land within the White Peak study area and permitted aggregate Quarries

	Total Designated Land within White Peak in ha (% of total area)	Designated land within Permitted Aggregates Sites in ha (% of total area)	Proportion of total designated land in the White Peak found within Permitted Aggregates Sites (%)
Sites of Specific Scientific Interest	4987.1 (9.4 %)	162.4 (5.8 %)	3.3
Special Areas of Conservation	2339.7 (4.4 %)	49.9 (2.85%)	2.1
National Nature Reserves	345.4 (0.7 %)	2.8 (0.1%)	0.8
Special Protection Areas	8.1 (0.02 %)	0.0	0.0

However, a total 162.4 ha of SSSI-designated land does fall within permitted aggregates sites, accounting for over 3% of the total SSSI land area in the White Peak, comprising twenty two SSSIs.

Of the twenty two SSSIs that fall within or overlap permitted aggregates sites, ten sites, accounting for 33 ha, are designated predominantly for geological interest. Six further sites are designated for both biological and geological interest. This includes Castleton SSSI which is designated for its geological and geomorphological interest, although it also includes calcareous grassland and small areas of metalliferous flora that has developed on the spoil heaps of old vein mineral workings.

Included within the remaining twelve predominantly biological sites are three internationally important sites, designated as cSAC, the Peak District Dales, Gang Mine and Bee's Nest and Green Clay Pits. The 2326 ha Peak District Dales cSAC, a conglomerate of limestone dales are primarily designated for semi-natural dry calcareous grasslands, ravine woodlands and populations of white clawed crayfish[13]. The Peak District Dales includes a number of individual SSSIs that are adjacent to or partially within permitted aggregates sites. These include Ballidon Dale, Wye Valley, Stoney Middleton Dale, Topley Pike and Deepdale and Lathkill Dale.

The majority of limestone dales have undergone localized limestone extraction throughout history. In some cases, these historical quarries have become formalized in the planning system and extraction has continued. Where these quarries are now inactive, for instance in Lathkill Dale, they now display notable geological exposures of Carboniferous Limestone and support developing calcareous grassland habitats. The outcrops at Lathkill Dale are also likely to support a regionally important lichen flora, described on the SSSI citation. The limestone cliffs and older quarry faces of Stoney Middleton Dale, that are not subject to grazing and support species-rich grassland communities with a number of nationally or locally uncommon species such as Nottingham catchfly (*Silene nutans*), spring cinquefoil (*Potentilla tabernaemontanii*), limestone bedstraw (*Galium sterneri*) and greater knapweed (*Centaurea scabiosa*) [14]. Darlton Quarry which falls partially within Stoney Middleton Dale currently remains active.

A small part of Ballidon Dale, a SSSI and cSAC, lies within Ballidon Quarry, an active aggregates quarry. Ballidon Dale has been altered by past quarrying activity and up to 16 ha of calcareous grassland, listed on the lowland grassland inventory, has been lost within this quarry since 1989. Ballidon Quarry is studied in more detail in Appendix 1. Topley Pike SSSI is also reported to have been affected by dust, which it has been suggested has altered the acidiphilous flora of heavily leached limestone plateau tops[15]. Both these sites are part of the Peak District Dales cSAC for their calcareous grassland habitats of international importance.

Gang Mine, a very small proportion of which is within Dene Quarry, an active limestone quarry, is an example of Calaminarian grassland, ie a metalliferous flora, developed upon abandoned vein mineral workings. The grasslands of Gang Mine are also potentially threatened by dust deposition from the neighbouring quarry.

Bee's Nest and Green Clay Pits cSAC encompasses a series of silica sand pits, supporting a complex mosaic of acidic and calcareous grassland, with small areas of heathland communities. There are also areas of open water, flushes and communities of disturbed

[13] Peak District Dales cSAC Site Account (Joint Nature Conservation Council)
[14] Stoney Middleton Dale SSSI Citation (English Nature)
[15] Topley Pike SSSI Citation (English Nature)

ground. Great crested newts (*Triturus cristatus),* an international interest feature occur in a number of ponds on site[16].

Rue Hill SSSI is a 15 ha site of which half falls within Cauldon limestone quarry. The SSSI interest is for calcareous grassland that has developed upon old limestone workings where disturbed ground has revegetated with plants that have gradually colonised from neighbouring unimproved limestone pastures. These pastures are now largely destroyed or botanically impoverished and therefore Rue Hill now provides an important refuge for many species intolerant of modern grassland management[17].

Table 6 below briefly describes the SSSIs that fall partially within permitted aggregates boundaries.

Table 6 – Biological SSSIS overlapping the boundaries of minerals PLANNING permissions within the White Peak Study Area

SSSI	Description (from SSSI citation)	Area of SSSI overlapping minerals planning permission (ha)
Ballidon Dale	Designated for the tracts of species-rich limestone grassland; acidophilous grassland on leached limestone soils and neutral grasslands. The dale has been substantially altered in the past by quarrying. This site is additionally designated cSAC.	1.8
Bees Nest & Green Clay Pits	Designated as cSAC for the unimproved calcareous grassland habitats and its population of great crested newt. No SSSI citation was available.	14.2
Caldon Dales	Designated for its unimproved traditionally managed calcareous and neutral grassland, including both pasture and meadows.	8.0
Castleton	Designated predominantly for its geological interest, but also for the species-rich limestone grasslands and rock ledge communities of the Winnatts Pass and Cave Dale. Old mineral workings also support a metallophyte flora, including nationally rare spring sandwort.	40.3
Rose End Meadows	Designated for extensive areas of unimproved species-rich grasslands, including calcareous, neutral and metallophyte species. Fauna includes scarce butterfly species and slow worm.	3.0
Rue Hill	Designated for small parcels of limestone grassland developed on the site of old limestone workings.	7.7
Via Gellia Woodlands	An ancient wooded limestone dale supporting ash-elm-hazel woodland; metallophyte flora on old lead workings; a cave system with winter hibernation sites for four bat species and a diverse assemblage of invertebrates. This site is additionally designated cSAC.	31.4

[16] Gang Mine cSAC Site Account (Joint Nature Conservation Council)
[17] Rue Hill SSSI Citation (English Nature)

SSSI	Description (from SSSI citation)	Area of SSSI overlapping minerals planning permission (ha)
Stoney Middleton Dale	Designated for both geological and biological interest. Ancient upland ashwoods, limestone crags, scrub, herb-rich pasture and old limestone quarry faces supporting rare bryophytes and grassland species.	14.6
Topley Pike & Deep Dale	Designated for both geological and biological interest, including ancient ash woodland, scrub, species-rich grassland and limestone cliffs and screes. This site is additionally designated cSAC.	2.9
Hamps and Manifold Valley	Designated for its ancient ash-lime woodland, scrub and semi-natural calcareous grassland habitat, invertebrate communities and karst scenery.	<0.1
Lathkill Dale	Designated for its ancient ash-elm woodland, calcareous grassland, limestone river valley and karst geomorphology.	2.75
Wye Valley	Designated for its ancient ash-elm woodland, species-rich grasslands, scree and scrub habitats. The site also has considerable geological interest. This site is additionally designated cSAC.	2.4
TOTAL		**129.1**

Rue Hill SSSI is a clear indication where past mineral workings, now long abandoned, have developed a biodiversity interest when the surrounding landscape contained a higher proportion of semi-natural habitats. These habitats and species are no longer well-represented in the surrounding area and are therefore deemed to be of conservation importance. This type of "refuge" is important for providing both important populations of species and providing a source of these species for the new sites as they develop.

A total of 129.1 ha of SSSI, which include habitats of high biodiversity value, occur within the boundaries of permitted aggregates sites. It is likely that minerals operators will be aware of the presence of SSSI designated land within their land holding and would enter into management agreements with English Nature to maintain the habitats in favourable condition. However, this area of SSSI is under a degree of threat resulting from the continued extraction of aggregates from neighbouring aggregates sites. It is highly likely that this threat of further encroachment into and indirect impacts upon SSSIs would be dealt with during the review of mineral consents under the 1995 Environment Act by negotiation between interested parties.

County designated wildlife sites

Information regarding county designated wildlife sites was only available from Staffordshire, through Staffordshire County Council, and Derbyshire, through Derbyshire Wildlife Trust, outside the Peak District National Park. The National Park Authority does not designate sites at the county level, although the National Park is in itself an indication of a landscape of high biodiversity value. Table 7 shows the incidence of county-designated sites occurring within permitted aggregates sites.

A proportion of county designated sites also fall within permitted aggregates boundaries, with a further small number of sites occurring adjacent to quarry boundaries. A total of thirteen

sites of county nature conservation importance have the potential to be affected by aggregates quarrying activity. The majority of these sites comprise calcareous grassland habitats, with lesser amounts of neutral grassland, scrub and woodland.

Whilst there remains potential for these areas to be negatively affected by the minerals industry, it should be recognised that without the presence of the industry it is likely that a number of the county-designated sites would not be present. For example, Hopton Quarry Field, Cauldon (W. of) and Hoffman Quarry are all habitats that have been retained by aggregates industry or created as a result of natural colonisation of abandoned minerals workings.

Table 7 – County-designated wildlife sites within Derbyshire and Staffordshire (outside the PDNP) that overlap with Permitted Aggregate Quarries

Name	Designation	Description
Bee's Nest Rocks	Derbyshire CWS	Grassland.
The Moor	Derbyshire CWS	Semi-improved neutral grassland (1999).
Hoffman Quarry	Derbyshire CWS	Unimproved calcareous grassland and tall dales grassland.
Hopton Quarry Field	Derbyshire CWS	Species poor neutral grassland (1999).
Land adjacent to Waterswallows Quarry	Derbyshire CWS	No description available.
Ramshorn Wood	Staffs SBI 1	A woodland, replanted with Scot's pine, supporting a small number of ancient woodland indicator species. Tunbridge filmy fern recorded here in 1907.
The Walk	Staffs SBI 1	Unimproved calcareous grassland (31 ha) with small areas of semi-improved grassland and ancient woodland.
Dale Farm (North)	Staffs SBI 1	Unimproved and semi-improved calcareous grassland with small areas of scrub and tall herbs.
Moorend Strip	Staffs SBI 1	Small unimproved and semi-improved neutral grasslands associated with a small stream.
Yew Tree Verges	Staffs SBI 1	Species-rich road verges and hedgerows.
Huddale	Staffs SBI 1	A site adjacent to The Dale SSSI, composed of unimproved and semi-improved calcareous grassland
Broomyshaw (East)	Staffs SBI 1	Streamside habitats including unimproved neutral grassland, marshy grassland and scrub.
Ramshorn Moor, Threelows Hollow, Sullymoor	Staffs SBI 2	Semi-improved neutral grassland with wet flushes and scrub.
Cauldon (W. of)	Staffs SBI 2	Scrub and small areas of unimproved neutral grassland.

The majority of county-designated wildlife sites support remnant areas of unimproved or semi-improved calcareous and neutral grassland areas that have been retained within quarry boundaries. The lack of agricultural improvement to these habitats may well be a result of a protection of these habitats offered by the minerals industry.

However, these sites remain under a degree of threat from continuing extraction operations and indirect impacts, such as dust deposition. Currently, the vast majority of the industry

follows good management practices regarding these designated sites and continues to protect designated habitats from extraction, other indirect impacts, and assists with the on-going management of those areas within its control. Through this kind of positive management, the industry will continue to make an important contribution to the overall biodiversity of aggregates quarries in the Study Area.

Priority habitats

The priority habitat inventories available for the White Peak Study area were examined to identify where these priority habitats had been identified within permitted aggregates sites. The occurrence of priority habitats within non-operational land under control of the mineral operator would represent an important contribution towards biodiversity. Table 8 shows the incidence of priority habitats within minerals planning boundaries.

Table 8 – Priority habitats within the boundaries of permitted aggregate quarries

Priority Habitat Type	Total Priority Habitat in White Peak in ha (% of total area)	Priority habitats within Permitted Aggregates Sites in ha (% of total area)	Proportion of total priority habitat in the White Peak found within Permitted Aggregates Sites (%)
Ancient Woodland	960.3 (1.8%)	23.7 (0.8 %)	2.5 %
Lowland Grassland	4258.3 (8.1%)	124.1 (4.4 %)	2.9 %
Lowland Heathland	40.0 (0.1%)	0.0	0%
Upland Heathland	206.0 (0.4%)	10.7 (0.4 %)	5.2 %

Comparison of priority habitats within minerals sites with the remaining area of the White Peak suggests that within permitted aggregates sites a significantly smaller proportion of priority habitat is supported than in the surrounding countryside. Very small areas of ancient woodland and upland heathland are found within the boundaries of permitted aggregates sites. This could suggest either that land that has been selected for limestone extraction has a lower proportion of these priority habitats than other land in the study area or potentially that extraction is concentrated on areas where they were previously present. Without historical data to groundtruth this, this method cannot distinguish between these two opposing possibilities.

A total of over 4000 ha of lowland grassland habitats have been identified within the White Peak. The majority of this habitat is described as lowland calcareous grassland. Within aggregates quarries only just over 4% of the total area is described as lowland grassland, although this still amounts to over 120 ha of habitat. These habitats, where they have been retained outside the extraction area, represent an important contribution towards biodiversity.

Species

A list of species indicators for the biodiversity audit of the White Peak was drawn up based upon the criteria set out in Part A of this report and through consultation with record holders.

The indicator species selected for the White Peak are:

- birds: curlew, ring ouzel, skylark, lapwing, song thrush, bullfinch, kestrel, peregrine, raven;
- plants: bilberry, mat grass, tormentil, adder's tongue, yellow rattle, Jacob's ladder; rock-rose, stemless thistle, bird's-foot trefoil, dog's mercury, wood sorrel, wild garlic, heather, gorse, bilberry, spring sandwort, moonwort, alpine pennycress;
- herpetofauna: common lizard, great crested newt, palmate newt, smooth newt;
- mammals: pipistrelle bat, water vole; and
- invertebrates: whiteletter hairstreak, gatekeeper, orange tip, green hairstreak, common blue, white clawed crayfish.

Records for these species were requested from sources of biological record holders in the area and the Derbyshire Wildlife Trust, Staffordshire Record Centre and English Nature all supplied species records for the indicator species listed.

Due to a high level of plant recording activity in Derbyshire, including recent efforts to collate information for the recently published Derbyshire Flora, the Derbyshire Rare Plants database was assessed in addition to the species listed above. This database is considered to be a reasonably complete and accurate picture of the current distribution of rare and notable plants in the County. The majority of records are from the last 10-15 years, and therefore they are assumed to be extant populations. Rare plant data are not as comprehensive within Staffordshire.

A database of species protected by law is maintained by English Nature and there is reasonable coverage for the White Peak. In addition to records for water vole, bats, great crested newts and white clawed crayfish; species records for otter were also collected. Unfortunately, comprehensive records of bird, plant and butterfly records were not available from the sources approached and therefore no records were collected for a number of the indicator species selected. Figure B1.4 shows the distribution of protected species within the Study Area.

Rare and notable plants

The following nationally scarce and locally rare plants have been recorded within permitted aggregates sites:

Alpine Penny-cress (*Thlaspi caerulescens*);
Narrow-leaved Bitter-cress (*Cardamine impatiens*);
a whitebeam (*Sorbus rupicola*);
Wall Whitlowgrass (*Draba muralis*);
Hutchinsia (*Hornungia petraea*);
Limestone Fern (*Gymnocarpium robertianum*);
Spring Cinquefoil (*Potentilla neumanniana*);
Mezereon (*Daphne mezereum*);
Pyrenean Scurvygrass (*Cochlearia pyrenaica*);
Alpine Clubmoss (*Diphasiastrum alpinum*);
Fir Clubmoss (*Huperzia selago*);

Herb Paris (*Paris quadrifolia*);
Buck's-horn Plantain (*Plantago coronopus*);
an eyebright (*Euphrasia nemorosa*); and
Horseshoe Vetch (*Hippocrepis comosa*).

In addition to these species, the following nationally scarce and locally rare plants have been recorded within a 100m buffer of quarry boundaries:

Nottingham Catchfly *(Silene nutans);*
Wood Barley (*Hordelymus europaeus*);
Large-leaved Lime (*Tilia platyphyllos*);
Green winged orchid *(Orchis morio);*
Jacob's-ladder (*Polemonium caeruleum*);
Common Wintergreen (*Pyrola minor*);
Woolly Thistle (*Cirsium eriophorum*);
Creeping Willow (*Salix repens*); and
Slender Trefoil (*Trifolium micranthum*).

Protected species

Figure B1.4 shows the incidence of protected species (water vole, bats, otter, native crayfish and great crested newt). Only three of these species have been recorded from within or in the vicinity of aggregates quarries. There are no recorded bat roosts within the aggregates quarries studied and the only record for a bat is for a pipistrelle observed within 50m of a quarry. Water vole and otter are well recorded from the River Wye and the River Dove, but are not associated with aggregates quarries.

Whilst no specific records were made available for this study, anecdotal evidence suggests that the distribution of peregrine falcons within the White Peak is strongly associated with former and currently active aggregate extractions, especially limestone quarries. Peregrines nest on cliff faces with a low level of disturbance and therefore privately owned quarries represent an excellent breeding habitat resource for this species.

Great crested newts appear to have a strong affinity with aggregates quarries, with six populations recorded six different quarries within the White Peak. At least four of the populations are well established and two quarries support populations described as "exceptional". A particularly important regional population of great crested newts occurs in the disused silica sand extractions at Bee's Nest and Green Clay Pits SSSI.

Aggregates quarries in the Derbyshire White Peak are known to support populations of eight nationally scarce plants and seven plants recorded as rare in Derbyshire. Within a hundred metres of aggregates quarries are records for a further nine rare plant species. No information was available to indicate whether there had been any losses of rare plants as a result of mineral extraction.

Rare plant species within aggregates quarries are dominated by species associated with the specialised habitats of limestone rock, bare ground and scree (Narrow-leaved Bitter-cress, Wall Whitlowgrass, Hutchinsia, Limestone Fern, Spring Cinquefoil, Pyrenean Scurvygrass, Buck's-horn Plantain). However, the most regularly recorded rare plant is the metallophyte, alpine pennycress, recorded from five separate quarries. This plant has a very strong

association with mining spoil, particularly where it is rich in heavy metals. This coincidence is an indirect one associated with the historic lead mining industry and the prevalence of lead deposits in the White Peak, rather than a direct result of aggregate extraction. Two other rare plants, mezereon and a whitebeam, have been recorded from limestone woodland habitats.

Rare plants found within 100m of quarries are typically associated with limestone rock and scree, calcareous grassland and ancient woodland habitats.

None of the species records for Staffordshire coincided with aggregates quarries or within 100m of quarry habitats.

Aggregates quarries, especially on limestone, make an important contribution towards the total populations of rare plants in Derbyshire, particularly those plants associated with bare rock, mine spoil and scree. It is considered likely that plants associated with these habitats have colonised as a result of quarrying activity creating new habitat. Other rare plants recorded in quarries and associated with semi-natural habitats, such as calcareous grassland and woodland are likely to be remnant populations of previously more extensive habitats and can therefore be considered to be under a degree of threat from an extension of quarrying activity into the semi-natural habitats that support them. However, such potential losses could be identified and mitigated under the review of the consent under the 1995 Environment Act.

Rare metallophyte plants, such as alpine pennycress, are almost entirely dependant upon mine spoil habitats in the UK. Perhaps the greatest threat to these populations would be the restoration and amelioration of metal contaminated spoil habitats that may reduce the habitat availability for the metallophyte plants associated with them.

Great crested newts are relatively well distributed throughout the White Peak, especially in the south and east. The populations of this species supported by aggregates quarries in the White Peak are considered to be important in the context of the local population. Due to the fact that mineral sites are subject to ecological surveys for new applications and planning reviews it is often the case that the presence of great crested newt is identified. Due to the statutory protection afforded to this species mineral operators are required to ensure that any populations are safeguarded and that favourable conservation status is secured. Mineral sites often become a haven for this species as the management of agricultural ponds and maintenance of favourable conservation status of this species in adjacent non mineral habitats is not necessarily subject to the same level of compliance to the legislation.

Potential future gains through restoration

The potential projected gains to biodiversity have been assessed qualitatively through an evaluation of the exiting restoration plans for a sample of currently active sites. Three sites have been selected from three different minerals operators. Restoration plans for limestone quarries only have been reviewed. Limestone makes up the largest proportion of aggregates extraction within the White Peak and no restoration plans for other minerals were available for the study.

The figures quoted for areas of habitat created should be viewed with some caution as there may be significant time lapses between restoration and maturation of particular habitats.

The detail of the restoration plan is subject to review on a rolling 15 year programme under the 1995 Environment Act therefore any Biodiversity issues that are apparent should be addressed at this stage.

Ballidon Quarry

The restoration of Ballidon Quarry began in 1999 with the extension of calcareous grassland across the north-facing slopes of one of the tips; this work is due for completion in 2004. The final stage of the restoration will be completed in 2037 with the restoration of the quarry floor. Table 9 below shows the approximate area and proportions of habitat created within Ballidon Quarry[18].

Table 9 – Areas and proportions of habitats for the planned restoration of 71 ha of Ballidon Quarry

Habitat type created	Approximate area due to be created (ha)	Proportion of total restored area (%)
Upland calcareous grassland	33.1	46
Mesotrophic hay meadow	18.3	26
Ash woodland	3.8	5
Oak-birch woodland	9.2	13
Wet woodland	1.2	2
Limestone scree	0.7	1
Limestone heath	0.7	1
Ponds	1.4	2
Other Habitats	3	4

Further details regarding the restoration proposals relating to Ballidon Quarry are shown in Appendix 1.

Kevin Quarry

The restoration proposals made for the Planning Application for Kevin Quarry[19] (1999) were also reviewed. The restoration concept was to unify the restoration of existing planning permissions and make a commitment towards habitat creation for nature conservation. The restoration design was to create a system of wooded river valleys with calcareous grassland and scrub on the higher ground. It was also proposed that restoration completed prior to 1999, which included the restoration of the Main Tip to improved grassland, would be included in the scheme. A large lake and wetland would be created in the base of the quarry.

Working methods for the proposed restoration would aim to use nutrient rich soils for wetlands and woodland. Ash woodland (NVC W8), the target woodland habitat, would be created through planting a mix of native tree species, comprising ash, pedunculate oak, field maple, hazel and hawthorn. Following tree establishment, a shade tolerant ground-flora seed

[18] Tarmac 2003 Ballidon Quarry – Biodiversity Action Plan.
[19] Planning Application and Phase 2 Environment Act Submission April 1999. Kevin Quarry, Tilcon South. (SECOR, 1999)

mix would be planted. Wetland habitats, including wet woodland willow carr and reedbed would be established on lake shores.

Calcareous grassland would be created using nutrient poor rocky overburden, which was naturally colonising with calcareous grassland species in-situ. These materials would be translocated to higher ground for use as a substrate. Natural regeneration would be facilitated by planting an open nurse of fescues and bent grasses and seed collected from nearby sources of calcareous grasslands.

Aftercare for the site was proposed for 5 years following establishment, with regular monitoring of the newly created grasslands. The operator was also prepared to consider a financial bond to support the long-term management of the site.

Shining Bank Quarry

The draft restoration plan for Shining Bank Quarry was also reviewed. The concept for the restoration is the creation of nature conservation focussed habitats including the following:

- calcareous grassland;
- ash climax woodland and associated flora;
- pioneer woodland and associated flora;
- areas of seasonal wetland; and
- permanent water bodies.

In addition to created habitats, areas of existing partially vegetated limestone cliffs and calcareous grasslands would be retained within the quarry.

The final restored landforms within the quarry would make use of on-site materials only and would rely upon natural regeneration and colonisation to re-vegetate bare areas. A fine nurse grass seed mix is proposed to allow colonisation gaps for other native calcareous flora. Waterbodies would be fed from groundwater and surface water sources and would include extensive shallow margins that would be planted with reeds and wet woodland and scrub habitats.

Contribution of restoration proposals to biodiversity

Following cessation of active aggregate extraction, almost all extant quarries have a restoration plan that includes the re-establishment of habitats of biodiversity interest generally considered to be of greater value than the active areas of quarry they are replacing. However, due to the lack of baseline information it is not be possible to directly evaluate the change in habitat quality/biodiversity value from the original habitats at a pre-quarrying site to the post-restoration quarry. The following key issues relating to aggregate extraction restoration have been highlighted through the review of restoration proposals:

- habitats proposed within a restoration plan may not represent the actual habitats that are created;
- many restoration plans cite biodiversity or nature conservation as the major goal of the restoration and long-term management of the site and follow the lead from

planning guidance and advice to create habitats that are desirable in local policy terms;

- proposed restoration habitats may not represent locally typical or locally important habitats and are likely to include a percentage of habitat that is neither locally typical not important in biodiversity terms;
- restoration plans are subject to review and therefore planning policy and subsequently proposals may change prior to implementation; and
- management obligations may only be for a very short time period following establishment, potentially allowing land to become unmanaged in the long-term and leading to a possible lowering the biodiversity potential.

Planning and policy context to future mineral extraction

Though much of the analysis undertaken so far provides a comment on historical and confirmed changes (ie already permitted mineral extraction sites) it does not provide an analysis of the likely impact of the minerals industry in this area in the future.

It is a necessity that any new quarries meet the requirements of the increasingly stringent planning policy and legislation that relates to such development.

As the White Peak study area falls within three planning regions there are a number of planning policy documents that relate to the area these include the following:

- Peak National Park Structure Plan (adopted April 1994);
- Derby and Derbyshire Minerals Local Plan (Adopted April 2000);
- Derby and Derbyshire Joint Structure Plan – Adopted Written statement (adopted January 2001);
- Staffordshire and Stoke-on-Trent Structure plan 1996-2011 (adopted May 2001); and
- Staffordshire and Stoke-on-Trent Minerals Local Plan (Adopted December 1999).

The key policies of these documents are shown in Table 10. Information presented is in abbreviated form to highlight the relevant part of the policy.

Table 10 – Planning policies relating to biodiversity and aggregate extraction in the White Peak

Planning Policy Ref	Adopted Policy
Peak National Park Structure Plan (adopted April 1994)	
CP1	The Natural Zone: Development will not be permitted in the gritstone moors, limestone heaths, limestone hills, limestone dales, semi-natural woodlands or other land in the natural Zone, other than in exceptional circumstances.
CP8	Evaluating Sites and features of Special Importance: In all cases involving statutory designation or international, national or regional interest, and wherever otherwise appropriate, an evaluation of the develop proposals' impact on these interests will be required.
CP 11	Other than in exceptional circumstances, development will not be permitted where it adversely affect the site or feature (or its setting) or species which has statutory designation or is of international, national or regional importance including: a Site of Special Scientific Interest, a National Nature Reserve; a Local Nature Reserve; Species listed under Schedules 1, 5 or 8 of the Wildlife and Countryside Act 1982; and a Special Protection Area. In addition a development would not normally be permitted where it would result in loss or damage to any other site, feature or species of ecological importance or to its setting. Where development is permitted, the developer will be required to minimise its impact and as appropriate, to record, safeguard and enhance the sites or features of special importance.
CP13	Development will not normally be permitted where it could lead to the loss of or damage to important trees and woodlands.
CP14	Wherever a scheme is permitted, a design will be sought that respects the character of the area and, where appropriate, incorporates habitat conservation or creation and the provision of other features which enhance the valued characteristics of the area.

Derby and Derbyshire Joint Structure Plan – Adopted Written Statement	
EP 14	Development will take full account of its likely impact upon Nature conservation value. Impact assessments are required when an adverse impact could occur as a result of a proposed development. Where the need for development overrides the need for protection, measures will be taken to minimise the impact and/or seek the provision of compensatory habitats by means of planning conditions and planning obligations. In particular, development will not be permitted where it: • may have an adverse impact upon an area designated or proposed for designation as being of international (SPA,SAC, Ramsar) or national (NNR, SSSI) importance for nature conservation, unless there are no alternative solutions and there are imperative overriding reasons; • would have an adverse impact on a site which supports a species protected by law or identified as being nationally rare, unless the levels of disturbance can be reduced to an acceptable minimum; and • does not have proper regard, taking account of their relative significance, of the need to protect from adverse impact a Local Nature Reserve, a Site of Importance for nature Conservation identified in the local plan, a site supporting a locally rare or endangered species, habitats identified in local Biodiversity Action Plans or landscape features of major importance for wild fauna and flora.

Derby and Derbyshire Joint Structure Plan – Adopted Written Statement	
EP 15	Measures will be taken top enhance the range and quality of natural heritage sites and landscape features, especially in the environmental priority areas by: • the establishment of local nature reserves; and • ensuring that the potential for creation, enhancement and management of new and existing sites and features is given consideration in the determination of applications.
MP 1	Mineral Development will be permitted provided that its impact on the environment is acceptable and that adverse effects can be minimised; proposals that would cause irreparable or unacceptable damage to interests of acknowledged environmental importance will not be permitted. Proposals for extensions to established mineral working sites will be permitted in preference to new sites provided that they can be accommodated in an environmentally acceptable way.
Derby and Derbyshire Minerals Local Plan	
MP 1	Proposals for mineral development will be permitted provided that the impact on the environment is acceptable having regard to: ……, • the effect on the character and quality of the landscape including the effects on trees, hedgerows and woodland and topographical features; • the effect on sites and features of wildlife….. importance; and • the effect on the quality and quantity of water resources including ecology of water resources and wetlands.
MP 3	Proposals for mineral development will be permitted provided that any adverse effects upon the environment can be eliminated ort reduced to an acceptable level.
MP 4	Proposals for mineral development will not be permitted where irreparable or unacceptable damage would result to interests of acknowledged environmental importance, where: • development would adversely affect nature conservation interests of international or national importance including SPAs, SACs, SSSIs, NNRs and the habitats of protected species; and • development would cause significant disturbance to other sites of importance for nature conservation including local nature reserves, county wildlife sites and habitats of locally rare or endangered species.
MP 6	Where proposals for mineral development would affect areas of known or potential importance for nature conservation, the mineral planning authority will require submission of a field evaluation and impact assessment and, where appropriate, mitigation proposals, prior to determining the application. Where such development is permitted, the mineral planning authority will impose conditions or seek planning obligations as appropriate, to minimise the impact of development, and to preserve features in situ as far as practicable, or secure translocation of habitats or the creation of new habitats prior to, or during, development.

Staffordshire and Stoke-on-Trent Structure Plan 1996-2011	
NC 5	Planning authorities will seek to further the objectives of the UK and Staffordshire Biodiversity Action Plans through appropriate policies and proposals for safeguarding and increasing key habitats and species. Opportunities will be sought to achieve UK and Staffordshire Biodiversity Action Plan targets for key habitats and species.
NC 6	In considering or formulating proposals for development or land use change, planning authorities will ensure, wherever possible, that damage to important semi-natural habitats or other features or sites of significant nature conservation value is avoided. Particular care will be taken to safeguard and consolidate the integrity of linear and other landscape features which are of major importance for wild fauna and flora. Where damage is unavoidable, measures to mitigate or compensate through establishment of replacement habitat or features should be taken, wherever possible.

Staffordshire and Stoke-on-Trent Structure Plan 1996-2011	
NC 7A	Proposals for development of land or land use change which are likely to have significant effects on an existing or proposed site of international importance for nature conservation will be subject to the most rigorous examination. Where the site concerned holds a priority natural habitat type and/or a priority species, development or land use change will not be permitted unless it is necessary for reasons of human health or public safety or for beneficial consequences of primary importance for nature conservation.
NC 7B	Proposals for development or land use change in or likely to affect SSSIs will be subject to special scrutiny. Where such proposals are likely to have an adverse effect, directly or indirectly, they will not be permitted unless there are no reasonable alternative means of meeting that development need and the reasons clearly outweigh the nature conservation value of the site itself and the national policy to safeguard the national network of such sites.
NC 7C	Development or land use change likely to have an adverse effect on a Local Nature Reserve or Site of Local Nature Conservation Importance will not be permitted, unless it can be clearly demonstrated that there are reasons for the proposal which outweigh the need to safeguard the intrinsic value of the site.
NC 8	Development or land-use change which would have an adverse impact, incapable of satisfactory mitigation, on legally protected species will not be allowed. Planning authorities will seek, to: • reduce disturbance to a minimum; • facilitate the survival of individual members of the species; and • provide adequate alternative habitats to sustain at least the current population levels.
Staffordshire and Stoke-on-Trent Minerals Local Plan	
MLP 54	The mineral planning authority will encourage the submission of applications which provide for co-ordinated working and restoration of adjoining limestone quarries and improvements to the environment. The mineral planning authority will favourably consider a planning application provided that the proposal would not cause an unacceptable adverse impact, that it is compatible with the development plan and that the effect is: • to reduce environmental and landscape impacts and to produce a satisfactory landform on completion by implementation of appropriate working and restoration proposals; and • to protect and secure the beneficial long term future management of SSSIs and other sites of nature conservation value.

The adoption of these policies by the respective local planning authorities ensure that impacts upon biodiversity in the form of existing recognised sites and features of importance (habitats and species) are considered when a planning application is determined and conditions are set. Further to this all mineral existing sites with planning consent are subject to review every 15 years under the 1995 Environment Act. During these reviews environmental impact assessments are generally undertaken and the restoration scheme is reviewed. It should be noted that in the Peak District National Park there is a presumption against further extraction of aggregates.

In addition, many of those large mineral extraction companies that operate across the UK now have their own policies relating to wildlife and biodiversity and they have established relationships with statutory and non-statutory wildlife organisations to ensure that their restoration schemes reflect the local biodiversity conservation priorities.

In view of the mechanisms detailed above it would seem unlikely that there will be any new areas of mineral extraction, whether as an extension to an existing site or a new extraction, in this study area that would have a significant adverse impact upon biodiversity. Any schemes

that are consented, in future, are also likely to have a high value restoration scheme that provides long-term benefits to local and national biodiversity priorities.

The balance sheet

A major aim of this study was to determine whether it was possible to produce a "balance sheet" of the gains and losses to the White Peak Study Area as a result of the operations of the aggregates industry since 1947. The Balance Sheet presented below summarises the data analysis presented in the previous chapter. It has been divided into the following broad sections:

- **historical**, describing changes that occurred prior to 1947;
- **recent past**, describing changes resulting from operations active between 1947 and 2003;
- **foreseeable future**, describing the changes that are likely to occur through operation and restoration in the coming generation (2003-2033);
- **distant future**, describing the changes that may occur in the future beyond the next generation (2033 onwards).

Due to the nature of the data available and the high degree of uncertainty in predicting historical and distant future changes, descriptions are limited to broad habitat and landscape changes and the predicted direction of change. Table 10 presents the Balance Sheet summary of the Pilot Biodiversity Audit for the White Peak Study Area.

Table 11 – Balance Sheet Summary of the Biodiversity losses and gains in the White Peak Study Area

Distant past	Recent past	Foreseeable future	Distant future
Losses There are archaeological records for small-scale limestone and vein mineral workings within the White Peak from Roman times and this kind of working will have continued until the Industrial Revolution. Many of these quarries are subsequently abandoned to naturally regenerate. From the 18th Century onwards, limestone extraction is likely to have increased within the White Peak. Small-scale workings from this period have often been incorporated into modern quarries and extended. It is possible that unimproved calcareous grassland and ancient woodland habitats were lost during this phase of extraction. These habitats would have been more widespread in the area prior to intensification of agriculture.	**Losses** Continued aggregate extractions within the White Peak, with the scale of workings increasing to create larger voids, steeper, longer cliff faces. Limestone working below the water table, eg within Shining Bank quarry, has the potential to cause negative effects to surrounding habitats due to groundwater drawdown. Historical damage to 2 SSSIs, is recorded through dust deposition at Topley Pike SSSI and land take at Ballidon Dale SSSI affecting the area of daleside habitats and associated calcareous grassland. Land-take increases significantly in this period. Habitats lost due to extraction are likely to be predominantly improved grassland and calcareous grassland, with smaller areas of broad-leaved woodland and yew woodland.	**Losses** Existing consents for aggregates in the White Peak often have a lifespan of 20-30 years and there is a possibility of continued loss of habitats. The habitats at most risk from further quarrying development are calcareous grassland and improved grassland. 12 biological SSSIs and 14 County Wildlife Sites occur within the planning permission boundary of aggregates quarries within the White Peak and are considered at risk through extension of currently permitted quarrying activity. In view of the planning and company policies it would seem unlikely that there would be any new areas of mineral extraction in this area that would have a significant adverse impact upon biodiversity. Any schemes that are consented, are also likely to have a high value restoration scheme that provides long-term benefits to local and national biodiversity priorities.	**Losses** Proposals for further extension of aggregates extractions within the White Peak are likely to be subjected to rigorous planning regulations and new biodiversity legislation limiting extraction to areas of negligible biodiversity interest. Climate change and other factors beyond the control of the industry, or the planning system that regulates it, are likely to have the most significant effects upon the biodiversity value of the aggregates workings. Commitment to the long-term management of created habitats would be required to ensure that biodiversity value does not decline in the future. Continued maintenance is essential to ensure that non-climax communities do not become dominated by secondary woodland or dense scrub communities that would reduce the overall diversity of the area.

Distant past	Recent past	Foreseeable future	Distant future
Gains Limestone quarries abandoned to naturally regenerate develop biodiversity interest as calcareous grassland colonises and becomes established. For instance, Rue Hill SSSI and Hopton Wood Quarry CWS are now recognised as of national and regional significance for the limestone grassland habitats they support. Old quarry faces also support regionally important lichen and other epiphytic flora, including nationally rare mosses, Appleyard`s Feather-moss. Miller's Dale SSSI is another good example, until 1930 Miller's Dale was an active limestone quarry, since abandonment natural re-colonisation has taken place and the quarry now supports species-rich calcareous grassland, with fragrant orchid, cowslip, early purple orchid, and harebell. Common blue and other Lepidoptera occur within the quarry and the cliff faces support nesting kestrel and jackdaw.	**Gains** Retained areas of calcareous grassland within non-operational areas of quarries are less likely to be agriculturally improved. Gains to biodiversity through creation of extensive areas of cliff habitats, suitable for nesting peregrine and raven. Peregrine populations within the White Peak are currently recovering following population crashes due to pesticides and persecution. The creation of pond clusters provide habitats suitable for great crested newts and a number of exceptional populations are recorded from aggregates quarries, including a population of international significance at Bees Nest and Clay Pit. The creation of bare limestone and metaliferous spoils, suitable for rare plant species has occurred, with quarries now supporting internationally important metalliferous flora communities. Abandoned limestone quarries such as Hopton Wood CWS, now managed as a nature reserve by Derbyshire Wildlife Trust support calcareous grassland, scrub and cliffs. This quarry has a rich diversity of orchids, including uncommon fly orchid and frog orchid, as well as fragrant orchid and common spotted orchid. Along the margins of the quarries scrub has invaded and in places woodland is well established, encouraging more shade-tolerant species including broad-leaved helleborine and common twayblade.	**Gains** Restoration of currently active limestone aggregates sites is likely to be completed between 2020-2050. As restored areas become established and populations of species expand to fill the new habitats created it is likely that a further increase in the populations of plants, invertebrates, birds and amphibians and other groups of biodiversity value would occur. Created habitats may become relatively more important for biodiversity in the event that agriculture continues to intensify. Sites restored to nature conservation after-uses will provide a refuge for wildlife regardless of what occurs in the surrounding countryside.	**Gains** Limestone aggregate quarries within the area will develop further biodiversity value through natural regeneration and as long-term restored habitats establish. Restoration proposals include provision of calcareous grassland, ash woodland, hay meadow, wet woodland, limestone heath, limestone scree, wetlands and open water. Restored quarries are managed for nature conservation and so long –term management of biodiversity interests is assured. Increased protection of restored and naturally regenerated quarries, through designation as CWS and SSSI provides a longer term guarantee to the biodiversity interests. Habitats created around silica sand extractions will continue to develop with acidic grasslands, acidic woodlands and other slow maturing habitats reaching their biodiversity potential. Sand pits and quarry ponds continue to provide important refuges for great crested newt.

Discussion and recommendations

The pilot study of the White Peak has highlighted a number of discussion points and recommendations for minerals operators and their regulators.

Methodological assumptions

Methods used to calculate broad habitat change in aggregates sites are imperfect, due to a lack of historical and contemporary habitat datasets for comparison. Therefore, the estimated gain or loss was calculated on the assumption of habitat homogeneity throughout landscape types and represents an obvious short-coming of the technique. However, it does provide a benchmark to make general comments on likely historical changes, and, importantly, provides a current baseline from which to assess future changes.

The LCM 2000 dataset is estimated to be broadly 90% accurate at a national scale. However, some shortfalls in the accuracy of the dataset at the fine scales studied have been highlighted by this study. It is recommended that the methodology used for LCM 2000 is refined for future studies of this kind.

Further analysis of habitats

Due to the current limitations of the LCM 2000 dataset it is possible that a significant amount of habitat of biodiversity value has been missed. This is likely to include areas of naturally colonising ground, limestone grassland on rocky substrates, undisturbed cliffs, recently restored habitats and other features such as vegetated screen and soil storage bunds. The LCM survey is likely to be repeated in the near future (2006). As technology and analysis methods improve, it is likely that there will be an improvement in the definitions of habitats, although the fundamental method of data capture and analysis are likely to remain the same.

In order to improve upon the broad habitat data captured by LCM2000, it is recommended that further analysis based upon the interpretation of aerial photographs and potentially from site visits be undertaken for ground-truthing. This ground-truthing could also provide answers to key questions such as:

- How long limestone grassland has to develop before it is identified as “calcareous grassland” by LCM 2000?
- What is the biodiversity value of bare ground and inland rock quarry features prior to restoration?

For example, many active limestone quarries provide habitat for peregrine falcon on cliff faces and orchid species on upper benches and the quarry margins where suitable undisturbed habitat is located. Active silica sand quarries are also likely to support sand martins.

Record-keeping

The availability of relevant biodiversity data, especially relating to species, is poor and the absence of detailed and comprehensive species data has meant that only broad trends in gains and losses to species can be inferred. The notable exceptions to this were the availability of comprehensive rare and notable plant data for Derbyshire and extensive great crested newt

records. However, despite the detail provided by these datasets, the information was not collected in a systematic survey of the whole study area and therefore it is possible that populations have not been fully recorded.

It is suggested that minerals operators and regulators store the results of biodiversity surveys carried out on minerals land in a central location, preferably following data standards set by the National Biodiversity Network. This would maintain an up-to-date database of biodiversity gains and losses and would assist with further studies of this nature.

Planning policy and guidance

It is the responsibility of policymakers in both national and local government to ensure that planning policy and legislation continues to conserve biodiversity. This responsibility is likely to be is likely to become more focussed and effective as county structure plans and local minerals plans are reviewed. It is recommended that the mineral companies and local planning authorities and other interest groups work together more closely to ensure that opportunities for biodiversity gains are realised during operation as well as at the restoration stage.

Post-restoration monitoring

As some of the former aggregate extraction sites in this study area are monitored or managed by a range of groups with nature conservation agendas it is recommended that in the future a process of feedback be established where they can make comment on the success (both intentional and incidental) of the restored mineral sites and the practicality of managing such features for biodiversity (this could also include observations on the ground conditions in old abandoned quarries of biodiversity interest). Such feedback may guide some of the restoration yet to be undertaken in the area and advise the industry in general.

Way forward

The method designed for the present study is seen as the first stage in a long-term monitoring programme of biodiversity contribution made by the aggregates industry. The methodological assumptions required to construct the historical view do not apply to future monitoring and it is therefore hoped that the predictions for biodiversity in the future made in this document are measured against the actual changes that occur within the Study Area over the coming generation. The challenge remains to meet and exceed the predictions made for the industry to contribute to biodiversity in the future.

Conclusion

An analysis of the biodiversity gains and losses of the aggregates minerals industry in the White Peak was undertaken. This analysis, summarised in a balance sheet, has shown that broad habitat changes have occurred, most significantly during the period 1947-2000. Estimates of habitat change have been calculated and examples of changes in the biodiversity value of specific sites and for specific species have been highlighted.

Historical and more recent losses of habitats and species have occurred, mainly as a result of land take. Many historically quarried areas, even in the absence of planned restoration, have now developed into sites of up to international nature conservation importance in their own

right. It is hoped that with appropriate restoration techniques and long-term management currently quarried areas can develop into habitats that are of higher biodiversity value than surrounding agricultural land.

It is considered that completed, existing and future aggregates extractions within the White Peak can continue to provide habitats of high biodiversity value into the future through:

- continued avoidance of existing areas of biodiversity value, especially non-replaceable habitats such as ancient woodland and limestone dales;
- the focus of biodiversity led-restoration; and
- commitment to long-term management of restored areas.

It is clear that in the White Peak an individual quarry has an exceptionally long lifespan, well beyond the length of a human generation. The current review of losses and gains in this Study Area suggests that biodiversity for the current generation is in a negative balance. The analysis technique used fails to pick up some of the subtleties of temporary habitats that may also be of biodiversity importance and recommendations have been made to assess this further. However, in the long term, as the industry ceases to operate in the area and restored sites begin to establish there is potential for a number of aggregates sites to develop high biodiversity value. These sites are likely to support habitats such as limestone grassland, scree and broad-leaved woodland that are high priorities under current biodiversity policies and therefore the potential for long-term gain is high.

Appendix 1 Ballidon Quarry case study

Introduction

Ballidon Quarry is situated 15km of the north west of Ashbourne, Derbyshire within the Peak District National Park. The quarry has been a commercially active operation since the 1930s. Quarrying is currently undertaken by Tarmac and is scheduled to finish operating in 2037. A restoration plan, which began implementation in 1999, aims to create habitats of biodiversity value within the quarry following recommendations of the Ballidon Biodiversity Action Plan prepared in 2003.

Ballidon Quarry is within the White Peak Natural Area, within a landscape of agricultural grassland, calcareous grassland and meadows, oak and ash woodland and broad riparian corridors and occurs at the southern end of limestone deposits in the Peak District National Park.

Current Biodiversity within Ballidon Quarry

The quarry is made up of two areas, Ballidon Quarry to the south of Ballidon Dale SSSI and Wood Barn Quarry to the north and west of Ballidon Dale SSSI. These two areas are linked by a tunnel. Both quarries are currently active.

The active areas of the quarries generally support floral and faunal communities of low diversity, with abundant areas of bare ground. Areas of exposed rock and spoil that have colonised naturally often support differing amounts of small herbs and/or dense patches of grassland dominated by ruderal species. Other areas have been restored to grassland or plantation.

Overburden mounds restored to grassland support a range of coarse grasses and common herbs, including harebell and small scabious. Other restored overburden mounds support a wider range of grassland species and one has been restored for agricultural use.

A number of areas in and adjacent to the quarry have been planted with woodland, these support and number of different species although sycamore tends to dominate, with grey alder, elder, hawthorn and ash often occurring.

A number of bird species have been recorded in the quarry or its immediate surrounds. These include the following species of conservation concern:

- peregrine falcon, a UK BAP long list species;
- grey partridge, a UK BAP priority species;
- linnet, a UK BAP priority and RSPB Red list species;
- skylark, a UK BAP priority and RSPB Red list species;
- kestrel; a UK BAP long list and RSPB Amber list species; and
- jackdaw and raven, cliff nesting birds, are also associated with the quarry.

Badgers and moles are also likely to be present in the area. A number of widely distributed grassland butterfly species have been recorded, especially on restored grassland, these included meadow brown, small heath, common blue, small skipper, large skipper and red admiral.

Current biodiversity outside Ballidon Quarry

The habitat surrounding the quarry boundaries is considered to be of nature conservation value and includes a large area of SSSI-designated habitat, Ballidon SSSI.

Ballidon SSSI extends over 51 ha and forms the eastern edge of Ballidon Quarry. It has extensive tracts of species-rich limestone grassland, with the differing slopes and aspects of the dales providing a variety of grassland communities and supporting a number of rare and local butterflies and moths have been recorded in the SSSI, including the chalk carpet moth.

The extension of Ballidon Quarry into Wood Barn Quarry has altered the south western section of the main dale and the southern part of the western dale of the SSSI and has caused loss of areas of formerly designated SSSI habitats from these areas. Planning permission within further areas of the SSSI has been rescinded.

Changes in broad habitat biodiversity due to quarrying

It is clear that quarrying activity has led to a change in the presence and abundance of habitats and species within Ballidon Quarry. The majority of losses to biodiversity are likely to have occurred when quarrying was begun. Local, small scale extractions are likely to have occurred in the decades prior to the formalisation of the area as a commercial venture in the 1930s.

Table 1 below shows the area and direction of change (gain or loss) in broad habitats within Ballidon Quarry, estimated using LCM 2000 broad habitat information.

The change in broad habitats within Ballidon Quarry has been estimated by calculating the difference between the current proportion of a broad habitat within the planning permission boundary and the current proportion of the same habitat in the surrounding landscape type (LCT – 52 HLN High Limestone Dales). Only those habitats where there has been a measurable change are reported in the table.

The calculation is based upon the assumption that broad habitats occur in the same proportion throughout the High Limestone Dales landscape type (52HLN), regardless of inter-type topographic, climatic and edaphic conditions. This calculation also assumes that Ballidon Quarry contained the same proportion of habitats as the surrounding landscape prior to extraction. These generalisations of habitat homogeneity represent a short-coming of the use of this technique at this small scale. However, it does provide a benchmark to make general comments on the likely broad habitat gains and losses that have occurred as a result of aggregate extraction in Ballidon Quarry.

For instance, 2.7% of the total land area of the High Limestone Dales landscape type is broad-leaved woodland. It can be assumed that Ballidon Quarry would have also supported 2.7% by area of broad leaved woodland, had quarrying not occurred. Ballidon Quarry is calculated to currently support only 0.5% broad-leaved woodland, which is assumed to

represent a total area decline of 2.2%, or a decrease of 1.54 hectares of broad-leaved woodland.

However, visual analysis of recent aerial photographs suggests that woodland is not an extensive habitat type in the vicinity of Ballidon Dale, with the majority of tree cover provided by hedgerows and hedgerow trees and may well account for less than 2.7% of the land area. In addition to this; misclassification of an area of small fields with hedgerow boundaries as broadleaved woodland gives the impression that the landscape is more densely wooded than it actually is. Both these observations suggest that the total change in broad-leaved woodland habitats within the quarry may in fact be less than the total calculated using the method described above.

Table 1 – Estimated area and direction of change in broad habitats at Ballidon Quarry

LCM 2000 habitat type		Percent change	Estimated change in habitat (ha)	Direction of change
Broad habitat type	**Code**			
Broadleaved, mixed and yew woodland	1.1	-2.2	-1.54	Decrease
Coniferous woodland	2.1	-0.1	-0.07	Decrease
Arable and horticulture - cereals	4.1	-2.5	-1.75	Decrease
Arable and horticulture – unknown crop, bare ground	4.2	13.3	9.31	Increase
Improved grassland	5.1	-16.7	-11.69	Decrease
Neutral grassland	6.1	-0.2	-0.14	Decrease
Calcareous grassland	7.1	-39.1	-27.37	Decrease
Bracken	9.1	-2	-1.4	Decrease
Dwarf shrub heath	10.1+10.2	-0.4	-0.28	Decrease
Inland rock	16.1	10.7	7.49	Increase
Built up areas and gardens	17.1	-1.4	-0.98	Decrease
Continuous urban	17.2	40.5	28.35	Increase

Table 1 above suggests that the largest increase has been in continuous urban habitats. Figure B1.7 suggests this to be a misclassification for the floor of the working quarry. Other major increases are of bare ground and inland rock habitats. These three habitats represent the majority of the active area of the quarry and currently comprise 64.5% or 45 ha of the total permitted area of the quarry. The remaining broad habitats of the quarry are found in the retained habitats outside the permitted extraction area and restored land.

Semi-natural habitats are relatively uncommon in Ballidon Quarry, with only broad-leaved, mixed and yew woodland; improved grassland; and calcareous grassland occurring in any quantity. The proportions of these habitats is significantly lower than in the surrounding landscape and it can be inferred that these habitat types are the most likely to have been lost through the extraction of limestone from Ballidon Quarry.

There has been an estimated loss of 27 ha of calcareous grassland that would have formerly been found within the quarry, accounting for nearly 40% of the total land area of the quarry. Improved grassland habitats have also undergone a decline, accounting for an estimated decrease in 12 ha of habitat. Other habitats, eg broad-leaved woodland, bracken, built-up

areas and gardens, cereal crops, dwarf shrub heath, neutral grassland and coniferous forest, have also undergone small declines.

A number of broad habitats found within the Natural Area are not recorded within Ballidon Quarry, although this is likely to be an artefact of the small area of quarry, compared to the surrounding Natural Area; meaning that the likelihood of encountering small and locally distributed habitats is significantly smaller. This is considered to be the case with habitats that are uncommon in the surrounding landscape. For instance coniferous woodland, acid grassland, set-aside, fen, marsh and swamp, neutral grassland, dwarf shrub heath and open water.

Through a comparison with the habitats of Ballidon Dale, which have not undergone the same degree of agricultural improvement as other areas, it can be inferred that the quarry could have supported species-rich calcareous grassland, neutral grassland, semi-natural woodland and scrub prior to quarrying beginning. However, agricultural intensification has meant than grassland habitats in the surrounding non-SSSI areas are now predominantly improved and of lower biodiversity value.

It is interesting to note that 25%, or nearly 18 hectares, of grassland within Ballidon Quarry has been classified as improved by LCM 2000. However, field survey has shown that many of the grasslands within the quarry have been restored and support a species-rich, if coarse, sward of both circum-neutral and calcicolous grasses and herbs. These herb-rich grasslands are known to support populations of butterflies, amongst other wildlife. This apparent inaccuracy of the LCM data may be repeated across the data analysis, potentially underestimating the biodiversity contribution of restored grassland areas.

Designated nature conservation sites

Figure B1.7 clearly shows that the planning permission boundary of Ballidon Quarry encroaches upon Ballidon Dale SSSI. Closer examination of aerial photographs show that the large majority of SSSI-designated land within the planning permission boundary of the quarry has not been directly affected by quarrying activity. However, the shape and extent of the western arm of Ballidon Dale do appear to have been altered by the tunnel and extension into Wood Barn Quarry.

Surrounding and partially within Ballidon Quarry is 92 ha of land listed as calcareous and mesotrophic lowland grassland inventory site. Approximately 10ha of this site, first surveyed in 1989, are now recorded as Inland Rock or Continuous Urban habitats within the working area of the quarry and are likely to have been removed by quarrying in the intervening time. Habitats within this area may have included grassland habitats of high biodiversity value.

Potential future gains to biodiversity

Ballidon Quarry has a detailed restoration plan, which will be progressively implemented until completion in 2037. This will lead to an increase in the biodiversity value of the site over time. The restoration plan will result in 71.46 hectares of land being created and managed principally for biodiversity, with a number of the habitat types created being UK or Peak District (Local) BAP Priority habitats. Full details of the specific areas for each habitat type are given in Table 2.

Table 2 - Summary of each habitat type restored at Ballidon Quarry and the approximate area for each habitat type

Habitat type created	Approximate area due to be created (ha)
Upland calcareous grassland	33.1
Mesotrophic hay meadow	18.3
Ash woodland	3.8
Oak-birch woodland	9.2
Wet woodland	1.2
Limestone scree	0.7
Limestone heath	0.7
Ponds	1.4

Restoration at Ballidon Quarry began in 1999 with the first of a series of five year restoration plans within inactive areas. As part of the restoration, calcareous grassland was sown across north-facing slopes of one of the spoil tips; this work is due for completion in 2004. The final stage of the restoration will not be completed until 2037 with the completion of quarry floor restoration and the development of habitats including neutral grassland, ponds, wet woodland and limestone scree. It should be noted that the planning of restoration at Ballidon Quarry has been written with respect to the already restored and recolonising vegetation, as well as the habitats present in the adjacent SSSI.

A number of the habitats that are proposed are national BAP priorities, these include:

- upland calcareous (limestone) grassland, created to extend the resources of this habitat surrounding Ballidon SSSI;
- unimproved calcareous pasture and hay meadows (neutral grassland);
- upland mixed ash woodland and upland oak woodland, created through planting and enhancement of existing plantations; and
- wet woodland, created through new planting within restored damp habitats on the quarry floor.

Peak District BAP habitats that are proposed under the restoration are:

- limestone scree, cliffs and scrub are habitats that form essential parts of the Limestone Dales mosaic habitat type that would be created in part within the restored quarry; and
- ponds, which would include the potential restoration of an abandoned dew pond and quarry settling ponds.

In addition to these habitats, notable species would potentially be attracted to the restored quarry. Whilst it is very difficult to predict the species that would be attracted to created or restored habitats, the restoration of Ballidon may benefit the following UK BAP and local Peak District BAP species: song thrush, linnet, grey partridge, skylark, tree sparrow, corn bunting, peregrine and brown hare. Additionally it was felt that number of butterfly and

moth species could also benefit, including white-letter hairstreak butterfly and chalk carpet and light-feathered rustic moths.

The implementation of restoration work, in addition to other projects such as increasing farmland biodiversity in the surrounding area are hoped to further enhance the biodiversity of the area.

Residual losses and gains to biodiversity

Earlier sections of this report describe changes in biodiversity in a snapshot of time, whilst Ballidon Quarry is still within its operational phase. Following restoration, the biodiversity contribution made by the formally quarried areas is likely to increase, as a result of the creation of habitats of biodiversity value. Table 3 aims to show the final, or residual, changes in biodiversity, as measured by broad habitat type, following completion of quarrying activity and the proposed restoration.

Table 3 – Residual loss or gain of broad habitats at Ballidon Quarry following restoration completed by 2037

LCM 2000 habitat type		Current area of broad habitat (ha)[1]	Broad habitats proposed by restoration by 2037 (ha)[2]	Residual loss (-) or gain (+) of habitat in 2037 (ha)
Broad habitat type	Code			
Broadleaved, mixed and yew woodland	1.1	0.38	14.2	+13.82
Arable and horticulture – unknown crop, bare ground	4.2	11.66	0	-11.66
Improved grassland	5.1	17.89	0	-17.89
Neutral grassland	6.1	0	18.3	+18.3
Calcareous grassland	7.1	2.02	33.1	+31.08
Bracken	9.1	0.24	0	-0.24
Dwarf shrub heath	10.1+10.2	0	0.7	+0.7
Inland rock	16.1	9.29	0.7	-8.59
Standing open water	13.1	0	1.4	+1.4
Continuous urban	17.2	28.56	0	-28.56
TOTAL		**70**	**68.4**	

[1] LCM 2000 (CEH)
[2] Ballidon Biodiversity Action Plan, July 2003

Table 3 above shows the habitats that are projected to be present at Ballidon Quarry by 2037 and calculates the projected change in these habitats from the current baseline. This table should be interpreted with caution as habitat creation is an inexact science and the habitats desired through restoration, and those that actually develop, may be different.

The table indicates that habitats of biodiversity value, namely broad-leaved woodland, neutral grassland, calcareous grassland, heath and standing open water would be created, resulting in a net gain of these habitats types over the time period 2003-2037. Man-influenced habitats of lower biodiversity importance, eg continuous urban, inland rock, improved grassland and bare ground would be lost.

A comparison with the targets set under both UK and Peak District BAPs shows that the restoration of Ballidon Quarry would help to achieve BAP targets for the following habitats in the long-term:

- wet woodland, UK BAP target of 3,375 ha created by 2015;
- upland ash wood, UK BAP target of 6,000 ha created by 2015;
- upland oak wood, UK BAP target of 7,000-10,000 ha created by 2015;
- limestone Grassland, UK BAP target of 1000 ha created by 2010;
- neutral grassland (lowland meadow), UK BAP target of 500 ha created by 2010;
- limestone Dales, Peak District BAP target of 10ha by 2010;
- ponds, Peak District BAP target of restoration of 50% existing ponds by 2010 and recreation of 100 new ponds by 2010.

However, it should be noted that all BAP targets are set to be achieved by 2010 or 2015, whereas Ballidon would not be restored until 2037.

In addition to the contribution to BAP targets, the restored Ballidon Quarry would create a local landscape that would be more diverse, in terms of the habitats present, than the existing baseline habitats of the surrounding landscape character type, High Limestone Dales (52-HLN). The restored quarry would support habitats of conservation importance that are uncommon within the surrounding landscape, such as limestone heath, limestone scree, wet woodland and ponds.

Conclusion and recommendations

From this case study it is clear that there have been changes to the broad habitats within Ballidon Quarry due to quarrying activity. The major habitats gained through quarrying are inland rock, urban habitats and unknown arable (bare ground) habitats; which are likely to have replaced calcareous grassland, improved grassland and small areas of broad-leaved, mixed and yew woodland and other habitats. Other habitats appear to play a lesser role, although the biodiversity benefits provided by small areas of semi natural habitat, for instance, neutral grassland, should not be underestimated.

Comparison between the broad habitat information available from LCM 2000, recent aerial photographs and pre-existing ecological survey has shown that, broadly speaking, LCM 2000 is capable of identifying changes in broad habitat types. However, misclassification of habitat has occurred; notably the interpretation of restored, species-rich grassland within the quarry as improved grassland and the interpretation of close networks of hedgerows as woodland blocks.

Further detailed analysis at the site level has revealed that only very small areas of SSSI designated habitats have been affected by quarrying, despite larger areas occurring within the planning permission boundary. An area of approximately 10 ha of calcareous grassland listed on the national Lowland Grassland Inventory has been lost through quarrying activity.

The restoration plan reviewed indicates that, in the long term, the habitats created during the restoration process would replace lost habitats with those of potentially higher biodiversity

value, such as oak and ash woodland, calcareous grassland and limestone dale habitats. The habitats created have potential to contribute towards future UK and Peak District BAP targets, although they will not be created until after the end of the current BAPs. The appropriate management of created habitats during the long term (2037 and beyond) would be required to ensure that habitats maximise their biodiversity potential.

In conclusion, it is currently considered that Ballidon Quarry is at a period of its life-cycle when it is not achieving its full biodiversity potential; as many of the habitats it currently supports are of low ecological value for flora and fauna. However, proposed restoration in the future means that it is likely to develop additional biodiversity value in the future.

References

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Part B2 - Biodiversity audit – Northamptonshire Vales

Executive summary

Extraction of aggregates, most notably sand and gravel, has probably occurred in some form for hundreds of years in the Northamptonshire Vales. Along with other changes in land use in the area, there is very poor documentation to show what was present before the industry expanded to its current extent.

A method has therefore been developed (See Part A - Evaluation of Techniques in Pilot Study Areas) to assess losses and gains to biodiversity through the minerals industry and applied in the Northamptonshire Vales pilot study area. Data used to assess biodiversity are imperfect, and methodological assumptions and statistical inaccuracies in the main broad habitat dataset (Land Cover Map 2000) are highlighted in the main report.

It is estimated that a total of 3031 ha of land within the Northamptonshire Vales has been the subject of planning permissions for aggregate extraction since 1947. Sand and gravel extraction is by far the largest proportion of this industry, although limestone is also quarried. Analysis of the Northamptonshire Vales Study Area showed the vast majority of aggregate extraction occurs within a single Landscape Character Type (LCTs), the Nene Valley (89RBN), accounting for 98.5% of the total extraction within the Study Area.

- analysis of change in broad habitats in the recent past (1947-2000) within aggregates extractions in the Nene Valley, when compared to a modern-day baseline which has shown a general decline in habitat quality since 1947, has shown that there has been:
- an estimated decline of 822 ha of agricultural land uses (improved grassland, arable and horticulture);
- an estimated decline of 104 ha of built up areas and gardens
- an estimated increase at 605 ha of open water habitats;
- increases in calcareous grassland, estimated at 95ha; and
- increases in both broad leaved woodland and coniferous woodland, estimated at 191 ha and 75 ha respectively;

Other broad habitats eg set aside, inland rock, neutral grassland, non-annual arable crops and continuous urban habitats have not show any significant change in area over the given period. Loss of built up areas and gardens could be attributable to the restoration of ancillary areas such as offices and workshops associated with quarries.

Within inactive sand and gravel extraction sites a large number of habitats of conservation importance now occur. Aggregate planning permission boundaries include 100 ha of SSSI designated land, comprising four sites. Higham Ferrers Gravel Pit SSSI (103 ha) and Titchmarsh Duck Decoy SSSI are directly derived from former sand and gravel extractions. Disused aggregates workings, predominantly sand and gravel, represent greater than 30% of the total area of county-level nature conservation sites, with over 900 ha of County Wildlife

Site and Northamptonshire Wildlife Trust Nature Reserves within former aggregates workings. This represents a significant proportion of the total biodiversity resource in the Northamptonshire Vales.

A wintering bird population of national importance has developed on the complex of flooded gravel pits in the area, including internationally important populations of gadwall and golden plover. The effects of the aggregates industry upon the majority of other indicator species were difficult to measure, due to the absence of complete survey data. The species data reviewed suggested the broad habitats within aggregates planning permission boundaries support a range of species typical of those habitats.

Whilst only a small number of current restoration plans have been examined, it appears to be the case that biodiversity-led restoration plans are popular. The focus of restoration plans appears to be open water, wetland, grassland and woodland habitats. The focus of restoration planning has shifted in the past, being dependant upon the planning policies at the time. Emerging planning policy within the Nene Valley suggests that land-based restoration, such as restoration to agriculture and parkland, may be promoted instead of the current focus upon open water and wetland habitats.

It is clear, in the Northamptonshire Vales, that there has been a significant contribution to biodiversity resulting from the extraction of aggregates. Abandoned and naturally regenerated sand and gravel extractions and more recent restored extractions support a range of species, including wildfowl, waders, dragonflies, butterflies, water vole and wetland plants, of at least regional biodiversity value. In the case of wintering birds, the valley is considered to be of at least national importance and may qualify as a site of international importance for wetland birds, ie through its regular support of over 20 000 birds.

Planning polices ensure that impacts upon biodiversity are considered when a planning application is determined and conditions are set by the local planning authority. Further to this all existing sites with planning consent are subject to review every 15 years. In recent years there has been significant recognition of biodiversity issues by the minerals industry and as a result many operators have developed their own policies relating to biodiversity and have established close working relationships with nature conservation organisations. As an example, Hanson Aggregates have worked closely with the RSPB in the Nene Valley.

The handover of a number of the sites that have been restored to a nature conservation after-use to the county council, Northamptonshire Wildlife Trust and other nature conservation bodies ensures that biodiversity monitoring and appropriate management of habitats is likely to continue in the long-term. Further to this, the proposed designation of the Nene Valley as a SSSI/SPA for its important overwintering bird population provides statutory protection of the biodiversity interests and ensures that suitable management of the area shall continue.

It is considered that completed, existing and future aggregates extractions within the Northamptonshire Vales can continue to provide habitats of high biodiversity value into the future through:

- continued avoidance of existing areas of biodiversity value;
- the focus of biodiversity led-restoration; and

- commitment to long-term management of restored areas and areas of high biodiversity value within the ownership of the minerals industry..

It is concluded that, in the Northamptonshire Vales, there has been a significant contribution to biodiversity resulting from the extraction of aggregates and that any new schemes that are consented are likely to be restored to provide long-term benefits to local and national biodiversity.

Introduction

SLR Consulting Ltd (SLR) has been commissioned by English Nature on behalf of the Minerals Nature Conservation Forum (MNCF), to undertake a pilot study of the minerals industry's contribution to and impacts upon biodiversity.

This is the third (Part B2) of three documents that present the findings of the pilot study. The first report (Part A) describes and reviews sources of information available with which a biodiversity change audit can be carried out. It was found that there is no suitable information source that could be used to make a direct comparison of losses and gains to biodiversity over the time period set by the project (1947-present day). The second report describes a pilot study of the biodiversity changes due to the limestone extraction industry in the White Peak of Derbyshire.

The most effective method was determined to be the use of a range of information sources, these were:

- "baseline" habitat data from UK-wide remote sensed land use/broad habitat data (Land Cover Map 2000);
- national and local nature conservation site inventories;
- national inventories for UK BAP Priority habitats; and
- survey and biological record data for a selection of indicator species relevant to each study area.

These various datasets were queried using a Geographical Information System (GIS) and were considered to represent the best available information to undertake a selective, yet representative, audit of biodiversity. The method chosen provides the additional benefit that the major data sources used are likely to be updated and repeated in the future, thereby providing a useful baseline for monitoring future change.

This report describes the results of the pilot biodiversity audit for the Northamptonshire Vales study area, providing a comparison of apparent losses and gains to biodiversity attributable to the extractive industry.

The final section of this report concludes with a review of the ways in which the extractive industries are contributing to biodiversity within the Northamptonshire Vales, which should be regarded as good practice that should be encouraged through the mineral planning process.

Report structure

The following biodiversity audit report has been divided into the following sections:

Section 2: Data sources;
Section 3: The study area;
Section 4: Data analysis;
Section 5: Balance sheet;
Section 6: Discussion and recommendations; and
Appendix 1: Case study – Stanwick Quarry

Data sources

Introduction

Part A of this report has explained the rationale behind the selection of data types and the methods used to analyse them. Table 1 presents a brief summary of the data sources that have been used for the biodiversity audit of the Northamptonshire Vales and describes any constraints within those data that may have an effect upon the final analysis.

Table 1 – Summary of data sources, methods and constraints for the Northamptonshire Vales biodiversity and minerals study

Biodiversity feature	Data source	Analysis methods	Constraints on use and extent of data
Broad Habitats	Countryside Survey LCM 2000 in GIS polygons.	Estimation of change of broad habitat lost in minerals sites compared to a baseline derived from the proportion of broad habitats within each Landscape Character Type.	LCM 2000 is estimated to be 80-90% accurate by CEH. Inaccuracies in classification become more apparent at small scales or habitats of limited extent, eg ponds, linear and boundary features are often under-recorded.
Designated Areas – National Inventories	SSSI, cSAC, SPA and NNR inventories. English Nature data in GIS polygons. Citations for SSSI and SAC.	GIS calculation of the coincidence of minerals planning area polygons with SSSI polygons.	Boundary data for SSSI designated areas is definitive English Nature data and therefore of high accuracy. No data available from English Nature for areas of SSSI quality habitat that may have been damaged or lost, except that reported in citations.
Designated Areas – County Inventories	Northamptonshire Wildlife Trust County Wildlife Sites (GIS polygons).	GIS calculation of the coincidence of minerals planning area polygons with CWS polygons.	Northamptonshire CWS datasets have been recently updated (2000-2002) and are of high accuracy, only very limited data available on habitats and species supported by CWS sites.
Priority Habitats	EnglishNature Priority Habitat Inventories for lowland grassland, lowland heathland, and upland	GIS calculation of the co-incidence of minerals planning area polygons with Priority Habitat polygons.	Lowland Heathland Priority Habitats are provisional. Lowland grassland Inventory data was compiled 1980-1990 through field survey. Ancient Woodland Inventory was compiled from historic maps and has not been

Biodiversity feature	Data source	Analysis methods	Constraints on use and extent of data
	heathland. English Nature Ancient Woodland Inventory. All GIS polygons.		ground-truthed.
Species data	Northamptonshire Wildlife Trust biological records database.	GIS co-incidence analysis of indicator species records and minerals planning permissions area polygons.	The unknown quality of anecdotal species data means that the absence of records for a species does not imply it is not present at a site. Species records within Northamptonshire are sparse, due to the lack of a well-established local Records Centre.
WeBS Data	RSPB.	GIS mapped summary data of wetland and wildfowl bird counts undertaken between Sept 02 and March 03.	Data collected from a total of 122 individual gravel pits within the River Nene valley. Pits outside the valley would not have been recorded.

Notes:

LCM 2000	Land Cover Map 2000, remote-sensed land use/broad habitat data
CEH	Centre for Ecology and Hydrology
SSSI	Site of Special Scientific Interest
cSAC	candidate Special Area of Conservation
SPA	Special Protection Area
NNR	National Nature Reserve
GIS	Geographical Information System
CWS	County Wildlife Sites (Second Tier Nature Conservation Sites)
WeBS	The Wetland Birds Survey, Wildfowl and Wader Counts (RSPB, BTO, WWT and JNCC)

The study area

Introduction

The following section outlines the work undertaken to define the scope of the study. The scope includes the definition of the Study Area and the types of extraction to be assessed.

Types of mineral extraction

It was agreed with the Steering Group that the biodiversity audit should focus upon above ground aggregates workings that have continued or begun operating since 1947. Within the study area, aggregates are predominantly extracted from sand and gravel deposits; but limestone workings outside the valley also occur. Other types of minerals; notably clay and ironstone are used in different industries and are not considered further by this study. A complete list of aggregate extraction sites in the study area is provided on Figure B2.1.

Historical aggregates extractions, ie those completed prior to 1947 have been excluded from the pilot audit. This was for two reasons:

- to prevent the introduction of what might be perceived as bias from long-abandoned workings that have had decades to develop biodiversity interest as a result of abandonment and low-intensity management;
- to ensure that the analysis only examines the industry that has been subject to planning regulations,ieit is the modern minerals industry; and
- to avoid logistical problems with identifying quarries that were active prior to the introduction of planning legislation.

Where areas of pre-1947 workings are included within the planning permission boundaries of current aggregates workings, there was no method to remove them from the assessment. Where such older workings have been incorporated into a planning permission it is considered likely that its operation would then come under the same range of the planning policy guidelines as a post 1947 permitted site (apart from location). Figure B2.1 shows that of forty-eight aggregate quarries that were included within the study, forty-five of these workings are now recorded by the British Geological Survey (BGS) as inactive.

Based on SLR's understanding of recent development in the quarry industry in the study area, it is apparent that some pits have amalgamated and others have closed, or have been "mothballed" since the BGS collected the information. All quarries with a recorded planning history are considered in the same way in this analysis.

Defining the study area

The study area of the Northamptonshire Vales was originally set as the Character Area boundary, ie the biogeographic area of Northamptonshire Vales defined by English Nature and the Countryside Agency in 1998. This boundary was further refined by sub-dividing it by the Landscape Character Types (LCT) that fall within the Character Area. Landscape Character Typology has arisen through the living landscape project, led by the Countryside Agency. The definition of LCTs can be seen as a finer grain landscape-scale characterisation of the English countryside.

LCTs have been derived by an analysis of soils, geology, woodland pattern and extent, settlement pattern and topography. The sub-division of the study area by LCT was assumed to provide a more accurate picture of habitat diversity than using the Character Area boundary as a single unit. The LCTs that comprise the Northamptonshire Vales study area are shown on Figure B2.2.

An advantage of refining the study area by LCT has been to focus the study upon the LCTs where the majority of the aggregates extraction has occurred. Table 2 clearly shows that for the Northamptonshire Vales Character Area only a small proportion of its component LCTs, four out of a total of thirteen actually contain significant areas of current mineral extraction.

With the exception of six small outlying sand and gravel pits, and a single outlying limestone quarry, Boughton Green Road; all aggregate quarries are within the River Nene Valley. Table 2 clearly shows that for the Northamptonshire Vales Character Area only a very small proportion of its component LCTs, four out of a total of thirteen, actually contain areas of mineral extraction. From these four, one LCT, 89RBN, contains the vast majority of the sand and gravel extraction, accounting for 98.5% of the total area. This is probably because the

other LCTs within the Northamptonshire Vales do not contain significant aggregate resources, being predominately on clay soils, and do not, therefore, have a history of aggregate extraction and its associated infrastructure.

Table 2 - Analysis of total area of permitted aggregate quarries by landscape character type in the Northamptonshire Vales Study Area
(Figures calculated from BGS Minerals Planning Data and Countryside Agency LCT data, using GIS, rounded to the nearest hectare).

LCT	Landscape Character Type description	Total area of LCT in Northamptonshire Vales Natural Area in hectares (% of total area)	Total area of LCT within consented aggregate sites within Northamptonshire Vales in hectares (% of total area)
88RCA	A landscape type of intermediate clay land with ancient woods.	6563 (7.3)	8 (0.3)
88RCN	A landscape type of intermediate clay land with nucleated settlements.	207 (0.2)	0
88Urban	Urban	<1	0
89LCN	A landscape type of lowland clay land with nucleated settlements.	6260 (6.9)	0
89RBN	A landscape type of intermediate other light land with nucleated settlements.	38117 (42.2)	2982 (98.4)
89RCN	A landscape type of intermediate clay land with nucleated settlements.	18968 (21.0)	27 (0.9)
89Urban	Urban	5016 (5.5)	5 (0.2)
91RCA	A landscape type of intermediate clay land with ancient woods.	4496 (5.0)	8 (0.3)
91RCN	A landscape type of intermediate clay land with nucleated settlements.	7314 (8.1)	0
92RCA	A landscape type of intermediate clay land with ancient woods.	443 (0.5)	0
92RLA	A landscape type of intermediate limestone land with ancient woods.	233 (0.3)	0
93RCA	A landscape type of intermediate clay land with ancient woods.	17	0
95RBN	A landscape type of intermediate other light land with nucleated settlements.	2184 (2.4)	0
95RCN	A landscape type of intermediate clay land with nucleated settlements.	80 (0.1)	0
95Urban	Urban	490 (0.5)	0
TOTAL		**90388 ha**	**3031 ha**

Eleven LCTs within the character area of the Northamptonshire Vales contain no permitted sand and gravel extractions. A further three LCTs contribute 1.5% (or 48 hectares) of the total permitted limestone extraction within the Northamptonshire Vales study area. These fifteen LCTs were excluded from the broad habitat analysis, on the basis that the areas of extraction concerned were insignificant to the total and would have created anomalies in those figures of the areas that truly represent the minerals industry in the Northamptonshire Vales.

Together, the fifteen excluded LCTs account for 48% of the study area and only 48 ha (1.5%) of the total area of permitted extraction. Therefore only 89RBN is considered further by this broad habitat study. This LCT covers the major part of the River Nene Valley, running approximately west to north-east across the Study Area. For ease of reference, LCT 89RBN will be referred to as the Nene Valley, although it should be noted that the area also includes tributary valleys of the Nene.

Active and inactive aggregate extraction

Within the aggregates industry of the Nene Valley, only two gravel pits are listed by the BGS as currently active. These are the Earl's Barton Complex and Stanwick/Irthlingborough. All other minerals extractions are listed as being currently inactive. The length of time these extraction sites have been inactive was not recorded in the data provided by the BGS.

Table 3 shows that active mineral planning permissions account for 403ha of the Nene Valley. This is likely to be an over estimate of the total active area, as within the planning boundaries for each of these sites are non-operational land (*i.e.* land outside the extraction zone), restored land and land yet to be worked. The remaining 2628 ha of aggregates planning permissions within the Nene Valley are inactive and are presumed to be either restored or undergoing restoration.

Table 3 – Total area of permitted active and inactive aggregate sites within the Northamptonshire Vales

Active sites	Inactive sites	Total area of permitted aggregates sites
403 ha	2628 ha	3031 ha

Data analysis

The data analysis for the biodiversity audit has been largely undertaken using a Geographical Information System (GIS), a computer system capable of handling and analysing large quantities of spatially referenced data. The data analysis has been undertaken for each of the assessed biodiversity features separately. These features are:

- broad habitat type (LCM 2000);
- designated site inventories;
- priority habitat inventories; and
- species records.

Broad habitats

The broad habitat analysis, derived from the LCM 2000 dataset, provides an overview of the broad habitat types currently present within quarried areas and the broad habitats present in areas within the same landscape type that have not been quarried. This information is analysed further to provide an overview of the types of habitats that have been gained and lost from mineral extraction areas.

This baseline information has then been used to compare areas with consents for mineral extraction and areas outside consent boundaries, and to make inferences as to the losses and gains of habitat that have resulted from the industry in these areas. Current baseline data have been used for the comparison because historic data were not available and because this approach allows a comparison with the current land use situation, not comparison with habitats that may have been present within extraction areas and the surrounding landscape prior to extraction.

Baseline broad habitat data, provided by the LCM 2000 dataset, were used to calculate the area and proportion of habitats that have been gained. As a single baseline date has been used the "gains" in actual fact represent a snapshot of the habitats within a quarry at the time LCM 2000 data were collected. This will include habitats that have been retained within the non-operational areas of a quarry; habitats that have been either created or developed on previously quarried land; and habitats that have arisen through the operation of the quarry.

A comparison between the proportion of present-day habitats within aggregates quarries and the proportion of habitats in the surrounding landscape (defined as the LCT boundary) allows inference to be drawn on the type, proportion and ultimately area of habitats that may have been lost as a result of aggregates extraction within the Study Area.

Table 4 - Proportion of broad habitat types in the Nene Valley landscape type (89RBN) and within aggregate quarries

LCM 2000 habitat type		Habitats within consented aggregates sites		Baseline of broad habitats in Northamptonshire Vales	
Broad habitat type	**Code**	**Area (ha)**	**Proportion (%)**	**Area (ha)**	**Proportion (%)**
Broadleaved, mixed and yew woodland	1.1	368.9	12.4	2108.2	6.0
Coniferous woodland	2.1	96.5	3.2	263.5	0.7
Arable and horticulture – Cereals	4.1	359.1	12.0	9287.4	26.4
Arable and horticulture – bare, other, unknown	4.2	602.9	20.2	10109.0	28.8
Arable and horticulture – not annual crop	4.3	22.9	0.8	269.9	0.8
Improved grassland	5.1	220.0	7.4	4205.9	12.0
Set aside	5.2	15.9	0.5	921.2	2.6
Neutral grassland	6.1	58.8	2.0	1130.7	3.2
Calcareous grassland	7.1	375.0	12.6	3319.4	9.4

LCM 2000 habitat type		Habitats within consented aggregates sites		Baseline of broad habitats in Northamptonshire Vales	
Broad habitat type	**Code**	**Area (ha)**	**Proportion (%)**	**Area (ha)**	**Proportion (%)**
Bracken	9.1	0.7	<0.1	1.8	<0.1
Dwarf shrub heath	10.1	0.7	<0.1	11.2	<0.1
Open dwarf shrub heath	10.2	0.0	<0.1	7.2	<0.1
Fen, marsh and swamp	11.1	0.0	<0.1	16.5	<0.1
Standing open water and canals	13.1	614.1	20.6	118.1	0.3
Inland rock	16.1	25.3	0.8	27.7	0.1
Built up areas and gardens	17.1	72.0	2.4	2082.7	5.9
Continuous urban	17.2	148.9	5.0	1254.6	3.6

Table 4 shows that the proportion of broad habitats within aggregates sites (both active and inactive sites) of the Nene Valley are quite different in a number of ways when compared with the habitat baseline for the surrounding Character Area (89 RBN). This difference can be partially attributed to the size differences between the whole landscape type and the area of consented mineral development. This proportional difference in size is likely to account for the small or zero amounts of certain habitats within mineral workings. However, the information presented in Table 4 does show some clear differences in open water, woodland habitats and arable land. Figure B2.3 clearly shows some of these differences.

The Nene Valley is an intensively farmed landscape, with over half the land area (56%) being arable. In contrast, aggregates sites contain only 33% arable land. Permanent grassland habitats are predominantly improved grassland within the Nene Valley as a whole (12%), with calcareous grassland accounting for 9% of the total. Within aggregates sites, the situation is reversed, with calcareous grassland comprising nearly 13% of sites and improved grassland only 7%. Intensive modern farming methods are often unsympathetic towards native flora and fauna and therefore arable land and improved grassland are generally considered to be habitats of low biodiversity value. The smaller proportion of these habitats within aggregates sites therefore has the potential to represent increased biodiversity value.

Neutral grassland habitats are sparsely distributed within both aggregates sites and the surrounding landscape, representing 2% and 3% respectively. Within the Northamptonshire Vales, and the Nene Valley in particular, neutral grassland habitats are a high conservation priority because of their rarity.

Aggregates sites contain 12% broad-leaved woodland and 3% coniferous woodland, compared to only 6.7% woodland across the landscape as a whole. This represents a considerable contribution to biodiversity, as Northamptonshire is generally considered to be a sparsely wooded county.

Perhaps the most significant difference between aggregates sites and the surrounding landscape is the very high proportion of open water. All open water shown within aggregates planning permissions is likely to have arisen through flooding of disused gravel workings. These pits are an obvious feature on Figure B2.2 and represent 20% of the total land area of aggregates sites. Flooded gravel pits have been a feature of the landscape of the Nene Valley

for decades and the longer established pits have developed a particular biodiversity value. These flooded pits are especially attractive to wintering bird species, such as waders and wildfowl. It is likely that a proportion of the banks of these features have areas of aquatic, marginal and swamp vegetation associated with them, but as such habitat tends to form a narrow strip of less than 25m wide it would not be detected by the LCM dataset.

Gains and losses of broad habitats through the aggregates industry

Table 5 and Figure 1 below shows the estimated area and direction of change (gain or loss) in broad habitats within aggregates sites in the Nene Valley (89RBN).

The estimated gain or loss has been calculated on the assumption that broad habitats occur in the same proportion throughout the landscape type, regardless of inter-type topographic, climatic and edaphic conditions. This calculation also assumes that all aggregates extractions contained the same proportion of habitats as the surrounding landscape prior to extraction. These generalisations of habitat homogeneity represent a potential short-coming of the technique. However, they do provide a benchmark to make general comments on the likely broad habitat gains and losses that have occurred as a result of aggregate extraction. In reality, the actual habitats gained or lost could only be calculated by a detailed analysis on a site by site basis.

Methodological assumptions

The estimated gain or loss has been calculated on the assumption that broad habitats occur in the same proportion throughout the landscape type, regardless of inter-type topographic, climatic and edaphic conditions. This calculation also assumes that all aggregates extractions contained the same proportion of habitats as the surrounding landscape prior to extraction. These generalisations of habitat homogeneity represent an obvious short-coming of the technique. However, it does provide a benchmark to make general comments on the likely broad habitat gains and losses that have occurred as a result of aggregate extraction. In reality, the actual habitats gained or lost could only be calculated by a detailed analysis on a site by site basis.

The LCM 2000 dataset has been extensively ground-truthed at a national scale and shown to be broadly 90% accurate. However, some shortfalls in the accuracy of the dataset have been highlighted by this study, particularly:

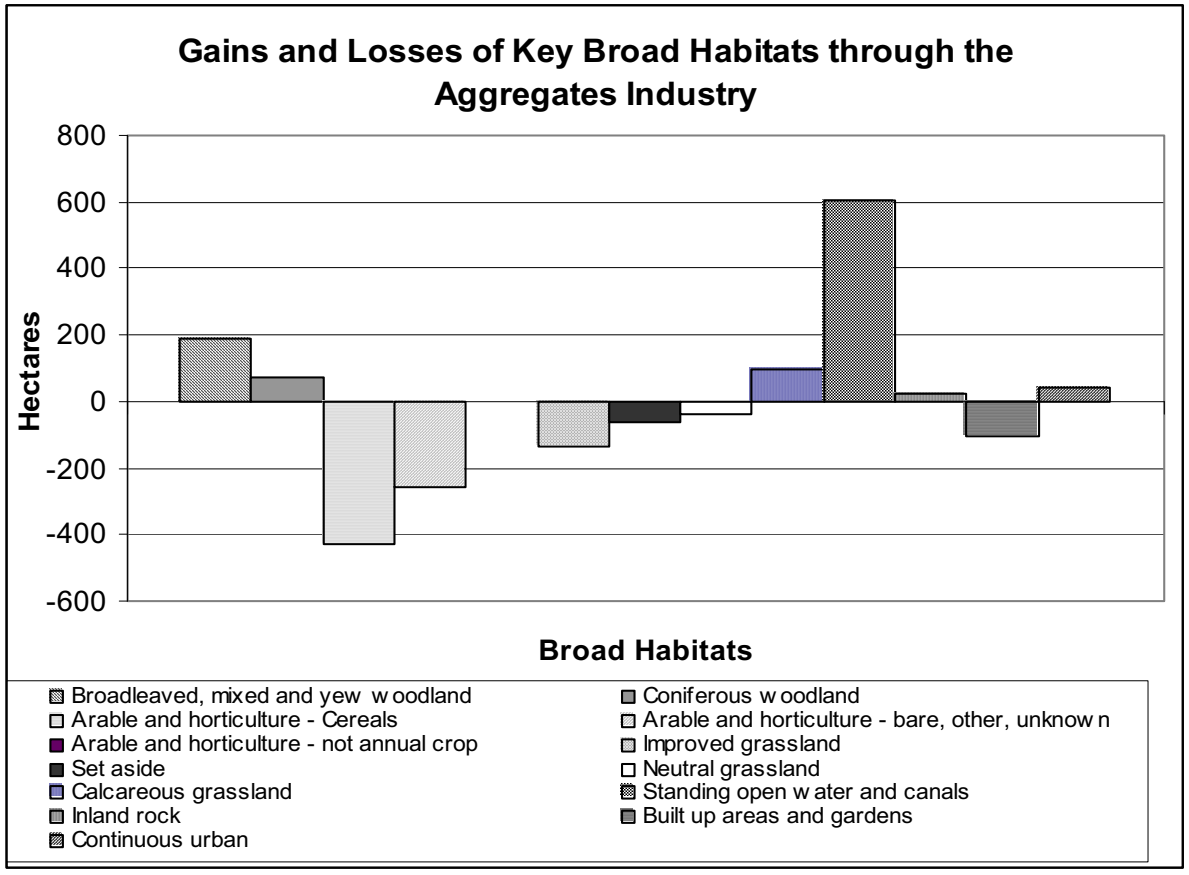
- the pixel size of $25m^2$ which means that small habitat patches and ribbon habitats such as ponds and marginal vegetation are not classified; and
- the misclassification of complex landscapes and habitat mosaics, such as small field patterns through over simplification.

Results based upon the information provided by the LCM 2000 should therefore be interpreted with these shortfalls in mind.

Table 5 – Estimated area and direction of change in broad habitats through the aggregates industry

LCM 2000 habitat type		Percent change	Estimated change in habitat (ha)	Direction of change
Broad habitat type	Code			
Broadleaved, mixed and yew woodland	1.1	6.4	191	Increase
Coniferous woodland	2.1	2.5	75	Increase
Arable and horticulture – Cereals	4.1	-14.4	-429	Decrease
Arable and horticulture – bare, other, unknown	4.2	-8.6	-256	Decrease
Arable and horticulture – not annual crop	4.3	0	0	No Change
Improved grassland	5.1	-4.6	-137	Decrease
Set aside	5.2	-2.1	-63	Decrease
Neutral grassland	6.1	-1.2	-36	Decrease
Calcareous grassland	7.1	3.2	95	Increase
Standing open water and canals	13.1	20.3	605	Increase
Inland rock	16.1	0.7	21	Increase
Built up areas and gardens	17.1	-3.5	-104	Decrease
Continuous urban	17.2	1.4	42	Increase

Figure 1 – Graphical representation of the estimated gains and losses of broad habitats within planning permission boundaries of permitted aggregate extraction sites



The analysis above suggests that by far the greatest change within the Nene Valley, over an area of 605 ha, is the increase of open water habitats. The greatest losses have been to arable, horticulture and improved grassland land uses. Increases in calcareous grassland, broad-leaved woodland and coniferous woodland are also estimated to have occurred. Set-aside, inland rock, neutral grassland, non-annual arable crops and continuous urban habitats are broadly the same in both aggregates sites and the surrounding landscape. The estimated decrease in built-up areas is likely to be an artefact relating to the fact that aggregates sites are rarely developed into built up areas.

Habitats that contribute <0.1% of either the baseline or aggregate quarries have not been considered by this assessment of change, as they represent too small an area to be relevant to a study at this scale. It is highly likely that habitats such as fen, marsh and swamp occur within both the Nene Valley and aggregates sites but in areas that are too small to be mapped by the LCM 2000 data.

Designated sites

Analysis of the coincidence of designated sites with areas of aggregates extraction within the Northamptonshire Vales Character Area provides an indication of what effects the aggregates industry may be having upon those areas that are identified as important reserves of biodiversity. These effects may be positive, through the retention of important habitats within quarry boundaries and through protection of them from other types of modification or through the development of new areas of biodiversity interest within disused aggregates sites. However, negative effects, whereby quarrying activities damage or disturb the protected site, may also occur.

Nationally and locally protected sites have been dealt with in separate sections. Figure 3 shows the distribution of designated land within the study area.

Nationally designated sites

Table 6 below indicates that a larger proportion of land designated as Site of Special Scientific Interest (SSSI) falls within the planning permission boundaries of aggregates extractions in the Northamptonshire Vales (3.3%) than would expected from the proportion of the total SSSI designated land within the study area (0.4%). This is composed of four SSSIs. A large proportion of this is due to 96 ha of Higham Ferrers Gravel Pit SSSI. No nature conservation sites designated as cSAC, SPA or NNR occur within permitted aggregates sites.

Table 6 – Areas of designated land within permitted aggregates sites

	Total Designated Land within Northamptonshire Vales in ha (% of total area)	Designated land within Permitted Aggregates Sites in ha (% of total area)	Proportion of total designated land in the Northamptonshire Vales found within Permitted Aggregates Sites (%)
Sites of Specific Scientific Interest	369.8 (0.4%)	99.9 (3.3%)	27
NWT Local Nature Reserves	289.2 (0.3%)	171.5 (5.7%)	59.3
County Wildlife Sites	2469.6 (2.7%)	817.7 (26.9%)	33.1

Higham Ferrers Gravel Pits SSSI is a 103 ha site, newly designated SSSI in 1984. The site comprises flooded abandoned gravel workings within part of the Stanwick-Irthlingborough gravel pit complex, east of Wellingborough. The site supports a rich and diverse bird fauna, including nationally important wintering gadwall and a wintering population of over 5000 birds (WeBS, winter 2002-2003). The site, which has arisen as a result of the aggregates industry, is one of the top three sites in the Nene Valley region for wintering birds (estimated from WeBS winter 2002-2003 data).

Aldwinckle Marsh SSSI is a 2 ha site designated in 1961 comprising a shallow peat fen and marshland habitat. The site is adjacent to inactive gravel workings at Thrapston. The SSSI citation states that the site has been "considerably reduced" in size and quality through drying in recent years,ie between 1970 and 1984. The reasons for the drying of the site are attributed to a lowering of groundwater levels. The former extent of the site, or whether groundwater lowering is in any way associated with the aggregates industry, is not known.

Titchmarsh Duck Decoy SSSI is a 2.5 ha site designated in 1970 and supports one of the largest heronries in the region. The site comprises willow carr, reeds and wetland habitats and regularly floods in winter. It is bounded by the River Nene to the east and disused gravel pits of the Thrapston complex to the other three sides. There is no evidence to suggest that this SSSI has been affected by aggregates extraction. In fact, it is possible that the size of the heronry may be partly attributed to the large increase in wetland habitats created by the mineral industry in the area.

Wollaston Meadows SSSI is a neutral grassland site surrounded by the Earl's Barton gravel pit complex. The squared-off shape of the SSSI designation is suggestive that either historic (ie pre-1947) aggregates industry or agricultural land uses have contained this site to its present size, from a formerly more extensive area.

County designated wildlife sites

A large number of county designated sites occur within or adjacent to abandoned aggregate extractions in the Nene Valley. Over 30% of the total area of aggregates workings (989.2 ha) have been designated County Wildlife Site or NWT Local Nature Reserve. This represents more than a third of the total area of County-level nature conservation sites in the whole of the Northamptonshire Vales study area. It is clear from a review of County Wildlife Sites that disused, restored or naturally regenerated, gravel pits have developed significant biodiversity interest.

The nature conservation interest of disused gravel pits can be characterized by large areas of wetland and open water habitat, which provide ideal roosting and breeding habitat for a wide range of birds and other aquatic wildlife. Gravel pit restoration designs have advanced considerably in the past few decades. Sculpturing of the final restoration contours creates a highly complex underwater topography to mimic natural systems and maximise the area of aquatic habitat within the zone of primary productivity (about 1m below water level). It is thought that the application of these design principles have assisted in the rapid establishment of aquatic vegetation, bird and invertebrate life within flooded gravel pits.

Other habitats associated with old gravel pits, such as scrub, woodland and freshwater ditches also support a range of wildlife, many of which are declining in the wider countryside through increased pressures of intensive agriculture.

Priority habitats

The priority habitat inventories available for the Northamptonshire Vales Study Area were examined to identify where priority habitats occurred within, or near to, planning permission boundaries for aggregate extraction.

Due to the nature of the intensive farmland landscape of Northamptonshire, only a very small number of lowland grassland and ancient woodland sites occurred within the Study Area. No areas of upland or lowland heathland were recorded within the Study Area. No areas of ancient woodland coincided with the planning permission boundaries of aggregates sites.

A total of four lowland grassland priority habitat sites occur on the boundaries of aggregates sites and appear, from current map evidence, to have been avoided by the aggregate extraction industry. Three of these sites: Wollaston Meadows, Aldwinckle Marsh and Bugbrooke Meadows have also been designated SSSI, which would offer them additional protection from potential disturbance.

Though it is possible that lowland grassland habitats, notably unimproved neutral flood meadows and grazing land in the floodplain of the Nene Valley, may have been lost to the industry historically there are no historic records of the distribution or abundance of these habitats and therefore there is no way that the potential losses can be accounted for. It is likely though that agriculture in this area has played the main part in the decline in abundance of floodplain grassland habitats to their present status. Northamptonshire Wildlife Trust reported that only 20 flood meadows remain in the county.

Species

A list of species indicators for the biodiversity audit of the Northamptonshire Vales was drawn up based upon the criteria set out in Part A of this report and through consultation with record holders.

The indicator species selected for the Northamptonshire Vales are:

- birds: waders, wildfowl, skylark, lapwing, kestrel, buzzard, sand martin;
- plants: pillwort, alder, pyramidal orchid, narrow leaved water dropwort;
- herpetofauna: common lizard, great crested newt, palmate newt, smooth newt;

- mammals: pipistrelle bat, water vole; and
- invertebrates: scarce chaser dragonfly, orange tip, gatekeeper.

Records for these species were requested from Northamptonshire Wildlife Trust and RSPB (WeBS survey data).

Birds

WeBS survey for the Nene Valley was undertaken in winter 2002-2003 in a total of 15 gravel pit complexes, representing approximately 120 waterbodies. A summary of this survey is presented in Figure B2.6.

The data clearly shows that the Nene Valley gravel pits support a nationally important wintering bird population. In particular, the gravel pits, when treated as a single site, support nationally important (ie >1% of UK population) populations of the following species:

- gadwall;
- great crested grebe;
- widgeon;
- mute swan;
- coot;
- golden plover;
- cormorant;
- shoveller;
- pochard;
- tufted duck; and
- goldeneye.

The Nene Valley also supports an internationally significant population of golden plover and gadwall. Other bird species are also found in significant numbers. The site as a whole supports a total population of over 26,000 birds, which exceeds the criteria for an internationally important wetland (Ramsar site criteria 3c), of 20,000 birds. Similar criteria have been set for the recognition of internationally important bird sites (SPA) under the EU Birds Directive 1979. Accordingly, the Nene Valley gravel pits are under consideration for designation as SPA in the near future (RSPB, personal communication).

Other bird species selected as indicator species are also found to be positively associated with aggregate extraction. There are eight records of sand martin from five different aggregate sites, suggestive of at least five populations of this species within planning permission boundaries. This species is closely associated with the sand and gravel industry, needing soft sand cliffs for nesting.

There are also regular records of kestrel, buzzard and skylark from within aggregates planning permission boundaries, with the majority of recorded from designated sites, eg County Wildlife Sites.

Other species

There are records for many of the species indicators selected for the Northamptonshire Vales within aggregate planning permission boundaries. Water vole is recorded from five different disused gravel pits, although the lack of any records post-1996 could mean that these populations have succumbed to the general decline of this species in recent years. There are no records for pipistrelle bats, which is likely to reflect the fact that most bat records originate from roost visits to residential properties and that no systematic surveys are undertaken across the wider countryside.

Gatekeeper and orange-tip were selected as indicators of ancient hedgerows, although they are also associated with neutral grassland and scrub mosaic habitats. Gatekeeper has been recorded from a total of five aggregates sites, whilst orange-tip has only been recorded from two sites, and both of these sites also have records for gatekeeper. These species are regularly recorded for these two sites, Higham Ferrer's Gravel Pit SSSI and Stanton's Gravel Pits CWS, suggesting that a local butterfly enthusiast is active in these areas.

There are only very few records for common lizard within the study area, which suggest a relatively sparse distribution, or a low recording effort for this species. Only one record of common lizard occurs within an aggregates planning permission boundary within the Stanwick gravel pit complex. The lack of comprehensive records makes it very difficult to draw any conclusions about the distribution of this species.

Alder is relatively well distributed within the study area, with fifty-five records in total. This species has been recorded at nine separate sites and was chosen as an indicator of wet woodland, a UK BAP priority habitat. The recorded presence of alder suggests that wet woodlands habitats are present within a proportion of aggregates planning permission boundaries, and that these woodland habitats must represent some proportion of the total of 369 ha of the broad-leaved woodland (LCM 2000 data) recorded in aggregates sites.

Pyramidal orchid, selected as a calcareous grassland indicator, has only been recorded at one site, Higham Ferrers SSSI. This may suggest that either calcareous grassland is not a major contributor to the grassland resources within aggregates sites, or that there has been a lack of recording effort for this species.

Estimated future gains through restoration

The potential projected gains to biodiversity have been assessed through an evaluation of the exiting restoration plans for a sample of currently active sites. Due to the lack of current activity within the Nene Valley, both of the currently active aggregates extractions have been reviewed. These figures should however be viewed with some caution as there may be significant time lapses between restoration and maturation of such a habitat type.

Stanwick Gravel Pits (Irthlingborough) extension

An extension to the Stanwick Gravel Pits at Irthlingborough was approved in 1996 and gravel extraction commenced in 1997. A revised restoration plan and planting scheme was proposed in 2001 and restoration according to this plan has now been completed in this area.

The restoration objectives for Stanwick Quarry (Irthlingborough extension) were to:

- retain the character of the existing flood meadows;
- to improve the habitat for wading birds;
- to create open water areas for wildfowl; and
- to create an area suitable for low key recreational activities such as fishing, walking and bird watching.

The extraction of sand and gravel at Stanwick (Irthlingborough extension) has resulted in the loss of the following habitats:

- loss of eight fields of improved grassland;
- loss of two fields of moist neutral grassland; and
- loss of a small area of fen, marsh and swamp (less than one field).

Restoration of the extraction area has resulted in the creation of a number of different habitats; these included flood meadow, rough grassland margins, hedgerows, ponds, streams and reedbeds. Lakes were created with areas of bank, shallow and deep water as well as islands. Islands were designed to provide safe nesting sites, with the open water being a safe area for wildfowl. Woodland creation included two habitat types: wet woodland along the marshy lakeside edges and dry mixed broad-leaved woodland elsewhere.

Earl's Barton

Application for an extension to the Earl's Barton sand and gravel workings in the Nene Valley was made in 2002; this application remains currently undetermined (January 2004). The restoration scheme, as outlined in the Environmental Impact Assessment[20] states that on completion of the workings, the majority of the northern section of the operation would return to agricultural production, with replanting of hedgerows and trees. On the southern banks of the River Nene, land would be returned to a range of habitats of wildlife value. These habitats include:

- replanting hedgerow, in replacement of 2500m of hedgerow lost;
- replanting more than double the amount lost of woodland and scrub habitats;
- creating 11 ponds, providing extensive open water habitat;
- reedbed habitat; and
- a mosaic of wet and rough grassland, scrub and woodland surrounding wetland areas.

On completion of the restoration scheme it was considered likely that a number of species of high biodiversity value would be accommodated. These include great crested newt, otter, pipistrelle bat, water vole, ground nesting birds, wildfowl, waders, amphibians, dragonflies and aquatic flora.

[20] Earl's Barton Quarry Western Extension – Environmental Statement, Chapter 7 Ecological Impact Assessment SLR Report 4D-242-007 (March, 2002)

In total, the restored land at Earl's Barton Extension would provide quantifiable change in the following habitats:

- loss of arable land, estimated at 20 ha;
- replacement of 600m of species-poor hedgerow with species rich hedgerow and a replanting a further 1200m of species-rich hedgerow, a UK BAP priority habitat;
- loss of 700m of hedgerow in total would occur;
- increase of approximately 3 ha of broad-leaved woodland, including wet woodland and scrub, a UK BAP priority habitat;
- increase in 13ha open water and wetland habitats; including
- increase of 3.8 ha of reedbed, a UK BAP Priority habitat.

Considering the biodiversity value that has arisen at aggregates sites within the Nene Valley following a similar restoration scheme, it is likely that the restoration of the Western Extension of Earl's Barton would result in a habitat resource of up to regional value. The wetland and open water habitats are likely to contribute to the overall value of the Nene Valley for wildfowl and wading birds, currently considered to be of national importance.

Contribution of restoration proposals to biodiversity

Restoration plans usually include the re-establishment of habitats of biodiversity interest often considered to be of greater value than the active areas of quarry they are replacing. However, it has not been possible to directly evaluate the change in habitat quality/biodiversity value from the original habitats at a pre-quarrying site to the post-restoration site. The following key issues relating to aggregate extraction restoration have been highlighted through the review of restoration proposals:

- habitats proposed within a restoration plan may not represent the actual habitats that are created;
- many restoration plans cite biodiversity or nature conservation as the major goal of the restoration and long-term management of the site and follow the lead from planning guidance and advice to create habitats that are desirable in local policy terms;
- proposed restoration habitats may not represent locally typical or locally important habitats and are likely to include a percentage of habitat that is neither locally typical not important in biodiversity terms;
- restoration plans are subject to review and therefore planning policy and subsequently proposals may change prior to implementation; and
- management obligations may only be for a short time period following establishment, potentially allowing land to become unmanaged in the long-term and leading to a possible lowering the biodiversity potential.

Planning and policy context to future mineral extraction

Though much of the analysis undertaken so far provides a comment on historical and confirmed changes (ie already permitted mineral extraction sites) it does not provide an analysis of the likely impact of the minerals industry in this area in the future.

It is a necessity that any new quarries meet the requirements of the increasingly stringent planning policy and legislation that relates to such development.

The policies relating specifically to mineral planning in the Nene Valley area are the Northamptonshire Minerals Local Plan 1991-2006 (Adopted April 1997) and the Northamptonshire Structure Plan 1991-2016 (adopted March 2001). The key policies of these documents are shown in Table 7. Information presented is in abbreviated form to highlight the relevant part of the policy.

Table 7 – Planning policies relating to biodiversity and aggregate extraction in the Nene Valley

Planning Policy Ref	Adopted Policy
Northamptonshire Structure Plan 1991-2016	
M1	The strategy for minerals extraction in Northamptonshire in the period of 1996-2016 will reflect the following principles: and to shift minerals extraction away from the River Nene to the glacial deposits; and to protect unexploited river valleys.
M5	Proposals for minerals extraction will be considered having regard to the impact on the environment and the suitability of the restoration proposals and the potential after-use of the site.
AR3	Planning permission will not be granted for development which will harm sites of designated importance for biodiversity, unless the need for the development demonstrably outweighs the value of the site. Development proposals likely to affect a Special Protection Area or a Special Area of Conservation will be subject to special scrutiny, having particular regard to their international importance. Where the site concerned is a Site of Special Scientific Interest (SSSI) or National Nature Reserve (NNR) particular regard will be paid to the national importance of that site. Where development proposals are likely to affect a Local Nature Reserve, a County Wildlife Site, a wildlife corridor, or where a protected species may be affected, developers will need to demonstrate that there are reasons for the proposal or other considerations which outweigh or overcome the adverse impact.
AR4	Local plans will identify measures to help protect and enhance sites and features important for biodiversity and opportunities for creating new habitats.
AR5	Where development is approved which will adversely affect landscape features of major importance to wild flora and fauna, measures will be required to prevent any net loss of biodiversity throughout the County.

Planning Policy Ref	Adopted Policy
Northamptonshire Minerals Local Plan 1991-2006	
NLMP 20	In assessing proposals for mineral extraction, including extensions to existing sites, the mineral planning authority will have particular regard to the effects upon and nature conservation, (including SSSI, NNR, and other locally designated sites such as Sites of Nature Conservation Value, prime Sites, Ancient woodlands and nature conservation interests generally).
NLMP 22	Proposals involving mineral extraction which affect National Nature Reserves and Sites of Special Scientific Interest will not normally be permitted unless the natural history Interest can be safeguarded.
NLMP 23	Where proposals involving mineral extraction affect sites of nature conservation value, county wildlife sites …the mineral planning authority will seek to exclude workings from or near such sites unless the natural history interest can be safeguarded.
NLMP 36	..... Restoration schemes which provide for after uses such as nature conservation and other amenity uses (including wet meadows and woodlands) will be encouraged. Such schemes should be accompanied by proposals for aftercare and management.

The adoption of these policies by the local planning authority ensure that impacts upon biodiversity in the form of existing recognised sites and features of importance (habitats and species) are considered when a planning application is determined and conditions are set. Further to this all existing sites with planning consent are subject to review every 15 years under the 1995 Environment Act. During these reviews environmental impact assessments are undertaken and the restoration scheme is reviewed.

In addition, many of those large mineral extraction companies that operate across the UK now have their own policies relating to wildlife and biodiversity and they have established relationships with statutory and non-statutory wildlife organisations to ensure that their restoration schemes reflect the local biodiversity conservation priorities.

In view of the mechanisms detailed above it would seem unlikely that there will be any new areas of mineral extraction in this study area that would have a significant adverse impact upon biodiversity. Any schemes that are consented, in future, are also likely to have a high value restoration scheme that provides long-term benefits to local and national biodiversity priorities.

Balance sheet

A major aim of this study was to determine whether it was possible to produce a "balance sheet" of the gains and losses to the Northamptonshire Vales Study Area as a result of the operations of the aggregates industry since 1947. The balance sheet presented below summarises the data analysis presented in the previous chapter. It has been divided into the following broad sections:

- **historical**, describing changes that occurred prior to 1947;
- **recent past**, describing changes resulting from operations active between 1947 and 2003;
- **foreseeable future**, describing the changes that are likely to occur through operation and restoration in the coming generation (2003-2033);

- **distant future**, describing the changes that may occur in the future beyond the next generation (2033 onwards).

Due to the nature of the data available and the high degree of uncertainty in predicting historical and distant future changes, descriptions are limited to broad habitat and landscape changes and the predicted direction of change. Table 8 presents the Balance Sheet summary of the Pilot Biodiversity Audit for the Northamptonshire Vales Study Area.

Table 8 – Balance sheet summary of biodiversity losses and gains in the Northamptonshire Vales study area

Distant past	Recent past	Foreseeable future	Distant future
Losses Small-scale gravel workings probably occur within the Nene Valley prior to 1947 and are subsequently abandoned to naturally regenerate. It is possible that unimproved neutral grassland, flood meadows and fen, marsh and swamp habitats were lost during this phase of extraction. These habitats would have been more widespread in the area prior to intensification of agriculture. Small-scale limestone quarries and glacial sand extractions may also have occurred in the wider landscape. Limestone quarries may have resulted in losses of calcareous grasslands and glacial sand extraction may have resulted in the loss of acidic grassland, woodland or lowland heath habitats.	**Losses** Continued sand and gravel extractions within the Nene Valley, with the scale of workings increasing to create larger voids. Land-take increases in this period, which represents the most active phase of extraction of sand and gravel in the valley. Habitats lost due to extraction are likely to be predominantly improved grassland and arable land, with smaller areas of neutral grassland, flood meadows, fen, marsh and swamp. Limestone and glacial sand operations are also likely to have increased in size and extent, leading to loss of habitat through land-take. It is possible that losses to habitats adjacent to aggregates workings have occurred resulting from lowering of groundwater during dry working of sand and gravel extraction. For instance, Aldwinckle Marsh SSSI is described to have shrunk as a result of groundwater lowering.	**Losses** Existing consents for aggregates in the Nene Valley floodplain have largely finished and current planning policy suggests that new permissions would not be granted unless there are significant environmental benefits. However, the mineral quality in the Nene Valley mean that operators will continue to press for further extraction of minerals from the valley in the future, due to the high demand for high quality sand and gravel deposits. Extraction of aggregates in limestone and glacial sand quarries outside the valley floodplain may continue in the future. Planning policy guidance currently suggests that there is a presumption against new minerals workings in areas of existing biodiversity interest, eg SSSI, CWS, and other semi-natural habitats.	**Losses** Proposals for aggregates extractions within the Nene Valley or surrounding area are likely to be subjected to rigorous planning regulations and new biodiversity legislation limiting extraction to areas of negligible biodiversity interest. Climate change and other factors beyond the control of the industry, or the planning system that regulates it, are likely to have the most significant effects upon the biodiversity value of the Northamptonshire Vales and abandoned aggregates workings. Commitment to the long-term management of created habitats would be required to ensure that biodiversity value does not decline in the future. Continued maintenance is essential to ensure that non-climax communities do not become dominated by secondary woodland or dense scrub communities that would reduce the overall diversity of the area.

Distant past	Recent past	Foreseeable future	Distant future
Gains Where undertaken in the floodplain of the river, small workings are likely to have flooded, creating small lakes, wet woodland and scrub habitats. Due to the long time that has elapsed since abandonment to the present day, these smaller workings are likely to have developed significant biodiversity interest. Well-established gravel pit lakes, wet woodlands, reedbeds and scrub are often now listed as County Wildlife Sites and support populations of wildfowl and wading birds, warblers, water voles and other species of high biodiversity value.	**Gains** Abandoned limestone quarries such as Earl's Barton Quarry CWS, now support calcareous grassland, scrub and cliffs. This quarry has a rich diversity of orchids, damselflies and butterflies, including a county rarity, small blue butterfly. Gravel pit lakes of various sizes have developed biodiversity interest. Longer-established lakes and those specifically restored with nature conservation in mind are likely to provide greater benefits. Artificial wetlands and open water created predominantly during this period now support a nationally important wintering bird population. In recent years, best practice landscape design has improved both underwater contouring and planting regimes to maximise the areas of productive aquatic habitats within gravel pit lakes. Aquatic habitats are designed to encourage birds, invertebrates and plants and to maximise the biodiversity potential of created aquatic features.	**Gains** Restoration of currently active sand and gravel sites is completed. As restored areas become established and populations of species expand to fill the new habitats created it is likely that a further increase in the populations of wildfowl, waders, amphibians, wetland invertebrates and other groups of biodiversity value would occur. It is likely that much of the existing wildlife resource in old gravel pits will at least maintain and possibly increase in value due to its management by bodies committed to nature conservation. Increased protection through designation of the gravel pit complex to SSSI/SPA shall provide a longer tern guarantee to the biodiversity interests. Created habitats may become relatively more important for biodiversity in the event that agriculture continues to intensify. Sites restored to nature conservation after-uses will provide a refuge for wildlife regardless of what occurs in the surrounding countryside. There are opportunities for strategic forward planning for the further development of sand and gravel extraction in the Nene Valley to maximise the advantages for biodiversity across the whole valley landscape; creating linked habitats of high biodiversity value.	**Gains** Limestone aggregate quarries within the area will develop further biodiversity value through natural regeneration and as long-term restored habitats establish. Habitats created around sand and gravel extractions will continue to develop with woodlands and other slow maturing habitats reaching their biodiversity potential. It is likely that much of the existing wildlife resource in old gravel pits will be maintained due to its management by bodies committed to nature conservation. Increased protection through designation of the gravel pit complex to SSSI/SPA shall provide a longer tern guarantee to the biodiversity interests.

Discussion and recommendations for further study

The pilot study of the Northamptonshire Vales has highlighted a number of key recommendations for minerals operators and their regulators. Specific recommendations relating to the techniques adopted for the study are presented in Part A of this report. The recommendations specific to the Northamptonshire Vales are as follows:

Record-keeping

The availability of relevant biodiversity data, especially relating to species, is poor and the absence of detailed and comprehensive species data has meant that only broad trends in gains and losses to species can be inferred. The exception to this is the availability of detailed wintering bird survey data (WeBS, 2002-2003). This information provided an important summary of the bird interest of the Nene Valley.

It is suggested that minerals operators and regulators store the results of biodiversity surveys carried out on minerals land in a central location, preferably as part of the National Biodiversity Network. This would maintain an up-to-date database of biodiversity gains and losses and would assist with further studies of this nature.

Further analysis of habitats

Habitats recorded by the LCM 2000 as having a restricted distribution within the Nene Valley are often those habitats that are of considerable biodiversity value. For instance, only a very small area of fen, marsh and swamp (16.5 ha, <0.1% total land area) has been recorded in the Nene Valley by the LCM 2000. No areas of this habitat have been recorded within aggregates planning permission boundaries. However, a review of restoration plans and Environmental Impact Assessments for Stanwick and Earl's Barton gravel pits and selected CWS citations suggest that these habitats account for a proportion of existing marginal areas of open water habitat and other small pockets of habitat throughout these areas.

The fen, marsh and swamp broad habitat is considered especially important as it includes the UK and local BAP Priority habitats of reedbed, springs and flushes and fens. These habitats are important for a range of species, including breeding and wintering birds, invertebrates and wetland plants. It is likely that the LCM analysis has not identified these areas as they are linear or fragmented in nature. The apparent inability of LCM 2000 to capture small scale habitat variations, such as a sparsely colonised reedbed, or small areas of habitat, such as isolated spring habitats, is a notable constraint upon the method devised for studying biodiversity change.

Unfortunately, due to the timing of this particular study, English Nature's Priority Habitat inventory for reedbed was not yet complete. This, and other Priority Habitat Inventories, will add significant value to future studies following this method. It is also recommended that further analysis based upon the interpretation of aerial photographs should be undertaken to measure reedbed, fen and other wetland habitat resources. This analysis could also form a baseline assessment of these habitats for future assessments of change.

The biodiversity value of other habitats may also have been underestimated by the LCM 2000 broad habitat analysis. For instance, the "arable and horticulture – non-cereals/bare ground"

classification may include early successional habitats that are capable of supporting a range of invertebrates, plants and other taxa of conservation importance.

Planning policy and guidance

Planning policy and legislation relating to the conservation of biodiversity is likely to become more focussed and effective as county structure plans and local minerals plans are reviewed. The potential of biodiversity gains and the creation, as far as is possible, of appropriate habitats should be encouraged through specific planning policies.

The industry has been criticised for creating good, yet inappropriate, habitats for an area. For example in the Nene Valley, an ideal habitat for re-creation is considered to be lowland wet grassland or shallow wetlands, habitats which have become particularly scarce through agricultural intensification. However, the restoration of such habitats is not always practicable. Such habitats require the backfilling of excavations with large quantities of materials that have to meet the stringent requirements of the waste regulation system and would often have to be transported to the site. In the Earl's Barton complex, recent applications made use of the need to deposit silts, from the washing of the sand and gravel, into existing large open waterbodies in such a way that they shall become reedbed and swamp habitat. Guidance from the industry regulators is required to consider restoration of habitats that are desirable, feasible and in character with local landscape.

The development of a strategic landscape plan for future development within the Nene Valley could provide a range of benefits for both biodiversity and humans by creating connected landscapes and corridors of similar habitat along the valley floor. A strategic plan, built on a consensus approach, would allow both minerals operators, local planners and other stakeholders to work towards a common goal of improving the landscape and biodiversity qualities of the valley as a whole.

Post-restoration monitoring and management

As many of the aggregate extraction sites in this study area are monitored and managed by a range of groups with nature conservation agendas, it is recommended that in the future a process of feed back be established where they can make comment on the success (both intentional and incidental) of the restored mineral sites and the practicality of managing such features for biodiversity. Such feed back may guide some of the restoration yet to be undertaken in the area and advise the industry in general.

Contribution to biodiversity of historical sites

The contribution made by historical (pre-1947) extractions to the overall biodiversity resource of aggregates quarries has not been considered in detail in the report presented. This is largely due to the fact that locations of these extractions are not recorded in a systematic way. However, it is clear that early aggregate extractions now represent an important biodiversity resource in the Nene Valley with many sites being designated for nature conservation interest. Creating a quantitative measure for the actual biodiversity contribution made by these sites represents a major challenge. It may be possible to begin to measure this feature by creating an inventory of aggregates sites within the Nene Valley is collated, using the BGS minerals database, historical research and aerial photograph interpretation.

Maturation of sites of biodiversity importance

The change in circumstances of the older aggregates sites relative to the new sites is another area worthy of further study. Older sites were placed in a landscape containing a higher proportion of semi-natural habitat and subsequent colonisation has, in some instances, given rise to important populations of species that are not now so common in the local landscape. It may be that these older sites have undergone a "maturation" period, during which time those communities have developed. Comparison between the "maturation period" of different types of extraction in different geographical locations would provide useful information for calculating the biodiversity contributions of aggregates sites and may also provide information on the best techniques for restoration and management to minimise the time required for maturation.

Assessment of habitat quality

A major drawback of the chosen method is its inability to differentiate between the quality of similar habitats, eg a steep-sided gravel pit lake with no marginal vegetation and a sculpted lake with extensive shallows, reedbeds and mosaic aquatic/wetland habitats. It should also be noted that the replacement of existing semi-natural habitats with newly created habitats of the same type may well have occurred and differences in biodiversity quality between these two types cannot be assessed. Replacement habitats may not perform biologically in the same manner as semi-natural habitats due to our poor understanding of the complexities of habitat functioning and the species which they support.

Only through detailed comparison of semi-natural habitats and examples of established replacements for these habitats would be able to quantify these differences.

Further ecological study of species associated with aggregate extractions

A number of species, such as sand martins, dragonflies or the orchid family, appear to be closely linked to habitats provided by the aggregate industry. Further autecological studies or encouragement of recording effort for these species, may provide greater detail of the biodiversity interest of aggregate extractions. There is also the opportunity for the industry to become "biodiversity champions" of species or habitats of conservation concern; raising awareness and funding for increasingly scarce biodiversity resources.

Conclusion

An analysis of the biodiversity gains and losses through the activities of the aggregates industry in the Northamptonshire Vales was undertaken. This study, summarised in a balance sheet, has shown that broad habitat changes have occurred, most significantly during the period 1947-2000. Estimates of habitat change have been calculated and examples of changes in the biodiversity value of specific sites and for specific species have been highlighted.

Historical and more recent changes in broad habitat have occurred, mainly as a result of land take of agricultural land and the subsequent restoration to open water and wetland habitats. Many historically active aggregate extraction areas, even in the absence of planned restoration, have now developed into biodiversity areas of regional importance in their own

right, and contribute to a complex of wetland habitats that are of national importance for their bird interests.

It is considered that completed, existing and future aggregates extraction sites within the Northamptonshire Vales can continue to provide habitats of high biodiversity value into the future through:

- continued avoidance of existing areas of biodiversity value, especially non-replaceable habitats such as ancient woodland and fenland;
- the focus of biodiversity led-restoration; and
- commitment to long-term management of restored areas.

It is concluded that, in the Northamptonshire Vales, there has been a significant contribution to biodiversity resulting from the extraction of aggregates.

Appendix 1 Stanwick quarry (Irthlingborough extension) case study

Introduction

Stanwick Quarry (Irthlingborough Extension) is located in the Nene Valley in Northamptonshire, west of the A6 and south east of Irthlingborough (SP 953 700). Stanwick Quarry itself began operating in 1985, with an extension at Irthlingborough approved in 1996. Hanson Aggregates' commenced gravel extraction in 1997 in the extension area, phased restoration and continued extraction commenced in 1999 with restoration completed in 2002. This case study only addresses the Irthlingborough Extension to Stanwick Quarry complex.

Historical biodiversity within Stanwick Quarry

Prior to sand and gravel extraction, Stanwick Quarry (Irthlingborough Extension) was located in an area which comprised improved pasture, mature scrub and areas of flood meadows along the River Nene corridor.

The Environmental Advisory Unit (EAU) 1992 survey of the extraction area for the Environmental Statement classified the 14 fields that made up the application area as the following NVC communities:

- three fields were classified as MG13 *Agrostis stolonifera-Alopecurus geniculatus,* an inundation neutral grassland characteristic of moist and sometimes waterlogged neutral soils;
- one field was classified as MG9 *Holcus lanatus-Deschampsia cespitosa*, a coarse neutral grassland which is ubiquitous at suitable lowland sites across the country;
- two fields were classified as MG7d *Lolium perenne-Alopecurus pratensis* meadow, characteristic of alluvial soils;
- six fields were classified as improved grassland MG7b *Lolium perenne-Poa trivialis* ley or *Lolium perenne-Plantago lanceolata* grassland; and
- two fields comprising mosaic habitats of neutral grassland, improved grassland and fen, marsh and swamp (MG13/MG7b/S22 (*Glyceria fluitans* water-margin vegetation) and MG7d/MG6 (*Lolium perenne-Cynosurus cristatus* meadow)).

The survey concluded that whilst typical stands of these NVC habitats are generally species-poor, they were semi-improved and species-poor even in comparison to the classification. The semi-improved flood pastures (MG13, MG9 and mosaic habitats) were recognised as of local nature conservation value due to their botanical and ornithological interest. The extent of these habitats has diminished rapidly in Northamptonshire over recent years.

Meadow saxifrage (*Saxifraga granulata*) had previously been recorded on the site, although this species was not recorded during the 1992 environmental survey. There were only 12 remaining sites known in Northamptonshire at the time of survey. One field also supported a widespread population of great burnet (*Sanguisorba officinalis*) which is generally frequent to local common in distribution in England and Wales, although it is rare in the south (Rose,

1981). It is unclear whether this species is a remnant of past floristically richer flood meadows or has recolonised the site.

Wading birds observed during the 1992 survey on the area outlined for extraction included snipe, lapwing and redshank. These species were only observed in one area of the site and were not considered to be breeding.

Current biodiversity within Stanwick Quarry

The current biodiversity of Stanwick Quarry has been assessed using a combination of aerial photographs and LCM 2000 data (See Figure B2.6).

Stanwick Quarry currently supports extensive open water habitats, interspersed by mosaic wetland habitats, calcareous grassland, establishing plantation broad-leaved and coniferous woodland. Small areas of bare ground and urban habitats are likely to represent buildings and screening plant. The site is no longer actively worked for sand and gravel, although it was active at the time aerial photographs and LCM 2000 data were captured (2000-2001). Minor discrepancies between LCM 2000 habitat classifications and aerial photographs are likely to be due to this fact.

An apparent omission by LCM 2000 is the lack of fen, marsh and swamp habitats around the edges of water bodies. Wetland habitats, for instance reedbed and marginal vegetation, are now established on the margins of lake habitats, although none have been recorded by the LCM 2000 data. This is likely to be due to two factors, the low proportion of vegetation cover at the time of survey and the small size and narrow shapes of these habitats, which may preclude them from being identified by the satellite imagery.

Current biodiversity in the surrounding area

The area immediately surrounding Stanwick Quarry largely comprises agricultural land, especially arable, in addition to calcareous, neutral and improved grasslands in the river valley and urban habitats on higher ground. Open water only accounts for 0.3% of the total land area of the surrounding landscape (Landscape Character Type – 89RBN), almost entirely comprising former gravel pits and reservoirs.

Changes in broad habitat biodiversity due to quarrying

It is clear that quarrying activity has led to a change in the presence and abundance of habitats and species within Stanwick Quarry. The land at Irthlingborough under consideration has been under three distinct land-use phases in recent history:

- semi-natural and agricultural habitats, described in Section 1.2, present prior to 1997;
- habitats present during operation of the extraction (1997-2002) ;and
- habitats present in the post-restoration landscape (2002 onwards).

Table 1 below shows the area and direction of change (gain or loss) in broad habitats within Stanwick Quarry, estimated using LCM 2000 broad habitat information. This change is for a snapshot of time in the year 2000 when the quarry was partially restored and still active. Only those habitats where there has been a measurable change are reported in the table.

The calculations of loss or gain are based upon the assumption that broad habitats occur in the same proportion throughout the surrounding landscape (Landscape Character Type 89-RBN), regardless of intra-type topographic, climatic and edaphic conditions. This calculation also assumes that Stanwick Quarry contained the same proportion of habitats as the surrounding landscape prior to extraction. These generalisations of habitat homogeneity represent a short-coming of the use of this technique at this small scale. However, it does provide a benchmark to make general comments on the likely broad habitat gains and losses that have occurred as a result of aggregate extraction in Stanwick Quarry.

In addition to habitat changes measured by LCM 2000, a description is given of the changes predicted in the Environmental Statement (EAU, 1992).

Table 1 – Estimated area and direction of change in broad habitats at Ballidon Quarry

LCM 2000 habitat type		Percent change	Estimated change in habitat (ha)	Direction of change
Broad habitat type	**Code**			
Broadleaved, mixed and yew woodland	1.1	3.4	7.599	Increase
Coniferous woodland	2.1	2	4.47	Increase
Arable and horticulture - cereals	4.1	-20.6	-46.041	Decrease
Arable and horticulture		-22.1	-49.3935	Decrease
Arable and horticulture – unknown crop, bare ground	4.2	-0.8	-1.788	Decrease
Improved grassland	5.1	-7.7	-17.2095	Decrease
Set-aside		-1.2	-2.682	Decrease
Neutral grassland	6.1	-3.2	-7.152	Decrease
Calcareous grassland	7.1	16.3	36.4305	Increase
Standing water	13.1	32.5	72.6375	Increase
Inland rock	16.1	-0.1	-0.2235	Decrease
Built up areas and gardens	17.1	-3.7	-8.2695	Decrease
Continuous urban	17.2	5.4	12.069	Increase

Table 1 suggests that broad-leaved and coniferous woodland, calcareous grassland and open water have all increased when compared to the surrounding landscape in 2000. It is estimated that decreases of arable land, improved and neutral grassland and built-up areas have occurred.

The estimation of habitat change broadly confirms the predicted actual habitat losses, with loss of the majority of improved and semi-improved neutral grassland and flood meadows. However, the LCM 2000 data does not indicate that the areas of neutral grassland of high biodiversity value were not developed; instead these habitats appear to be classified by LCM 2000 as calcareous grassland and improved grassland. The retention of the majority of these habitats within the original quarrying proposal is significant as it would represent retention of the most ecologically valuable land within the extraction area.

The majority of the existing hedgerows, scrub and trees were also retained; including most of the existing railway embankment scrub. This, in addition to the newly planted trees as part of the restoration process, would account for the measured increase in these habitats.

Residual losses and gains to biodiversity

LCM 2000 represents a snapshot of time, prior to the completion of the restoration of the Irthlingborough extension. Following completion of the restoration, the biodiversity contribution made by the formally quarried areas is likely to increase, as a result of the creation of habitats of biodiversity value.

The restoration objectives for Stanwick Quarry (Irthlingborough extension) were to retain the character of the existing flood meadows, to improve the habitat for wading birds, to create open water areas for wildfowl and to create an area suitable for low key recreational activities such as fishing, walking and bird watching. In order to meet these objectives a number of different habitats were created during the restoration phase, these included flood meadow, rough grassland margins, hedgerows, ponds, streams, reedbeds and woodland.

The re-created flood meadows are 30cm below the original levels to encourage winter flooding. This is likely to encourage greater numbers of breeding and migrant waders to the site (Briggs, 2002). The flood meadow was restored by the mixing the topsoil with the subsoil to reduce its nutrient content, to promote the occurrence of wild flowers and grasses and to discourage invasive weeds.

Lakes were created with areas of bank, shallow and deep water as well as islands. The lakes were allowed to fill naturally with water, having been kept dry during extraction by pumping. Islands were designed to provide safe nesting sites, with the open water being a safe area for wildfowl. Woodland, including wet woodland along the marshy lakeside edges and dry woodland species elsewhere, has also been planted. The operator plans to continue managing these habitats once the restoration work is completed, to ensure that restored habitats establish.

As an example of the success of the restoration procedure, northern lapwings (*Vanellus vanellus*) were found to be nesting in the flood meadow area (Briggs, 2002) during the establishment of restored habitats.

Conclusion and recommendations

From this case study it is clear that there have been changes to the broad habitats within Stanwick Quarry due to quarrying activity. Due to the short lifespan of sand and gravel quarries within the area, the ecological information available has allowed a comparison between the pre-quarrying baseline, habitats present during quarrying and those proposed as part of the restoration.

The major habitats that had been gained through quarrying by 2000 are open water, woodland, urban habitats and calcareous grassland. These habitats replaced improved and neutral grasslands. Other habitats appear to play a lesser role, although the biodiversity benefits provided by small areas of semi natural habitat retained within the development should not be underestimated. Information contained in the Environmental Statement suggests that the most ecologically important land,ieneutral grassland designated as of county importance, was retained. Scrub and woodland habitats were also retained within the development.

Whilst major changes occurred when quarrying began; subtle, yet significant, changes would have occurred prior to extraction as a result of agricultural improvements. These changes

include the re-seeding and nutrient enrichment of grassland and the drainage of riverside meadows.

Comparison between the broad habitat information available from LCM 2000, recent aerial photographs and pre-existing ecological survey has shown that, broadly speaking, LCM 2000 is capable of identifying changes in broad habitat types. However, misclassification of habitat has occurred; notably the interpretation of restored, flood meadow grassland within the quarry as arable land or calcareous grassland and the misclassification of wetland habitats as either open water or grassland habitats.

The restoration plan reviewed indicates that, in the long term, the habitats created during the restoration process would replace lost habitats with those of potentially higher biodiversity value, such as wet and broadleaved woodland, floodplain grassland, open water habitats with shingle beaches, islands etc. with value for wading birds. The habitats created have potential to contribute towards future UK and Northamptonshire BAP targets. Hanson is committed to continued management of the site post-restoration to ensure that that potential gains to biodiversity are met. The appropriate management of created habitats during the long term would be required to ensure that habitats maximise their biodiversity potential.

In conclusion, it is considered that the restored Stanwick Quarry will provide greater biodiversity opportunities, especially for waders and waterfowl, than the intensively farmed landscape which it replaced.

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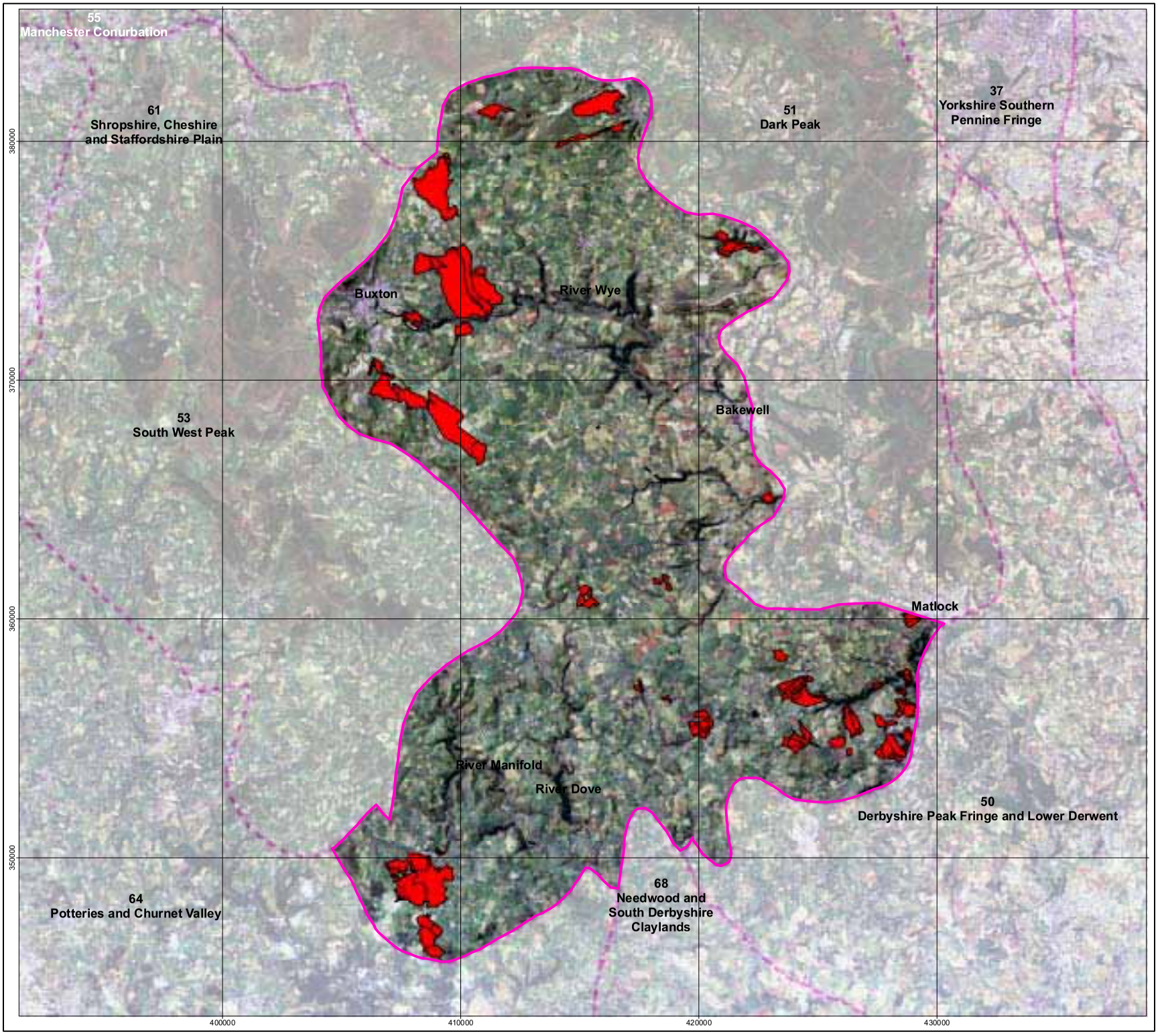
Figures



Legend

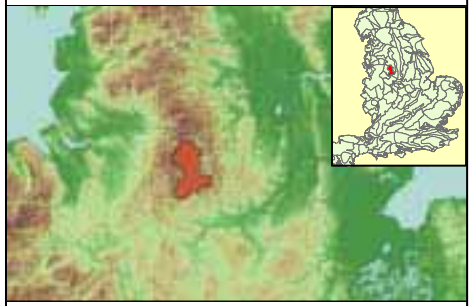
White Peak Study Area (Natural Area 52)

Natural Areas

Post-1947 aggregate planning permissions

White Peak

Ashwood Dale	Hoe Grange
Ball Eye	Hope
Ballidon	Hopton
Bee Low	Ivonbrook
Brassington Moor	Kenslow Farm
Brownend	Kenslow Pit West
Buxton	Kenslow Pits
Cauldon	Kevin
Cauldon Low	Low Moor
Darlton	Middle Peak
Dene	Middleton Mine
Dove Holes	Moss Rake
Dowlow	Once-a-Week
Eldon Hill	Parish
Furness Quarry	Prospect
Goddards	Shining Bank
Grange Mill	Slinter Top
Gravel pits	Surface Workings on Lathkildale Vein
Griffe Grange Silica Pit	Topley Pike
Hall Dale	Tunstead - Old Moor
Hartington Station	Upper Great Rocks
Hartshead	Wardlow
Hazelbadge Hills	Waterswallows
Hillhead	Whitecliffe Farm
Hindlow	Wredon
Hoben Quarry	Hoe Grange



N
W E
S

Kilometers
0 1.25 2.5 5 7.5 10

Scale: 1:150,000

Geodetic Information
British National Grid
Transverse Mercator
False Easting = 400,000m
False Northing = -100,000m
Central Meridian = -2 °
Scale Factor = 0.9996
Latitude Of Origin = 49 °

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Project

MEASURING THE MINERALS INDUSTRY'S CONTRIBUTION TO BIODIVERSITY

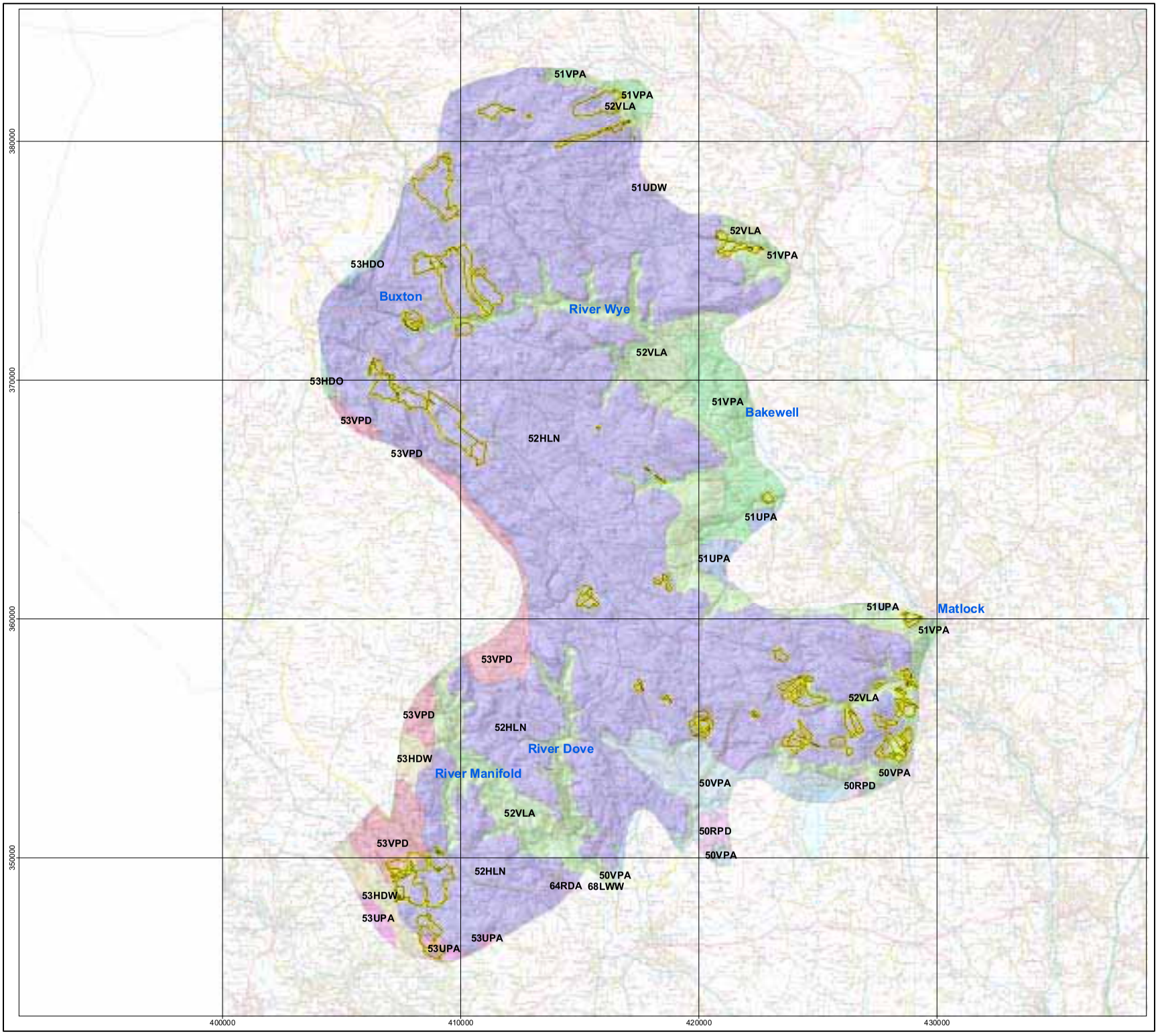
Drawing **White Peak Study Area**

Date February 2004

Figure B1.1

Sheet No. **1**

Ref 4D.648.001 ENBD 150 - FIG B1.1 - JIH



Legend

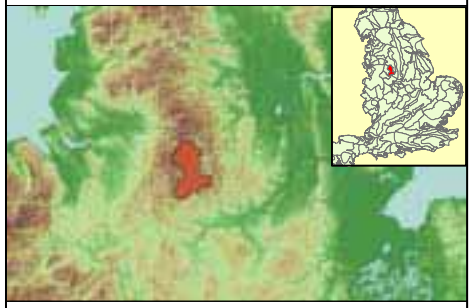
Landscape Character

LCT No., Physiography, Landcover, Culture

50RPD	**Physiography**		
50VPA	H	High hills	
51UDW	U	Low hills	
51UPA	V	Upland vales & valleys	
51VPA	R	Intermediate	
52HLN	L	Lowlands	
52VLA	**Landcover**		
53HDO	W	Wetland	
53HDW	D	Heath & moorland	
53UPA	L	Chalk & limestone	
53VPD	B	Other light land	
64RDA	C	Clay land	
68LWW	P	Other heavy land	
	Cultural pattern		
	A	Ancient woods	
	E	Estate land	
	S	Secondary woodland	
	D	Dispersed unwooded	
	N	Nucleated unwooded	
	W	Wetland / waste unwooded	
	O	Unsettled / open land	
	C	Coalfields	
	Ur	Urban	

Post-1947 aggregate planning permissions

White Peak



N

W E

S

Kilometers

0 1.25 2.5 5 7.5 10

Geodetic Information
British National Grid
Transverse Mercator
False Easting = 400,000m
False Northing = -100,000m
Central Meridian = -2 °
Scale Factor = 0.9996
Latitude Of Origin = 49 °

Scale: 1:150,000

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MEASURING THE MINERALS INDUSTRY'S CONTRIBUTION TO BIODIVERSITY

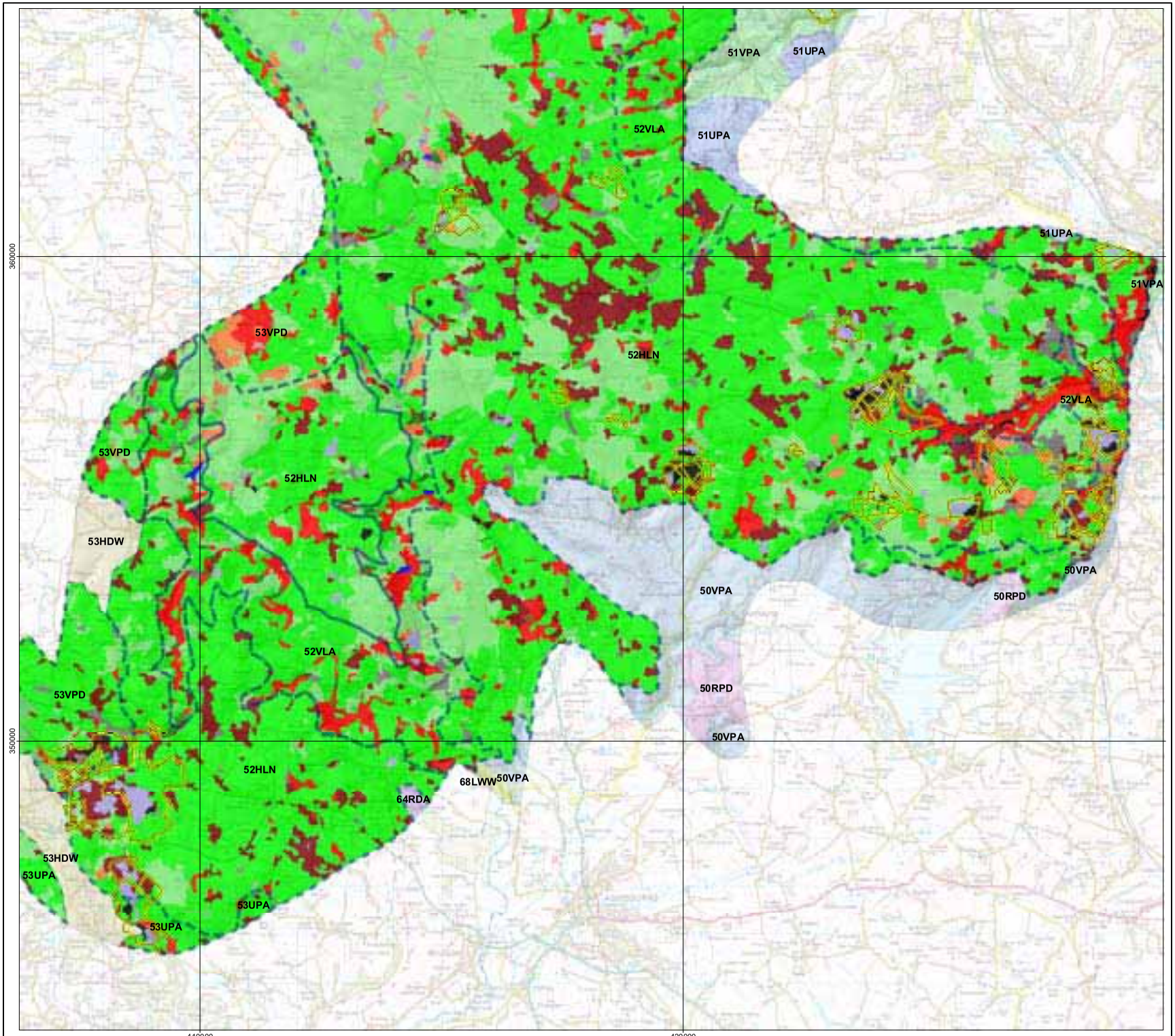
Drawing **Distribution of Aggregate Quarries by Landscape Character Type**

Date February 2004

Figure B1.2

Sheet No. **1**

Ref 4D.648.001 ENBD 150 - FIGB1.2 - JIH



Legend

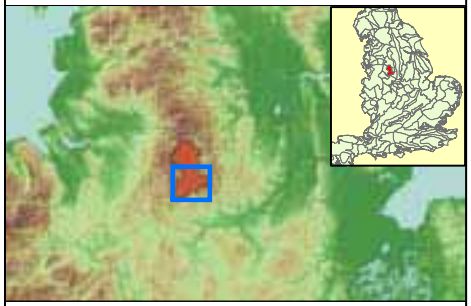
Landscape Character Type

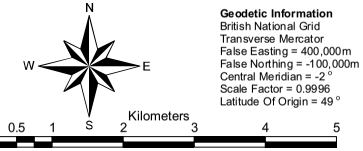
- 50RPD
- 50VPA
- 51UPA
- 51VPA
- 52HLN
- 52VLA
- 53HDW
- 53UPA
- 53VPD
- 64RDA
- 68LWW

Post-1947 aggregate planning permissions
White Peak

Land Cover Map 2000

- 1.1 Broad-leaved, mixed & yew woodland
- 2.1 Coniferous woodland
- 4.1 Arable & horticulture (cereals)
- 4.2 Arable & horticulture (bare, other, unknown)
- 5.1 Improved grassland
- 6.1 Neutral grass
- 7.1 Calcareous grass
- 8.1 Acid grass
- 9.1 Bracken
- 10.2 Open dwarf shrub heath
- 11.1 Fen, marsh, swamp
- 13.1 Standing water
- 16.1 Inland rock
- 17.1 Built up areas, gardens
- 17.2 Continuous urban





Geodetic Information
British National Grid
Transverse Mercator
False Easting = 400,000m
False Northing = -100,000m
Central Meridian = -2 °
Scale Factor = 0.9996
Latitude Of Origin = 49 °

Scale: 1:75,000

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MEASURING THE MINERALS INDUSTRY'S CONTRIBUTION TO BIODIVERSITY

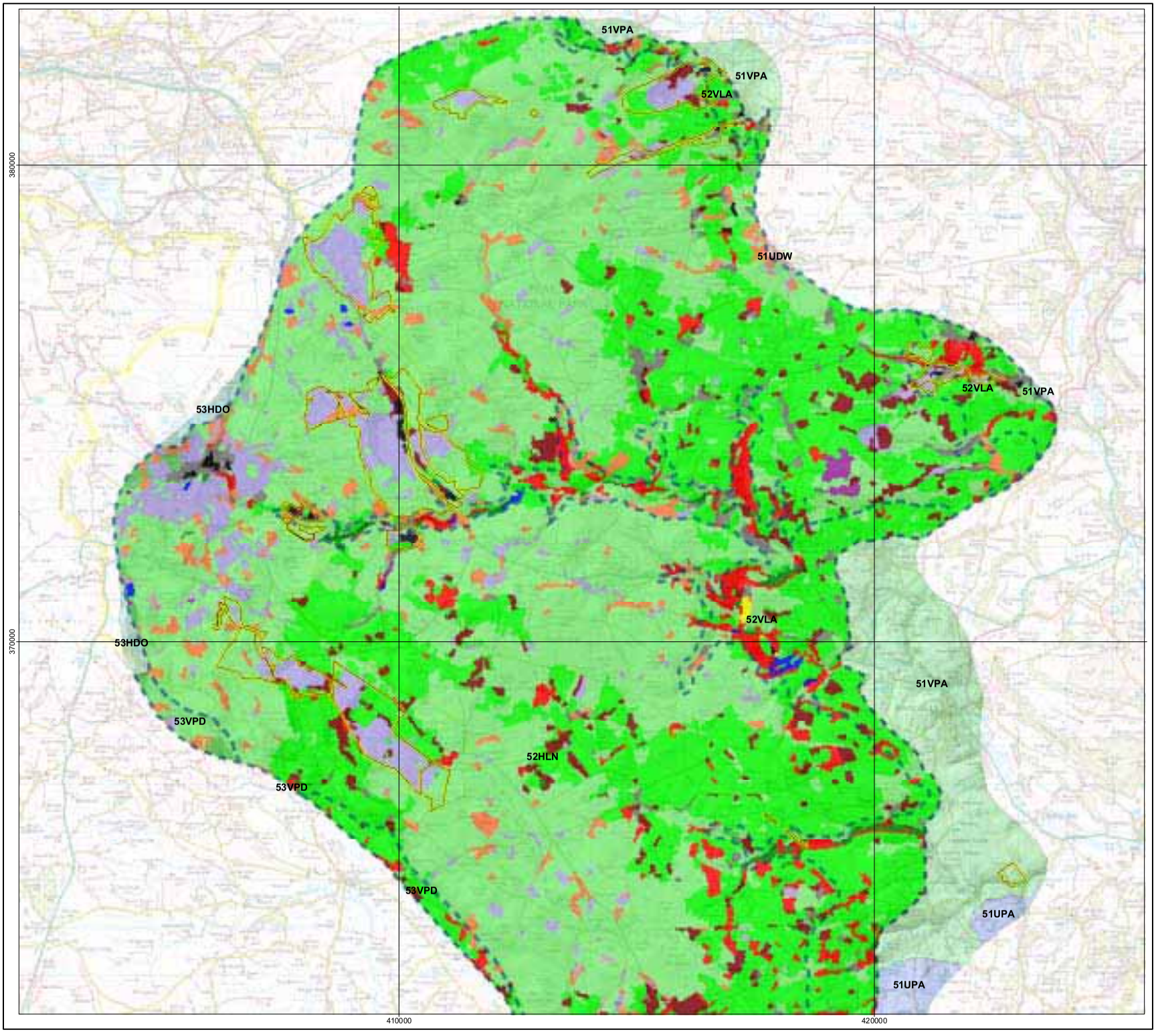
Drawing **Broad Habitats (LCM 2000) within White Peak - South**

Date February 2004

Figure B1.3a

Sheet No. **1**

Ref 4D.648.001 ENBD 75 - FIGB1.3a - JIH



Legend

Landscape Character Type

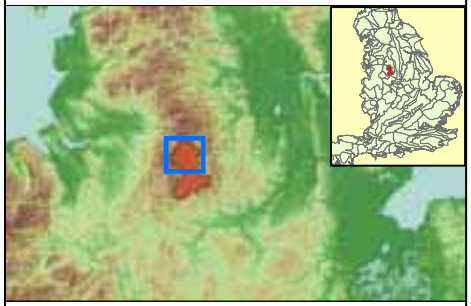
- 51UDW
- 51UPA
- 51VPA
- 52HLN
- 52VLA
- 53HDO
- 53VPD

Post-1947 aggregate planning permissions

White Peak

Land Cover Map 2000

- 1.1 Broad-leaved, mixed & yew woodland
- 2.1 Coniferous woodland
- 4.1 Arable & horticulture (cereals)
- 4.2 Arable & horticulture (bare, other, unknown)
- 5.1 Improved grassland
- 5.2 Setaside grass
- 6.1 Neutral grass
- 7.1 Calcareous grass
- 8.1 Acid grass
- 9.1 Bracken
- 10.1 Dwarf shrub heath
- 10.2 Open dwarf shrub heath
- 11.1 Fen, marsh, swamp
- 13.1 Standing water
- 16.1 Inland rock
- 17.1 Built up areas, gardens
- 17.2 Continuous urban



N W E S

Kilometers 0 0.5 1 2 3 4 5

Scale: 1:75,000

Geodetic Information
British National Grid
Transverse Mercator
False Easting = 400,000m
False Northing = -100,000m
Central Meridian = -2 °
Scale Factor = 0.9996
Latitude Of Origin = 49 °

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MEASURING THE MINERALS INDUSTRY'S CONTRIBUTION TO BIODIVERSITY

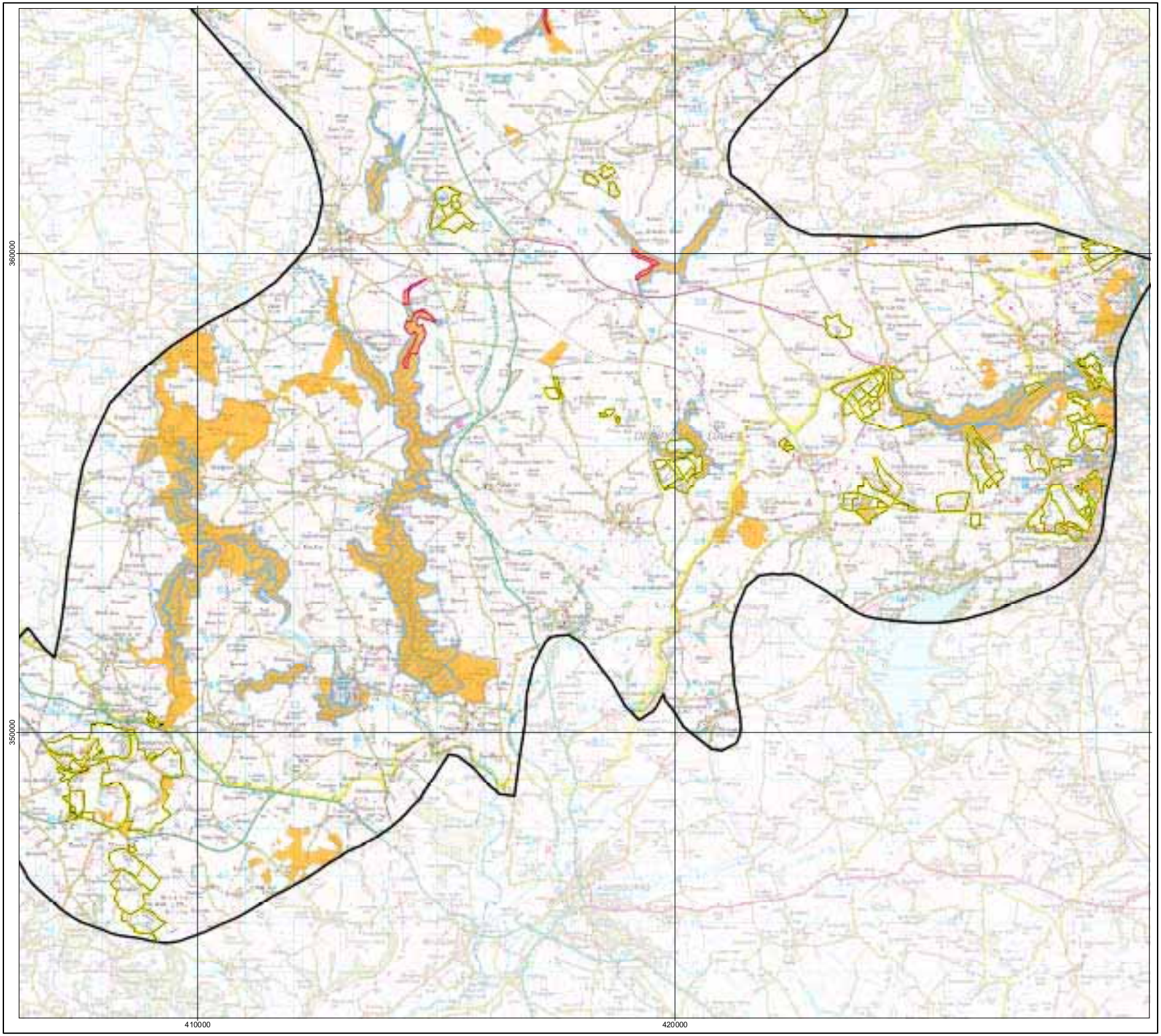
Drawing **Broad Habitats (LCM 2000) within White Peak - North**

Date February 2004

Figure B1.3b

Sheet No. **2**

Ref 4D.648.001 ENBD 75 - FIGB1.3b - JIH

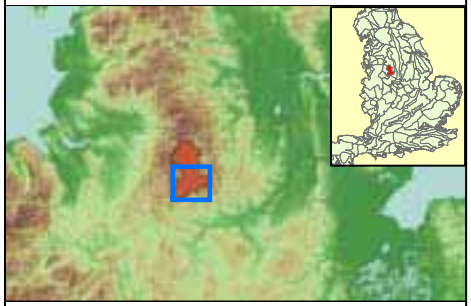


Legend

- Candidate Special Areas of Conservation
- Sites of Specific Scientific Interest
- National Nature Reserves

Post-1947 aggregate planning permissions

- White Peak



N
W E
S

Kilometers
0 0.5 1 2 3 4 5

Scale: 1:75,000

Geodetic Information
British National Grid
Transverse Mercator
False Easting = 400,000m
False Northing = -100,000m
Central Meridian = -2 °
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Latitude Of Origin = 49 °

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MEASURING THE MINERALS INDUSTRY'S CONTRIBUTION TO BIODIVERSITY

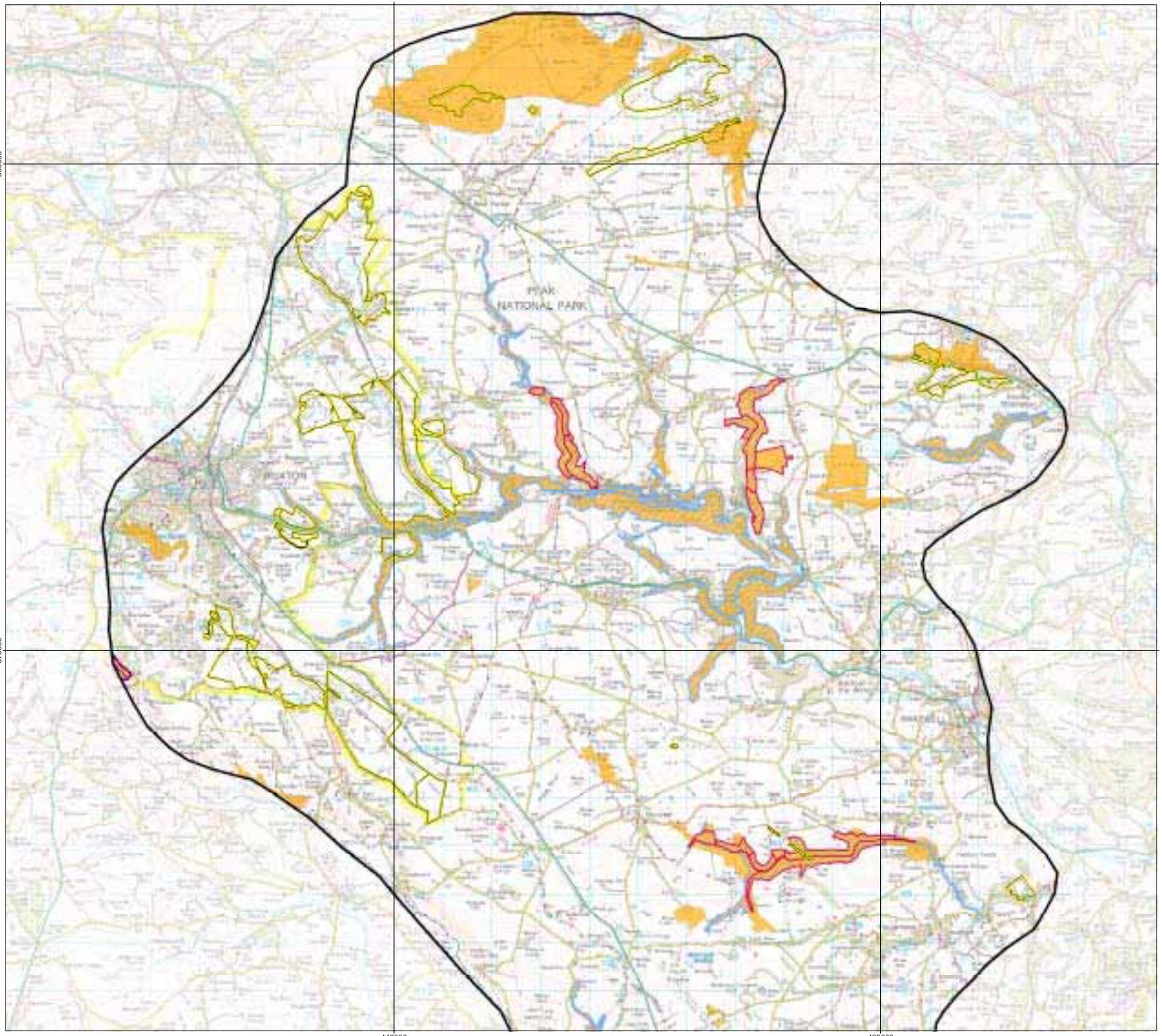
Drawing **Designated land within White Peak - South**

Date February 2004

Figure B1.4a

Sheet No. **1**

Ref 4D.648.001 ENBD 75 - FIGB1.4a - JIH

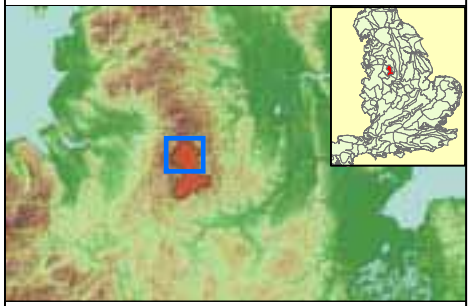


Legend

- Special Protection Areas
- Candidate Special Areas of Conservation
- Sites of Specific Scientific Interest
- National Nature Reserves

Post-1947 aggregate planning permissions

- White Peak



N
W E
S

Kilometers
0 0.5 1 2 3 4 5

Scale: 1:75,000

Geodetic Information
British National Grid
Transverse Mercator
False Easting = 400,000m
False Northing = -100,000m
Central Meridian = -2 °
Scale Factor = 0.9996
Latitude Of Origin = 49 °

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MEASURING THE MINERALS INDUSTRY'S CONTRIBUTION TO BIODIVERSITY

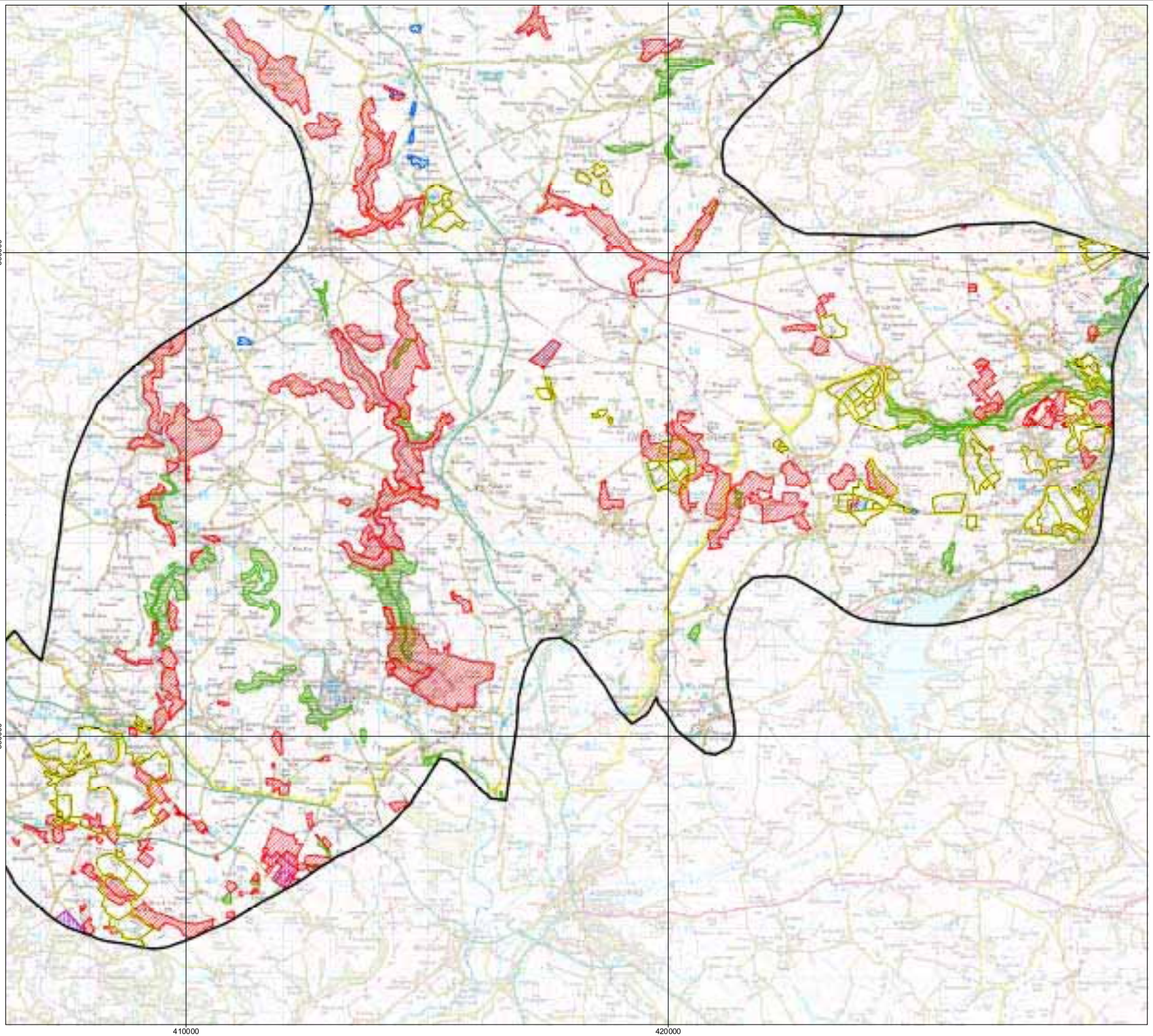
Drawing **Designated land within White Peak - North**

Date February 2004

Figure B1.4b

Sheet No. **2**

Ref 4D.648.001 ENBD 75 - FIGB1.4b - JIH

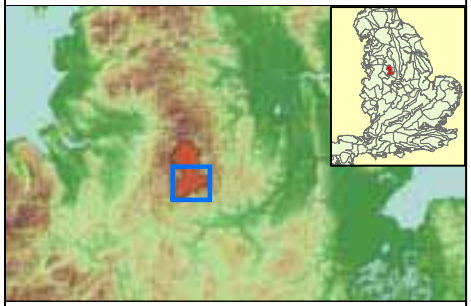


Legend

- Lowland Grassland
- Lowland Heathland
- Upland Heathland
- Ancient Woodland

Post-1947 aggregate planning permissions

- White Peak



N
W E
S

Kilometers
0 0.5 1 2 3 4 5

Scale: 1:75,000

Geodetic Information
British National Grid
Transverse Mercator
False Easting = 400,000m
False Northing = -100,000m
Central Meridian = -2 °
Scale Factor = 0.9996
Latitude Of Origin = 49 °

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MEASURING THE MINERALS INDUSTRY'S CONTRIBUTION TO BIODIVERSITY

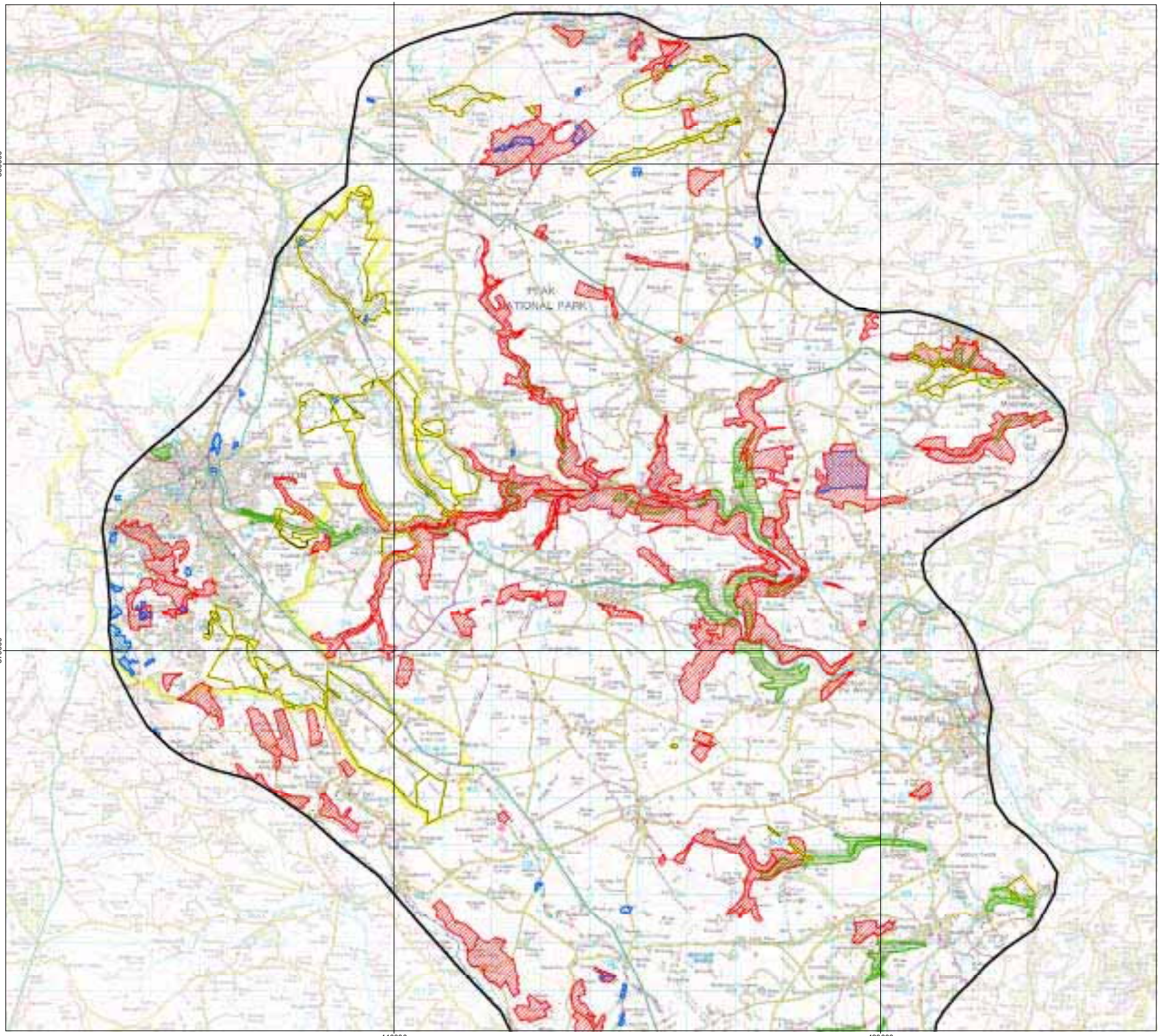
Drawing **Priority habitats within White Peak - South**

Date February 2004

Figure B1.5a

Sheet No. **1**

Ref 4D.648.001 ENBD 75 - FIGB1.5a - JIH

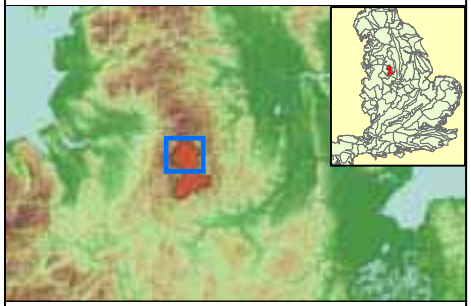


Legend

- Lowland Grassland
- Lowland Heathland
- Upland Heathland
- Ancient Woodland

Post-1947 aggregate planning permissions

- White Peak



N

W E

S

Kilometers

0 0.5 1 2 3 4 5

Scale: 1:75,000

Geodetic Information
British National Grid
Transverse Mercator
False Easting = 400,000m
False Northing = -100,000m
Central Meridian = -2 °
Scale Factor = 0.9996
Latitude Of Origin = 49 °

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MEASURING THE MINERALS INDUSTRY'S CONTRIBUTION TO BIODIVERSITY

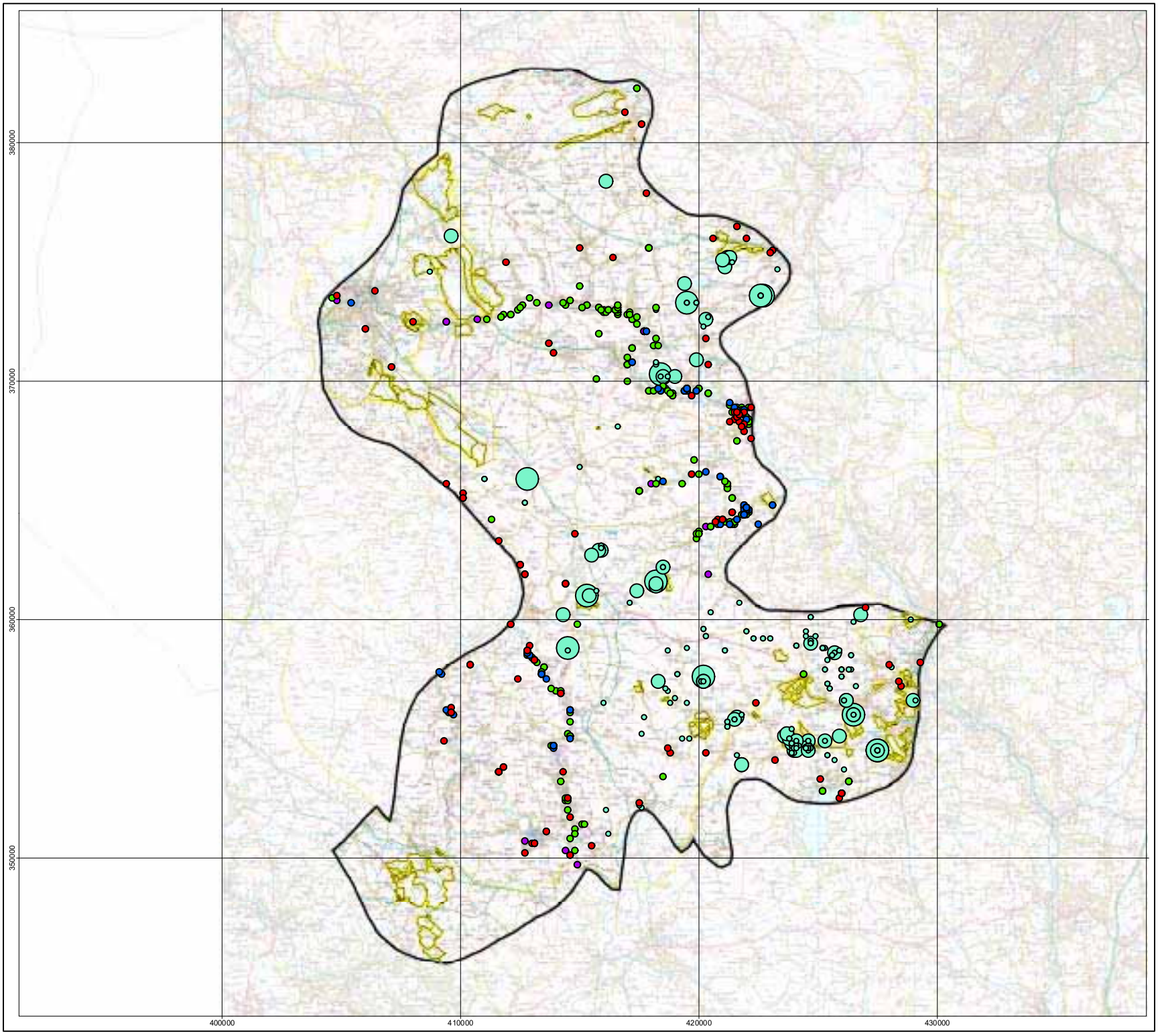
Drawing **Priority habitats within White Peak - North**

Date February 2004

Figure B1.5b

Sheet No. **2**

Ref 4D.648.001 ENBD 75 - FIGB1.5b - JIH

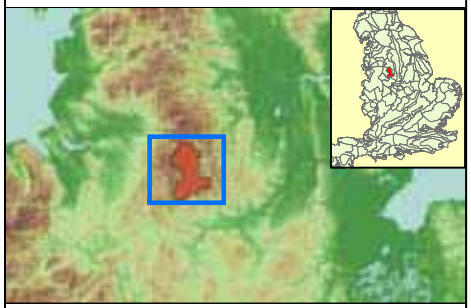


Legend

- Bats
- Crayfish
- Water Voles
- Otters

Great Crested Newts
ABUNDANCE
- 1-10 : small
- 11-100 : medium
- 100+ : exceptional

Post-1947 aggregate planning permissions
White Peak



N
W E
S

Kilometers
0 1 2 4 6 8 10

Geodetic Information
British National Grid
Transverse Mercator
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False Northing = -100,000m
Central Meridian = -2 °
Scale Factor = 0.9996
Latitude Of Origin = 49 °

Scale: 1:150,000

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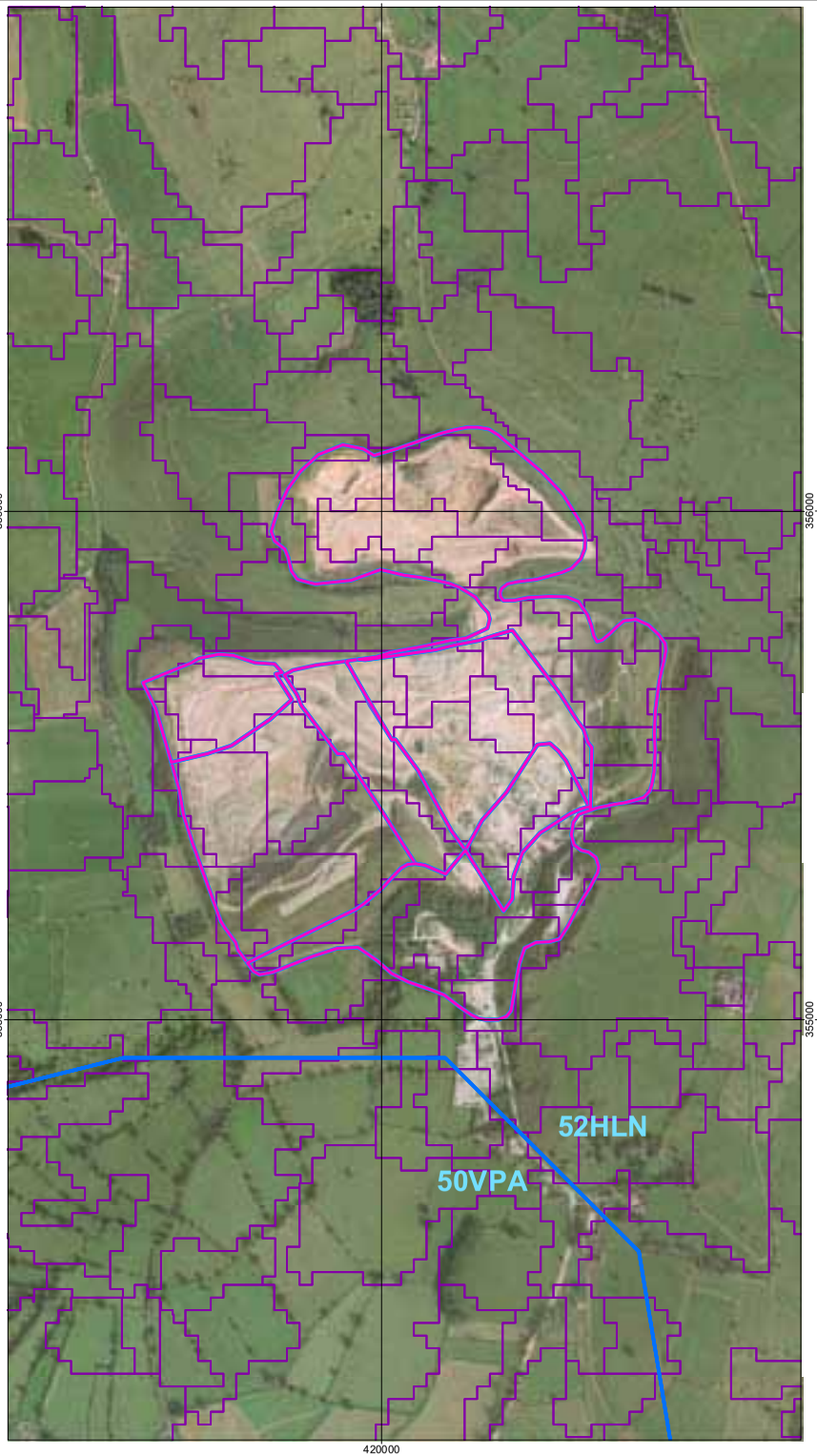
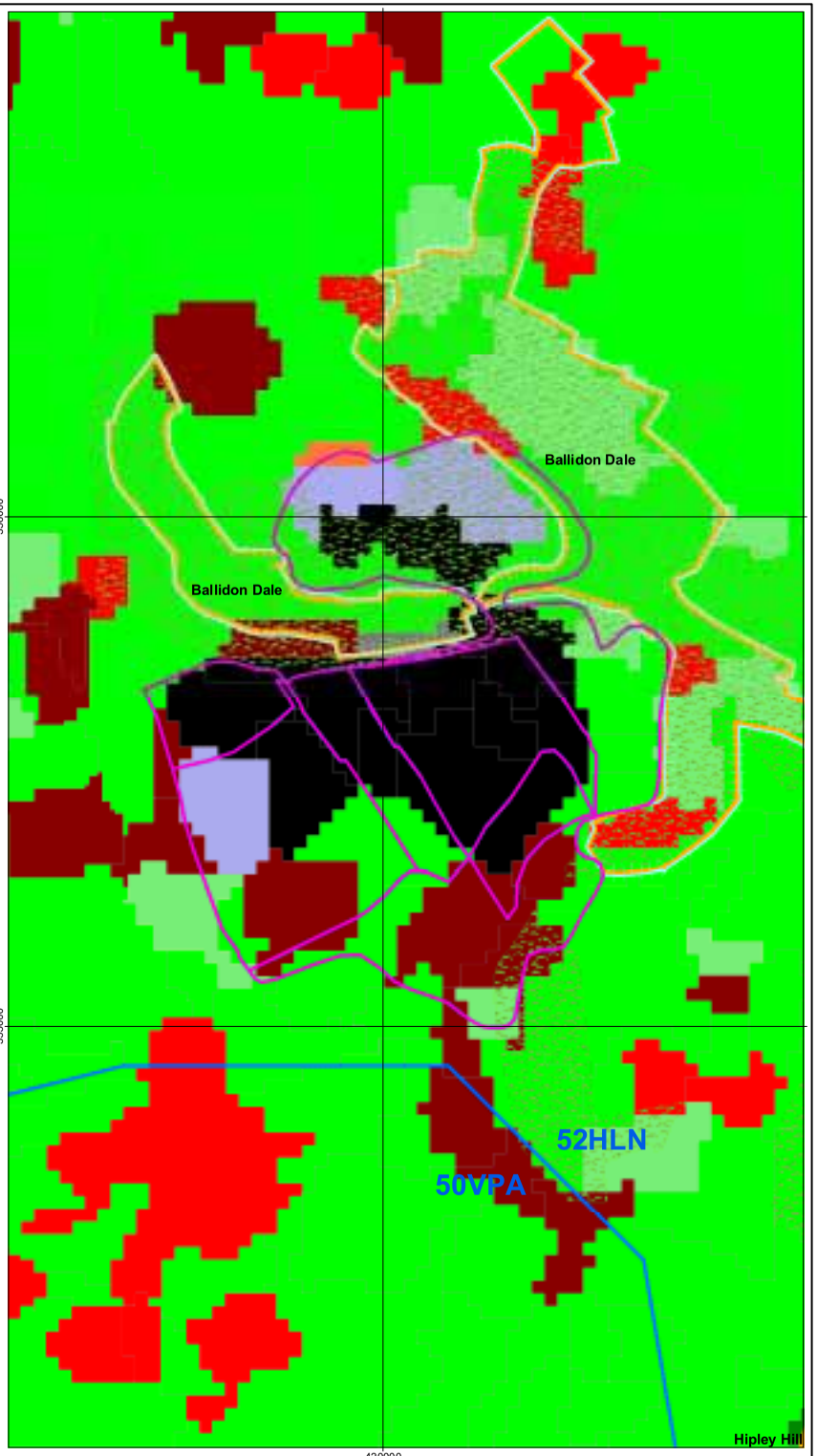
MEASURING THE MINERALS INDUSTRY'S CONTRIBUTION TO BIODIVERSITY

Drawing Date February 2004 **Figure B1.6**

Protected species within White Peak Sheet No. **1**

Ref 4D.648.001 ENBD 150 - FIGB1.6 - JIH





Legend

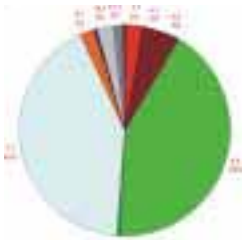
- Ballidon Quarry Permitted Boundary
- Landscape Character
- Sites of Specific Scientific Interest
- Candidate Special Area of Conservation
- Lowland_Grassland

Land Cover Map 2000

- 1.1 Broad-leaved, mixed & yew woodland
- 2.1 Coniferous woodland
- 4.1 Arable & horticulture (cereals)
- 4.2 Arable & horticulture (bare, other, unknown)
- 5.1 Improved grassland
- 7.1 Calcareous grass
- 9.1 Bracken
- 16.1 Inland rock
- 17.1 Built up areas, gardens
- 17.2 Continuous urban

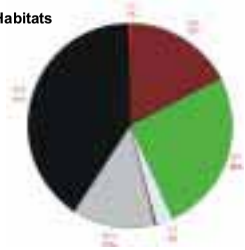
52HLN Habitat Baseline

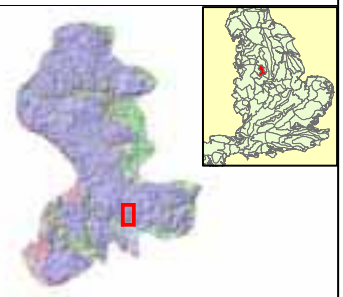
945.2	2.7
51.4	0.1
885.7	2.5
1202.4	3.4
14972.7	42.2
0.6	0.0
75.6	0.2
14907.3	42.0
6.9	<0.1
809.8	2.3
53.5	0.2
61.8	0.2
0.0	0.0
13.9	<0.1
920.2	2.6
546.6	1.5
61.5	0.2



Ballidon Quarry LCM2000 Habitats

0.4	0.5
0.0	0.0
0.0	0.0
11.7	16.7
17.9	25.5
0.0	0.0
0.0	0.0
2.0	2.9
0.0	0.0
0.2	0.3
0.0	0.0
0.0	0.0
0.0	0.0
0.0	0.0
9.3	13.3
0.0	0.1
28.5	40.7





N
W E
S

Kilometers
0 0.05 0.1 0.2 0.3 0.4 0.5

Scale: 1:10,000

Geodetic Information
British National Grid
Transverse Mercator
False Easting = 400,000m
False Northing = -100,000m
Central Meridian = -2 °
Scale Factor = 0.9996
Latitude Of Origin = 49 °

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MEASURING THE MINERALS INDUSTRY'S CONTRIBUTION TO BIODIVERSITY

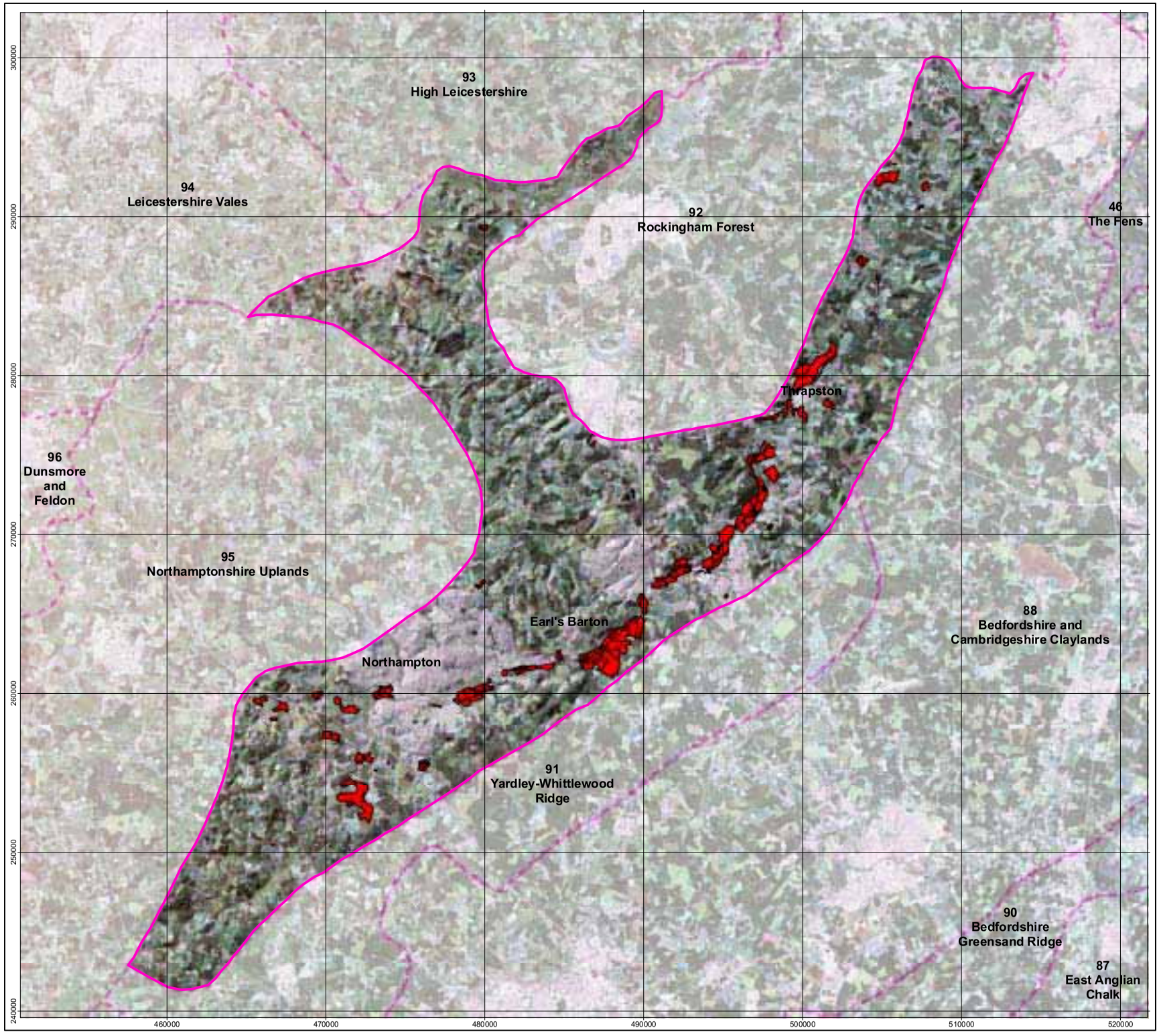
Drawing **White Peak**
Case Study - Ballidon Quarry

Date February 2004

Figure B1.7

Sheet No. **1**

Ref 4D.648.001 ENBD 10 - FIG B1.7 - JIH



Legend

Northamptonshire Vales Study Area (Natural Area 89)

Character areas

Post-1947 aggregate planning permissions

Northamptonshire Vales

Aggate Way	Kettering Sewage works
Aldwincle Gravel Pit	Kislingbury
Ashley Road	Milton Malsor
Barnwell	Milton Sand Quarry
Barnwell Mill	Nassington sandpit
Bedford Road	Overstone
Blisworth	Pytchley
Boughton Green Road	Rectory Farm
Brackmills	Ringstead Grange Farm
Brook Farm	Ringstead Gravel Pit
Clifford Hill Quarry	Rothersthorpe
Collingtree Road	Rushden
Ditchford	Sanders Lodge
Duston Mill	Skew Bridge
Duston Mill Reservoir borrow pit	Spring Meadows
Eaglethorpe	Stanwick
Earls Barton Sand Pit	Station Road
Fotheringhay	Tansor
Heyford Mill Farm	Thrapston
Highham Road	Thrapston Bridge
Hipwells Farm	Thrapston Pit
Irthlingborough	Weedon Road
Kettering Rd	Woodford Grange
Kettering Road	Wootton

N

W E

S

Kilometers

0 2 4 8 12 16

Geodetic Information
British National Grid
Transverse Mercator
False Easting = 400,000m
False Northing = -100,000m
Central Meridian = -2 °
Scale Factor = 0.9996
Latitude Of Origin = 49 °

Scale: 1:225,000

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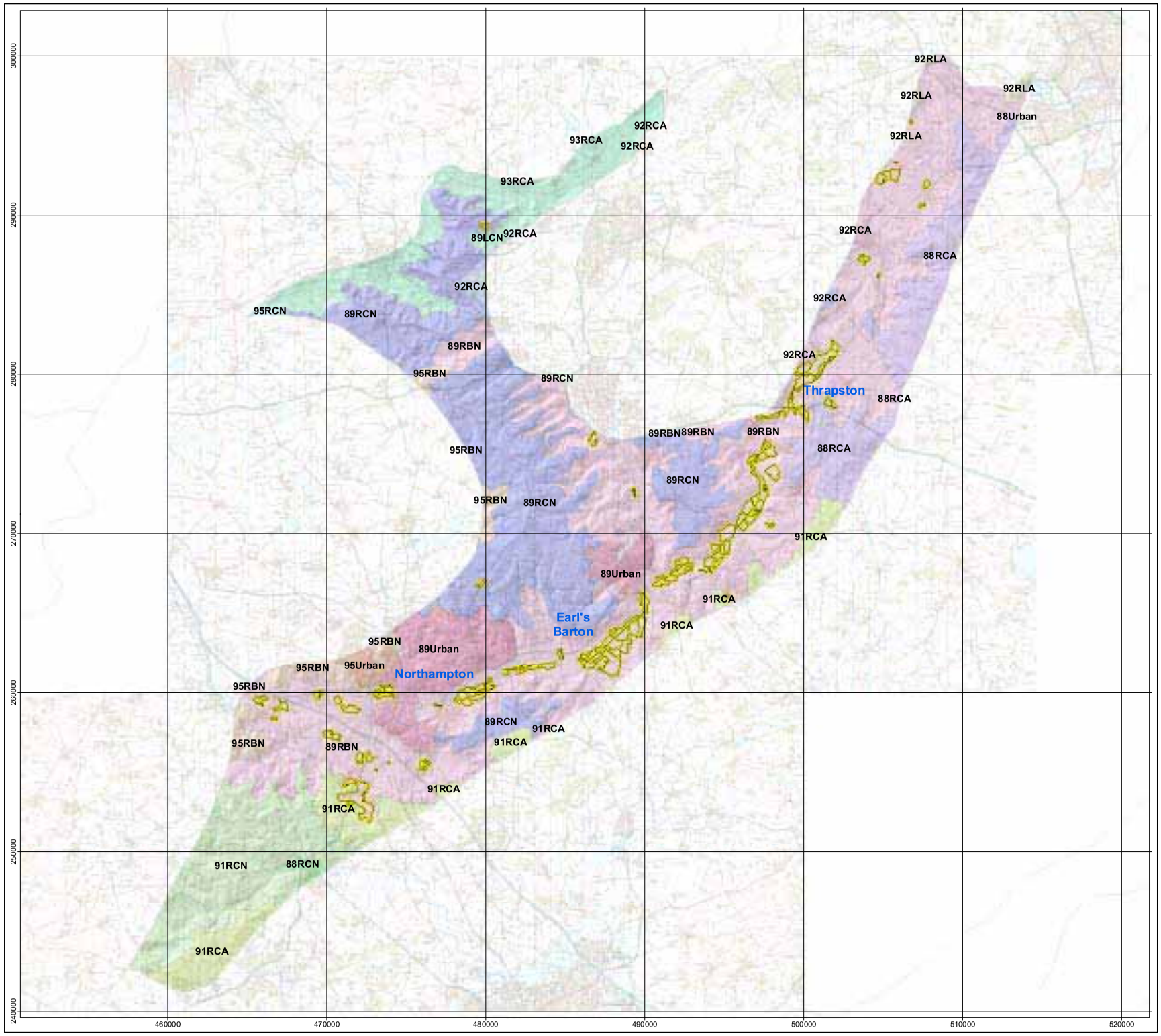
MEASURING THE MINERALS INDUSTRY'S CONTRIBUTION TO BIODIVERSITY

Drawing Date February 2004 **Figure B2.1**

Northamptonshire Vales Study Area Sheet No. **1**

Ref 4D.648.001 ENBD 225 - FIGB2.1 - JIH



Legend

Landscape Character

LCT No., Physiography, Landcover, Culture

88RCA
88RCN
88Urban
89LCN
89RBN
89RCN
89Urban
91RCA
91RCN
92RCA
92RLA
93RCA
95RBN
95RCN
95Urban

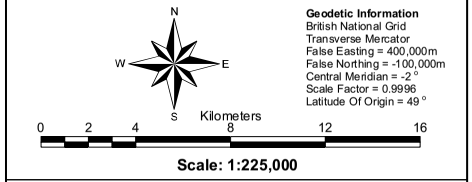
Physiography
- H High hills
- U Low hills
- V Upland vales & valleys
- R Intermediate
- L Lowlands

Landcover
- W Wetland
- D Heath & moorland
- L Chalk & limestone
- B Other light land
- C Clay land
- P Other heavy land

Cultural pattern
- A Ancient woods
- E Estate land
- S Secondary woodland
- D Dispersed unwooded
- N Nucleated unwooded
- W Wetland / waste unwooded
- O Unsettled / open land
- C Coalfields
- Ur Urban

Post-1947 aggregate planning permissions

Northamptonshire Vales



Geodetic Information
British National Grid
Transverse Mercator
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Central Meridian = -2 °
Scale Factor = 0.9996
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Scale: 1:225,000

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MEASURING THE MINERALS INDUSTRY'S CONTRIBUTION TO BIODIVERSITY

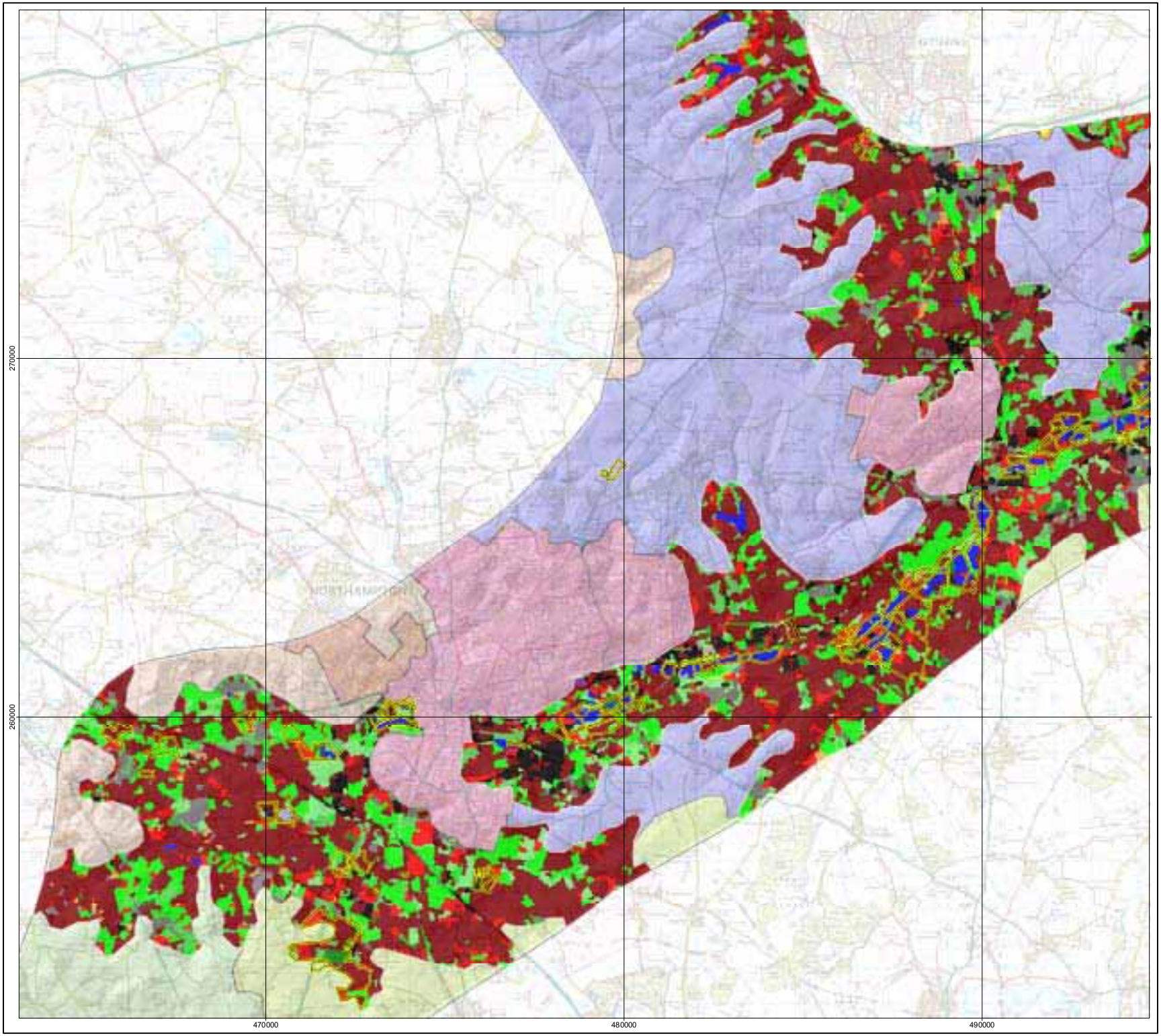
Drawing **Distribution of Aggregate Quarries by Landscape Character Type**

Date February 2004

Figure B2.2

Sheet No. **1**

Ref 4D.648.001 ENBD 225 - FIGB2.2 - JIH



Legend

Landscape Character Type No.

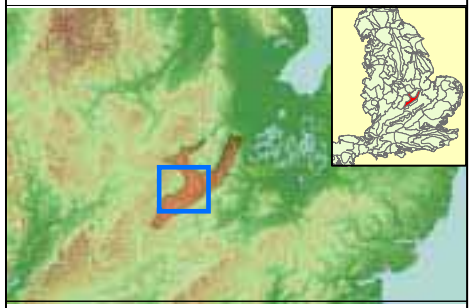
- 89RBN
- 89RCN
- 89Urban
- 91RCA
- 91RCN
- 95RBN
- 95Urban

Post-1947 aggregate planning permissions

- Northamptonshire Vales

Land Cover Map 2000

- 1.1 Broad-leaved, mixed & yew woodland
- 2.1 Coniferous woodland
- 4.1 Arable & horticulture (cereals)
- 4.2 Arable & horticulture (bare, other, unknown)
- 4.3 Arable & horticulture (not annual crop)
- 5.1 Improved grassland
- 5.2 Setaside grass
- 6.1 Neutral grass
- 7.1 Calcareous grass
- 9.1 Bracken
- 10.1 Dwarf shrub heath
- 10.2 Open dwarf shrub heath
- 11.1 Fen, marsh, swamp
- 13.1 Standing water
- 16.1 Inland rock
- 17.1 Built up areas, gardens
- 17.2 Continuous urban



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Kilometers
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Geodetic Information
British National Grid
Transverse Mercator
False Easting = 400,000m
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Central Meridian = -2 °
Scale Factor = 0.9996
Latitude Of Origin = 49 °

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MEASURING THE MINERALS INDUSTRY'S CONTRIBUTION TO BIODIVERSITY

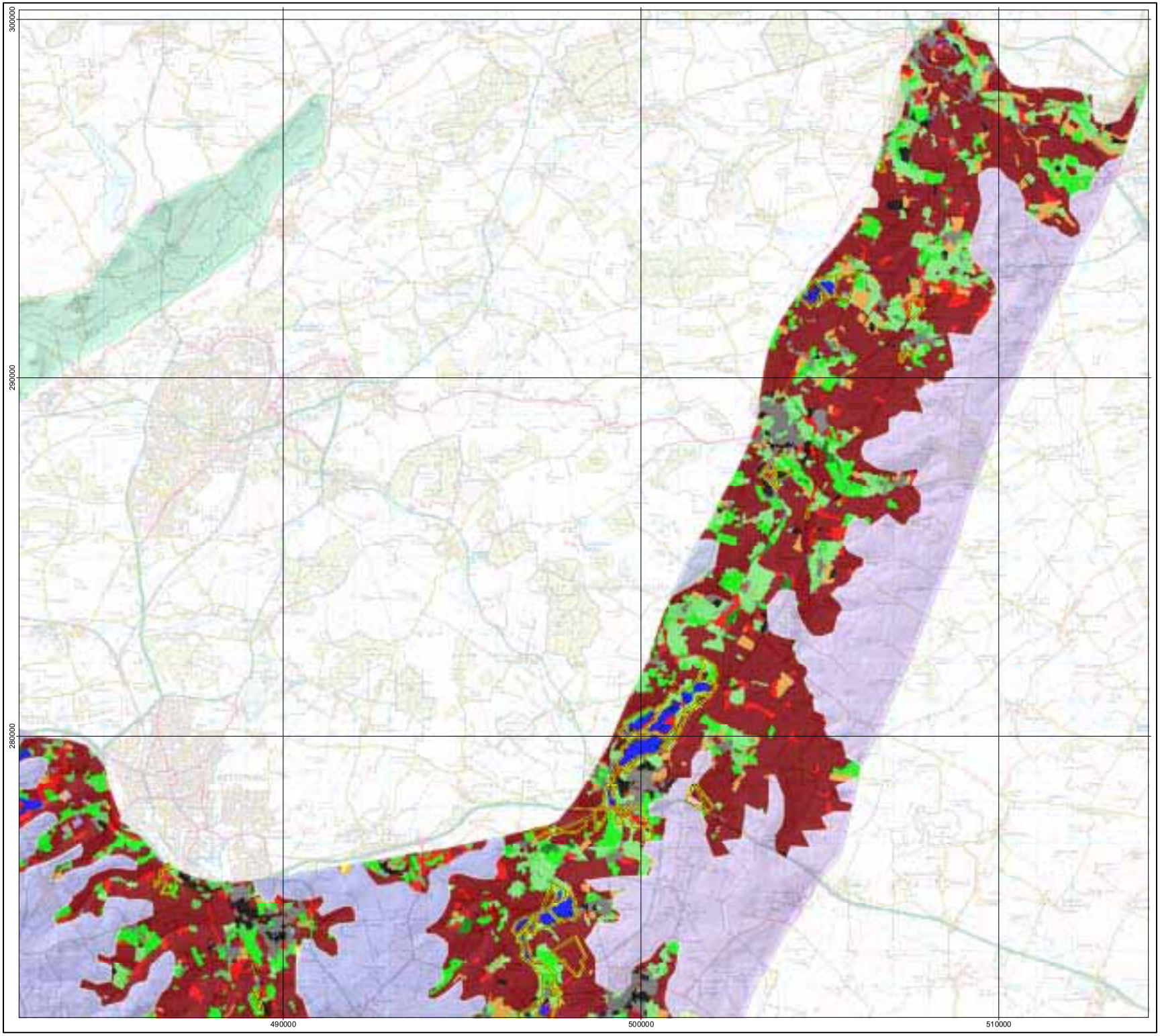
Drawing **Broad Habitats (LCM 2000) within LCT 89RBN Nene Valley - South**

Date February 2004

Figure B2.3a

Sheet No. **1**

Ref 4D.648.001 ENBD 100 - FIGB2.3a - JIH



Legend

Landscape Character Type No.

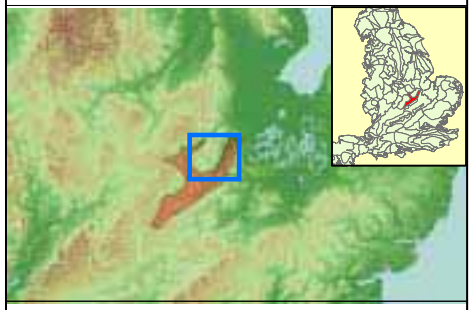
- 88RCA
- 88Urban
- 89LCN
- 89RBN
- 89RCN
- 91RCA
- 92RCA
- 92RLA
- 93RCA

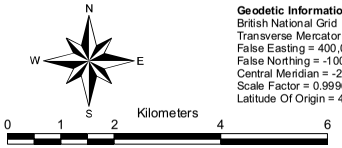
Post-1947 aggregate planning permissions

- Northamptonshire Vales

Land Cover Map 2000

- 1.1 Broad-leaved, mixed & yew woodland
- 2.1 Coniferous woodland
- 4.1 Arable & horticulture (cereals)
- 4.2 Arable & horticulture (bare, other, unknown)
- 4.3 Arable & horticulture (not annual crop)
- 5.1 Improved grassland
- 5.2 Setaside grass
- 6.1 Neutral grass
- 7.1 Calcareous grass
- 9.1 Bracken
- 10.2 Open dwarf shrub heath
- 11.1 Fen, marsh, swamp
- 13.1 Standing water
- 16.1 Inland rock
- 17.1 Built up areas, gardens
- 17.2 Continuous urban





Geodetic Information
British National Grid
Transverse Mercator
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Scale Factor = 0.9996
Latitude Of Origin = 49 °

Scale: 1:100,000

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MEASURING THE MINERALS INDUSTRY'S CONTRIBUTION TO BIODIVERSITY

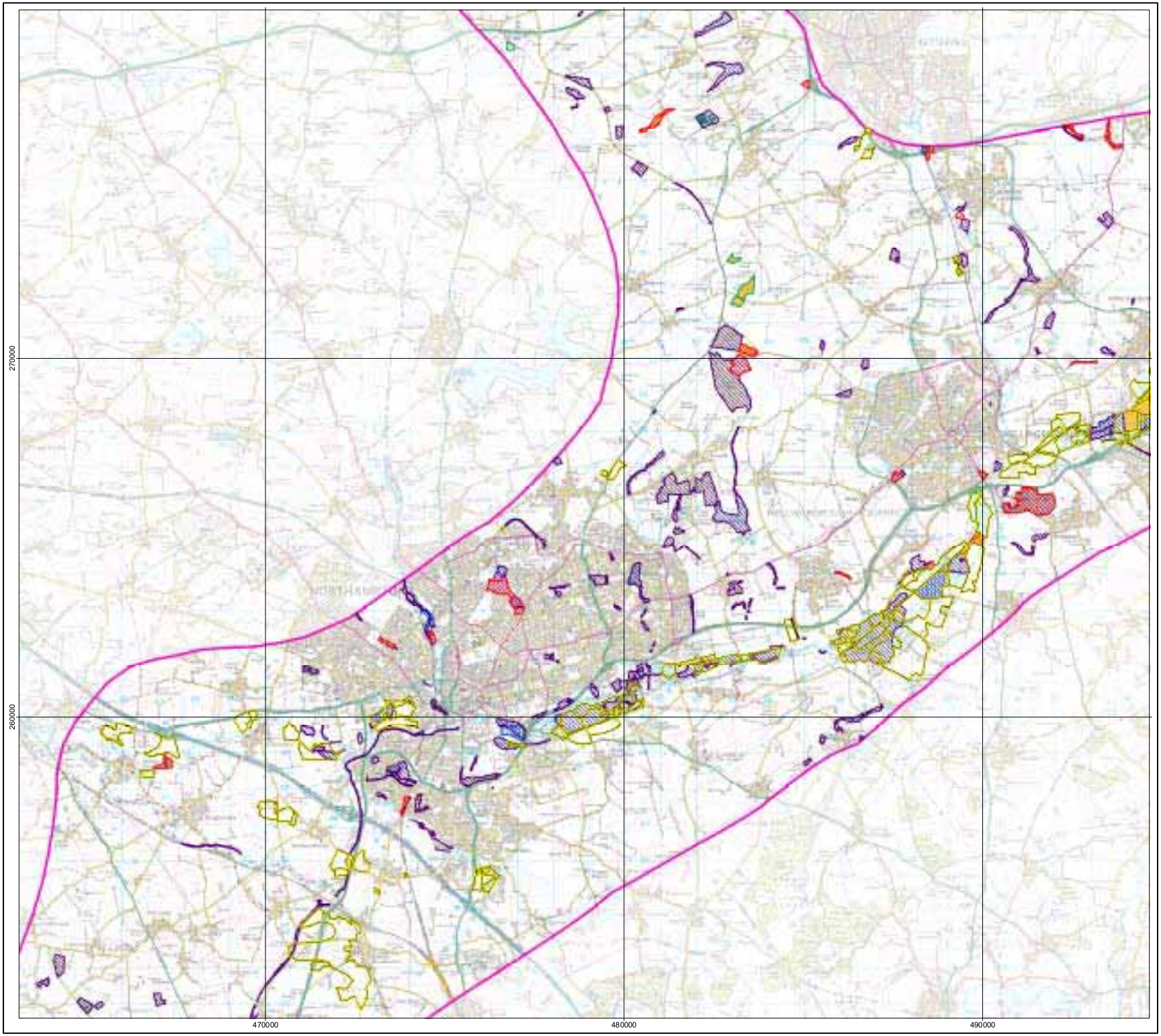
Drawing **Broad Habitats (LCM 2000) within LCT 89RBN Nene Valley - North**

Date February 2004

Figure B2.3b

Sheet No. **2**

Ref 4D.648.001 ENBD 100 - FIGB2.3b - JIH



Legend

Priority Habitats

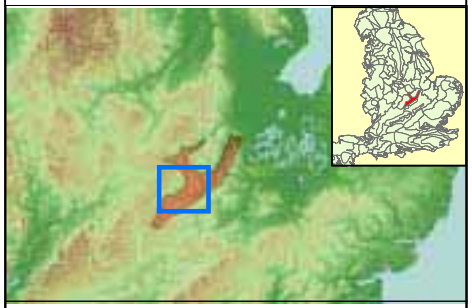
- Lowland Grassland
- Ancient Woodland

Designated Sites

- Sites of Specific Scientific Interest
- NWT Local Nature Reserves
- County Wildlife Sites

Post-1947 aggregate planning permissions

- Northamptonshire Vales



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Geodetic Information
British National Grid
Transverse Mercator
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Central Meridian = -2 °
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Latitude Of Origin = 49 °

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MEASURING THE MINERALS INDUSTRY'S CONTRIBUTION TO BIODIVERSITY

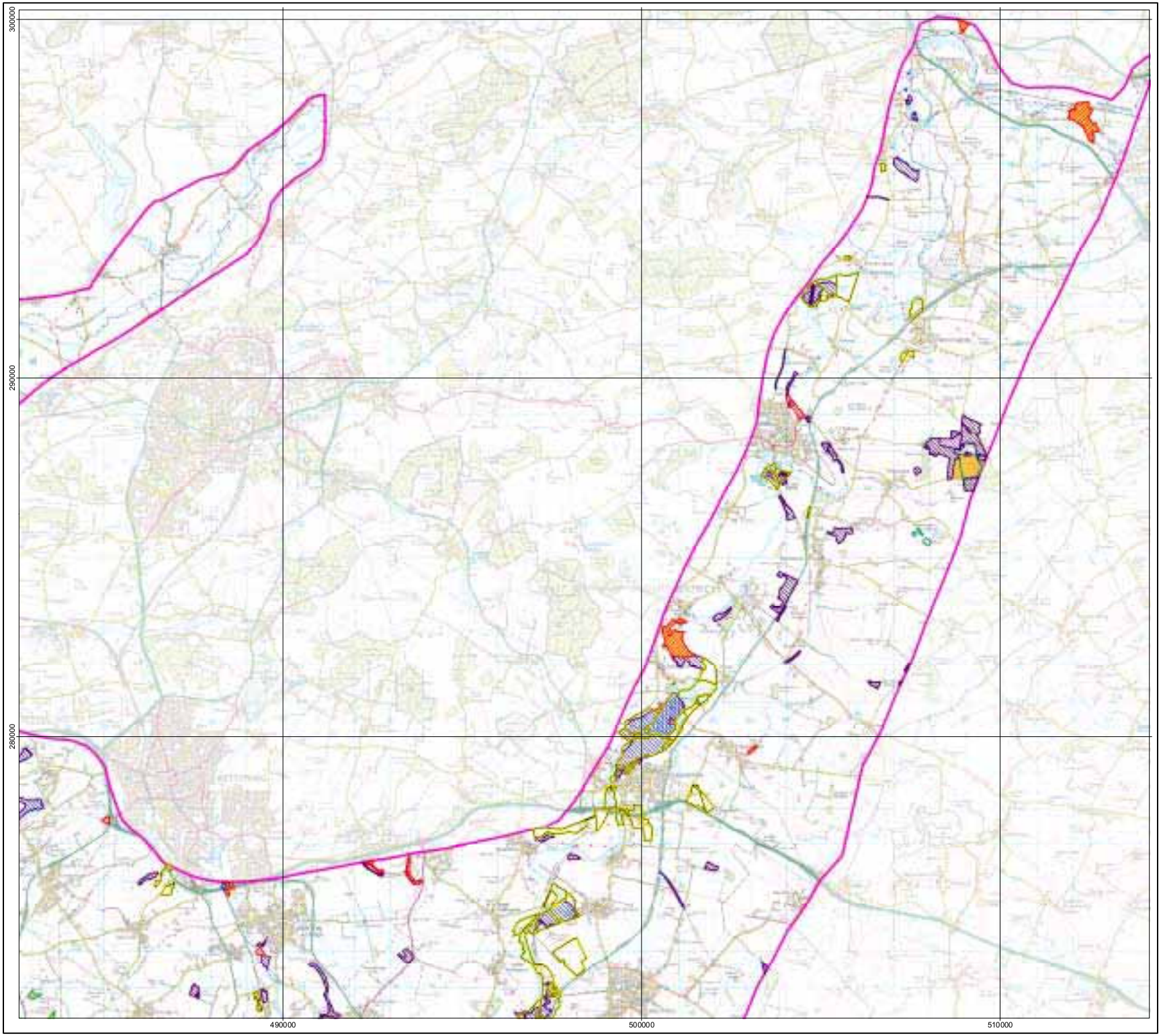
Drawing **Designated land within Nothamptonshire Vales - South**

Date February 2004

Figure B2.4a

Sheet No. **1**

Ref 4D.648.001 ENBD 100 - FIG B2.4a - JIH



Legend

Priority Habitats

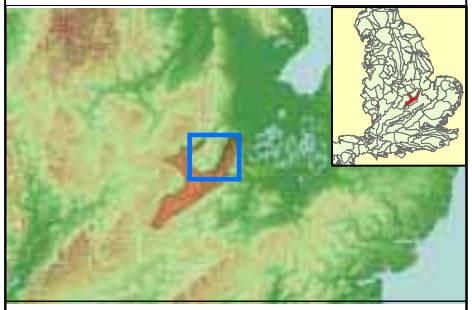
- Lowland Grassland
- Ancient Woodland

Designated Sites

- Sites of Specific Scientific Interest
- NWT Local Nature Reserves
- County Wildlife Sites

Post-1947 aggregate planning permissions

- Northamptonshire Vales



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Kilometers
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Scale: 1:100,000

Geodetic Information
British National Grid
Transverse Mercator
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MEASURING THE MINERALS INDUSTRY'S CONTRIBUTION TO BIODIVERSITY

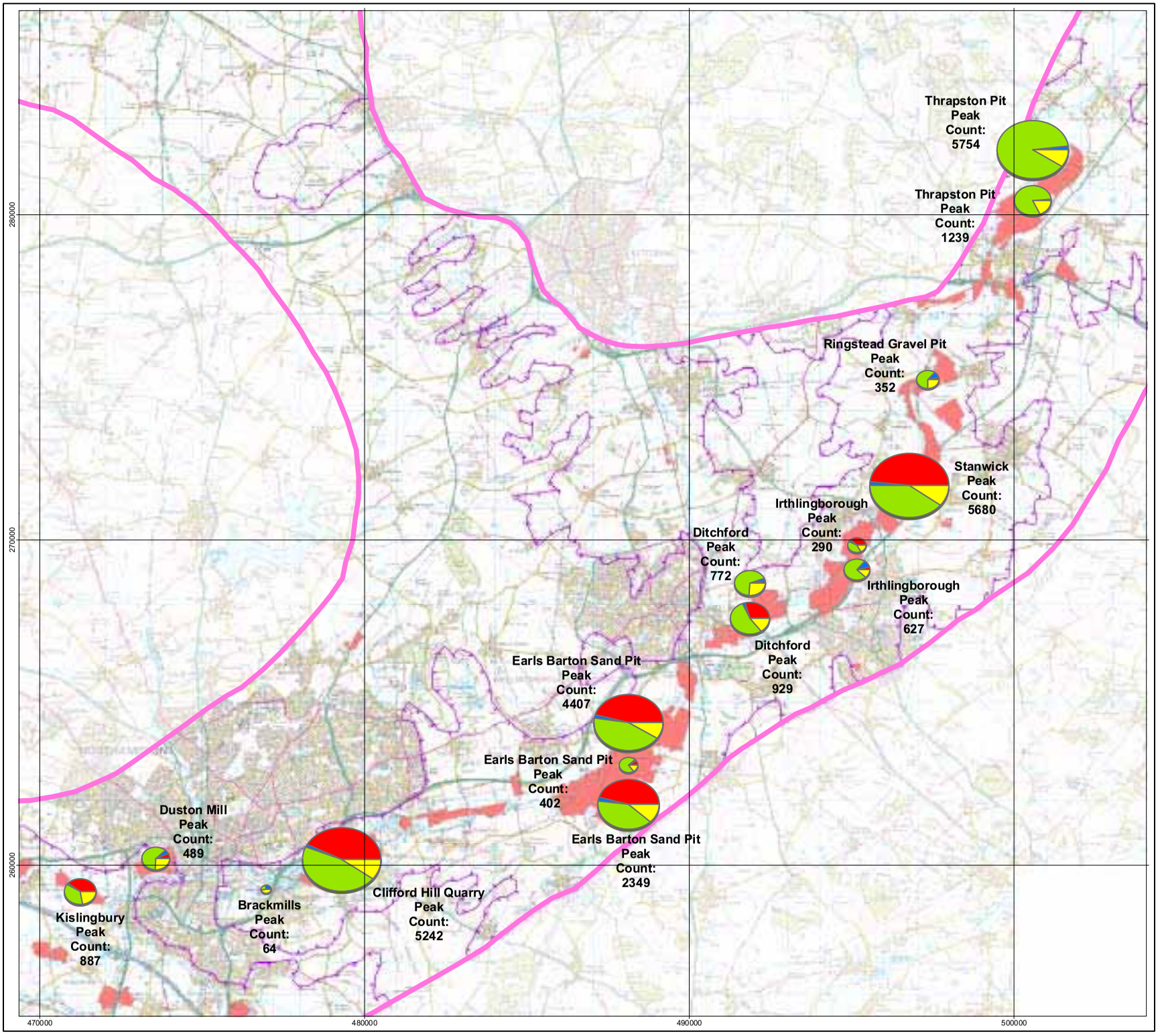
Drawing **Designated land within Nothamptonshire Vales - North**

Date February 2004

Figure B2.4b

Sheet No. **2**

Ref 4D.648.001 ENBD 100 - FIG B2.4b - JIH



Legend

Landscape Character Type

89RBN

Post-1947 aggregate planning permissions

Northamptonshire Vales

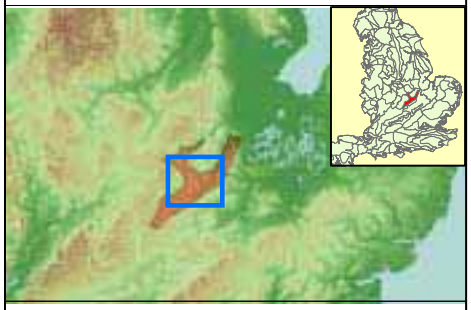
WeBS wildfowl and wader counts

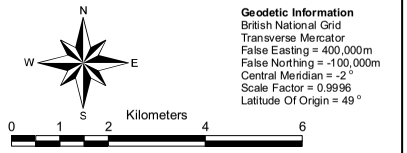
Winter 2002 - 2003

Aggregate of peak monthly count for each species, summarised by taxonomic group

- Waders
- Divers, Grebes, & Herons
- Ducks
- Geese

Peak Count = highest count of all birds in a single month





Geodetic Information
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Latitude Of Origin = 49 °

Scale: 1:110,000

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MEASURING THE MINERALS INDUSTRY'S CONTRIBUTION TO BIODIVERSITY

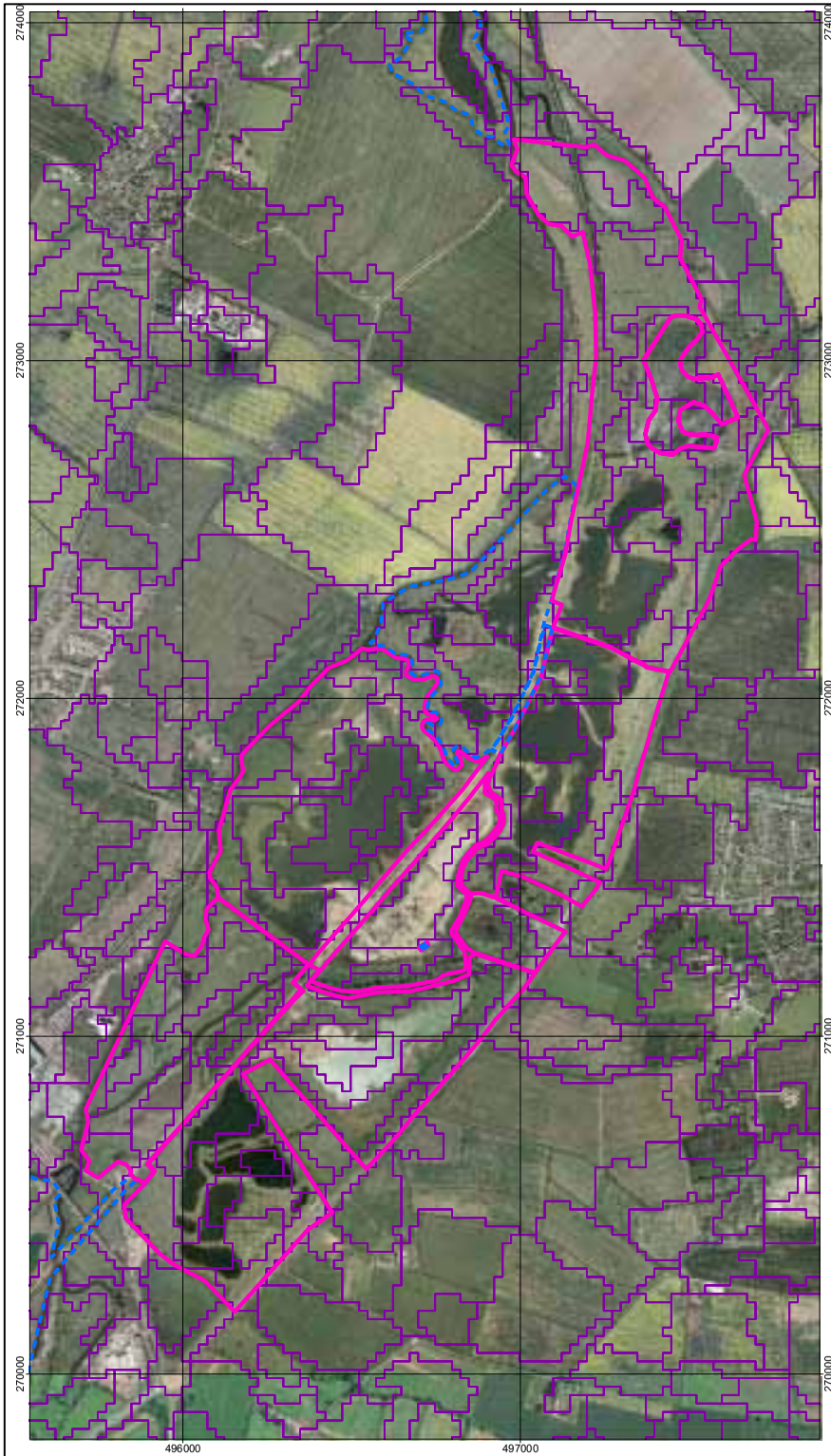
Drawing **Wetland Bird Peak Counts LCT 89RBN Nene Valley, Winter 2002 - 2003**

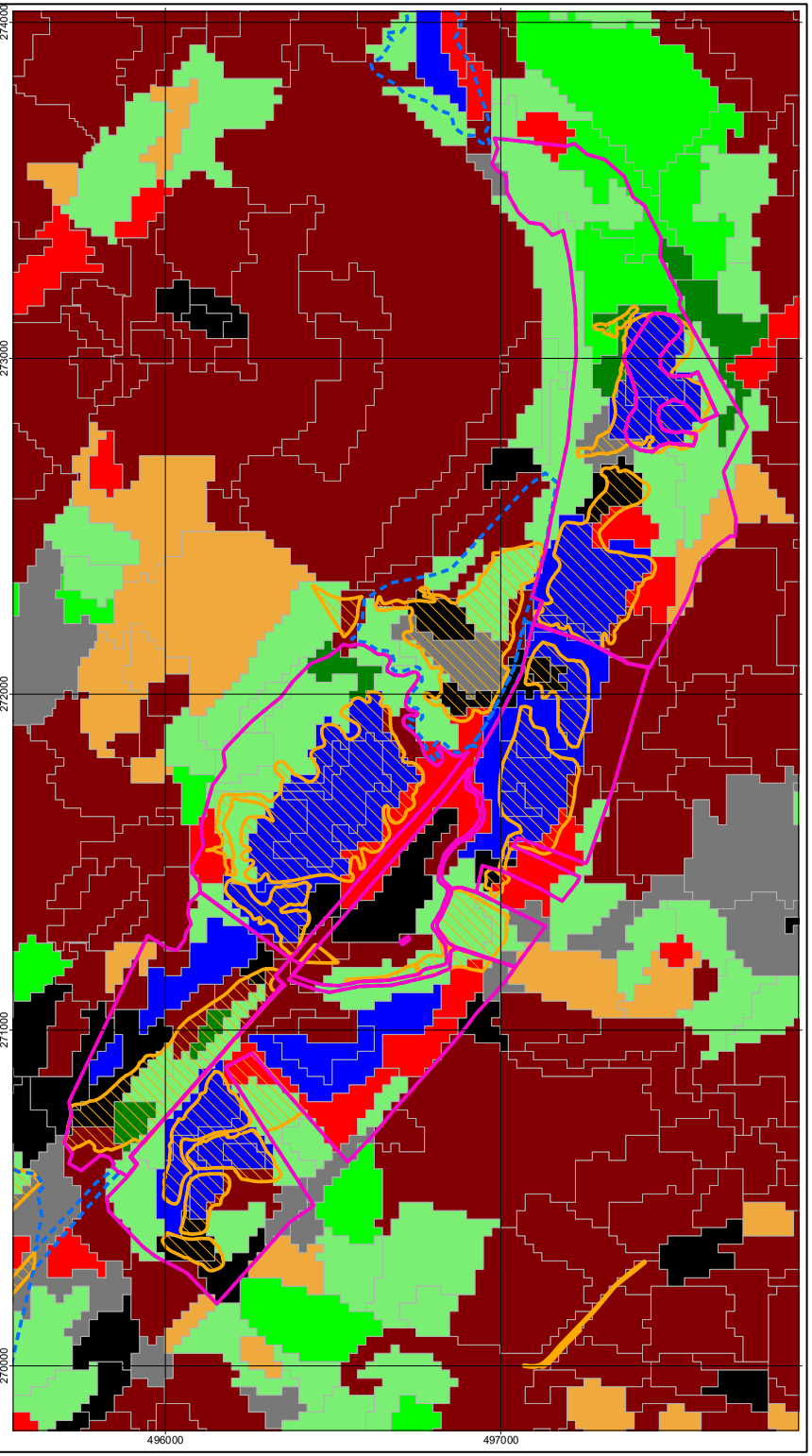
Date February 2004

Figure B2.5

Sheet No. **1**

Ref 4D.648.001 ENBD 110 - FIGB2.5 - JIH





Legend

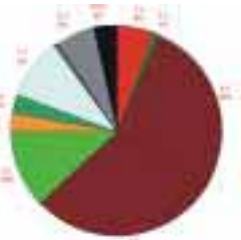
- Stanwick Quarry
- Other Quarries
- County Wildlife Sites

Land Cover Map 2000

- 1.1 Broad-leaved, mixed & yew woodland
- 2.1 Coniferous woodland
- 4.1 Arable & horticulture (cereals)
- 4.2 Arable & horticulture (bare, other, unknown)
- 5.1 Improved grassland
- 5.2 Setaside grass
- 7.1 Calcareous grass
- 13.1 Standing water
- 17.1 Built up areas, gardens
- 17.2 Continuous urban

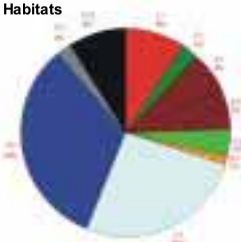
89RBN Habitat Baseline

2164.5	6.1
288.1	0.8
9419.4	26.5
10198.4	28.7
270.2	0.8
4231.9	11.9
921.7	2.6
1146.8	3.2
3344.3	9.4
1.8	<0.1
11.2	<0.1
7.2	<0.1
16.5	<0.1
118.1	0.3
27.7	0.1
2090.9	5.9
1254.9	3.5



Stanwick Quarry LCM 2000 Habitats

21.2	9.5
6.3	2.8
13.2	5.9
14.7	6.6
0.0	0.0
9.3	4.2
3.2	1.4
0.0	0.0
57.4	25.7
0.0	0.0
0.0	0.0
0.0	0.0
0.0	0.0
73.4	32.8
0.0	0.0
5.0	2.2
20.0	8.9



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Geodetic Information
British National Grid
Transverse Mercator
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False Northing = -100,000m
Central Meridian = -2 °
Scale Factor = 0.9996
Latitude Of Origin = 49 °

Kilometers
0 0.1 0.2 0.4 0.6 0.8 1

Scale: 1:15,000

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MEASURING THE MINERALS INDUSTRY'S CONTRIBUTION TO BIODIVERSITY

Drawing **Northamptonshire Vales Case Study - Stanwick Quarry**

Date February 2004

Figure B2.6

Sheet No. **1**

Ref 4D.648.001 ENBD 10 - FIG B2.6 - JIH

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Top left: Using a home-made moth trap.
Peter Wakely/English Nature 17,396
Middle left: Co_2 experiment at Roudsea Wood and Mosses NNR, Lancashire.
Peter Wakely/English Nature 21,792
Bottom left: Radio tracking a hare on Pawlett Hams, Somerset.
Paul Glendell/English Nature 23,020
Main: Identifying moths caught in a moth trap at Ham Wall NNR, Somerset.
Paul Glendell/English Nature 24,888

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