Historic England

Suffolk

Building Stones of England

The Building Stones of England

England's rich architectural heritage owes much to the great variety of stones used in buildings and other structures. The building stones commonly reflect the local geology, imparting local distinctiveness to historic towns, villages and rural landscapes.

Historic England and the British Geological Survey (BGS), working with local geologists and historic buildings experts, have compiled the Building Stones Database for England to identify important building stones, where they came from and potential alternative sources for repairs and new construction.

Drawing on this research, plus BGS publications and fieldwork, guides like this one have been produced for each English county. The guides are aimed at mineral planners, building conservation advisers, architects and surveyors, and those assessing townscapes and countryside character. The guides will also be of interest if you want to find out more about local buildings, natural history, and landscapes.

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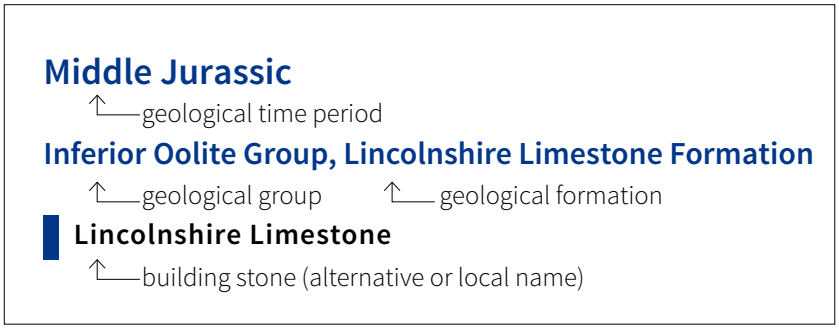
Front cover: Butley Priory gatehouse, Butley. Flint flushwork. © geogphotos / Alamy Stock Photo.

How to Use this Guide

Each guide describes the local building stones in their geological timescale order, starting with the oldest layers through to the youngest. The guide ends with examples of other notable building stones from other parts of England and further afield.

Geological time periods, groups, formations and building stones

Each building stone is listed under the relevant geological timescale, group and formation. A formation may be divided into members and where relevant these are referenced in individual building stone sections.



Bedrock geology map and stratigraphic table

To help you with the geology of the area, there is a bedrock geology map and a stratigraphic table which shows the layers of rocks and the associated building stones in this geological timescale, group, formation order.

Page numbers for each building stone are included in the stratigraphic table for ease of reference. The page numbers are inverted to correspond with the geological age order.

Contents list

If you click on the page number for a building stone in the Contents list, you will go straight to the relevant section in the guide.

Building stone sources and building examples

A companion spreadsheet to this guide provides:

- More examples of buildings. Information is included on building type, date, architectural style, building stone source, and listed/ scheduled status
- A list of known (active and ceased) building stone sources such as quarries, mines, pits and delphs
- Additional information on building stones including lithology, grain size, sedimentary structures, key identification features, and notes on failure/weathering, and use.

The Building Stone GIS map allows you to search the Building Stones Database for England for:

- A building stone type in an area
- Details on individual mapped buildings or stone sources
- Potential sources of building stone sources within a given proximity of a stone building or area
- Buildings or stone sources in individual mineral planning authority area.

Further Reading, Online Resources and Contacts

The guide includes geological and building stone references for the area. A separate guide is provided on general Further Reading, Online Resources and Contacts.

Glossary

The guides include many geological terms. A separate Glossary explaining these terms is provided to be used alongside the guides.

The guides use the BGS lexicon of named rock units.

Mineral and local planning authorities

This guide covers the Suffolk County Council mineral planning authority area, and the five local planning authority areas of Ipswich, East Suffolk, Mid Suffolk, Babergh and West Suffolk.

Contents

1 Introduction

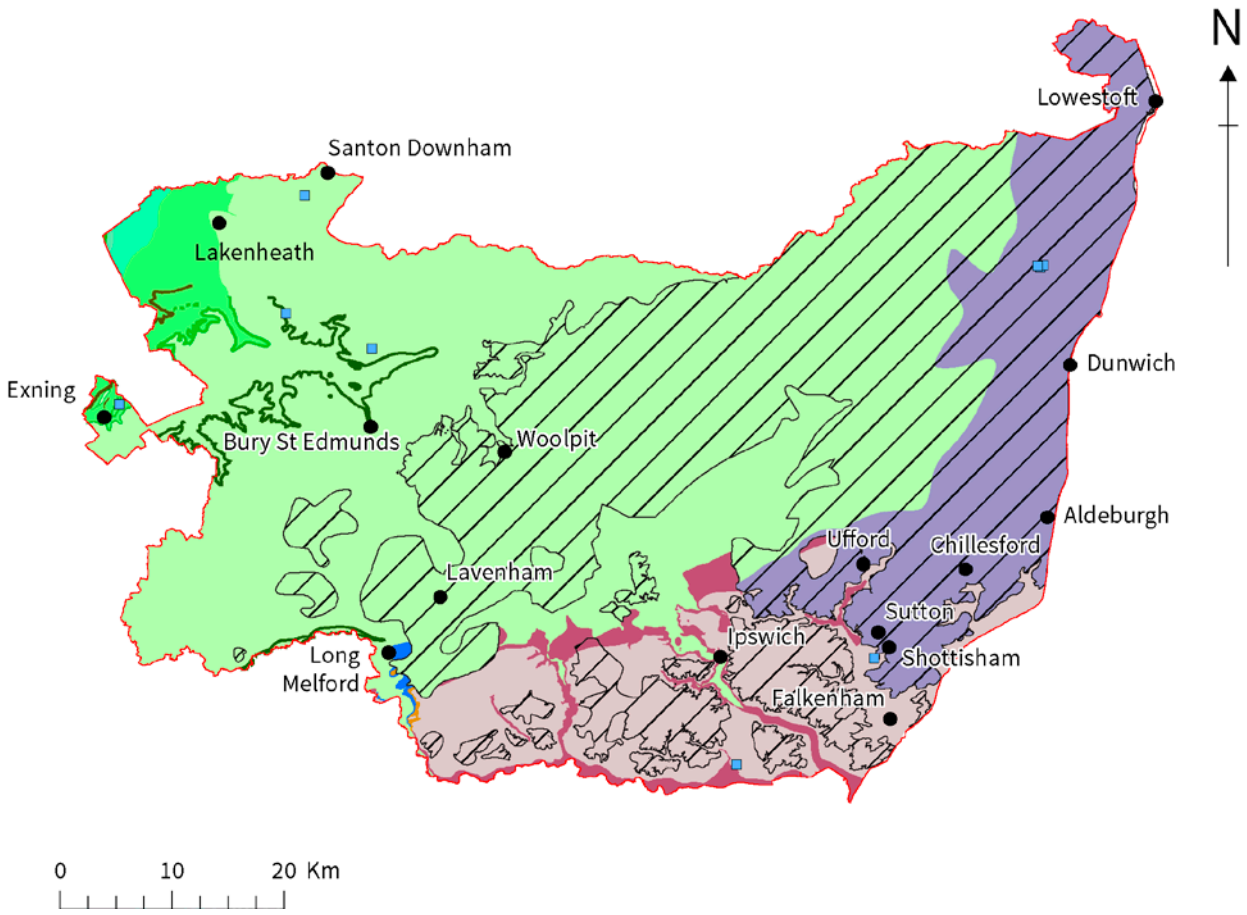
The geology of Suffolk comprises sedimentary strata laid down during the Cretaceous, Tertiary and Quaternary periods. The succession becomes younger as you travel south-eastwards across the county.

The oldest exposed strata, which are represented by mudstones of Late Jurassic period, occur in a very small area north-west of Lakenheath. Overlying these is a Lower Cretaceous sequence, which comprises the Lower Greensand and Selborne Groups. The former includes the Woburn Sands Formation, which itself includes cemented, yellow-brown-coloured, ferruginous sands (carstone). The bedrock geology of most of northern, western and central Suffolk comprises the Upper Cretaceous Grey and White Chalk Subgroups. Tertiary strata (including the Thames Group) are present in southern and eastern Suffolk, and are locally exposed.

From Bury St Edmunds and Sudbury eastwards, the chalk is overlain by an extensive series of relatively soft shelly sandstones, sands and gravels, and clays that represent the Crag Group. The sands are typically dark green (from glauconite) when fresh, but quickly weather bright orange. Much of the geology of central and eastern Suffolk (including the coastal belt from Lowestoft to Felixstowe) is obscured by a veneer of Quaternary-aged glacial deposits (till) and various river and coastal sands, silts and gravels. Recent research has demonstrated that some Crag deposits occur interbedded with these younger sediments. Consequently, the Crag Group is now also considered to be part of the Superficial Deposits.

Cretaceous and Tertiary rocks in Suffolk have provided a limited range of building stones for local use. However, the succession contains no freestones. Consequently, large volumes of Middle Jurassic Lincolnshire Limestone, and some Caen Stone from Normandy, were imported into the county from medieval times onwards. Upper Cretaceous strata in Suffolk yielded both chalk and flint for building purposes, the latter being the most common type of building stone seen in the county. Tertiary and younger successions provided septaria and occasional Crag limestones, such as the Bryozoan Rock Bed, and ironstones for local building. Pebbles of flint and more exotic lithologies, derived from glacial till and ships ballast, have also been used for building purposes. No building stone quarries are currently operating in the county.

Bedrock Geology Map



Key

Building stone sources

Bedrock geology

Extent of Crag Group Cover

Tertiary Strata (projected where overlain by Crag Group)

Thames Group (including London Clay Formation) — clay, silt, sands and cementstones

Lambeth Group — clay, silt and sand

Thanet Formation and Lambeth Group (undifferentiated) — clay, silt, and sand

Thanet Formation — sand

White Chalk Subgroup — chalk

Chalk Rock Member — chalk

Melbourn Rock Member — chalk and limestone

Grey Chalk Subgroup — chalk

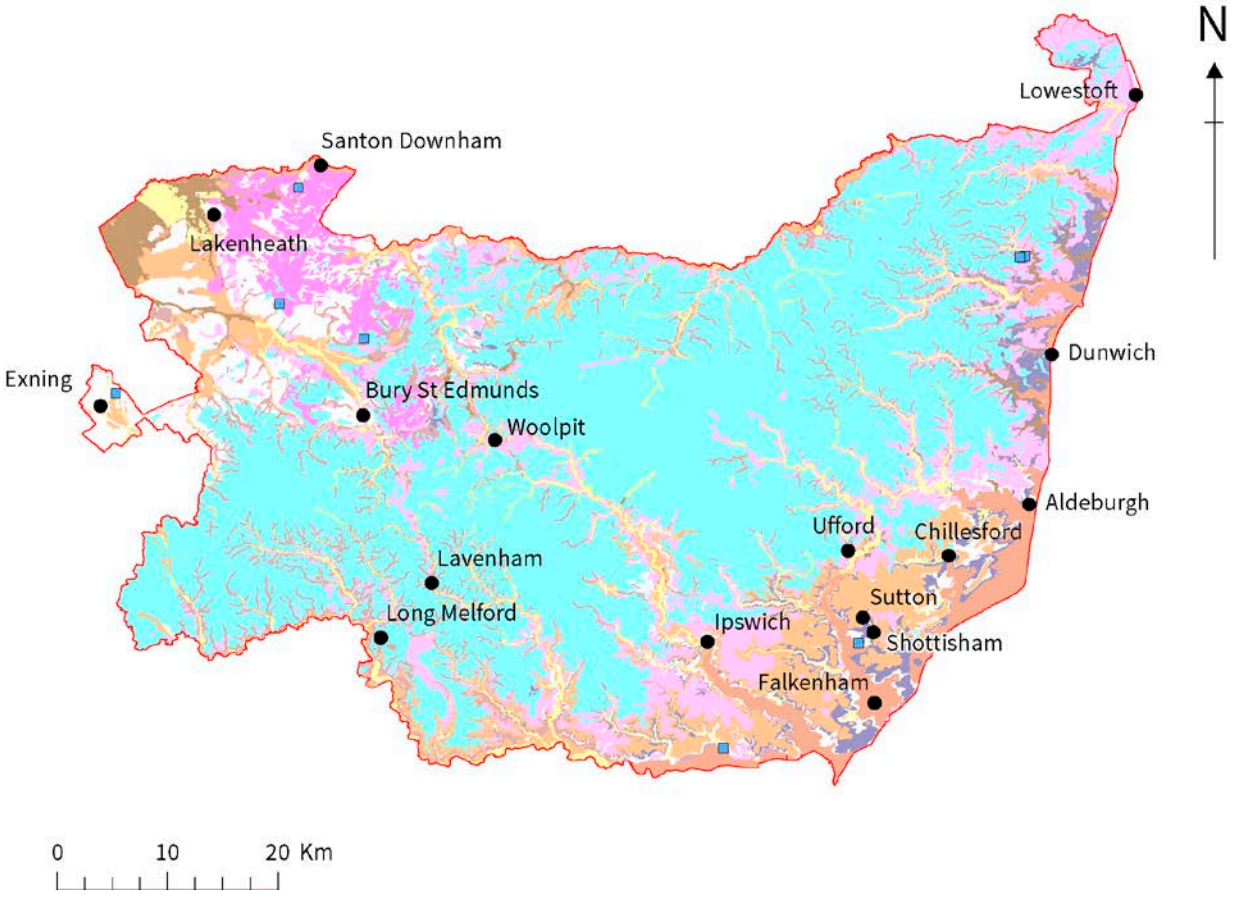
Totternhoe Stone Member — chalk and limestone

Gault Formation — mudstone

Woburn Sands Formation — sandstone

Ancholme Group — mudstone

Superficial Geology Map



Key

Building stone sources

Superficial geology

- Tufa — limestone
- Alluvium and lacustrine deposits — clay, silt, sands and gravels
- Coastal Deposits — sands, gravels, silt, clay and peat
- River Terraces — sands, gravel, silts and clay
- Aeolian Deposits — sands
- Head — sands, gravels, silt and clay
- Glaciofluvial and glaciolacustrine deposits — sands, gravels, silts and clay
- Glacial tills — clays, sands, gravels and boulders
- Peat — peat
- Crag Group — sands, gravels, silts and clays

Stratigraphic Table

Geological timescale	Group		Formation	Building stone	Page
Quaternary	Great Britain Superficial Deposits Supergroup	various	various	Chert and quartzite pebbles and cobbles Quaternary Flint (Fluvio-glacial Flint, Field Flint, Beach Flint) Sarsen Stone	43 41 41
		Crag Group	includes Norwich and Reg Crag, and Coralline Crag formations	Red Crag ironstone Bryozoan Rock Bed (Rock Bed) Boxstones (Boxstone Bed)	40 38 38
Tertiary	Thames Group		includes the London Clay Formation	Septaria (Cementstone)	36
	Lambeth Group		not defined		
	Montrose Group		Thanet Sand Formation		
Upper Cretaceous	Chalk Group	White Chalk Subgroup	Upper Chalk	Chalk (Clunch, White Clunch) Quarry Flint	35 34
			Middle Chalk		
		Grey Chalk Subgroup	Lower Chalk	Totternhoe Stone	32
Lower Cretaceous	Selborne Group	Gault Formation			
	Lower Greensand Group	Woburn Sands Formation		Carstone	31
Upper Jurassic	Ancholme Group	Kimmeridge Clay Formation			

Building stones in geological order from the oldest through to the youngest layers.

2 The Use of Stone in Suffolk Buildings

Background and historical context

Suffolk has more than 13,300 listed buildings, structures and monuments. They range from graveyard monuments to the Willis Building in Ipswich, designed by Foster Associates (1970-75). There are 175 conservation areas.

Good building stones are generally scarce in Suffolk. Timber was the main material used for the construction of secular buildings throughout the medieval period, and the county is rich in timber-framed buildings. The earliest surviving date from the 13th century.

Flint was the predominant material used in prestigious structures, such as castles, grand houses and ecclesiastical buildings from the Roman period. It was obtained as Quarry Flint from the chalk and Quaternary Flint from fluvio-glacial deposits, and beaches. From the 16th century, flint was also used for cottages and farm buildings, particularly on the coast. Brick remained expensive, so flint was used in the 16th and 17th centuries as the main component of walls, with brick for dressings. Flint became fashionable again for more prestigious homes with the rise of the Romantic movement in the late 18th century. It continued to be used into the 19th century for the walls of villas, farmhouses, schools and cottages.

There was a limited supply of other local building stones, including Coralline Crag, Red Crag, septaria (cement stones), Suffolk Boxstone and ironpans. Ironpans were used in the Lakenheath area. The use of the other stone types was generally geographically limited to areas of their occurrence, close to the east coast. Chalk was quarried in the East Anglian Chalk area to the north-west.

The availability of suitable clays led to the production of brick in the Roman period, and then the re-emergence of the industry in the 12th century. Suffolk is important for its exceptional brickwork of the Tudor period. In the north of the county, clay lump (large unfired clay bricks) was used particularly in the 18th and 19th centuries.

Building stone has been imported into Suffolk since at least the Roman period. Caen Stone was used in several monastic and church buildings in the 11th and 12th centuries. Various types of Lincolnshire Limestone were widely used in churches. In the 19th century, the lack of good indigenous stone and improvements in transportation led to the importation of a wide range of stones.

Twenty-seven Suffolk castles were built between 1066 and 1200, the majority in the late 11th and mid-12th centuries, particularly during the civil war period (1136–53). Nearly all of Suffolk's castles were originally earth and timber. Those that survive were rebuilt in stone before *c* 1300. They include Orford Castle, Bungay Castle and Framlingham Castle. Septaria were used extensively in all three. Periods of unrest resulted in the construction of more castles and the strengthening of existing defences. In the 14th century, additional castles and fortified manor houses were built, for example at Mettingham, Wingfield and Little Wenham.

Figure 1: Framlingham Castle, Framlingham. Septaria.

Until the Dissolution of the Monasteries by Henry VIII, religious communities had a significant influence on the landscape, the economy and the extraction and use of building stone in Suffolk. There were more than 80 establishments, including abbeys, priories, friaries, nunneries, colleges, hospitals and small cells. They owned extensive areas of land and manors, and controlled many parish churches and market towns, such as Mildenhall, Stowmarket and Bungay. The north and west of the county was dominated by the great Benedictine Abbeys of Bury St Edmunds and Ely. In the east, land ownership was fragmented among several secular lords and monastic foundations, including Norwich. About 40 establishments survived until the Dissolution, when more than 200 manors were handed to the king.

The Abbey Church at Bury St Edmunds was begun in the 1080s and completed by 1140. It was the second largest in England. The abbey was built mainly of flint rubble. Barnack Stone was used extensively for facings and dressings and St James' Tower, one of the largest remnants of the abbey, was built of Barnack Stone. (Barnack Quarry was leased by Abbot Samson in the 13th century.) At Butley Priory, it is thought that the stone used came from the valley of the Yonne in France.

After the Dissolution, the buildings of many such communities were dismantled or sold for conversion into dwellings. Some buildings survive, such as at Clare Priory and Ixworth Abbey. At Butley Priory, the ruined gatehouse was only converted into a house in 1773.

Figure 2: Abbey west front, Bury St Edmunds. Quaternary Flint pebbles and blocks of Caen Stone and Barnack Stone.

More than 400 churches were recorded in Suffolk in 1086, the greatest total for any county in England. By the 11th century, the use of flint and, occasionally, other stone was widespread. There are 38 round-towered 11th to 12th-century churches in Suffolk, the second highest number in any English county. Most lie along the Waveney Valley, east of Diss, or in the east between Saxmundham and Beccles. There are also small clusters north of Lowestoft and west of Bury St Edmunds. Uncoursed rubble and roughly coursed whole and/or cut flint were the predominant building materials used, occasionally with other materials such as Red Crag, carstone, chalk, limestone, septaria and exotic pebbles.

In the early 14th century, Suffolk was one of the most densely populated, intensively farmed and economically advanced counties in England. The Black Death and economic decline led to a significant reduction in population and changes in land holdings. In the late 14th century, the prosperity created by the developing woollen trade, particularly in the south-west and in the Stour Valley, led to the rise of towns such as Lavenham and Hadleigh. By the 1470s, Suffolk produced more cloth than any other county. From the early 14th century, knapping and squaring of flints to produce flat surfaces became common. High-quality flint flushwork became very fashionable in the late 15th century, particularly as ornamentation to towers, parapets, plinths and new porches. Decorative panels were introduced, which often featured letters and symbols. Increasing wealth, in combination

with changes to religious practices and beliefs, resulted in the 'Great Rebuilding' in the Perpendicular style of churches, as seen at Long Melford and Lavenham. The open timber roofs of Suffolk's 14th to 16th-century churches are remarkable: 21 of England's surviving 32 double hammerbeam roofs are found in the county, together with 53 single hammerbeam roofs.

Brick started to be made in the 12th century, but it did not become widely used until *c* 1500. From the first half of the 16th century, nearly all 'polite' houses were built in brick. Large houses tended to cluster around Bury St Edmunds and Ipswich, reflecting the increase in secular ownership of estates after the Dissolution; many date to the 16th century. Large brick-built courtyard and 'U' or 'E'-shaped houses were characteristic. The largest, Hengrave Hall, was built of white bricks in imitation of limestone.

Much of western and central Suffolk had been enclosed piecemeal by the 17th century. Between 1500 and 1700, many farmsteads developed within the county, particularly in central and north-east Suffolk. The lighter soils of the coastal areas favoured livestock grazing and required a range of buildings for livestock rearing and fodder. In the west, arable predominated on the heavier soils and large aisled storage barns were needed. Rising grain prices from the 1760s to the early 19th century and the impact of agricultural improvement brought about a significant increase in the extent of arable production. In the Brecks and the chalk downland areas around Newmarket, extensive parliamentary enclosure of lands was carried out between 1790 and 1840. Many new farm buildings, including barns, stables, granaries, and buildings and enclosures for livestock were erected.

Wealth from commerce, office, inheritance and marriage, as well as agricultural prosperity, led to the construction of many new houses in the second half of the 18th century. Nearly all were built of brick, sometimes stuccoed in imitation of stone, and generally with imported stone dressings.

Figure 3: Church of Holy Trinity, Long Melford. Flint, stone and ornamented flushwork.

In the 19th century, houses were built or rebuilt for new owners, such as Bawdsey Manor for Sir William Cuthbert Quilter. It made some use of Portland Stone ashlar, and in the garden, there is elaborate Pulhamite artificial rockwork. Estate villages (for example, at Easton, Somerleyton and Helmingham) were often built in flint and brick In the far west of the county, the development of Newmarket as the national centre for horse breeding and racing led to the construction of many more flint and brick buildings.

Figure 4: Bawdsey Manor, Bawdsey. Pulhamite artifical rock work.

In the 19th century, most existing churches were restored, reconstructed or extended and new churches were built, largely in the towns. Flint was the predominant material used, with a variety of Lincolnshire Limestones being employed for repairs and new dressings. Several new churches were constructed to serve the expanding populations of Ipswich and Lowestoft. Most were built of red brick, such as All Saints' Church in Ipswich and St John the Baptist's Church in Felixstowe; the latter has Bath Stone dressings. Large Roman Catholic churches were constructed in the late 19th century in Lowestoft, Bungay, Beccles, Ipswich and Bury St Edmunds. They include the large St Benet's Minster, which, unusually, is built of limestone ashlar not brick.

Non-conformism grew rapidly in Suffolk from the 17th century. In the 1670s, at least 98 towns and villages had congregations. Purpose-built chapels and meeting houses started to be constructed soon after the Toleration Act of 1689. Many new chapels were built in the 19th century, mainly in brick. Several chapels in Ipswich were faced in Kentish Ragstone, including Christchurch Baptist Church, which has dressings in Caen Stone, and the United Reformed Church at Barrack Corner.

Suffolk's population grew strongly in the first half of the 19th century, and many rural schools were built in the county. Between 1833 and 1860,

Parochial, British and National schools were constructed. Many were built in pebble or knapped flint with brick dressings, such as Hepworth Primary School and Bardwell School. Some were endowed by local landowners, such as Somerleyton's picturesque estate school. After 1871, the state began to replace churches as the principal source of elementary education. Many Board Schools were built, or existing schools enlarged. When the local education authorities were set up in 1903, there were more than 450 elementary schools in the county.

Figure 5: The Old Schoolhouse, Brookside, Moulton. Knapped flint with buff brick dressings.

Later in the 19th century, rural depopulation was dramatic, particularly in the north and centre of the county. Urban growth was, however, substantial, particularly in Ipswich and Lowestoft. The arrival of the railways to Ipswich (via both Cambridge and Colchester) and Lowestoft in the mid-19th century led to further growth and the increased importation of stone and roofing slate. Several prestigious new municipal and commercial buildings were constructed. They were often faced in imported stones. Aldeburgh, Southwold and Felixstowe were reached by rail a little later. The increased accessibility of the coast enabled the development of the former ports as flourishing seaside resorts, with seafront villas and gardens. Thorpeness is an early 20th-century, purpose-made holiday village, with Jacobean and Tudor Revival styling. Some houses made use of imported stones, such as Ketton and Ancaster types of Lincolnshire Limestone.

St James' Church was originally built within the precinct of Bury St Edmunds in the 11th century, and then largely rebuilt in the 16th century. It has continued to grow over the centuries, with alterations in the 18th to 21st centuries. It was completed in 2005.

Figure 6: St James' Church, Kenny Hill. Quaternary Flint with Lincolnshire Limestone dressings.

There has been a revival in the use of vernacular materials, such as flint, for domestic architecture in the late 20th and 21st centuries, particularly encouraged by local authority design guidance.

National Character Areas (NCAs)

Local landscape character and the combination of history, cultural and economic activity, geodiversity and biodiversity have been mapped for the whole of England and national National Character Areas (NCA) defined (see Further Reading, Online Resources and Contacts). For each NCA there is a profile document which describes the natural and cultural features that shape the landscapes, how the landscapes have changed over time, the current key drivers for ongoing change, and a broad analysis of each area's characteristics and ecosystem services. The profiles include notes on local vernacular and building materials which are expanded in the following section on the seven NCAs covered by this guide:

NCA 46 The Fens
NCA 80 The Broads
NCA 82 Suffolk Coast and Heaths
NCA 83 South Norfolk and High Suffolk Claylands
NCA 85 The Brecks
NCA 86 South Suffolk and North Essex Clayland
NCA 87 East Anglian Chalk

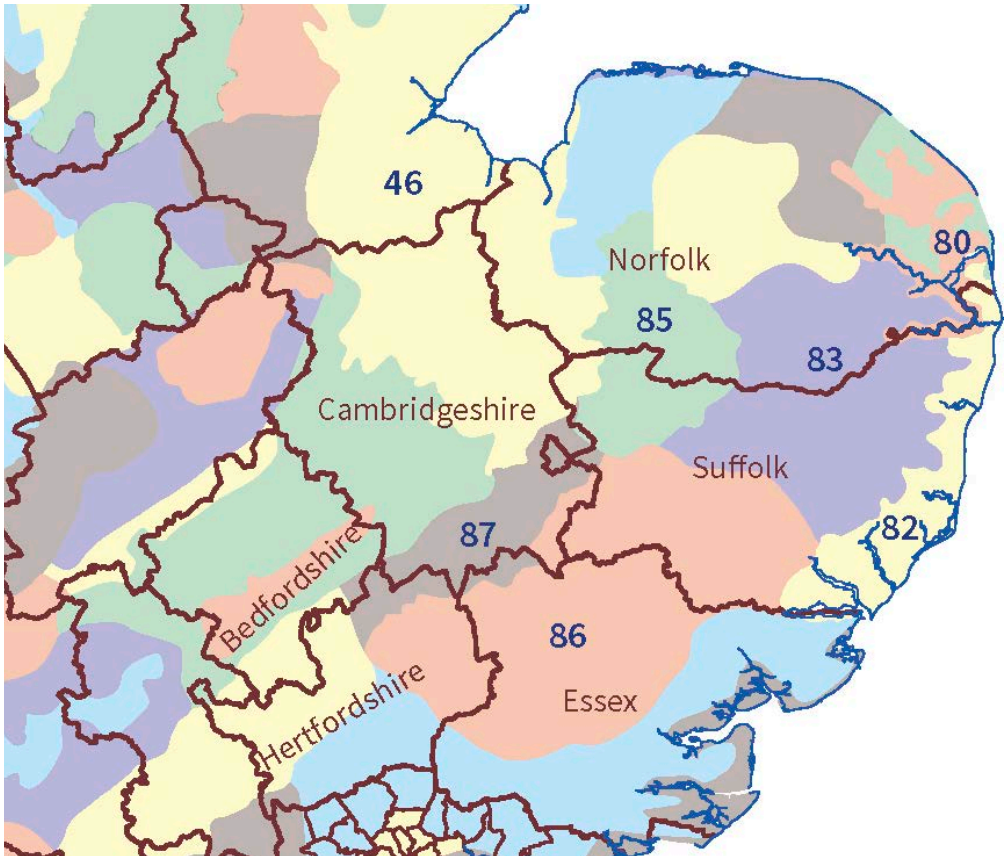


Figure 7: Map showing the National Character Areas (and the NCA numbers).

The Fens

The distinctive, historic and human-influenced wetland landscape of the Fens lies to the south of The Wash. It is mostly located in Lincolnshire and Cambridgeshire, with a smaller area in west Norfolk. Only a very small area, largely that of Mildenhall Fen, lies within Suffolk, west of Mildenhall and Lakenheath. It was reclaimed after a Drainage Act of 1759. There are few buildings in the area other than isolated modern farmsteads and one church, St James at Kenny Hill. This is built mainly of roughly coursed Quaternary Flint, with brick and Lincolnshire Limestone dressings.

The Broads

A small area of Suffolk, on its north-eastern borders between Bungay and Lowestoft, lies within the Broads NCA. The market towns of Bungay and Beccles, as well as villages such as Barsham, Mettingham and Barnby, are within the NCA. Bungay and Beccles are bridging points across the Waveney.

Timber frame was the dominant form of vernacular construction until the rise of brick in the 17th century. Aisled barns from the 14th century survive. Weatherboarding is characteristic. Some barns have parapet gable ends of flint and red brick, such as the 16th-century barn near the remains of Barsham Hall.

Many timber-framed houses of the 16th and 17th centuries in towns, and farmhouses on the margins of the Broads, were refaced in brick during the 18th century. Red brick with glazed pantile roofs and, frequently, gables is characteristic of the area.

Flint, often accompanied by septaria and other pebbles, was used in churches, monastic buildings and castles, for example in the stone keep of the castle at Bungay. Round-towered churches from the 11th and 12th centuries occur at Bungay, Mettingham and Barsham.

Bungay had five churches at the time of the Norman Conquest; two survive today. Holy Trinity Church at Bungay has a round tower built of cut uncoursed flint, with some herringbone work. The tower also contains sandstone and other exotic pebbles. St Mary's Church, also at Bungay, was originally the church of the town's Benedictine nunnery. The remains of the conventual buildings are attached. The walls are of cut flint, with septaria, limestone, brick and pebbles, and Lincolnshire Limestone dressings. The 15th-century tower has fine flushwork and proudwork to the plinth, buttresses and parapet. The church was rebuilt after Bungay suffered a devastating fire in 1688.

The Church of the Holy Trinity at Barsham is thatched, and its 11th-century tower is built of flint rubble. Large erratic stone blocks were used as footing stones in places. Uniquely, the east end of the chancel is decorated with a lozenge grid of flint flushwork, the design being carried through as tracery

Figure 8: St Mary's Church, Bungay. Flint, septaria, limestone, brick and pebbles, with Lincolnshire Limestone dressings.

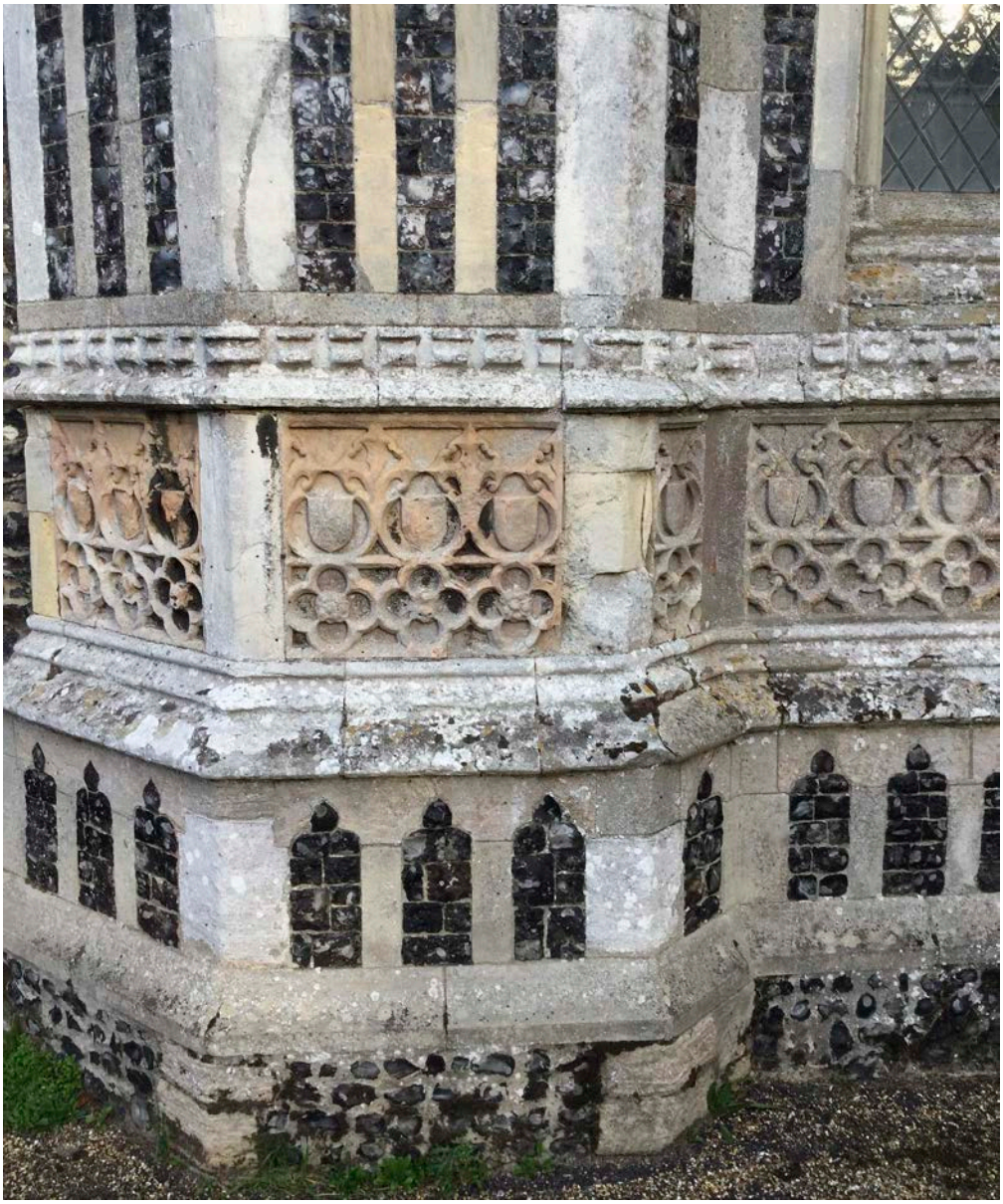


Figure 9: Church tower detail, St Mary's Church, Bungay. Lincolnshire Limestone flushwork and proudwork.

across the whole of the window. It probably dates from the early 17th century, when the chancel roof was renewed.

Beccles also suffered from a series of fires. St Michael's Church has a detached bell tower faced in Lincolnshire Limestone ashlar. The main church is largely of flint with various pebbles and brick and areas of chequerwork. The two-storey south porch is of ashlar, with a fine base frieze. The north porch is also two stories high and has a flushwork panelled front. St Benet's Minster, also at Beccles, is a very large church faced in Lincolnshire Limestone ashlar.

Other 19th-century churches and chapels were largely built of brick, often with Lincolnshire Limestone dressings. For example, the Church of St Edmund's at Bungay is built in red brick, with an abundance of Bath Stone dressings, pinnacles and decoration.

Occasionally, flint was used for other buildings. The Beccles and District Museum originated as a free school. The front is of worked flint, with many brick headers and yellow brick jambs and quoins.

Suffolk Coast and Heaths

This NCA between Great Yarmouth in the north and Felixstowe in the south, forming a long, narrow band that extends between 10 and 20km inland. The coast is interrupted by five estuaries: Stour, Orwell, Deben, Alde/Ore and Blyth. Settlement is generally sparse in the area, with small, isolated villages and farmsteads. Larger urban settlements include Lowestoft and the coastal towns of Aldeburgh, Southwold and Felixstowe, as well as estuarine port towns such as Woodbridge. The once important medieval port of Dunwich is now almost entirely lost due to coastal erosion. The eastern suburbs of Ipswich also fall within this NCA.

Timber frame was the dominant form of vernacular construction until the adoption of brick in the 17th century. The use of brick, clay tile and render became characteristic for vernacular buildings. Dutch influences featured in the coastal town buildings, particularly the use of shaped gables. Flint was the predominant material used in churches and monastic buildings of the area, although a wide range of other stones often form a more minor constituent of the fabric. They include Coralline Crag and Red Crag, boxstones and septaria. Caen Stone was used for dressings at Greyfriars Priory, Dunwich. Dunwich Leper Hospital was mainly built of Caen Stone and septaria, with various exotic and ballast pebbles and occasional isolated blocks of Paradoxica Bed Stone.

Figure 10: Greyfriars Priory, Dunwich. Flint flushwork and Caen Stone dressings.

Flint was used in the round-towered 11th and 12th-century churches that lie within the area. In particular, they occur north of Lowestoft, such as at Blundeston, Ashby, Herringfleet and Lound, and south-west between Lowestoft, Beccles and Yoxford, such as at Mutford and Thorington. Whole, split and knapped flint was used, either coursed or uncoursed. In coastal areas, beach cobbles were often used for rubble walls, sometimes faced in dressed stone, such as at Leiston Abbey. Lincolnshire Limestone dressings were often used in medieval churches. Such stone was employed as ashlar and for capitals and decoration in some of the larger churches and monastic foundations of the area.

The Suffolk Coast was a very wealthy area in the 14th to 16th centuries. Many churches were built or rebuilt in the Perpendicular style, such as at Aldeburgh, Lowestoft, Southwold, Walberswick and Woodbridge. Flint was the dominant material used, but the adoption of high-quality flushwork with decorative panels and chequerwork became features of churches of the area. Many 14th to 15th-century churches exhibit flint walls with exotic pebbles. For example, the walls of St Mary's Church at Wherstead have granite, gneiss and quartzite pebbles (some derived from Scotland and Scandinavia) incorporated in the largely flint fabric. In the 19th century, many churches were restored and rebuilt, and some were constructed using knapped flint.

Coralline Crag limestone was used as a building stone in some of the area's medieval buildings and, for example, in the boundary wall of Greyfriars Priory. Occasionally, it was also used in churches. At Wantisden and Chillesford, the towers of both churches were built of sawn blocks of Coralline Crag during the 14th century. St Mary's Church at Stoke-by-Nayland exhibits Coralline Crag blocks randomly used among flint. E B Lamb's 19th-century Church of St Margaret at Leiston uses single courses of squared crag, alternating with bands of a roughly coursed mix of knapped flint and other exotic pebbles. Coralline Crag was often used in farm outbuildings and walls, but seldomly for domestic buildings. Smithy Cottage at Snape is a rare example. Here, it was used with yellow brick dressings.

Red Crag Ironstone crops out widely over the southern half of the NCA. At St Mary's Church at Ufford, rough blocks of Red Crag Ironstone were used in herringbone pattern courses in the north wall of the nave, and for forming quoins. At All Saints' Church at Eyke, the south side of the chancel contains many Red Crag cobbles. Shelly Red Crag cobbles can also be seen in the churches at Falkenham and Newbourne.

Boxstones were used in the restoration of All Saints' Church at Sutton and St Margaret's Church at Shottisham. Both are faced in coursed and random rubble flint with ashlar dressings. Many of the flints are barnacle encrusted or have Red Crag shells adhered to them. Septaria were used from the late 12th century in a substantial number of churches, at Orford, Chelmondiston, Erwarton, Harkstead and Felixstowe, for example. Orford Castle is largely built from septaria, with Lincolnshire Limestone and some Coralline Crag on a Caen Stone plinth.

Figure 11: All Saints' Church, Sutton. Quaternary Flint nodules from Red Crag, boxstone, septaria, Lincolnshire Limestone and imported pebbles.

Figure 12: All Saints' Church, Sutton. Boxstone.

Kentish Ragstone was used in several 19th-century churches, including St Botolph's at Iken and St Andrew's at Melton. At the latter, Caen Stone was used for dressings. Bath Stone was used for dressings to a number of 19th-century brick churches, such as SS John the Baptist and Felix at Felixstowe.

The use of natural flint fragments, selected for uniformity of size and set uncoursed and projecting from the backing mortar, is characteristic of some 19th-century secular buildings between Aldeburgh and Southwold. Examples also occur at Bramfield, Theberton and Westleton. The local flint (better known as chert) is often brown or amber in colour, or sometimes nearly white, and lacks the usual grey or black flint colouration. Many buildings in

Southwold have carefully coursed, regular-sized, close-set, grey flint walls with occasional galleting. At Blythburgh, the flint is often less rigidly coursed and wider set, with blue-grey, amber and light grey random colouring.

From the 17th century, trade with Europe and aristocratic connections with London increased wealth in the area. Several imposing houses and large estates developed on the fertile soils of the larger southern river valleys and claylands, at Broke Hall, Stutton Hall and Crowe Hall on the Stour, for example. Most were built in brick, but Woolverstone Hall on the River Orwell has a Portland Stone basement.

The 'ancient countryside' of the inland river valleys and claylands had undergone extensive piecemeal enclosure by 1700 and few new farms were built after 1750. In the coastal strip, the enclosure of some of the extensive Sandlings heaths in the 18th to mid-19th centuries led to the construction of substantial new farmsteads, generally in brick, such as for the large estates of Benacre, Henham and Sudbourne. The area became renowned for its sheep breeding.

Anti-invasion coastal defences were established from the Roman period. Felixstowe's Landguard Fort was constructed in 1624 to 1630 and rebuilt in 1711 and *c* 1871, when granite was used as facing stone. During the Napoleonic wars, Martello towers were built from 1809 to 1812 at Aldeburgh, Alderton, Bawdsey, Felixstowe, Shingle Street and Shotley, for example. The Martello tower at Aldeburgh is built of red brick on a granite plinth with ashlar dressings.

South Norfolk and High Suffolk Claylands

This NCA occupies much of central East Anglia, stretching from just below Norwich in the north to the River Gipping in the south. It includes the market towns of Eye, Debenham, Framlingham, Halesworth, Saxmundham and Wickham Market.

By 1066, the area was one of the most densely populated in England. Most of the present villages and many isolated farmsteads and hamlets had been established. Between the 11th and early 14th century, the expanding population led to the development of secondary settlements on the central plateau. These often gathered around the edges of large grazed commons or greens. Most of the area was enclosed piecemeal during the medieval period.

Timber-framed farmhouses and barns are characteristic of the area. It has one of the highest concentrations nationally of surviving pre-1750 farmstead buildings. The frames of farmhouses are largely concealed behind colour-washed plaster. Most barns are clad with black-painted weatherboarding. Roofs are mainly red clay tiles or thatched. Slate became common from the 19th century. Brick was increasingly used from the 15th century, initially for high-status buildings and then for vernacular buildings. Close to the boundary with Norfolk, clay lump became popular for cottages, outbuildings and farm buildings in the 18th to 19th centuries.

Many moated sites were established on the plateau. Significant numbers of houses, cottages and barns as well as occasional cattle housing (locally termed 'neathouses') and other farm buildings built before 1750 survive. As the area's woodlands were cleared, timber became an increasingly scarce resource. Flint and brick gradually replaced it. From the 1790s, the area gained a national reputation for its barns. In the south, where woodland remained more extensive, timber framing continued to predominate into the 18th century.

Thetford and Bury St Edmunds abbeys were major landowners, although they were located just outside the NCA. Within the NCA, there were more than 20 monastic establishments, including at Eye, Hoxne, Ixworth, Rumburgh and Sibton. Flint was commonly used for the construction of medieval churches, monastic buildings and castles. At the Dissolution, the former priory at Rumburgh continued in use as SS Michael and Felix's Parish Church. It was built of random flint with limestone dressings. Other former churches were adapted as domestic buildings or gradually demolished.

The South Norfolk and High Suffolk Claylands NCA has the greatest concentration of round-towered medieval churches in the country. They are most frequent in Norfolk, but also in this NCA along the Waveney Valley, such as at Barsham, Mettingham, Bungay, Syleham, Stuston, Weybread and Wortham. Most churches were built of irregular Quaternary Field Flint set in mortar, either uncoursed or as roughly coursed rubble. Flint was often used for jambs and arches. Imported limestone was generally preferred for dressings and quoins from the 12th century. In the late 13th century, the use of knapped flint and galleting became commonplace.

Framlingham Castle is an exceptionally well-preserved late 12th-century structure. Built by Roger Bigod, Earl of Norfolk, it was home to the dukes of Norfolk for more than 400 years. The flint and rubble septaria, 10m-high curtain walls and towers replaced an earlier castle. Other remnants of stone castles can be found at Eye and the fortified manor houses of Wingfield and Mettingham. At Eye, parts of the 12th-century flint curtain wall survive. The gatehouses of Wingfield and Mettingham also survive. Both were built of flint rubble with limestone and brick dressings.

In the 14th to 16th centuries, the area grew wealthy as a result of the wool trade. Many churches were rebuilt in the Perpendicular style. Flint was the dominant material used in their construction. A particularly fine example is the Church of SS Peter and Paul at Eye, with its west tower panelled in flint flushwork and an ashlar and brick flushwork south porch. Other examples are the Churches of St Michael at Framlingham, St Mary at Halesworth and St Mary at Woolpit. The last of these has an opulent ashlar-fronted, two-storey south porch, built in 1430 to 1455. The west tower was replaced in 1853 to 1854 with a tower of Quaternary Flint pebbles and cobbles, with Bath Stone dressings topped by a Nene Valley -style spire. Flint was extensively used in 19th-century restorations and rebuilding. The Church of St Mary at Huntingfield is a particularly fine example of a Victorian restoration with outstanding painted internal roofs and the Church of SS Mary and Peter at Kelsale was restored by Norman Shaw and E S Prior.

Figure 13: Church of SS Peter and Paul, Eye. Flint flushwork panels.

Figure 14: Church of St Mary, Woolpit. Squared flint and Ancaster Stone.

After the Dissolution, monastic lands were sold off and the new owners often built new houses, particularly around Norwich. From the 15th century, the use of brick became commonplace in vernacular buildings. Many earlier houses were rebuilt from the 17th century. Brick-stepped and Dutch gables were frequently adopted in the 16th to 18th centuries. Estates and parks developed, particularly in the Waveney Valley, close to Bury St Edmunds and along the edge of the Sandlings from Ipswich to Henham. Several imposing houses were constructed, too, including Badley Hall, Brome Hall, Helmingham Hall and Letheringham Abbey. All were built of brick, with imported stone dressings.

Linen weaving developed as a cottage industry in the 16th to 18th centuries, particularly in the north of the area, including the Waveney Valley. Locally grown hemp and flax were processed. There were several markets for linen, sailcloth and sackcloth close to the main growing area between Eye and Beccles. In the 16th and 17th centuries, the wool and linen trade and connections with London increased wealth in the area.

From the late 18th century, the high price of grain and the urban demand for foodstuffs led to the conversion of dairying pastures into more lucrative arable units. Many fields were rationalised. New farm buildings were created. Village greens were also enclosed, and others were often built on to accommodate the rapidly rising population. Several country houses were rebuilt at this time, particularly in the Waveney Valley and near the eastern boundary of the NCA along the edge of the Sandlings. They included Heveningham Hall, Suffolk's only major Palladian house. It was designed by James Wyatt and built in brick and stucco, with artificial Coade Stone detailing.

In the 18th and 19th centuries, timber-framed buildings were often refaced or encased in brick in the countryside and in market towns. Much of the area suffered substantial rural depopulation in the latter half of the 19th century. Brick was the predominant material employed for new buildings, although clay lump was also used quite commonly in the north of the area for farm buildings, cottages and some farmhouses. This occurred in the first half of the 19th century, when there was a tax on fired bricks.

In the north-east of the area, Welsh Slate was used from the early 19th century, imported by boat along the River Waveney. After the construction of the railways, using such material became commonplace. Other building stones were imported for use in commercial and municipal buildings in the area's towns. In the 19th century, there was a revival in the use of flint in church restoration, rebuilding and construction.

The Brecks

The Brecks occupy much of south-west Norfolk and part of north-west Suffolk, together with a small part of north-east Cambridgeshire. Brandon and Mildenhall are the main towns of the area. Settlement is relatively sparse in the central area of the Brecks, with estate villages such as Santon

Downham, Elveden and Euston dominant. More villages and hamlets are clustered on the Fen edge to the west (Lakenheath, Beck Row and Freckenham, for example) and in the Lark and Little Ouse Valleys to the north of Bury St Edmunds (Culford, Icklingham, West Stow and Great Livermere, for example).

Most historic buildings in the Brecks date from the 18th and 19th centuries. Flint and brick had become the dominant materials used for vernacular buildings by the 17th century. In the Fen edge communities such as Lakenheath, chalk and carstone were used in churches and vernacular buildings. Few medieval timber-framed buildings survive from before *c* 1700. Those that do, such as Eriswell Hall and Wangford Hall, are largely located towards the margins of the area. Sometimes, they have been encased in brick. Flint beds in the White Chalk Subgroup have been quarried since the Neolithic period (as at Grime's Graves near Brandon) and from the chalk exposed close to the Fen edge. Elsewhere, flint was obtained from the surface, often from the glacial drift. Irregular flint nodules or pebbles were largely used as random rubble; less frequently, they were roughly coursed.

Much land within the Brecks was controlled by the abbeys at Bury St Edmunds and Thetford, which lie immediately outside the area. Many medieval churches in the Brecks are quite small and they are built in a simple style that reflects the relative poverty of their parishes. For example, All Saints' Church at Wordwell is mainly built of roughly coursed flint rubble, with dressings of Lincolnshire Limestone. There are many exotic pebbles, including quartzite, andesite and Rhineland (Niedermendig) Lava. Larger churches are found in the then more prosperous Fen edge and river valley settlements. They are mainly constructed of flint. At St Mary's Church at Mildenhall, the 13th-century north chapel is of limestone ashlar. St Mary's Church at Lakenheath is built of more varied materials, including carstone, Quaternary Flint and chalk, with dressings of Lincolnshire Limestone (including Barnack Stone).

Figure 15: All Saints' Church, Wordwell. Quaternary Flint with Lincolnshire Limestone dressings.

Quaternary Flint was used for all the known warren lodges in the Brecks. They were occupied by those responsible for managing the warrens, where rabbits were farmed for their fur and meat. This industry dominated the Brecks landscape for more than 600 years and it was a mainstay of the local economy. Mildenhall Warren Lodge is a surviving example. It is constructed of mortared Quaternary Flint pebbles and nodules with limestone quoins.

Figure 16: Mildenhall Warren Lodge, Mildenhall. Quaternary Flint pebbles and nodules with limestone quoins.

By the late 14th century, sheep farming had become extremely profitable. Several churches were built, rebuilt or embellished, often with new west towers, clerestories or porches funded by wealthy patrons. Knapped, cut flint and flushwork became common. New or largely rebuilt churches include All Saints' Church at Icklingham, built of flint rubble, with limestone dressings where the tower and south aisle were added, and St Mary's Church at Mildenhall, with its fine west tower with fan vaulting, porches, clerestory and hammerbeam 'angel' roof. At the Church of St Mary at Santon Downham, the tower dates from the 15th century. Impressive houses were also built around this time. Hengrave Hall, one of the most important and largest courtyard houses of the late 15th century in Suffolk, was constructed in white brick in imitation of limestone and dressed with real Lincolnshire Limestone (possibly King's Cliffe Stone). It incorporates material from the dissolved monastic houses at Bromehill, Ixworth and Thetford.

Flint was also used widely in secular buildings. In domestic and farm buildings, random or roughly coursed flint was the most common material used before 1700. Coursed cobbles projecting from the mortar are found in many barns, cottages and farmhouses in the area. The use of brick trickled down to larger vernacular houses from the 16th century. The production of off-white and yellow shades of brick started in the 18th century and became the dominant and characteristic building material of the area. Flint with brick was most commonly used towards the west of the Brecks; buildings of flint alone are rather more widely distributed.

Chalk was used in Fen edge communities, such as Lakenheath, particularly as rubble for farm buildings, walls and cottages. It was used in some churches, such as St Mary's Church at Lakenheath and All Saints' Church at Worldwell. Burwell Rock (Totternhoe Stone) was brought from Cambridgeshire for use in some churches: for example, the arcade of St Lawrence's Church at Lackford includes this stone. Carstone was used in some buildings in the Fen edge communities. For example, the chancel and south aisle of St Mary's Church at Lakenheath are partially built of the stone. At Brandon, the former National school and workhouse is built of coursed, squared chalk block, with gault and red brick quoins.

In the 18th and 19th centuries, there was an increase in enclosure and in the number and extent of landed estates, such as at Euston and Elveden. Many estate buildings and cottages were built in flint and brick. Galleting became popular in the 19th century. New flint mines around Brandon were developed in the 19th century to support the gun flint industry, particularly during the Napoleonic Wars. The industry produced significant quantities of black knapped flint, which was used extensively for building in the town and nearby area. Fine knapped flint is found in quite modest buildings, which also employ shaped flint ovals and squares. There are many boundary walls of knapped flint fragments, a waste product of the industry. Knapped flint was also used extensively in 19th-century church restoration and building work. For example, at St James' Church at Icklingham, the nave and chancel were refaced in squared, knapped flint in the 1860s. Several estate churches were extensively rebuilt, such as the Church of SS Andrew and Patrick at Elveden by W D Caroe in Art Nouveau Gothic style. It has two towers, two naves and a cloister. Flint, Bath Stone and Cotswold Slate roofs were used. The nearby First World War memorial is a 39m-high Corinthian column of Lincolnshire Limestone (Weldon Stone) with a Portland Stone urn. Flint was used in several modern buildings in Brandon, such as 10-12 High Street, and for facing many modern housing developments in the area.

Clay lump construction was popular between *c* 1790 and *c* 1860. It is commonest in the eastern margins of the area, towards the boulder clay soils of north Suffolk and south Norfolk, where property tended to be owned by small proprietors, rather than large estates.

The use of thatch in this area is surprisingly rare when compared with the rest of Suffolk. From the 18th century, pantiles and slate became relatively cheap. Improvements in the river and road system also reduced transport costs. Pantiles were produced locally from the 18th century. Black glazed tiles were introduced from the mid-18th century. The use of slate in the 18th and early 19th centuries was more frequent in the fenland edge area, where water transport was available. Once the railway network had developed, the use of slate became widespread, particularly in towns and for estate buildings.

South Suffolk and North Essex Claylands

This NCA covers much of south and west Suffolk, from Bury St Edmunds to Ipswich, north Essex, east Hertfordshire and a relatively small part of south-east Cambridgeshire. The area has a long history of settlement, including Palaeolithic finds, Roman sites, medieval monasteries and castles, isolated moated farmsteads, barns and several large country houses. There are many notable medieval towns and villages, such as Bury St Edmunds, Stowmarket, Needham Market, Lavenham, Long Melford, Hadleigh, East Bergholt, Sudbury, Clare and Haverhill. The centre and west of Ipswich also falls within the NCA. Ipswich was established in the 6th and 7th centuries and was a significant international trading port throughout the medieval period. By the late 11th to 12th century, St Edmund's shrine at Bury St Edmunds had developed into one of Europe's premier pilgrimage sites.

Many vernacular buildings from the 13th to the 17th century survive. Elaborate timber-frame buildings with exposed timbers, colour-washed render and steeply pitched roofs, with peg tiles or long straw thatch, are characteristic of the area. Pargeting plaster work was popular in the 17th century.

There were several 11th-century motte and bailey castles in the area. At Clare Castle, a shell keep was built of rubble flint in the 13th century. Fortified manor houses were built within the site at Haughley Castle. The fortified manor of Little Wenham Hall was largely built of brick, with flint and septaria used for the plinth and Caen Stone for the dressings and buttresses. It is one the earliest uses of brick in medieval England.

As well as the large abbey church at Bury St Edmunds, there were smaller priories and hospitals, and many controlled parishes and manors. Clare Priory, for example, enjoyed rents from 17 Suffolk parishes. As elsewhere, after the Dissolution, monastic buildings were converted into dwellings. At Ixworth, the west range of the priory was incorporated in the house now known as Ixworth Abbey. Its stone was also used to build Hengrave Hall, north of Bury St Edmunds, in the early 16th century. At Great Bricett, the Church of SS Mary and Lawrence incorporates the remains of the priory church. It is built of random flint and roughly coursed rubble, with limestone blocks and dressings. The priory's timber-framed hall attached to the church also survives, now converted to domestic use.

The churches of the area are generally built of Quarry Flint and/or Quaternary Flint, with pebble rubble and sometimes chalk. A few 11th and 12th-century round-towered churches are found, particularly to the east and west of Bury St Edmunds, such as at Risby, Little Saxham, Little Bradley, Beyton and Onehouse. They are built of whole and cut flint. Risby and Little Saxham churches have flint jambs and heads to their belfry windows. Little Bradley Church has long and short-work quoins, with a 14th-century octagonal belfry added.

Figure 17: Abbey gate and gatehouse, Bury St Edmunds. Barnack Stone.

Chert and quartzite pebbles and cobbles were used as part of the fabric with Quaternary Flint nodules, commonly laid uncoursed or roughly coursed. For example, the tower of Hawstead Church has a coursed mixture of black and grey knapped flints and brown chert or quartzite pebbles. Chalk was used for some dressings to flint churches, such as at All Saints' Church at Gazeley and St Lawrence's Church at Great Waldingfield. The latter also makes use of quartzite pebbles, Lincolnshire Limestone and a range of other exotic stones. Septaria were used with flint and limestone rubble in several churches, such as St Andrew's Church at Brockley and St Mary's Church at Combs. The Chapel of St Nicholas, built as a private chapel for Sir James Tyrrell of Gipping Hall, has walling entirely of squared limestone rubble and knapped flint or brown septaria, in a chequerboard pattern.

From the 13th to the 17th century, the wool and cloth trade generated much wealth. Guilds played an important part in the social and religious life of parishes. Rich merchants and their families, such as the Claptons at Holy Trinity Church at Long Melford and the Springs and Branches at SS Peter and Paul's Church at Lavenham, endowed the reconstruction and embellishment of 'wool' churches. Both are of knapped Quarry Flint, with richly ornamental flushwork and limestone ashlar and dressings. Casterton Stone was used at Lavenham. On a lesser scale, the funding of new towers, porches, clerestories and chantry chapels was particularly favoured. Towers were rebuilt at Kersey, Rougham and Stoke-by-Nayland, for example, and porches added to churches in Boxford, Stratford St Mary, Woolpit and Yaxley.

Figure 18: SS Peter and Paul's Church, Lavenham. Knapped Quaternary Flint, with ornamental flushwork, limestone ashlar and Casterton Stone dressings.

The woollen and cloth trade declined in the 17th century, outcompeted by northern and western England. Consequently, development in much of the area largely stopped. During the 18th and 19th centuries, arable farming replaced dairy farming, particularly to serve the London market. Many estates were amalgamated. Grand houses such as Ickworth, Flixton, Shrubland Hall, Tendring Hall and Barham were built. Brick was primarily used, with imported Lincolnshire Limestone dressings and stucco.

Most churches in the area were restored or rebuilt in the 19th century. Refacing in knapped flint was commonplace. New churches were erected in the larger towns, in particular. They include St Peter's Church at Bury St Edmunds, which is built of flint with Caen Stone dressings. Roman Catholic churches were also constructed, such as St Edmund's at Bury St Edmunds,

which has a Greek classical stone facade. Several new Church of England and Roman Catholic churches were built in Ipswich. Nearly all were in brick, with imported Lincolnshire Limestone dressings. New rural churches include St Stephen's Church at Higham by G G Scott, in flint with Ancaster Stone dressings, and St Mary's Church at Willisham by H J Green. The latter is built of flint and septaria rubble, with freestone dressings.

In the 18th and 19th centuries, many Nonconformist chapels were built in the area. Most were in brick, sometimes with imported limestone dressings. Occasionally, other materials were used, such as for the Baptist Chapel at Whepstead, which has a front in uncoursed flint and septaria rubble, with gault brick quoins. Many rural schools and parish workhouses were also constructed in the area during the 19th century. Most were of brick. Occasionally, knapped flint with brick was used, such as at Barrow School and school house, Pakenham School and the town workhouse, now 60 College Street, Bury St Edmunds.

In the 19th century, the population of the urban centres increased while that of the rural hinterland declined. Civic, municipal and commercial buildings were erected. They were generally built in brick with imported stone dressings, such as the Old Shire Hall, Bury St Edmunds, where Ketton Stone was used, and the Corn Exchange, Bury St Edmunds, which employed Ancaster Stone.

Clay lump was also utilised as a building material in the 19th century, mainly for farm buildings and cottages. Other forms of clay construction, such as cob or rammed earth, are found, too. There is a concentration of clay buildings in Buxhall, for example, where the Reverend Copinger Hill was a strong advocate of clay building in the 1840s.

Figure 19: Church of St Mary, Willisham. Flint and septaria rubble with freestone dressings.

East Anglian Chalk

The East Anglian Chalk of Bedfordshire, Cambridgeshire, Hertfordshire, Suffolk and north-west Essex is part of the narrow ridge of chalk that runs south-west to north-east across southern England, from Devon to the eastern edge of The Wash. Only a small area of north-west Suffolk around Newmarket falls within the NCA. This area includes Newmarket and the villages of Exning and Landwade to the north, and Moulton and Kentford in the Kennet Valley to the east.

The East Anglian Chalk was historically sparsely populated due to a shortage of wood and water. Villages developed where water was available. Some 16th and 17th-century timber-frame farmhouses, outbuildings and dwellings survive. From the 17th century, brick increasingly became the dominant vernacular material used in the villages north of Newmarket and in the town itself. Flint was employed in the churches of the area. The Church of St Nicholas at Landwade is built of flint and pebble rubble, with some reused Lincolnshire Limestone dressings. St Martin's Church at Exning is built of flint rubble, with much use of roughly shaped chalk blocks to raise the roof level of the nave, chancel and north transept. Chalk was also used in the 17th to the 19th century for extensions, farm buildings and walls in the area. For example, Street Farmhouse at Freckenham was extended in the 19th century in chalk. The Dovecote at Exning, is built of chalk (clunch) with brick quoins.

Figure 20: St Martin's Church, Exning. Flint rubble with rough shaped chalk blocks.

Newmarket developed as a horse racing and breeding centre from the 17th century onwards. Training studs became established on the heaths to the east of the area. Much of the open chalk heathland was enclosed in the early 19th century. The industry expanded considerably in the 19th century and early 20th century. Many new buildings were constructed to meet the needs of the horse breeding industry, often in brick or flint with brick dressings.

Flint was sometimes mixed with chalk block and clay lump. Rapid growth in the 19th century led to the construction of many fine Regency, Victorian and Edwardian buildings. Brick was generally used. Sometimes, flint was employed for rear and side walls, such as at Ragotsky House, and for boundary walls. Knapped flint was used for some buildings, such as the Girls and Infants School and the Mount Public House.

The Church of St Mary the Virgin at Newmarket was heavily restored in the 19th century. All Saints' Church was rebuilt in 1875 to 1877 in flint, with limestone dressings. As the town grew in the 19th century, several new churches were built, mainly in brick with limestone dressing. The Church of SS Philip and Etheldreda was built as a workhouse chapel; it is constructed of flint with brick dressings. The 19th-century chapels at Exning and Newmarket cemeteries are of knapped flint.

To the east of Newmarket, villages are tucked into the more undulating terrain. Rendered timber frame is dominant in the surviving houses and cottages that date from the 16th and 17th centuries. Flint was used in the medieval period in churches and for the rubble flint packhorse bridge at Moulton. St Peter's Church at Moulton is of random flint rubble, with chalk rubble and limestone dressings; it was heavily restored in the 19th century. St Mary's Church at Kentford is of roughly coursed flint rubble with dressings in chalk and Lincolnshire Limestone. Many 18th and 19th-century village houses are built of rubble flint, with red or gault brick dressings and either slate, peg tile or thatched roofs. Boundary walls were also often constructed of flint. Moulton Rectory School is built in Gothic style, in knapped flint with gault brick dressings.

3 Local Building Stones

Lower Cretaceous

Lower Greensand Group, Woburn Sands Formation

Carstone

The outcrop of the Woburn Sands Formation in Suffolk is confined to an extremely small area to the north-west of Lakenheath, which adjoins the county boundary with Cambridgeshire. The strata comprise distinctive red-brown to orange-brown, highly ferruginous sandstones and ironstones, which are typically medium to coarse-grained.

Carstone is rarely encountered in buildings in Suffolk. One of the few examples of its use is in the walls of St Mary's Church and St Michael's Church at Lakenheath. Here, some weathered blocks strongly resemble Quaternary-age ironpan and, based on current (albeit very limited) evidence, a different stratigraphic origin for the Suffolk carstone cannot be discounted. Also, given the very small outcrop area of the Woburn Sands Formation in Suffolk, it is possible that at least some of the carstone employed at Lakenheath was imported from neighbouring Norfolk.

Figure 21: St Mary's Church, Lakenheath. Quaternary Flint, chalk and carstone, with Lincolnshire Limestone dressings, including Barnack Stone.

Figure 22: St Mary's Church, Lakenheath. Roughly coursed carstone blocks.

Figure 23: St Mary's Church, Lakenheath. Roughly coursed chalk and more regularly coursed carstone, with Lincolnshire Limestone dressings.

Upper Cretaceous

Chalk Group, Grey Chalk Subgroup, Lower Chalk Formation

Totternhoe Stone

The Totternhoe Stone is a distinctly harder unit within the Grey Chalk Subgroup. It typically comprises creamy to pale brownish-grey, fine-grained calcarenite. It often appears sandy or gritty due to the presence of coarse fossil fragments. Totternhoe Stone is usually compact and well jointed.

In Suffolk, Totternhoe Stone was traditionally hewn from quarries using a type of two-edged battle-axe or sawn into blocks. It is easily carved, but weathers readily, and was, therefore, mostly used for interior work. However, if properly dried, traditionally during the summer months, Totternhoe Stone becomes harder and more durable and so it was occasionally used externally. A particularly fine example can be seen at the church at Santon Downham.

Figure 24: Church of St Mary, Santon Downham. Quaternary Flint walls with a Totternhoe Stone arch and Barnack Stone dressings.

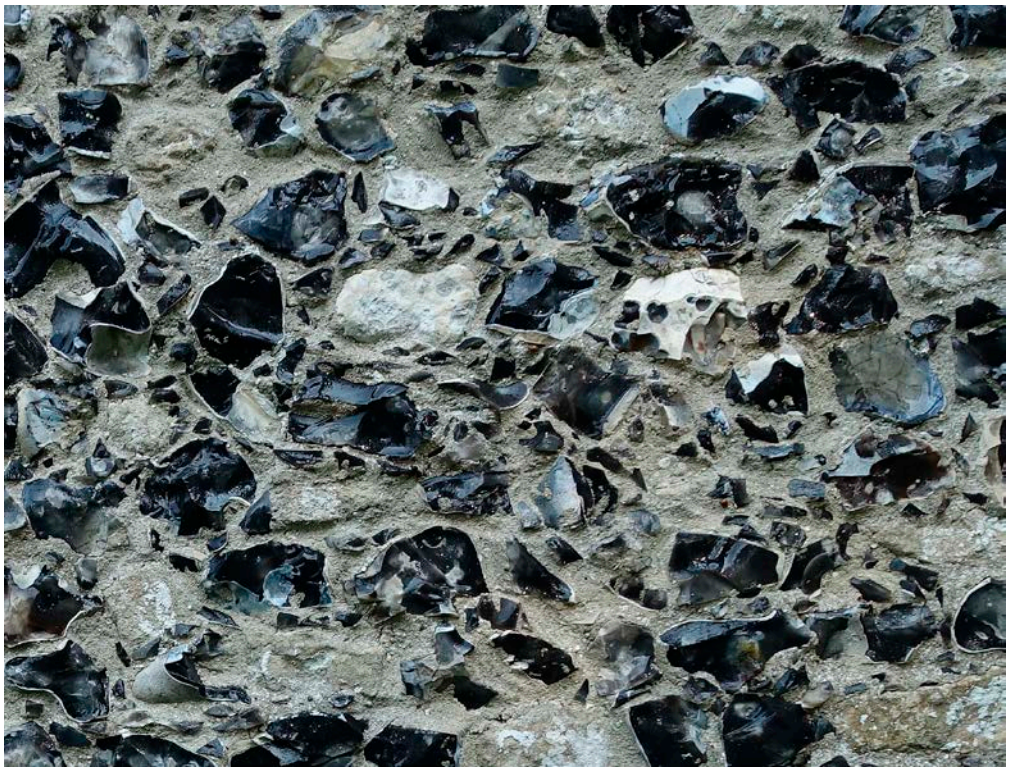


Figure 25: Church of St Mary, Santon Downham. Knapped Quarry Flint with Totternhoe Stone blocks.

Chalk Group, White Chalk Subgroup, Middle Chalk Formation, Upper Chalk Formation

Quarry Flint

Quarry Flint occurs as bands or isolated nodules within the chalky limestone beds of the White Chalk Subgroup. It is an extremely fine-grained (cryptocrystalline) and hard form of silica, containing microscopic quartz-crystal aggregates. Quarry Flint usually occurs as irregularly shaped nodules that are 100 to 200mm across, or as (sub-)rounded pebbles or cobbles. Occasionally, it is found as weakly banded tabular sheets or layers up to 200mm thick. The colour is very distinctive: fresh nodules have a white outer cortex with a black or dark grey interior.

Quarry Flint breaks with a characteristic conchoidal fracture, producing razor-sharp, fine edges. The cleaved surfaces may exhibit banding caused by the alternation of layers of slightly different composition. Flint nodules may contain cavities lined with translucent botryoidal chalcedony or small transparent quartz crystals. Some nodules contain well-preserved fossils, with echinoids, sponges, bivalves, burrow structures and, occasionally, belemnites being seen.

Quarry Flint is one of the most commonly encountered and extensively used building stones in Suffolk. It is often seen in association with Quaternary Flint. Quarry Flint was employed in a wide variety of ways, including as knapped, faced, trimmed or 'cleaved faced' stone, and sometimes in squared chequerwork and flushwork.

The extremely hard and resistant nature of Quarry Flint-type nodules occurs because they have been recycled by natural processes into younger deposits. These reworked types of flint, which show specific characteristics, are described in the Quaternary section of this guide.

Figure 26: 19th-century House, Lakenheath. Knapped and roughly coursed nodules of Quarry Flint with buff brick dressings.

Chalk (Clunch, White Clunch)

The white chalky limestones of the Upper Cretaceous White Chalk Subgroup are among the most distinctive and easily recognised building stones employed in Suffolk. They are white to very pale grey or pale buff, typically structureless chalky limestones, which in places contain fossil oysters (inoceramids) and echinoids, and occasionally crinoids, brachiopods and belemnites. When freshly quarried, chalk is easily worked. However, it is generally unsuitable for exterior stonework because repeated wetting and drying (coupled with frost action) causes the relatively soft chalk to powder and disintegrate into small angular brash. Softer forms of the stone, when used externally, may show concave weathering away from mortar lines.

Rough chalk walling is relatively common in many west Suffolk villages and farm buildings. It can be seen at Lakenheath, both in the church and surrounding churchyard walls, and at Kentford Church (where the stone is deeply weathered). At Exning Church, chalk has been employed to infill former doors and arches. A particularly fine example of dressed and coursed chalk block can be seen at the Victoria National School in Brandon.

Figure 27: Churchyard wall adjoining Back Street, Lakenheath. Roughly dressed and coursed clunch.

Figure 28: Detail of churchyard wall, Lakenheath. Clunch.

Palaeogene

Thames Group, London Clay Formation

Septaria (Cementstone)

Sediments of the Thames Group crop out along the Suffolk coast, from Bawdsey southwards, and along the lower reaches of the Rivers Deben and Orwell. These include dark brownish-grey, fine-grained, calcareous mudstone concretions, known as septaria or cementstones. Septaria have been used as a building stone in Suffolk, either collected from the foreshore or removed from the low cliffs that are present locally. Septaria were also obtained through offshore dredging, and were once used for the manufacture of Roman cement. Impressions and borings by marine organisms can be seen in many of the blocks incorporated into the walls of churches, and these testify to their origins. Unfortunately, septaria fracture and weather relatively easily, sometimes leading to the collapse of the sections of walling in which they occur (for example, at the churches in Orford, Bawdsey and Alderton).

Septaria are widely used in Suffolk's Norman churches, most often in conjunction with Caen Stone (as seen in the Leper Chapel at Dunwich). Orford Castle provides one of the most impressive examples of the use of septaria as a building stone in Suffolk. Adjacent to the castle earthworks is an old quarry, from which some of the stone used in the construction of the keep is thought to have been obtained. Other examples of septaria can be seen at the Churches of St Ethelbert at Falkenham and All Saints at Hemley. Septaria also occur in the ruined remains of Blackfriars in Ipswich.

Figure 29: Leper Chapel, Dunwich. Septaria and Caen Stone.

Figure 30: Leper Chapel, Dunwich. Septaria.

Figure 31: Orford Castle, Orford. Septaria with Caen Stone dressings.

Neogene to Quaternary

Crag Group, Coralline Crag Formation

Boxstones (Boxstone Bed)

Boxstones are pale brown to pale grey-coloured, rounded pebbles found within an impersistent remanié deposit at the base of the Coralline Crag Formation in south-east Suffolk and north-east Essex, most notably around the Rivers Orwell and Deben. They represent the vestiges of marine sediments of the early Quaternary period that were deposited in this general area. Boxstone pebbles are considered to represent the waste material from mid-19th-century coprolite (phosphatic nodule) excavations, and formed a cheap, readily available source of local building stone.

Boxstones have a very restricted and localised use in Suffolk. The restoration of the wall fabric at All Saints' Church, Sutton includes some Boxstones. They are also recorded in the church walls at Alderton and Shottisham, and in the vestry of Melton Church.

Figure 32: All Saints' Church, Sutton. Quaternary Flint, boxstones, quartzite exotic pebbles and septaria.

Bryozoan Rock Bed (Rock Bed)

This golden yellow to yellow-brown shelly sand deposit within the Coralline Crag Formation has become cemented to form a hard limestone known as the Bryozoan Rock Bed (Rock Bed). This stone is unique to Suffolk and occurs along the south-eastern coastal strip, from just north of Aldeburgh to Gedgrave near Orford. The stone is readily cut and dressed into tabular blocks.

The mid-14th-century tower of the Church of St Peter at Chillesford provides one of the best examples of Bryozoan Rock Bed. Blocks of this stone required for recent restoration works at Chillesford came from Crag Farm Pit, near Sudbourne (some 5km to the east). Other examples of it can be seen at the Churches of St John the Baptist at Wantisden and St John the Baptist at Butley, a 15th-century extension to the chancel of All Saints' Church at Eyke and the boundary wall of the medieval Greyfriars Priory at Dunwich (repaired in 2013). With the possible exception of Orford Castle, the Rock Bed was seemingly not used by the Normans. It was employed mainly during the 14th to 16th centuries for lesser farm-related structures, general walling (such as along Quay Street and enclosing the churchyard in Orford) and repair work (for example, at Iken and Bawdsey).

Figure 33: Church of St Peter, Chillesford. Bryozoan Rock Bed, Quaternary Flint nodules, septaria and exotic pebbles.

Figure 34: Church of St Peter, Chillesford. Bryozoan Rock Bed.

Crag Group, Norwich Formation, Red Crag Formation

Red Crag ironstone

The Red Crag Formation crops out in southern coastal districts of Suffolk and in northern Essex. In some places, the relatively soft Red Crag sandstones have become impregnated and cemented by iron oxides to form decalcified ironstones. These are typically medium grained and dark purple-red in colour, and are sufficiently hard and durable to be employed as a building stone.

Red Crag Ironstone has a rather restricted area of use in south-east Suffolk. At the Church of St Mary of the Assumption at Ufford, roughly shaped blocks of ironstone occur in herringbone pattern courses in the north wall of the nave and as occasional quoins. At the nearby All Saints' Church at Eyke, up to 10 per cent of the wall fabric on the south side of the nave is Red Crag ironstone pebbles.

Figure 35: Church of St Mary of the Assumption, Ufford. Quaternary Flint, Quarry Flint, Red Crag ironstone and Bryozoan Rock Bed.

Figure 36: Church of St Mary of the Assumption, Ufford. Red Crag ironstone and Quaternary Flint nodules.

Various groups, various formations

Sarsen Stone

Sarsen stone is a hard quartzitic sandstone that typically occurs as rounded or elongate boulders, but sometimes as metre-scale slabs. It is grey to pale brown in colour, becoming distinctly creamy buff when weathered, and possesses a very fine-grained, saccharoidal (sugary) texture, comprising sub-rounded quartz grains set within a silica matrix (which is visible on fractured surfaces). Sarsen stone is very hard and resistant to weathering. Its surfaces are often smooth and may occasionally show poorly defined bedding structures.

Sarsen stone is seldomly encountered in Suffolk. It can be seen within a rockery at the Lower Arboretum in Christchurch Park, Ipswich. The stones here are believed to originate from excavations at Ipswich Dock during the 1840s. Many large Sarsen stone boulders were also extracted from the bed of the Orwell River during work on the Ipswich flood protection scheme in 1975. They were arranged to create a riverside feature upstream of Stoke Bridge, by the dock, in Pocket Park.

Quaternary Flint (Fluvio-glacial Flint, Field Flint, Beach Flint)

Quaternary Flint typically occurs as irregularly shaped nodules that are found lying on the surfaces of fields or as pebbles in fluvio-glacial sands and gravels and tills. The size of the nodules typically ranges from 80 to 200mm. The colour is variable: less weathered flint nodules or pebbles have a cream outer cortex with a darker coloured (greyish) interior; weathered flints, in contrast, or those that have lain in soil or superficial deposits for a long period of time, may be variously discoloured or bleached, and often have brown stained interiors due to the precipitation of iron hydroxides from percolating ferruginous waters. The weathered appearance of Quaternary Flint helps distinguish it from the much fresher looking Quarry Flint.

A combination of hardness, durability and resistance to weathering has resulted in Quaternary Flint being much used as a building stone in Suffolk. Many walls and buildings across the county include Quaternary Flint in one form or another. As a walling stone, Quaternary Flint was mainly employed as little-dressed nodules or pebbles laid randomly or to course. Knapped, faced, trimmed or cleaved faced forms of Quaternary Flint, used in a random fashion or as part of decorative arrangements, are also encountered with some regularity. Particularly fine examples of Quaternary Flint can be seen in the garden walls and buildings surrounding St Edmundsbury Cathedral in Bury St Edmunds.

Figure 37: Churchyard wall, Long Melford. Quaternary Flint nodules.

Figure 38: All Saints' Church, Sutton. Knapped Quaternary Flint pebbles with marine shells and other pebbles.

Figure 39: All Saints' Church, Hemley. Knapped Quaternary Flint nodules.

Figure 40: St Ethelbert's Church, Falkenham. Quaternary Flint, chert, quartzite, exotic stones and septaria.

Chert, quartzite pebbles and cobbles

Accumulations of Quaternary fluvio-glacial deposits in Norfolk encompass a diverse range of poorly sorted, relatively soft and unconsolidated sediments. These vary in composition, but sometimes contain harder pebbles and cobbles, which mainly comprise orange-brown to brown-coloured chert and quartzite. The latter are typically encountered in walls as hard, rounded, ovoid pebbles that may have derived from the Triassic Chester Formation of the West and East Midlands.

Suffolk's fluvio-glacial deposits were formerly exploited for construction materials on mainly a local scale, and the harder chert and quartzite pebbles and cobbles yielded as a by-product of this activity served as a convenient source of stone for nearby buildings and other walling. The use of chert pebbles and cobbles in Suffolk walls is not especially common, but quite widespread nonetheless. Where seen, such pebbles have often been used in conjunction with Quaternary Flint. The east-facing wall of Church Cottage at Lakenheath provides a particularly fine example.

Figure 41: Church Cottage, Lakenheath. Chert, quartzite pebbles and cobbles, and Quaternary Flint.

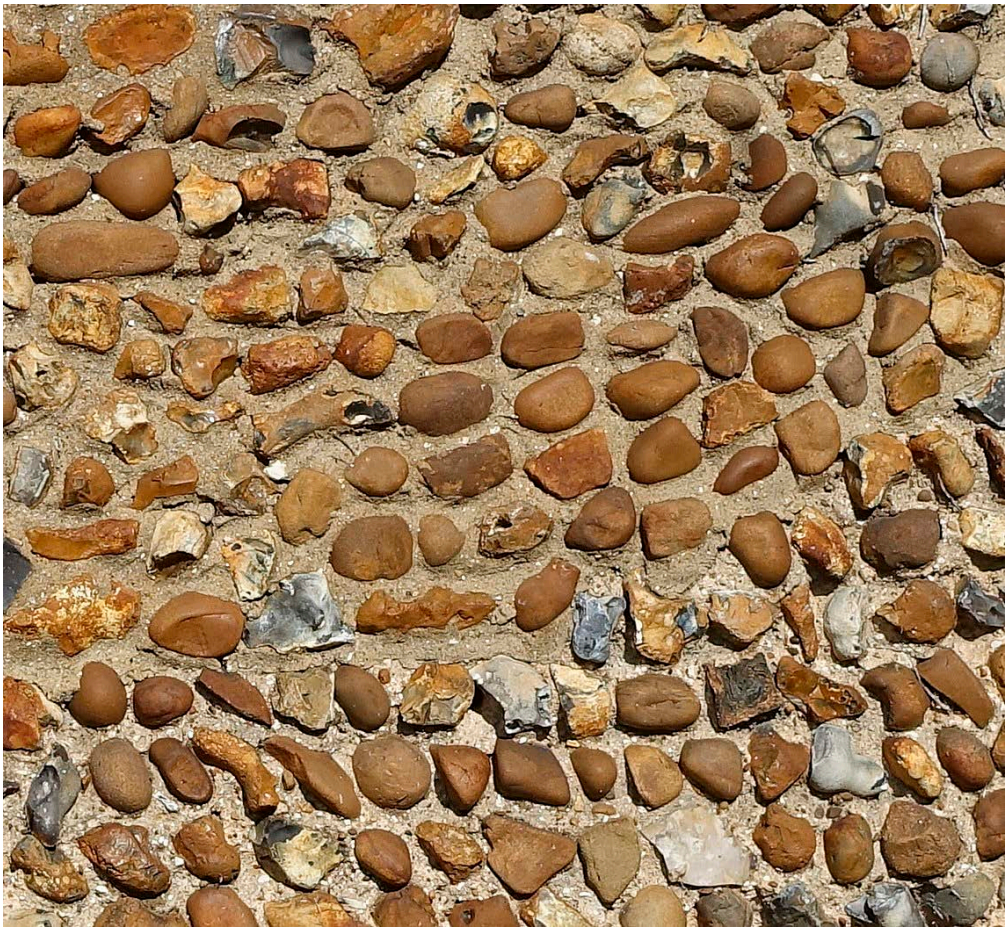


Figure 42: Churchyard wall of Church Cottage, Lakenheath. Chert, quartzite pebbles and cobbles, and Quaternary Flint.

4 Examples of Imported Building Stones

Although the Cretaceous bedrock succession and younger sedimentary deposits of Suffolk have yielded a variety of local building stones, ready supplies of good quality building stone are limited in some areas. Extensive use has, therefore, been made of stones imported into the county from other parts of England.

Sedimentary building stones

Carboniferous Sandstone, Derbyshire

Marsden Formation, Millstone Grit Group

A fine to medium-grained sandstone, with a buff, light orange or pink colouration. Carboniferous Sandstone is well bedded to massive, and some layers exhibit cross-bedding. Historically, over many centuries, several hundred quarries were opened in Derbyshire for the extraction of this stone type, which has achieved a national reputation for its durability and aesthetic qualities.

Figure 43: Boer War Memorial, Christchurch Park, Ipswich. Carboniferous sandstone pedestal.

Upper Carboniferous

Pennine Coal Measures Group, Elland Flags Formation

York Stone (general sense), West/South Yorkshire

Buff to pale grey or greenish-grey, typically fine-grained sandstones, which are often micaceous and laminated, but occasionally show small-scale cross-bedding features. Usually weathers evenly, but may separate along mica-rich horizons. In Suffolk, York Stone (or Yorkshire Flags) is employed mainly as paving stones or as plinths.

Figure 44: Christchurch Mansion, Christchurch Park, Ipswich. Yorkshire Flagstone paving.

Permian

Zechstein Group, Cadeby Formation

Red Mansfield Stone, Nottinghamshire

A distinctive, uniform, red-brown dolomitic sandstone that has seen very occasional use in Suffolk as a facing or decorative stone.

Figure 45: 59 Abbeygate Street, Bury St Edmunds. Red Mansfield Stone.

Middle Jurassic

Inferior Oolite Group, Lincolnshire Limestone Formation

Lincolnshire Limestone, Northamptonshire/Rutland

There are a wide range of Lincolnshire Limestone Formation building stones used in Suffolk. The name encompasses several varieties of Lincolnshire Limestone, including Weldon Stone, King's Cliffe Stone, Stanion Stone and Casterton Stone, but they cannot reliably be distinguished for a number of reasons. Ancaster Stone and Barnack Stone are provisionally retained as distinct named varieties of Lincolnshire Limestone on account of the features they typically and consistently exhibit when seen as isolated blocks in buildings.

The Lincolnshire Limestones incorporate pale cream to pale grey-coloured limestones, which weather to shades of buff-yellow. Textures may be ooidal and/or bioclastic. The stone may or may not display cross-bedding features, and it is variably porous. It has seen common use throughout Suffolk, especially for church dressings and quoins.

Figure 46: Church of St Peter and St Paul, Lavenham. Knapped flint and Casterton-type stone.

Figure 47: St Edmundsbury Cathedral, Bury St Edmunds. Lincolnshire Limestone and Clipsham Stone.

Ancaster Stone, Ancaster, Lincolnshire

A medium to coarse-grained, creamy white to pale yellow-coloured (although rather ochreous in places) ooidal and bioclastic limestone. Weathered surfaces commonly display a distinctive 'streaky bacon-like' patterning. In Suffolk, Ancaster Stone (along with other types of Lincolnshire Limestone) tends to have been used in the construction of prestigious buildings, especially cathedrals, churches and chapels.

Figure 48: Corn Exchange, Bury St Edmunds. Ancaster Stone and Portland Stone.

Barnack Stone, Barnack, Cambridgeshire

A typically hard, pale buff-coloured, medium to coarse-grained, shelly limestone cemented with sparry calcite. The stone usually displays cross-bedding, and differential weathering of its constituent grains (ooids and peloids of varying sizes and fossil shell debris up to 5mm in size) imparts a rough feel to exposed surfaces. In Suffolk, the stone has been employed mainly for the dressings of churches and other ecclesiastical buildings that pre-date the Reformation.

Great Oolite Group, Chalfield Oolite Formation

Bath Stone, Bath, NE Somerset and possibly Corsham area, Wiltshire

A creamy white to buff-yellow, ooidal limestone (freestone). This stone has been used occasionally in Suffolk for prestigious administrative buildings and in connection with Victorian new-build and church refurbishment schemes, especially as ashlar and window and door mouldings. A particularly noteworthy example of its use as ashlar is Ipswich Town Hall, which was constructed in 1878 in a grand Victorian architecture style.

Figure 49: Ipswich Town Hall, Ipswich. Bath Stone ashlar with Red Mansfield Stone pillars.

Calcaire de Caen Formation

Caen Stone, Normandy, France

An off-white to pale creamy yellow-coloured limestone with a fine-grained texture and few large fossils. It may exhibit spalling, and individual blocks of Caen Stone may also show uneven weathering. It has been employed only occasionally in Suffolk, in ecclesiastical buildings or fortifications dating to Norman times.

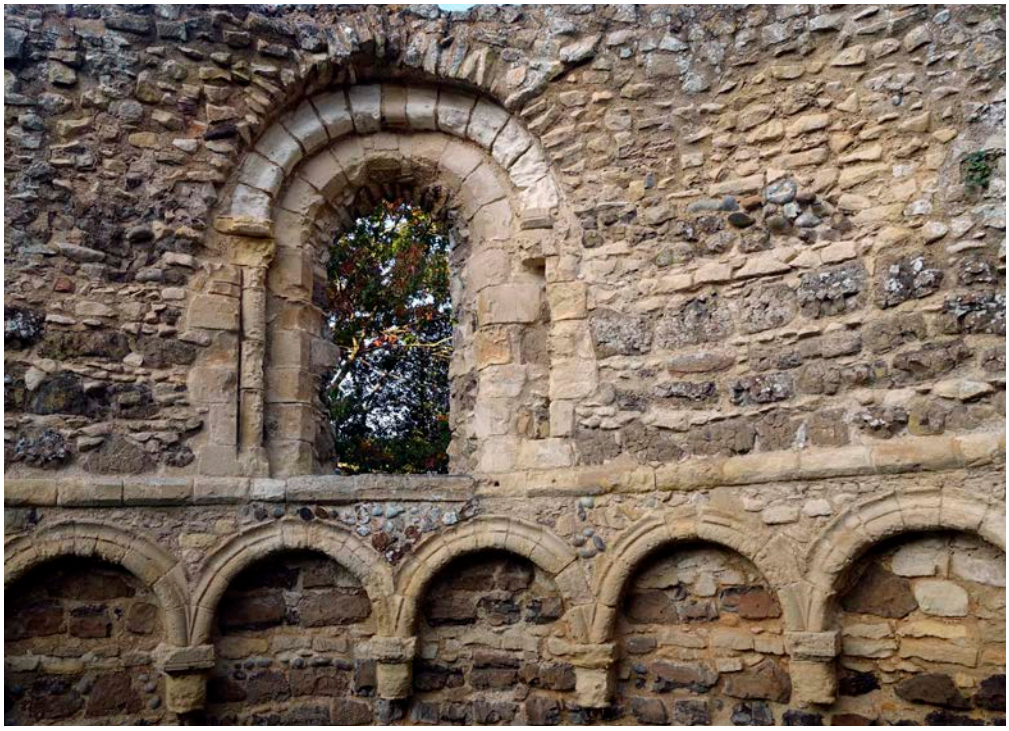


Figure 50: Leper Chapel, Dunwich. Caen Stone, London Clay septaria, flints and other materials.

Upper Jurassic

Portland Group, Portland Stone Formation

Portland Stone, Isle of Portland, Dorset

A near-white or very pale coloured limestone that (in its 'basebed' guise at least) is typically a fine and even-grained freestone. It has seen widespread use across Suffolk, especially in urban areas in carved form. It has been used for monuments, war memorials, gravestones, fountains and columns. Portland Stone is also employed as high-quality walling, notably in civil, administrative and financial buildings.

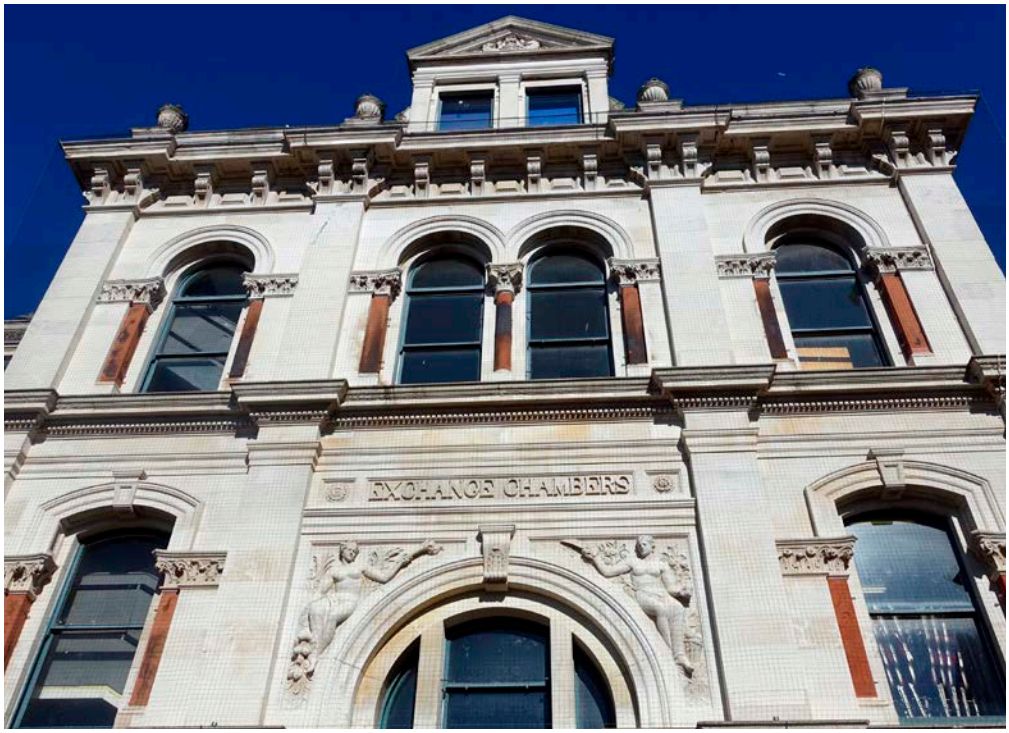


Figure 51: Exchange Chambers, Ipswich. Portland Stone ashlar.

Lower Cretaceous

Lower Greensand Group, Hythe Formation

Kentish Ragstone, Weald of Kent

A medium to coarse-grained, pale greenish-grey or pale brown limestone that contains greater or lesser amounts of quartz, glauconite and fossil shell debris. Kentish Ragstone has been employed only occasionally in Suffolk, and usually for the walling of ecclesiastical buildings. It may be found as dressed (typically rock-faced) tabular blocks or forming irregular random rubblestone patterns.

Figure 52: Methodist Church, Museum Street, Ipswich. Kentish Ragstone with Bath Stone dressings.

Upper Cretaceous

Chalk Group, Grey Chalk Subgroup, Lower Chalk Formation

Paradoxica Bed Stone, Norfolk

One of the Lower Chalk hardgrounds, the Paradoxica Bed Stone is a pale grey to pale cream or pink-coloured, splintery, chalky limestone. It is characterised by the presence of a ramifying network of fossil burrows, formed by small crustaceans. These Lower Chalk hardgrounds are used only very occasionally and locally as building stones in Suffolk. Where encountered, they usually occur as isolated rubblestone blocks in the walls of ecclesiastical buildings.

Figure 53: Leper Chapel, Dunwich. Paradoxica Bed Stone and septaria.

Igneous and metamorphic stone types

Granite, various sources including Devon and Cornwall

A coarse-grained igneous rock, often pale grey coloured (but other coloured varieties occur), comprising an interlocking network of grey quartz and white (sometimes pink) feldspar crystals. The latter may form distinctly larger crystals (termed phenocrysts) and display good morphologies. Smaller amounts of darker iron- and magnesian-bearing minerals and glinting flakes of mica are also usually present. Granite is very durable, and different types are employed in Suffolk. They have been put to various uses, and can be seen in dressed and polished form as a facing stone (on buildings such as banks, offices and so forth) or roughly dressed as paving setts, kerb stones and memorial stones, or within the fabrics of military fortifications.

Figure 54: Martello Tower, Aldeburgh. Brick on granite ashlar plinth.

Rhineland Lava (Niedermendig Lava), Niedermendig or Mayen, Eifel, Germany

Lavas in the Niedermendig-Mayen region of western Germany have been quarried since Roman times for the production of querns and grinding stones. They were transported to Britain from the Roman period onwards and were imported into East Anglia until well into the post-medieval period. Lava quern fragments are often recovered from mid and late Saxon sites; large quantities of such materials have been recovered from several mid-Saxon sites in Ipswich. Occasionally, lava quern fragments have been included in the wall fabrics of medieval buildings, especially churches. Pieces of Niedermendig Lava quern stone are very distinctive: they comprise a dark grey to black-coloured basaltic rock that is distinctly vesicular and rough surfaced.

Exotic pebbles, cobbles and ballast, various sources

A wide variety of exotic pebbles and cobbles are seen in the wall fabrics of many buildings, notably churches and ecclesiastical buildings (especially those in coastal areas). The range of different stones typically includes igneous granites, gabbros, dolerites and basalts, metamorphic gneisses and schists, along with white and pink quartzites, various sandstones and hard limestones. Some of these pebbles and cobbles are likely derived from the extensive deposits of boulder clay (till) and other superficial deposits that mantle eastern Suffolk. Others, however, given the common use of these stones in coastal areas, likely represent pieces of off-loaded ballast. Particularly fine examples of exotic pebbles and cobbles can be seen in the walls of St James' Church at Dunwich and the nearby ruin of Greyfriars friary (including the perimeter wall completed in 1307).

Figure 56: St James' Church, Dunwich. Exotic pebbles and cobbles.

Figure 57: St James' Church, Dunwich. Detail of the exotic pebbles and cobbles.

Metamorphic stone types

Welsh Slate

Several different types of roofing slate have been imported into and used across Suffolk, especially since mid-Victorian times. Purple and grey Welsh Slate, for example, has been widely employed in many of the county's villages and towns.

Figure 58: Shakespeare Lodge, Back Street, Lakenheath. Welsh Slate roof.

5 Further Reading

The Further Reading, Online Resources and Contacts guide provides general references on:

- Geology, building stones and mineral planning
- Historic building conservation, architecture and landscape.

There is also a separate glossary of geological terms.

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Figures

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