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## Mineral Resource Information for Development Plans

### **Northamptonshire: Resources and Constraints**



TECHNICAL REPORT WF/00/4  
Mineral Resources Series

**Mineral Resource Information for  
Development Plans:  
Phase One Northamptonshire  
Resources and Constraints**

A J Bloodworth, D G Cameron,  
A N Morigi, D E Highley  
and S Holloway

*Planning Consultant:* J F Cowley  
Mineral & Resource Planning Associates



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This report accompanies the 1:100 000 scale map:  
Northamptonshire Mineral Resources

*Cover Photograph*

Pre-glacial Milton Sand being worked at Hill Farm  
Quarry (Hanson Aggregates) near Northampton.

*Photo: D G Cameron*

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## SUMMARY

This report is one of a series prepared by the British Geological Survey for various administrative areas in England and Wales for Phase One of the Department of the Environment, Transport and the Regions Research Project *Mineral Resource Information for Development Plans*.

The report and accompanying map relate to the area of the Mineral Planning Authority of Northamptonshire. The report and map delineate and describe the mineral resources of current, or potential, economic interest in the area and relate these to national planning designations which may represent constraints on the extraction of minerals. Three major elements of information are presented and described:

- the geological distribution and importance of mineral resources
- the extent of mineral planning permissions and the location of current mineral workings
- the extent of selected planning constraints (national statutory designations)

This wide range of information, much of which is scattered and not always available in a consistent and convenient form, is presented as a digitally-generated summary map. The map is produced at 1:100 000 scale, which is convenient for overall display and allows for a legible topographic base on which to depict the information. In addition, as the data are held digitally using a Geographical Information System (GIS), easy revision, updating and customisation are possible, including presentation of subsets of the data at larger scales.

Basic mineral resource information is essential to support mineral exploration and development activities for resource management and land-use planning, and to establish baseline data for environmental impact studies and environmental guidelines. It also enables a sustainable pattern and standard of development to be achieved by valuing mineral resources as national assets.

The purpose of the work is to assist all interested parties involved in the preparation and review of development plans, both in relation to the extraction of minerals and the protection of mineral resources from sterilisation, by providing a knowledge base on the nature and extent of mineral resources and the environmental constraints which may affect their extraction. However, it is anticipated that the map and report will also provide valuable data for a much wider audience, including the minerals industry, the Planning Inspectorate, the Environment Agency, the Countryside Agency, other agencies and government bodies, environmental interests and the general public.

The mineral resource information has been produced by the collation and interpretation of data principally held by the British Geological Survey. The methodology for the collection and display of the data is described and a range of sources of information and further contacts is presented. The mineral resources described are sand and gravel, limestone, building stone, ironstone, refractory clay, hydrocarbons and secondary aggregates.

## INTRODUCTION

*‘..... it will become increasingly important to have reliable information about the nature, quantity and location of mineral resources as workable reserves in environmentally acceptable areas become scarcer.’*

Sustainable Development: The UK Strategy.

The UK Government’s response to the Rio Earth Summit.

This report is one of a series that has been prepared by the British Geological Survey for various administrative areas in England and Wales as part of the Department of the Environment, Transport and the Regions, research project *Mineral Resource Information for Development Plans*.

The report relates to the county area of Northamptonshire and should be used in conjunction with the mineral resources map of the county which accompanies this report. The report and its associated map delineate and describe the mineral resources of current or potential economic interest in Northamptonshire. These are related to national planning designations which may represent constraints on the extraction of minerals. The purpose of the work is to assist all interested parties involved in the preparation and review of development plans, both in relation to the extraction of minerals and the protection of mineral resources from sterilisation, by providing a knowledge base, in a consistent format, on the nature and extent of mineral resources and the environmental constraints which may affect their extraction. An important objective is to provide baseline data for the long term. The results may also provide a starting point for discussions on specific planning proposals for mineral extraction or on proposals which may sterilise resources.

All the data are held in digital form which can be readily revised on a regular basis. This also provides scope for producing customised maps of selected information, including the display of part of an administrative area in greater detail or a grouping of administrative areas to provide a broader picture. The mineral resources map is at 1:100 000 which is a convenient scale for overall display and to show the information on a legible topographic base. The report and map represents the situation at 1<sup>st</sup> April 2000.

Mineral resources are valuable national assets and their extraction and use makes a major contribution to wealth creation, the infrastructure of our society and quality of life of individuals. An adequate supply of minerals is therefore essential to the development of our economy. However, minerals can only be worked where they occur and their extraction, particularly in the densely populated landmass of Britain, causes conflicts with other

desirable aims of society, either by loss or change to valued landscapes, habitats or features of historical and archaeological interest, or due to amenity impact.

Basic mineral resource information is essential to support mineral exploration and development activities. In the wider context of sustainable development, mineral resource data are required for resource management and land-use planning. These data also contribute to the baseline information needed for environmental impact studies and environmental guidelines. Moreover, knowledge of the extent and quality of mineral resources, and their rate of extraction, can help value them as national assets. This ensures that the capital they represent is managed properly and rates of depletion monitored.

## **MINERALS PLANNING**

It is the function of the planning system through the development plan and individual decisions to manage the supply of essential minerals at best balance between economic, social and environmental costs. Achieving that balance requires adequate data on the relevant competing objectives, including the extent and details of mineral resources. As the development of workable resources in environmentally acceptable areas is becoming more difficult, it will become increasingly important in the policy development process to have comparative and reliable data on the distribution and quality of such resources.

The 'development plan' includes structure plans, which contain strategic planning policies, and local plans, containing detailed policies and proposals, or unitary development plans, which combine both functions. In addition, relevant authorities must produce local plans on minerals and/or waste. Development plans set out the main considerations on which planning applications are determined and form the essential framework of the planning system. The importance of the development plan system in planning decisions is emphasised by Section 54A of the Town and Country Planning Act 1990, which requires that planning applications and appeals be determined in accordance with the development plan, unless material considerations indicate otherwise. The planning system is, therefore, a plan-led system. Development plans are produced through an extensive process of consultation with prospective developers and the general public. Development plan preparation must take account of Government guidance. This is primarily set out in Planning Policy Guidance notes (PPGs), Mineral Planning Guidance notes (MPGs) and Regional Planning Guidance notes (RPGs). These provide advice on a range of general and specific issues.

The Planning and Compensation Act 1991 introduced a mandatory requirement that all Mineral Planning Authorities (MPAs) in England and Wales prepare either a local plan or a unitary development plan which set out the policies and proposals against which planning applications and appeals are determined. Mineral local plans are intended to provide a clear guide to mineral operators and the public where mineral extraction is likely in principle to be acceptable and where not. They cover a period of at least 10 years and are reviewed periodically to take account of new information and changing circumstances. MPAs are, therefore, required to undertake regular assessments of the mineral resources in their areas and of the reserves for which planning permissions have been granted.

The key elements of a minerals local plan or of the mineral policies of a unitary development plan are:

- to balance through its policies the essential need for minerals against protection of the environment and local amenity
- to make an appropriate provision for the supply of minerals and provide an effective framework within which the minerals industry may make planning applications
- to set policies for the control of mineral working and associated development
- to identify areas of possible future mineral working
- to prevent unnecessary sterilisation of resources by the use of safeguarding policies, including defining mineral consultation areas

It follows from the above that information on the extent, quality and, if possible, quantity of mineral resources is an essential prerequisite for the production of mineral local plans, both in the context of identifying areas of future mineral working and the longer term objective of the protection of important mineral resources against sterilisation. Such data should be available to all parties to assist them in their contribution to the development plan process, both to protect mineral resources from sterilisation and to provide for sufficient resources to meet the needs of society. This work is intended to assist that process.

Three major elements of information are presented and described:

- the geological distribution and importance of all mineral resources
- the extent of mineral planning permissions and the location of current mineral workings
- the extent of selected planning constraints (national statutory designations)

The maps bring together a wide range of information, much of which is scattered and not always available in a consistent and convenient form. The data are held digitally using a Geographical Information System (GIS), which allows for easy revision, updating and customisation, including presentation of subsets of the data at larger scales. It is anticipated that the maps and report will also provide valuable background data for a much wider audience, including the different sectors of the minerals industry, other agencies and authorities (e.g. The Planning Inspectorate Agency, the Environment Agency, the Countryside Agency and English Nature), environmental interests and the general public.

## **MINERAL RESOURCE CLASSIFICATION**

Mineral resources are natural concentrations of minerals, or bodies of rock, that are or may become of potential economic interest as a basis for the extraction of a commodity. They will exhibit physical and/or chemical properties and be present in sufficient quantity to be of intrinsic economic interest. Mineral resources are thus economic as well as physical entities.

The identification and delineation of mineral resources is inevitably somewhat imprecise as it is limited not only by the quantity and quality of data currently available but also involves predicting what might, or might not, become economic to work in the future. The assessment of mineral resources is, therefore, a dynamic process which must take into account a range of factors. These include geological reinterpretation as additional data becomes available, as well as the continually evolving demand for minerals, or specific qualities of minerals, due to changing economic, technical and environmental factors. Consequently areas that are of potential economic interest as sources of minerals may change with time. Criteria used to define resources, for example in terms of mineral to waste ratios, also change with location and time. Thus a mineral deposit with a high proportion of waste may be viable if located in close proximity to a major market, but uneconomic if located further away. The criteria used to delineate mineral resources are outlined in the relevant commodity section of the report. These criteria vary depending on the quality of the information available.

The map of Northamptonshire mainly shows the extent of **inferred mineral resources**, that is those mineral resources that can be defined from available geological information. They have neither been evaluated by drilling or other sampling methods, nor had their technical properties characterised, on any systematic basis.

Where sand and gravel assessment studies have been undertaken by the British Geological Survey or other organisations, sufficient information may be available to define mineral resources at the **indicated resource level**. The sand and gravel resources in the Nene

Valley, and in the area between Northampton and Rugby fall into this category. The linework is based on the 1:25 000 scale mineral assessment maps, where these are available.

Mineral resources defined on the map delineate areas within which potentially workable minerals may occur. These areas are not of uniform potential, nor do they take account of planning constraints which may limit their working. The economic potential of specific sites can only be proved by a detailed evaluation programme. Such an investigation is an essential precursor to submitting a planning application for mineral working. The individual merits of the site must then be judged against other land-use planning issues.

That part of a **mineral resource** which has been fully evaluated and is commercially viable to work is called a **reserve** or **mineral reserve**. The relationship between **measured, indicated and inferred resources** and evaluated commercial deposits (**reserves**) is described in more detail in Appendix 3. In the context of land-use planning, however, the term **mineral reserve** should strictly be further limited to those minerals for which a valid planning permission for extraction exists (i.e. **permitted reserves**). Without a valid planning consent, no mineral working can take place and consequently the inherent economic value of the mineral resource cannot be released and resulting wealth created. The ultimate fate of mineral resources is to be physically worked-out, or to be rendered non-viable by changing economic circumstances.

The map has been produced by the collation and interpretation of data principally held by the British Geological Survey. The geological lines are taken, with some generalisations, from available BGS 1:25 000, 1:50 000 scale and 1:63 630 scale maps. These published maps are based on 1:10 560 or 1:10 000 scale surveys, which cover most of the county. In general, the more recent the survey the more detailed it is likely to be.

## **MINERAL WORKINGS AND PLANNING PERMISSIONS**

The location and name of mineral workings that are currently active or temporarily inactive, together with the main mineral commodities produced, are shown on the map and in Appendix 1.

The extent of all known mineral planning permissions is also shown on the Mineral Resources Map. They include all permissions granted since 1st July 1948 and all IDO permissions, whatever their subsequent status in relation to legislation relating to the Planning and Compensation Act 1991 and the Environment Act 1995. Planning permissions cover active mineral workings, former mineral workings and, occasionally, unworked deposits. They represent areas where a commercial decision to work minerals has been taken in the past and where the permitted mineral reserve may have been depleted to a greater or lesser extent. Within the overall site, there

may be a number of individual planning permissions at various stages of development and restoration. All planning permissions data were obtained from Northamptonshire County Council, which is the Mineral Planning Authority for the whole area.

The present physical and legal status of individual permissions is not qualified on the map or in the report. The areas shown may, therefore, include inactive sites, where the permission has expired due to the terms of the permission, i.e. a time limit, and inactive sites where the permission is still valid. Sites which have been restored have not been separately identified. However, information is available on the planning and operational status of each planning permission on the database which underpins the map. A planning permission may extend beyond the mapped resource as it may make provision for operational land, including plant, overburden tips and landscaping, or it may extend to an easily identified or ownership boundary. Information on the precise status and extent of individual planning permissions should be sought from Northamptonshire County Council (Appendix 2).

## **ENVIRONMENTAL DESIGNATIONS**

The map shows the extent of selected, nationally-designated planning constraints as defined for the purposes of this study. These are defined on a common national basis and therefore represent a consistent degree of constraint across the country. No interpretation should be made from the map with regard to the relative importance of the constraints, either in relation to mineral development proposals or in relation to each other. Users should consult policy guidelines issued by the relevant Government department, statutory agency or local authority.

The constraints shown on the map are:

- National Nature Reserves (NNR)
- Sites of Special Scientific Interest (SSSI)
- Scheduled Monuments

Mineral development may also be constrained by other factors not shown on the map including local landscape designations, considerations relating to the protection of other resources, such as groundwater, the best and most versatile agricultural land, and local amenity or environmental concerns such as noise, traffic and visual impact. These have been excluded because the constraint is not defined on a national basis or the information is not generally available. The extent or degree of relevance of such constraints can be ascertained from the relevant statutory agency or the appropriate Mineral Planning Authority (Appendix 2).

English Nature has provided digital data on SSSIs and NNRs. Information on the location of Scheduled Monuments has been obtained in digital form from English Heritage. The areas shown as NNRs and SSSIs may also be subject to international designations reflecting their wider ecological importance. They may include Ramsar sites (wetlands of international importance as listed in accordance with the Ramsar Convention), or Special Protection Areas (SPAs) and Special Areas of Conservation (SACs) as identified in accordance with EU Directives on wild birds and natural habitats, respectively.



## **MINERAL RESOURCES**

### **OVERVIEW**

The mineral resources of Northamptonshire occur within Jurassic sediments, which occur across the county, and also within superficial deposits of Quaternary age which overlie these rocks.

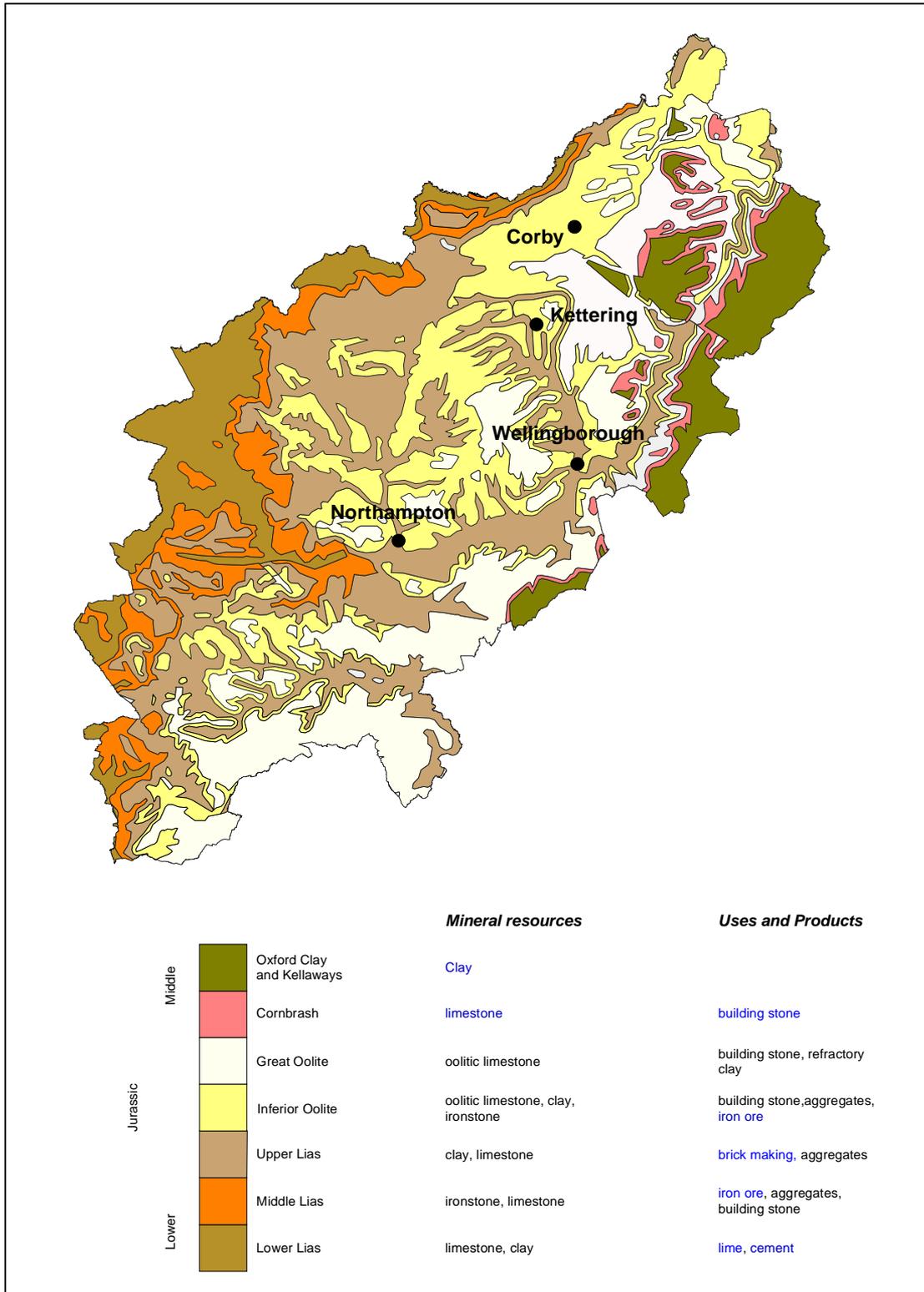
Economically, sand and gravel is by far the most important mineral produced in Northamptonshire. Resources occur within superficial sediments of Quaternary age. Historically, the river sand and gravel resources of the Nene Valley has been the major source of supply, some of which was exported from the county. The Nene Valley is now declining in importance as much of the available reserve has become exhausted. The pre-glacial Milton Sand occurs in a belt to the south of Northampton and forms an important resource of fine aggregate. Deposits of glacial sand and gravel are scattered throughout the county. Many of these deposits are of limited extent, although more extensive deposits occur in the M1 corridor which runs between Northampton and Rugby.

The Lincolnshire Limestone, which occurs in the Middle Jurassic sequence in the northern part of the county, is an important regional source of crushed rock aggregate for less-demanding applications. The Lincolnshire Limestone is also locally-important as a source of building stone, although only 'Weldon Stone' (from the upper part of the Formation) has been exported for use outside Northamptonshire. The 'Collyweston Slate', which occurs in the basal beds of the Lincolnshire Limestone, is also worked as a distinctive and attractive roofing material.

A low-iron, high-silica silty clay from within the Jurassic Rutland Formation in the north east of the county is used as an ingredient in the manufacture of refractories for use in the foundry industry.

Ironstone from the Northampton Sand Formation was formerly a nationally-important iron ore resource. It was extensively worked in the county from the mid-19<sup>th</sup> Century through until 1980. Changing economic and technological conditions in the iron and steel industry led to the demise of the Northampton Sand Formation as an iron ore resource. A legacy remains in the county of extensive planning permissions to work ironstone. Today, it is used locally on a limited basis as a source of low-grade, crushed-rock aggregate.

The potential for the discovery of hydrocarbon resources in Northamptonshire is very low.



**Figure 1. Simplified ‘solid’ geology map of Northamptonshire. Material no longer worked shown in blue.**

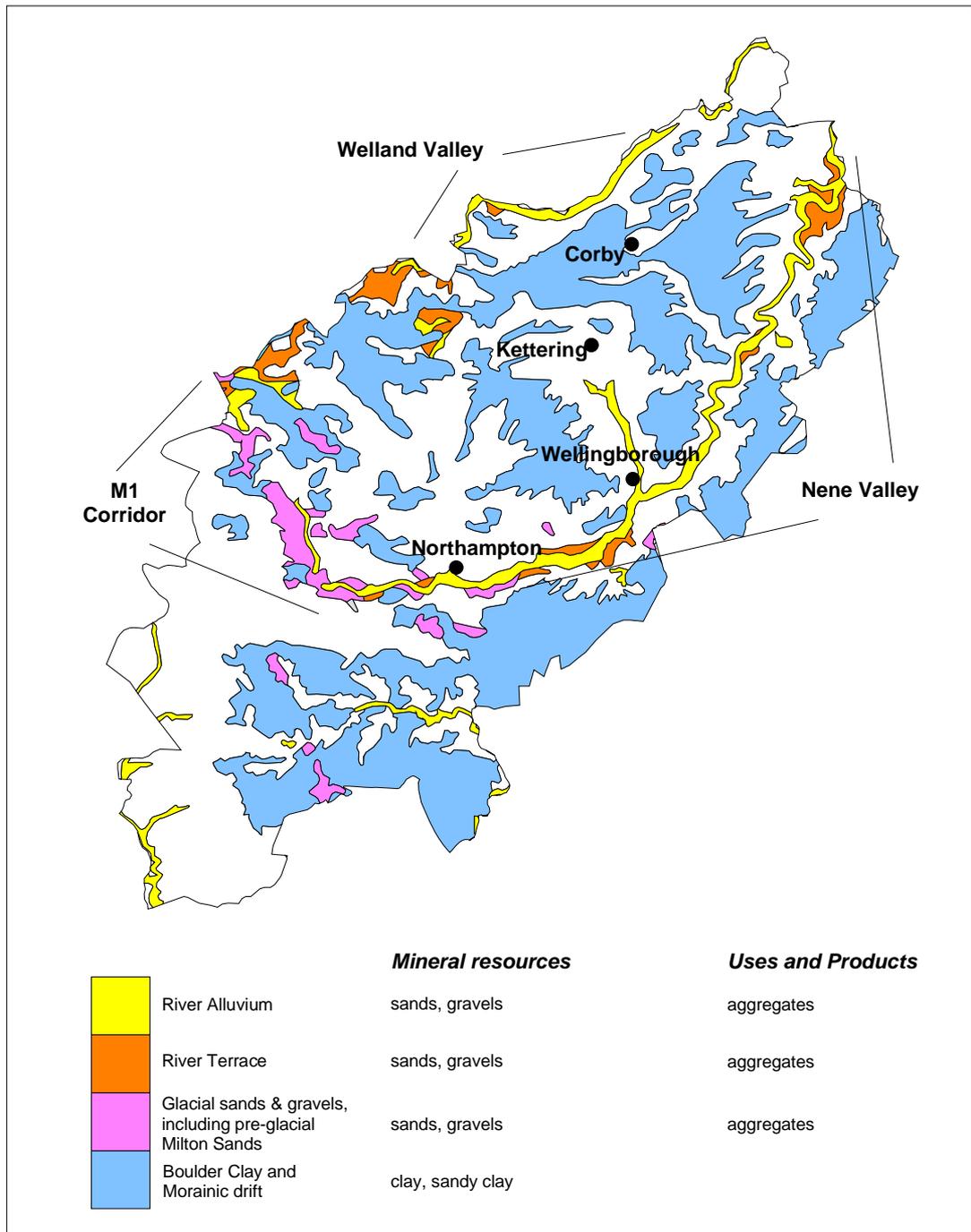


Figure 2. Simplified map the superficial deposits of Northamptonshire.

## SAND AND GRAVEL

Although currently grouped together, sand and gravel are separate commodities which are defined on the basis of particle size rather than composition. The term ‘gravel’ is used for material which is coarser than 5 mm, with a maximum size of 40 mm. The term ‘sand’ defines material finer than gravel but coarser than 0.075 mm. The principal use of sand is as fine aggregate in concrete, mortar and asphalt. Gravel is mostly used as coarse aggregate in concrete.

Substantial quantities of sand and gravel may also be used as constructional fill.

Sand and gravel production in Northamptonshire was some 1 047 000 in 1999. Resources are confined to superficial or 'drift' deposits of Quaternary age, subdivided for practical purposes into 'pre-glacial sand and gravel', 'glacial sand and gravel', and 'river sand and gravel'.

Sand and gravel deposits are variable and may be concealed within or beneath till (boulder clay). This means that, in comparison with other bulk minerals, it is more difficult to infer the location and likely extent of potentially workable resources from geological maps. Properties that influence the economic potential of a sand and gravel deposit include:

- sand to gravel ratio
- proportion of fines and oversize material
- presence of deleterious rock types (such as coal or mudstone)
- thickness of deposit and overburden ratio
- position of the water table
- possible presence of unwanted interbedded material
- the ease with which material can be processed to produce a
- saleable product (clay fines are more difficult to remove than silt)
- location relative to demand

Sand and gravel assessment surveys carried out by BGS cover almost half the county. In these areas, the distribution of sand and gravel shown on the map is upgraded to the 'indicated' resource level. These areas are clearly delineated and include the category 'concealed sand and gravel' which is not shown elsewhere. In the remaining portion of the map, the sand and gravel distribution is at the inferred resource level. The physical criteria used by BGS Mineral Assessment Reports (MARs) to define indicated sand and gravel resources are given in Table 1.

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Deposit thickness	>1 m
Overburden : sand and gravel ratio	3:1
Proportion of fines (<63:µm)	<40%
Proximity of deposit to surface	within 25 m

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**Table 1. The physical criteria used by BGS Mineral Assessment Reports to define 'indicated' sand and gravel resources.**

*Source: Harrison, 1981*

## SUPERFICIAL DEPOSITS

Quaternary superficial deposits comprise unconsolidated sands and gravels that accumulated during the last 1.8 million years. In Northamptonshire, the oldest such deposits date from about 700 000 BP.

### Pre-glacial sand and gravel (Milton Sand)

Pre-glacial sand and gravel, known locally as Milton Sand, occurs in a belt running to the south and west of Northampton between Nether Heyford and Preston Deanery. There is evidence of this deposit in boreholes as far west as Kilsby (Clarke and Moczarski, 1982), and at Yardley Chase to the east (Samuel, 1982), although it is mostly concealed beneath till and other superficial deposits. It is probable that this sand was laid down by a river system that existed in the area prior to glaciation. With an average thickness of 5 m, the Milton Sand appears to reach its maximum thickness of about 13 m near Milton. Here, sand with thin gravel beds containing mainly locally-derived sandstone and ironstone pebbles has been extensively worked.

On the Mineral Resources map, Milton Sand is not differentiated from glacial sand and gravel although their characteristics are different. Milton Sand has a lower proportion of coarse sand and a higher proportion of fine and medium sand than typical glacial material. Examples of grading data are shown in Table 2.

Deposit type	Fines %	Sand %	Gravel %
Milton Sand	12	81	7
Glacial sand & gravel	19	52	29
River sand & gravel	12	43	45

**Table 2. Mean grading data for sand and gravel from the area to the immediate south and west of Northampton.**

*Source: Clarke and Moczarski, 1982.*

Milton Sand is used principally as a source of building sand. It is also transported outside the county for use as fine aggregate in asphalt and concrete products.

## GLACIAL SAND AND GRAVEL

‘Glacial Sand and Gravel’ is sand and gravel that has been deposited either by melt-water streams issuing from an ice sheet, or by streams flowing within, beneath, or on the surface of the ice. The till (boulder clay) that is widespread in the county was laid down by the

same ice sheet, so that glacial sand and gravel and the till are often intimately associated. Consequently, sand and gravel deposits may occur sporadically within, beneath and on top of the till.

Outcrops of glacial sand and gravel are scattered throughout much of the county, but are only extensive along the M1 corridor between Northampton and Daventry. Work by BGS also revealed quite extensive concealed glacial sand and gravel resources, approximately doubling the known extent of the resource within this area, as well as the area assessed around Kettering and Wellingborough (Clarke and Moczarski, 1982; Harrison, 1983). A preliminary desk study of sand and gravel deposits in the northern part of the county concluded that there was insufficient data to determine the extent of concealed sand and gravel, although boreholes showed it to be present (Jackson, 1978). More recent site investigation boreholes for the A1 – M1 link road may provide additional information. Another desk study covering the southern part of the county was also unable to delimit the extent of concealed sand and gravel (Wild, 1984). However, this report does note evidence for the presence of sand and gravel concealed beneath till in Towcester-Brackley area.

The thickness of the glacial sand and gravel deposits is highly variable. East of Corby, boreholes have proved up to 5 m of sand and gravel increasing to 9 m further south, to the east of Kettering (Harrison, 1981,1983). In the upper reaches of the Nene Valley, between Kilsby and Brockhall, up to 20 m of glacial sand and gravel has been encountered in boreholes (Clarke and Moczarski, 1982). Between Welford and Scaldwell (in the west central part of the county), up to 33 m of concealed sand and gravel has been reported (Jackson, 1978). Thicknesses of up to 9 m are known in the south of the county (Wild, 1984). Overburden thickness is extremely variable and difficult to predict. In the north of the county it typically ranges up to 11 m; in the centre and west, up to 18 m; in the south up to 19 m; and in the south-east, exceptionally, up to 39 m.

Typically glacial sand and gravel deposits are clayey to very clayey, sandy gravels. The gravel fraction is commonly composed of roughly equal proportions of ironstone, limestone and flint, with smaller amounts of quartz, quartzite and chalk, while the sand is mainly quartz and ironstone.

## **RIVER GRAVELS**

River gravels outcrop along the valleys of the rivers Nene, Ouse, Welland, Isle and Tove, as a series of level surfaces, or terraces. These terraces, of which there may be up to three in each valley, are the dissected, or eroded, remnants of earlier, abandoned river floodplains. The alluvium of the present day rivers, comprising largely silt and clay, is usually channeled into the lowest terrace, so

that gravel deposits may also lie beneath the alluvium. Unlike glacial sand and gravel, river gravel deposits generally have a simple, tabular morphology and a straightforward relationship to other superficial deposits.

The most extensive river gravel resources in the county are to be found in the Nene Valley. The entire Northamptonshire extent of the valley of the Nene, along with its River Isle tributary, is covered in detail by BGS sand and gravel surveys (Harrison, 1981,1983; Clarke and Moczarski, 1982). The river gravels in these valleys range up to about 6 m thick, (up to 8 m near Warmington) with a mean thickness of between 2.5 and 3 m. Overburden, comprising alluvial silty clay, rarely exceeds 2 m in thickness, although up to 6 m has been recorded in isolated boreholes. The Nene Valley gravels have been extensively worked over the past 100 years.

The majority of the River Nene gravels are sandy gravels that fall within a fairly narrow grading range (Table 2). Limestone, ironstone and flint are the main constituents of the gravel fraction, with smaller amounts of quartz, quartzite, and sandstone and, less commonly, chalk.

Extraction operations produce a range of products from coarse concreting aggregate through to building sand. The majority of sand and gravel produced in Northamptonshire is consumed within the county, although the market for these materials extends southwards to Milton Keynes and the Luton area. A large proportion of the sand and gravel is consumed in ready-mix and concrete products.

Although data are limited, gravel resources along the other river valleys in the county are likely to be extensive. In the north, boreholes sited on the alluvium of the River Welland encountered between 3.6 and 4.4 m of sand and gravel, with overburden up to 3.6 m thick (Jackson, 1978). In the south, around the confluence of the Ouse and the Tove, between 1.2 and 4 m of sand and gravel were proved in boreholes (Wild, 1984). River gravels have also been worked from pits near Deanshanger. The composition of these gravels appears to be similar to that of the Nene Valley gravels. Scant information is available for river gravel in the remaining river valleys. Few of the site investigation boreholes drilled along the route of the M1 proved sand and gravel in the Avon Valley; where such deposits were encountered they were less than 1 m thick. This was also the case in the Cherwell Valley.

## **LIMESTONE**

The Jurassic Lincolnshire Limestone (Inferior Oolite Group) forms the principal limestone resource in Northamptonshire. It is utilised mainly as a source of crushed rock aggregate, but also as a building stone. This formation is up to 40 m thick in the Grantham area, but

thins rapidly to the south and disappears altogether in the Kettering-Oundle area.

Although the Lincolnshire Limestone is a sub-regional source of crushed rock aggregate and is worked extensively in neighbouring counties, there remain only two active operations working this material in Northamptonshire. Some 283 000 tonnes of limestone were produced in the county in 1999, most of which was derived from the Lincolnshire Limestone. No aggregate test data are available for material from the county, although typical data for the Lincolnshire Limestone in neighbouring Lincolnshire and Cambridgeshire are given in Table 3.

	Lincolnshire		Cambridgeshire
Relative density (oven-dried)	2.24-2.4	2.32	2.31-2.37
Water absorption (%)	5.1-6	5.4	5.2-5.4
Aggregate impact value	47	30	43
Aggregate crushing value	36	NA	44
10% fines (dry)	25-70	25-70	25-70

**Table 3. Typical aggregate test data for Lincolnshire Limestone.**

Definitions:

*Relative density (RD) (calculated on an oven-dried basis)*

The relative density of an aggregate is the ratio of its mass to the mass of an equivalent volume of water.

*Water absorption (WA%)*

Capacity to absorb water; an indirect measure of porosity.

*Aggregate Impact Value (AIV):*

Resistance of an aggregate to repeated impact as measured by the aggregate impact test. The smaller the value, the more resistant the rock is to impact.

*Aggregate Crushing Value (ACV):*

Resistance of an aggregate to crushing when subjected to a crushing force as measured by the aggregate crushing test. The smaller the value, the more resistant the rock is to crushing.

*Ten per cent fines value (TFV)*

Resistance of an aggregate to crushing under a gradually applied compressive load. It is applicable to relatively weak or variable quality aggregates. It is the load required to produce 10 per cent fines. The smaller the value, the less resistant the rock is to crushing.

The relatively low strength and high water absorption of the Lincolnshire Limestone restrict its use to undemanding applications such as fill and sub-base material.

## **BUILDING STONE**

In the extreme north of the county, the basal beds of the Lincolnshire Limestone Formation form a fissile sandy limestone known as the Collyweston Slate. This material is used locally as stone slates for roofing and as a building stone and is worked at a quarry near Stamford, along with stone used for crushed rock aggregate. Elsewhere in Northamptonshire, the Lincolnshire Limestone consists mainly of a series of oolitic limestones with variable amounts of shell debris. Bedding is more massive in the upper part of the formation. In the area to the east of Corby, this upper part of the Lincolnshire Limestone was worked (in quarries and underground) as a high quality dimension stone. Known locally as 'Weldon Stone', this material is the only dimension stone from Northamptonshire to be employed extensively outside the region.

The Blisworth Limestone Formation (Great Oolite Group) is a building stone of local significance and is worked near Oundle and in a small operation south of Towcester. Although the Northampton Sand Formation ironstone has been used in buildings in many parts the county, there are no quarries currently working this material. Because of their limited local significance, the outcrop area of both of these formations is shown on a small-scale inset map.

## **REFRACTORY CLAY**



**Figure 3. Dark grey mudstone overburden is stripped from pale grey silty refractory clay at the Nassington Quarry operated by Vesuvius (UK) Ltd.**

In the north-eastern part of the county, unbedded rootlet beds of greyish-white and brown silty 'fireclays' up to 3 m thick occur within the Jurassic Rutland Formation (formerly Upper Estuarine Series) of the Great Oolite Group. These are worked in the Kingscliffe - Nassington area for refractory applications (Figure 3). The map shows the outcrop of the Rutland Formation in this area only. Elsewhere in the county, this Formation is too thin and/ or variable in lithology to be of any economic interest.

	Wt %
SiO <sub>2</sub>	84.6
Al <sub>2</sub> O <sub>3</sub>	7.42
Fe <sub>2</sub> O <sub>3</sub>	1.52
CaO	0.28
MgO	0.15
Na <sub>2</sub> O	0.05
K <sub>2</sub> O	0.30
TiO <sub>2</sub>	2.19
Loss on ignition	3.12

**Table 4. Chemical composition of silty clay used for producing refractories, Kingscliffe, Northamptonshire (Highley, 1982).**

Quartz predominates in the clays, which are highly siliceous. Clay minerals consist of interstratified smectite-vermiculite, kaolinite and mica (Highley, 1982). Although described as 'fireclays', they are more akin to ganisters because of their high silica content. A typical chemical composition of Rutland Formation clay from this area is given in Table 4.

The clays are utilised in monolithic refractories, used mainly in the automotive castings industry. They form an important component of a siliceous 'gunning mix' and 'ganister' used in various foundry applications.

## IRONSTONE

The Jurassic Northampton Sand Formation (Inferior Oolite Group) consists principally as ironstone and occurs extensively in Northamptonshire. It was formerly worked on a large scale by opencast methods, particularly in the vicinity of Corby, Wellingborough and Kettering. Production ceased with the closure of the integrated iron and steelmaking plant at Corby in 1980, which was the last plant in Britain based entirely on domestic iron ores. The ironstone bed is up to 6 m thick, although most commonly only 2-4 m was worked beneath an overburden of up to about 30 m. The iron ore had an average Fe content of about 35 per cent, with 12 per

cent SiO<sub>2</sub>, 3 per cent CaO and 0.7 per cent P. Northampton Sand Formation ironstone has the highest phosphate content of all British iron ores. Phosphorus is a serious impurity in iron ores and needs to be removed prior to the production of the finished steel. The element was removed into the slag (slag produced at Corby contained 10–12 per cent P<sub>2</sub>O<sub>5</sub>). This ground basic slag was Britain's only indigenous source of phosphate fertiliser until the closure of the steel plant.

Although ironstone mining in Northamptonshire had its origins in the 19<sup>th</sup> Century, post-1900 quarrying became much more extensive as larger and more efficient earthmoving equipment became available. Removal of overburden and loading of ironstone using draglines and mechanical shovels enabled larger and deeper pits to be developed. An extensive networks of mineral railways was laid to transport ore from the quarries. Underground mining of ironstone was not common, although a number of mines were active in the area between Kettering and the Nene Valley during the period 1900-1960. All mines were adits, with ironstone being worked by the pillar and stall method (Tonks, 1988).

Ironstone working, particularly in the period prior to and during the Second World War, resulted in much dereliction. However, the operation of the Town and Country Planning (Ironstone Areas Special Development) Order 1950 and the Mineral Workings Act 1951, which established the Ironstone Restoration Fund, led to the successful restoration of most of the worked ground. Several large voids created by ironstone working in Northamptonshire are currently in use as landfill sites.

Technological and economic changes within the UK iron and steel industry has led to the demise of the Northampton Sand Formation as a source of iron ore. For this reason it is not shown as a resource on the face of the main map. However, there remain some 80 planning permissions granted for the extraction of ironstone and overlying minerals within the county. These cover about 8 900 hectares of land and are shown on the main map. They give an indication of the extent of the post-1948 working of ironstone (i.e. the maximum extent of working). Areas of pre-1948 working are not shown. A small number of these permissions cover active sites which are used for the extraction of the ironstone for local use as crushed-rock aggregate. This material accounts for about 10 per cent of the county production of crushed-rock aggregate (Northamptonshire County Council, 1997). Where planning permission exists for the extraction of ironstone and overlying minerals, Lincolnshire Limestone may also be extracted.

## **HYDROCARBONS**

### **Conventional oil and gas**

Northamptonshire is unprospective for oil and gas because of a lack of mature source rocks. Potential source rocks have not been buried to sufficient depths to generate significant quantities of oil or gas. Similarly, the coals in the Westphalian C-D Coal Measures of the Oxfordshire Coalfield are of very low rank and have not been buried sufficiently deeply to produce thermogenic gas. Ordovician (Tremadoc) shales occur under the Jurassic strata beneath parts of Northamptonshire, but any potential these had to generate oil and gas was probably exhausted in Palaeozoic times. Poor prospectivity is reflected in the fact that no exploratory wells have been drilled for hydrocarbons, and only a few seismic lines have been acquired. The seismic lines are all in the extreme south west of the county, where Coal Measures of the Oxfordshire Coalfield occur beneath the surface.

### **Coalbed methane**

Northamptonshire is not prospective for coalbed methane. Although Coal Measures occur beneath the surface in the south west of the county, the gas content of the coals is too low to allow coalbed methane production. Measured values are 0.4 m<sup>3</sup>/tonne (Creedy, 1991).

## **SECONDARY AGGREGATES**

The term 'secondary aggregates' is used to describe a range of materials which may be used as alternatives to primary aggregates (subject to considerations of quality and contamination), but which arise as wastes from a variety of activities. They may be considered under three main headings:

- Naturally-occurring materials arising from mineral extraction and processing operations, such as colliery spoil, overburden and quarry/processing waste
- Materials arising from industrial processes, such as slags and ash, which may be of variable composition
- Construction and demolition wastes which may be either in a natural or manufactured state and include asphalt plantings, road sub-base, concrete rubble and masonry. These materials are excluded from this study as their arisings are highly variable in location, type and duration.

Utilising the aggregate potential of such materials may have the advantage of both reducing the demand for primary aggregates and thus land for extraction, and the problems of disposing of waste. In

general, however, secondary aggregates are only suitable for less demanding aggregate applications, and their production and use may not always be environmentally or economically desirable. There are no coal-fired power stations, smelting activities or large spoil dumps from mining operations in Northamptonshire. The potential for producing secondary aggregates is, therefore, limited.

## **MINERAL RESOURCES AND PLANNING CONSTRAINTS**

Mineral extraction can cause irrevocable, but not necessarily harmful, change to a locality over a relatively short timescale. In order to ensure that such changes are sustainable, and do not harm the environment, the most valuable landscapes and habitats (National Parks, AONBs, SSSIs etc.) are given a greater degree of protection from mineral working. The need for mineral workings in such areas has to be justified by a most rigorous examination of the merits of the proposal. This examination considers the wider public interest in the development of the resource and the social and economic issues as well as the need to protect the environment.

Mineral extraction in areas designated or proposed as Special Protection Area (SPA) and/ or Special Areas of Conservation (SAC) may be acceptable if there are no alternatives and if there are imperative reasons of overriding public interest which support the development. For certain priority SACs, development can only be considered to be acceptable if there are overriding reasons of public health or safety or due to beneficial environmental consequences. Whilst the requirement to assess the acceptability of mineral working in such designated areas is therefore stringent, there is no total prohibition on working minerals in such areas.

The resolution of conflicts between mineral resource development and other considerations is undertaken through the development plan framework and the development control system with a balanced appraisal of the issues raised. The Mineral Resource Map of Northamptonshire provides a synthesis of available information which can be revised and updated as additional data becomes available. Additional environmental designations may be incorporated as required. It is hoped that the map and the associated report will assist local and national government, the minerals industry and other interested parties in the consideration and production of policies in development plans.

The landscape character of Northamptonshire reflects the nature and structure of the underlying rocks, the erosive forces to which they have been subjected and the soil and vegetation that they support. This character is constantly changing due to economic and social pressures in the short-term and to geomorphological processes in the long-term. Although the county is predominantly rural in character, it does include the urbanised and industrialised areas in and around Northampton, Kettering and Corby. The clay vales of the central and eastern parts of the county are drained by the rivers Welland and Nene, giving rise to broad valleys with rich alluvial soils. To the south and west of the vales are the Northamptonshire Uplands which are cut by the M1 corridor. Jurassic limestone and ironstone

forms the upland area in the north of the county known as Rockingham Forest. Heavy soils formed by the capping of glacial till on these hills result in this area being extensively wooded. Intensive extraction of ironstone in this area in the 19<sup>th</sup> and 20<sup>th</sup> centuries has left a considerable legacy of worked ground and extensive planning permissions for ironstone and overlying minerals.

There are no National Parks or Areas of Outstanding Natural Beauty within Northamptonshire. There are a large number of SSSIs within the county, covering a wide range of landscape and habitat types. These include designations on a number of former mineral workings. There are two National Nature Reserves, at Collyweston Woods in the north of the county, and at Buckingham Thick Copse in the south.

Local landscape and conservation designations made by local authorities are not shown on the accompanying map however these will be found on the relevant local plans. These include Green Belts and Areas of High Landscape Value, which lie outside the nationally designated areas. Green Belt policy is to keep land open and prevent urban sprawl. Mineral extraction need not be incompatible with Green Belt status provided high environmental and restoration standards are maintained

Other local and site specific factors may affect mineral operations, these include the designation of high-grade agricultural land which may become a constraint if land cannot be restored to at least the same grade after extraction. These factors represent technical constraints rather than fundamental policy constraints and can only be considered on a site by site basis, They are excluded from the map.

## SELECTED BIBLIOGRAPHY

For further information on national planning policy, users should consult the following :

- Planning Policy Guidance
- Mineral Planning Guidance Notes
- Regional Planning Guidance Notes

These are published by the HMSO for the Department of the Environment, Transport and the Regions.

Information from the following documents and maps was used in the compilation of the map

### a) British Geological Survey 1:50 000 geological map sheets

Sheet	Name	Edition	Published
157	Stamford	S&D	1978
170	Market Harborough	S&D	1969
171	Kettering	S&D	1976
184	Warwick	S&D	1984
185	Northampton	S&D	1980
186	Wellingborough	S&D	1974
201	Banbury	S&D	1981
202	Towcester	S&D	1969
203	Bedford	No modern map available	
218	Chipping Norton	S&D	1968
S&D Solid and Drift combined			

**b) British Geological Survey Sheet Memoirs**

EDMUNDS, E A, POOLE, E G & WILSON, V. 1963. Geology of the country around Banbury and Edgehill. *Memoirs of the Geological Survey of Great Britain*. Sheet 201 (England and Wales).

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**c) British Geological Survey Reports and other publications**

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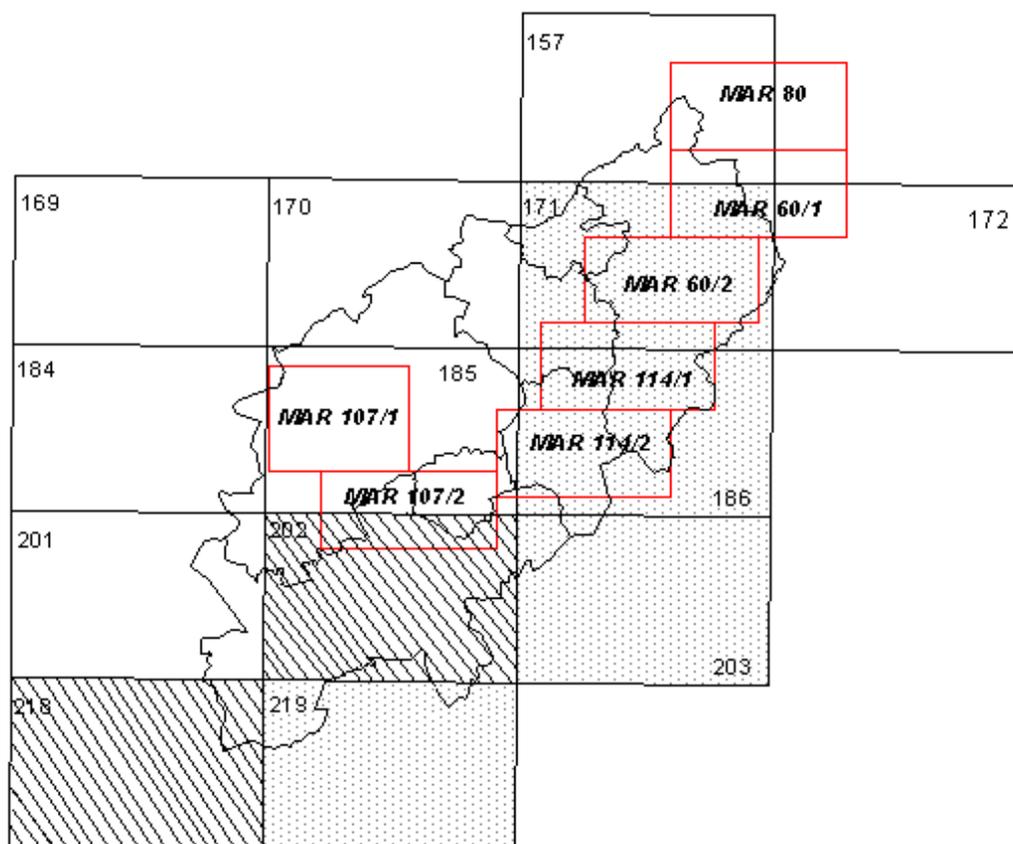
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Key:

157	1:50 000 map published
202	1: 63 360 map published
203	Modern geological map not available
MAR 107/1	1:25 000 Industrial Mineral Assessment Report

For details of digital availability of map sheets, see [www.british-geological-survey.co.uk](http://www.british-geological-survey.co.uk)

**Figure 4. Availability of British Geological Survey 1:50 000 or 1:63 360 scale New Series geological map coverage of Northamptonshire**

## **ACKNOWLEDGEMENTS**

This trial study has greatly benefited from the co-operation of many organisations and individuals who provided information and advice, and their assistance is gratefully acknowledged. Particular thanks are due to Dr Brian Marker the Contract Manager at the Department of the Environment Transport and the Regions, Northamptonshire County Council, English Heritage and English Nature.

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**APPENDIX 1 MINERAL WORKINGS IN NORTHAMPTONSHIRE (2000)**

<b>Name</b>	<b>Location</b>	<b>Commodity</b>	<b>Operator</b>
Nassington	Peterborough	Fireclay	Vesuvius UK
Collyweston	Stamford	Limestone	Bullimores Sand & Gravel Ltd
Corby, Cowthick & Weldon	Corby	Limestone	Lafarge Redland Aggregates
Harlestone	Northampton	Limestone	Barton Plant
Pury End	Paulerspury	Limestone	D A Bird Ltd
Earls Barton	Northampton	Sand & Gravel	Hanson Aggregates - Central
Irthlingborough, Higham Ferrers	Irthlingborough	Sand & Gravel	Hanson Aggregates - Central
Hill Farm	Bugbrooke	Sand & Gravel	Hanson Aggregates - Central
Passenham	Deanshanger	Sand & Gravel	RMC Aggregates (Eastern Counties) Ltd
Stanwick	Irthlingborough	Sand & Gravel	Hanson Aggregates - Central
Wollaston	Wellingborough	Sand & Gravel	RMC Aggregates (Eastern Counties) Ltd

**APPENDIX 2 CONTACT ADDRESSES FOR FURTHER ENQUIRIES**

<p>Northamptonshire County Council County Hall Guildhall Road Northampton NN1 1DN Tel: (01604) 236056 Fax (01604) 236065</p>	<p>Corby Borough Council Deene House New Post Office Square Corby Northamptonshire NN17 1GD Tel: (01536) 402551 Fax: (01536) 464076</p>
<p>Daventry District Council Lodge Road Daventry Northamptonshire NN11 5AF Tel: (01327) 871100 Fax (01327) 300011</p>	<p>East Northamptonshire Council East Northamptonshire House Cedar Drive Thrapston Northamptonshire NN14 4LZ Tel (01832) 742000 Fax (01832) 734859</p>
<p>Kettering Borough Council Municipal Offices Bowling Green Road Kettering Northamptonshire NN15 7QX Tel: (01536) 534316 Fax (01536) 410795</p>	<p>Northampton Borough Council Cliftonville House Bedford Road Northampton Northamptonshire NN4 0RN Tel: (01604) 233500 Fax (01604) 238795</p>
<p>South Northamptonshire Council Springfields Towcester Northamptonshire NN12 6AE Tel: (01327) 322322 Fax (01327) 322074</p>	<p>Borough Council of Wellingborough Council Offices Tithe Barn Road Wellingborough Northamptonshire NN8 1BN Tel: (01933) 231920 Fax (01933) 231982</p>
<p>Countryside Agency 18 Market Place Bingham Nottingham NG13 8AP Tel: 01949 876200 Fax: 01949 876222</p>	<p>English Nature Northminster House Northminster Peterborough PE1 1UA Tel: 01733 455000 Fax: 01733 455103</p>
<p>English Heritage Fortress House Savile Row London SW1X 1AB Tel: 0207 973 3000 Fax: 0207 973 3001</p>	<p>Environment Agency Regional Office Kingfisher House Goldhay Way Orton Goldhay Peterborough PE2 5ZR Tel: 01733 371811 Fax: 01733 231840.</p>

### APPENDIX 3: METHODOLOGY

The British Geological Survey (BGS) was commissioned in 1993 by the Department of the Environment to prepare, on a trial basis, a set of concise statements mainly in map form, to show the broad distribution of mineral resources in selected counties and to relate these to selected, nationally-designated planning constraints. The trial study developed a methodology for the collection and display of data in a consistent and comparable format for four Mineral Planning Authority (MPA) areas - Bedfordshire, Derbyshire, Staffordshire and the Peak District National Park. The concept developed by the BGS for the trial study is now being extended to some twenty mineral planning authorities in England and Wales through a further phase of the project which started in 1996.

The main element of the trial study was the production of maps, with accompanying interpretative reports, for each MPA area. All mineral resource and planning constraint information has been collated digitally on a PC-based system using Intergraph Microstation to produce a cartographic database. Data has been captured as a series of files, structured on separate levels so that they can be viewed either independently or in various combinations, as required. Most of the information has been taken digitally from hard copy maps, mainly with scales between 1:50 000 and 1:10 000. Other material was obtained in a variety of digital formats which have had to be converted for use by the Intergraph Microstation System. The structure of the information will allow the data to be transferred in digital form to the BGS MINGOL (MINerals GIS On-Line) system. MINGOL is being developed to provide a decision-support system for the rapid solution of minerals-related problems to aid corporate and public mineral resource management. It applies a state-of-the art GIS to relate the nature and distribution of mineral resources to other information such as planning and environmental constraints, and mineral exploration, borehole and commodity statistics datasets.

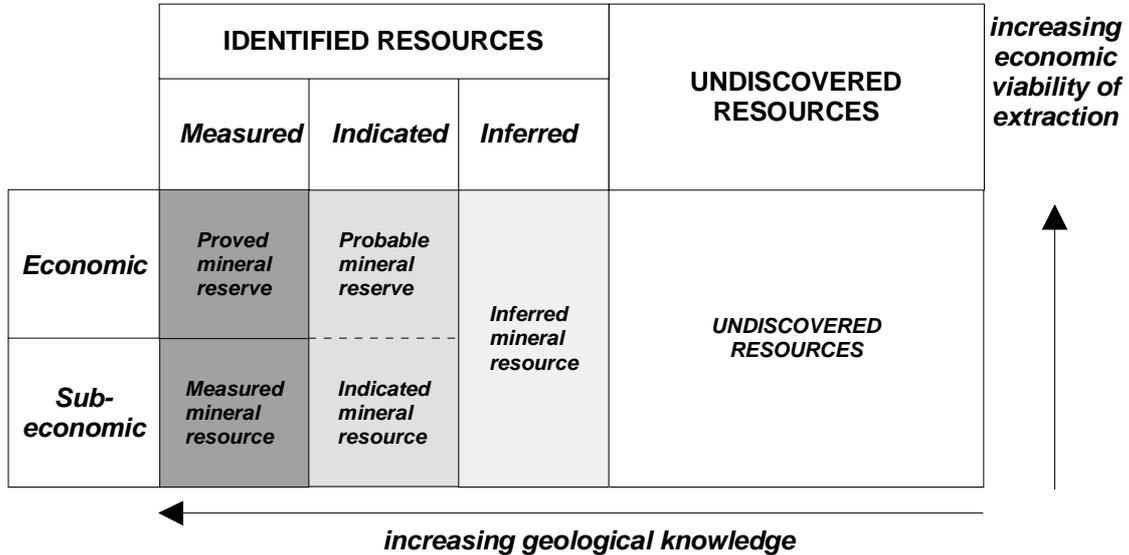
As the data are held digitally, map output can be on any scale but 1:100 000 has been found to be a convenient size to summarise the information for individual MPAs. This provides a legible topographic base which enables both the broad implications of the information, and sufficiently accurate detail, to be shown. The particular advantage of holding all the information in digital form is that it is comparatively easy to update and revise as additional information becomes available, and also provides scope for producing customised maps of selected information or areas on request.

#### Classification of reserves and resources

The diagram, Figure 1, is a representation of a conventional method for classifying mineral reserves and resources, based on a system introduced the US Bureau of Mines and the US Geological Survey and adapted by the British Geological Survey. In this conceptual diagram the vertical dimension of the diagram represents the economic viability of the resource and consists simply of two categories, **economic** and **sub-economic**, depending on whether or not it is commercially viable under prevailing economic circumstances. As demand, mineral prices and costs of extraction may change with time, so mineral resources may become reserves and vice versa.

The horizontal dimension represents degrees of geological knowledge about the resource, from mere speculation about its existence (right-hand side) to thorough assessment and sampling on a systematic basis (left-hand side).

**Figure 1 Classification of resources**



*Based on McKelvey, 1972*

In the present study the mineral resource information has been produced by the collation and interpretation of data principally held by the British Geological Survey. Since the mineral resource data presented are not comprehensive and the quality is variable, the boundaries shown are approximate. Most of the mineral resource information presented is, therefore, in the **inferred resource** category (Figure 1), that is to say, those resources that can be defined from available geological information and which may have some economic potential. They have neither been evaluated by drilling, or other sampling methods, nor had their technical properties characterised on any systematic basis. Inferred resources may be converted into indicated and measured resources with increasing degrees of investigation and assessment. However, where mineral resource studies (including drilling and testing) have been carried out, sufficient information is available to define the resource at the **indicated** level. Sand and gravel assessment studies have been carried out in parts of Northamptonshire.

A mineral resource is not confirmed as economic until it is proved by a relatively expensive evaluation programme. This usually involves a detailed measurement of the material available for extraction together with an evaluation of the quality of the material, its market suitability, the revenues generated by its sale and, ultimately, the viability of the deposit. This activity is an essential precursor to submitting a planning application for mineral extraction. That part of a resource that is both ‘measured’ and ‘economic’, i.e. that has been fully evaluated and is commercially viable to work, is called a **reserve** or **mineral reserve**. It is customary to distinguish **proved** and **probable reserves**, which correspond to the economic parts of measured and indicated resources respectively (Figure 1).

In the context of land-use planning, however, the term **reserve** should strictly be further limited to those minerals for which a valid planning permission for extraction exists, i.e. **permitted reserves**. The extent of mineral planning permissions (other than coal) is shown on the Mineral Resources Map. These cover both active mineral workings and inactive mineral workings. Some mineral planning permissions may have been worked-out and some may have remained unworked, others may have become uneconomic prior to being worked out. In many cases the areas involved are likely to have been worked to some extent in the past, and may now be restored. In addition, parts of the resource areas may have been fully evaluated by the minerals industry, but either have not been subject to a planning application or have been refused permission for extraction. These areas are not depicted on the map.

A **landbank** is a stock of planning permissions and is commonly quoted for aggregates. It is composed of the sum of all **permitted reserves** at active and inactive sites at a given point of time, and for a given area, with the following provisos:

- it includes the estimated quantity of reserves with valid planning permission at dormant or currently non-working sites;
- it includes all reserves with valid planning permission irrespective of the size of the reserves and production capacity of particular sites;
- it does not include estimated quantities of material allocated in development plans but not having the benefit of planning permission; and
- it does not include any estimate for the contribution that could be made by marine dredged, imported or secondary materials.

**It is important to recognise, however, that some of the permitted reserves contained within landbanks have not been fully evaluated with the degree of precision normally associated with the strict use of the term reserves, indeed some may not have been evaluated at all.**

### **Mineral workings and planning permissions**

The locations and names of mineral workings in Northamptonshire are shown on the map. The information is derived from the British Geological Survey's Mines and Quarries Database, updated as appropriate from mineral planning authority records. Letters (e.g. **Sg** = sand and gravel) are used to show the main mineral commodity produced.

The extent of the planning permissions shown on the Mineral Resources Map cover active mineral workings, former mineral workings and, occasionally, unworked deposits. The present physical and legal status of the planning permissions is not qualified on the map. The areas shown may, therefore, include inactive sites, where the permission has expired due to the terms of the permission, i.e. a time limit, and inactive (dormant) sites where the permission still exists. Sites which have been restored are not separately identified. However, information on the planning and operational status of each planning permission may be available in the database which underpins the map. Under the provisions of the 1995 Environment Act, after 1 November 1997, sites that are classified as dormant may no longer be worked until

full modern planning conditions have been approved by the Mineral Planning Authority. A 'dormant site' is defined as a site where no mineral development has taken place to any substantial extent in the period 23 February 1982 and ending 6 June 1995. Information on the precise status and extent of individual planning permissions should be sought from Northamptonshire County Council.

Most planning permissions appear on a mapped mineral resource area and thus the underlying resource colour identifies the mineral type. Planning permissions may fall outside resource areas for the following reasons:

- permissions shown partly off resource areas may extend to ownership, or other easily defined boundaries, or to include ground for ancillary facilities such as processing plants, roads and overburden tipping
- isolated workings occurring outside defined resource areas may reflect very local or specific situations not applicable to the full extent of the underlying rock type:

The latest data available for the total areas of planning permissions in Northamptonshire, collected for the Department of Environment Minerals Survey of 1994, is shown in Table 1. This information is updated at intervals.

<b>Commodity</b>	<b>Total permitted</b>	<b>No. of sites</b>	<b>%</b>
<b>Surface workings</b>			
Clay/shale	3	1	0.05
Ironstone	5244	32	86.84
Limestone/dolomite	220	9	3.64
Sand & gravel	467	13	7.73
Sand (industrial/silica)	26	3	0.43
Sandstone	7	1	0.12
Other minerals	72	3	1.19
<b>Total</b>	<b>6039</b>	<b>62</b>	<b>100</b>

**Table 1. Areas of planning permissions for mineral workings in Northamptonshire (as at 1.4.94)**

Source: *Department of the Environment. 1996. Survey of Land for Mineral Workings in England 1994.*