British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL
OFFICE OF THE DEPUTY PRIME MINISTER

SURREY

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

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

Mineral Resources

Scale 1:100 000

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This map comprises part of a summary of the 'Mineral Resources of South East England Region'.
For further information see www.mineralsUK.com

BIBLIOGRAPHIC REFERENCE

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SAND & GRAVEL

Superficial deposits

- Sub-alluvial: Inferred resources
- River Terrace deposits
- Boundary of area assessed for sand and gravel at the indicated resource level

Bedrock deposits (sand)

- Construction Sand
- Silica Sand/Construction Sand

(Folkestone Formation: Cretaceous)

FULLER'S EARTH

- Sandgate Formation (Redhill area only) — Cretaceous

CHALK

- High purity chalk (93-98% $CaCO_3$) — White Chalk Subgroup: Upper Cretaceous
- Low purity chalk (< 93% $CaCO_3$) — Grey Chalk Subgroup: Upper Cretaceous

BRICK CLAY

- Weald Clay Formation: Principal brick clay resource
- Wadhurst Clay Formation

(Cretaceous)

MINERAL PLANNING PERMISSIONS (as at 30.06.03)

Source: Mineral Planning Authorities

- Surface planning permission (valid and expired)

MINERAL WORKINGS

- Hengrove Farm — Active site
- *Hollybush* — Inactive (including sites not yet worked), worked-out and/or restored site

Mineral commodity

Sg	Sand & gravel	Istn	Ironstone	SiS	Silica Sand
Cs	Construction Sand	FE	Fuller's Earth	Sst	Sandstone
Ch	Chalk	Cl	Common clay & shale	Oil	Oil
Gas	Gas				

ENVIRONMENTAL DESIGNATIONS (as at 30/04/03)

- National nature conservation designations (SSSIs and NNRs)
- International nature conservation designations (SACs, SPAs and Ramsar sites)
- Area of Outstanding Natural Beauty: Surrey Hills (part) and High Weald (part)
- + Scheduled Monument

ADMINISTRATIVE AREAS

- Region
- Mineral Planning Authority
- District

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Contact address:
English Nature, Northminster House, Northminster, Peterborough, PE1 1UA, Tel: 01733 455000, Fax: 01733 455103, Web page: www.english-nature.org.uk

Positions of Scheduled Monuments at 15th August 2001 as supplied by English Heritage.
The majority of monuments are plotted using a centred NGR symbol. Consequently the actual area and/or length of a monument protected by the legal constraints of scheduling cannot be represented here. Monuments scheduled since that date are not accounted for. © Copyright English Heritage.
Contact address:
English Heritage, 23 Savile Row, London, WS1 2ET, Tel: 020 7973 3132, Web page: www.english-heritage.org.uk

Digital AONB boundaries © Countryside Commission 1986 (now Countryside Agency).
Contact address:
Countryside Agency, John Dower House, Crescent Place, Cheltenham, Gloucestershire, GL50 3RA, Tel: 01242 521381, Fax: 01242 584270, Web page: www.countryside.gov.uk

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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. They have 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 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.

SILICA SAND

Surrey is one of the most important sources of high quality silica sand in Britain, and one of the few sources of colourless glass sand.

Silica (industrial) sands contain a high proportion of silica in the form of quartz and are marketed for purposes other than for direct application in the construction industry. They are essential raw materials for the glass and foundry casting industries, but also have a wide range of other industrial and horticultural uses, including ceramics and chemicals manufacture, and for water filtration. They are produced from both loosely consolidated sand deposits and by crushing weakly cemented sandstones. Unlike construction sands, which are used for their physical properties alone, silica sands are valued for both their chemical and physical properties and it is on a combination of these properties that their industrial applications are based. These include a high silica content in the form of quartz and, more importantly, an absence of deleterious impurities, such as 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. Consequently different grades of silica sand are usually not interchangeable in use.

Depending on the end use of a silica sand, processing is of varying degrees of complexity and often requires a high capital investment in plant. A critical factor in defining a sand or sandstone deposit as a silica sand resource is the ease with which contaminants, such as iron-bearing impurities and clay can be removed, together with the level of losses incurred in removing oversize and undersize fractions to obtain the desired size distribution. Resources of silica sand occur in only limited areas and the special characteristics of silica sand extraction and, in particular, the cost of processing means that the industry has a restricted distribution. Silica sands command a higher price than construction sand, which allows them 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 (<0.035% Fe_2O_3). These include colourless glass sand and foundry sand. In addition, the sands are also unusual in having low (<0.1%) alumina contents, making them one of the few viable sources of silica sand suitable for the manufacture of soluble 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 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 clay. Sand unsuitable for use as silica sand is sold for construction applications.

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 locally, limestones which brick makers tend to avoid. The mudstones 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 very 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.

BUILDING STONE

Rocks of Lower Cretaceous age have been 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 Hythe Formation of the Lower Greensand Group (at Hurtwood near Cranleigh) produces sandstone for building purposes.

A limestone within the Weald Clay (known as 'Bethersden Marble') was formerly 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 has yielded quartz-cemented 'sarsen' sandstones in the past.

CHALK

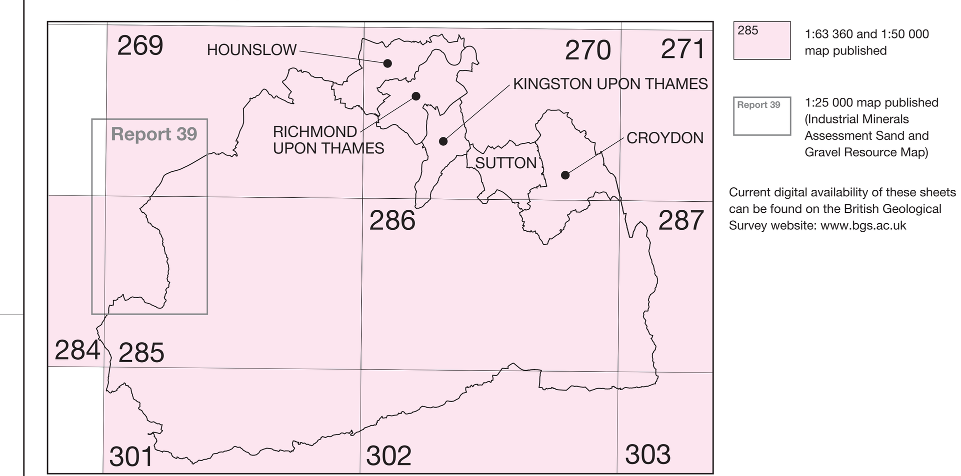
Chalk is a relatively soft, fine-grained, white limestone, consisting mostly of the debris of planktonic algae. In Surrey, it forms the prominent natural feature of the North Downs. Almost the entire outcrop of the chalk is within the Surrey Hills AONB. The Chalk is divided into the Grey Chalk Sub-Group, and the White Chalk Sub-Group and is up to 320 m 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 50-75 m 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.

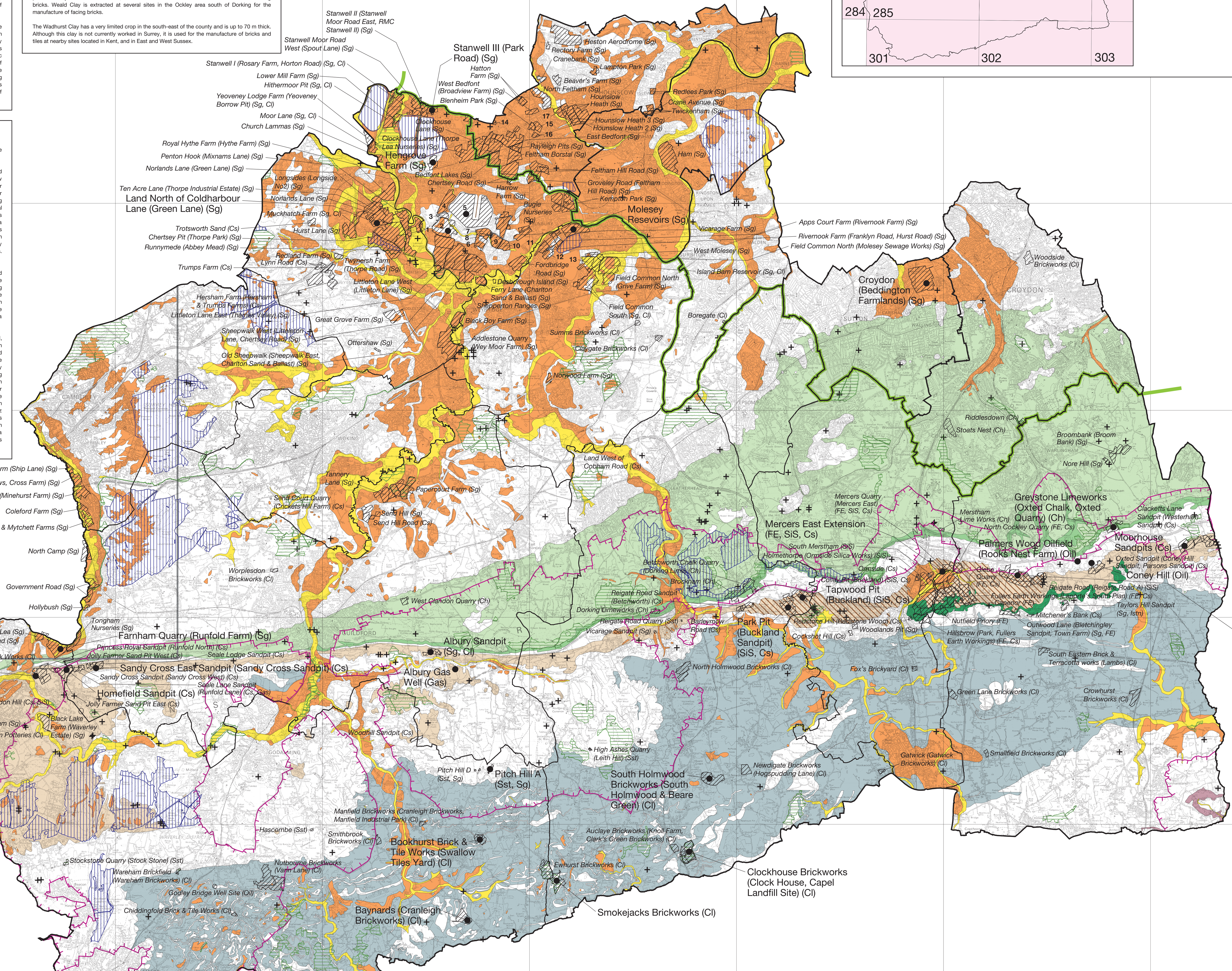
The Chalk is a major aquifer and is the most important source of groundwater in the county.

BGS publications covering Surrey and the London Boroughs of Croydon, Hounslow, Kingston upon Thames, Richmond upon Thames and Sutton



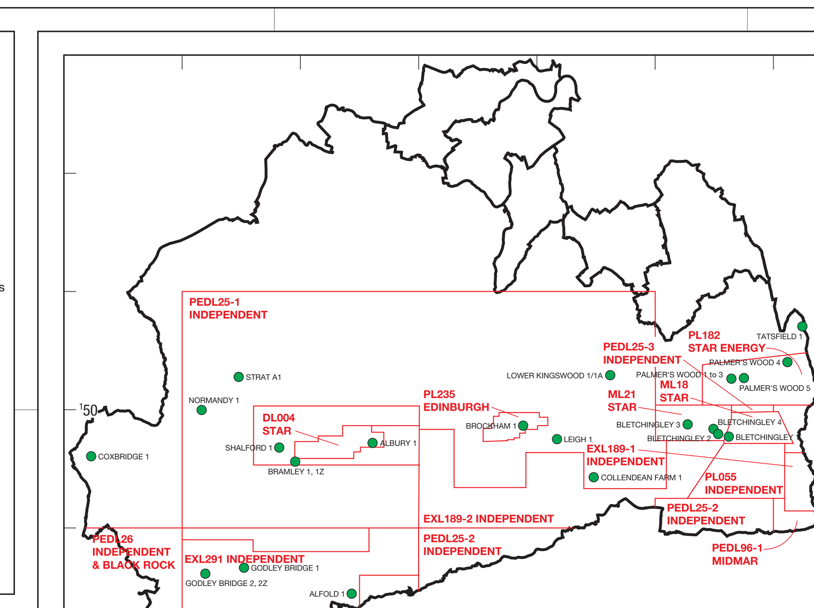
- 285 — 1:63 360 and 1:50 000 map published
- Report 39 — 1:25 000 map published (Industrial Minerals Assessment Sand and Gravel Resource Map)

Current digital availability of these sheets can be found on the British Geological Survey website: www.bgs.ac.uk



KEY TO PLANNING PERMISSION NUMBERS ON MAP

1. *Mixnams Lane (Penton Hook) (Sg)*
2. Home Farm (Laleham Nurseries) (Sg)
3. *Land SW of Queen Mary Reservoir (Sg)*
4. *West of Queen Mary Reservoir (Sg)*
5. Queen Mary Reservoir (Sg)
6. *Staines Road (Staines Road Farm) (Sg)*
7. *Littleton (Sg)*
8. *Nutty Lane (Sg)*
9. *Charlton Lane (Sg)*
10. *Upper Halliford (Sg)*
11. *Sunbury Lane (Rivernook Farm Site) (Sg)*
12. *Rivernook Farm (Franklyn Road, Hurst Road) (Sg)*
13. *Field Common North (Hersham Pit) (Sg)*
14. *Bedfont Close (Sg)*
15. *Feltham Arena (Sg)*
16. *Bedfont Lane (Sg)*
17. *Baber Bridge (Sg)*



- Hydrocarbon Well
- PEDL26 — Petroleum Exploration and Development Licence issued under the Petroleum (Production) Act 1934 (as at March 2002)

HYDROCARBONS

Conventional Oil and Gas

Surrey and adjacent London Boroughs occupy a large tract of land along the northern flank of the Weald Basin. The table 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 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.

Name of Borehole	Drilling Date	Operator at time	Type of discovery (oil or gas)	Current license area and (main) operator	Recoverable reserves/ peak production
Bletchingley	1965	BP	Gas	ML21; Star Energy UK Onshore Ltd (at end 2000)	Subcommercial; flowed 1.02 mcm/d. Recoverable reserves estimated as 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	Oil	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

Coal Bed Methane (CBM) potential

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

Licencing

The Department of Trade and Industry grants licences for exclusive rights to explore and exploit oil and gas onshore within Great Britain. The rights granted by landward licences do not include any rights of access, and the licensees must also obtain any consent under current legislation, including planning permissions. Licensees wishing to enter or drill through coal seams for coalbed methane and abandoned mine methane must also seek the permission of the Coal Authority.

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 by BGS 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 and also digital data supplied by Hounslow and 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.

Contact addresses:

Surrey County Council, Environment Department, County Hall, Penrhyn Road, Kingston upon Thames, KT1 2DT, Tel: 0208 541 8800, Fax: 0208 541 9399, web address: www.surreycc.gov.uk

Croydon London Borough, Department of Planning & Development, Taberner House, Park Lane, Croydon, CR9 1JT, Tel: 0208 686 4433, Fax: 0208 760 5408, web address: www.croydon.gov.uk.

Hounslow London Borough, Environmental Services Department, Civic Centre, Lampton Road, Hounslow, TW3 4DN, Tel: 0208 583 2000, web address: www.hounslow.gov.uk.

Royal Borough of Kingston upon Thames, Environmental Services, Guildhall 2, Kingston upon Thames, KT1 1EU, Tel: 0208 546 2121, Fax: 0208 547 6363, web address: www.kingston.gov.uk.

Richmond London Borough, Department of Planning and Building Control, Civic Centre, 44 York Street, Twickenham, TW1 3BZ, Tel: 0181 891 1141, Fax: 0181 891 7702, web address: www.richmond.gov.uk.

Sutton London Borough, Environment Services Department, 24 Denmark Road, Carshalton, SM5 2JG, Tel: 0208 770 5000, Fax: 0208 770 6298, web address: www.sutton.gov.uk

Aims and Limitations

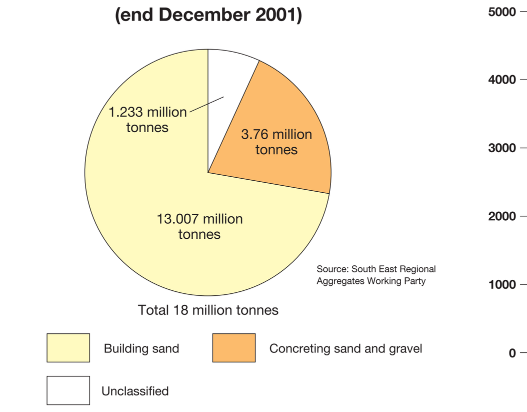
The purpose of the maps in this series is to show the broad distribution of those mineral resources which may be of current or potential economic interest and to relate these to selected nationally-recognised planning designations. The maps are intended to assist in the consideration and preparation 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.

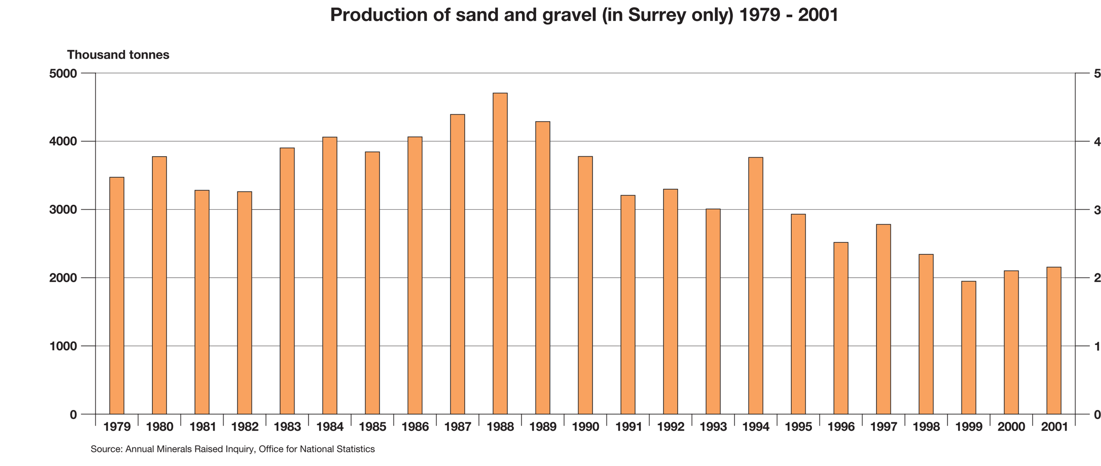
The mineral resource data presented are based on the best available information, but are not comprehensive and their quality is variable. The inferred boundaries shown are, therefore, approximate. Mineral resources defined on the map delineate areas within which potentially workable minerals may occur. 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.

Permitted Reserves of Sand and Gravel (end December 2001)



Production of sand and gravel (in Surrey only) 1979 - 2001



SAND & 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 in 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 Folkestone Formation.

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.

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.

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.

Bedrock deposits (sand)

Folkestone Formation

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