National Character Area profile:

43. Lincolnshire Wolds

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Introduction

As part of Natural England's responsibilities as set out in the Natural Environment White Paper[1], Biodiversity 2020[2] and the European Landscape Convention[3], we are revising profiles for England's 159 National Character Areas (NCAs). These are areas that share similar landscape characteristics, and which follow natural lines in the landscape rather than administrative boundaries, making them a good decision-making framework for the natural environment.

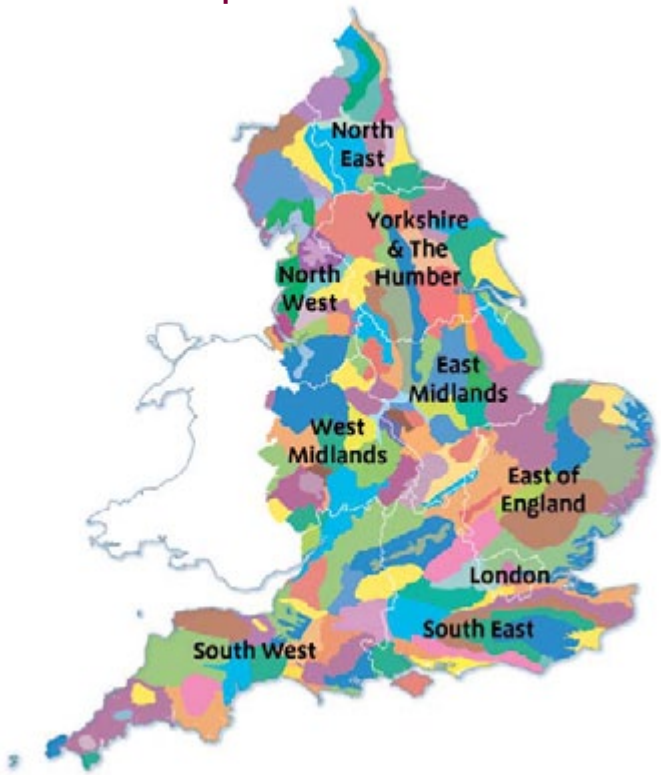
NCA profiles are guidance documents which can help communities to inform theirdecision-making about the places that they live in and care for. The informationthey contain will support the planning of conservation initiatives at a landscape scale, inform the delivery of Nature Improvement Areas and encourage broader partnership working through Local Nature Partnerships. The profiles will also help to inform choices about how land is managed and can change.

Each profile includes a description of the natural and cultural features that shape our landscapes, how the landscape has changed over time, the current key drivers for ongoing change, and a broad analysis of each area's characteristics and ecosystem services. Statements of Environmental Opportunity (SEOs) are suggested, which draw on this integrated information. The SEOs offer guidance on the critical issues, which could help to achieve sustainable growth and a more secure environmental future.

NCA profiles are working documents which draw on current evidence and knowledge. We will aim to refresh and update them periodically as new information becomes available to us.

We would like to hear how useful the NCA profiles are to you. You can contact the NCA team by emailing ncaprofiles@naturalengland.org.uk

National Character Areas map



[1] The Natural Choice: Securing the Value of Nature, Defra (2011; URL: www.official-documents.gov.uk/document/cm80/8082/8082.pdf)
[2] Biodiversity 2020: A Strategy for England's Wildlife and Ecosystem Services, Defra (2011; URL: www.defra.gov.uk/publications/files/pb13583-biodiversity-strategy-2020-111111.pdf)
[3] European Landscape Convention, Council of Europe (2000; URL: http://conventions.coe.int/Treaty/en/Treaties/Html/176.htm)

Summary

The Lincolnshire Wolds National Character Area (NCA) is a long, narrow band of rolling agricultural land dominated by a west-facing chalk escarpment approximately 50 m high. The area is characterised by a range of varied yet unified features including open, arable plateau hill tops, chalk escarpments, deep dry valleys with sinuous beech woods and isolated ash trees punctuating the skyline. The area is sparsely settled with many villages hidden within the folds of the landscape and modest country houses and farmsteads.

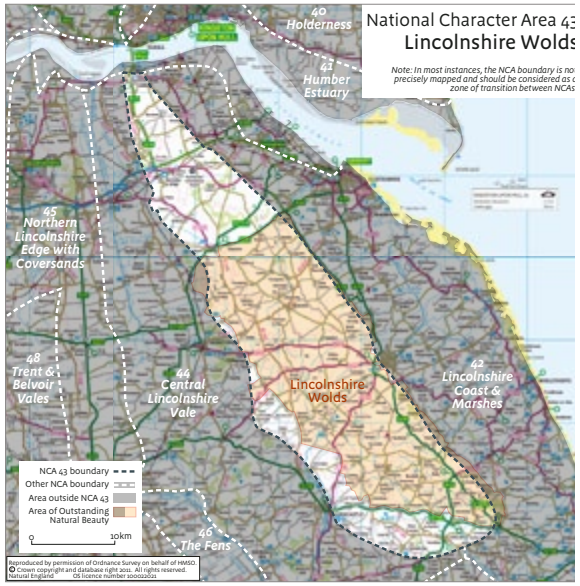
The landscape of the Wolds is strongly influenced by the underlying geology and the later glacial action that reshaped it. The solid geology is largely made up of a sequence of sandstones, clays, sandy limestones, ironstones and chalk deposited between 155 and 95 million years ago during the late Jurassic and Cretaceous periods. The chalk is capped in places by glacial deposits, while glacial meltwater channels have carved away parts of the Wolds to leave steep valleys. To the south-east, the overlying glacial till creates a rounded edge to the Wolds, and towards the southern end the chalk cap has been removed to reveal the Lower Cretaceous sands, clays and ironstones which form a series of low hills with gravel terraces. A variety of local materials, some of which are used as building material, are found across the area including sandy limestone, sandstone, ironstone and chalk, with striking red chalk being notable.

The soils closely reflect the underlying geology. Shallow, lime-rich soils predominate across the chalk plateau but many valley bottoms have lime-rich loamy soils. Sandy loams and heavier clay soils and localised wet areas in valleys reflect local sandstone geology and Jurassic Kimmeridge Clays.

Woodland cover is generally sparse but the trees and woods remain an important component of the landscape. The open skies and long views add to the character, creating an area recognised as a place of tranquillity and inspiration.

Sixty-two per cent of the area lies within the nationally protected landscape of the Lincolnshire Wolds Area of Outstanding Natural Beauty, which was designated in 1973 in order to conserve and enhance the natural beauty, outstanding views and tranquillity.

The NCA is an important food producing area and consists of a commercially farmed, predominantly arable landscape. Semi-natural habitats cover only a small area and are often under pressure. There is a nationally important assemblage of farmland birds which include skylark, lapwing, turtle dove and tree sparrow.



Click map to enlarge; click again to reduce.

The chalk aquifer is one of the main aquifers of the East Midlands, providing a major regional resource of freshwater. The resulting springs and chalk streams and interconnected blow wells found throughout the Lincolnshire Wolds provide a nationally important wildlife habitat.

The Lincolnshire Wolds are generally sparsely populated, with villages predominantly lying hidden at the foot of the slopes. Only a few small towns, such as Barnetby, Spilsby and Caistor, are found within the Wolds with the larger market towns such as Louth and Horncastle located on the periphery of the NCA. These settlements have all retained much of their historic built character.

The Wolds is a treasure trove of heritage dating back many thousands of years. There are many ancient burial sites with monuments including Neolithic long barrows and bronze-age round barrows. There is also evidence of Roman occupation and a number of Roman roads are still in use. An interesting aspect of the historic environment is the high concentration of deserted medieval villages and the remains of these are often still visible in the landscape. There are over 100 abandoned settlements, representing one of the highest concentrations in the country. Remnants of ridge and furrow can also be seen, showing a legacy of medieval ploughing and cultivation in an open field system. Another aspect of the historic environment is numerous moats indicating a defensive purpose such as the medieval moated site at Brinkhill.

The area has inspired many artists, writers and poets including Tennyson, the 19th-century Poet Laureate, who came from Somersby. This part of Lincolnshire attracts increasing numbers of visitors and a variety of cultural and community activities continue today in celebration of the Wolds' rich local heritage. The Viking Way long-distance footpath passes through the Wolds as does the National Cycle Network.

St.Mary's Church, Barnetby-le- Wold. An ancient church on the edge of the Wolds as they slope down to the Humber.

Statements of Environmental Opportunity

- **SEO 1:** Protect, enhance and promote the rolling chalk landscape of the Lincolnshire Wolds with its open plateaux, outstanding long views, enclosed valleys, important habitats and high sense of tranquillity. Improve opportunities to enhance people's access and enjoyment of the Wolds' special qualities and the natural beauty.

- **SEO 2:** Protect and manage the Lincolnshire Wolds' water resources and wetland habitats, including the Lincolnshire chalk aquifer, conserving the groundwater resource and biodiversity of the chalk streams by working in partnership to manage issues affecting water flow and quality at a catchment scale.

- **SEO 3:** Maintain sustainable and productive agricultural practices for the continued provision of food and for the important contribution that farming makes to the sense of place. Enhance farmland habitats and expand and connect semi-natural habitats such as species-rich grassland, woodland and hedgerows to benefit biodiversity, soil and water quality.

- **SEO 4:** Protect and appropriately manage the area's rich historic environment and geodiversity for its contribution to local character and sense of identity and as a framework for habitat restoration. Ensure that the wide range of historic features and geodiversity assets are recognised, promoted and valued.

Walkers in the Lincolnshire wolds.

Description

Physical and functional links to other National Character Areas

The Lincolnshire Wolds is a long, narrow; north–south aligned National Character Area (NCA) stretching between the Humber and the Wash. It is situated on the highest land in Lincolnshire, giving long views and strong visual links with adjacent NCAs. To the west there are views over the Central Lincolnshire Vale towards Lincoln Cathedral and the wider Trent Valley, and to the east of the Lincolnshire coast and marshes and the North Sea. To the north the Wolds subside to the Humber Estuary and to the south lie the extensive Fens.

Sixty-two per cent of the NCA is designated as an Area of Outstanding Natural Beauty (AONB), which also extends into the Central Lincolnshire Vale NCA and the Lincolnshire Coast and Marshes NCA.

The area is separated into the 'Chalk Wolds' to the north with geological chalk formations extending into the Yorkshire Wolds, and the 'Wolds Scarp, Ridges and Valleys' further to the south and west.

Springs and chalk streams are characteristic of the area and the headwaters of several rivers, including the Bain, Waring and Lymn, rise in the Wolds. The Great Eau and Waithe Beck drain to the North Sea via the Lincolnshire Coast and Marshes NCA. The River Bain drains south through the Central Lincolnshire Vale NCA where it meets the River Witham, while the River Lymn drains south through the southern edge of the Lincolnshire Coast and Marshes NCA to the Great Steeping River. There is a large chalk aquifer underlying the Lincolnshire Wolds which also extends beyond it. This is a regional resource which is a major supplier of water for industry, irrigation and domestic supplies.

No major settlements lie within the Lincolnshire Wolds although several A roads link the surrounding market towns and the popular coastal destinations to the east. The railway network also acts as a link, particularly in the northern part of the NCA. Here the distinctive Humber Bridge crosses the Humber Estuary where the Wolds meet the Humber Estuary NCA at Barton-upon-Humber.

A number of historic routes traverse the higher ground of the high Wolds. More modern trails such as the Viking Way long-distance footpath link to the Humber, extending through the area towards Rutland. The National Cycle Network's Hull to Harwich cycle route also crosses the Lincolnshire Wolds.

Although the NCA is generally unwooded in character, there are some significant areas of woodland, particularly on the lower-lying clay soils overlapping with the adjacent Lincolnshire Coast and Marshes NCA. A number of estates within the NCA are well wooded, including the one at Brocklesby.

Key characteristics

- Rolling chalk hills and a predominantly agricultural landscape with a pronounced scarp edge to the north and west affording panoramic views across the surrounding land.
- A diverse geology of chalk, sandy limestone, ironstone and clay gives rise to a combination of elevated plateau and deep-sided dales. Soils are generally shallow and lime rich with rich loamy soils associated with valley bottoms. Typically sandy loams dominate the Lymn Valley with permeable loams in the Bain Valley which are interspersed with clay soils associated with Kimmeridge Clay beds.
- Predominantly arable, but some pasture fields with rectilinear patterns and clipped hawthorn hedgerows. Farmland habitats are found together with farmland birds including skylark, linnet, yellowhammer, reed bunting, corn bunting, yellow wagtail, curlew, tree sparrow, grey partridge, bullfinch and turtle dove.
- Woodland is limited particularly to the north but there are occasional shelterbelts, hedgerow trees and scattered beech clumps. Important alder carr woodland is associated with some of the valleys in the south-west.
- Isolated chalk and neutral grasslands typically on the steepest uncultivated slopes.
- Valuable semi-natural acidic mires are found in the valley marshes of the Lymn and Bain. The broader south-west valleys of the rivers Lymn and Bain have tree-lined watercourses. The mixed farmed landscape of irregular medium-sized fields in the south-west valleys provides contrasts with the arable-dominated plateau.
- Broad grass verges up to 20 m on some roads and historical tracks provide valuable species-rich linear habitats thought to be remnants of pre-enclosure pastures.
- Chalk springs and flushes and chalk stream habitats supporting submerged plants such as water crowfoot, a rich invertebrate fauna and flagship species such as otter, water vole, kingfisher and brown trout.
- A historically and archaeologically rich landscape of small parklands and modest country houses, ancient trackways, west–east salters' roads, deserted or shrunken villages and prehistoric round and long barrows.
- A sparse settlement pattern of small market towns and small nucleated villages (often in sheltered valleys) and scattered farmsteads. The settlements are predominantly linked by west–east A roads linking to coastal areas.
- A diverse geology gives rise to a variety of building materials including brick, sandy limestone, sandstone and ironstone with churches built of local stone.
- Development of wartime airfields including Kirmington (now operating as Humberside International Airport), Elsham Wolds, Binbrook, Ludford and Kelstern.

Arable farmland, woodland, hedgerows and gently rolling hills near Horncastle.

The Lincolnshire Wolds today

The Lincolnshire Wolds NCA is predominantly a rolling landscape of open, rural character. The distinctive west-facing chalk escarpment is a dominant feature. Steep-sided dry valleys, open plateau hilltops, strong escarpments, long, open views and planted beech woods also contribute strongly to the distinctive sense of place. Much of the NCA is nationally designated as an AONB for its natural beauty and tranquillity.

Lying mid-way between Lincoln and the East Coast, the chalks Wolds rise to over 150 m along their western edge, the highest point being at Normanby le Wold. The underlying Lower Cretaceous strata are revealed in the bottoms of the valleys and at the foot of the scarp slope. These strata include ironstone, limestone and sandstone which creates a hummocky landscape punctuated by springs and isolated landslips, for example at Nettleton and Hainton. To the south-east, the overlying glacial till creates a rounded edge broken only by the deep valleys at Louth and Calceby. Towards the southern end of the Wolds, the chalk cap has been removed to reveal the Lower Cretaceous sands and clays.

The soil patterns are a close reflection of the solid and drift geology. To the north, plateau tops are dominated by light, chalky soil. On the west scarp edge there is a striking variation of colour and texture reflecting the underlying Red Chalk and Lower Cretaceous beds. To the south-east the clayey tills give rise to heavy, seasonally waterlogged soils whereas near the Lymn Valley, Spilsby Sandstone provides the parent material for well-drained, sandy loams. In the Bain Valley there are deep, coarse permeable loams except where the presence of Jurassic Kimmeridge Clays gives rise to localised wet areas.

Farming is an important part of life in the Lincolnshire Wolds. The quality of the soil underpins the provision of food.

Despite the overall cohesive character of the Wolds, variation in the underlying geology has led to some distinct subdivisions within the landscape. The pronounced and sinuous north-west-facing chalk scarp which runs from South Ferriby, on the Humber, down to North Willingham is steep and hummocky, and lined by compact springline villages at the foot of the slope. Rough pasture, scrub and woodland areas clothe the scarp, along which there are dramatic views. The high, open arable plateau of the Wolds themselves stretches from the Humber

down past Louth. Within this upland rolling plain are a series of inward-facing valleys, for example at Rothwell and Cuxwold on Laceby Beck. The planting of woodland on the steep slopes serves to emphasise the valley features. A series of villages are located in the dry valleys which face eastwards. Another distinct area of the NCA are the ridges and valleys of the south-west, marking the edge of the chalk outcrop. Between the villages of Donington on Bain and Tetford, an internal escarpment faces south-west overlooking ridges of glacial drift and valleys cut into sandstone. Three rivers, the Bain, Waring and Lymn, drain southwards through these valleys. River valley floors are marshy and alder carr woods are common. In the south-east claylands, the chalk ridge is masked by clay till which creates more rounded forms as the Wolds drop away to the Middle Marsh around Alford. Ancient oak and ash woodlands give this area a distinctive feel.

Some 18 main-stem rivers such the Great Eau, Waring, Bain and Lymn rise in the Wolds and are important for their biodiversity.

Springs, which originate from the chalk aquifer that underlies the higher parts of the Wolds, are common and the resulting chalk streams provide internationally rare priority habitat. Wild brown trout, European eel, grayling and brook lamprey are present in the streams, as well as otter, water vole, kingfisher, rare invertebrates including flatworm species, and the plants arrowhead and water crowfoot.

Woodland cover in these areas is sparse, particularly to the north, while to the south sinuous beech woods and younger mixed plantations follow the steeper slopes of the deep valleys. Isolated beech and ash trees form occasional markers. On the north-west scarp there is a mixed pattern of woodland, scrub and pasture created by the hummocky landform and poorer nature of the soils. The extensive mixed woodlands of the Brocklesby Estate to the north-east provide the other major area of woodland cover. Here some 1,200 ha of woodland were planted between 1750 and 1950. The alder carr woodlands on the heavy, seasonally waterlogged clay soils in the south are important nationally, as is the ancient woodland at Tetford. A number of moth species visit the woodland and the numbers of butterflies are showing signs of recovery.

This is an important food producing landscape and the rural economy is mainly based on arable farming with large cereal units together with some pasture land. Large rectilinear fields on the rolling plateau are enclosed by hawthorn hedges. To the south-west there is a more complex pattern of medium-sized irregular fields where grazing combines with crop cultivation. Pasture is less common now but livestock and sheep in particular have traditionally had great importance in the area. The large Lincoln Longwool sheep, which is now a rare breed, has a long association with the Lincolnshire Wolds. Grassland remains an important land use where mixed farming occurs and provides an important farmland habitat. Semi-natural habitats within this NCA are important because of the geology but the extensive arable areas mean that there are limited semi-natural habitats remaining. Isolated chalk grasslands located on the steepest uncultivated slopes and the broad, herb-rich road verges along ancient trackways and drover roads provide species-rich grassland habitats. Further important pockets of grassland occur in the churchyards and redundant quarries and pits found across the Wolds. Hedgerows provide linear habitats and these and other farmland habitats are important for farmland birds, with a nationally important 'Arable Assemblage East Midlands' including breeding lapwing, turtle dove and yellow wagtail.

The whole area is rich in archaeological remains, including ancient trackways, tumuli along the scarp and a high concentration of deserted medieval villages. Bronze-age round barrows and an important collection of Neolithic long barrows are located on thin chalk soils on the edges of escarpments and ridges.

Long barrows are particularly vulnerable to damage from cultivation and these earthworks are especially notable as they are ancient and very rare. Significant archaeological sites including the Neolithic long barrows continue to be at risk from arable cultivation, and remain on the Heritage at Risk register.

Georgian manors and parkland, avenue tree plantings and wide roadside verges are also distinctive features. There are no great parklands but a series of smaller estates, for example at Harrington and South Ormsby. These often include gracious but modest Tudor or Georgian country houses with Victorian farmsteads and farm workers' cottages. Bolingbroke Castle, the birthplace of Henry IV, is now in ruins but occupies a prominent setting at the foot of the southern sandstone scarp.

Sparsely settled, the NCA's distinctive topography and underlying geology act to hide the villages within the folds of this east Lincolnshire landscape and church spires characteristically rise out of the rolling landscape. The settlement density is marginally higher in the south-west river valleys while on parts of the high Wold there is no settlement. In the north the villages are simple and nucleated while in the south a rectangular plan is found with lanes enclosing a central area of cottages, farmhouses and paddocks in villages such as Old Bolingbroke. Settlements tend to follow physical features, such as the foot of the north-west scarp as at Tealby and Claxby, or the deep valleys within the chalk uplands as at Rothwell. There are no major urban areas within the Wolds but a series of small market towns lie at the foot of the hills including Horncastle, Spilsby, Louth and Caistor.

The area is not distinguished by a unified pattern of building material or style. Brick walls with pantile roofs are most common in domestic buildings. The varied geology is reflected in the variety of local material typically found as building material, particularly in many churches and older buildings; this includes Tealby Limestone, Spilsby Sandstone and local ironstones. Newer building has occurred near Binbrook where extensive housing was introduced to serve the airfield.

Large chalk quarries existed in the north of the Wolds at South Ferriby and Melton Ross and to the south at South Thoresby, and mineral extraction continues, albeit on a relatively small scale.

The road network generally follows ancient east–west routes across the Wolds and the A roads are particularly busy in the high season with tourists visiting the coastal resorts; the M180 in particular causes intrusion.

Visitors come to the area, especially in the summer months when they visit the nearby East Coast and the Lincolnshire Wolds. Located on the edge of the Wolds, market towns such as Louth (just beyond the NCA) with its steepled church attract tourists. The network of footpaths attracts walkers to the area and the annual Lincolnshire Wolds Walking Festival is a popular attraction for both residents and visitors. The Viking Way long-distance footpath which starts at the Humber passes through the area towards Rutland. Cycling is another popular pastime in the Wolds and the National Cycle Network passes through the NCA. Motorcyclists are also attracted to the relatively quiet roads of the Wolds and to the circuit at Cadwell Park.

The landscape through time

The Wolds are predominantly a dissected chalk table, falling gently eastwards from a western scarp face. The bedrock was laid down in marine conditions over a period of some 60 million years during the Upper Jurassic and Cretaceous periods. The lowest exposed rocks include the Jurassic Kimmeridge Clay which passes upwards into the younger Spilsby Formation; this predominantly consists of sandstones and spans the transition from the Jurassic to the Cretaceous period. Above this is the Lower Cretaceous Tealby Formation made up of clays and sandy limestone and ironstones. The Chalk, including the characteristic Red Chalk, is the youngest solid rock in the NCA (95 million years old) and is made up of millions of microscopic marine creatures. The solid geology of the area has since been extensively shaped to create the varied geology and landform that exist today. The bedrock was extensively moulded by glacial and periglacial action during the last ice age, when the drainage pattern was altered by the deposition of sands, gravels and clay till. The previous pattern of eastward drainage was locally blocked by ice tills which resulted in the cutting of several glacial meltwater channels, particularly in the south. Glaciers stripped away the chalk to expose Lower Cretaceous and even a few Upper Jurassic Kimmeridge sands, clays and ironstones, and shape the prominent west-facing chalk escarpment which dominates much of the area. The exposed Spilsby Sandstone to the south formed localised pockets of acidic soil with the clays producing seasonally waterlogged areas.

The area has a long history of farming as a result of its easily-worked chalk soils and loams. The present landscape of the Wolds is primarily the result of the enclosure of a largely typical open-field farming regime, and the subsequent changes to the associated nucleated settlement pattern. The earliest enclosures are to be found in close proximity to historic settlements. This is quite common

Hoe Hill, at 127 metres, is one of the highest points in the area and an outlier of Roachstone.

in Lincolnshire and represents an historic trend from arable farming to livestock rearing. Typically this was undertaken in order to raise sheep for wool production, which could then be sold. However, in the Wolds, these ancient enclosures are both more extensive than in the county as a whole, and more widespread, indicating that livestock made a proportionally larger contribution to the medieval economy.

Later enclosure typically follows the same planned form as elsewhere in the county. The pastoral history of the area has historically been closely allied to the fortunes of the neighbouring marshes and fens. In the later medieval period, and in the post-medieval period, wealthy Wold's farmers would rent grazing land on the marshes in order to fatten their stock on the rich grasslands close to the sea. The many east-west aligned roads and tracks, perhaps initially intended to provide access to the coastal salt industry, would have served as drove roads taking livestock between the two areas.

Visible archaeology today includes the many barrows which cap the hill tops, such as Six Barrows at Tathwell. It is the Neolithic long barrows found in this location that are particularly notable – they are very rare because of their great age. Located on thin chalk soils on the edges of escarpments and ridges, they are particularly vulnerable to damage from cultivation; they are often, however, found under arable cultivation and are therefore at high risk on the Heritage at Risk register.

The Lincolnshire Wolds have produced evidence of human remains in the 1,000-year-old burial site at the Saxon church at Barton-upon-Humber. The significance of these remains lies in their representation of the pathology of an isolated community from circa 950 ad onwards.

In the Neolithic period, early settlement concentrated on the highest, drier ground of the high Wolds. Later, in the Bronze and Iron Ages, settlement extended onto chalk in the southern Wolds, for example at Skendleby. From the Iron Age the chalk uplands had a well-established network of trackways; High Street and Bluestone Heath Road are examples of this. Many of the roads are still in use, for example Caistor High Street linking Horncastle and Caistor. These two important market towns were fortified in Roman times. Roman occupation was equally widespread, linked by major roads and by east–west tracks related to the coastal salt industry.

The area's village-based settlements have their origins in the late first millennium AD, many bearing Saxon or Danish place name elements. Village names with 'ham' or 'ton' are probably Saxon, while names ending in 'by' or 'thorpe' are of Danish origin. Depopulation of the Wolds villages began early, partly owing to epidemics and poor harvests in the 14th century, and partly through the actions of powerful landowners keen to turn arable land to pasture in order to capitalise on the value of sheep rearing in the 15th and 16th centuries. As a result of all these changes the mixed arable and grazing landscapes of the earlier medieval period gave way to extensive enclosed pasture from the 16th century onwards into the early 19th century.

There is evidence of a relatively high number of deserted (and shrunken) medieval villages across the Lincolnshire Wolds providing an insight into the area's interesting history. There are over 100 abandoned settlements, with this being one of the highest concentrations in the country. Remnants of ridge and furrow can also be seen, showing a legacy of medieval ploughing and cultivation in an open field system. Another aspect of the historic environment is numerous moats indicating a defensive purpose such as the medieval moated site at Brinkhill or as a status symbol.

Monasteries were once situated on the edge of the Wolds (for example North Ormsby) and evidence of priories can also be found (such as Orford Priory) with many of the Wolds' churches demonstrating the prosperity of the area when they were built. One source of income for priories was farming, particularly sheep for wool. The Dissolution of the Monasteries brought this era to an end around 1536 and caused the break-up and sale of former monastery land to wealthy individuals and hence the rise of post-16th century small estates.

A period of enclosure in the 17th century was concerned with improving arable production and between 1760 and 1850 the landscape was transformed by the Parliamentary enclosures, sweeping away the common pasture and huge open fields. Miles of hawthorn hedges were planted to enclose large rectilinear fields, and new Georgian manors, parks and farmsteads were created away from the villages. For example, the Brocklesby Estate's 400-ha park and woodland were laid out in 1770s by Capability Brown. Through a new interest in hunting and shooting, shelterbelts and avenues were planted in the open landscapes, while broad drove roads up to 20 m in width were created to provide grazing for sheep headed for the coastal grazing marshes. The lustre wool from Lincoln Longwool sheep was much prized and was also exported. The development of estates continued through the Victorian period and is evidenced by estate workers' cottages such as those at Wold Newton. These changes have made the Wolds into one of the most distinctive estate landscapes of the Agricultural Revolution in England, broadly comparable in terms of the date of the changes and their patterns (large fields and courtyard-plan farmsteads) with the Yorkshire Wolds to the north.

The area still retained a substantial number of villages until the final phase of enclosures in the later 18th and early 19th centuries, maintaining a sparse and dispersed settlement pattern, especially on the high Wolds. In the north the villages remained simple and nucleated while in the south a rectangular plan with lanes enclosing a central area of cottages, farmhouses and paddocks emerged, now seen in villages such as Old Bolingbroke. Owing to the varied geology, the Wolds did not develop a unified pattern of building materials or styles. The local chalk was generally a poor building material, being crumbly and weak, but was used in medieval buildings such as the the now ruined church at Calceby (meaning the farm or small settlement on the Chalk), later being replaced by brick or other stone. In the north-west, the locally quarried

Nettleton Valley was once the home of Roman occupiers and of early ironstone mining activity.

Tealby Limestone and Claxby Ironstone were used and at Nettleton, where the buildings are a rich ochre colour, ironstone was utilised. To the south, the distinctive green or brown Spilsby Sandstone, although rather soft, was used in the more ornate 14th- and 15th-century churches built with the wealth of the wool industry. For domestic buildings, brick and render walls with pantile roofs were preferred. The Louth architect James Fowler is noted for his work in local churches, particularly at Binbrook and Ludford.

Pasture was important for cattle and sheep and ley pasture rotation was once common practice, although it is now rare. Changes in farming practice in the 20th century further altered the farmed landscape of the Wolds. This involved a shift to an even larger scale of arable production, often with significant loss of habitats such as unimproved grasslands, hedges, streams, ponds and woodland copses. While most permanent calcareous grassland disappeared during the period of the Enclosure Acts, the decline continued in the 20th century through a combination of ploughing, agricultural 'improvement' and neglect leading to scrub encroachment. As a result, some of the best surviving grassland habitats are restricted to the wide roadside verges.

Aside from agricultural intensification, 20th-century influence has been less marked than that of preceding years, but includes military land use – most notably airfields such as Binbrook (owing to its good drainage), many of which continued in use into the Cold War period, and the late 1930s radar station at Stenigot. Wartime airfields were often developed for industrial purposes. Humberside International Airport, previously RAF Kirmington, was extended in 1992 and has seen significant growth in cargo throughput and general aviation activity. There is a national motor racing circuit at Cadwell Park.

Following a number of years of consultation and landscape assessments, a large proportion of the Wolds was designated as an AONB in 1973. This ensured national recognition and protection on account of the area's natural beauty – comprising its wildlife, physiographic, cultural and heritage features, all of which combine to create the area's unique sense of place.

The main roads are generally A roads, including the A16 on the eastern edge; there is also the M180, which opened in 1979. To the north the rail networks cross the area with stations at Barton-upon- Humber and Barnetby le Wold.

Other modern impacts include infill housing, quarrying and the construction of irrigation reservoirs to support cropping. Telecommunications masts and power cabling infrastructure have had significant impacts on the visual character of the area. Sourcing renewable energy has led to wind farms adjacent to the NCA and singular/paired wind turbines are a more recent issue.

The areas of land planted for biofuels and biomass have increased in recent times to supply anaerobic digesters and power plants located on the Humber.

In the agricultural landscape many areas have been brought under Environmental Stewardship, which has led to improved management of sites. Since 2000 data shows a dramatic increase in managed boundary features with 1,877 km under Environmental Stewardship options, mainly through the Entry Level Scheme (2011). The total length of hedgerow being managed has increased, resulting in tightly cropped hedges filling out and becoming taller and wider.

Ecosystem services

The Lincolnshire Wolds NCA provides a wide range of benefits to society. Each is derived from the attributes and processes (both natural and cultural features) within the area. These benefits are known collectively as 'ecosystem services'. The predominant services are summarised below. Further information on ecosystem services provided in the Lincolnshire Wolds NCA is contained in the 'Analysis' section of this document.

Provisioning services (food, fibre and water supply)

- **Food provision:** The Lincolnshire Wolds are an important food production area with 50 per cent of soils in the NCA classified as Grade 2 and 43 per cent being Grade 3. Grade 1 agricultural land amounts to 2 per cent and 3 per cent is Grade 4 with non-agricultural land/urban as the remaining type. Approximately 50 per cent of the farmed area is devoted to cereals and 19 per cent is grassland with predominantly sheep and cattle. Pig farming is also important, but in recent years livestock numbers, including pigs and sheep, have been decreasing. Crops such as oilseed have increased rapidly.

- **Water availability:** The geology of the area has led to the formation of a major aquifer under the NCA. The Lincolnshire chalk aquifer is located in this NCA and is regionally important in terms of public water supply, industry and agriculture. The demand for potable water transfers have been growing in Lincolnshire[4] and little surplus groundwater is available. The aquifer currently has a Catchment Abstraction Management Strategy (CAMS) 'over abstracted' status[5] Abstracted water used for agricultural irrigation and drinking water affects water levels in drought conditions and licences are constrained in order to manage saline intrusion along the south bank of the Humber Estuary and to help to minimise environmental impacts at low flows.

Farming plays a major part in the Lincolnshire Wolds where fields are predominantly arable.

There are a number of rivers which rise in the NCA including the Great Eau, Lymn, Bain and Waithe Beck. The waterbodies in the northern part of the NCA – Laceby Beck and Waithe Beck – are 'over abstracted' according to the CAMS for the area. The Great Eau and Lymn are 'over licensed' while the Bain is assessed as having 'no water available'.

[4] *The Grimsby, Ancholme and Louth Catchment Abstraction Management Strategy*, Environment Agency (April 2006)

[5] *River Witham Catchment Flood Management Plan Summary Report*, Environment Agency (December 2009); *Humber River Basin Management Plan, Annex A: Current state of waters*, Environment Agency (December 2009); *Anglian River Basin Management Plan*, Environment Agency (December 2009)

Robust abstraction control is required in order to protect Lincolnshire chalk streams and calcareous springs for their biodiversity. Abstraction strategies are proposed that make use of water available under higher river flows and take pressure away from low natural river flows. This should help to counter the rising pressure on water resources from irrigation reservoirs to support arable cropping.

- **Genetic diversity:** A number of specific breeds of farm animals have strong connections with Lincolnshire in terms of their provenance. These include Lincoln Red cattle, Lincoln Longwool sheep, Meatlinc sheep (a relatively new breed) and Lincolnshire Buff fowl.

  Lincoln Longwool sheep have been popular in the past for the production of both meat and lustre wool, and have a long association with the Lincolnshire Wolds. They now have rare breed status – deemed 'At Risk' by the Rare Breeds Survival Trust, with more stock crucially needed to improve their chances of survival. Lincoln Red cattle were similarly widely grazed across the mixed farms of the Wolds but the original stock of Lincoln Red now has 'Vulnerable' status, with an increase in numbers required to ensure their long-term survival.

Regulating services (water purification, air quality maintenance and climate regulation)

- **Regulating soil erosion:** Soils within the NCA vary according to the local geology but they are generally thin and light. Soil erosion is likely to occur more on steeper slopes under arable production where cultivated or bare soil is exposed or where soils are becoming compacted. Soil erosion is impacting on water quality and causing sedimentation. Part of the North Lincolnshire Priority Catchment is located in the NCA where soil loss leading to sedimentation of watercourses is identified as a particular issue.

  Part of the Lincolnshire Coast and Rivers Priority Catchment is located in the south of the NCA including the River Lymn and the Great Eau. Here, sedimentation (caused partly by enhanced soil erosion) has a major effect on the ability of the Great Eau to support populations of salmon and trout, as sediment covers the gravel bed where spawning takes place. By reducing soil erosion the biodiversity (including fish populations) in the watercourses would improve. More sustainable management of the land within the catchments of these chalk streams, and increasing the amount of semi-natural habitat adjacent to watercourses, can lead to better regulation of soil erosion.

- **Regulating soil quality:** Most of the soils are Grade 2 and 3 and are in agricultural use. The thin chalky soils have a low carbon content of 0–5 per cent and there is a risk of compaction in certain soils.

  Carbon storage could be improved by increasing the organic matter content of cultivated soils and reducing the frequency and area of cultivation. Cultivation practices need to address organic content, such as extending grasslands where appropriate and ensuring that nutrient inputs are carefully managed, adhering to nitrate vulnerable zone guidelines. This type of practice could improve soil quality, benefiting farming as well as biodiversity.

  The role of soil quality in water filtration to the aquifer and water pollution is of significance to groundwater quality in the major chalk aquifer and to the biodiversity of chalk streams.

- **Regulating water quality:** Since the chalk aquifer is regionally important for water supplies and chalk stream biodiversity is influenced by water quality, regulating water quality is very important in the Lincolnshire Wolds.

Some 99 per cent of the NCA is a nitrate vulnerable zone and in the more urbanised area of the North Lincolnshire Priority Catchment high nitrate levels have been identified in groundwater resources and high phosphate levels and sedimentation in surface streams.

The priority areas in terms of protection of water include Ground Water Management Units identified within the Grimsby. Ancholme and Louth Catchment Abstraction Strategy. In particular the Grimsby, Ancholme and Louth Chalk Unit comprising a groundwater body covering the northern chalk outcrop in the north of the NCA and has been classed as being of poor status for the Water Framework Directive. Nitrate concentrations show a significant and sustained upward trend. Water abstraction and diffuse agricultural pollution are an issue as is point source pollution, mainly from small sewage treatment works attached to villages and clusters of septic tanks where houses are unsewered.

Within the NCA steep slopes increase rates of run-off, potentially adding to the amount of chemicals and sediment from cultivated soils in the watercourses. Rapid run-off needs to be carefully controlled to reduce the incidence of this.

River basin management plans show that at least 18 per cent of the waterbodies of the NCA have good ecological status /potential; with the Humber River Basin Management Plan indicating that the waterbodies' ecological status is generally moderate, while the ecological status of headwaters, such as the Waithe Beck, is good.

Within the Lincolnshire Coast and Rivers Priority Catchment high phosphate levels and eutrophication are issues in both the River Eau area and the River Lymn/Steeping. The surface water chemical status of the River Bain and the River Lymn is good but the ecological status of both these rivers is only moderate. The reduction of diffuse agricultural pollution through nitrates will improve the quality of the groundwater and chalk streams. Catchment sensitive farming measures are being promoted across some catchments with a particular focus in the Humber Basin's North Lincolnshire target area.

- **Pollination:** The semi-natural habitats are important for pollination as they are valuable for pollinating invertebrates and thus benefit agriculture, particularly when adjacent to certain food crops and oilseed rape. The NCA contains areas of semi-natural habitats, including roadside verges and hedgerows, linking other habitats that are likely to support sources of nectar. Creating a mosaic of habitats and arable margins will provide breeding sites and a food source for pollinators. Adding to the extent of semi-natural habitats increases the number and diversity of plants, which assists pollination.

  Pest regulation: Semi-natural habitats and hedges close to areas of commercial agriculture may support predators which help to regulate populations of pests that adversely affect food production.

Cultural services (inspiration, education and wellbeing)

- **Sense of place/inspiration:** The Lincolnshire Wolds NCA has a strong sense of place provided by the rolling hills, scattered settlements, unified rural landscape features and patterns, long, open views and a tranquil, undisturbed nature. This is complemented by enclosed, steep-sided valleys, occasional woodlands, and some drystone walls to the north, a variety of chalk streams and some small settlements nestling into the landscape.

  The area has inspired poets and artists including Poet Laureate Alfred, Lord Tennyson, who was born in Somersby in the Lymn Valley. This landscape

provided a source for many of his poems including In Memoriam AHH, The Lady of Shalott, Maud and The Brook. Tennyson wrote of the area: "Calm and deep peace on this high wold, and on these dews that drench the furze, and all the silvery gossamers, that twinkle into green and gold." In 1990, the Wolds again provided a setting for literature in A S Byatt's novel Possession, where she wrote: "The valleys are deep and narrow, some wooded, some grassy, some ploughed. The ridges run sharply across the sky, always have ... These slightly rolling hills appear to be folded out of the surface of the earth, but that is not the case, they are part of a dissected tableland. The villages are buried in the valleys, at the end of blind funnels."

The strong landscape character led to the national designation of AONB and the area is a rural tourist destination although, because of the limited number of 'honeypot' sites, the peaceful character is still retained.

- **Sense of history**: There is a strong sense of history across the Lincolnshire Wolds. With a rich archaeological heritage of ancient trackways, deserted and shrunken medieval villages and ancient barrows there is evidence of the Wolds' long history of settlement and communications.

Visible archaeology today includes the many barrows which cap the hill tops, such as Six Barrows at Tathwell. A network of ancient trackways once existed and many remain routes today, for example Caistor High Street and Bluestone Heath Road. The Romans built roads here primarily to access the coastal salt industry. A post-medieval ironwork industry has also been identified showing the area's industrial heritage such as Claxby ironworks.

The area was once well populated but as a result of disease and other factors depopulation occurred leading to the numerous deserted villages across

Lincoln Longwool rare breed sheep.

the Wolds, which give character to the area, for example Calcethorpe. The area contains evidence of some of the oldest human remains in Britain with important finds at the closed St Peter's Saxon church at Barton-upon-Humber. These date from circa 950 ad onwards and have been used extensively for the study of pathology.

Early Parliamentary enclosures (from 1760) transformed the area, sweeping away the common pasture and huge open fields. Hawthorn hedges were planted and new Georgian manors, parks and farmsteads were created. Shelterbelts and avenues were planted in the open landscape and broad drove roads which add historic character to the area were created for livestock grazing en route to the coast. The development of estates is evidenced by estate workers' cottages.

There are important buildings including country houses and estates which date from the late-medieval period. Aspects of history that are most evident to the general public include historic buildings such as those constructed from local materials, including Tealby church, which is built from local limestone.

The area also shows remnants of its recent history in relation to 20th-century military land use, from Stenigot Mast, a listed structure, through to the airfields such as at Binbrook, Cold War bunkers and a missile base at Ludford.

- **Tranquillity:** The Lincolnshire Wolds NCA is a predominantly sparsely populated landscape with dispersed settlement which is free in most part from major infrastructure, the exception being the short stretch of the M180 and Humberside Airport which cause disturbance locally. The area has generally escaped pressure from modern development and growth and affords a high level of tranquillity, especially on the high, open Wolds away from more built-up areas. It is also valued for its dark skies and astronomical observation.

- **Recreation:** The AONB is a leisure destination serving the nearby population as well as seasonal visitors. People are attracted to the general area by its tranquil and undisturbed character, the long views and the opportunities for outdoor recreation. The Viking Way passes through the NCA and 1.3 per cent of the land is publicly accessible via 578 km of public rights of way. The network of quiet roads and paths has led to a growth in recreational activities with walking, cycling and horse riding all being popular. The Lindsey Trail is a 110-km multi-user route, primarily for carriage drivers, but also cyclists, horse riders and walkers. The annual Lincolnshire Wolds Walking Festival is well attended and both Caistor and nearby Market Rasen (outside the area) have received 'Walkers are Welcome' status. Destination Lincolnshire Wolds is a partnership which promotes the area. There are a number of active volunteer groups and projects across the Lincolnshire Wolds.

- **Biodiversity:**There is a total of 1,662 ha of priority habitat covering approximately 6 per cent of the area. Although it represents only a small percentage of the NCA, this priority habitat includes broadleaved woodland, lowland meadow and fragments of lowland calcareous grassland, and chalk streams.

Although there are no internationally designated sites the area has 23 Sites of Special Scientific Interest (SSSI) making up nearly 1 per cent of the total area, and 26 local sites in the Wolds cover 4 per cent of the area. There are also a number of local wildlife sites, and a variety, of local nature reserves which are managed for their biodiversity. Some of the local nature reserves are located at the roadside providing opportunities for community conservation, surveys and engagement; for example, the Life on the Verge project.

The River Bain has particularly varied freshwater habitats. Chalk streams and their associated blow wells, calcareous springs and flushes are important BAP priority habitats and they are found in only a few places in the world. Their varied freshwater habitats include protected species such as otter and water vole, many invertebrates and rare aquatic plants. The Lincolnshire Chalk Streams Project has helped with enhancement and monitoring of the streams.

Tetford Wood is a rare example of semi-natural ancient woodland on chalk soil with hazel and ash. The woodland holds a diversity of plants indicative of its ancient origins and the associated ground flora plants are scarce. Another example of ancient semi-natural woodland is at Claxby.

Calcareous, acidic and neutral grasslands are valuable and the species-rich calcareous grasslands are particularly important. Roadside verges, many of which are protected, have some good grassland habitats along ancient

trackways with locally scarce southern and early marsh orchid. Other important species found within the area are nationally scarce plants such as the fine-leaved sandwort.

Farmland birds are an important asset to the area with arable habitats supporting nationally important assemblages of farmland birds including corn bunting, turtle dove, curlew, tree sparrow, lapwing and yellowhammer, and are a part of the 'Arable Assemblage East Midlands'.

- **Geodiversity:** The geology and geomorphological processes are factors influencing the topography and hydrology of the area and the geology is visible in terms of exposures and local vernacular. The solid geology of the area is complex and is made up of chalk, limestone and sandstone. Tealby Limestone, Spilsby Sandstone and colourful rusty-brown carstones can all be found in local building material as can chalk in some of the medieval buildings. Superficial deposits are made up of sands, gravels and glacial till. Jurassic Kimmeridge Clays are found in the NCA and a number of disused chalk and clay pits remain, although quarrying is ongoing. Some of the remnant pits across the area form sites of geological interest and a number of them are used for research and geodiversity education as part of the Lincolnshire Geodiversity Action Plan.

There are nine geological and one mixed-interest SSSI. In addition, at least 38 Local Geological Sites can be found here including chalk pits, and although many are inaccessible they are an important resource for research. Red Hill Nature Reserve near Goulceby is an important educational resource, featuring rare exposures of Red Chalk (a formation extending only through Norfolk, Lincolnshire and Yorkshire).

The Chalk bedrock influences the Wolds landscape of today.

Statements of Environmental Opportunity

SEO 1: Protect, enhance and promote the rolling chalk landscape of the Lincolnshire Wolds with its open plateaux, outstanding long views, enclosed valleys, important habitats and high sense of tranquillity. Improve opportunities to enhance people's access and enjoyment of the Wolds' special qualities and the natural beauty.

For example, by:

- Protecting the sense of place by conserving the outstanding views into the adjacent National Character Areas (NCAs), intimate, steep-sided valleys and geological features which provide a sense of inspiration and a tranquil recreational resource.
- Planning for the creation of a strong landscape framework to provide a setting for new and existing development and transport infrastructure, ensuring that the valuable and protected landscape of the Lincolnshire Wolds is not diluted and that its tranquillity is not negatively affected.
- Encouraging more people to visit the distinctive open countryside for quiet enjoyment, re-connecting them with the importance of the landscape, geodiversity and biodiversity.
- Providing the necessary recreational infrastructure to meet the significant demand without detriment to the landscape. Improving access across the area and supporting and promoting participation and community engagement.
- Avoiding development in remote and tranquil areas, in particular protecting the remote qualities of the Area of Outstanding Natural Beauty (AONB) and the wider landscape of the Lincolnshire Wolds. All new development should be well designed, sympathetically located and screened. The dark skies featuring in the more remote areas also need protection.
- Working in partnership to implement the Lincolnshire Wolds AONB Management Plan, and ensuring that local plans and policies recognise and support the plan.
- Managing the unique biodiverse assemblage of habitats including calcareous and other species-rich grasslands.
- Protecting the many verges and nature reserves with their species-rich grasslands by involving local communities and volunteers in their care and management.
- Expanding isolated and fragmented woodland where this is not in conflict with remnant grassland areas or important views. Woodland will enhance landscape character and habitat adaptation to climate change.
- Conserving and extending riparian habitats and nationally important wet alder carr woodland along the streams in the south-west valleys.

SEO 2: Protect and manage the Lincolnshire Wolds' water resources and wetland habitats, including the Lincolnshire chalk aquifer, conserving the groundwater resource and biodiversity of the chalk streams by working in partnership to manage issues affecting water flow and quality at a catchment scale.

For example, by:

- Promoting the extensive sustainable management of agricultural land within key catchments to improve the water quality of streams and to increase biodiversity, and increasing and promoting catchment sensitive farming and the regulations relating to nitrate vulnerable zones.
- Maintaining and improving the chalk aquifer for public water supply, its long-term resilience and water storage by working with the local farming community to adopt sustainable farming practices and to improve filtration into the ground and reduce run-off through the creation or restoration of a network of grasslands.
- Managing and significantly enhancing the area's water resources and associated riparian habitats, including the valuable chalk streams, wet meadows and alder carrs which may come under increasing pressure from climate change, over-abstraction and low flows.
- Maintaining the chalk streams' biodiversity of related plant and invertebrate communities, including protected and rare species, for example aquatic bryozoans, invertebrate species, water vole, otter and lamprey.
- Improving chalk-based aquatic habitats by managing rivers, streams and flushes to maintain hydrological processes and enhance water quality and provision.
- Controlling the spread of non-native invasive species to water bodies.
- Creating and managing riparian corridors along watercourses and considering the reversion of arable to grassland on steeper slopes, where appropriate, to reduce soil erosion and to create links to existing semi-natural sites.
- Ensuring that local plans and policies recognise and support the Lincolnshire Wolds AONB Management Plan.
- Through landscape-scale partnership, undertaking joint initiatives in the adjoining NCAs to protect water quality and supply of groundwater of the chalk streams.
- Increasing semi-natural buffer areas around remaining calcareous springs flushes and blow wells.
- Restoring the physical diversity of chalk stream habitats where necessary, including patchy riparian tree planting and natural introduction of wood debris.

Water resources and wetland habitats, such as chalk streams, are key to the area and need careful management.

SEO 3: Maintain sustainable and productive agricultural practices for the continued provision of food and for the important contribution that farming makes to the sense of place. Enhance farmland habitats and expand and connect semi-natural habitats such as species-rich grassland, woodland and hedgerows to benefit biodiversity, soil and water quality.

For example, by:

- Improving soil and crop management by encouraging the practice of green cover crops such as grasslands on cultivated or bare soil on steep slopes and field margins, and by encouraging extensive grazing regimes as appropriate.
- Developing an integrated package of catchment sensitive farming initiatives, and increasing and promoting catchment sensitive farming and sustainable farming practices.
- Seeking opportunities to re-create grassland and grassland buffers by increasing the quality, extent and interconnectivity of semi natural habitats; which will also improve water infiltration, reduced nitrate input resulting increased soil carbon content and improve overall soil quality.
- Promoting the management and restoration of traditional field boundaries, including species-rich enclosure hedgerows, to increase structural diversity and improve pollination, and encouraging good management of existing hedges and hedgerow trees, filling in gaps and allowing hedges to fill out.
- Increasing the uptake of agri-environment schemes and Countryside Stewardship arable options, extending grasslands along field margins and slopes to prevent sediment run-off and improving water quality, biodiversity and pollination.
- Encouraging management interventions on arable farmland and implementing plans to increase the numbers of important 'Arable Assemblage East Midlands' farmland birds which include English partridge, lapwing, curlew, turtle dove, reed bunting and tree sparrow.
- Managing woodland cover including through sustainable management of ancient woodlands, the oak and ash woodlands in the south-east and sinuous woods of the deep valleys, and isolated beech clumps on the Wolds.
- Restoring and enhancing existing woodland cover, parklands, shelterbelt plantations and wooded landscapes.
- Extending woodland and creating buffers around these habitats, linking with hedgerows and other boundary features to increase habitat networks.
- Conserving and extending riparian habitats and nationally important wet alder carr woodland along the streams and reservoirs in the south-west valleys.
- Planting new woodland in the north, and expanding isolated and fragmented woodland where this is not in conflict with remnant grassland areas or important views. Conserving archaeological features through land management practices.

SEO 4: Protect and appropriately manage the area's rich historic environment and geodiversity for its contribution to local character and sense of identity and as a framework for habitat restoration. Ensure that the wide range of historic features and geodiversity assets are recognised, promoted and valued.

For example, by:

- Protecting and promoting the Lincolnshire Wolds for the contribution they make as a historical, cultural, scientific and educational resource.
- Protecting the distinctive Wolds towns and villages, with their local building materials and nucleated settlement pattern, recognising that large-scale development would be severely detrimental to their character.
- Encouraging the use of traditional building materials, for example brick and pantile roofs, to retain the connection with underlying geology, and restoring and maintaining existing traditional buildings and farmsteads.
- Maintaining the lightly settled character and traditional settlement pattern of medieval villages traditionally located on springlines and later estate villages and scattered farmsteads.
- Protecting the historic character of the settlement of larger villages of the Lincolnshire Wolds and ensuring that new development and expansion are sensitively designed and located.
- Improving the condition of significant archaeological sites and evidence for past use and settlement through appropriate measures and seeking to reduce conflicting or unsympathetic management regimes, while recognising the high potential in this landscape for undiscovered remains.
- Protecting, managing, enhancing and promoting important manmade and natural exposures of Cretaceous and Jurassic geology (chalk, sandstone, sandy limestones, ironstones and clays) and glacial features of geomorphological interest such as meltwater valleys.
- Maintaining the visible and hidden finite resource of past human landscape change, land use and settlement – the extensive prehistoric landscapes, iron-age and medieval settlements and later historic landscapes and parkland.
- Altering practices that could damage features at risk in the historic landscape and protecting remnant earthworks from agricultural practices and development pressure.
- Conserving archaeological features through land management practices, for example by reversion of arable to grassland, where land management threatens the integrity of earthworks and below-ground archaeology (Neolithic, bronze-age and iron-age monuments).
- Enhancing green infrastructure links throughout the NCA and promoting recreation and opportunities for interpretation for local people and visitors so that they can access, understand and connect with heritage features for enjoyment.
- Restoring disused chalk quarries and sand and gravel pits in line with their biodiversity and their designation as Local Geological Sites.
- Planning to limit the visual impact of any new development and, as appropriate, the encroachment of urbanising influences into areas with high tranquillity and low levels of light pollution.
- Ensuring the restoration of traditional farm buildings across the area.
- Protecting the geodiversity of the area and developing educational opportunities to learn about the Wolds' geology and geomorphology.

Supporting document 1: Key facts and data

Total area: 84,486 ha

1. Landscape and nature conservation designations

There is one Area of Outstanding Natural Beauty (AONB) in this NCA, the Lincolnshire Wolds, which covers 52,092 ha or 62 per cent of the area.

More information about the protected landscape can be found at: http://www.lincswolds.org.uk/

Source: Natural England (2011)

1.1 Designated nature conservation sites

The NCA includes the following statutory nature conservation designations:

Tier	Designation	Name	Area (ha)	Percentageof NCA
International	n/a	n/a	0	0
European	Special Protec-tion Area (SPA)	n/a	0	0
	Special Area of Conservation (SAC)	n/a	0	0
National	National Nature Reserve (NNR)	n/a	0	0
National	Site of Special Scientific Interest (SSSI)	A total of 23 sites wholly or partly within the NCA	102	<1

Source: Natural England (2011)

Please note: (i) Designated areas may overlap (ii) all figures are cut to Mean High Water Line, designations that span coastal areas/views below this line will not be included.

There are 342 local wildlife sites in the Lincolnshire Wolds covering more than 3,700 ha or 4 per cent of the NCA.

Source: Natural England (2011); Greater Lincolnshire Nature Partnership (2012)

- Details of individual Sites of Special Scientific Interest can be searched at: http://www.sssi.naturalengland.org.uk/Special/sssi/search.cfm
- Details of Local Nature Reserves (LNR) can be searched: http://www.lnr.naturalengland.org.uk/Special/lnr/lnr_search.asp
- Maps showing locations of Statutory sites can be found at: http://magic.defra.gov.uk – select 'Designations/Land-Based Designations/ Statutory'

1.2 Condition of designated sites

A breakdown of SSSI condition as of March 2011 is as follows:

SSSI condition category	Area (ha)	Percentage of SSSI in category condition
Unfavourable declining	12	12
Favourable	62	60
Unfavourable no change	10	10
Unfavourable recovering	18	18

Source: Natural England (March 2011)

Details of SSSI condition can be searched at: http://www.sssi.naturalengland.org.uk/Special/sssi/reportIndex.cfm

2. Landform, geology and soils

2.1 Elevation

Elevation ranges from a minimum of 3 m above sea level to a maximum of 167 m. The mean average elevation is 77 m.

Source: Natural England (2010)

2.2 Landform and process

The Lincolnshire Wolds is dominated by a west-facing Chalk escarpment some 50 m high. The Wolds comprise a high open, arable plateau stretching from the Humber past Louth to a 'bluff' above the Lincolnshire fens at East Keal. Within this upland rolling plain are a series of inward facing valleys. Between the villages of Donington-on-Bain and Tetford, an internal escarpment faces south-west overlooking ridges of glacial drift and valleys cut into sandstone. To the south-east the Chalk ridge is masked by clay till which creates more rounded forms as the Wolds fall down to the Middle Marsh of the adjacent Lincolnshire Coast and Marshes NCA around Alford.

Source: Lincolnshire Wolds Countryside Character Area Description

2.3 Bedrock geology

Underlying Lower Cretaceous strata are revealed in the bottom of the valleys and at the foot of the scarp slope in the Wolds. The Lincolnshire Wolds is dominated by a west-facing Chalk escarpment some 50 m high. These strata include ironstone, limestone and sandstone. Within the valleys of the rivers Bain and Lymn, Jurassic Kimmeridge Clay creates marshy poorly drained vales. The bedrock was extensively moulded by glacial and periglacial action during the last ice age, when the drainage pattern was altered by the deposition of sands, gravels and clay till.

Source: Lincolnshire Wolds Countryside Character Area Description

2.4 Superficial deposits

In the south-east the overlying glacial till creates a rounded edge broken by deep valleys at Louth and Calceby.

Source: Lincolnshire Wolds Countryside Character Area Description

2.5 Designated geological sites

Tier	Designation	Number of Sites
National	Geological Site of Special Scientific Interest (SSSI)	9
National	Mixed interest SSSI	1
Local	Local Geological Sites	42

Source: Natural England (2011); Greater Lincolnshire Nature Partnership (2012)

- Details of individual Sites of Special Scientific Interest can be searched at: http://www.sssi.naturalengland.org.uk/Special/sssi/search.cfm

2.6 Soils and Agricultural Land Classification

In the northern Wolds along the plateau tops are light chalky soils. On the valley sides, rivers have cut through to the underlying Red Chalk and Lower Cretaceous series. In the south-east from Louth to Candlesby, chalky boulder clays produce a heavy seasonally waterlogged soil giving rise to a gentle rounded landform. The Lymn valley has cut through to the Lower Cretaceous Spilsby Sandstone that provides parent material for well-drained, acidic loams. Along the river valleys of the Bain, Waring and Lymn glacial sands and gravels have produced deep, course and generally permeable loams. The presence of Upper Jurassic Kimmeridge Clay gives rise to localised areas of impermeable soil which is seasonally waterlogged.

Source: Lincolnshire Wolds Countryside Character Area Description

The main grades of agricultural land in the NCA are broken down as follows (as a proportion of total land area):

Agricultural Land Classification	Area (ha)	Percentage of NCA
Grade 1	1,353	2
Grade 2	42,410	50
Grade 3	36,702	43
Grade 4	2,290	3
Grade 5	0	0
Non-agricultural	1,496	2
Urban	236	<1

Source: Natural England (2010)

Maps showing locations of sites can be found at: http://magic.defra.gov.uk – select 'Landscape' (shows ALC and 27 types of soils).

3. Key waterbodies and catchments

3.1 Major rivers/canals

The following major rivers/canals (by length) have been identified in this NCA.

Name	Length in NCA (km)
River Bain	22
Steeping River	17
Great Eau	5

Source: Natural England (2010)

Please note: other significant rivers (by volume) may also occur. These are not listed where the length within the NCA is short.

The Bain, Waring and Lymn drain southwards through the valleys to the south-east of the Wolds.

Source: Natural England (2010)

3.2 Water quality

The total area of Nitrate Vulnerable Zone is 84,479 ha, which is 99 per cent of the NCA.

Source: Natural England (2010)

3.3 Water Framework Directive

Maps are available from the Environment Agency showing current and projected future status of water bodies http://maps.environment-agency.gov.uk/wiyby/wiybyController?ep=maptopics&lang=_e

4. Trees and woodlands

4.1 Total Woodland Cover

The NCA contains 4,561 ha of woodland, 5 per cent of the total area, of which 448 ha is ancient woodland.

Source: Natural England (2010), Forestry Commission (2011)

4.2 Distribution and size of woodland and trees in the landscape

It is estimated that only 5 per cent woodland cover remains in this NCA compared with the national average of 8 per cent. A variety of woodland is present, although there is only one ancient semi-natural woodland on the chalk, which can be seen at Tetford Hill. This occurs on the scarp slope and consists of hazel, ash and wych elm with sycamore. Wet woodlands can be found on heavy soils in the valleys; particularly in the north around Stainton le

Vale and in the south along the Bain and Lymn. In the north, oak-ash stands are most common, while in the south, alder carr frequently lines the streams. The most extensive woodlands occur on the calcareous clay soils in the south-east and largely consist of oak-ash-hazel woodlands.

Source: Lincolnshire Wolds Natural Area Profile, Lincolnshire Wolds Countryside Character Area Description

4.3 Woodland types

A statistical breakdown of the area and type of woodland found across the NCA is detailed below.

Area and proportion of different woodland types in the NCA (over 2 ha):

Woodland type	Area (ha)	Percentage of NCA
Broadleaved	3,595	4
Coniferous	569	1
Mixed	145	<1
Other	252	<1

Source: Forestry Commission (2011)

Area and proportion of ancient woodland and planted ancient woodland sites (PAWS) within the NCA:

Woodland type	Area (ha)	Percentage of NCA
Ancient semi-natural woodland	116	<1
Ancient re-planted woodland (PAWS)	332	<1

Source: Natural England (2004)

5. Boundary features and patterns

5.1 Boundary features

Large rectilinear fields with clipped and degraded hedgerows date from late enclosure. Occasional shelter belts, concentrated on steeper sided valley and scarp slopes, emphasise the landform. The broad verges to some roads and tracks provide valuable herb-rich habitats.

Source: Lincolnshire Wolds Countryside Character Area description; Countryside Quality Counts (2003)

5.2 Field patterns

Land cover is predominantly arable with large rectilinear fields on the rolling plateau that are enclosed by clipped and 'gappy' hawthorn hedgerows. To the south-west there is a more complex pattern of medium-sized irregular fields where grazing combines with crop cultivation.

Source: Lincolnshire Wolds Countryside Character Area description; Countryside Quality Counts (2003)

Old Bolingbroke showing settlement patterns within the Lincolnshire Wolds area.

6. Agriculture

The following data has been taken from the Agricultural Census linked to this NCA.

6.1 Farm type

Cereal holdings represent the largest type of farm, with 156 holdings or 38 per cent of the total. The second largest type is general cropping with 104 holdings or 25 per cent of the total. The total number of holdings fell from 458 in 2000 to 409 in 2009, a fall of 11 per cent.

Source: Agricultural Census, Defra (2010)

6.2 Farm size

Farms over 100 ha in size are the most numerous with 205 holdings, covering 92 per cent, or 65,568 ha, of the farmed area within the NCA. The number of holdings in each size category has fallen slightly since 2000.

Source: Agricultural Census, Defra (2010)

6.3 Farm ownership

Sixty-six per cent of the land farmed (47,029 ha) is owner managed, a similar figure to 2000.

2009: Total farm area = 71,159 ha; owned land = 47,029 ha
2000: Total farm area = 77,762 ha; owned land = 49,303 ha

Source: Agricultural Census, Defra (2010)

6.4 Land use

Cereals are grown most widely in this NCA with nearly 50 per cent (35,252 ha) of the farmed land devoted to growing cereals. This is followed by grassland with 19 per cent of the farmed land (13,343 ha). The area used to grow oilseed crops has increased since 2000 by nearly 116 per cent, from 4,540 ha in 2000 to 9,790 ha in 2009.

Source: Agricultural Census, Defra (2010)

6.5 Livestock numbers

Pigs are the most numerous livestock with 31,500 animals, followed by sheep (28,200) and cattle (12,200). The numbers of pigs and sheep have fallen significantly since 2000, with 28,600 fewer pigs, a fall of 48 per cent, and 21,100 fewer sheep, a fall of 43 per cent).

Source: Agricultural Census, Defra (2010)

6.6 Farm labour

There are 509 principal farmers in the NCA, suggesting that the majority of holdings are run by dedicated farmer / managers. This number is 17 per cent lower than the number in 2000 (673 principal farmers). The number of fulltime farm workers has also fallen by over 100 since 2000, to 336 workers.

Source: Agricultural Census, Defra (2010)

Please note: (i) Some of the Census data are estimated by Defra so may not present a precise assessment of agriculture within this area (ii) Data refers to commercial holdings only (iii) Data includes land outside of the NCA where it belongs to holdings whose centre point is recorded as being within the NCA.

7. Key habitats and species

7.1 Habitat distribution/coverage

Calcareous, acidic and neutral grasslands are all present in this NCA. Calcareous grasslands are particularly important as they are species rich; only 44 ha of this grassland type remains, the rest has been 'improved' or ploughed.

Nationally scarce plants include the fine-leaved sandwort. Road verges have some of the best surviving grassland habitats, particularly along ancient trackways and drove roads.

River headwaters and chalk streams constitute the main aquatic and riparian habitats.

The River Bain contains particularly varied freshwater and riparian habitats. Notable species include otter, kingfisher, many invertebrates and locally scarce plants such as the southern and early marsh orchards. Another rare aquatic plant in the Wolds is the arrowhead.

Little woodland remains in the Wolds. Most large woods are found on the clay soils of the south-east scarp of the Wolds where they overlap with the Lincolnshire Coast and Marshes NCA.

Tetford Wood is a rare example of an ancient semi-natural wood on chalk soil. A number of important alder carr woods occur on spring lines and valley bottoms.

The white satin moth, along with the common fan-foot and the hook-tip are important moths that visit the woodlands. The 1960s saw the loss of all the woodland fritillary butterflies, but the numbers of white admiral and speckled wood butterflies are showing signs of recovery.

In addition the NCA contains important arable habitats. These support nationally important assemblages of farmland and arable birds.

Source: Lincolnshire Wolds Natural Area Profile, Natural England (2011)

7.2 Priority habitats

The Government's new strategy for biodiversity in England, Biodiversity 2020, replaces the previous Biodiversity Action Plan (BAP) led approach. Priority habitats and species are identified in Biodiversity 2020, but references to BAP priority habitats and species, and previous national targets have been removed. Biodiversity Action Plans remain a useful source of guidance and information. More information about Biodiversity 2020 can be found at; www.naturalengland.org.uk/ourwork/conservation/biodiversity/protectandmanage/englandsbiodiversitystrategy2011.aspx.

The NCA contains the following areas of mapped priority habitats (as mapped by National Inventories). Footnotes denote local/expert interpretation. This will be used to inform future national inventory updates.

Priority habitat	Area (ha)	Percentage of NCA
Broadleaved mixed and yew woodland (broad habitat)	1,103	1
Lowland meadows	286	<1
Lowland calcareous grassland	157	<1
Purple moor grass and rush pasture	69	<1
Fens	35	<1
Lowland dry acid grassland	12	<1

Source: Natural England (2011)

Recent habitat creation has resulted in the creation of approximately 65 ha of flood plain grazing marsh (based on NE and EA information)

Maps showing locations of priority habitats are available at:

- http://magic.defra.gov.uk – Select 'Habitats and Species/Habitats'

7.3 Key species and assemblages of species

- Maps showing locations of some key species are available at: http://magic.defra.gov.uk – Select 'Habitats and Species/Habitats'
- Maps showing locations of S41 species are available at http://data.nbn.org.uk/

8. Settlement and development patterns

8.1 Settlement pattern

The Wolds has maintained a very sparse and dispersed settlement pattern over the last few centuries. Population density is marginally higher in the south-west river valleys while on parts of the high Wold there is no settlement at all. In the north villages are simple and nucleated while in the south a rectangular plan is often found with lanes enclosing a central area of cottages, farmhouses and paddocks, such as the village of Old Bolingbroke. Settlements tend to follow the physical features found within the NCA, such as the foot of the north-west scarp as at Tealby and Claxby, or the deep valleys within the chalk uplands as at Rothwell. To the south-west, villages such as Hemingby and Tetford are located in the river valleys. There are no major urban areas within the Wolds, but a series of small market towns, such as Louth in the east and Spilsby in the south lie at the foot of the hills.

Source: Lincolnshire Wolds Countryside Character Area description; Countryside Quality Counts (2003)

8.2 Main settlements

The main settlements are; Spilsby, Caistor, Binbrook and Barnetby le Wold and the fringes of Louth, Horncastle and Barton-upon-Humber. The total estimated population for this NCA (derived from ONS 2001 census data) is: 29,368.

Source: Lincolnshire Wolds Countryside Character Area description; Countryside Quality Counts (2003), Natural England (2012)

8.3 Local vernacular and building materials

The Wolds is not distinguished by a unified pattern of building materials or styles. The local chalk is generally a poor building material being crumbly and weak but was used in medieval buildings however later, brick or other types of stone have been preferred. In the north-west the locally quarried Tealby Limestone and Claxby Ironstone can be seen. To the south the distinctive green or brown Spilsby Sandstone is used in the more ornate 14th- and 15th-century churches. Domestic buildings on the other hand are commonly built with brick and render walls, with pantile roofs.

Source: Lincolnshire Wolds Countryside Character Area description; Countryside Quality Counts (2003)

9. Key historic sites and features

9.1 Origin of historic features

The Lincolnshire Wolds has produced evidence of some of the oldest human remains in Britain. Visible archaeology is strong with many barrows capping the hill tops, such as Six Barrows at Tathwell. From the Iron Age the chalk uplands had a well established network of trackways, an example of which is High Street and Bluestone Heath Road. The Romans built east-west roads to access the coastal salt industry. Village names with -ham or -ton are evidence of the permanent and extensive settlement undertaken in the Saxon period. Those with names ending in -by or -thorpe are likely to be of Danish origin. Deserted village locations have been identified, such as Calcethorpe, thought to be related to the Black Death and the growth of the wool industry. Post-medieval ironwork sites are also found as at Claxby.

Source: Draft Historic Profile, Countryside Quality Counts, Countryside Character Area description

9.2 Designated historic assets

This NCA has the following historic designations:

- 4 Registered Parks and Gardens covering 1,475 ha.
- 1 Registered Battlefield covering 176 ha.
- 120 Scheduled Monuments.
- 740 Listed Buildings.

Source: Natural England (2010)

More information is available at the following address:

http://www.english-heritage.org.uk/caring/heritage-at-risk/

http://www.english-heritage.org.uk/professional/protection/process/national-heritage-list-for-england/

10. Recreation and access

10.1 Public access

- 1.3 per cent of the NCA or 1,094 ha is classified as being publically accessible.
- There are 578 km of public rights of way at a density of 0.7 km per km^2.
- There are no national trails within the NCA.

Sources: Natural England (2010)

The table below shows the breakdown of land which is publically accessible in perpetuity:

Access designation	Area (ha)	Percentage of NCA
National Trust (Accessible all year)	0	0
Common Land	0	0
Country Parks	40	<1
CROW Access Land (Section 4 and 16)	8	<1
CROW Section 15	6	<1
Village Greens	2	<1
Doorstep Greens	0	0
Forestry Commission Walkers Welcome Grants	1	<1
Local Nature Reserves (LNR)	82	<1
Millennium Greens	<1	<1
Accessible National Nature Reserves (NNR)	0	0
Agri-environment Scheme Access	152	<1
Woods for People	896	<1

Sources: Natural England (2011)

Please note: Common Land refers to land included in the 1965 commons register; CROW = Countryside and Rights of Way Act 2000; OC and RCL = Open Country and Registered Common Land.

11. Experiential qualities

11.1 Tranquillity

Based on the CPRE map of tranquillity (2006) the least tranquil areas in the NCA are around the main settlements such as Louth. The most tranquil areas can be found on the high, open Wolds.

A breakdown of tranquillity values for this NCA are detailed in the table below:

Tranquillity	Score
Highest value within NCA	36
Lowest value within NCA	-59
Mean value within NCA	4

Sources: CPRE (2006)

More information is available at the following address:
http://www.cpre.org.uk/resources/countryside/tranquil-places

11.2 Intrusion

The 2007 Intrusion Map (CPRE) shows the extent to which rural landscapes are 'intruded on' from urban development, noise (primarily traffic noise), and other sources of visual and auditory intrusion. This shows a similar picture to the tranquillity data with a fairly low rate of disturbance in the more rural isolated areas with greater disturbance around settlements and the road network. A breakdown of intrusion values for this NCA is detailed in the table overleaf.

Intrusion category	1960s (%)	1990s (%)	2007 (%)	Percentage change (1960s-2007)
Disturbed	2	12	19	17
Undisturbed	97	88	80	17
Urban	0	0	<1	<1

Sources: CPRE (2007)

The notable trend from the 1960s to 2007 is a very small increase in the percentage of undisturbed land in this NCA.

More information is available at the following address:
http://www.cpre.org.uk/resources/countryside/tranquil-places

12. Data sources

- British Geological Survey (2006)
- Natural Area Profiles, Natural England (published by English Nature 1993-1998)
- Countryside Character Descriptions, Natural England (regional volumes published by Countryside Commission/Countryside Agency 1998/1999)
- Joint Character Area GIS boundaries, Natural England (data created 2001)
- National Parks and AONBs GIS boundaries, Natural England (2006)
- Heritage Coast Boundaries, Natural England (2006)
- Agricultural Census June Survey, Defra (2000,2009)
- National Inventory of Woodland & Trees, Forestry Commission (2003)
- Countryside Quality Counts Draft Historic Profiles, English Heritage (2004)*
- Ancient Woodland Inventory, Natural England (2003)
- BAP Priority Habitats GIS data, Natural England (March 2011)
- Special Areas of Conservation data, Natural England (data accessed in March 2011)
- Special Protection Areas data, Natural England (data accessed in March 2011)
- Ramsar sites data, Natural England (data accessed in March 2011)
- Sites of Special Scientific Interest, Natural England (data accessed in March 2011)
- Detailed River Network, Environment Agency (2008)
- Source protection zones, Environment Agency (2005)
- Registered Common Land GIS data, Natural England (2004)
- Open Country GIS data, Natural England (2004)
- Public Rights of Way Density, Defra (2011)
- National Trails, Natural England (2006)
- National Tranquillity Mapping data, CPRE (2007)
- Intrusion map data, CPRE (2007)
- Registered Battlefields, English Heritage (2005)
- Record of Scheduled Monuments, English Heritage (2006)
- Registered Parks and Gardens, English Heritage (2006)
- World Heritage Sites, English Heritage (2006)
- Incorporates Historic Landscape Characterisation and work for preliminary Historic Farmstead Character Statements (English Heritage/Countryside Agency 2006)Detailed River Network, Environment Agency (2008)

Please note all figures contained within the report have been rounded to the nearest unit. For this reason proportion figures will not (in all) cases add up to 100%. The convention <1 has been used to denote values less than a whole unit.

Supporting document 2: Landscape change

Trees and woodlands

- The Brocklesby Estate to the north east has some of the largest woodland blocks and oldest plantations. Woodland character in the estate is being enhanced through new woodland panting and woodland management.
- Woodland character in the area has improved through new woodland planting and reversal of previous periods of neglect and planting of conifers on steeper slopes.
- The planted beech woodlands are generally found on the thinner chalk soils and are susceptible to wind blow.

Boundary features

- The uptake of management agreements for boundary and woodland elements has maintained and in some cases strengthened the character of boundary features. Specific recent changes and trends include:
  - Data from 2011 shows a dramatic increase of managed boundary features with 1,877 km under Environmental Stewardship options, mainly through the Entry Level Scheme.
  - The total length of hedgerow being managed in 2011 is 1,600 km resulting in tightly cropped hedges filling out and becoming taller and wider.
  - This includes 17 km hedgerow restoration-laying coppicing and gapping up and 1.6 km of hedge planting.

Agriculture

- Between 2000 and 2009, there was a decline in the farmed area of both cereals and grassland. More land was ploughed and there was an increase in oilseeds and other arable crops.
- The number of principal farmers has fallen by 17 per cent since 2000 and the employment of full time farm workers was reduced by 23 per cent.
- Livestock farming has changed within the NCA as numbers of livestock have reduced-particularly the number of pigs and sheep (down by 48 per and 43 per cent respectively) between 2000 and 2009.
- Pressure on water resources has increased, leading to the construction of irrigation reservoirs to support cropping; this has impacted on local character.
- The neglect and loss of traditional agricultural buildings-of predominantly brick and pantile is generally having an impact on the landscape.
- More land is taken up land use for biomass and biofuels.

Settlement and development

- Development pressure within the NCA is generally low, although localised impacts include commercial and residential expansion around Barnetby le Wold, Barton-upon-Humber and around both Spilsby and Horncastle.

- Telecommunication masts are visually impacting on the Wolds notably on the chalk wolds.

- Beyond the area itself wind farms that have been constructed in the last 10–15 years and which are currently operational can be seen from this NCA and visually impact on the landscape character. The visual impact of expanding renewable energy developments is one of the biggest pressures on this NCA because of the impacts on the long, rural, undisturbed views which are characteristic to the area.

- Light, noise and air pollution comes from roads including M180/A180, settlements, quarries and other localised activities including Humberside International Airport.

Semi-natural habitat

- 61 per cent of the area's SSSI are in favourable condition, while 18 per cent are in unfavourable condition but recovering.

- More Local Wildlife Sites are in positive conservation management.

Historic features

- A large number of archaeological and historic features exist and have been designated as 'at risk'.

- Threats to the archaeological resource/ scheduled monuments from agriculture and woodland planting/lack of management have been reduced.

- There remains some threat to archaeological sites from ploughing with a number of scheduled monuments on the national 'Heritage at Risk' owing to plough damage, however this is improving.

- Planting of miscanthus as biomass; there could be adverse impacts in archaeologically sensitive areas, as well as on historic landscape character, associated with this crop.

Coast and rivers

- The catchments face a range of challenges including diffuse pollution from agriculture and water abstraction has increased together with raising the demand for the potable water.

The historic environment is visible in Spilsby market town which shows the red brick, characteristic in many traditional buildings and in the settlements of the area.

- The chemical and quantitative trends for groundwater suggest that the Lincolnshire chalk aquifer suffers from over abstraction.
- Water Storage for flood alleviation schemes has increased- and more reservoirs exist.
- Some stream/river barriers have reduced opportunities for the migration of fish.
- High phosphate levels and eutrophication are increasingly important issues particularly in the Rivers Eau and Lymn – which is part of a Priority Catchment.

Minerals

- Chalk quarries and sand/gravel pits are found. Historic extraction has left a legacy of old quarries on the landscape, some of which are designated Local Geological Sites.

Drivers of change

Climate change

- Climate trends suggest increased rainfall, periods of drought, and more frequent storm events. Increased summer droughts could result in demands on groundwater resources associated with the underlying chalk aquifer. Low groundwater levels inside the NCA are likely to result in lower river levels.
- Unpredictable and frequent periods of drought and flood will give rise to erratic flows and difficulties in managing flows. Water dependent chalk streams and springs and wetland habitats are vulnerable to low groundwater levels and resilience may be reduced by historical low flows along many streams.
- Warmer, drier summers may lead to drought causing potentially increased demands on agricultural land for food production in relation to food security. The need for food security will result in continued agricultural production along with changing farming practices. Agri-environment schemes provide an opportunity to work with land managers to incorporate farmland habitats, develop networks of linked habitats and enhance the rural character of the landscape.
- Increasing temperatures, drier summers may lead to new varieties of crops of and cropping patterns and new livestock systems may emerge. The longer cropping seasons could potentially lead to double cropping.
- Warmer, drier summers may lead to drought causing impacts on semi-natural habitats, in particular on chalk grasslands, and on species through drought conditions and including dominance of drought-resistant species. Thermal stress will also impact on a range of species especially those near their southern limit of their range. Loss of small or isolated habitats, notably unimproved grasslands surviving on steeper slopes and road verges.
- Warmer, drier summers may lead to drought causing reduced rainfall in summer months leading to deterioration in water quality due to reduced flows in wetland habitats on major valley floodplains.
- Warmer, drier summers may lead to drought causing increased demand for water abstraction during the summer months, while the pattern of rainfall may also reduce the opportunities for aquifer recharge with winter events increasingly concentrated in major downpours, much of which is lost to surface run-off.
- With changing climate and unpredictable conditions opportunities for invasive species exotic pests and disease pose a potential threat.

- Drier summers and increased frequency of storms could lead to loss of beech through drought and wind throw. Any loss of mature landmark trees will be significant in terms of impact on the overall landscape.
- Effective adaptation and mitigation and long-term climate change strategy will help safeguard the Lincolnshire Wolds AONB.
- Rise in water temperatures may have an impact on biodiversity of the chalk streams.

Other key drivers

- The protected Lincolnshire Wolds Area of Outstanding Natural Beauty covers 62 per cent of the NCA. The AONB Management Plan will be used to drive change in the area within the protected landscape, demonstrating how partnerships can continue to protect environments.
- There is provision for the protection of the Lincolnshire Wolds and enhancement in the local planning policy framework. Further development would need to be of the highest standard in order to make a positive contribution to the distinctive character of the area.
- Recreation, access and tourism bring opportunities for improved facilities for the enjoyment of nature. This may bring with it a pressure on the landscape and biodiversity especially at the most popular destinations.
- Decline in livestock farming and implications on the Wolds landscape and biodiversity.
- Private ownership will sometimes restrict opportunities for public access, though there is further potential for promoted cycle routes, plus improved circular routes under the Rights of Way Improvement Plan.
- Threats to the tranquillity from visual impact of road improvements and increased pollution from heavy seasonal traffic, plus noise and light pollution from settlements and developments.
- Demand for wind turbines and renewable energy, oil exploration and telecommunication infrastructure can create disturbance.
- Promotion of careful development will be required concerning mineral/aggregates abstraction. Sustainable after-use and assimilation into the rural landscape of and chalk quarries and sand/gravel pits.
- Demand for re-use of redundant airfields and the threats to impact on the rural landscape and tranquillity.
- Opportunities for the re-creation of flood plain grasslands and the enhancement of ditches for wildlife, plus management of valley marshes, mires and carrs to retain wetland character of river valleys.
- Threats to woodland including continued decline in management and isolation of woodland, change in woodland composition, notably loss of beech, ash dieback, inappropriate location/species mix. Opportunities to promote appropriate management practice and the provision of wood fuel.

Supporting document 3: Analysis supporting Statements of Environmental Opportunity

The following analysis section focuses on a selection of the key provisioning, regulating and cultural ecosystem goods and services for this NCA. These are underpinned by supporting services such as photosynthesis, nutrient cycling, soil formation and evapo-transpiration. Supporting services perform an essential role in ensuring the availability of all ecosystem services.

Biodiversity and geodiversity are crucial in supporting the full range of ecosystem services provided by this landscape. Wildlife and geologically-rich landscapes are also of cultural value and are included in this section of the analysis. This analysis shows the projected impact of Statements of Environmental Opportunity on the value of nominated ecosystem services within this landscape.

Cawkwell Bank on the edge of the chalk escarpment.

Statement of Environmental Opportunity	Ecosystem service: Food provision	Timber provision	Water availability	Genetic diversity	Biomass provision	Climate regulation	Regulating water quality	Regulating water flow	Regulating soil quality	Regulating soil erosion	Pollination	Pest regulation	Sense of place / Inspiration	Sense of history	Tranquillity	Recreation	Biodiversity	Geodiversity
SEO 1: Protect, enhance and promote the rolling chalk landscape of the Lincolnshire Wolds with its open plateaux, outstanding long views, enclosed valleys, important habitats and high sense of tranquillity. Improve opportunities to enhance people's access and enjoyment of the Wolds' special qualities and the natural beauty.	↔ *	↑ **	↔ **	↗ **	↔ **	↗ *	↔ ***	↔ ***	↔ ***	↔ ***	↗ **	↔ ***	↑ ***	↑ ***	↔ **	↑ **	↔ **	↗ ***
SEO 2: Protect and manage the Lincolnshire Wolds' water resources and wetland habitats, including the Lincolnshire chalk aquifer, conserving the groundwater resource and biodiversity of the chalk streams by working in partnership to manage issues affecting water flow and quality at a catchment scale.	↔ *	↗ **	↗ *	↗ **	↔ ***	↗ **	↑ **	↗ **	↗ **	↗ **	↗ **	↗ **	↗ ***	↔ **	↗ **	↔ **	↗ ***	↗ *
SEO 3: Maintain sustainable and productive agricultural practices for the continued provision of food and for the important contribution that farming makes to the sense of place. Enhance farmland habitats and expand and connect semi-natural habitats such as species-rich grassland, woodland and hedgerows to benefit biodiversity, soil and water quality.	↗ ***	↔ ***	↗ **	↔ **	↔ **	↗ *	↗ **	↗ **	↑ ***	↑ ***	↗ ***	↗ **	↔ **	↔ **	↔ ***	↔ ***	↑ ***	↔ ***
SEO 4: Protect and appropriately manage the area's rich historic environment and geodiversity for its contribution to local character and sense of identity and as a framework for habitat restoration. Ensure that the wide range of historic features and geodiversity assets are recognised, promoted and valued.	↔ ***	↔ ***	↔ ***	↔ ***	↔ ***	↔ ***	↔ ***	↔ ***	↔ ***	↔ ***	↔ ***	↔ ***	↑ ***	↑ ***	↔ ***	↗ **	↗ ***	↗ ***

Note: Arrows shown in the table above indicate anticipated impact on service delivery ↑=Increase ↗ =Slight Increase ↔=No change ↘ =Slight Decrease ↓=Decrease.
Asterisks denote confidence in projection (*low **medium***high) ○ =symbol denotes where insufficient information on the likely impact is available .

Dark plum =National Importance; Mid plum =Regional Importance; Light plum =Local Importance

Landscape attributes

Landscape attribute	Justification for selection
The rolling landform that has been extensively shaped by glacial activity, resulting in prominent escarpments and deep valleys and chalk exposures.	■ The rolling, open plateau is a key characteristic of the Lincolnshire Wolds, while the scarps and valleys provide striking distinguishing features. ■ Long views are afforded from the ridge tops both over surrounding NCA and within the area. ■ A varied geology due to the effects of glacial activity, resulting in distinct areas of land cover/use. ■ Important geological exposures of chalk occurring largely in quarries and deposits of Lower Cretaceous sandstones, ironstones and clays, plus meltwater valleys of geomorphological interest.
The prominent north west scarp.	■ The scarp is clothed in rough pasture, scrub and woodland, providing contrast with the open arable plateau. ■ There are panoramic views to the Central Lincolnshire Vale.
The area's localised woodland cover, including extensive oak-ash-hazel woodlands in the south-east, sinuous beech woodlands in the deep southern valleys, isolated beech clumps on the Wolds, wet woodland to the south, and the extensive mixed woodlands of the Brocklesby Estate to the north-east.	■ Little woodland remains in the Lincolnshire Wolds, with the most extensive areas occurring on the calcareous clay soils in the south-east. ■ Tetford Wood is a rare example of an ancient semi-natural wood occurring on chalk soil, while the alder carr woods in the Bain and Lymn valleys are also of high nature conservation interest. ■ Game coverts and isolated beech and ash trees form prominent features on the open arable plateau. ■ Lack of traditional management such as coppicing, with sycamore invading many woodlands.
Hedgerow field boundaries in large, geometric patterns, with local variations including the dry-stone walls to the north and irregular patterns in the south-west valleys.	■ Hedgerows are predominantly hawthorn and gappy –with significant opportunities to enhance wildlife value and landscape.

Landscape attribute	Justification for selection
The area's rivers and wetland habitats, including chalk streams in the north and the more acidic waters of the southern rivers.	■ The chalk streams are a habitat of special interest and are internationally rare habitat confined mainly to England and north-west Europe. They occur in an otherwise dry landscape supporting a high diversity of species of national conservation importance including mammals, freshwater fish, invertebrates and aquatic plants. ■ Chalk streams mainly occur where groundwater reaches the surface in chalk valleys. ■ Wetland habitats such as wet meadows and floodplain grazing marsh have been lost to development and agricultural improvement. ■ Numerous springs and flushes arise at the foot of the scarp. ■ Calcareous marshes and spring-line flushes and blow wells form further important wetland components of the wider river catchments. ■ The award winning Lincolnshire Chalk Streams project is dedicated to the conservation and enhancements of the streams.
The broad, marshy south west valleys of the Bain and Lymn.	■ The mixed farmed landscape of irregular medium-sized fields in the south west valleys provides contrasts with the arable dominated plateau. ■ Alder carr is a distinctive feature of the Bain and Lymn valleys in particular, and has become nationally rare, increasing its importance for conservation.
Fragments of calcareous grassland surviving on steep slopes, roadside verges and old quarries, plus neutral/acidic grassland in river valleys and other patches.	■ The resource is less extensive and more fragmented than other areas known for chalk grassland. This is a consequence of the unique combination of a complicated topography, distribution of other habitats and pattern of land use over the centuries. ■ Calcareous species rich grassland is an internationally important habitat, with most remaining fragments in the NCA now SSSI designated; or part of highway verges.

Landscape attribute	Justification for selection
An agricultural landscape of predominantly arable habitats including arable field margins and conservation headlands. Livestock farming remains important where mixed farming occurs.	■ The farmed landscape dominates land use and Grade 3 land accounts for a mix of arable and livestock farming. ■ Opportunities exist to greatly improve the wildlife value of the intensively farmed, arable-dominated landscape. ■ The hedgerows shelter belts, farm ponds, arable field margins provide wildlife habitats. ■ Livestock numbers have been in decline but some remain and these help conserve remaining areas of grasslands and meadows. Rare/traditional breeds are associated with the Wolds include Lincoln Red cattle and Lincolnshire Longwool sheep. ■ Nationally important populations Farmland birds are found in the arable areas such as lapwing, grey partridge, turtle dove, yellow wagtail, tree sparrow and corn bunting.
A highly dispersed settlement pattern, with typically nucleated villages located along the foot of the north west scarp and nestled within the southern valleys, often associated with small estates.	■ The Wolds plateau is sparsely settled, and the settlement pattern contributes to the open, tranquil character and sense of history. ■ The open landscape is vulnerable to the visual impacts of more recent development.
A varied local vernacular, including brick and render walls with pantile roofs for many domestic buildings, with stone in larger buildings varying according to the distribution of limestone, ironstone and sandstone.	■ Local vernacular contributes to the landscape character with the area's stone buildings reflect the distribution of underlying geology, contributing to a localised sense of place. ■ Unsympathetic development/restoration has led to a loss of local distinctiveness in some Wolds villages.
A rich historic environment, including extensive prehistoric barrows and trackways that line the Wolds plateau and a particularly high concentration of deserted medieval village sites.	■ The Lincolnshire Wolds have the densest distribution of long barrows in the country and an important grouping of round barrows, as well as one of the highest concentrations of deserted medieval villages in England. ■ Archaeological remains are under threat from deep ploughing, as well as potentially through neglected woodland management and inappropriate planting.
Tranquillity – 80 per cent of the NCA is still classified as 'undisturbed'.	■ Tranquillity is a significant feature of the Wolds plateau. ■ A lack of light pollution is a key feature of much of the area.

Landscape opportunities

- Protect the designated landscape of the Area of Outstanding Natural Beauty.
- Protect the distinctive character of the landscape and nucleated settlement pattern.
- Protect expansive views as this is generally a landscape of large scales where wide expanses of the large fields and rolling hills meet vast skies affording extensive views and tranquillity.
- Ensure adequate clean groundwater supply to the chalk wolds aquifer and hydrology of the NCA.
- Protect existing boundary features and restore hedgerows-creating connectivity with existing habitats. Priority should be given to schemes following historic boundaries. Manage and enhance the hedgerows to create a robust network throughout the arable areas.
- Encourage land management interventions to provide food and shelter for farmland birds of East Midlands Arable assemblage (-including skylark, linnet, yellow hammer, reed bunting, corn bunting, yellow wagtail, curlew, tree sparrow, grey partridge, bull finch and turtle dove).
- Restore and create areas of calcareous grassland (in combination with other unimproved grasslands.) Grassland creation should favour high and steep ground, and where there is strong heritage interest. In addition to encouragement of low input grassland adjacent to streams.
- Manage rivers, streams and wetland habitats, including the restoration and interlinking of wet meadows and calcareous flushes to maintain hydrological processes and enhance the biodiversity of important plant and invertebrate communities and in particular those of the chalk streams.
- Manage existing trees and woodland encouraging new planting to ensure a diverse age and ecological structure. Although woodland cover is limited featuring more in the southern section of the NCA-there are opportunities for in new small scale woodlands in appropriate areas, and around key settlements, ensuring that the open character of the landscape is maintained. The creation of broadleaved woodlands outside the AONB can provide screening in the north, helping to enhance landscape character and maintain tranquillity. All schemes require sensitive planning to minimise undesirable impacts particularly on prominent viewpoints and heritage assets. Proposals should be undertaken in collaboration with partners with appropriate expertise and guidance.
- Protect manage enhance and restore species rich grasslands.
- Protect and manage historical features including drove ways and enclosure roads with wide verges, ensuring their continued contribution to biodiversity and landscape character.
- Protect the cultural heritage of the Wolds including archaeological evidence and features such as barrows, settlement sites and earthworks through conservation and appropriate management.

- Manage and enhance the conservation of the archaeological and historical resource-supporting land managers and local communities. Identify in combination with the historical resources opportunities for geodiversity education, access and research.

- Plan new building to be sympathetic to local styles and materials reflecting the diverse vernacular/geology.

- Consider the impact of any new tourist facilities and any diversification of farms.

- Support developments that are sensitive to protecting the expansive views of the Wolds. Protect the character of the NCA by siting structures away from prominent locations and ensuring that installations are of appropriate size and scale. Built development is affecting the pattern and character of rural settlement in the Wolds and both noise and light pollution should be avoided especially in hilltop and brownfield sites. The area has visually prominent and sensitive locations and the impact of development on long distance views should be considered.

- Manage disused quarries including chalk quarries for their biodiversity with restoration through minerals planning with landscape, geodiversity biodiversity educational and recreational benefits.

- Create better access and recreation opportunities working with the Local Access Forum. Manage and maintain existing rights of way network and plan access opportunities building on best practice and experience in for example, Caistor and Market Rasen.

- In the southern area where Fen and Marsh margin farmlands exist in adjoining areas consideration should be given to local variations and the landscape should maintain a sense of openness.

Alder carr woods in the Lincolnshire Wolds at Keal Carr, also a Site of Special Scientific Interest.

Ecosystem service analysis

The following section shows the analysis used to determine key Ecosystem Service opportunities within the area. These opportunities have been combined with the analysis of landscape opportunities to create Statements of Environmental Opportunity.

Please note that the following analysis is based upon available data and current understanding of ecosystem services. It does not represent a comprehensive local assessment. Quality and quantity of data for each service is variable locally and many of the services listed are not yet fully researched or understood. Therefore analysis and opportunities may change upon publication of further evidence and better understanding of the inter-relationship between services at a local level.

Service	Assets/ attributes: main contributors to service	State	Main beneficiary	Analysis	Opportunities	Principal service offered by opportunities
Food provision	Livestock systems Cereal and oilseed production Soils	A high percentage of grade 2 and 3 agricultural land exists and is dominated by arable production with mixed farming and livestock production. Between 2000 and 2009 there was a reduction in livestock grazing units. The number of sheep and pigs reduced together with an increase in cereal and oilseed production.	National	Food provision is a significant service in the area. This industry is predominantly arable and farming contributing to sustaining national food production levels and the preservation of the historic landscape character of this area. However production can also lead to decreased water availability due to irrigation demand, and loss of soil and water quality due to high nitrate input. Extensive arable and limited semi-natural habitats in the NCA mean that there are limited resources for pollinating insects which are important in sustaining food production within this NCA. Hedgerows and managed boundary features offer a more structurally diverse habitat and may protect against soil erosion.	Work with land managers and farmers to support food production in ways that it can deliver multiple benefits for biodiversity soil quality, carbon storage, water quality, water availability and landscape. Enhance historic landscapes by working with land managers to alter cultivation practices to avoid damaging historic landscape patterns and buried archaeology, while maintaining levels of food production. Promote the management of traditional field boundaries for multiple benefits.	**Food provision** **Biodiversity** **Sense of history** **Sense of place / inspiration** **Climate regulation** **Regulating soil quality** **Regulating soil erosion** **Regulating water quality** **Water availability**

Service	Assets/ attributes: main contributors to service	State	Main beneficiary	Analysis	Opportunities	Principal service offered by opportunities
Timber provision	Woodland Soils Conifer plantations	Existing woodland cover represents 5 per cent of the NCA (4,561 ha). The majority of this is broadleaved woodland. There is currently little commercial timber in production other than that produced from small estate woodlands and shelterbelts.	Local	Existing woodland cover is low (5 per cent); comprising predominantly linear cover with a small amount of ancient semi-natural woodland. Much of the broadleaved woodland that exists is of high nature conservation value and should be protected and maintained. Limited opportunities exist for further woodland creation because of the potential impact on productive agricultural land and landscape character. This restricts opportunities for planting to small woodland blocks on higher land, steep slopes, and around development. Greater opportunities exist for Woodland creation outside the AONB (38 per cent of NCA is outside the AONB).	Promote the management of multi-purpose woodland for multiple benefits. Plant to extend existing cover and to create buffers and semi natural grassland around wooded habitats.	**Timber provision** **Regulating water flow** **Regulating water quality** **Biomass energy** **Regulating soil quality** **Recreation** **Climate regulation** **Regulating soil erosion**

Service	Assets/ attributes: main contributors to service	State	Main beneficiary	Analysis	Opportunities	Principal service offered by opportunities
Water availability	Aquifers Semi natural chalk grasslands	The main rivers in the NCA are the River Bain, the River Lymn (also Steeping River) and the Great Eau and Waithe Beck and River Lud. The chalk substrate forms a major aquifer supplying domestic water as well as irrigation for agriculture. There are some issues with sedimentation.	Regional	There is little surplus water available, with the aquifer considered to be over-abstracted, potentially creating a risk to the base flows in some rivers and streams.[6] Abstracted water used for agricultural irrigation and drinking water supplied to the region is likely to affect water availability in drought conditions. The demand for water is increasing. In the Great Eau there is evidence that abstraction has impacted on the sensitive chalk habitats within the river.[7] Excessive water abstraction and drainage is one of the main issues affecting freshwater habitats.	Maintain and improve adequate clean groundwater supply of the chalk aquifer and improve the overall hydrology of the NCA. Work with the farming community to adopt sustainable farming practices such as the creation or restoration of a network of grasslands to improve filtration into the ground and prevent nutrient run-off. Promote winter storage reservoirs instead of direct abstraction from rivers. Protect the chalk streams for their biodiversity. Protect the flows of the Rivers and protect and enhance the catchments for multiple benefits.	**Water availability** **Climate regulation** **Regulating water quality** **Food provision** **Biodiversity** **Regulating soil quality**

[6] Lincolnshire Wolds Natural Area Profile

[7] DEFRA ECFSDI priority catchments Information

Service	Assets/ attributes: main contributors to service	State	Main beneficiary	Analysis	Opportunities	Principal service offered by opportunities
Genetic diversity	Rare sheep and cattle breeds Areas of species-rich semi-natural grassland habitat Permanent pasture	Rare breeds with a heritage from the area include; *Lincoln Longwool Sheep have an 'At risk' status on the Rare Breeds Survival Trust schedule. *Lincoln Red Cattle original stock- has status 'Vulnerable' on the Rare Breeds Survival Trust schedule.	Local	Maintaining rare breeds is important for food security. Numbers of livestock have been reducing and strategies exist to improve numbers and genetic diversity. Hardy adaptable rare breeds can also aid future land management through conservation grazing. This will help to maintain a sense of place and increase biodiversity.	Encourage the promotion and development of supply chains and markets for high quality local produce. Increasing areas of permanent pasture. Putting in place appropriate grazing for specific habitats to deliver multiple benefits. Support native livestock breeds and genetic diversity and highlight the heritage of livestock and practice.	**Genetic diversity** **Biodiversity** **Food provision** **Sense of place / inspiration** **Sense of history**

Service	Assets/ attributes: main contributors to service	State	Main beneficiary	Analysis	Opportunities	Principal service offered by opportunities
Biomass energy	Existing woodland Short rotation coppice Miscanthus	There is limited availability of existing woody biomass. The existing woodland cover (5 per cent) consists of small isolated plantations and copses that offer limited potential for the provision of biomass.	Local	Improved woodland management on existing sites could provide a local source of fire wood and chip. The area offers limited locations for new biomass plantings because of the special landscape qualities of the area, and the detrimental impacts that new plantings would have. The NCA generally has a medium potential yield for short rotation coppice (SRC), while the potential miscanthus yield is generally medium. The sensitive historic environment and special /protected sensitive landscape needs to be considered in relation to any new planting. Semi-natural woodlands may require non-intervention for the protection of biodiversity within them. For example deadwood may be significant for Invertebrate species.	Opportunities for SRC exist and the potential miscanthus yield is generally medium in the south and central areas and high around Wooton and Barnetby le Wold. Where appropriate -existing woodlands are managed to produce surplus timber that could be used to provide sources of biomass. With a range of management techniques to be used in semi-natural woodlands. Options of non intervention should be considered. .	**Biomass energy** **Regulating soil erosion** **Climate regulation** **Regulating soil quality** **Biodiversity**

Service	Assets/ attributes: main contributors to service	State	Main beneficiary	Analysis	Opportunities	Principal service offered by opportunities
Climate regulation	Soils Woodland Semi-natural habitats Permanent pasture	The soils over most of the NCA have a low carbon content of 0-5 per cent reflecting a dominance of mineral soils. The relatively thin chalk soils have low levels of organic matter, especially where they are under continuous arable cultivation. Woodlands, semi-natural habitats and permanent pasture such as in the south west and on the steeper slopes are valuable for storing carbon.	Local	There are a few scattered pockets of land within the NCA with a higher carbon content of 5-10 per cent likely to be associated with areas of woodland and permanent grassland. However the low woodland cover (5 per cent) contributes little to carbon storage. The mineral soils may have potential for carbon sequestration by increasing organic matter inputs. Soil cultivation and fertiliser used for arable farming are likely to be a significant source of the greenhouse gas, nitrous oxide. The low woodland cover that is present (5 per cent) contributes little to carbon storage in its current state.	Promote cultivation practices that retain and increase the organic content of soils and increase the area of over wintering stubble and include fallow rotation to management practices. Adopt cultivation practices that reduce reliance on high levels of fertiliser input and that follow NVZ regulations. Encourage management of hedges and hedgerow trees, gapping up and allowing them to fill out. Encourage woodland creation and extend existing woodland within valleys or as shelter belts- where appropriate. Sensitivity to the special landscape qualities will need to be considered and guidance sought.	**Climate regulation** **Regulating soil erosion** **Regulating soil quality** **Biodiversity** **Timber provision** **Regulating water quality**

Service	Assets/ attributes: main contributors to service	State	Main beneficiary	Analysis	Opportunities	Principal service offered by opportunities
Regulating water quality	Chalk aquifer Semi-natural habitats Watercourses - rivers and chalk streams	99 per cent of the area falls into a Nitrate Vulnerable Zone (NVZ) and part of the area falls into a catchment sensitive farming priority catchment (The Lincolnshire Coast and Rivers catchment.) In the north and east of the NCA the groundwater chemical status is generally poor. High nitrate levels have been identified in groundwater resources and high phosphate levels and sedimentation in surface streams. High nutrient levels (including high phosphate levels and eutrophication) are issues in both the River Eau area and the River Lymn/Steeping. The surface water chemical status of the River Bain and the River Lymn is good but the ecological status of both these rivers is moderate.	Local	Diffuse agricultural pollution through nitrates is likely to affect water quality of the groundwater, the waterways in adjoining NCAs and the fragile chalk streams. Point source pollution is an issue in the catchment area. Much of the groundwater is abstracted for use in the region. The abstraction and water quality have impacts on the NCA and on adjacent NCAs, for example, the Humber Estuary NCA. (Issues of saline intrusion downstream are affected by water abstraction within the Lincolnshire Wolds NCA.) In agricultural areas measures can be taken to reduce nutrient and sediment run –off by establishing permanent grassland as a buffer along water courses. The chalk streams are also benefiting from the application of conservation activities delivered through partners involved in the Lincolnshire Chalk Streams Project. The North Lincolnshire Target Area Catchment Sensitive Farming (CSF) falls within the Lincolnshire Coast and Rivers catchment.	Reduce diffuse pollution by encouraging sustainable farming practices: adhering to NVZ guidelines. Reduce demand for water for irrigation by selecting drought resistant crops and / or increasing water storage capacity on farms. Establish buffers of permanent grassland along watercourses. Chalk Stream Enhancements opportunities exist on the Waithe Beck, Great Eau, and Laceby Beck. Follow best practice from the Catchment Sensitive Farming - North Lincolnshire Target Area.	**Regulating water quality** **Regulating soil erosion** **Biodiversity** **Water availability**

Service	Assets/ attributes: main contributors to service	State	Main beneficiary	Analysis	Opportunities	Principal service offered by opportunities
Regulating water flow	Chalk aquifer Water courses Semi-natural habitats Permanent pasture Wooded valley sides	Some water courses are prone to drying / reduced flows in their upper reaches and the permeability of the Chalk means that infiltration can occur. Chalk streams with historically low flows have been a significant issue. The permeable nature of the underlying chalk ensures that there are no large areas at risk from river flooding but some localised flooding does occur. The 3 main catchments in the NCA are: -Grimsby and Ancholme -Louth Coastal and -River Witham. In the River Witham catchment, the River Bain (which rises at Ludford) is susceptible to flooding. Barton upon Humber is identified as being susceptible to flood risk from a combination of surface water and groundwater flooding. The River Lymn and the Great Eau have low to moderate flood risk associated with the two rivers in the Louth Coastal Catchment.	Local	Groundwater provides a consistent flow volume to chalk streams. However, abstraction can give rise to artificial and low flow which impact on ecology of rivers and habitats including fens, wet woodlands and meadows. Abstraction pressures contributing to low flows are currently a concern. The River Bain has been widened, straightened and embanked in places to reduce flood risk.[8] Flood issues exist downstream at Barton upon Humber (and downstream in the Humber Estuary NCA). Flood defence schemes are in development for the River Lud (Louth), and in the longer term the River Bain (Horncastle) Flood risk management within the areas should be maintained whilst ensuring that environmental opportunities are incorporated into flood risk management.	Manage flood risk by maximising the potential of natural assets in the catchment. Work with farmers and land managers to improve soil management and to maximise and create land cover which slows and filters run- off for example through arable reversion, hedgerow restoration and planting, permanent arable field margins, wooded slopes and reedbeds. Encourage the development of sustainable drainage systems and green space to store floodwaters and filter pollutants. Encourage the extension of flood storage areas. Restore historic and natural features in to floodplains to increase capacity for water storage. On the River Bain near Horncastle (within the NCA area) there is a relatively low risk of flooding but the floodplain in this area can provide important areas to store water during flood events. Flood alleviation schemes should be developed to incorporate opportunities to deliver multiple benefits.	**Water availability** **Regulating water quality** **Regulating soil erosion** **Biodiversity** **Climate regulation**

[8] *River Witham Catchment Flood Management Plan Summary Report*, Environment Agency (December 2009); *Humber River Basin Management Plan, Annex A: Current state of waters*, Environment Agency (December 2009); *Anglian River Basin Management Plan*, Environment Agency (December 2009)

Service	Assets/ attributes: main contributors to service	State	Main beneficiary	Analysis	Opportunities	Principal service offered by opportunities
Regulating soil quality	Soils Sustainable farming practices Semi-natural chalk grasslands Geological processes	The majority of the NCA has light chalky soils and permeable loams, with impermeable soils associated with the Jurassic Kimmeridge clays. The calcareous soil types are typically shallow and free draining. Although they are vulnerable to drought they also have a degree of natural resilience due to their calcareous nature. The soils are valuable for aquifer recharge. The NCA has chalky boulder clays, well drained acidic loams as well as areas of impermeable soils.	Local	Maintain soil structural condition and water infiltration for example by avoidance of compaction and increase in soil organic matter. Organic matter may be lost through frequent tillage associated with intensive arable farming; however, cultivation of some crops can help retain organic matter. Impermeable soils are seasonally waterlogged. Compaction may occur if heavy machinery is used.	Seek ways of reducing demand for water by selecting crops and /or increasing storage of water on farms. Encourage sustainable farming practices; adopt cultivation practices that increase organic content of cultivated soils, such as introducing fallow into rotations, over wintering stubbles, direct drill and green cover crops.	**Regulating soil quality** **Regulating soil erosion** **Biodiversity** **Regulating water quality** **Water availability**

Service	Assets/ attributes: main contributors to service	State	Main beneficiary	Analysis	Opportunities	Principal service offered by opportunities
Regulating soil erosion	Soils Sustainable farming practices Semi-natural habitats Woodland	The predominantly thin, chalky tills of the Lincolnshire Wolds are subject to soil erosion under certain land uses. Some soils are intrinsically vulnerable to erosion and steep slopes accentuate the issue. Wind erosion and water erosion occur but those soils under permanent vegetation are less prone to erosion. Soil loss leading to sedimentation of watercourses is identified as an issue in the Lincolnshire Coast and Rivers Priority Catchment in the NCA including the River Lymn and the Great Eau. In the Great Eau area there is evidence that sedimentation -a product of soil erosion- has a major effect on the ability of the river to support populations of salmon and trout.	Local	With the NCA falling into a Nitrate Vulnerable Zone overlying a regionally important aquifer, soil erosion is a concern in relation to water quality because water can transfer sediments and contaminants into groundwater and surface water. Soil erosion is likely to occur more frequently on steeper slopes under arable production where shallower lime-rich soils are at risk of erosion on cultivated ground, or where bare soil is exposed. Freely draining lightly loamy soils are also vulnerable where there is the potential for wind erosion. The loamy and clayey soils with impeded drainage, are easily compacted by machinery or livestock if accessed when wet, increasing the risks of soil erosion by surface water run-off. Soil management is critical as many of the soil types are vulnerable to damage and hence erosion. Erosion of thin chalk soils can lead to total loss of soil to expose bare rock. Soils under woodland will be conserved but are notaccessible for food production.	Encouraging sustainable farming practices. Encouraging the use of steep slopes for pasture and recognising that where thin chalk soils are present, there will be significant opportunities to deliver biodiversity benefits. Incorporation of organic matter into cultivated soils and reduced tillage will result in the avoidance of Compaction, minimising runoff and reduce soil erosion. The incorporation of features such as hedgerows and grassland buffers to intercept runoff will reduce widespread erosion, filter contaminants whilst enhancing the landscape and benefiting biodiversity. Encourage longer growing periods between grazing rotations to increase sward diversity, increase root penetration and increased soil stability.	**Regulating soil erosion** **Regulating soil quality** **Regulating water quality** **Water availability** **Climate regulation** **Biodiversity**

Service	Assets/ attributes: main contributors to service	State	Main beneficiary	Analysis	Opportunities	Principal service offered by opportunities
Pollination	Pollinating insects Semi natural chalk grasslands Semi-natural woodlands	The dominance of arable cultivation currently limits habitat available for pollinating insects to thrive. Current semi-natural, non-wooded habitats cover only a small percentage of the NCA. Lowland meadows provide some nectar sources for pollinating insects but overall this habitat is small limiting natural sources of nectar-bearing plants.	Local	The pollination of crops is essential for sustainable agricultural production. A lack of semi-natural habitats provides less variety of plant species for pollinating insects. Semi-natural woodlands can be a source of nectar, particularly early in the season.	Encourage sustainable farming practices; increase species-rich grasslands and plant nectar-rich seed mixes. Create an ecological network of habitats including roadside verges to support pollinating species. Extend the network of woodland cover where appropriate.	**Pollination** **Food production** **Biodiversity**
Pest regulation	Habitat mosaic	The area is arable production dominated by a few types of cereal crops and lacks semi natural pasture/grassland. A lack of heterogeneity in the landscape provides less resilience against widespread pest and disease damage.	Local	There is recognised pest damage affecting timber production/trees, mammals including grey squirrels, muntjac, fallow deer and insects, including oak processionary moth. Sudden oak death and ash dieback are also potentially affecting trees. Non-native invasive species are a potential threat to native aquatic biodiversity. The mosaic of woodlands, hedgerows and watercourses may facilitate disease and pest dispersal, however, the mosaic of habitats will also have potential to support natural predators.	Build resilience against pests and diseases, by supporting diversity within species populations and support habitats, through selection of crop types. Focus upon managing impacts upon food and timber provision and biodiversity. Establish pest and disease management strategies for the Wolds woodlands and watercourses, in particular.	**Pest regulation** **Timber production** **Biodiversity**

Service	Assets/ attributes: main contributors to service	State	Main beneficiary	Analysis	Opportunities	Principal service offered by opportunities
Sense of place/ Inspiration	Long open views of rolling hills and big skies Contrasting enclosed steep sided valleys Tree cover framing views Sparse settlement patterns Historic environment Poets, writers and artists- including Alfred, Lord Tennyson	An area characterised by rolling landform of and deep steep-sided valleys. A place providing inspiration –reflected through the work of poets and artists. Fine panoramic views and open skies. The pattern of enclosure and land cover gives the area a simple but strikingly bold character. A distinct rural character, emphasised by the sparse settlement pattern. A wide range of historic features and local materials.	National	Opportunities exist to celebrate the landscape's cultural ties including the area's long association with the poet laureate Alfred, Lord Tennyson. The Wolds provided inspiration to painter, Peter de Wint and the novelist A S Byatt. Inspiration and escapism are likely to be particularly associated with the far-reaching views and of the rural landscape throughout the area. The area is a protected landscape designated an Area of Outstanding Natural Beauty. Natural and cultural heritage is increasingly accessible and celebrated.	Ensure that development respects local settlement patterns, building material, views, wildlife, geology and historic evidence. Encourage visitors to the NCA. Offer good quality experiences and interpretation, and encourage opportunities for education and visitor/ community engagement in relation to landscape, biodiversity, geology and heritage. Further develop strong locally produced products and materials where this supports management of the landscape, for example woodland and sheep farming products and local building materials. Encourage community engagement and activity and 'join up' making links to the AONB Management Plan.	**Sense of place/ inspiration** **Sense of history** **Biodiversity** **Tranquillity** **Recreation** **Geodiversity**

Service	Assets/ attributes: main contributors to service	State	Main beneficiary	Analysis	Opportunities	Principal service offered by opportunities
Sense of history	Pre-historic monuments and Earthworks Deserted villages Field patterns Historical routes, high roads and tracks Estates and parkland Churches and historic buildings Quarrying Human remains	The history of the landscape is evident in an exceptional array of archaeological evidence. Prehistoric occupation and land use from the Neolithic period. Notable long barrows along the Wolds plateau and bronze-age barrows capping the hill tops. Roman roads linking to the coastal salt industry, villages of Saxon origin, numerous deserted medieval villages. Rectilinear field patterns reflecting late-medieval and Parliamentary enclosure. Country houses and estates that date from the late-medieval period and historic buildings built from the local stone.	National	TThe Lincolnshire Wolds has been settled since Neolithic times. Pre-historic barrows are numerous in the NCA and need protection and scheduling. Many historic features are at risk. Ancient track ways, Roman roads burial mounds and drovers routes are evidenced. The visible archaeology is an important feature of the area, and there are a number of scheduled monuments. A high proportion of deserted medieval villages exist and medieval settlements also remain such as Brinkhill. The small market towns have been very important historically and the Lincolnshire Wolds towns maintain their historic character with a number of listed buildings. Several parklands and historic buildings can be found in the NCA. There is also a military history with second world war air bases.	Protect historic features and encourage best practices in agriculture relating to earthworks and below ground archaeology. Maintain estates and parkland and protect ancient monuments at risk identifying opportunities through agri-environment schemes. Ensure developments respect the local vernacular. Develop opportunities for visitors to access and learn about the local historic environment. Encourage community involvement in learning about local history and archaeology.	**Sense of history** **Sense of place / inspiration** **Geodiversity** **Recreation**

Service	Assets/ attributes: main contributors to service	State	Main beneficiary	Analysis	Opportunities	Principal service offered by opportunities
Tranquillity	Expansive open views Sparse settlement patterns Few infrastructure routes	The area has a strong sense of Tranquillity and is known for its big open skies. Much of the area is sparsely populated and a high proportion of the area lies within the protected Lincolnshire Wolds Area of Outstanding Natural Beauty (AONB). In 2007, 80 per cent of the NCA was classified as undisturbed. (CPRE Intrusion Map). The area is also recognised for its dark skies at night.	Regional	The Lincolnshire Wolds is predominantly an area of higher ground. The majority of the area is located within the Lincolnshire Wolds Area of Outstanding Natural Beauty- nationally protected for its natural beauty and tranquillity. A very large proportion of the NCA contributes to the sense of tranquillity due to elevated views, sparse settlement patterns. The area predominantly has village settlements and it lacks any major towns/cities. It has a low proportion of manmade structures.	Encourage sensitive development respecting the open and expansive views and a strong rural character and natural beauty. The Lincolnshire Wolds AONB Management Plan provides a number of objectives and actions-under Theme1 'Protecting the Wolds' and Theme 4 'Developing the Wolds'.	**Tranquillity** **Sense of history** **Sense of place / inspiration** **Recreation**

Service	Assets/ attributes: main contributors to service	State	Main beneficiary	Analysis	Opportunities	Principal service offered by opportunities
Recreation	AONB Network of footpaths (0.53 per km^2) Viking Way – long distance footpath Estates and Parklands Historic sites National cycle routes Geological sites Woodlands	The Area of Outstanding Natural Beauty covers 62 per cent of the NCA and offers opportunities to protect and enhance the landscape. Only 1.3 per cent of the NCA is 'publically accessible' and with only 579 km of public rights of way at a density of 0.53 per km^2. There are few publicly owned and managed sites with country parks being the main type and Woods for People and Local Nature Reserves important in terms of access provision. Main routes include the Viking Way regional footpath links a number of historic sites and places of interest. The National Cycle Network crosses the NCA.	Regional	The NCA has a low density of public rights of way. It offers varied recreation and access opportunities and access to sites of cultural historic and geological interest. Market Rasen and Caistor share 'Walkers are Welcome' a nationwide initiative launched in 2007 to encourage towns and villages to be 'welcoming to walkers'. There is scope to improve access opportunities including promotion of the number of walks leaflets in the area. The Lincolnshire Wolds Walking Festival is now one of the largest in the country. There is potential for more cycling and promoted cycle routes. Potential to improve the access routes and to engage people in their development. There will also be opportunities to encourage sustainable transport links with adjacent / surrounding settlements. Access provides an opportunity to celebrate the history of the area, the geodiversity and biodiversity. A long association with Alfred, Lord Tennyson.	Improve and extend green tourism opportunities-providing sustainable solutions, where the natural environment is protected. Improve access to recreation for a wide range of users. Improve access by ensuring that paths are well maintained and signposted and that some surfaced paths are provided to ensure easy access walks There are opportunities to link the area to the coast and historical sites. There is scope for joining up of the main routes improving links into the AONB, developing walking and cycling routes from public transport interchanges. Supporting and promoting new linear and circular routes such as the Lindsey Trail suitable for horses, carriages, cyclists and walkers. Improved access provides an opportunity to celebrate the history of the area, the geodiversity and the biodiversity. Several cultural ties exist which offer opportunities to celebrate, for example, the association with Tennyson. The Lincolnshire Wolds AONB Management Plan provides a number of objectives and actions under Theme 3, 'Discovering the Wolds' which provide opportunities for recreation.	**Recreation** **Sense of history** **Tranquillity** **Sense of place / inspiration** **Biodiversity** **Geodiversity**

Service	Assets/ attributes: main contributors to service	State	Main beneficiary	Analysis	Opportunities	Principal service offered by opportunities
Biodiversity	National designations Semi-natural/ Priority habitats : Rivers and streams Broadleaved mixed woodland Lowland meadows Lowland calcareous grassland Small areas of Purple moor grass and rush pasture; Fens; and Lowland dry acid grassland	There are over 1,007 ha of Priority habitat representing 1 per cent of the area within the NCA. There are 23 nationally designated SSSI covering 102 ha. These are mostly in favourable condition. (March 2011). There are 342 local 'wildlife sites' within the NCA.[9] In comparison to many other NCAs this is a very limited area of semi-natural habitat. The NCA contains no Special Area of Conservation, Special Protection Area or Ramsar sites. [9] Lincolnshire Wolds Draft AONB Management Plan (2013–2018)	Regional	Improving the biological condition of the designated resource is likely to require sustainable land management practices to Increase in the coverage of semi-natural habitats: Creating buffer strips, extending grassland along field margins, slopes and arable margins. Maintenance and improvement of hydrological systems, employing sensitive grazing regimes and extending woodland in appropriate places. These will help to increase /improve regulating services such as water quality, and soil erosion while contributing to sense of place.	Protect SSSI and BAP habitats; species-rich grasslands and broadleaved woodlands: Establish a resilient ecological network, identify core areas and address gaps-particularly in relation to calcareous grassland and riparian habitats-including chalk streams. Conserve important species populations in semi-natural and farmland settings; chalk grasslands on steep slopes, wet meadows and alongside chalk streams. Create new grasslands for biodiversity linking with existing semi natural habitats to deliver multiple benefits. Manage the ancient woodlands and parkland trees for their biodiversity. Manage arable farmland habitats and farm woodlands to support increased numbers of farmland birds. Incorporate access improvements and make provision for public engagement with nature.	**Biodiversity** **Recreation** **Regulating soil erosion** **Regulating soil quality** **Regulating water quality** **Water availability** **Sense of place / inspiration** **Tranquillity**

Service	Assets/ attributes: main contributors to service	State	Main beneficiary	Analysis	Opportunities	Principal service offered by opportunities
Geodiversity	Designated geological sites Exposures in old quarries Local Geological sites Local building stone Rocks and fossils	There are currently 9 Nationally designated geological SSSI, 1 mixed interest SSSI and 38 Local Geological Sites. The Carstone, Red Chalk and white chalk are notable and provide a striking variation of colour and texture. Most of the older buildings in the NCA are built of local stone including Tealby Limestone, Claxby Ironstone and Spilsby Sandstone.	Regional	SSSI, Local Geological Sites and geological exposures and geomorphological features provide important opportunities for research education and interpretation enabling a greater understanding of the nature and evolution of the landscape through time. Exposing and managing the features for scientific, educational and recreational use makes a positive contribution to 'sense of place' and 'history'. Local building stone is still available and is used for building which enhances local distinctiveness.	Conserve, manage and promote geodiversity sites and features as an integral part of the NCA to a wide audience; developing and improving visitor access where appropriate.	**Geodiversity** **Sense of history** **Sense of place / inspiration** **Recreation** **Biodiversity** **Water availability**

Photo credits

Front cover: Walkers looking across the Bain Valley, which typically has alder trees along the water course. © Louise Niekirk/Lincolnshire Wolds Countryside Service
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NATURAL ENGLAND

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