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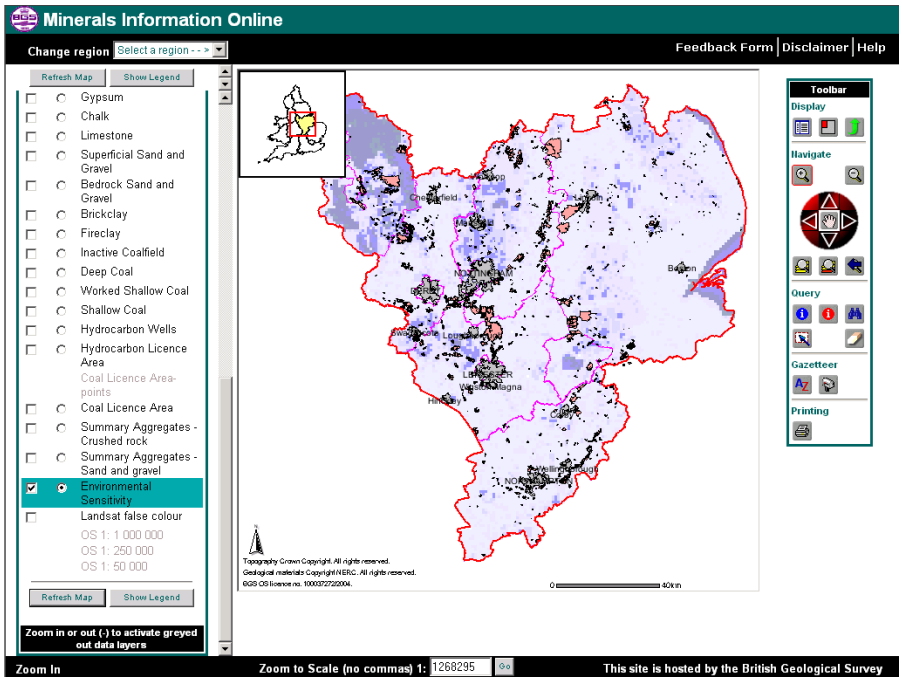
Environmental and economic information for aggregates provision

Economic Minerals Programme

Commissioned Report CR/05/081N



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COMMISSSIONED REPORT CR/05/081N

Environmental and economic information for aggregates provision

EJ Steadman, FM McEvoy, KA Linley, PD Bell, EJ Bee, EL Bartlett, A Napier and J Forster

Keywords

Aggregates; environment; economic; environmental sensitivity; East Midlands Region; aggregate specifications.

Front cover

Image of the environmental sensitivity layer in the online GIS.

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British Geological Survey offices

Keyworth, Nottingham NG12 5GG

☎ 0115-936 3241 Fax 0115-936 3488
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☎ 01491-838800 Fax 01491-692345

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☎ 029–2066 0147 Fax 029–2066 0159

Parent Body

Natural Environment Research Council, Polaris House, North Star Avenue, Swindon, Wiltshire SN2 1EU

☎ 01793-411500 Fax 01793-411501
www.nerc.ac.uk

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Contents

FIGURES

Summary

This report describes a one-year research project entitled 'Environmental and economic information systems for aggregates provision'. This project is an extension to previous research on *Strategic Environmental Assessment (SEA) and future aggregates extraction*, which was carried out by the British Geological Survey (BGS) and reported in early 2004 (Steadman, *et al.,* 2004). Both phases of the research were co-funded by the BGS and the Mineral Industry Sustainable Technology Programme (MIST).

Environmental, economic and social information are essential for sustainable planning for the provision of aggregates. There is a need to bring together disparate information relating to aggregate extraction. Datasets include the location of resources and their potential end-uses, as well as those on the environment and transport. Bringing this digital information together into one location or system will assist in supporting a more balanced and informed approach to the decision making process. A number of regulatory mechanisms are currently driving the gathering and compilation of relevant environmental, economic and social information. Current drivers for information relevant to aggregate provision include environmental appraisal of the provision of aggregates, SEA and Sustainability Appraisal (SA).

The objective of this research was to provide an interactive 'tool' or information system for the minerals industry, land-use planners and other stakeholders to use when considering options for future aggregate provision. The study area for the research was the East Midlands Region of England. The project had three main deliverables:

1. To provide an online Geographic Information System (GIS) to access the 'environmental sensitivity' map which was developed for the East Midlands Region during the first phase of research;
2. to compile aggregate end-use suitability maps for the East Midland Region; and
3. to hold a stakeholder consultation exercise and dissemination seminars.

Each of these was met within the agreed timeframe. The environmental sensitivity map information and associated attributes have been made available on the internet via the BGS 'Minerals information online' web GIS for the East Midlands Region (www.mineralsuk.com/web_gis). Accommodating these data in a web GIS environment has entailed some compromises on data resolution and system functionality.

A methodology has been developed to integrate a range of aggregate technical property data. This can be used to summarise the distribution of aggregate resources suitable for particular end-uses. These summary technical data are useful in communicating issues of variable aggregate quality and economic value to non-technical stakeholders in the mineral planning process. Availability of appropriate technical property data for different aggregate resources across a wide geographical area is critical in developing these maps.

Feedback from an extensive consultation and dissemination exercise has generally been very positive. Two critiques by independent consultants of the environmental sensitivity map were also undertaken. These were deemed an important aspect of the consultation process. Stakeholders raised several issues. There were some concerns about updating and maintenance of asset data and about the lack of social information. In addition, some fundamental issues of approach (particularly asset weighting) raised in the previous phase of this research resurfaced during this consultation.

Environmental sensitivity mapping will be carried out for the whole of England by the BGS in the near future. The data will be made available online as each region becomes available. It is anticipated that the mineral GISs for all regions of England (except London) will be completed by December 2005. New datasets may be added to the environmental sensitivity layer as they become available. The research into end-use suitability maps will be carried on by the BGS under its Minerals Programme, with the support of co-funding where possible. The project team continue to welcome feedback and criticism of this research.

1 Introduction

This report describes a one-year research project entitled 'Environmental and economic information systems for aggregates provision'. This project is an extension to previous research on *Strategic Environmental Assessment and future aggregates extraction*, which was carried out by the British Geological Survey (BGS) and reported in early 2004 (Steadman, *et al.,* 2004). Both phases of the research were co-funded by the BGS and the Mineral Industry Sustainable Technology Programme (MIST). MIST is managed by the Mineral Industry Research Organisation (MIRO) on behalf of the Department for Environment, Food and Rural Affairs (DEFRA).

1.1 PROJECT OBJECTIVES

The objective of this research is to provide an interactive 'tool' or information system for the minerals industry, land-use planners and other stakeholders to use when considering options for future aggregate provision. Specific applications of this tool might include Strategic Environmental Assessment (SEA) and/or Environmental Appraisal of plans for aggregates provision. The study area for the research is the East Midlands Region of England. In the long term, the research may contribute to the development of more sustainable sources of aggregates to meet the needs of the UK economy.

1.2 PROJECT DELIVERABLES

Project deliverables are:

1. To provide an online Geographic Information System (GIS) to access the 'environmental sensitivity' map which was developed for the East Midlands Region during the first phase of research;
2. to compile aggregate end-use suitability maps for the East Midland Region; and
3. to hold a stakeholder consultation exercise and dissemination seminars.

2 Background

This research project aims to provide an interactive 'tool' or information system for the minerals industry, land-use planners and other stakeholders to use when considering options for future aggregate provision. This section provides the rationale behind the project and explains some of the factors driving the demand for environmental and economic information.

2.1 AGGREGATE DEMAND

The main driver of aggregates demand is construction activity, such as infrastructure development and housing, although different types of construction activity vary in terms of the amounts of aggregates they consume and the technical specification of the aggregate required. Although there have been moves to reduce the requirement for externally quarried material by utilising material such as construction and demolition waste, it is difficult to plan for the provision of such material and it is not always suitable for medium and high specification applications. *Mineral Planning Guidance 6: Guideline for aggregate provision in England*, is provided by central government to Mineral Planning Authorities (MPA) and the minerals industry. This attempts to ensure that the construction industry receives an adequate and steady

supply of material at the best balance of social, environmental and economic costs, and that extraction and development are consistent with the principles of sustainable development (ODPM, 1994). In England, continuity of supply of aggregates to sustain development is achieved through a national and regional apportionment process.

2.2 ENVIRONMENTAL AND ECONOMIC INFORMATION

Environmental, economic and social information are essential for sustainable planning for the provision of aggregates. There is a need to bring together disparate information relating to aggregate extraction. Datasets include the location of resources and their potential end-uses, as well as those on the environment and transport. Bringing this digital information together into one location or system will assist in supporting a more balanced and informed approach to the decision making process. This will help to conserve these non-renewable resources as far as possible, whilst ensuring an adequate supply to meet the demands of society for minerals (ODPM, 1994).

Phase 1 of this research, concentrated on developing an environmental information tool (environmental sensitivity maps) for the minerals sector to use in the SEA of plans for future aggregate extraction (Steadman *et al.*, 2004). A key recommendation of this first phase of research was that the environmental sensitivity data should be made available 'online'. The report also suggested that further research was required on the provision of information on aggregate resources and their technical specifications. The present research addresses both these recommendations.

2.3 DRIVERS FOR INFORMATION

A number of regulatory mechanisms are currently driving the gathering and compilation of relevant environmental, economic and social information. Current drivers for information relevant to aggregate provision include environmental appraisal of the provision of aggregates, SEA and Sustainability Appraisal (SA).

In January 2004, the government published the document *Good practice guidance on the environmental appraisal of the provision of aggregates* (ODPM, 2004a). This guidance is designed to test different supply scenarios and alternatives for the provision of aggregates. To carry out the process, information about the location of aggregate resources and the location of significant environmental and cultural assets is required. The guidance is designed to provide a consistent and transparent framework for decision makers in evaluating different provision scenarios. Although the process of environmental appraisal is analogous to SEA, it does not satisfy its requirements. However, outputs from the environmental appraisal are designed to lead into the SEA process, by providing information for the SEA of those 'plans and programmes which fall within the scope of the 'SEA' Directive' (ODPM, 2004b). Examples of plans and programmes might include Local Development Plan Documents and Regional Spatial Strategies (ODPM, 2004c). To perform SEA, environmental baseline information is required and alternatives to the proposed plans/programmes must be identified for the purposes of comparison. Both environmental appraisal and SEA processes are designed to feed into SA, which considers all three dimensions of sustainability (environmental, economic and social), although this research only takes account of environmental and economic aspects. Where possible, this information should be both transparent and objective so that it informs decision-making, and also explains the decision-making process to a wide variety of stakeholders.

3 Online GIS access to environmental sensitivity map for the East Midlands Region

The first phase of the research developed a desktop GIS version of the environmental sensitivity mapping technique, from which a paper map was the principal output. A key limitation of the paper map identified through the consultation process was its inability to provide detailed information on what assets occur at a particular location. The obvious solution to this problem was to provide the information via an online GIS. This allows users to interrogate the data to ascertain why an area has high or low sensitivity and what assets are present at a certain location. It was decided at an early stage that the best place to locate the environmental sensitivity layer was within the already established BGS 'Minerals GIS' that can be accessed through www.mineralsUK.com.

3.1 OVERVIEW OF THE ENVIRONMENTAL SENSITIVITY MAPPING TECHNIQUE

Environmental sensitivity mapping provides a strategic overview of the environmental and cultural assets in a region. It is a technique that was developed to integrate numerous datasets into a single composite layer in a GIS. It uses a transparent methodology to provide the user with an easy to understand visual overview of these assets. Environmental sensitivity mapping is a rapid, objective and straightforward method of identifying areas which may be particularly sensitive to development.

This technique has a number of applications in land-use planning for minerals and other forms of development. It may be used both to aid and explain decision-making. It can form part of the SEA process and, more specifically, can be used in the environmental appraisal of plans and policies for aggregates provision.

The method is based on the number of environmental or cultural assets at a given location. It is analogous to a density map, whereby the higher the number of environmental and cultural assets in an area, the darker the colour on the map. Within a GIS, it is possible to weight or score different assets depending on their importance or significance. The environmental sensitivity map can then be based on the total score, rather than the total number of assets. The user can obtain a list of all environmental and cultural assets at a particular location by simply clicking on the area of interest. See Steadman *et al.,* (2004) or

http://www.bgs.ac.uk/mineralsuk/envsens/home.html

Environmental sensitivity mapping has been used by BGS as part of a study commissioned by the Yorkshire and Humber Regional Assembly (McEvoy *et al.,* 2005).

3.2 ACCESS TO THE ONLINE ENVIRONMENTAL SENSITIVITY DATA

Stakeholder access to the environmental sensitivity data is via the BGS online Minerals GIS which is hosted within the www.mineralsUK.com website. This web-based GIS provides access to a range of minerals-related information including:

- Mineral resources, which may be of current or potential economic interest;
- selected nationally-recognised landscape and habitat designations; and
- land where minerals are, or have been, licensed for extraction (mineral planning permissions).

Addition of the environmental sensitivity data to the online minerals GIS allows it to be related to these key minerals datasets, as well as more general topographic information (such as urban areas or transport links).

3.3 ONLINE VERSUS DESKTOP VERSION OF THE ENVIRONMENTAL SENSITIVITY DATA

There are significant differences between the desktop GIS sensitivity layer and the online sensitivity layer. Some of these are as a result of technical issues, some as a result of the inherent differences between the two types of GIS. For example, the resolution of the desktop GIS environmental sensitivity grid has been calculated to either 1 hectare or 100 hectare and can be viewed at either, but the online version can only be viewed at 100 hectares. This is due to the file size limitations of the online version. The online version has reduced functionality compared to the desktop GIS. The web version only allows simple interrogation to take place, such as identifying why an area has high or low sensitivity. The desktop version allows more complex interrogation or querying to take place. In the online version, the sensitivity data are restricted to 250 000 scale and effectively disappear below this scale. The desktop version is not scale dependent. In the desktop version, all the asset data can be made available as individual data layers (subject to licence agreements), so boundary information supplied by third parties can be viewed if required.

3.4 WEB PAGES

In addition to serving the environmental sensitivity layer online, web pages explaining the methodology, background to the technique, and other information have been created. These pages can be accessed at www.mineralsUK.com. Figure 1 shows the 'home' page for the environmental sensitivity mapping information. Figure 2 shows the environmental sensitivity layer within the East Midlands regional minerals GIS.

3.5 ATTRIBUTE DATA

In the online version of the GIS, display of attribute data for the environmental sensitivity layer is limited to the number of assets at a given location. Third party attribute data supplied with the individual asset data layers are not available.

A number of technical challenges were encountered in making this information available online. In desktop GIS, information on the presence or absence of an asset within a cell, together with its geographical location, is stored within an attribute table. Because of the size of this table, access to it from the online version of the East Midlands GIS was initially extremely slow. This attribute table had also inherited a series of 'user-unfriendly' field names from the desktop version (Figure 3) which would be difficult for the external user to interpret.

As a result of these initial difficulties, the attribute data was converted to a database and accessed by the GIS using a routine created using 'Cold Fusion' programming language. This enables rapid online display of a user-friendly table (Figure 4) within which assets can be hyperlinked to provide further information (see *Metadata section* below and Figure 5).

3.6 META DATA

Within the GIS, metadata (information that describes the data layer) was compiled for the environmental sensitivity layer. This enables the user to access information about the layer whilst using the online GIS. The metadata includes a description of what the environmental sensitivity layer shows and an alphabetical list of all the assets used to create the data layer. Metadata also gives information on asset type and details of the data provider (Figure 5).

Figure 1 Image of the environmental sensitivity home page

Figure 2 Environmental sensitivity layer in the online minerals GIS

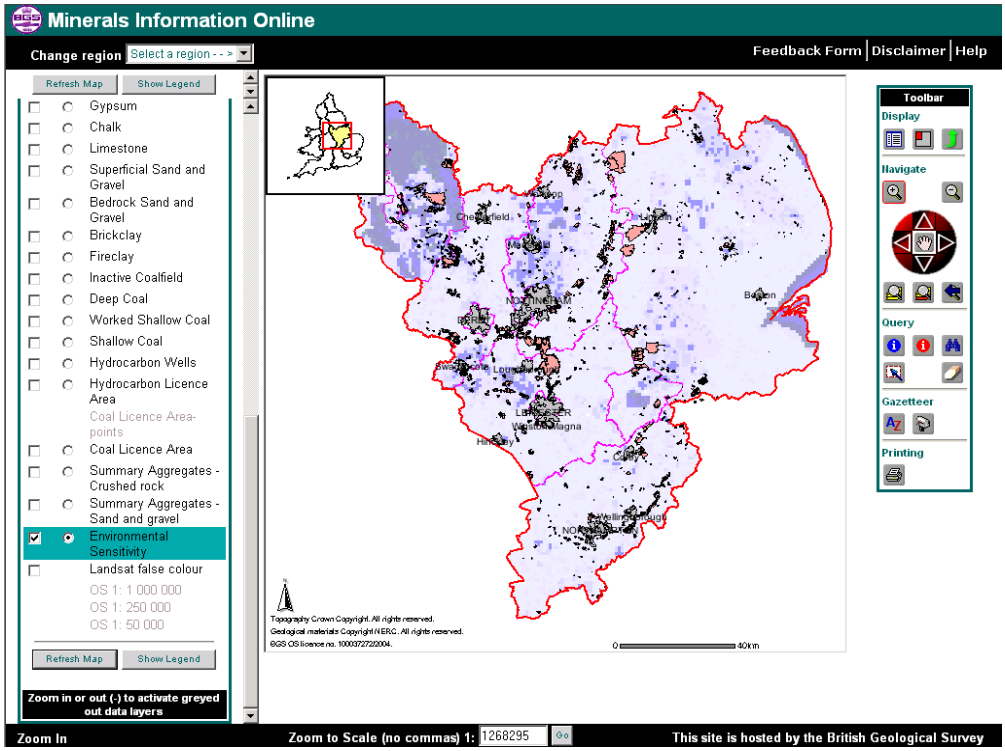


Figure 3 Part of the desktop GIS attribute table

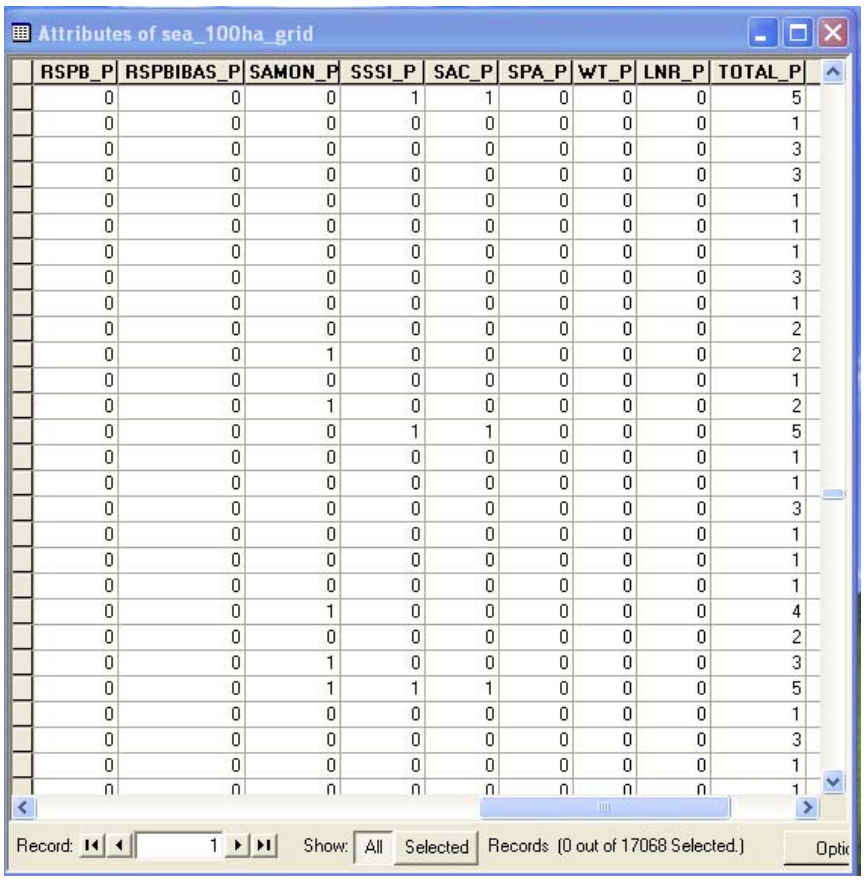
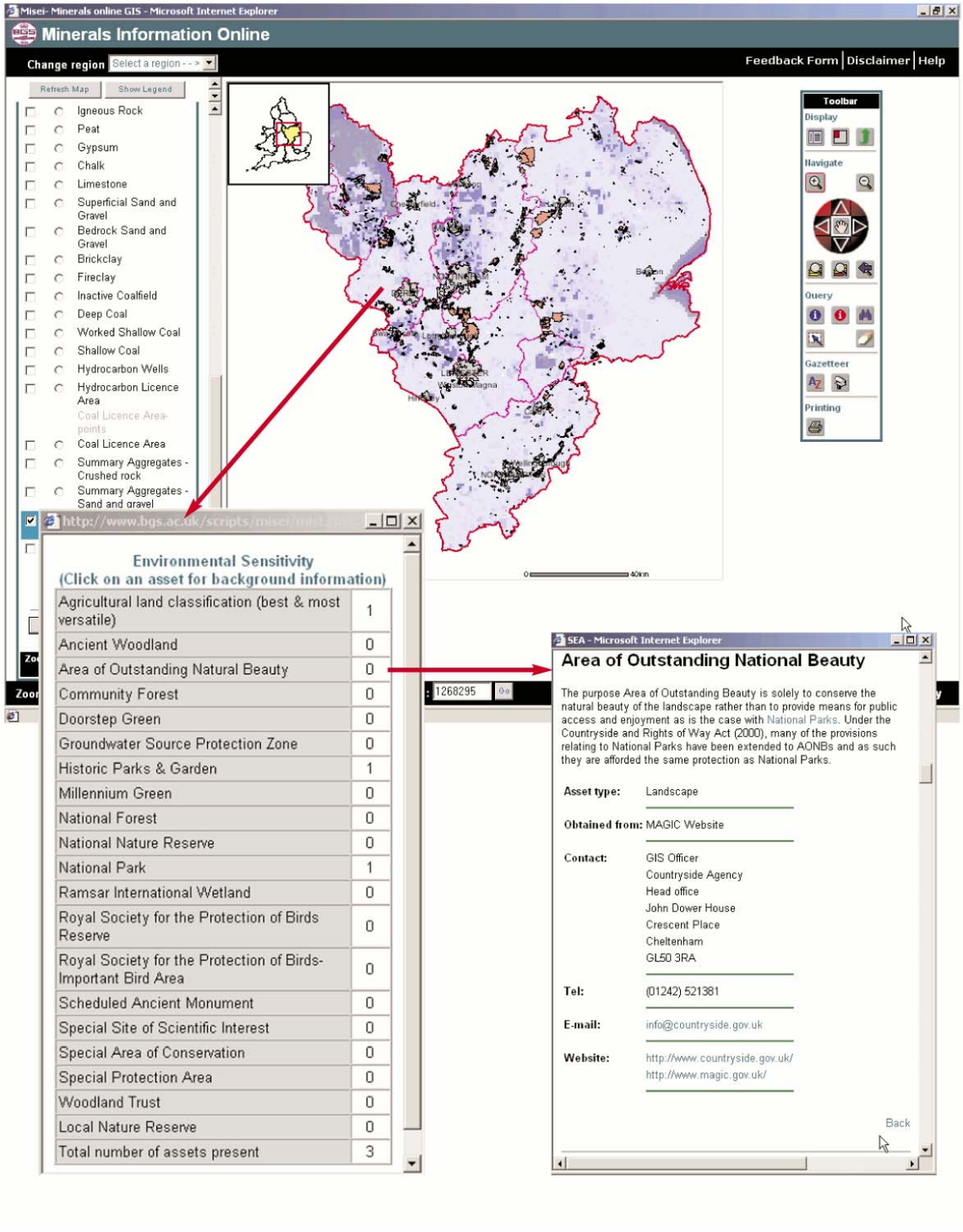


Figure 4 User-friendly attribute table for the environmental sensitivity layer in the online minerals GIS

Figure 5 Interrogation of the online environmental sensitivity layer



4 Aggregate end use suitability mapping

Moves toward more sustainable provision of aggregates requires that economic, as well as environmental and social issues, are considered during the planning process. Primary aggregates are natural materials which vary in technical quality and which can only be worked where they occur. Although the BGS has a considerable amount of digital spatial information on the type and location of mineral resources (including aggregates) in England, this does not generally include data about the quality and suitability of resources for specific aggregate applications. Whilst those within, or closely associated with, the industry normally have considerable knowledge of the technical properties of aggregate mineral resources, this information is not readily available in a form that can easily be used and assimilated by planners and other stakeholders. The second objective of this research was to develop a GIS based methodology to assign broad technical properties values to the different aggregate resources in the East Midlands Region. Not all aggregate resources have the same value for particular applications. This is intended to provide all stakeholders with an overview of the potential uses of different aggregate resources.

4.1 AGGREGATE RESOURCES OF THE EAST MIDLANDS REGION

Aggregate resources are distributed throughout the East Midlands Region and occur in a wide variety of geological environments, including both superficial and 'solid' (bedrock) deposits (Figure 6). The most important superficial deposits are river terrace and glaciofluvial deposits, with the former being the main source of sand and gravel in the Region. River terrace sand and gravel deposits are associated with all the major rivers in the Region, with deposit thickness varying from less than 1 m to maximum values of around 10 m. Sand to gravel ratios are also variable, but river deposits typically are relatively clean with a lower fines content (silt and clay) than glacial deposits. Glaciofluvial sand and gravel are sediments which were laid down by glacial meltwaters. The essential feature of these deposits, critical in terms of their economic value, is their variation in both thickness and composition. Thicknesses of over 30 m have been reported, but overburden thicknesses can also be high. Typically the deposits have a highly variable composition with often a high proportion of fines (silt and clay). The principal uses of sand are as fine aggregate in concrete, mortar and asphalt. The main use of gravel is as coarse aggregate in concrete. Unwashed sand and gravel can also be used for construction fill and as 'hoggin' for surfacing tracks and paths.

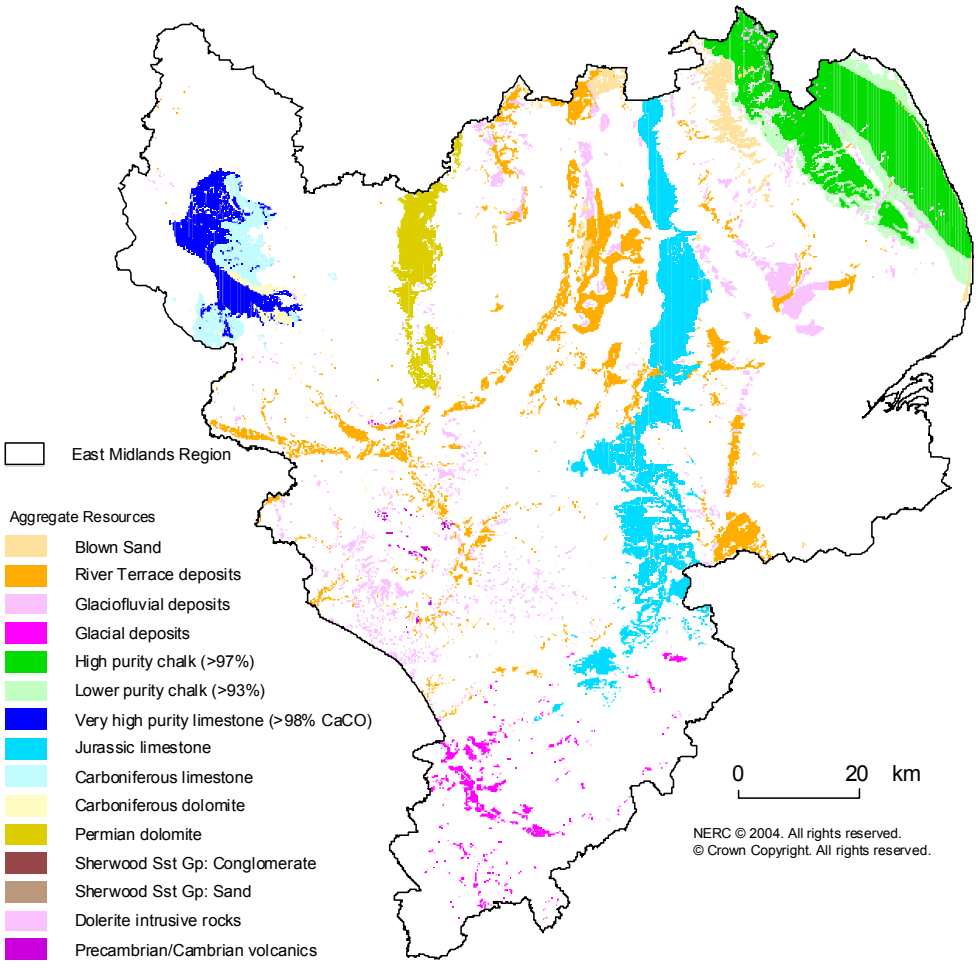
Solid deposits can be divided into crushed rock aggregate and bedrock sand and gravel. A variety of rocks are, when crushed, suitable for use as aggregate, either on their own or bound with cement to produce concrete or with bitumen for asphalt. Their technical suitability for different aggregate applications depends on their physical characteristics, such as crushing strength, porosity and resistance to impact, abrasion and polishing. Higher quality aggregates are required for specific uses, such as surfacing major roads and for use in concrete. Lower quality aggregates may be acceptable for applications, such as constructional fill.

The East Midlands is relatively well endowed with hard rock resources suitable for use as crushed rock aggregate. The main sources are limestone and igneous rock which account for 52% and 46% (www.mineralsuk.com) of total output in the region, respectively. Of these, limestone is the most important. It has a wide range of applications including concreting aggregate and roadstone. However, because of its poor resistance to polishing, it is unsuitable for use as a road surfacing aggregate. Igneous rocks are valued for roadstone, including moderately skid resistant road surfacing aggregate in all but the most demanding sites, and also for railway track ballast. Igneous rocks are also used for concrete aggregate, particularly where alternatives such as gravel and limestone are absent. Their suitability for aggregate use depends mainly on

fabric and texture (mineral grain size), together with the degree of alteration or weathering they have undergone. In general, intrusive igneous rocks tend to be more consistent in quality for aggregate production. In the East Midlands, igneous rock resources have a spatially restricted distribution and those of economic importance are confined to Leicestershire. Other than limestone, the small outcrops of igneous rock in Leicestershire provide the main sources of hard rock suitable for crushed rock aggregates in the East Midlands.

In addition to limestone and igneous rocks, minor quantities of sandstone, chalk and ironstone are also used as sources of low quality aggregate. The East Midlands Region is an important source of crushed rock aggregate in England and, because of its proximity to large centres of demand in the South East, London and the North West, it is also a major 'exporter' of these materials.

Figure 6 Aggregate resources of the East Midlands



4.2 AGGREGATE SPECIFICATIONS

Not all aggregate resources have the same value for particular applications. It is rare for aggregate obtained from a site to be physically or chemically suited for every type of aggregate use. Therefore, every potential deposit must be tested to determine what percentage of its various components can meet specifications for a particular type of use, and what processing is required to manufacture the required grades.

The EU and government departments/agencies establish specifications for various uses of aggregate material, to ensure that aggregates used are of suitable quality for particular uses. In the UK, the Highways Agency and Local Highway Authorities issue specifications for aggregate for use in road construction and evaluate aggregate for acceptance by using standard test procedures. Both the specifications and the tests are ultimately governed by harmonised European Standards, such as the *European Standards for Aggregates for use in the Construction Sector*, introduced in January 2004. This sets standards for aggregate for use in mortar **(BS EN 13139),** concrete (**BS EN 12620),** bituminous mixtures and surface treatments (**BS EN 13043)** and for use in unbound and hydraulically bound mixtures (**BS EN 13242).**

Some of the more common tests as set out in the new European Standards include aggregate size and grading, percentage of fines, Los Angeles Coefficient (LA) (resistance to fragmentation), micro-Deval (MD) (resistance to wear), Polished Stone Value (PSV) (resistance to polishing), Aggregate Abrasion Value (AAV) (resistance to abrasion), Magnesium Sulphate Value (MS) and Water Absorption (both measures of likely durability). Combinations of some or all of these tests can be used to determine the suitability of an aggregate resource for different applications. However, it must be noted that the use of one type/source aggregate over another for a particular use depends not only on the technical quality, but also on its location, since this affects both the economics, in particular transport costs, and the overall sustainability of supply to a particular destination.

4.3 METHODOLOGY

In order to provide spatial information relating to the suitability of different aggregate resources for different end-uses, a GIS-based methodology was developed to represent the different technical properties for each aggregate resource type.

1. Collating baseline data

Although the BGS hold detailed information on the location of aggregate resources and their general characteristics, there is a shortage of comprehensive and up-to-date information on technical/physical and chemical properties. Without such data, it is difficult to assign technical property values to different aggregate resource types and to assess variability within an individual resource type. As a result, the first part of the research focused on bringing together disparate datasets on aggregates and their properties from a number of different sources. Key sources were data held in-house at BGS and data provided by industry. Current aggregate operators in the East Midlands Region were asked to provide technical property data on products from each of their operations. To date, just over half of the operators in the region have given a positive response. The utility of the GIS layers produced will be limited by the quantity and quality of data provided.

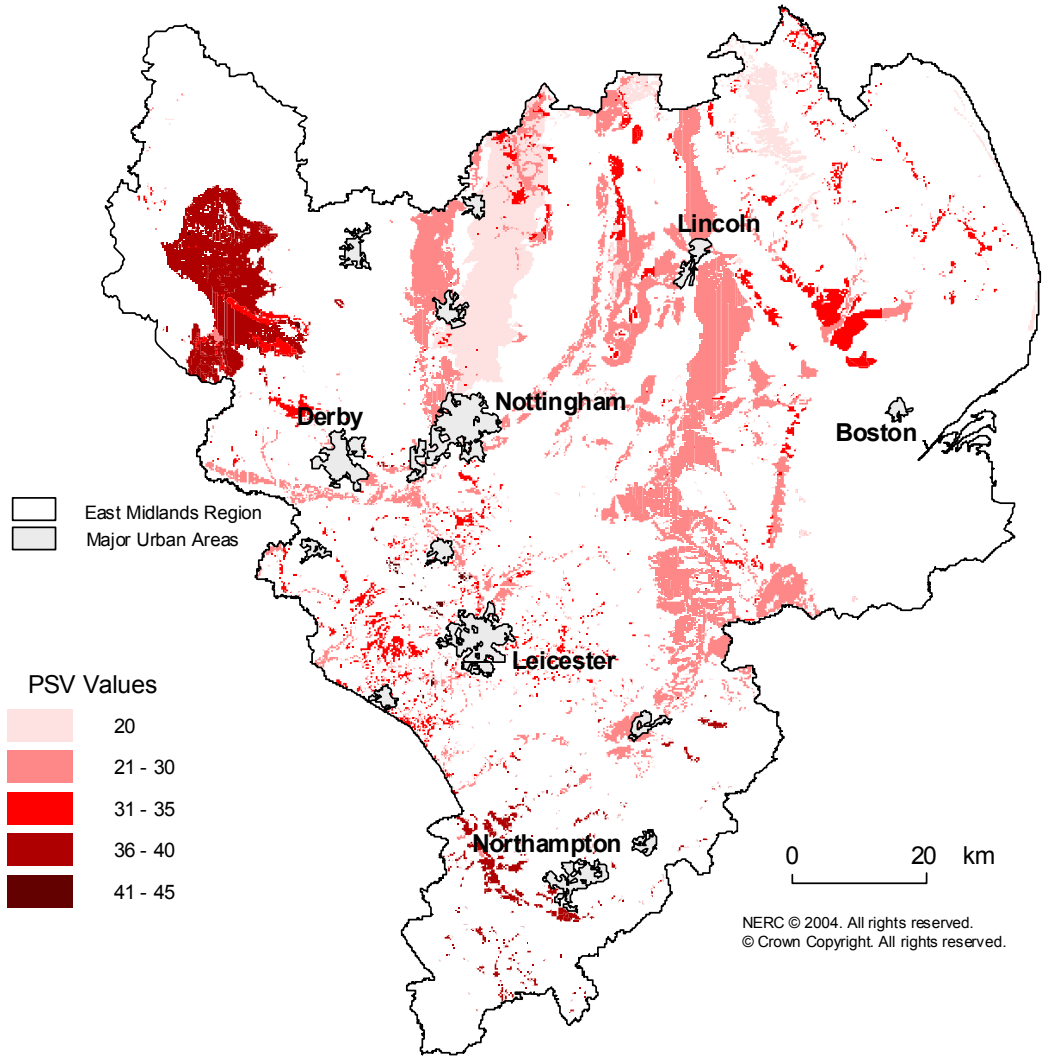
2. Developing a methodology to represent the technical properties with the GIS

A methodology was developed to represent each aggregate property within a GIS. A test database was created in which some of the more commonly used aggregate technical property values were assigned to each resource type including LA, PSV, AAV, MD and MS. The values assigned were generalised figures which best represented the known characteristics of each resource. A GIS layer was then created for each individual technical property for each aggregate resource. For example, a GIS layer was created representing the general AAV values of aggregate resources in the Region. All aggregate resources were assigned a value irrespective of their suitability for different applications. Variability of values within resources was not represented at this stage in the research. Figure 7 shows a generalised series of representative PSV values assigned to each resource in the Region and shows that there are no sources of good quality PSV material, suitable for use as road surfacing aggregate in the East Midlands. However, the map does illustrate variability in this property across the aggregate resources of the Region. For example, the igneous rocks in Leicestershire (which have a restricted outcrop to the

northwest of Leicester and thus are not visible on the map) have a relatively high PSV in comparison to all other aggregate resources (Figure 7).

There are a number of limitations associated with assigning technical resource values to all the aggregate resources in the East Midlands, some of which will not become apparent until all data have been received and the methodology is developed further. In order to assign technical data to the resources, some generalisations may have to be made, including some assumptions regarding the uniformity of certain deposit types. The degree of generalisation will depend on the quantity and quality of data available.

Figure 7 Map showing generalised representative values for PSV values across the East Midlands Region



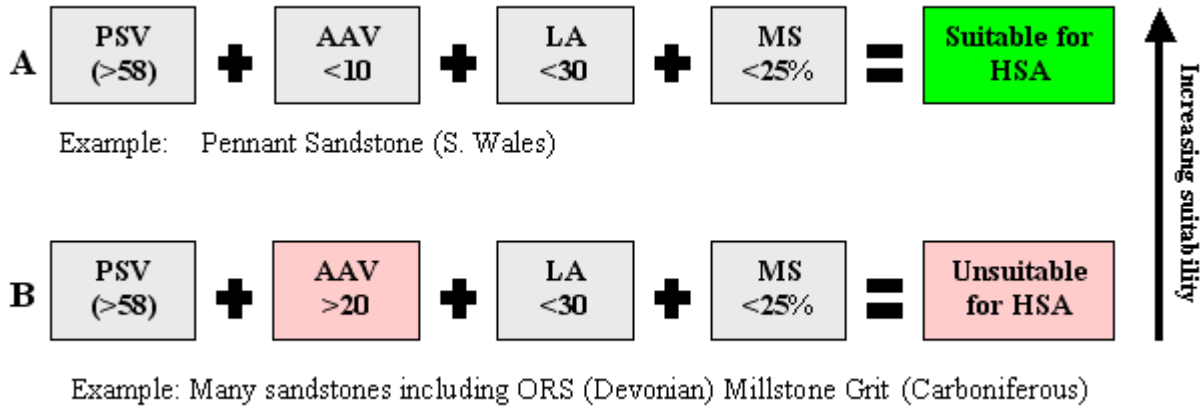
4.3.1 Deriving end-use suitability GIS layers

Once individual GIS aggregate property layers have been created for each technical property, different layers can be combined to analyse the suitability and versatility of individual resources for different uses. These derived outputs are termed 'end-use suitability layers'. The combination of technical properties allows judgments to be made for what resources are likely to be suitable for a particular end-use. Figure 8 provides a hypothetical example of how the resources of the

East Midlands Region could be analysed to determine their suitability and versatility for use as high specification aggregate (HSA) for road surface dressing.

Figure 8. Diagram showing an example of the creation of an end-use suitability map for high specification aggregate (HSA) by combining individual aggregate technical property layers.

PSV = Polished Stone Value, AAV = Aggregate Abrasion Value, LA = Los Angles Coefficient, MS = Magnesium Sulphate. Values in grey boxes meet minimum specified criteria. Values in pink boxes fail minimum specified criteria as provided by Thomson *et al*. (2005).

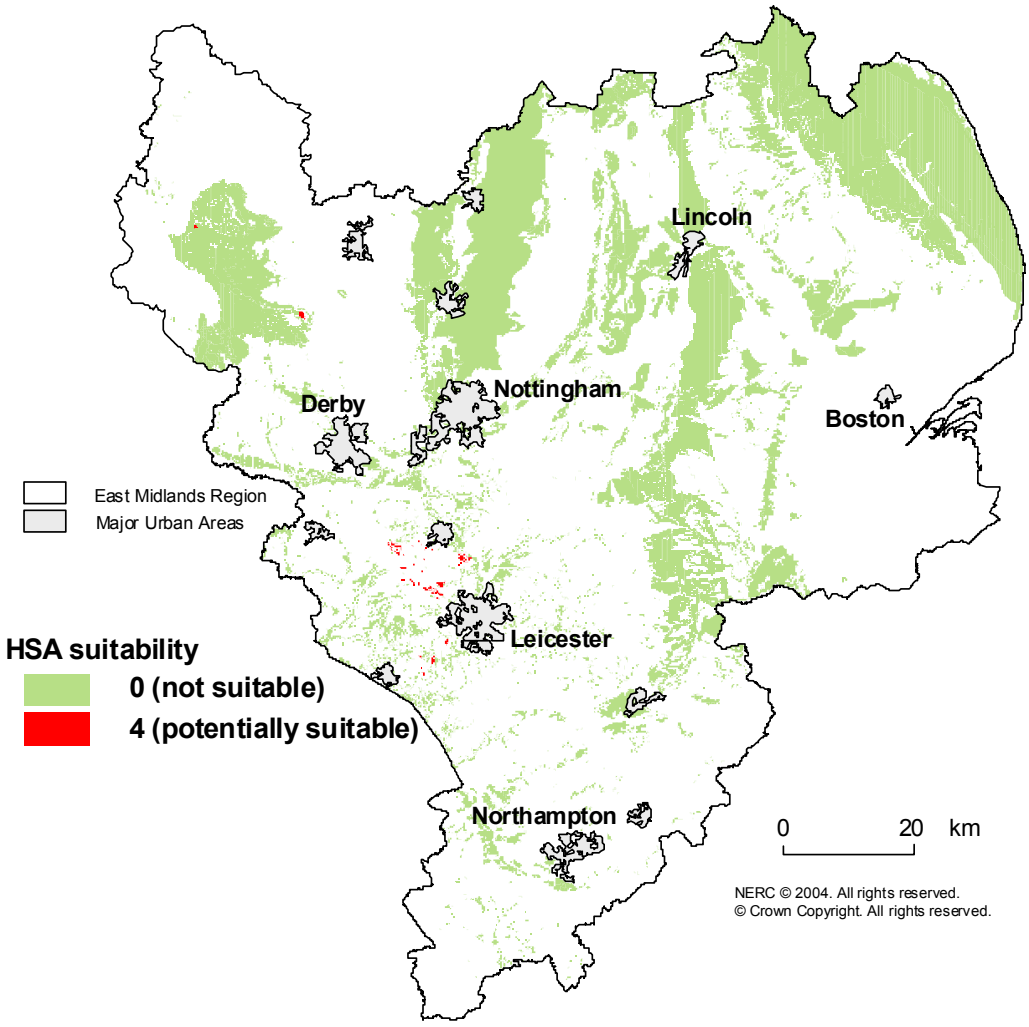


HSAs are defined as "natural and artificial coarse aggregates (≥3mm) that are suitable for use in road surfacing (including surface dressing) applications at the more difficult and/or heavily trafficked sites where high levels of skidding resistance and aggregate durability are required" (Thompson *et. al*, 2005). This equates to aggregates which have a high resistance to polishing (PSV ≥ 58) in combination with sufficient strength and durability to withstand heavy traffic (measured by LA and AAV with minimum values of ≤ 30 and ≤ 16 respectively) and a Magnesium Sulphate Value (MS) ≤ 25%.

To create an end-use suitability layer for HSA in the East Midlands Region, the technical property layers for the defining criteria (PSV, LA, AAV and MS), are combined together (Figure 8). Where all the minimum criteria are satisfied, the resource is shaded as suitable (Figure 8a), but where one or more criteria are not met, the resource is shaded as non-suitable for use as HSA (Figure 8b). The result is a colour-coded layer within the GIS, showing the suitability of the aggregate resources of the East Midlands Region for HSA (Figure 9). For other applications, such as concreting aggregate, the criteria may not be as clearly defined. In this case, the resultant layer might be colour coded showing varying degrees of suitability. Research into this methodology continues.

Within the minerals industry, the location of the important resources and their suitability for different applications is relatively well known and understood. However, making simple and impartial baseline information available is likely to improve the consultation process and assist in the communication of complex issues to a non-technical audience.

Figure 9 Map showing the suitability of the aggregate resources in the East Midlands Region for HAS



4.4 NEXT STEPS IN THE PROVISION OF ECONOMIC INFORMATION

In order to develop and test the methodology, further technical data are required. The quality of the final end-use suitability maps will be dependant on the amount and quality of this additional information. Even if all operators in the region provide data, large gaps of knowledge will remain. This may result in generalisations having to be made about the technical properties of the aggregates resources in the Region, and hence may under represent variability in some resources. For relatively uniform deposits, such as the Carboniferous Limestone, this may be less problematic.

Existing data on technical properties might be compiled from a variety of sources, including relevant publications and local authorities, in order to fill data gaps in the East Midlands pilot area. This will then allow the methodology to be properly tested and refined. Should further gaps in the data exist, limited field studies may be conducted to collect the required data. These data could then be used to create maps showing the 'best and most versatile' mineral resources in the region. This could provide important baseline information, similar to that provided by DEFRA for agricultural land. These might ensure that mineral resources are considered more routinely

when planning for other types of development and for safeguarding such deposits from unnecessary sterilisation.

Both end-use suitability maps, and maps showing the best and most versatile mineral resources in a Region, might be valuable tools to educate and inform non-specialists. For example, the availability of such maps could communicate the regional spatial distribution and relative quality of aggregate resources. The relative scarcity of certain types of resources, such as material for higher end-use applications such as HSA, would be readily demonstrated. Such maps might also illustrate that there may be, in some cases, no alternatives to working in an area of higher environmental sensitivity. In addition, it may help those with a local perspective to develop a broader, more strategic outlook.

5 Stakeholder consultation and dissemination

This section describes the consultation and dissemination undertaken during the project. This took the form of informal meetings, and formal seminars. In addition, independent consultants carried out a critical review of the environmental sensitivity information.

5.1 INDEPENDENT EXTERNAL REVIEWS OF ENVIRONMENTAL SENSITIVITY DATA

Independent critical reviews of the environmental sensitivity data were undertaken (Appendices 1 and 2). These reviews were undertaken by a mineral planning consultant and an environmental consultant. A summary of the mains points from these reviews are listed below:

- **Consistency:** The methodology is useful in presenting data in a consistent format across a planning region.
- **Coverage:** Coverage of environmental sensitivity data should be extended across the rest of England as quickly as possible.
- **Applications:** Data produced using this methodology have applications in regional and sub-regional studies, and in assessing cross boundary issues. The data are likely to be useful in providing background information in the production of development plans. The methodology also has applications in SEA, particularly in establishing the environmental and cultural characteristics of an area. It is not suitable for assessment of individual planning proposals, EIA or for predicting potential impacts. It was concluded that the data was of more use to mineral planners than environmental consultants, but that it might provide useful contextual information to the latter.
- **Scores versus frequency of assets:** The mineral planning consultant considered that the asset scoring technique was too subjective and preferred the frequency of assets methodology. The environmental consultant review provides a detailed comparison of the two (Appendix 2). This concludes that the most appropriate use of the scoring system would be for local areas. The scoring system is flexible and can be adapted to reflect local conditions, but it is highly subjective and reaching consensus on scores could be a potentially contentious issue. The frequency of assets system is more objective and its most appropriate use would be as an ‘early warning’ of areas where potentially significant issues and concerns will need to be investigated in more detail.

5.2 STAKEHOLDER CONSULTATION AND DISSEMIANTION

During the first phase of this research, it became apparent that consultation was central to the success of the environmental sensitivity mapping technique. This approach was also adopted

during this second phase of the project. As well as informal meetings and telephone discussions, most feedback was obtained through the formal consultation and dissemination seminars held towards the end of the project. These were:

Tuesday 18th January 2005
The Natural History Museum, London

Thursday 20th January 2005
BGS, Keyworth, Nottingham

Thursday 27th January 2005
Royal Armouries Museum, Leeds

The seminars provided an opportunity for direct feedback on the environmental sensitivity mapping technique and the end-use suitability maps. The seminars took the form of informal round table presentations, where delegates were free to contribute, comment and ask questions at any time. These were followed by a live demonstration of the online and desktop GIS versions of the environmental and economic data. Delegates were then split into small groups for a 'hands on' demonstration of the system. The seminar was completed with a discussion session. A list of all the stakeholders who took part in the consultation is provided in Appendix 3.

5.3 ISSUES RAISED AT THE SEMINARS

The majority of the discussion at the seminars focused around the environmental sensitivity mapping technique. The main points raised during the consultation process are detailed below.

- **Coverage**: There was a general consensus that the environmental sensitivity data should be made available England-wide. BGS plan to complete coverage of all English regions by summer 2005.
- **Sieve tool/constraints map:** Some consultees were concerned that the environmental sensitivity data layer was just another 'sieve map' or 'constraints map'. This concern was also raised during the Phase 1 consultation. In response, the project team stated that an asset on the map is not necessarily a constraint to development, as impacts or potential mitigation are not taken into account. The map shows the number of assets at a particular location and merely indicates that these assets will need to be considered in the decision making process.
- **Scoring versus frequency of assets:** Some consultees argued that assets should be weighted or scored according to their significance. This also revisits a debate which took place in Phase 1 when, as a result of comments, asset frequency counting replaced asset weighting or scoring because of failure to reach consensus on relative scores.
- **Range of datasets:** Clarification was sought as to why only 20 datasets were used when over 50 were originally identified. The project team stated that these were the only datasets available in digital format, freely available across the region.
- **Updating of datasets:** Consultees considered that regular updates were crucial to the success and value of the layer.
- **'Site-specific' data provision:** Some users requested provision of a system which would allow online access to these data at site/ local level. BGS is investigating inclusion of environmental sensitivity data in its online system for ordering data to assist in site investigation ('Georeports' http://www.bgs.ac.uk/Georeports/).
- **Pricing:** A number of stakeholders were interested in the cost of licensing the environmental sensitivity data. BGS is currently investigating pricing options for these data.

- **Economic information:** A key concern was the restricted availability of base data required to produce detailed end-use suitability maps. Other users questioned the flexibility of the end-use suitability maps and whether or not further classifications could be created. Another questioned the value of these maps, since industry already possessed sufficient technical knowledge of resource quality. It was pointed out by other consultees that other stakeholders in the mineral planning system were unlikely to have the same level of knowledge, and that end-use suitability maps might be a useful means of communicating difficult technical information to non-specialists.
- **Social information:** The project was criticised for focusing on environmental and economic information and ignoring social information. Some users suggested that the social element is often the most important in local decision-making.

6 Conclusions

The research objectives of this project have been met within the agreed timeframe. Listed below are the general conclusions for each objective.

Online access to the environmental sensitivity map for the East Midlands region

- the environmental sensitivity map information and associated attributes have been made available on the internet via the BGS 'Minerals information online' web GIS for the East Midlands Region (www.mineralsuk.com/web_gis);
- accommodating these data in a web GIS environment has entailed some compromises on data resolution and system functionality.

Feedback

- feedback from an extensive consultation and dissemination exercise has generally been very positive;
- the critiques by independent consultants were deemed an important aspect of the consultation process;
- there were some concerns about updating and maintenance of asset data;
- there was some concern about the lack of social information;
- some fundamental issues of approach (particularly asset weighting) raised in the previous phase of this research resurfaced in this consultation.

Aggregate end-use suitability

- a methodology has been developed to integrate a range of aggregate technical property data. This can be used to summarise the distribution of aggregate resources suitable for particular end-uses;
- these summary technical data are useful in communicating issues of variable aggregate quality and economic value to non-technical stakeholders in the mineral planning process;
- availability of appropriate technical property data for different aggregate resources across a wide geographical area is critical in developing these maps.

Future work

- environmental sensitivity mapping will be carried out for the whole of England by the BGS in the first half of financial year 2005. The data will be made available online as each region becomes available. It is anticipated that the mineral GISs for all regions of

England (except London) will be completed by December 2005. New datasets may be added to the environmental sensitivity layer as they become available.

- the project team continue to welcome feedback and criticism of this research.
- the research into end-use suitability maps will be carried on by the BGS under its Minerals Programme, with the support of co-funding where possible.

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Appendix 1 External critique: from a Mineral Planning consultant's perspective

ENVIRONMENTAL SENSITIVITY MAPPING – REVIEW & CRITIQUE FROM THE PERSPECTIVE OF A MINERAL PLANNING CONSULTANT

JOHN COWLEY
MINERAL & RESOURCE PLANNING ASSOCIATES LTD
23 Bayfran Way
Blandford Forum
Dorset
DT11 7RZ
Tel: 01258 456155
Email; jcmarpa@aol.com

"An acre in Middlesex is better than a principality in Utopia." Lord Macaulay on Francis Bacon

"Second Best tomorrow" Robert Waton-Watt

INTRODUCTION

I have been asked by BGS to comment on this project in relation to a mineral planning perspective. The following comments and the presentation at the meeting to consider the project are entirely the views of myself. I have advised the project team of the generality of my comments, but the details may not have surfaced in those discussions.

This is an important piece of work with the ability to carry forward planning for minerals in a consistent but flexible manner. The issues involved in the collection and plotting of data are, as I am aware from bitter experience, substantial. The team are to be congratulated on the quality of the outcome.

One factor that can bedevil many aspects of life is the propensity to seek perfection. Perfection cannot ever be attained in the planning process. Current policy and decisions reflect the issues of today against a background of an ever-changing pattern of land use in which there will never be a final perfect end state. For that reason I am more concerned with getting something workable up-and-running now rather than the detail or mechanics, although I acknowledge that agreement must be reached on such points.

The quote from Macaulay covers this well in more than one way. Utopia is unobtainable. More limited objectives are attainable. Further, one would probably never gain planning permission for mineral extraction in Utopia, but you could do in Middlesex (where an acre of ground could yield some 30,000 tonnes of sand and gravel at prime royalty rates). Just an aside – 'Middlesex' contains the busiest airport in the World which has been surrounded for the last 50 years by perhaps the most intensive area of wet gravel pits and landfill sites in the UK – have bird strike issues been a factor?

THE CONTEXT

Just about 31 years ago I was the Minerals Officer for Dorset County Council and was preparing evidence for the forthcoming public inquiry into the extraction of ball clay from Russell Quay, Arne, an area with major planning designations. In our list of exhibits was an 'Environmental Sensitivity Map' of the major part of the ball clay basin.

The appellants were unsure what this was (and how they might need to counter it). Was it a detailed assessment of the quality of the environment? Was it an evaluation of potential impacts? Was it part of an EIA? Did it deal with responses to ameliorate impacts, etc?

Our reply was that it was none of these. It simply showed on one map the extent of all the planning designations in the area so as to display the concentration of designations in the immediate area, given that this data was otherwise only available on separate maps and not easily assimilated.

That was a 'one-off' map. The production took time and the map suffered from minor 'cartographical errors', was unwieldy and difficult to use in detail. Produced for that one moment in time the map became out of date and of decreasing value as additional designations were made.

Since then I, like many others, have prepared other one-off generic environmental sensitivity maps many times. Most have suffered from the limitations identified above.

VALUE

The above draws out a fundamental value of the project. That is that it provides background data of as many individual elements as desired, in a format that can be manipulated for different areas and at different scales. The potential exists to increase or decrease elements included without negating the whole system. The result is easy to use, easy to up-date and accurate.

However, I also believe that a further fundamental value of the project is the consistency in the presentation of this data. In the past, and indeed still today, individual organisations typically go their own way producing products that are incompatible with documents produced by other organisations, either due to technical differences or varied value judgements.

The current work provides a consistent format for the East Midlands. Having that consistent format is of benefit to planning in the Region. However, that benefit can extend to other regions and to the country as a whole if the same format was extended across the country. I would therefore wish to see this work applied to other regions. Or to put it another way, I would be most unhappy if each region went its own way producing non-comparable studies, perhaps distorted by local issues.

There is more 'government' now. As practitioners we are also faced with a myriad of interested parties all wishing to ensure that their desires are given priority. If we don't provide that, such interested parties more frequently fall back on the courts to review decisions. Consistency, clarity and transparency of data used to guide the planning process are therefore important in justifying and defending actions.

APPLICATION

I believe this work has a range of applications, although it clearly is not suitable for consideration of individual planning proposals. The project will assist in three main areas.

First, it will be of value in regional or sub-regional studies and cross-boundary issues between MPAs can be properly addressed in a consistent manner. Similarly, if, as I desire, the work expands into different regions, cross-regional assessments can also be made. These are all important advantages for, as we all know, commercial considerations as to supply are not constrained by purely administrative local authority boundaries.

The second area of value is a background for the production of development plans. I would not wish the process to be used as a sieve map within the development plan, because that tends only to identify selected areas to meet basic statutory requirements. I have also been struck by the frequency of situations where areas designated in development plans as being the least constrained turn out to be no less constrained, if not more constrained, than areas not designated. The presence of this work will help to put designations into focus and clarify options on a consistent basis.

Lastly, I see the work as of value within industry as a method for rational appraisal of the optimal areas in a planning sense in relation to the areas that are available commercially. If an area is proposed for development then the extent of assets involved in the immediate area can be readily identified alongside the issues that might need to be addressed by amelioration. Similarly the pros and cons of alternatives can be identified without bias entering the process.

CONCERNS

Technical/Social/Economic Assets

I am pleased to see that the project has not included matters that I define as 'Technical', 'Social' or 'Economic'. I hope the exclusion of such matters continues both for the reasons set out below and their incompatibility with mapped factors.

'Technical' matters include matters such as the potential extent of vibration from blasting, noise, dust generation, visual impact, etc. I am aware that such matters feature prominently in decisions and that discussion on zones of influence or buffer zones to cater for such matters may be proposed elsewhere in the planning process.

However, my experience in using or challenging the relevance of such zones confirms that the impacts of these matters are almost wholly related to the detail of a particular location and development and as such any broad mapping distorts the extent of the impact conceptually and actually. Any such distortion would harm the rigor of the existing work. It also has the undesirable potential to constrain options (by over-emphasising issues in a locality, such as around an existing quarry) and thereby will lead to undesirable conclusions (undesirable in either environmental or economic terms).

'Social' matters may include considerations such as the acceptability of traffic movements to the community, planning gain, compensatory opportunities, etc. These matters are becoming more widely debated. They may affect the acceptability of an operation. However, they are tenuous, politically (both with a small and a large 'p') sensitive, subject to significant and rapid change and impossible to display sensibly in a map format.

'Economic' matters may include 'scarcity' of a resource, employment generation, rates, closeness to an existing quarry, etc. This is the one area that might be seen to provide a positive indication for industry. However, these matters suffer from the same range of difficulties noted above and any application of such matters will severely distort outcomes.

Other Factors and Assets

One can question the relevance of some 'assets' identified (why 'Millennium Greens' but not village greens or common land). I do not want to pursue this too far as the system is capable of excluding/adding new data.

I understand that there are data collection problems with some assets. Hopefully data on other assets will be become available in the future and the value of the approach is that other assets can be added at that time.

Scores

Scoring is used in the project. Scoring always implies the application of value judgement, which, in the range of assets considered, is the comparison in value between 'chalk and cheese'. Value judgements always have some bias. Stakeholder involvement may minimise bias but the stakeholder involvement normally only includes special interest groups and cannot be said to be free of bias. Stakeholders in the South West Region may challenge the basis for scores in the East Midlands. If this work is to provide a consistent and factual basis then it should not be 'leading' due to any built-in value judgement by the use of scores and I would propose that scoring is not used.

If scoring is felt to be essential then I suggest a scoring system below that reduces bias.

Local Non-Statutory		1
Local Statutory	2	
Regional	3	
National	4	
European	5	
Global		6

Range of Scores

The unsatisfactory aspects of scoring are increased by the application of a range of scores. I believe this approach to be suspect and distorting with the potential to reinforce bias in an inconsistent and irrational manner.

Obviously, parts of an AONB vary in relation to quality and the boundary of an AONB separates land even when the quality of landscape on either side of that boundary is precisely the same. The scarp face of the North Downs AONB is clearly a dramatic and attractive landscape. That quality of landscape within the AONB decreases away from the scarp but at what point it becomes of lesser value is a completely personal interpretation and one that is open to considerable debate.

The application of a range of scores therefore raises a whole raft of issues, including who decides the boundaries, who rates the quality of the area and how one defends the scores given.

An example of the potential problems is the approach that was put to me in relation to the Gower AONB, when during the Swansea Local Plan Inquiry in the late 1980s, it was suggested by the local planning authority that as the Gower was the first designated AONB it was of more importance than other AONB's.

I have another concern with the application of a range in scoring and that is its potential to lead to the situation where a local non-statutory designation (SNCI up to 8) could be scored higher than a national designation (SSSI down to 5).

Despite the fact that there is change in quality I believe we have to run, at this level of planning, with the concept that all land within a designation is of equal quality. That does not prevent a challenge on the quality of say land included within a particular SSSI in relation to an application.

Repetition of Layers

I have a concern that the present system over-emphasizes certain assets. This is particularly clear in relation to nature conservation interests.

If we take for example an area of wet moorland, designated of nature conservation interest due to the habitat and associated flora and fauna, such a locality could be an SSSI, an NNR, an SAC, an SPA and a Ramsar site. That indicates 5 assets with a score of 46. However, each of those designations refers to the same interest.

An alternative location could see 5 distinct assets (AONB, Ancient Monument, Grade 1 Agricultural Land, Groundwater Zone 1, Historic Parkland) raising different and diverse issues but which do not in total score as high (40) as the nature conservation total.

I believe this area should be looked at again as it does not provide the level-planning field required and that the approach should be modified.

NEXT STEPS

It is essential that the merits of this project be not wasted. To that end I regard it as most desirable, in fact essential, that the general format is expanded to cover the country. There is scope for local variation in assets in other regions, but the adoption of local variations should not

affect the main asset base and should continue to ensure that the presentation is consistent overall. It would be counter-productive if varied approaches were adopted.

There are issues. I have made comment on my own concerns. Those issues need to be addressed, but addressed promptly. However, it is vital that the difficulties with detail should not delay the wider adoption of the process. As Watson-Watt noted, we do not need perfection in the distant future but a workable process tomorrow.

John Cowley

Mineral & Resource Planning Associates Ltd

January 2005

Appendix 2 External critique: from an environmental consultant's perspective

Report on the Environmental Sensitivity Mapping website

Dr Paul Mitchell
Green Horizons Environmental Consultants Ltd
PO Box 137
Bexhill-on-Sea
East Sussex
TN40 1YA
Tel 01424 213380
Email enquiries@green-horizons.co.uk

Introduction

This brief report has been prepared by Dr Paul Mitchell (Green Horizons Environmental Consultants Limited) and is an objective critique of the British Geological Survey *Environmental Sensitivity Mapping* website[1] and the associated online GIS from an environmental consultant's perspective. The website and GIS were accessed in the period 5 - 10 January 2005 via a 1 MB broadband link and using Internet Explorer (version 6.0.2900.2180).

Commentary and assessment covers five areas:

1. User assessment.
2. General and technical assessment of the 'assets per grid cell' and 'weighted scores' approaches.
3. Scenario testing (e.g. use of the website to support studies on minerals and other land use perspectives and issues).
4. Comparative assessment relative to the GIS version.
5. Commercial valuation of access to the information contained on the website.

1. User assessment

General comments:

A general assessment of the introductory part of the website (i.e. all pages except '*View the online GIS*') is summarised in the following table:

Aspect	**Score** **(1 = poor** **5 = excellent)**	**Additional comments**
Clarity of text descriptions	Generally 4 to 5 (see specific comments below)	A glossary would be helpful to many users – either as a separate page, or by use of floating text accessed by passing the mouse over the word of interest. Words for inclusion: GIS, assets, SEA, sensitivity, polygon, resolution, digital/digitally…etc
Ease of use	4	Straightforward to use, but some aspects are perhaps oversimplified (see specific comments below)
Navigation	5	Cross-references and links are complete and easy to

[1] Entry page at www.bgs.ac.uk/mineralsuk/envsens/home.html

Aspect	Score (1 = poor 5 = excellent)	Additional comments
		follow
Layout	5	Layout has a clear and user-friendly structure
Use of colour	5	No obvious issues with colour use
Use of graphics	2-3	Several pictures are too small – see specific comments below
Printability	4	Text is generally fine, but pictures are not always clear in printed form
Speed of access	5	No delays apparent using a broadband connection

An assessment of the '*View the online GIS*' section is covered in the specific comments below.

Specific comments:

- *Title.* The title of the technique – Environmental Sensitivity Mapping – does not reflect the full extent of its application and content. Although the introductory text explains that both environmental and cultural assets are covered, perhaps the title should be amended to include 'cultural' ('Environmental and Cultural Asset Mapping') or a more general title (e.g. 'Sensitivity to Development') adopted?
- *Introductory page.* The order of links for further information on the introductory page could be reordered to offer a more logical progression through the technique, for example:

Current order	Potential alternative
Environmental sensitivity mapping - an overview	Environmental sensitivity mapping - an overview
View the online GIS	What are environmental and cultural assets?
Flexibility	Method used to create the environmental sensitivity layer
Method used to create the environmental sensitivity layer	Flexibility
What are environmental and cultural assets?	Limitations and technical information
Consultation and feedback	View the online GIS
Background to the environmental sensitivity project	Background to the environmental sensitivity project
Limitations and technical information	Consultation and feedback

- *What is environmental sensitivity mapping?* The text on this page should include a little more information on what the significance of environmental and cultural aspects is for development (e.g. not necessarily constraints, but may need specific measures on the part of the developer to ensure potential impacts are avoided or minimised). On the picture, perhaps replace '100 hectare resolution' with 'minimum resolution – 100 hectares'. The reference to scoring versus number of assets is too brief to allow the user to fully grasp the potential of the former option.
- *Flexibility, scoring and updating.* There is a need to clarify the difference between an area's sensitivity (resulting from the presence of assets) and the significance (or sensitivity) of the assets themselves. For example, the sentence "Composites of these can be quickly generated in a GIS to display the total sensitivity of these selected assets only" mixes the two different types of sensitivity, and should probably read "Composites of these can be quickly generated in a GIS to display the total sensitivity of an area resulting from these selected assets only". Again, the reference to scoring or weighting versus number of assets is too brief to allow the user to fully grasp the potential of the former option. Pictures for 'all assets' and 'certain assets only' could do with being larger as the text is

slightly difficult to read. The assets used on the 'certain assets only' picture need to be spelled out rather than presented as acronyms.

- *How was the environmental sensitivity layer created?* The text is clear, but the picture is too small to be able to properly follow the creation process. Perhaps increase the size of the picture (e.g. similar size to the picture on the '*What is environmental sensitivity mapping?*' page) and include the appropriate text under each step, or use multiple pictures (as used in the Phase I report).
- *What are environmental and cultural assets?* Assets require careful definition – the stated definition is probably too broad as "anything that society places a value on" could include things such as roads (and other infrastructure), landfills, quarries etc, which are not specifically included in the technique. Perhaps the definition should be narrowed by including a reference to the fact that environmental and cultural assets may be unique, rare, and/or difficult or impossible to replace or recreate? The full list and description of assets should acknowledge that there are other assets that could also potentially be included, as digital data becomes available.
- *Consultation and feedback.* Perhaps also offer a fax number (for comments and completed contribution-in-kind forms) and a telephone number (for comments). 'To have you time…' should read 'To have your time…'
- *Background to the environmental sensitivity mapping project.* This seems fine, but I wonder how many people will actually download the Phase I report or Executive Summary? Perhaps it would be better to also duplicate the Phase I Executive Summary here (which may also encourage readers to download the full report).
- *Limitations and technical information.* The pictures need to be slightly larger (at least the same size as the picture on the '*What is environmental sensitivity mapping?*' page). 'Data' is plural.
- *View the GIS online.* The environmental sensitivity mapping elements appear to be well integrated with the other available information, and if the '*Help*' section is read first the GIS is easy to use. Any links to the online GIS (i.e. from the sensitivity mapping website should recommend that the GIS '*Help*' section is read before the first use of the GIS. Graphically, it is difficult to distinguish between Special Protection Areas and National Parks, as the colour scheme for both is very similar. This appears to be the only visual issue. Printability is excellent. Speed of access via a broadband connection was excellent with page refreshing generally taking less than 5 seconds. Identifying some or all of the assets in selected areas took longer, but was still generally less than 2 minutes to task completion.

2. General and technical assessment of the 'assets per grid cell' and 'weighted scores' approaches

Although mentioned on the '*What is environmental sensitivity mapping?*' page and elsewhere, the concept of a 'weighted scores' approach is not discussed in sufficient detail for the concept to be fully grasped. Only by returning to the Phase I report would a reader understand how the 'weighted scores' approach might work and its strengths and weaknesses relative to the 'assets per grid cell' approach. I would recommend that an additional webpage be prepared that shows one or more worked examples of the 'weighted scores' approach, and compares them with the 'assets per grid cell' approach. This page should also include an assessment of how sensitive the 'weighted scores' approach is (i.e. how do relatively small or large changes in weighting influence the outcome) and how this approach should be used (e.g. should scores be reached by consensus or by expert opinion, how to present information in a transparent form to prevent manipulation of outcomes).

The technical strengths and weaknesses of the two approaches are summarised in the following table:

Aspect	**'Weighted Scores' approach**	**'Assets Per Grid Cell' approach**
Transparency	Medium – but possibly lower when altered from the baseline score to reflect the local conditions	High – number of assets per grid cell is dictated only by the available information and not by user choice
Sensitivity to changes in data	High (but see *Flexibility*, below)	Low
Potential for data manipulation	High (but see *Flexibility*, below)	Low

Aspect	'Weighted Scores' approach	'Assets Per Grid Cell' approach
Need for a consensus approach	Yes – potentially a contentious issue	No – number of assets per grid cell is dictated only by the available information and not by user choice
Need for reference or 'anchor' points	Yes – each score needs to be 'anchored' to a legislative reference point to reduce subjectivity of the assessment	No – number of assets per grid cell is dictated only by the available information and not by user choice
Integration with non-asset related factors and issues	Can be weighted to reflect significance in the wider context of non-asset related factors and issues	Significance relative to other non-asset factors and issues less obvious than for 'weighted scores' approach
Subjectivity versus objectivity	Can be highly subjective, even if 'anchored' to a legislative reference point. Different stakeholder groups may have very different views on the scores that should be assigned to the same asset	Objective – number of assets per grid cell is dictated only by the available information and not by user choice
Flexibility	High – can be adapted by planners to reflect local conditions, needs and issues	Low – a small locally important site carries is equivalent to a large nationally significant area
Most appropriate use	Comparison of sites within a narrow 'local' area where the number of assets is relatively low, or the context is consistent across the 'local' area	As an 'early warning' of areas where potentially significant issues and concerns will need to be investigated in greater detail

3. Scenario testing

For the process of scenario testing, the online GIS was interrogated as if being used for a range of activities that a 'typical' environmental consultant might be involved with. The relevance of the GIS to each of these activities was then assessed. This assessment is necessarily subjective and may vary from one consultant to another. Therefore, relevance is categorised only broadly, using 'high', 'medium' and 'low' as the most appropriate measures.

Relevance	Activity	Comments
High	Strategic Environmental Assessment	High relevance to establishing the context for an SEA and determining environmental and cultural characteristics of the area being considered. Will assist as a visual tool during stakeholder consultations, and in assessing and contrasting project alternatives
Medium	'Early warning' of potential environmental and cultural asset-related issues Setting the context for an Environmental Impact Assessment	A useful tool for indicating the environmental and cultural assets within the operational footprint of different developments. Relevance somewhat limited by the relatively small number of assets currently included in the GIS

Relevance	Activity	Comments
Low	Undertaking an Environmental Impact Assessment Predicting potential impacts Establishing site-specific good practice for companies	Limited relevance – the GIS can only establish the wider context. Site-specific impacts and related good practice to prevent or minimise these impacts would need to be assessed from additional desktop and field studies

4. Comparison with the GIS version

Resolution: The GIS version has a minimum resolution of 1 hectare, substantially increasing the level of detail during interrogation and the generation of outputs.

Functionality: The GIS version has an improved functionality relative to the online version, specifically its interactive features, which allow the user to specify the outputs (in terms of data and appearance) to a greater extent, increasing the fit between outputs and user requirements.

Usability: The improved functionality of the GIS increases the complexity relative to the online version through the enhanced capacity for data entry and manipulation, interrogation of data and derivation of outputs. While the online version is relatively straightforward to use and supported by a useful online 'help' facility, proper use of the GIS is likely to require users to have a reasonable understanding of manipulating input data, interrogation and generating outputs. For many potential users, some formal or informal "hands-on" training supported by an appropriate user's guide may therefore be required to maximise the benefits of the GIS version relative to the online version.

Accessibility: The principal users of the GIS are likely to be those with prior GIS experience, while the online version is likely to be used by a broad mixture of users with and without technical skills, including the full range of stakeholders interested in, or affected by, the planning and development process.

Data management: There is no option for data management in the online version, the user simply working with the data as made available. In contrast, the GIS version has the facility for the user to enter data and to use and change 'weighted scores' as well as the 'assets per grid cell' approach. Although this makes the GIS version more powerful and flexible, it does raise the possibility of localised adaptation of data to 'suit' the local context, which will degrade the consistent use of this approach to planning and development issues. In turn, this will potentially reduce the usefulness of the sensitivity mapping approach.

Applications: Although there is likely to be substantial crossover between the GIS and online version, it seems probable that the former will be applied in more rigorous and detailed applications overseen by planners and related users, while the latter is more likely to be widely used by those requiring contextual information (consultants, local communities, other stakeholders).

5. Valuation of access to information

The value to an environmental consultant of the online GIS (or rather, the price an environmental consultant would be willing to pay for access) would be dependent on:

- The nature of the project activities for which use of the GIS was proposed
- The relevance of the GIS to successful completion of those activities
- The fees charged by the consultant (and whether such costs are passed on to the client)

Using the 'typical' activities outlined in *Scenario Testing* above, the following indicative values are estimated based on a consultant charging between £300 and £600 per day and a 'licence' to access the GIS for a limited period of time (e.g. 1-5 days), with relatively limited rights to the data:

Activity	Likely maximum acceptable to consultant
SEA	£1000
'Early warning' of potential environmental issues	£400
Setting the context for an Environmental Impact Assessment	£400
Undertaking an Environmental Impact Assessment	£300
Predicting potential impacts	Free
Establishing site-specific good practice for companies	Free

Based on these estimates, an average valuation for access to information would be approximately £350 per discrete visit. Higher or lower charges could be applied if it were possible to differentiate between different uses (e.g. by limiting access to certain features of the GIS for 'scoping' studies).

Conclusions

The environmental sensitivity mapping tool is likely to be of more use to planners than environmental consultants. Its use can generate useful contextual information to some of a 'typical' environmental consultant's projects, but the GIS lacks the specific level of detail that many projects for company or site-level clients would require. The exception to this would be projects related directly to SEA studies.

Appendix 3 List of stakeholders

Below is a list of all the stakeholders that took part in consultation on this project either through personal meetings, telephone or the dissemination and consultation seminars.

Table 1 List of stakeholders

Name	Organisation	Venue
Viv Squires	Aggregate Industries UK Limited	Keyworth
Anthea Hoey	ATKINS Design Environment and Engineering	London
Carole Howarth	Bradford MDC	Leeds
Peter Huxtable	British Aggregates Association	London
Roger Cullimore	British Aggregates Association /Cullimore	Taunton
Charlotte Herbert	British Geological Survey	Keyworth
Tony Morigi	British Geological Survey	Keyworth
Mary Spiesberger	Calderdale MBC	Leeds
Liv Carroll	Capita Symonds	London
Carol Foster	Cornwall County Council	Taunton
Bill Froggatt	DEFRA	Leeds
Julie Holloway	DEFRA	London
Carol Barnett	Derbyshire County Council	Keyworth
Stewart Redding	Devon County Council	Taunton
Arthur Doyle	Doncaster Metropolitan Borough Council	Keyworth
Elaine Ward	Doncaster Metropolitan Borough Council	Keyworth
John Bennett	Dorset County Council	Taunton
Jason McKewon	Durham County Council	Leeds
Dr Jen Heathcote	English Heritage	London
James R Cuthbert	Glentoal Associates Ltd, Mineral Planning & Development Consultants	Keyworth
Robin Drake	Gloucestershire County Council	Taunton
Kevin Phillips	Gloucestershire County Council	Taunton
Neal Whitehead	GOSW	Taunton
Dr Paul Mitchell	Green Horizons Environmental Consultants Ltd	Leeds
Trevor Badley	Hampshire County Council	London
Matt Uttley	Hanson Aggregates	Keyworth
Dr Ian Selby	Hanson Aggregates Marine Ltd	London
Kirk Blackburn	Lafarge Aggregates Ltd	Leeds

Name	Organisation	Venue
Gareth Burdell	Lafarge Aggregates Ltd	Leeds
Gary Staddon	Lafarge Aggregates Ltd	Leeds
Nick Dexter	Leicestershire County Council	Keyworth
Steve Marriott	Leicestershire County Council	Keyworth
Adrian Winkley	Lincolnshire County Council	Keyworth
Nigel Weedon	Longcliffe Quarries Ltd	Keyworth
Gordon Riddler	Mineral Industry Research Organisation	Keyworth
Abbie Richards	Mineral Industry Research Organisation	Leeds
Lynn Alderman	Minerals Planning Group	Leeds
Martin Millimore	Minerals Planning Group	Leeds
Jessica Morgan	Minerals Planning Group	Leeds
Allan Davies	North Somerset County Council	Taunton
Alistair Hoyle	North West Regional Aggregate Working Party	Leeds
Josh Fothergill	North Yorkshire County Council	Leeds
Peter Moor	Northamptonshire County Council	London
Wayne Allum	Nottinghamshire County Council	Keyworth
Jonathan Smith	Nottinghamshire County Council	Keyworth
Mr Bill Mackenzie	ODPM	London
Richard Hilton	ODPM Minerals and Waste Planning	Taunton
Peter Day	Oxfordshire County Council	London
Shaun Walden	Oxfordshire County Council	London
Duncan Pollack	Quarry Products Association	Taunton
Colin Yelland	Quarry Products Association/Aggregate Industries UK Ltd	Taunton
Keith Frost	Quarry Products Association/RMC	Taunton
Steve Lamb	Quarry Products Association/Tarmac	Taunton
Keith Frost	RMC	Keyworth
David Roberts	RMC Aggregates	Keyworth
Shaun Denny	RMC Aggregates (UK)	Keyworth
Ken Hobden	Somerset County Council	Taunton
Chris Waite	South East England & London Regional Aggregate Working Party	London
Phil Hale	South West Regional Aggregate Working Party	Taunton
Nick Chase	South West Regional Assembly	Taunton
Nick Chase	South West Regional Assembly	London

Name	Organisation	Venue
Matt Griffin	Staffordshire County Council	Keyworth
David Lamb	Surrey County Council	London
Ross Gordon	Tarmac Northern Ltd	Harrogate
Craig Arditto	Tarmac Northern Ltd	Harrogate
Rob Moore	Tarmac Northern Ltd	Harrogate
Ross Gordon	Tarmac Northern Ltd	Leeds
Sue Martin	The National Assembly for Wales	London
Toby White	University of Leeds	Keyworth
Jim Davies	Warwickshire County Council	Keyworth
Geoff Winslow	Wiltshire County Council	Taunton
Dave Parrish	Yorkshire Dales National Park	Leeds