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Mineral Resource Information in Support of National, Regional and Local Planning

Surrey (comprising Surrey and the London Boroughs of Croydon, Hounslow, Kingston upon Thames, Richmond upon Thames and Sutton)

Commissioned Report CR/03/073N

BRITISH GEOLOGICAL SURVEY

COMMISSIONED REPORT CR/03/073N

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A J Bloodworth, D G Cameron, N A Spencer, E L Bartlett, S F Hobbs, D J Evans, G K Lott and D E Highley

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Front cover

Quarry face in Folkestone Formation sands being worked for aggregate at Runfold near Farnham.

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Contents

1 Introduction

This report is one of a series prepared by the British Geological Survey for various administrative areas in England for the Office of the Deputy Prime Minister's research project *Mineral Resource Information in Support of National, Regional and Local Planning.*

The accompanying map relates to the county of Surrey, together with the London Boroughs of Croydon, Hounslow, Kingston upon Thames, Richmond upon Thames and Sutton, and delineates the mineral resources of current, or potential, economic interest in the area and the sites where minerals are or have been worked. It also relates these to national planning designations, which may represent constraints on the extraction of minerals.

Three major elements of information are presented:

- the geological distribution and importance of mineral resources
- the extent of mineral planning permissions and the location of current mineral workings, and
- the extent of selected, nationally-designated planning constraints.

This wide range of information, much of which is scattered and not always available in a consistent and convenient form, is presented on a digitally-generated summary map on the scale of 1:100 000. This scale is convenient for the overall display of the data and allows for a legible topographic base on which to depict the information. However, all the data are held digitally at larger scales using a Geographical Information System (GIS), which allows easy revision, updating and customisation of the information together with its possible integration with other datasets. The information will form part of a *Summary of the Mineral Resources of South East England Region*.

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. It provides 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.

It is anticipated that the map 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.

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 more sustainable pattern and standard of development to be achieved by valuing mineral resources as national assets.

The mineral resources covered are sand and gravel, silica sand, limestone and chalk, building stone, brick clay, fuller's earth and hydrocarbons.

1.1 RESOURCES AND RESERVES

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 that make them suitable for specific uses and be

present in sufficient quantity to be of intrinsic economic interest. Areas that are of potential economic interest as sources of minerals change with time as new uses are developed, product specifications change, recovery technology is improved or more competitive sources become available.

That part of a mineral resource, which has been fully evaluated and is commercially viable, to work is called a mineral reserve. In the context of land-use planning, 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 reserves is to be either physically worked out or to be made non-viable by changing economic circumstances.

Mineral resources defined on the map delineate areas within which potentially workable mineral may occur. These areas are not of uniform potential and also take no account of planning constraints that may limit their working. The economic potential of individual 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. Extensive areas are shown as having no mineral resource potential, but some isolated mineral workings may occur in these areas. The presence of these operations generally reflects local or specific situations.

1.2 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:

- Surrey Hills and High Weald Area of Outstanding Natural Beauty (AONB)
- National nature conservation designations – National Nature Reserves (NNR) and Sites of Special Scientific Interest (SSSI)
- International nature designations – Special Areas of Conservation (SAC), Special Protection Areas (SPA) and Ramsar sites
- Scheduled Monuments

Mineral development may also be constrained by many other factors not shown on the maps, including local landscape designations, considerations relating to the protection of other resources, such as groundwater, 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.

2 Sand and gravel

Sand and gravel are defined on the basis of particle size rather than composition. In current usage, the term ‘gravel’ is used for material that is coarser than 5 mm, with a maximum size of 40 mm, and the term sand for the material that is finer, but coarser than 0.075 mm. Most sand and gravel is composed of particles that are rich is silica (quartz, quartzite and flint), but other rock types may occur locally.

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.

Sand and gravel resources occur in a variety of geological environments. In Surrey, these resources fall into two categories:

- superficial or 'drift' deposits, comprised predominantly of river sand and gravel;
- bedrock, or ‘solid’ deposits represented by the Cretaceous Folkestone Formation.

2.1 SUPERFICIAL DEPOSITS

Parts of the areas assessed for sand and gravel by BGS resource surveys are identified on the map. Indicated resources shown here are taken from these maps where available. Outside these areas, available data is more limited. Generally, only exposed sand and gravel is defined, although sub-alluvial inferred resources of sand and gravel occurring beneath modern river flood plains may be extensive in some places. Narrow (< 200 m) spreads of sub-alluvial deposits are mainly excluded from the map. Their limited width is likely to preclude economic working of any sand and gravel present.

2.1.1 River terrace deposits

River terrace deposits are the most important source of sand and gravel in the county. Of particular significance are those ‘younger’, flood plain terraces associated with the Thames and its tributaries. These occur in extensive spreads in the northern part of the county, along the western edges of the London conurbation.

In the north of the county, the extensive ‘younger’ terraces of the Thames, and those of the northward flowing tributaries (the Mole and the Wey) were laid down following the Anglian glaciation. Prior to this glaciation, the River Thames followed a course much further to the north. In this area, these deposits are subdivided into five separate terraces consisting of Boyn Hill (oldest and highest), Lynch Hill, Taplow, Kempton Park and Shepperton (youngest and lowest). The latter three are of most economic significance, with extensive past and present working in the area bounded by Byfleet, Staines, Hounslow and Esher. There is considerable pressure on these resources as a result of high levels of demand for sand and gravel from nearby urban areas, as well as from sterilisation by other forms of land use. The younger post-diversionary Thames terraces contain a significantly higher proportion of flint (85-95 per cent) compared to older, pre-diversionary deposits. In the Hounslow area, maximum thickness of the Taplow Gravel is 6.25 m, whilst the Kempton Park Gravel is up to 8 m thick.

Other important tracts of younger terrace occur further west in the valley of the Blackwater, with extensive working between Fareham and Camberley. Higher level ‘older’ terrace also occurs in this area, although this material is not worked.

2.1.2 Sub-alluvial gravel

Sub-alluvial gravels are encountered beneath the alluvium of the major valleys throughout the county and are compositionally similar to the river terraces deposits. The deposits rest on an irregular channelled surface and are thus of very variable thickness. These deposits are generally saturated and require wet working.

2.2 BEDROCK SANDS

2.2.1 Folkestone Formation

The Cretaceous Folkestone Formation forms an east-west trending outcrop across the southern part of the county. It is extensively worked in the Reigate area, where material unsuitable for use as silica sand (see below) is sold for use as construction sand. The Folkestone Formation is also extensively worked for construction sand in the area between Guildford and Fareham.

3 Silica sand

Silica (industrial) sand is marketed for a wide range of industrial uses rather than for direct application in the construction industry. Silica sand is an essential raw material for a number of industries, including glassmaking and foundry casting, as well as a wide range of other products, such as ceramics, chemicals and water filtration. Deposits occur only in limited areas and the special characteristics of silica sand extraction and, in particular the cost of processing, means that the industry is locationally restricted. Surrey is one of the few counties in England in which high-quality silica sand is produced.

Unlike construction sands, which are used for their physical properties alone, silica sands are valued for a combination of physical and chemical properties on which their industrial applications are based. These include high silica content in the form of quartz, an absence of deleterious impurities, particularly clay, iron oxides and chromite, and typically a narrow grain-size distribution (generally in the range 0.5 to 0.1 mm). For most applications silica sands have to conform to very closely defined specifications, specific uses demanding different combinations of properties. Different grades of silica sand are thus usually not interchangeable in use. Depending on end use, processing is of silica sand varies in degree of complexity but often requires a high capital investment in plant. The ease with which impurities, such as iron-bearing impurities and clay, together with the level of losses incurred in removing oversize and undersize fractions from a sand, has a major bearing on its possible use as silica sand. Silica sand commands a higher price than construction sand, which allows it to serve a wider geographical market.

The Folkestone Formation of Surrey, which forms the uppermost division of the Lower Greensand, has been an important source of silica sand since before the Second World War. The formation consists of weakly consolidated, clean and well-sorted sands which locally, as between Buckland and Godstone, have relatively low iron contents making them suitable for the production of the highest grades of silica sand. These include colourless glass sand and foundry sand. The sands are also unusual in having low (<0.1 per cent) alumina contents, making them one of the few viable sources of silica sand suitable for the manufacture of sodium silicates. Resources of silica sand are difficult to define without a detailed evaluation of their properties and, most importantly, the ease with which they can be processed to an acceptable quality. Currently the sands at Buckland and to the east of Redhill are processed by froth flotation to remove heavy minerals and acid leaching to remove iron oxides coating the individual quartz grains. Development of new processing methods may allow a wider range of sands to be used as silica sand but the Folkestone Formation outcrop between and Buckland and Godstone has been

defined as a silica sand resource. The Folkestone Formation dips gently to the north and silica sand is also worked beneath an overburden of Gault. Sand unsuitable for use as silica sand is sold for construction applications.

4 Chalk

Chalk is a relatively soft, fine-grained, white limestone, consisting mostly of the debris of planktonic algae. In Surrey, it forms the prominent natural feature of the North Downs. Almost the entire outcrop of the chalk is within the Surrey Hills AONB. The Chalk is divided into the Grey Chalk Sub-Group (formerly Lower Chalk), and the White Chalk Sub-Group (formerly Middle and Upper Chalk) and is up to 320m thick in this part of South East England. The White Chalk Sub-Group is the most extensive with the Grey Chalk forming a thin band, on average 50-75m in thickness, along the base of the south-facing scarp.

The Grey Chalk is characterised by relatively high clay content, particularly toward the base, and is classified as 'low purity' (<93% $CaCO_3$). The overlying White Chalk is of a higher purity (93-98% $CaCO_3$). Flints are common in the upper part of the White Chalk Sub-Group.

Although long established, only limited quarrying of chalk now occurs in Surrey. Currently, chalk extraction is carried out at one site working White Chalk near Oxted.

The Chalk is a major aquifer and is the most important source of groundwater in the county.

5 Brick clay

The term 'Brick clay' is used to describe clay used predominantly in the manufacture of bricks and, to a lesser extent, roof tiles and clay pipes. These clays may sometimes be used in cement manufacture, as a source of construction fill and for lining and sealing landfill sites. The suitability of a clay for the manufacture of bricks depends principally on its behaviour during shaping, drying and firing. This will dictate the properties of the fired brick such as strength and frost resistance and, importantly, its architectural appearance.

Most facing bricks, engineering bricks and related clay-based building products are manufactured in large automated factories. These represent a high capital investment and are increasingly dependent therefore on raw materials with predictable and consistent firing characteristics in order to achieve high yields of saleable products. Blending different clays to achieve improved durability and to provide a range of fired colours and textures is an increasingly common feature of the brick industry. Continuity of supply of consistent raw materials is of paramount importance.

The Cretaceous Weald Clay crops out extensively across the south of the county and forms the basis of a regionally-important brick manufacturing industry based in this part of Surrey and the area immediately over the county boundary in West Sussex. The Weald Clay consists of a sequence of mudstones and silty mudstones up to 450 m in thickness. They are often interbedded with sandstones and limestones which brick makers tend to avoid. The clays consist predominantly of kaolinite and illite, a combination which is ideal for the manufacture of facing bricks. Weald Clay is extracted at several sites in the Ockley area south of Dorking for the manufacture of facing bricks.

The Wadhurst Clay has a limited crop in the south-east of the county and is up to 70 m thick. Although this clay is not currently worked in Surrey, it is used for the manufacture of bricks and tiles at nearby sites located in Kent, and in East and West Sussex.

6 Fuller's earth

The term 'fuller's earth' is used to describe clays composed essentially of the clay mineral calcium-smectite, which exhibits a unique combination of properties on which its industrial applications are based. Calcium-smectite can be easily converted into sodium-smectite (bentonite) by a simple sodium-exchange process and most fuller's earth is used in this form in papermaking and foundry bonding applications. Fuller's earth deposits formed as result of the alteration of volcanic ash deposited in seawater. The accumulation and preservation of volcanic ash into thick beds involved a complex set of geological processes and consequently fuller's earth deposits of potential economic interest have a very restricted distribution in Britain.

The fuller's earth deposits in the Redhill – Nutfield area of Surrey are by far the largest in Britain and have been worked for many centuries. The deposits accounted for an estimated 65 per cent of total UK cumulative output of fuller's earth of about 9 million tonnes. However, production ceased in 1998 due to the exhaustion of permitted reserves.

Lenticular beds of fuller's earth have been traced almost continuously between Reigate and Oxted, a distance of some 13 km. However, production has been confined to an area between Redhill in the west and Bletchingley in the east with the bulk of production being between Redhill and Nutfield. Fuller's earth of commercial interest is confined to a distinctive unit of calcareous sandstones at the base of the Sandgate Formation within the Lower Greensand. Individual fuller's earth beds vary considerably in thickness, quality and extent. Between Redhill and Nutfield only the lowest, thickest bed has been worked; it averages 2 to 3 m in thickness with a maximum of 5.5 m. In the Nutfield- Bletchingley area, two fuller's earth beds were formerly worked.

The Sandgate Formation between Redhill and Oxted is shown on the map as the area where fuller's earth resources may occur. As the beds dip northwards resources may also occur beneath the sands of the overlying Folkestone Formation. A significant part of the resource has already been worked out and other sites have been shown on investigation either not to contain fuller's earth in commercial quantities or to have too high a mineral to overburden ratio to be of economic interest. However, in 1985 a planning application to extract a reported one million dry tonnes of fuller's earth at the Waterhouse Farm site, near Bletchingley and 0.59 million dry tonnes at the Jackass Lane site, near Tandridge were submitted. The application was refused in 1989 following a public inquiry. However, these two deposits represent the largest unworked resource of fuller's earth in Britain that are likely to be of commercial interest. Elsewhere in Surrey no fuller's earth of commercial interest has ever been reported.

7 Building stone

Lower Cretaceous rocks have been an important source of building stone in Surrey. Sandstones from the Lower Greensand Group were quarried for local use around Godalming, at Hurtmore (working material known as 'Bargate Stone'), and at Witley and Hurtwood. Ironstone beds within the Lower Greensand (known as 'carstone') were also once a source of local building material in the Oxted area. Today, only a single quarry in the Lower Greensand Group (at Hurtwood near Cranleigh) produces sandstone for building purposes.

Lower Cretaceous limestone (known as Bethersden Marble) was quarried for decorative use at Russ Hill and Charlwood, on the southern boundary of the county near Gatwick.

The most important building stone quarries in the county were formerly those in the Reigate-Gatton-Chaldon area. These produced a distinctive siliceous sandstone from the Upper Greensand Formation. This was also known as the 'Reigate Stone' or 'Firestone' or 'Malmstone'.

The Upper Cretaceous Chalk succession has yielded a small amount of flint for local building. The Palaeogene ('Tertiary') succession in the north of the county produced quartz-cemented 'sarsen' sandstones were locally important.

8 Conventional oil and gas

Surrey and adjacent London Boroughs occupy a large tract of land along the northern flank of the Weald Basin. Table 1 summarises the major oil and gas discoveries in Surrey. These discoveries lie in the southern half of the county along an E-W trend formed by the northern limb of the Weald Anticline. This feature formed during the Alpine (Palaeogene) inversion of the Weald Basin. This area is the focus of current exploration, as illustrated by the presently licensed areas and acreage awards made as recently as the 9th Onshore Licensing Round in 2000 (see inset map). There appears to be very limited oil and gas prospectivity over the NW of the county beneath the Palaeogene rocks of the London Basin.

The number of exploration wells and the existence of a network of seismic reflection surveys of varying vintage illustrates that the county has seen sporadic and often intensive exploration for hydrocarbons. The first hydrocarbon exploration wells drilled in Surrey were the Shalford No.1 (BP) and Collendean Farm No.1 (Esso) wells in 1958 and 1964 respectively. In 1965 BP drilled the Bletchingley No.1 well. It and three subsequent wells encountered gas that flowed from Corallian Limestones at a rate 1.02 million cubic metres per day. Recoverable reserves were estimated at 0.6 billion cubic metres. Further wells were drilled across the county, but it was not until 1983, when Conoco (UK) Ltd drilled the Palmer's Wood wells, that a commercial oil discovery was made. The main reservoir for the oil is the Upper Jurassic Corallian Limestone, with hydrocarbons also encountered in the Corallian Sandstones. Between 1983 and 1987, Conoco (UK) Ltd dominated hydrocarbon exploration in the county, drilling a series of exploration wells that included the Godley Bridge gas discovery. In 1987 they drilled Albury No.1, discovering the Albury Gasfield, where sands and limestones within the Purbeck Group (Upper Jurassic) form the main reservoirs, although gas was encountered at many levels within the Jurassic section. Recoverable gas reserves were estimated at 0.05 billion cubic metres, production of which commenced in 1994. Further significant oil was discovered by Teredo in 1988 in the Brockham No.1 well, located between the Albury Gasfield and the Palmer's Wood Oilfield, and also by Independent Energy Resources Ltd, in the Lingfield No.1 well. These discoveries remain undeveloped.

Table 1 Summary of major oil and gas discoveries in Surrey

Name of borehole	Drilling date	Operator at time	Type of discovery (oil or gas)	Current license area and (main) operator	Recoverable reserves/peak production
Bletchingly	1965	BP	Gas	ML21; Star Energy UK Onshore Ltd (at end 2000)	Subcommercial; flowed 1.02 mcm/d. Recoverable reserves estimated at 0.6 bcm
Godley Bridge	1983	Conoco (UK) Ltd	Gas	EXL291; Independent Energy Resources Ltd.	Production tests, but not developed
Palmer's Wood	1983	Conoco (UK) Ltd	Oilfield	PEDL96-1; Midmar	2,713,200 barrels
Albury	1987	Conoco (UK) Ltd	Gas	DL004, Star Energy UK Onshore Ltd (at end 2000)	0.05/0.0052 bcm
Brockham	1988	Teredo	Oil	PL235, Edinburgh Oil and Gas Ltd (at end 2000)	Production tests, but not developed
Lingfield	1999	Independent Energy Resources Ltd.	Oil & gas	PL055; Independent Energy Resources Ltd.	Production tests, but not developed

There is little or no potential in Surrey for coal bed methane development.

9 Aims and limitations

The purpose of the maps in this series is to show the broad distribution of those mineral resources that may be of current or potential economic interest and to relate these to selected nationally-recognised planning designations. The maps are intended to assist in the consideration and preparation of development plan policies in respect of mineral extraction and the protection of important mineral resources against sterilisation. They bring together a wide range of information, much of which is scattered and not always available in a convenient form.

The maps have been produced by collation and interpretation of mineral resource data principally held by the British Geological Survey. Information on the extent of mineral planning permissions has been obtained from the relevant Mineral Planning Authority (MPA). Some of these permissions may have lapsed or expired. The status of individual areas can be ascertained from the appropriate MPA. Location information on national planning designations has been obtained from the appropriate statutory body (Countryside Agency, English Nature and English Heritage). For further information the relevant body should be contacted.

The mineral resource data presented are based on the best available information, but are not comprehensive and their quality is variable. The inferred boundaries shown are, therefore, approximate. Mineral resources defined on the map delineate areas within which potentially workable minerals may occur. These areas are not of uniform potential and also take no account of planning constraints that 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. Extensive areas are shown as having no mineral resource potential, but some isolated mineral workings may occur in these areas. The presence of these operations generally reflect very local or specific situations.

The maps are intended for general consideration of mineral issues and not as a source of detailed information on specific sites. The maps should not be used to determine individual planning applications or in taking other decisions on the acquisition or use of a particular piece of land, although they may give useful background information which sets a specific proposal within context.

10 Planning permissions for mineral extraction

The extent of all known extant and former planning permissions for mineral working is shown on the map, irrespective of their current planning or operational status. The polygons were digitised from plotting sheets and other documents supplied by Surrey County Council and the London Boroughs of Croydon, Hounslow, Kingston upon Thames, Richmond upon Thames and Sutton. Any queries regarding the sites shown should be directed to these authorities at the addresses shown below. The polygons cover active, former and restored mineral workings and, occasionally, unworked deposits.

Planning Permissions represent areas where a commercial decision to work mineral has been made, a successful application has been dealt with through the provisions of the Town and Country Planning legislation and the permitted reserve will have been depleted to a greater or lesser extent. The current planning status is not qualified on the map but is available in the underlying database.

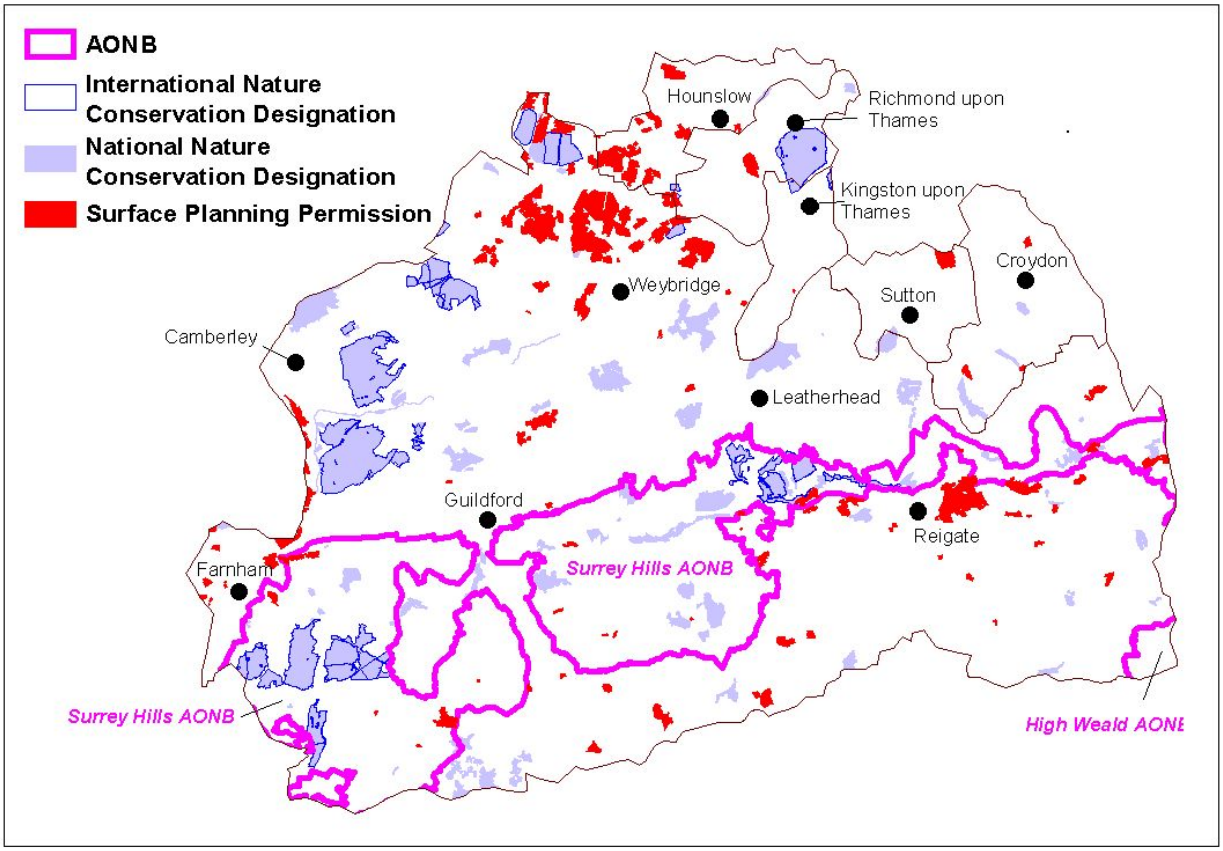

Figure 1 Surface mineral planning permissions and landscape and nature conservation designations in Surrey

Appendix 1

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