

Lincolnshire Coast 2100+ Coastal Investment Plan

Baseline report

Third Issue December 2024



ARUP

one architecture
new york city amsterdam

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Executive Summary

Land and Water

Up until the thirteenth century, the coast of Lincolnshire is thought to have been protected by a series of offshore coastal barrier islands that shielded the Lincolnshire coastline from the full force of the storms and tides of the North Sea. Storm surges in the 13th century are thought to have overwhelmed the offshore barrier islands, destroying a sheltered tidal lagoon.

Land reclamation first began in the area as a result of medieval salt making along the former coastlines. The process created large quantities of spoil mounds, made up of sand and silt on which settlements were built. In the 18th and 19th centuries, the agricultural landscape became more complex, supporting a range arable crops and pasture, with settlements rebuilt or displaced following enclosure acts.

Today, the Lincolnshire Coast is defined by its diverse mixture of dune and flood plain, saltmarsh, and soft cliffs. Due to the absence of 'hard rock' coastal area, large proportions of the coast are highly vulnerable to marine flooding and erosion. The area is a low-lying coastal plain adjacent to the north sea, consisting predominantly of rural farmland in a wide flat landscape containing many small historic villages and farmsteads. More than 95% of East Lindsey is classified as rural, but there are over 61,000 residents, a third of these in the town of Skegness. This is also supplemented by 2.73 million visitors each and every year to Coastal Lincolnshire.

The relatively flat Lincolnshire coastal plain is drained by a network of inland drainage systems, optimised to ensure crops survive, minor drains border fields and flow into major

drains. The inland drains and respective pumping stations in the study area are operated and maintained by the Lindsey Marsh Drainage Board.

The drainage systems all flow into the North Sea through tidal outfalls, these are at risk of tide locking. Sea level rise will result in longer periods of tide locking and the increased frequency and intensity of rainfall events will increase the demand on the drainage network and its pumping stations. The drainage channels are at risk of reaching capacity and breaching their banks due to increased discharges.

Sea defences in the form of embankments, seawalls and timber groynes were rebuilt in the aftermath of the 1953 storm surge and have been improved and refurbished over time. An integrated coastal defence system of hard and soft defences, including the maintained beach achieved through beach nourishment operations, currently provides protection against the risk of coastal flooding.

As the sea defences have continued to age their overall health has deteriorated and their resilience and reliability as sea defences has decreased. The risk also remains that an extreme surge event may exceed the current standard of protection.

Away from the coastline, the study area contains approximately 22,600 Ha of protected statutory designation coverage pertinent to biodiversity conservation, equating to 40% of the total project area, mostly marine habitats.

There are opportunities to boost 'blue' carbon capture on coastal saltmarshes, increasing capacity and rate of carbon

sequestration and build upon existing and ongoing research in this field. Conversely, retreating shorelines could become net carbon source, particularly if saltmarsh habitats are lost.

The opportunity to plan strategically at a regional level to provide long-term resilience and adaption to climate change would help to address these complexities.

An integrated coastal defence system of hard and soft defences, including the maintained beach achieved through beach nourishment operations, currently provides protection against the risk of coastal flooding.

As the sea defences have continued to age their overall health has deteriorated and their resilience and reliability as sea defences has decreased. The risk also remains that an extreme surge event may exceed the current standard of protection.

With approximately 22,600 Ha of protected areas, mostly marine habitats, there are opportunities to boost 'blue' carbon sequestration in the area.

LEGEND

⚠️ Situation in drainage channels due to construction and silt blocking

Permeable ground due to soil conditions and more less impervious landscape

Risk/ Constraints

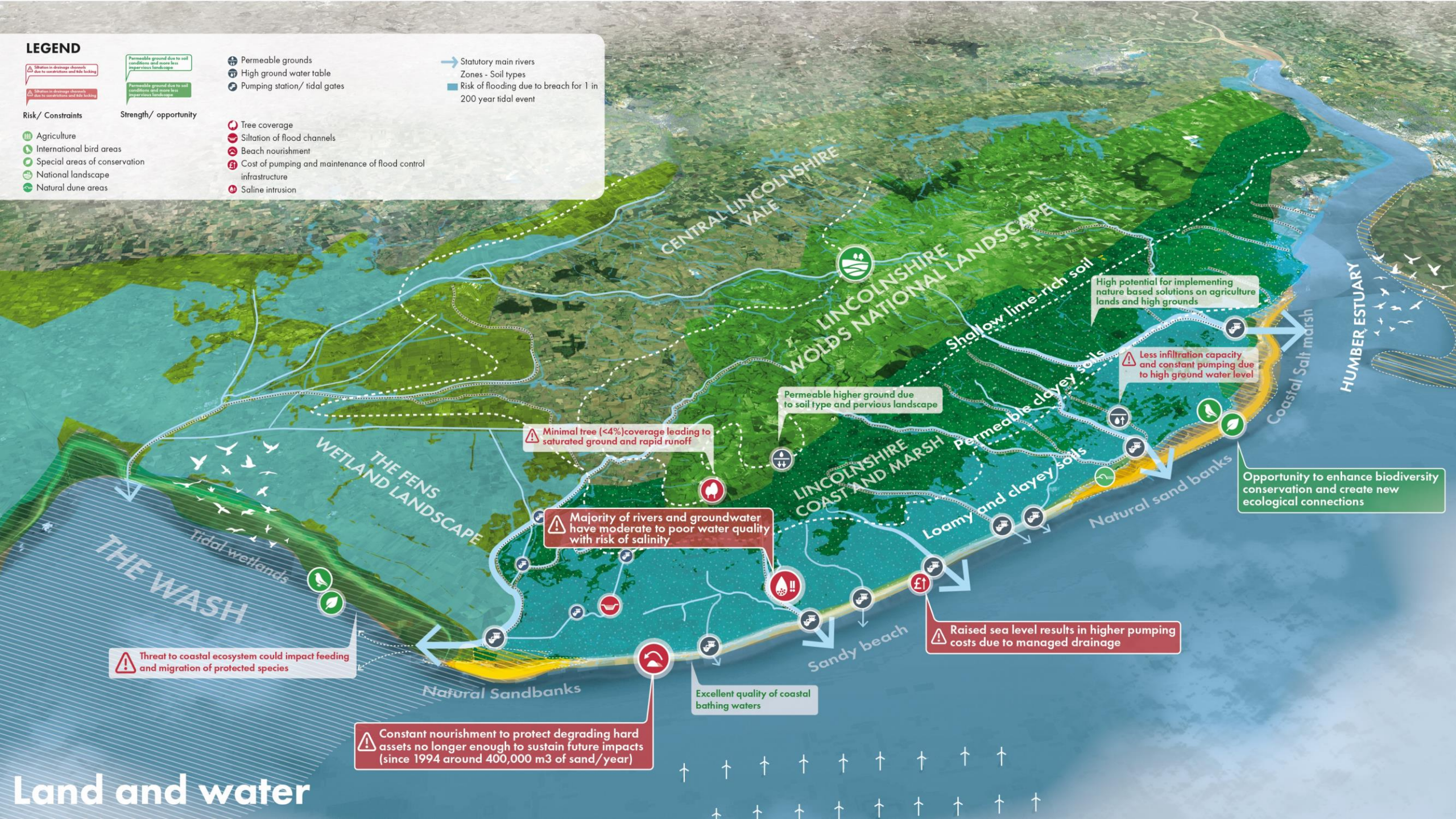
- 🌾 Agriculture
- 🐦 International bird areas
- 🌿 Special areas of conservation
- 🌳 National landscape
- 🏖️ Natural dune areas

Strength/ opportunity

- 🌳 Tree coverage
- 🚰 Siltation of flood channels
- 🏖️ Beach nourishment
- 💷 Cost of pumping and maintenance of flood control infrastructure
- 🌊 Saline intrusion

- 🌊 Permeable grounds
- 📊 High ground water table
- ⚙️ Pumping station/ tidal gates

- ➡️ Statutory main rivers
- 🗺️ Zones - Soil types
- 🌊 Risk of flooding due to breach for 1 in 200 year tidal event



⚠️ Minimal tree (<4%) coverage leading to saturated ground and rapid runoff

⚠️ Majority of rivers and groundwater have moderate to poor water quality with risk of salinity

⚠️ Threat to coastal ecosystem could impact feeding and migration of protected species

⚠️ Constant nourishment to protect degrading hard assets no longer enough to sustain future impacts (since 1994 around 400,000 m3 of sand/year)

Permeable higher ground due to soil type and pervious landscape

Shallow lime-rich soil
permeable clayey soils

High potential for implementing nature based solutions on agriculture lands and high grounds

⚠️ Less infiltration capacity and constant pumping due to high ground water level

Opportunity to enhance biodiversity conservation and create new ecological connections

⚠️ Raised sea level results in higher pumping costs due to managed drainage

Excellent quality of coastal bathing waters

Land and water



Executive Summary

Infrastructure

The Lincolnshire coast study area comprises a number of interrelated and dependent infrastructure systems. Skegness features a cluster of critical community infrastructure that not only serves the local community but also the wider region. These include a hospital, police station, secondary schools and lifeboat station. Other community infrastructure is spread throughout settlements in the area.

There is a range of energy infrastructure across the study region from existing electricity and gas networks to the Viking Interconnector and decommissioned nationally strategic gas site, Theddlethorpe. There is also 101MW of embedded electricity generation along with significant offshore wind connected into the region. Extensive investment is planned in the region including the expansion of the electricity transmission network as part of the Great Grid Upgrade and development of hydrogen and carbon networks, supporting the local and national transition to Net Zero.

The Lincolnshire Coast is serviced by one rail line that runs from Nottingham and terminates at Skegness and is operated by East Midlands Railway. There is one service per hour via Boston and Grantham. The lack of public transport connectivity and the sparsity of the population contributes to a dependency on cars for both locals and those visiting the area.

The study area is connected by several A-roads, with the A158 and A52 being the major routes linking coastal towns to larger inland cities. Many smaller B-roads and local routes

connect rural towns and villages. These can sometimes be narrow and winding but provide scenic routes across the Lincolnshire Wolds. Despite the high car usage in the area, main arterial roads in the area remain congestion-free on a typical workday.

To evacuate the study area, people would need to head inland, towards towns such as Louth, Spilsby and Horncastle. Due to the high car availability and dependency of the area, it is expected that most evacuation would be done by private vehicle. The primary rail service in this region runs to Skegness, with connections to Nottingham and other towns.

The entirety of the project area's potable water supply is provided and managed by Anglian Water with the wider district possessing a significant proportion of designated nationally important chalk streams. The supplies are primarily groundwater abstractions from the Lincolnshire Chalk, Lincolnshire Limestone and Spilsby Sandstone. These sources are over abstracted, and licence reductions are expected between 2025 and 2050. There is also a surface water abstraction from the Louth Canal into the Covenham pumped storage reservoir which is located about 10 km inland.

Anglian Water is planning a potential new 50 MI/d potable water desalination plant at Mablethorpe and a proposed Lincolnshire Reservoir in South Lincolnshire could support water supply needs in Lincolnshire, although it is primarily being constructed to meet water demands south of the

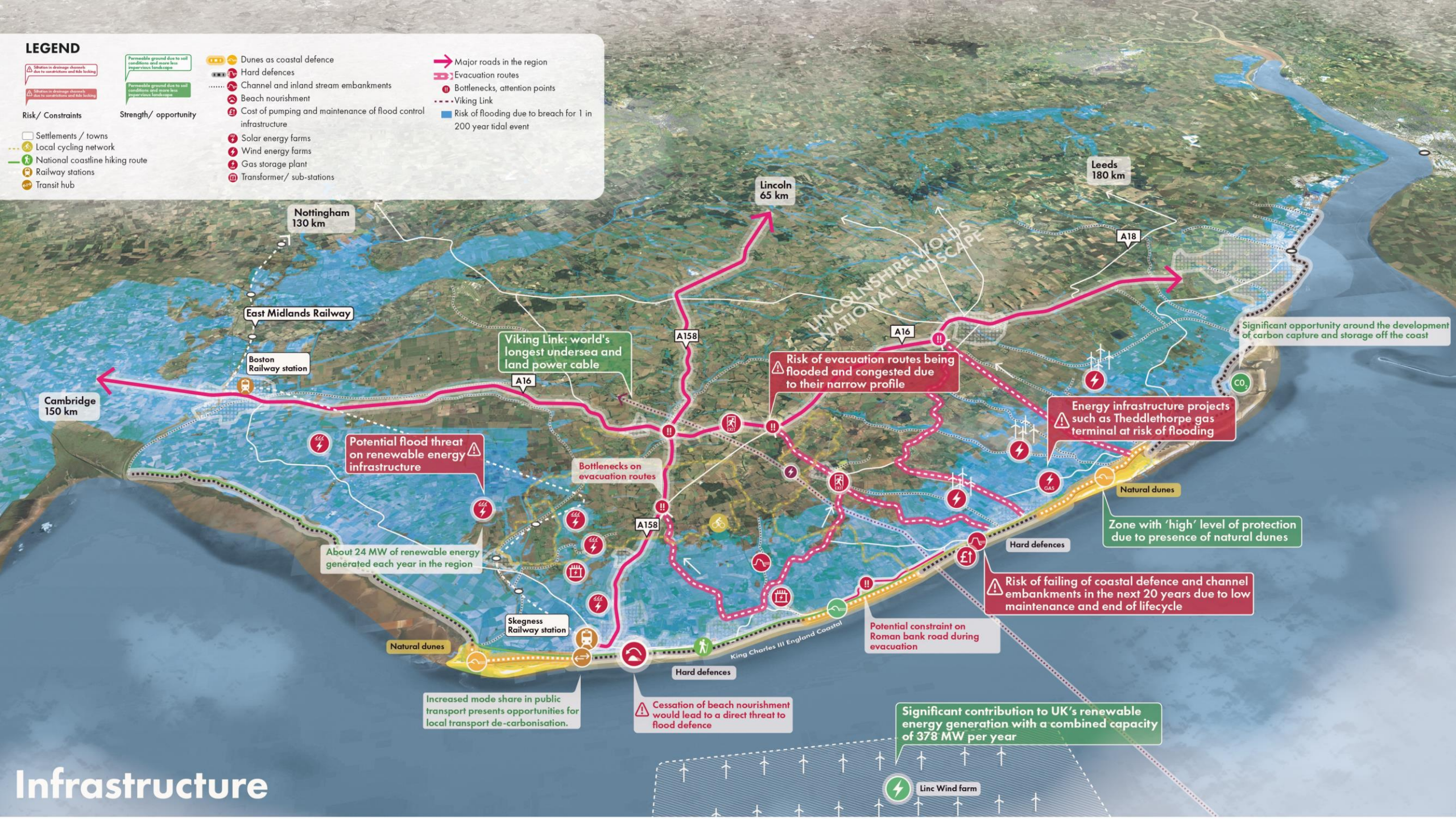
project area.

Extensive investment is planned in energy transmission in the region including the expansion of the electricity transmission network as part of the Great Grid Upgrade, though the area remains poorly connected to the wider region with only one rail service in Skegness.

While groundwater sources are over abstracted, Anglian water are planning new desalination plants as well as a new reservoir.

LEGEND

- Situation in drainage channels due to construction and tide locking
- Situation in drainage channels due to construction and tide locking
- Risk/ Constraints**
- Settlements / towns
- Local cycling network
- National coastline hiking route
- Railway stations
- Transit hub
- Strength/ opportunity**
- Permeable ground due to soil conditions and more less impervious landscape
- Permeable ground due to soil conditions and more less impervious landscape
- Dunes as coastal defence
- Hard defences
- Channel and inland stream embankments
- Beach nourishment
- Cost of pumping and maintenance of flood control infrastructure
- Solar energy farms
- Wind energy farms
- Gas storage plant
- Transformer/ sub-stations
- Major roads in the region
- Evacuation routes
- Bottlenecks, attention points
- Viking Link
- Risk of flooding due to breach for 1 in 200 year tidal event



Cambridge 150 km

Nottingham 130 km

Lincoln 65 km

Leeds 180 km

East Midlands Railway

Boston Railway station

Viking Link: world's longest undersea and land power cable

Potential flood threat on renewable energy infrastructure

Bottlenecks on evacuation routes

Risk of evacuation routes being flooded and congested due to their narrow profile

Energy infrastructure projects such as Theddlethorpe gas terminal at risk of flooding

About 24 MW of renewable energy generated each year in the region

Skegness Railway station

Natural dunes

Hard defences

Hard defences

Zone with 'high' level of protection due to presence of natural dunes

Risk of failing of coastal defence and channel embankments in the next 20 years due to low maintenance and end of lifecycle

Potential constraint on Roman bank road during evacuation

Increased mode share in public transport presents opportunities for local transport de-carbonisation.

Cessation of beach nourishment would lead to a direct threat to flood defence

Significant contribution to UK's renewable energy generation with a combined capacity of 378 MW per year

Linc Wind farm

Significant opportunity around the development of carbon capture and storage off the coast

Infrastructure

Executive Summary

Communities

The study area is part of East Lindsey District, one of seven districts of Lincolnshire County Council, that with two other local authority areas form Greater Lincolnshire.

In 1953, a major storm surge caused over-topping of sea defences along the eastern coast of England. It is widely regarded as one of the worst peacetime disasters to hit the country in the last century. Following the flood, much of the built coastline was protected by the construction of substantial concrete sea walls. The current condition of those assets, coupled with climate change, could severely disrupt lives and livelihoods across the region if they were to fail.

Today, a variety of hard sea defences separate the sea and beaches from five main settlements that form an almost continuous urban corridor along the coastline, from Mablethorpe to Skegness, via Sutton-on-Sea, Chapel St Leonards and Ingoldmells.

The area has been attracting repeat holidaymakers for generations, with lower overall cost of living compared to south-west coastal towns and more affordable restaurants, transportation and sports and leisure activities. However, there has been under-investment in seaside resorts, which struggle to attract higher-spending segments of the market. Expansive caravan parks incapsulate the urban edges off all the settlements and mostly occupy lower lying areas.

There are some areas of high agricultural land quality and productivity, while the majority of the coastal hinterland agricultural land is designated 'good to moderate'. However,

the underlying chalk aquifer is sensitive to over-abstraction and is potentially at risk from saline intrusion. Sea level rise will increase the local saltwater table which may impact the productivity of agricultural land and the communities that are dependent on this economy.

The majority of the 61,000 residents in the study area live in the seaside towns of Skegness, Mablethorpe, and Ingoldmells and the inland town of Alford, with the remainder residing in rural towns and villages on the coast and inland. Overall, the area has a relatively low population density. East Lindsey also has a significantly older population with a mean average of 52.2 years compared to 40.5 years for England. Despite this, the local area is expected to grow at a faster rate than the rest of England. This presents opportunities to diversify the economy beyond tourism, with a larger workforce providing local businesses with a wider pool of talent and higher tax revenues for the local government.

Life expectancy is slightly below the national average, and poorer health outcomes exist for residents in the study area. There are pockets of high deprivation, especially in Mablethorpe, Saltfleet, Sutton on Sea and Skegness.

Productivity in East Lindsey is lower than the rest of the UK. And there is a high prevalence of occupations in caring and leisure, accommodation and food service activities and retail and repairs sectors. Nevertheless, employment in East Lindsey has been increasing in recent years and the area is viewed positively as a place to do business, with lower cost and business rates and access to customers.

The area has been attracting repeat holidaymakers for generations, but there has been under-investment in seaside resorts.

The local area is expected to grow at a faster rate than the rest of England but the condition of coastal assets, coupled with climate change, could severely disrupt lives and livelihoods across the region if they were to fail.

LEGEND

Risk/ Constraints	Strength/ opportunity		



⚠ Threat to agriculture and freshwater availability due to retreating coastline and saline intrusion

⚠ Around 25,000 caravans under potential risk of flooding across the project area

ABOUT 38,000 HA OF FARMLANDS

Ageing population with highest median age in East Lindsey

⚠ A number of vital urban functions fall in the risk zone

⚠ Households with deprivation in two dimensions

⚠ Risk of environmental pollution due to landfills exposed to sea

SEASIDE RETIREMENT
About 12,700 inhabitants

2.73 million visitors to Coastal Lincolnshire in 2023

Vital urban functions

TOURISM GATEWAY
About 29,500 inhabitants

⚠ Skegness, the largest of the settlements with 20,700 inhabitants is at a major risk of inundation due to flood defence degradation and sea level rise

Communities



Introduction



Purpose of Document

The low-lying nature of Lincolnshire's coastal communities presents a significant risk of coastal flooding to those living, working and visiting the region.

Existing sea defences including sand dunes, beaches and concrete structures currently provide resilience to coastal erosion and flooding, however much of the infrastructure is aging and reaching the end of its serviceable life. With climate change there is an increased risk of more severe and more frequent storms, coupled with predicted sea level rise the risk of a major flood event will increase without continued coastal erosion and flood risk management.

Inland, the existing rivers and drainage system are also becoming increasingly costly maintain due to the reliance on pumps to move water from the low-lying land into the North Sea to reduce the risk of flooding.

A new sustainable approach is required to ensure that coastal erosion and flood risk management can be maintained in the long term. This requires an innovative approach to define a Coastal Investment Plan that can deliver an economic benefit, whilst also being technically feasible, buildable, sustainable, environmentally sensitive and financially deliverable through national funding and partnership with other key stakeholders.

Arup, in collaboration with ONE Architecture, have been commissioned to develop a Lincolnshire Coast 2100+ Coastal Investment Plan. The purpose of the Baseline Report is to establish a common understanding of the key parameters influencing the design and development of the coastal design strategies that will in turn inform the Coastal Investment Plan.

The Report establishes the current conditions of the Lincolnshire Coast and provides the foundations and the rationale for investment in the coastal protection on the Lincolnshire Coast, alongside the separate Lincolnshire Coast Vision which is being created by project partners.

In creating this evidence base, this report will support the development of a credible business plan for investment in coastal protection, which the Environment Agency and partners will ultimately present to the government upon the conclusion of the project. By looking at the historical baseline, current spatial, socio-economic, and environmental conditions, this reports helps to:

- build an understanding of how different levels of investment could avoid or mitigate future challenges
- identify any possible future opportunities for the area which could generate improvements.

This baseline enables development and prioritisation of strategic objectives and outcomes for the study area. This forms the start of an iterative process with the development of the conceptual design strategies, resulting in updated strategic design brief. It will be used to engage early with project partners and key stakeholders, ensuring the conceptual design strategies align with their strategic aims.

Introduction



The Lincolnshire Coast study area, approximately 56,000ha including roughly 35,900ha of land and 20,100ha of sea, falls within the boundaries of East Lindsey District Council. It extends over 38 km of coastline along the north sea. It is located south of the Humber estuary, and north of the Wash, two areas of significant importance due to their rich biodiversity, significant ecological importance, and crucial roles in supporting industrial activities and international trade in the UK.

This area, which lies 2-4 meters below sea level, reaching up to 15km inland, is characterised by its flat, low-lying terrain, generally between 1m and 4m above ordnance datum (AOD).

The region is a popular tourist destination, home to several towns such as Skegness, Wainfleet All Saints, Chapel St Leonards, and Sutton-on-Sea, and encompasses large areas of agricultural hinterland. Despite its attractions, the area is socio-economically challenged, with many parts falling within the 20% most deprived in the country, and some within the 10% most deprived.

Historically, the Lincolnshire coast has faced significant challenges, including severe flooding in 1953 that resulted in significant loss of life across the east of England. Since then, a series of man-made interventions have been implemented, including upgrading hard assets and nourishing beaches to support existing natural defences like dunes, intertidal mudflats and coastal marshes to enhance the flood protection from the sea. Significant land drainage schemes are also in place to manage freshwater inundation.

Currently, 84.6% of the coastal assets have a residual life of 20 years or less, according to a recent study. Funding is being sought for beach nourishment and limited maintenance of hard assets until 2040. However, post-2040, the reliance on hard assets is expected to become increasingly risky because of the increased risk of overtopping due to climate change and the degradation of the existing assets. It is therefore unlikely that government funding will continue at the same level for the same kind of approach. Alternative funding streams, as well as other cost and affordability considerations will have to be explored.



01

Historical Baseline

The Lincolnshire Coastline c.1250-1600

Until the thirteenth century, the coast of Lincolnshire is thought to have been protected by a series of offshore coastal barrier islands that shielded the Lincolnshire coastline from the full force of the storms and tides of the North Sea. A sheltered tidal lagoon between the island and the main coastline was characterised in part by saltmarsh, wide sand and mud flats, and tidal creeks and estuaries¹.

The storm surges of 1287 and 1288 are thought to have overwhelmed the offshore barrier islands, and those years saw significant damage to the Lincolnshire coast around Mablethorpe St Peter and Mablethorpe St Mary. The coastal landscape of Lincolnshire witnessed sudden and dramatic changes in its nature. No longer did it look out on to a sheltered lagoon, but rather to the open sea. In 1335, 1425 and 1443 storm surges again broke through the medieval sea-banks at Mablethorpe, the last resulting in the Lord of Mablethorpe Manor being exempted from offices and services in consideration of the loss of land and of the costs of repairing the coast².

1517 and 1526 saw severe flooding and destruction in Skegness, when the 'church and a great part of the parish was submerged'. By 1540, the town seems to have been entirely swallowed up by the waves, although 'manifest tokens of old buildings' were said to be visible at low tide, located around half a mile or so out to sea².

In the middle of the sixteenth century, Sutton-in-the-Marsh (now Sutton-on-Sea) suffered a similar fate. Decades later, in the 1630s, the parishioners of Sutton wrote to the Privy Council complaining that the sea-banks that protected their village were in decay and warning that some 80 years previously they had paid dearly for such neglect².



Present day examples of historic landscapes. Top left: tidal creeks, top right: saltmarsh, bottom left: sand and mud flats



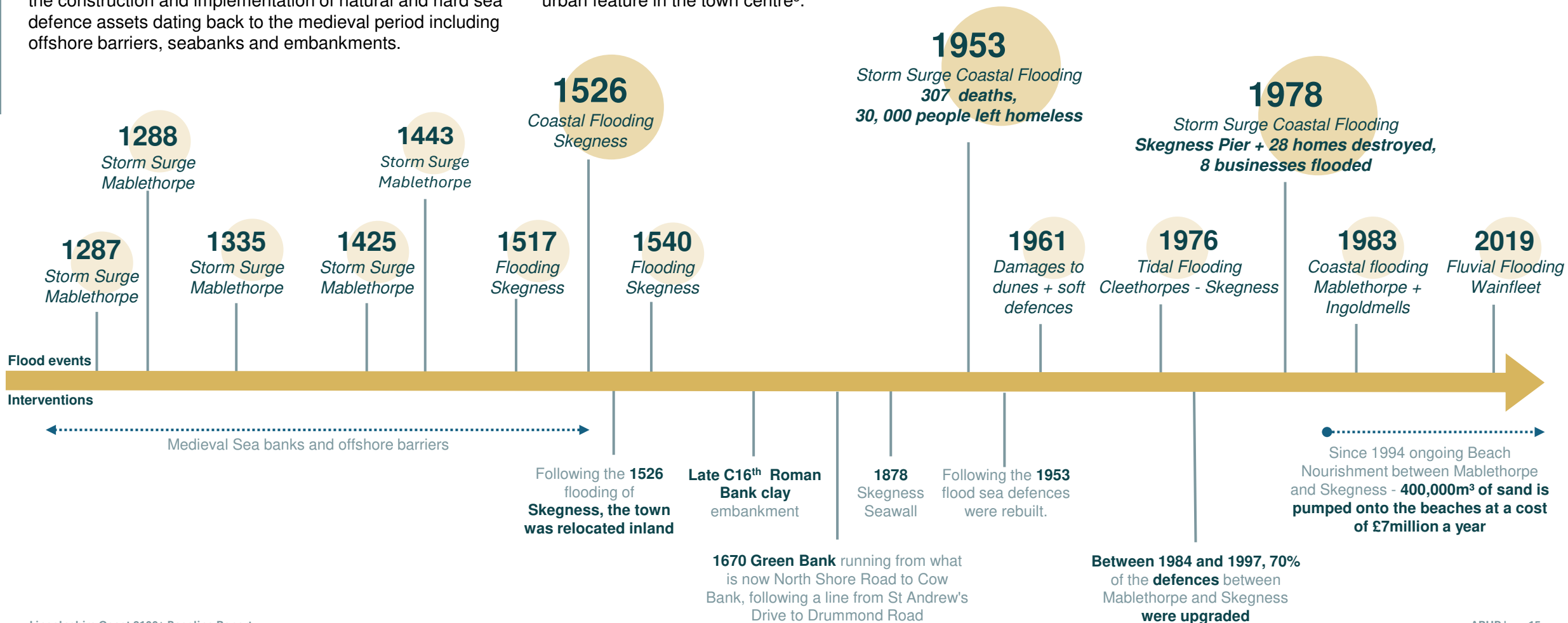
The coastline of Lincolnshire in the thirteenth century, adaption from C. R. Green after S. Pawley, Lincolnshire Coastal Villages and the Sea c. 1300–1600: Economy and Society (University of Leicester PhD thesis, 1984)

The Lincolnshire Coastline Timeline

The threat of storm surge and flooding has always been a significant aspect of life. The continual threat to flooding has over the centuries refined and reshaped the coastline through the construction and implementation of natural and hard sea defence assets dating back to the medieval period including offshore barriers, seabanks and embankments.

Skegness relocated inland to where it is today following the 1526 flooding and Roman Bank was constructed as a clay embankment in the late 16th century and is now a defining urban feature in the town centre³.

The most significant event in recent times is the 1953 flood which resulted in 307 deaths and left 30,000 people homeless⁴.



Land reclamation

Land reclamation first began in the area as a result of medieval salt making along the former coastlines. The process created large quantities of spoil mounds, made up of sand and silt on which settlements were built, such as Saltfleet, as the sea receded⁵.

Beginning in the 12th century, settlers drained and reclaimed more land on the marshes to use for common grazing and farmland along the Outmarsh zone. The area retains a high percentage of small, mainly pastoral fields related to the historical practice of fattening of cattle⁵.

In the 18th and 19th centuries, the agricultural landscape became more complex, supporting a range arable crops and pasture, with settlements rebuilt or displaced following enclosure acts. Land and salt marsh continued to be reclaimed in this period, with evidence of a long history of coastal defences found in several active and relict sea banks in the area⁵.

Much of the coast is still made up of salt marsh and dune systems which are well preserved. The Sandhills Act of 1932 effectively controlled the expansion of built development on the coast at Saltfleetby and Gibraltar Point, the northern- and southernmost boundaries of the project area, and remains in force for the dunes in the central section of the coast⁵.

Today, arable farming predominates, with farmers relying on a dense network of rivers, canals and ditches to drain the land and maintain water levels using a system of sluices, weirs and locks administered by internal drainage boards. Following the floods in 1953, much of the built coastline, such as between Mablethorpe and Skegness, is protected by massive concrete sea walls⁵.



The Great Eau (top left), Saltfleet Theddlethorpe Dunes National Nature Reserve (bottom left), arable fields in Lincolnshire (right)

The Great North Sea flood, 1953

On the night of 31 January 1953, a major storm surge caused over-topping of sea defences along the eastern coast of England. It is widely regarded as one of the worst peacetime disasters to hit the country in the last century. There were over 120 breaches in flood defences in Lincolnshire. The storm led to several coastal resorts being badly flooded, including Mablethorpe, Sutton-on-Sea and Skegness. Flood waters reached as far as 3km inland. After 1953, sea walls and defences were rapidly built and strengthened⁶.

The storm surge led to the development of the Storm Tide Warning Service, a national flood-warning organisation, which was created to improve the accuracy and efficiency of coastal surge warnings to the public as well as the authorities. Today this is provided through the joint Environment Agency and Met Office partnership in flood forecasting⁶.

Most recently, the importance of modern-day flood risk management practice was demonstrated in December 2013 when a storm surge added up to 1.8m to the astronomical spring tide levels along the Lincolnshire open coast frontage and peak water levels were up to 0.7m higher than the 1953 event at Immingham. Without the current flood defences the area would have been submerged to a depth of 3m⁷. Similarly, with the defences in place, the major storm surge event on 13th January 2017 passed without incident. Without defences, flooding of the extremely low and extensive flood plain would leave the land uninhabitable and unusable for any of the current activities⁸.



Photos of the 1953 flood damage along the Lincolnshire coastal areas



Official figures released after the event record that **307 people died** in England as a direct consequence of the floods, **over 160,000 acres (65,000 hectares) of land and 24,000 homes** were flooded, 50,000 animals were killed, and **over 30,000 people were left homeless**. The total damage was estimated at **£50 million (in excess of £1.2 billion at today's prices)⁶**.

Historic Context Summary

For centuries, coastal communities from Saltfleet to Skegness have been living and working with the dynamic processes that have shaped the coastline which is familiar to many today. Thanks to concerted efforts following the Great North Sea flood, that line has held firm for over 70 years, with many of the natural assets replaced by man-made defences.

Recent storm surges have proven the value of those assets to local communities. In 2017, the sea defences in Trusthorpe held back 3-meter-high waves at high tide, with reports that the walls at Skegness “did their job”⁹.

The scale of the current structures has also served to sever the connection between many communities and the sea, and with it, it has altered their perceptions of the risk that the sea poses and the change it can bring.

With degrading assets and the impacts of climate change becoming ever more apparent, past experiences are no longer a good indicator of future performance. The region is once again entering a period of flux, one in which the consequences of sea level rise and more extreme storms have the potential to overwhelm the current defences, drastically alter the appearance of the coast and severely disrupt lives and livelihoods across the region.



Photos of Skegness Pier (top) and current hard assets (bottom)

Spatial Baseline

Regional structure

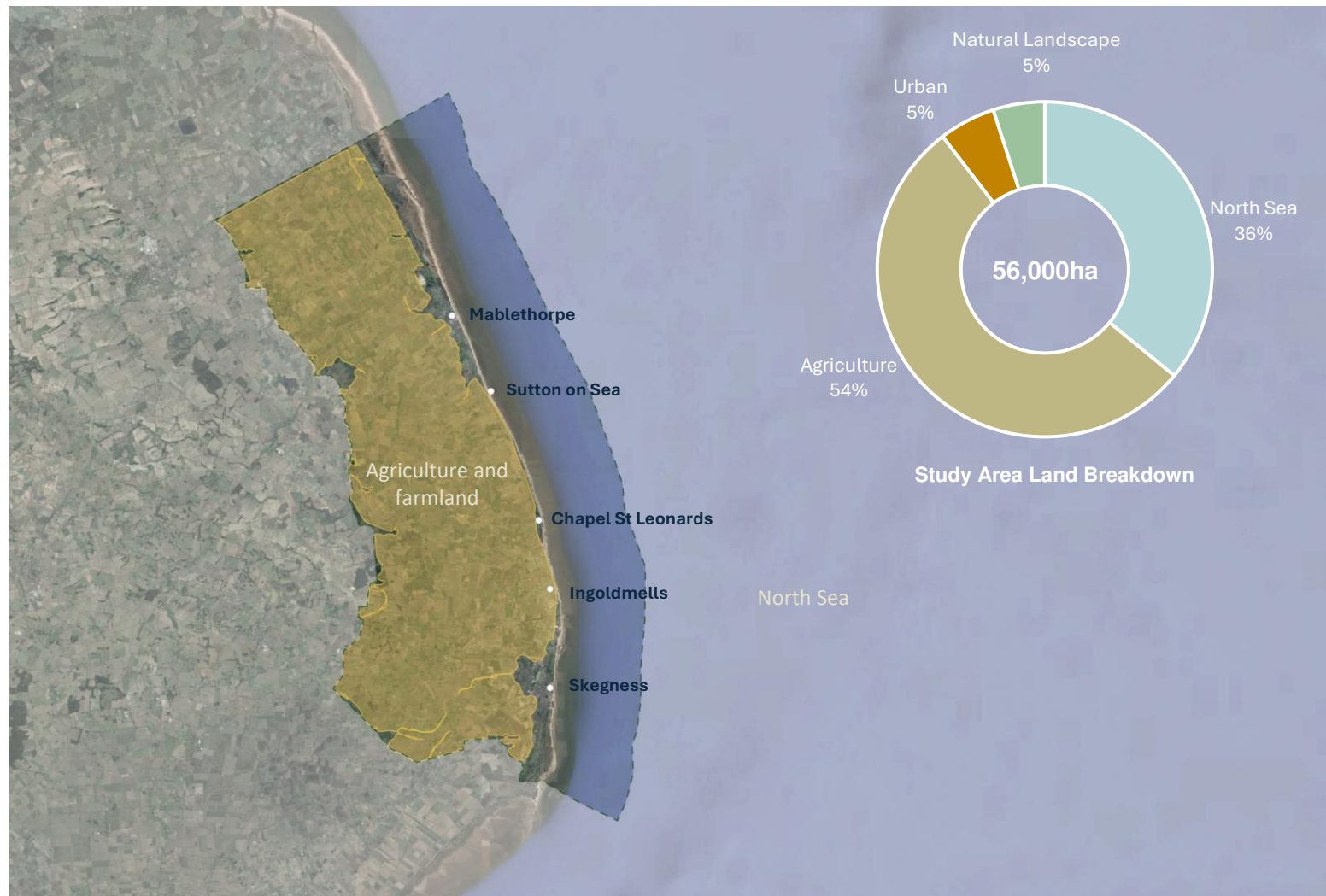
Coastal settlements strip and rural hinterland

The Lincolnshire coast study area, located in the East Lindsey District extends over 38 km of coastline along the North Sea. East Lindsey District is one of seven districts of Lincolnshire County Council, that with two other local authority areas, North Lincolnshire Council and North-East Lincolnshire Council, form Greater Lincolnshire.

The study area is approximately 56,000ha including roughly 35,900ha of land and 20,100ha of the North Sea. The area comprises of rich and diverse natural terrestrial and marine environments as well as agricultural urban and town centres.

Agricultural and farmland accounts for 30,029ha of the study area. This can be broadly categorised into arable land and modified grasslands, which are typically used as pastures for livestock grazing.

Urban land, such as towns, cities or villages consisting of built-up areas and gardens make up about 3,056ha, or 5.4% of land within the study area. Urban land is generally characterised by significant alteration from semi-natural habitats caused by humans.



Regional structure

Coastal settlements strip and rural hinterland

Natural Landscape

The study area and its immediate surroundings can be roughly divided into two main landscape character areas; the Lincolnshire Coast and Marshes and the Lincolnshire Wolds.

The coastline features Gibraltar Point National Nature Reserve to the south and Rimac Nature Reserve and Saltfleetby-Theddlethorpe Dunes National Nature Reserve in the north which make up part of the 12 statutory designated sites located along the coastal margins. These land-based sites encompass over 1,300 hectares of priority habitats, including intertidal mudflats, coastal saltmarsh, coastal sand dunes, reedbeds, coastal and floodplain grazing marsh, and saline lagoons. These coastal habitats protect against erosion and flooding by dissipating waves, trapping sediment, and creating buffer zones that store water during storms. They also provide various ecosystem services, including water quality improvement, carbon sequestration, biodiversity, recreation and tourism, cultural and historic value, and serve as nurseries for many commercial fish species.

In addition to flood protection and biodiversity, mudflats and marshes act as carbon sinks; sequestering carbon up to ten times that of forest systems¹.

The northern boundary is formed by a drainage channel north of Mablethorpe, whilst further inland the Steeping River defines the most southern boundary and forms part of an extensive freshwater system of rivers and wetlands (roughly 76ha), crucial for providing fresh drinking water supply and managing flood risk as well as supporting a wide variety

economic health and wellbeing benefits and can be a significant carbon sink. Freshwater that doesn't form part of rivers are classifiable as fen, marsh and swamp habitats that are scattered across the study area.

Broadleaved woodland makes up almost 200ha of land within the study area, of this approximately 11% or 21ha is classified as ancient woodland.

Woodlands are essential for carbon sequestration, biodiversity and economic value, significantly contributing to the country's natural capital. They also provide other vital ecosystem services such as soil formation, water regulation, and air purification. These services not only support environmental health but also enhance human well-being by improving air quality and reducing the impacts of climate change.

Additionally, woodlands offer recreational opportunities that promote physical and mental health, and they support various economic activities, including timber production and tourism.

The North Sea

The North Sea within the study area form part of the Greater Wash and North Norfolk Coast Special Protection Area (SPA) and Special Area of Conservation (SAC), as well as the Inner Dowsing, Race Bank, and North Ridge SAC. These habitats are crucial for supporting a wide range of marine fauna and ecologically important sandbanks and biogenic reefs. They play a vital role in coastal defence against extreme weather, flooding, and erosion through physical barriers like littoral rock habitats, sandbanks, seagrass, and kelp beds, which

dampen wave energy and attenuate currents. Additionally, seagrass and kelp beds provide benefits such as carbon sequestration and support various economic activities, including fisheries (e.g., fish nurseries), tourism, and recreation in the surrounding region.

The North Sea within the study area form part of the Greater Wash and North Norfolk Coast Special Protection Area (SPA) and Special Area of Conservation (SAC), as well as the Inner Dowsing, Race Bank, and North Ridge SAC.



125 kilometers
to Nottingham

70 kilometers
to Lincoln

100 kilometers
to Hull

Boston

Lincoln

Hull

Grimsby

Louth

The Humber Estuary
Coastal plain estuary

The Wash
One of the largest
estuaries in Britain

The Fens
Wetland landscape

Lincolnshire Coast
and Marshes

Alford

Natural coastline

East Midlands
Coastal Waters

Natural coastline

Sreeping River

Mablethorpe

Sutton on Sea

Skegness

Ingoldmells

Chapel St Leonards

King Charles III England
Coast Path
26km from Skegness to Mablethorpe

39km
of coastline

5
settlements

+60,000
people

Lincs Offshore Wind Farm

Regional structure

Character of the Region – Lincolnshire Coast and Marshes

The Lincolnshire Coast and Marshes National Character area is a low-lying coastal plain adjacent to the north sea, consisting predominantly of rural farmland in a wide flat landscape, with a strong sense of undeveloped space.

Whilst the study area is dominated by agricultural and farmlands, the quality and suitability of these lands for crop cultivation and harvesting varies. Majority of the agricultural land is classified as grade 3 and 4 agricultural land, having good to poor quality land with moderate to severe limitations that affect the choice of crops and level of yields whilst 5,200ha is classified as grade 1 and 2, which is considered to be excellent quality land with minor to no limitations that affect crop yield, cultivation or harvesting. The area contains many small historic villages and farmsteads of traditional building materials scattered throughout the area. Several chalk streams run from the Wolds to the sea, contained by flood embankments which are a distinctive feature in the landscape. The network of dykes and ditches is geometric in the north altering to sinuous and meandering in the south.

The arable landscape contains large woodland blocks associated with settlements and historic parklands in the west, with planting becoming more limited, including sparse hedgerow cover, to the east, creating open long-distance views and level horizons.

Adjacent the coast, a number of seaside resorts including many large caravan parks, introduce urban influences and detract from the rural landscape.

With features of localised distinctiveness and predominantly rural, the area is thought to be moderate to highly sensitive to any changes to the Landscape Character.

The extreme north and south of the area provide a more naturalist coast, free of settlements, with flat tidal strips, large mud flats and stretches of long sandy beaches. This landscape is considered to be highly sensitive to changes in Landscape Character.



Photo by Crispin Jones on Unsplash



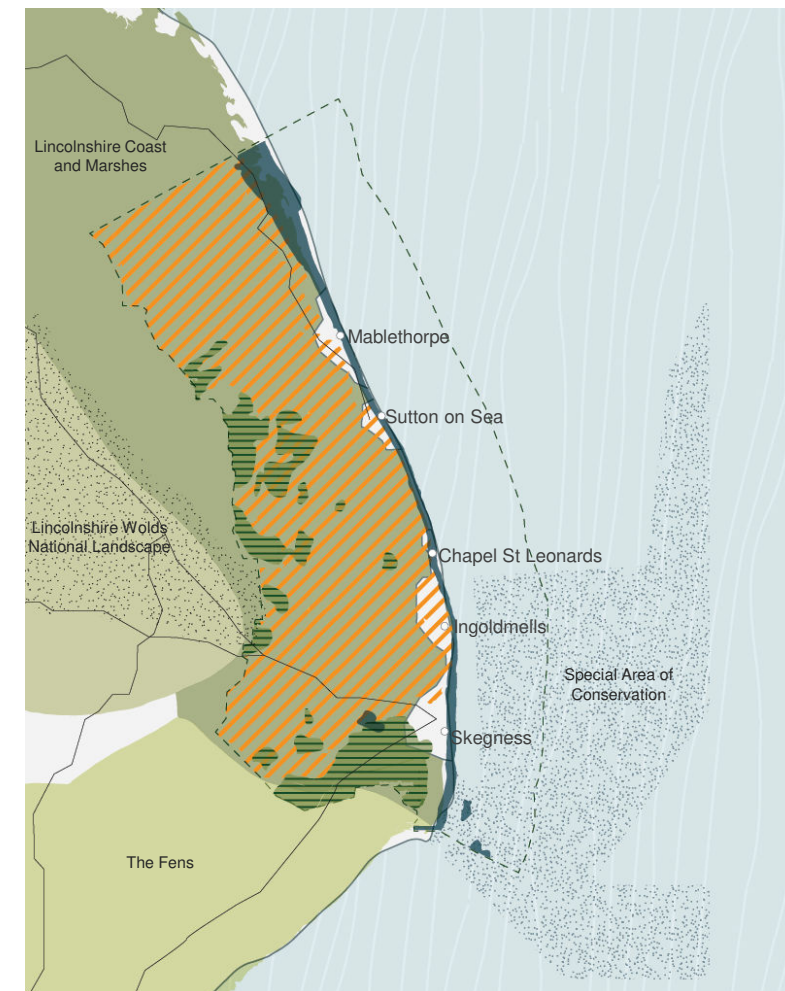
Saltmarshes Gibraltar Point

© <https://timeforgeography.co.uk/videos-list/coasts/formaton-sand-dunes/>

Marshes and intertidal flats

Agricultural Land Classification

Grade 1 and 2
Grade 3 and 4



Regional structure

Character of the region – Lincolnshire Wolds

Lying outside of the western boundary of the study area, the Lincolnshire Wolds are a National Landscape rich in natural beauty and tranquillity.

The area is characterised by a distinctive rolling and open agricultural land dominated by a chalk escarpment. Woodland is sparse and largely limited to escarpments. Valley sides are steep with open plateau hilltops offering extensive views. Chalk streams run through the landscape, originating from the chalk aquifer that lies under the Wolds.

The area contains no large settlements², with market towns and villages dispersed throughout the area largely hidden by the topography of the rolling landscape, with church spires rising out of the hills a key feature of the settlements.

This natural landscape is considered to be moderate to highly sensitive to changes in Landscape Character.

Adjacent to the southwest boundary of the study area lies The Fens National Character Area.

The Fens is an expansive, flat, and open low-lying wetland landscape influenced by the Wash estuary. It offers extensive vistas to level horizons and huge skies, providing a sense of rural remoteness and tranquillity. The area is characterised by rich, fertile soils, making it significant for agriculture, with numerous farms producing a variety of crops. The landscape features a network of drains and rivers, sparse woodland, and notable built structures like Boston Stump (St. Botolph's Church). The Fens also support important wildlife habitats, including salt marshes and mudflats.



Lincolnshire Wolds National Landscape

Topography

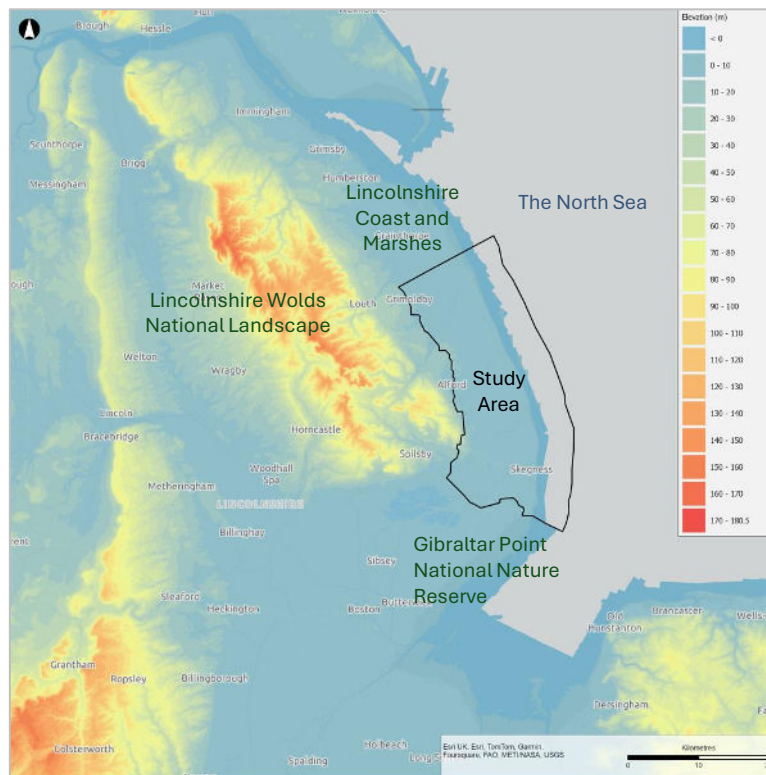
Along the Lincolnshire coastline, the area is predominantly low-lying, characterised by tall defences directly next to the sea which provide flood resilience from storm surges and waves.

The coastal zone is notably extremely low-lying, with elevations generally two metres above sea level relative to ordnance datum Newlyn (+2m ODN). This flat landscape extends most of the reporting area, apart from a few localised areas of higher elevation. As the land progresses inland toward the Lincolnshire Wolds National Landscape, the terrain gradually rises. However as illustrated in the topographic plan, much of the study area is still located below +6m ODN.

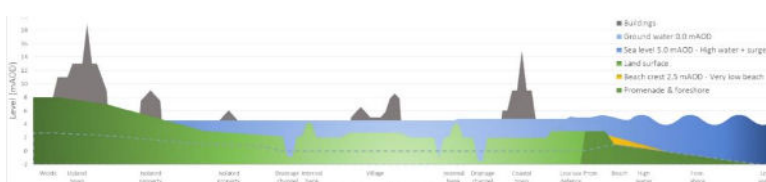
Beyond the reporting area, extending further into Lincolnshire, the land remains relatively flat before the Lincolnshire Wolds National Landscape, where the topographic profile distinctly changes from the flat lying coastal area.

The flat terrain of the Lincolnshire coast emphasises the vulnerabilities of the region, as the low-lying land faces significant flood risk should a breach occur in the current coastal defences and pressures associated to climate change and sea level rise (see page 59 for further detail).

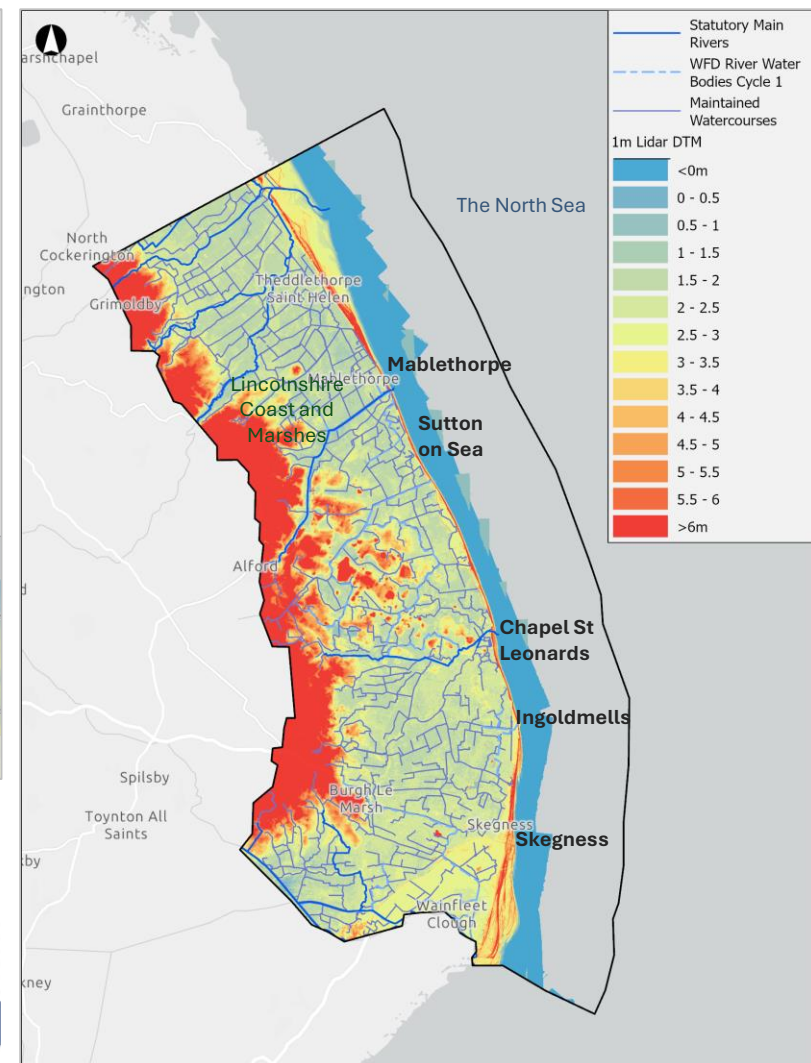
It should be further noted that this coastal flood cell catchment is also connected to the north and south where the coastal region is also distinctly low lying.



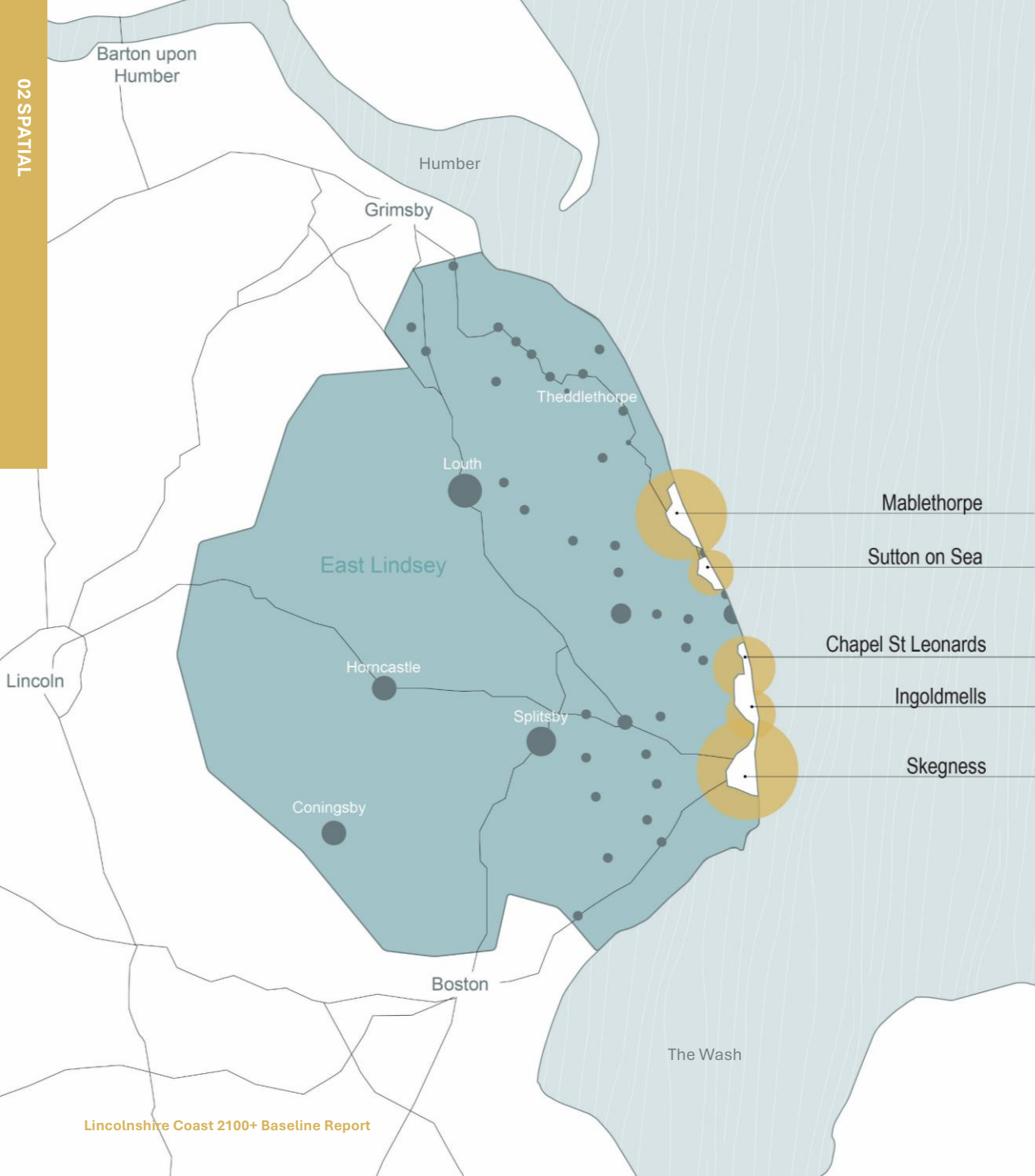
Regional Topography (elevation relative to Ordnance Datum Newlyn)



Cross section through catchment



Topographic Plan of Study Area (elevation relative to Ordnance Datum Newlyn)



Settlement Patterns

Introduction

The coastal area shows a distinctive widespread settlement pattern as a legacy of historical small farming communities with local markets and coastal villages with fishing and trade. Five main settlements form an almost continuous urban corridor along the coastline, with more diverse and visitor focussed urban centres at each end, Mablethorpe and Skegness, and smaller, more local community-based settlements Sutton-on-Sea, Chapel St Leonards and Ingoldmells with extensive caravan parks with static caravans in between. Some remnants of natural coastline are encapsulated in this coastal strip.

The settlement pattern of the rural hinterland is characterised by an irregular scatter pattern of small villages and farmsteads, connected by an irregular and organic pattern of small roads with each other and some of the coastal towns. Economic activity, tourism and leisure activities and housing is dispersed extensively across relatively small-scale centres.

The East Lindsey Local Plan Core Strategy and Settlement Proposals DPD were adopted in July 2018. The Local Plan is currently being reviewed with consultation undertaken in 2021/22³. Furthermore, updates to the National Planning Policy Framework (NPPF) would include (increased) mandatory housing targets for local authorities such as East Lindsey.

Nuclear Waste Services (NWS) are developing plans for a Geological Disposal Facility (GDF) for nuclear waste and are investigating a number of potential sites. The sites include the former Theddlethorpe gas terminal site and the deep geology offshore, up to 22km beyond the coast. This search area also includes the electoral wards of Withern & Theddlethorpe and Mablethorpe.

The potential development of NWS within the study area brings with it considerations including the need to protect nationally significant infrastructure, as well as opportunities such as employment and infrastructure investment to the region.

Settlement Patterns

Skegness

Urban form

Skegness is the biggest town of the five settlements, approaching 29,500 inhabitants is the southern gateway to the coastline, and the only settlement with access to a railway station connecting to Nottingham via Wainfleet, which is being modernised into a multi-modal interchange. Despite this public transport hub, cars and car parks dominate the station environment and town centre.

The town has maintained some of its historic seaside town character, including a historic pier, a high street that leads from the station to the seaside, and wide boulevards flanked by hotels and historic town houses. There are a few smaller scale holiday parks scattered around Skegness without dominating the urban character or creating barriers between town and sea. Leisure destinations are located around the main entrances to the beach and Skegness Pier, with large car parks creating a visual and physical barrier between the beach and the town.



Listed clocktower

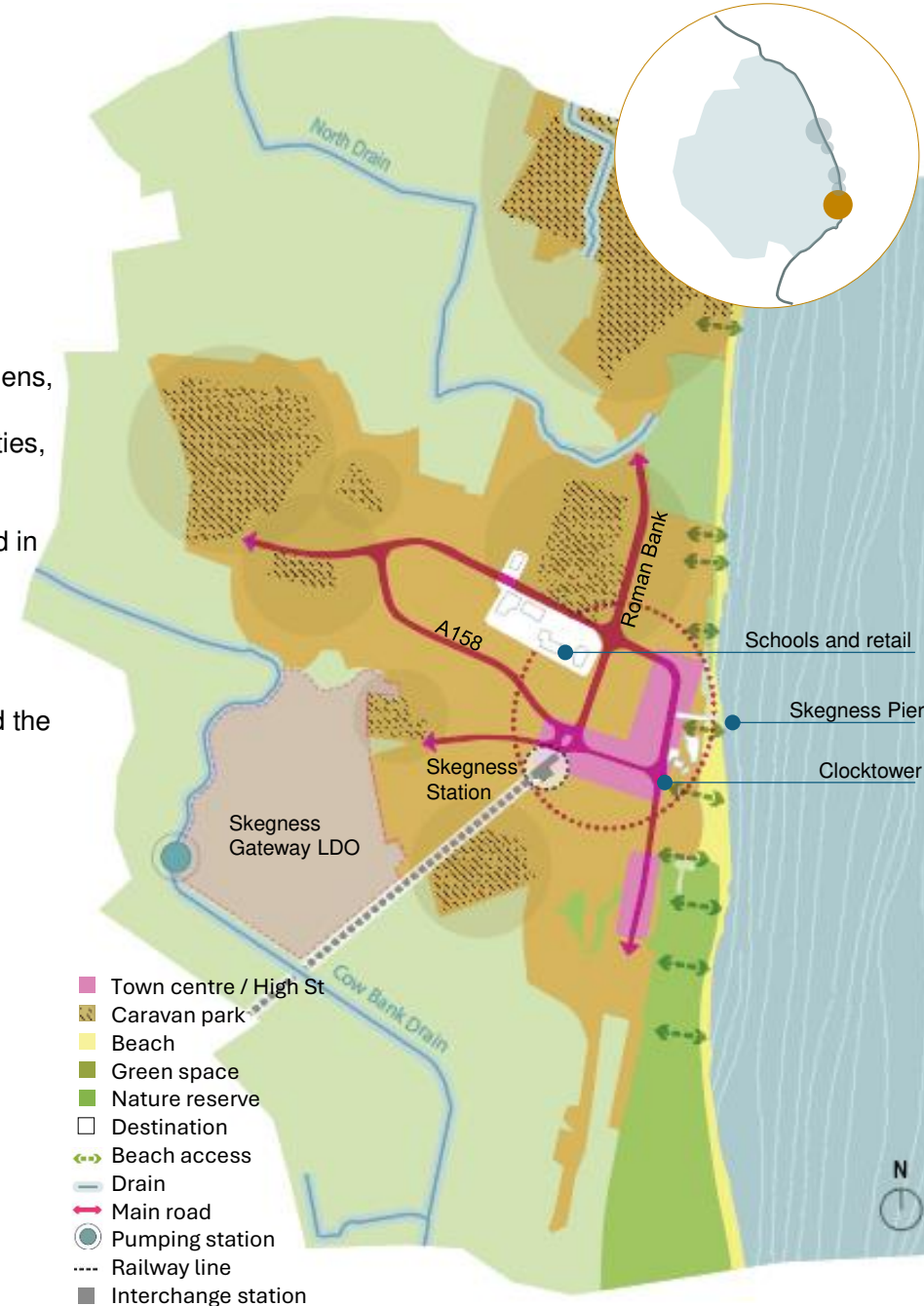
Amenities and Services

Skegness is an urban, mixed-use settlement with the broadest offering in terms of services, facilities, and activities. These include parks, such as the Tower Gardens, and the historic pleasure gardens which are being renovated. The town also has various educational facilities, including the purpose-built learning campus, a flagship Town Deal project in Skegness, set to be a catalyst for change in the area, the police training academy, located in the town's former magistrates court, as well as health facilities (general hospital, various medical practices).

Skegness also offers multiple culture and leisure destinations, including a Pleasure Park, the Pier, and others, employment opportunities (industrial estate) and the Embassy Theatre.



Listed Skegness Pier



Settlement Patterns

Skegness

Proposed plans and developments

Significant investment is planned across multiple major projects in Skegness providing improved employment, education and recreational opportunities not only for the local community, but also the wider region.

Skegness Gateway LDO was approved in March 2024, a 336-acre mixed-use site, which will deliver a major new sustainable urban extension for Skegness and help drive regeneration of the area. The development will include new retail, commercial and industrial space creating hundreds of new jobs in addition to much needed open space and amenities, a new school and over 1,000 new homes for the area⁴.



Skegness Gateway LDO proposed masterplan

A new **TEC campus** in Skegness is due to be completed in 2025 offering further and higher education tailored towards vocational skills training to meet the needs of local and neighbouring communities. Courses will cover a range of

industries including construction, engineering, hospitality, digital and tourism. The TEC campus will also provide increased employment opportunities for residents with the ambition to provide over 1,000 jobs over the next few years⁵.

In 2024 The Arts Council awarded £5 million in funding for expansion and upgrades to the **Embassy Theatre and Skegness Pier**. Plans for the 1926 Embassy Theatre, an important live entertainment include upgrades to the seating in the auditorium, to the back of house and staging equipment, improved access and the creation of a new feature entrance and multi-purpose space. Plans for the Skegness Pier, which opened in 1881, include improved accessibility, public realm, upgrades to the pier's facade, renewing the lighting, furniture and the construction of a new amphitheatre⁶.

The extension and upgrades to the theatre and pier will further establish Skegness as a cultural hub with ongoing partnerships with the Royal Shakespeare Company and school programmes, increasing pathways and employment opportunities in the creative sector and strengthening the tourist offer in Skegness and the Lincolnshire Coast.

In 2023 it was announced that Skegness would receive £20M in government funding over the next ten years, to bring improvements to the town around the themes of safety and security; transport and connectivity, and high streets, heritage, and regeneration. Community engagement has been undertaken in helping to develop a long-term plan for Skegness, which is still currently under development.



Visualisation of the proposed upgrades to Embassy Theatre (image above) and Skegness Pier featuring near restaurants and rooftop bar (image below).

Settlement Patterns

Skegness

Coastline

The Skegness coastline consists of a long sandy beach, separated from the town centre by a variety of sea defences that contribute to the immediate surrounding character, including rock revetments, a formal walled promenade, concrete revetments to the north and natural dunes to the south of the town. North Parade, the closest road running parallel to the shoreline is positioned at an elevated level and acts as the last line of defence protecting Skegness town from coastal flooding.

The beach is separated from the urban form of the town centre by a wide soft buffer (minimum 100m) running parallel with the coast, consisting of formal parks, natural dunes and wildlife sites, broken only in the centre of the town by entertainment complexes that protrude into the coastal buffer further than the surrounding historic frontage and urban centre. Large blocks of caravan park development surround and intersect with the boundaries of the traditional town centre.

Views to the horizon from the beach front are broken by the presence of an offshore windfarm, the Lynn and Inner Dowsing Wind Farms.



Aerial of Skegness coast featuring the historic Skegness pier in the foreground

Skegness has a Local Plan and a Foreshore Development Plan⁷ that establish the following principles:

- Development should protect views of the iconic Clock Tower and offer un-broken sightlines between the Clock Tower and the Beach
- There is a requirement for a gap between the beach and any development on the foreshore
- The Foreshore's historic built environment should be sustained and enhanced
- New developments should consider ways in which views of the beach and the sea beyond could be opened up and exploited from within the Foreshore
- Existing green space should be protected and enhanced.

Settlement Patterns

Ingoldmells

Urban form

Roman Bank road is a distinct structural element in an otherwise fragmented and irregular patchwork of static caravan parks, that dominate most of Ingoldmells. Thanks to its elevated position and its rectilinear aspect, this thoroughfare provides orientation and access in a dense tapestry of static caravans, dotted with leisure and recreation areas.

Although this is the smallest settlement with an estimated permanent population of 2,000, the seasonal population of people living in static caravans for extended periods or permanently, coupled with the number of daily visitors exacerbates existing challenges around lack of green and open spaces, amenities and services.

The original town centre and high street (Sea Lane) are located towards the western border at more than a kilometre distance from the coast.

Amenities and services

The 81ha Butlins Resort first opened in 1936 provides a wide range attractions such as a swimming pool, funfair, rock climbing, archery, go-kart, golf etc and temporary accommodation. The resort attracts over 400,000 visitors per year with 350,000 being resident and 70,000 visiting for the day⁸.

The resort theme park Fantasy Island is the largest family entertainment centre on the UK's east coast featuring rides restaurants, market and 340 static caravan homes attracting around 3 million visitors per year⁹.

The overwhelming scale of holiday and caravan parks developments, the temporary character of caravan park residents and the high visitor population represents a challenge to plan, finance and manage the necessary community infrastructure.



Aerial of Ingoldmells static caravan parks



Settlement Patterns

Ingoldmells

Coastline

The elevated main road and the narrow but high dyke-like sea defence cause a visual and physical barrier between the sea and beach, and the urban areas. This is exacerbated by strips of private land with purpose-built holiday accommodations and large areas with leisure and entertainment parks. The northern end of Roman Bank leads to a viewing point, the main beach access and a hard beach promenade that runs alongside a narrow encapsulating dune strip leading to Skegness.

The elevated promenade separates the long sandy beach and dunes from the caravan park developments that sit in a flat landscape at a lower level. Planting on the steep embankments of the dyke-like defence further visually separate the village from the coast.

Long range views from the promenade to the east are dominated by caravan parks and associated tourism and leisure facilities whilst to the west, coastal views are interrupted by the solar farm.

Connections between the historic village and the surrounding rural landscape have been largely degraded by the overwhelming scale of caravan park developments.



Aerial of Ingoldmells coastline

Settlement Patterns

Chapel St Leonards

Urban form

Chapel St Leonards with a population of around 4,000, is a low-rise, suburban coastal village. It comprises of bungalows in the northern half and static caravan parks in its southern half, with a small centre with shops around a "village green", the Pullover, in the middle. Most of the village has been developed after WWII, although there are some older properties.

The River Orby flows through the settlement but is canalised and fenced-in, hidden from sight and from its natural and urban context, as well as disconnected from the sea.

The northern end of the village has a distinct promontory at Chapel Point. This strategic location accommodates UK's only purpose built and accessible marine observatory which serves as not only hub for environmental research and coastal ecosystem monitoring but also a tourist attraction featuring exhibitions on the local areas rich and diverse ecosystems and wildlife, an art space, café, public toilets and car park. It is also a popular location for birdwatchers.

The North Sea observatory is slightly disconnected from the centre and as such is an independent visitor attraction. Both northern and southern urban edges are enclosed by extensive caravan parks that exceed the size of the existing town centre.

Amenities and services

Chapel St Leonards provides a range of services, including shops, banking facilities, several public houses, a primary school and doctors. It also supports several businesses and associated employment.



North Sea Observatory



River Orby



Settlement Patterns

Chapel St Leonards

Coastal Strip

The Chapel St Leonards coastline features a long sandy beach, with bands of Marram grass and developing dune structure to its rear, runs north-south adjacent to the eastern edge of the village. The beach is separated from the town by a high planted bund. The western edge of the village is bordered by a flat agricultural coastal plain landscape. The lack of views and access points to the sea from the town and hard infrastructure have created a visual and physical disconnect between the town and the sea.



Image of Chapel St Leonards coastline featuring dunes and high planted bund.

Settlement Patterns

Sutton-on-Sea

Urban form

A quiet, suburban village feel with bungalow style homes characterises this settlement. With a population of around 5,000, Sutton-on-Sea is a quieter town attributed to the low proportion of caravan sites and attractions that draw large visitor and seasonal population numbers elsewhere.

The high street leads to the main entrance to the beach where food and beverage and a few leisure destinations are located. Sutton-on-Sea is a relatively unspoiled seaside town that has maintained its original character. The retirement population is more affluent than in the other settlements. The town seems to have frozen in time after the railway left. Parts of the former railway line are now used as a footpath.

Amenities and Services

A small-town centre next to the main entrance to the sea provides facilities for the local community. In the town centre a new development, the Colonnade and Pleasure Gardens, will provide residents and visitors with a new pavilion that is home to a café, space for markets, events, and other facilities.



Proposed Colonnade and Pleasure Gardens development



Sutton-on-Sea beach huts

- Town centre / High St
- Caravan park
- Beach
- Green space
- Nature reserve
- Destination
- ↔ Beach access
- Drain
- Main road
- Pumping station



Settlement Patterns

Sutton-on-Sea

Coastal Strip

The sandy beaches along Sutton-on-Sea are more accessible than the other towns, with various access points along the coastline.

Splash decks on the sea defences are used as a promenade and are a mixture of concrete walkways and planted raised earth bunds. The defence is more urban towards the centre of the town, with soft bunds and sand dunes softening the structure as you move to the peripheries in the north and south. Large sections of the sea defence are topped with beach shelters, creating a distinctive coastal feature.

As in other areas, the high planted bund visually and physically separates the town from the coast.

Towards the south, Sutton-on-Sea shares a border with Sandilands, which is a nature reserve and national trust site. The reserve is part of the Lincolnshire Coastal Country Park and offers access to a more unspoiled piece of nature and the unique "submerged forest". A planning application was submitted by the National Trust to develop an accessible and eco-friendly visitor and community hub as an entrance point to this nature reserve.

Sutton-on-Sea is located approximately 7km north of Chapel St Leonards, with the area between the two settlements being mainly rural agriculture, typical of the Lincolnshire Coast and Marshes Character. To the rear of the beach, large bands of land that run parallel to the coast are given over to nature reserves, consisting of marshes, scrub planting and natural dunes. The elevated coastal roads, Roman Bank and Huttoft Bank form distinctive features in the landscape.



Aerial of Sutton-on-Sea coastline featuring a promenade and planted raised earth bunds in the distance.

Settlement Patterns

Mablethorpe

Urban form

Mablethorpe is the most northern settlement comprising of a more established community of around 13,000 people (incl. Trusthorpe). The settlement offers a healthier balance between community and tourism than some of the more southern settlements. A more compact spatial layout with a grid structure has created a clearer separation between the urban areas and the more rural hinterland.

Amenities and Services

The town is home to a more established community with key community infrastructure, such as a library, cinema and a primary school. More investments are being made into facilities for the local community, such as a new Station Leisure & Learning centre, with a crucial role in supporting local people's physical and mental wellbeing, bringing improved and new opportunities for leisure and learning to Mablethorpe and a focus on increasing employment opportunities by pushing the health agenda and building a Campus for Future Living, centred around medi-tech innovation.



Mablethorpe Seal Sanctuary and Wildlife Centre



Station Leisure & Learning Centre



Campus for Future Living



Settlement Patterns

Mablethorpe

Coastal Strip

Mablethorpe forms the gateway to the more natural coastline to the north and has embraced the natural area as an asset more than the other coastal towns. There is a stronger relationship with the natural sand dunes.

The urban form does not run parallel with the coast and becomes increasingly separated as you move northwards. With a green wedge infilling the space consisting of natural sand dunes, tidal sand and mudflats, salt and freshwater marshes and forms Saltfleetby-Theddlethorpe Dunes Nature Reserve¹⁰.

Sea defences range from the feature steps of the North Promenade, to a concrete promenade and raised bund in the south to natural sand dunes in the north.

Church Lane and Golf Road provide a hard stop to the urban development, giving way to the agricultural landscape to the west, with a strong network of channel drainage features.



Photo of Mablethorpe beach promenade steps



Aerial of Mablethorpe featuring a more natural coastline in the background

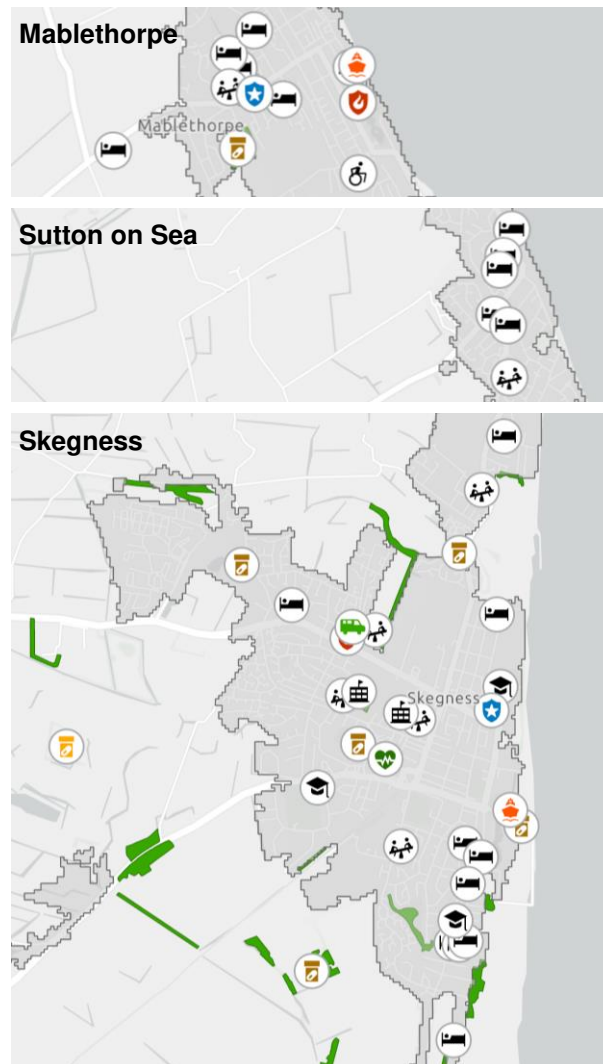
Community Infrastructure

Critical community infrastructure exists in clusters in settlements along the Lincolnshire coast. There are no Accident and Emergency (A&E) services within the study area, however Skegness and District General Hospital does include a 24 hours Urgent Treatment Centre.

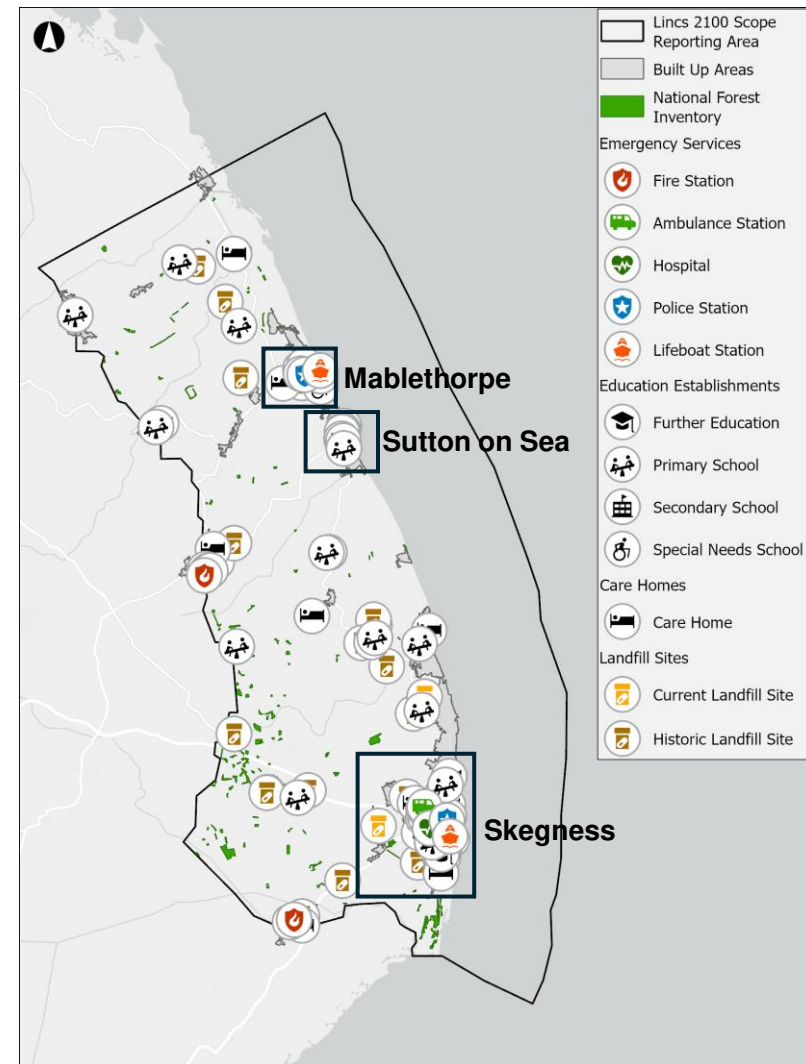
In the reporting area, there are two secondary schools within Skegness and one in Alford. There are 31 care homes accommodating elderly residents. There are 22 historic landfill sites, some of these are close to the coastline and could result in environmental pollution if exposed to the sea.

Numbers of key infrastructure assets in the reporting area

Infrastructure Classification	Count	Location
Fire Station	4	Wainfleet, Skegness, Mablethorpe, Alford
Ambulance Station	1	Skegness
Hospital	1	Skegness
Police Station	2	Skegness, Mablethorpe
Lifeboat Station	2	Skegness, Mablethorpe
Further Education	3	Skegness
Primary School	22	Numerous
Secondary School	3	Skegness, Alford
Special Needs School	1	Mablethorpe
Care Home	31	Numerous
Historic Landfill Site	22	Numerous
Current Landfill Site	2	Skegness, Ingoldmells



Key Community Infrastructure



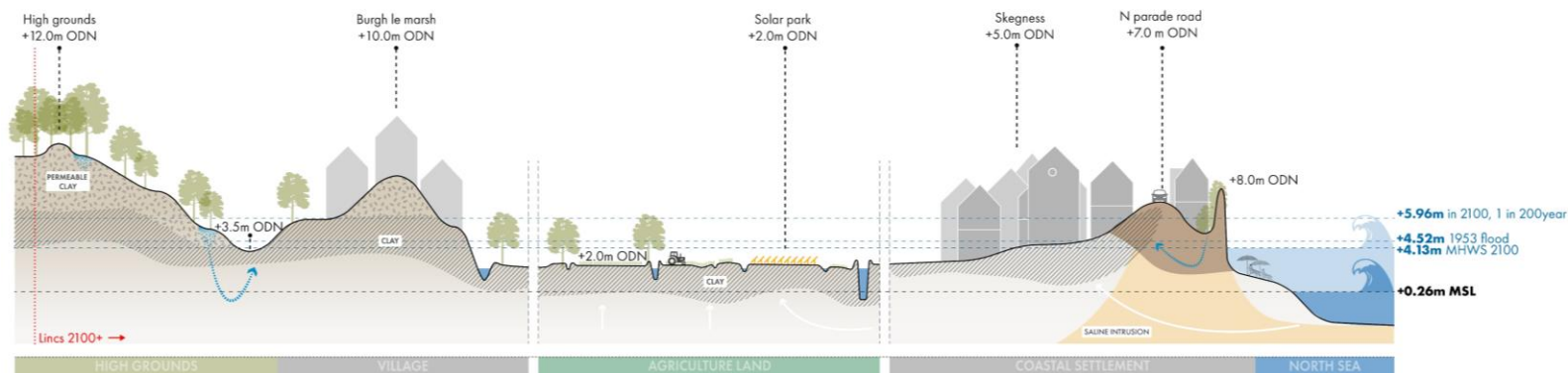
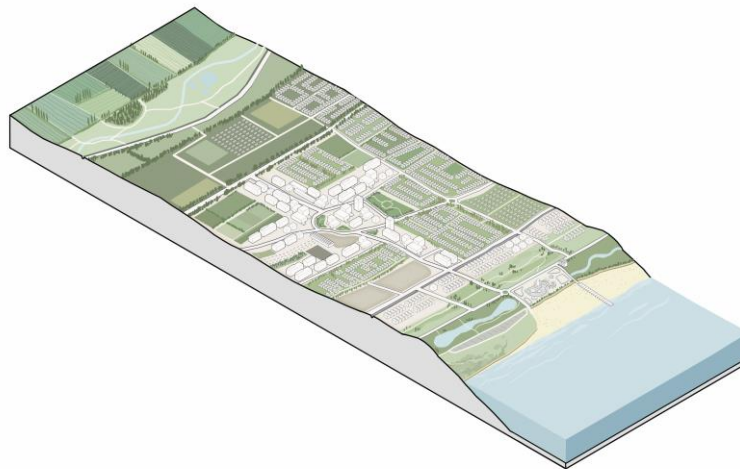
Key infrastructure locations

Coastal Conditions

Introduction

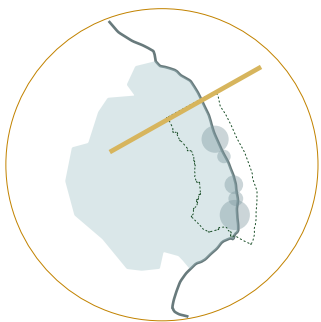
The Lincolnshire 2100+ study area has a diverse landscape informed by natural systems and topography, historic settlement patterns along with natural and hard flood defence infrastructure such as seawalls and revetments.

A series of 3-dimensional cross sections and 2D sections have been developed to demonstrate the different coastal conditions that exist across the study area and the diverse interrelationship between land use, communities, environment and engineered systems.



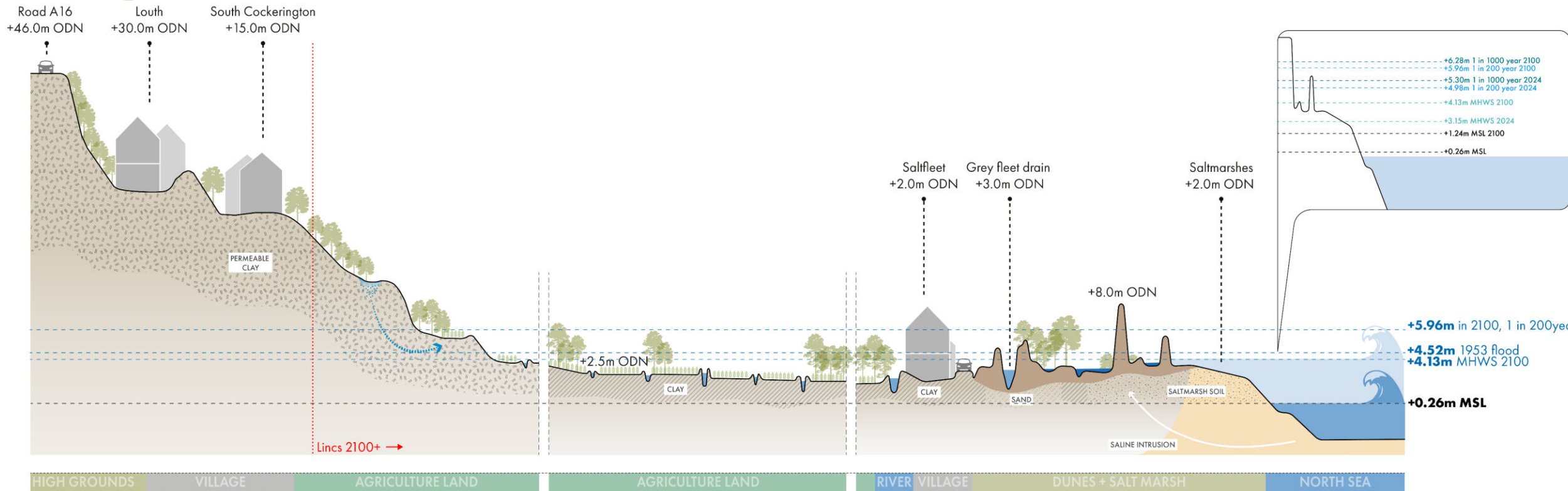
Coastal Conditions

Saltfleet – South Cockerington



Saltfleet coastline features an extensive natural landscape of tidal sand and mudflats, salt and freshwater marshes and sand dunes reaching up to +8m MSL. This combined with a network of man-made drainage systems strengthens resilience to storm surge for the adjacent communities and agricultural lands.

Whilst the dunes are an important natural sea defence they do also act as a visual and physical barrier, disconnecting the low lying communities from the shore.



Coastal Conditions

Saltfleet

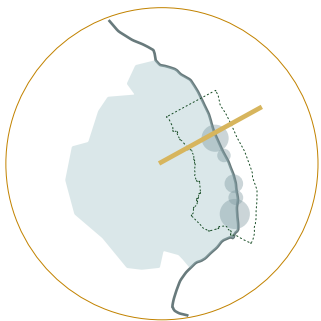
The Saltfleet coastal conditions feature an extensive intercoastal landscape of saltmarshes and wide and more natural dunes that strengthen flood resilience, provide habitat and contribute to the character of the area.



Please note that this 3D section is illustrative

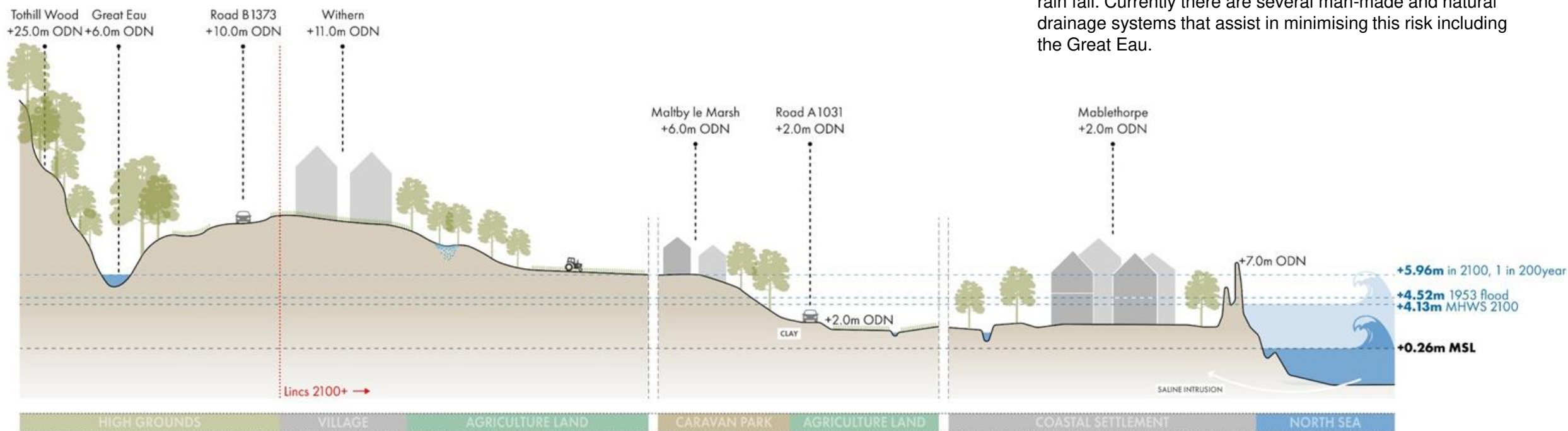
Coastal Conditions

Mablethorpe - Withern



Mablethorpe is located along the shoreline with development including theme parks and bungalows fronting the beach. Landscaped embankments reaching up to +7.0m MSL provide some resilience to storm surge at locations, however these do not extend along the extent of the coast.

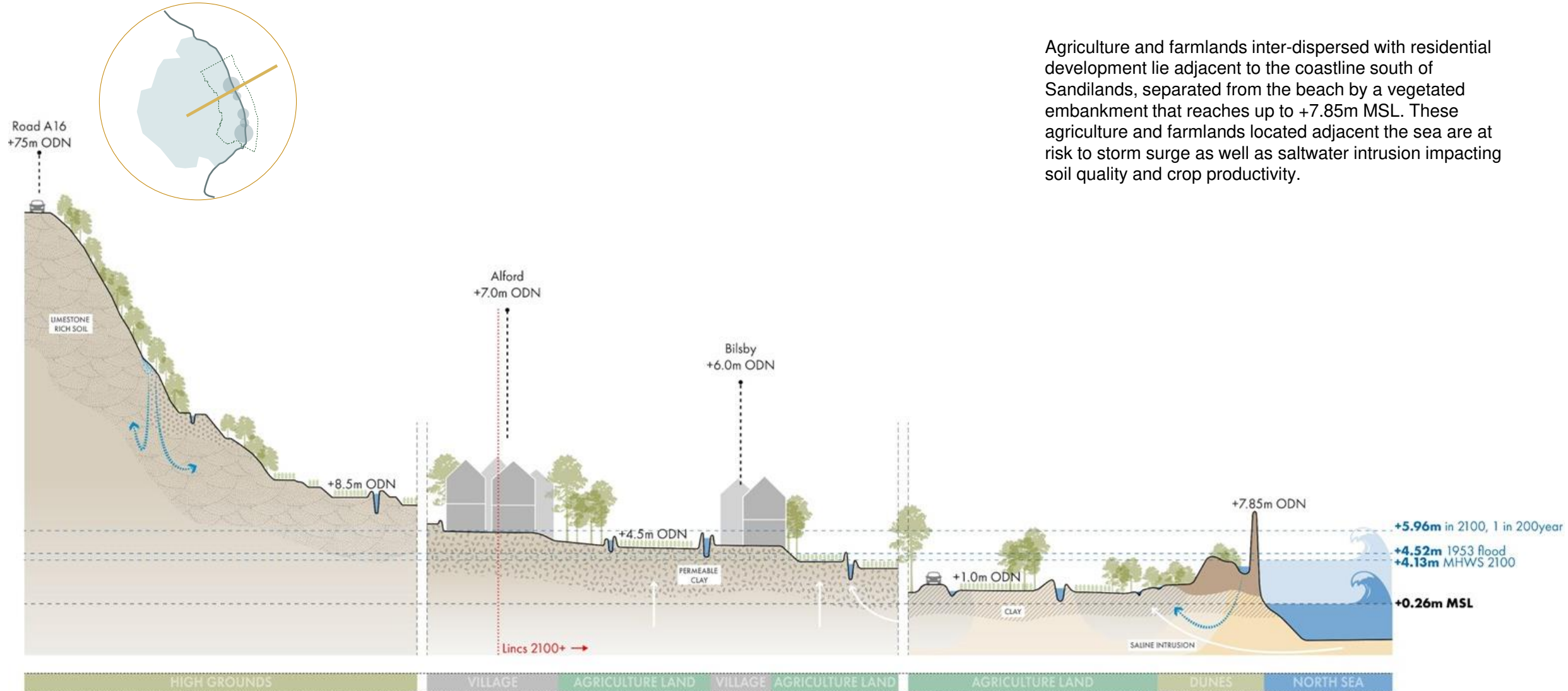
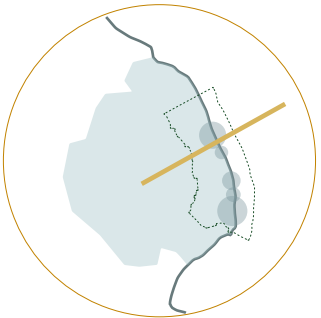
Withern, further west towards the study area boundary is located +11.0m MSL, over 6m above the 1953 flood level. The topographical variance along with the impermeable nature of clay ground puts lower lying agricultural lands and communities at risk to fluvial flooding in the event of heavy rain fall. Currently there are several man-made and natural drainage systems that assist in minimising this risk including the Great Eau.



Note: these sections are diagrammatic and are intended to communicate levels, land use and flood defence systems.

Coastal Conditions

Sandilands - Alford

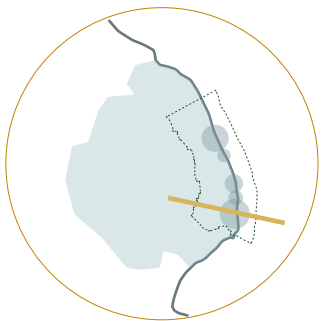


Agriculture and farmlands inter-dispersed with residential development lie adjacent to the coastline south of Sandilands, separated from the beach by a vegetated embankment that reaches up to +7.85m MSL. These agriculture and farmlands located adjacent the sea are at risk to storm surge as well as saltwater intrusion impacting soil quality and crop productivity.

Note: these sections are diagrammatic and are intended to communicate levels, land use and flood defence systems.

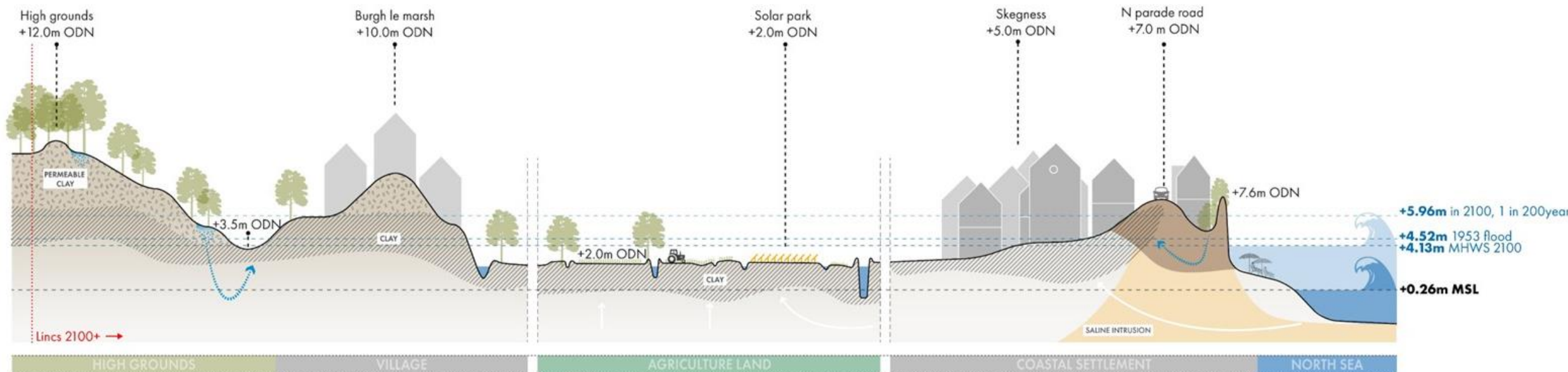
Coastal Conditions

Skegness – Burgh le Marsh



The town of Skegness is located along the shoreline and in most part separated to the beach by a combination of natural and hard assets including concrete and rock revetments, promenades, embankments and dunes. N Parade Road and Roman Road running parallel to the coast are constructed at a higher level providing some flood resilience to adjacent developments.

Burgh le Marsh further west is located at +10m MSL over 5m above the 1953 flood level. The topographical variance along with the impermeable nature of clay ground put lower lying agricultural lands, communities and infrastructure such as the solar park at risk to fluvial flooding in the event of heavy rain fall.



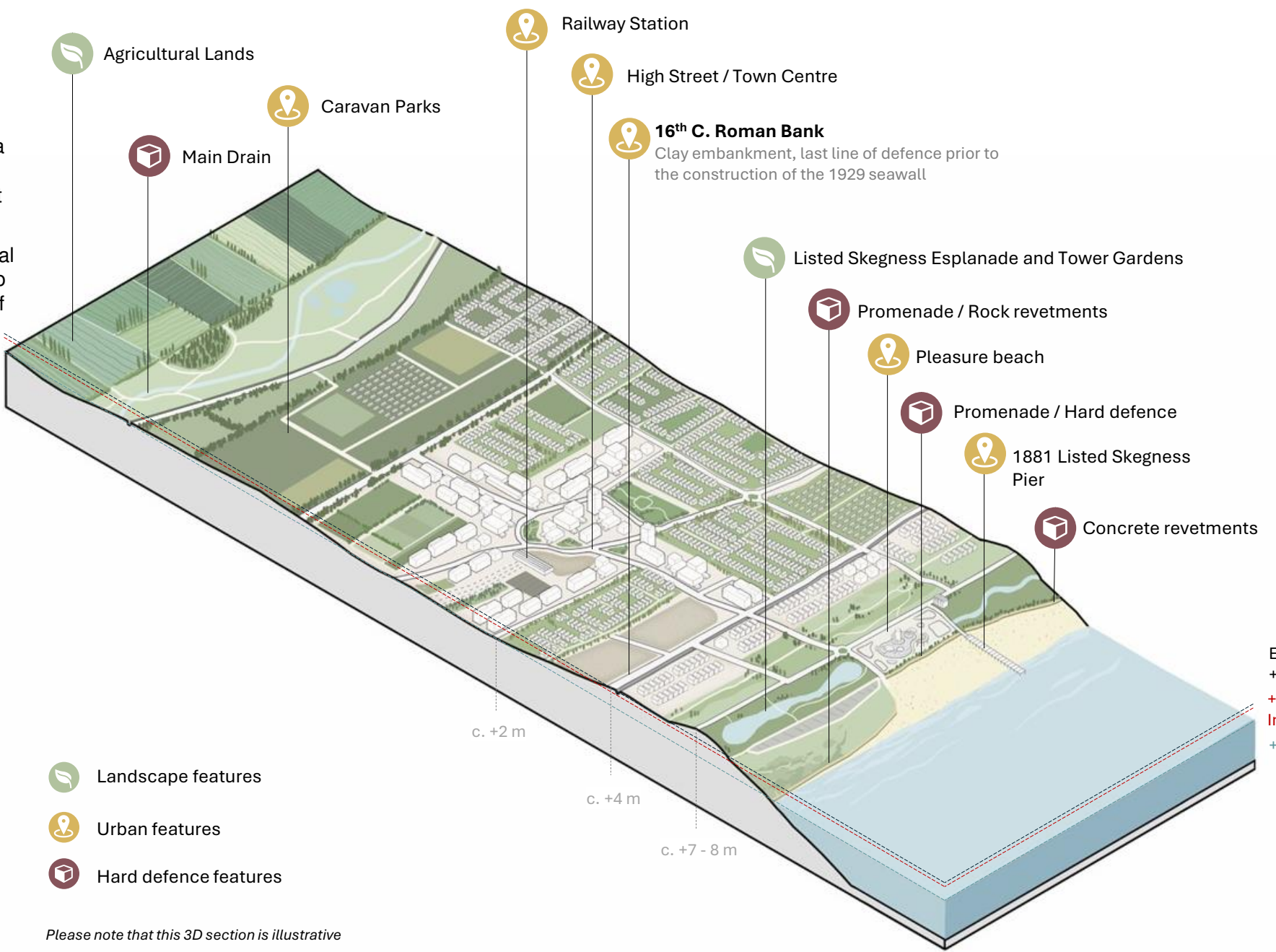
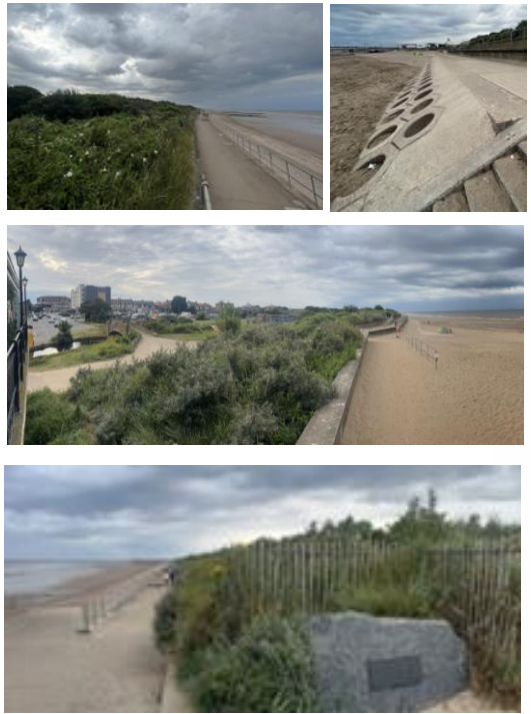
Note: these sections are diagrammatic and are intended to communicate levels, land use and flood defence systems.




Coastal Conditions

Skegness

The Skegness coastal conditions feature a series of different flood resilience and defence systems extending from the coast to the agricultural lands.

The coastal flood defences include a formal walled promenade, concrete revetments to the north and natural dunes to the south of the town.

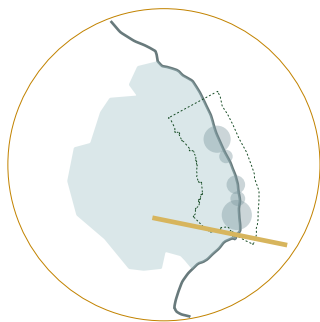


-  Landscape features
-  Urban features
-  Hard defence features

Please note that this 3D section is illustrative

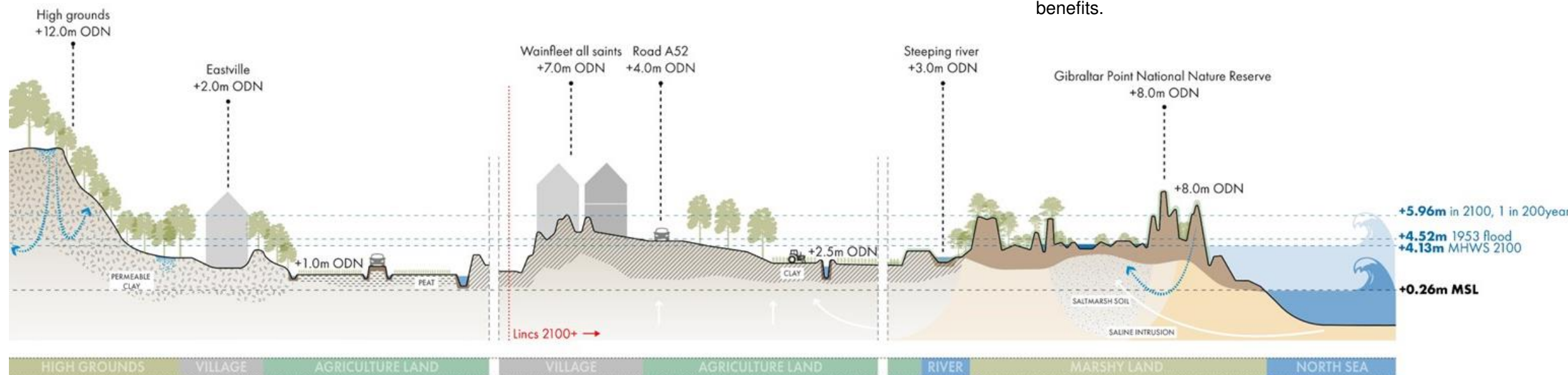
Settlement Patterns

Gibraltar Point – Wainfleet All Saints



Gibraltar Point's unique natural landscape of parallel ridge dunes and marshlands, extending approximately 5km along the coast and 1.5km inland, plays a pivotal role in strengthening resilience to storm surge and flooding. Reaching up to +8.0m MSL the sand dunes act as natural barriers to storm surge, whilst adjacent marshlands and river systems assist capture, store and slow water flow protecting nearby agricultural lands and communities. The marshlands also act as a carbon sink, helping to mitigate climate change.

In addition to flood resilience, the Gibraltar Point Nature Reserve provides critical habitat for local and migrating birds and is a popular destination for both locals and tourists, providing economic, recreational and health and well-being benefits.



Note: these sections are diagrammatic and are intended to communicate levels, land use and flood defence systems.

Spatial Context Summary

Strengths, Weaknesses, Opportunities and Threats

Strengths

- The study area includes over 1,300 hectares of (land-based) priority habitats along the coastal margins, such as intertidal mudflats, coastal saltmarsh, coastal sand dunes, reedbeds, coastal and floodplain grazing marsh, and saline lagoons. These habitats provide crucial ecosystem services, including water quality improvement, carbon sequestration, biodiversity, recreation, and tourism. Additionally, they serve as nurseries for many commercial fish species.
- The coastal habitats within the Lincolnshire Coast 2100+ study area, including saltmarshes and intertidal mudflats, play a crucial role in carbon storage and sequestration. By protecting and restoring these coastal habitats, the region can leverage their natural ability to sequester carbon, contributing to both local and global climate goals and become resilient to climate change.
- Population is concentrated in a coastal strip with a clear differentiation between five coastal towns and a dependent inland network of farms and settlements. Each coastal town has a central high-street that leads to the beach and sea and offers central services and facilities.
- Skegness is a strong “regional centre” of reference, a gateway to the East Lindsey coast, a clear town centre with a broad range of services and facilities, good accessibility thanks to the station interchange.

- Mablethorpe and Sutton on Sea are typical, more tranquil seaside residential areas that form the gateway to a more natural coastline to the north and have embraced the natural area as an asset more than the other coastal towns. There is a stronger relationship with the natural sand dunes.
- Skegness has linear park as a wide green buffer between town and sea, consisting of formal parks, natural dunes and wildlife sites, broken only in the centre of the town by entertainment complexes that protrude into the coastal buffer. It is the only settlement with a Foreshore Development Plan.
- Agriculture and tourism are cornerstones of the Lincolnshire Coast 2100+ study area’s economy.
- Rich and diverse natural terrestrial and marine landscapes that provide critical habitat, drinking water, recreational amenity, economic benefits and flooding resilience.

Weaknesses

- Coast and beach are separated from the town centres by a variety of sea defences that contribute to a robust, artificial surrounding character, including rock revetments, a formal walled promenade, concrete revetments, steps and plateaus.
- The Roman Bank, an elevated main road and the narrow but high dyke-like sea defence cause a visual and physical barrier between the sea and beach, and the urban areas. This is exacerbated by strips of private land with purpose-built holiday accommodations and large areas with caravan parks and leisure and entertainment parks.
- Expansive caravan parks incapsulate the urban edges off all the settlements and mostly occupy lower lying areas. Their irregular and high-density layouts mostly lack green and open spaces, amenities and services to support the population that lives there.
- Majority (approximately 69%) of agricultural land is classified as grade 3 and 4 quality having good to poor quality land with moderate to severe limitations that affect the choice of crops and level of yields.
- The temporary character of visitors and residents in holiday parks and caravan parks represents a challenge to plan, finance and manage the necessary community infrastructure.

Spatial Context Summary

Strengths, Weaknesses, Opportunities and Threats

Opportunities

- Investing in the enhancement of natural habitats, such as coastal wetland/habitat restoration, can improve ecosystem resilience. These actions can enhance biodiversity, improve water quality, and increase carbon sequestration, contributing to climate change adaptation and mitigation. Additionally, restoring degraded habitats can provide new recreational opportunities and boost local tourism.
- Future sea defences could contribute positively to the character of an area, enhance placemaking, provide ecosystem services, recreational amenity, habitat and strengthening of the tourism offer.
- Involvement of the community in the process, development and implementation of interventions could strengthen sense of community.

Threats

- Community resistance to change.
- Differing priorities and levels of risk between various stakeholders, such as farmers, residents, local businesses, government bodies and environmental groups.
- Vulnerability to coastal changes: Agricultural land and ecologically valuable habitats, including designated sites (SACs, SPAs, SSSIs, etc), are at risk from retreating coastlines, saline intrusion, and coastal flooding. These threats can lead to the loss of valuable farmland, reduced agricultural productivity, and degradation of critical biodiversity areas, directly impacting both economy and ecology of the region, as well as indirectly through the erosion of ecosystem service provision due to habitat degradation.
- Alterations and changes to the coastline, land uses and habitats affected by future sea defences if no nourishment occurs

03 Infrastructure Baseline

Introduction

Overview

The Lincolnshire Coast study area comprises of several interrelated and dependent infrastructure systems.

This section of the report presents these infrastructure systems as they currently are and how these may change into the future. Further detail of each system can be found hereafter.

Infrastructure Systems Overview:

Nationally Significant Infrastructure

System of facilities that support everyday life of the country. This typically includes energy; transport; water; wastewater; waste and business and commercial.

Coastal Flood & Coastal Erosion Assets

A system of physical features that provide a defined level of protection against the risk of erosion and flooding from the coast.

Rivers and Drainage

A system of drains, watercourses, embankments, pumps and control structures which move water from rivers and rainfall across the landscape to drain into the sea.

Hydrogeology

A system that involves the interaction of water, land and ecosystems that includes the recharge, flow and storage of groundwater below the surface.

Water Supply

The collection, transmission, treatment, storage and distribution of water for use in homes, commercial establishments, industry, agriculture and the natural environment.

Wastewater

The collection, transmission, treatment and safe discharge of wastewater following its use to support everyday life.

Transport

Networks that facilitate the movement of people, products and information between locations catering for different user groups demand and mobility.

Energy

Facilities designed to supply energy services for use of people to support everyday life.

Digital Communications

Systems, networks and technologies that enable the transmission, reception, and exchange of data.



Introduction

Emerging National Significant Infrastructure Projects

Nationally Significant Infrastructure Projects

Nationally Significant Infrastructure Projects (NSIP) are large scale major development projects which require a Development Consent Order (DCO) from the government rather than the local planning authority¹.

NSIPs fall into the following categories: energy, transport, waste, wastewater, and water.

Emerging NSIP infrastructure within the east coast region are summarised on the right (project number 6 onwards).

Flood and Coastal Erosion Risk Management Schemes

- 1 **Fens2100+**: aims to deliver £58 billion of benefits through a Fens-wide flood resilience investment strategy to plan for the next 20-25 years, strategy will be completed in 2025².
- 2 **Humber 2100+**: partnership between 11 local authorities and the Environment Agency to address tidal flood risk and enable sustainable growth around the Humber estuary³.
- 3 **Barton to New Holland Tidal Flood Alleviation Scheme**: aims to alleviate tidal flooding as these defences were identified as requiring improvement by 2028 as part of the Humber 2100+ strategy⁴.
- 4 **Boston Barrier**: a primary barrier gate and associated flood walls completed in 2020 to protect more than 13,500 properties in the town of Boston⁵.
- 5 **Saltfleet to Gibraltar Point Strategy Enhancing the Lincolnshire Coast**: involves beach nourishment every year since 1994 to widen the beach to protect degrading defences from wave action⁶.

Water, Wastewater and Waste

- 6 **Theddlethorpe geological disposal facility (GDF)**: former gas terminal site being considered as a GDF for nuclear waste stored in deep rock layers below the sea⁷.
- 7 **Lincolnshire reservoir**: Anglian Water (AW) are planning a reservoir exceeding 30 million cubic metres with associated water transfer, treatment and supply infrastructure. The DCO application is expected in Q1 of 2026⁸.
- 8 **Mablethorpe desalination**: proposed for 2039, AW would abstract seawater for potable water (25-100 MI/d) to East Lincolnshire or non-potable water (60 MI/d) to the Humber⁹.

Energy (see Energy section for further information)

- 9 **Theddlethorpe Flexible Generation and Battery Storage**: application expected in early 2027 for land adjacent to gas terminal. Turbines will be fuelled by natural gas with carbon capture storage or use hydrogen generation^{10,11}.

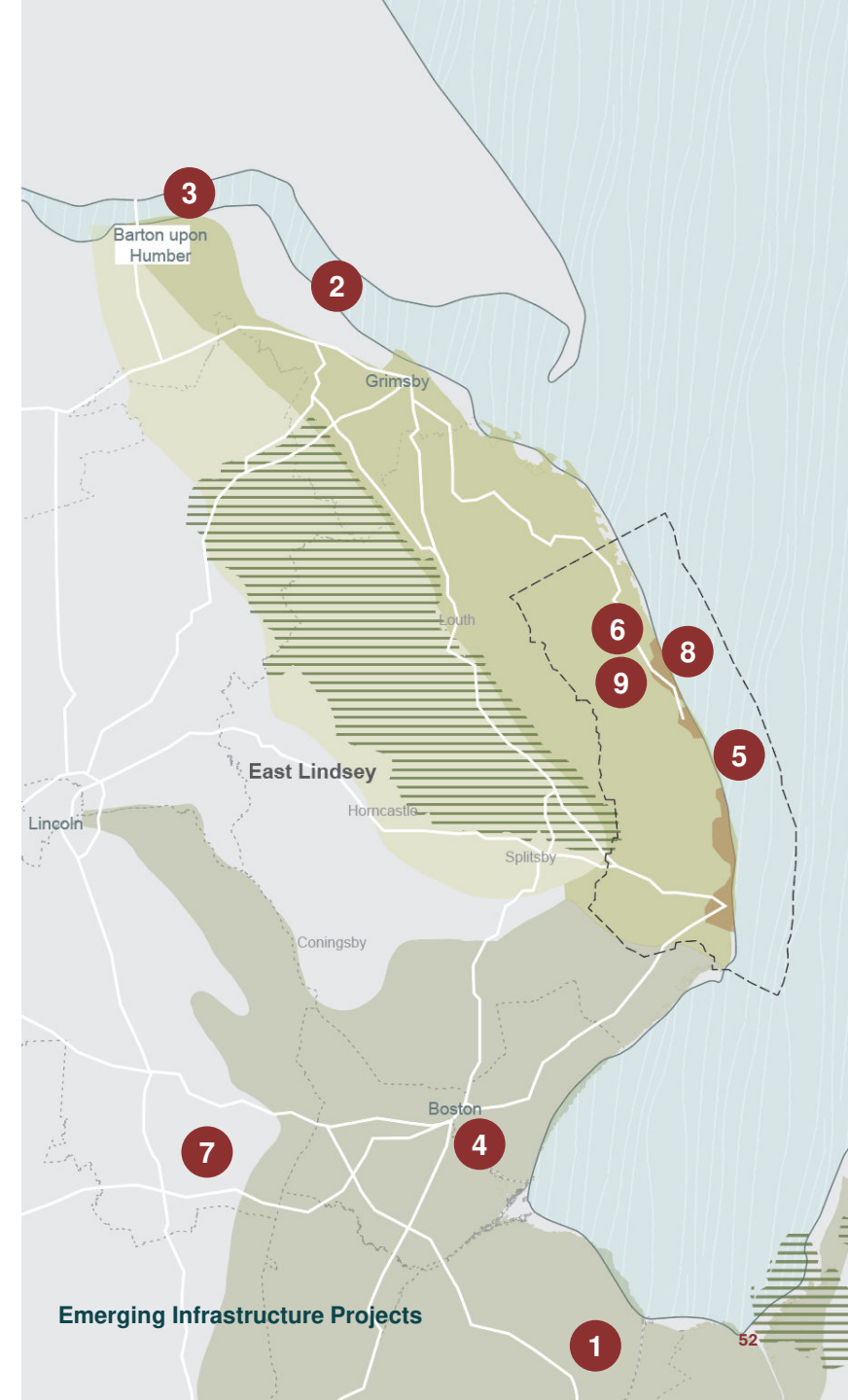
'Great Grid Upgrade' - Grimsby to Walpole: the National Grid are proposing a new 400 kV transmission line between Grimsby and Walpole¹² (within the Lincolnshire Coast 2100+ study region).

Outer Dowsing offshore wind project: a planned 1.5 GW offshore wind farm 54 km off the Lincolnshire coast to supply 1.6 million households by 2030 with an onshore cable route from Anderby Creek to Boston¹³.

Transport (see Transport section for more information)

Lincolnshire Coastal Highway: £7 million allocated to improve transport corridors to the Lincolnshire coast¹⁴.

Coastal Carriageway improvements: £8.4 million scheme with full carriageway reconstruction of the Old Roman Bank and the A1104 between Mablethorpe and Maltby-Le-Marsh¹⁵.



Emerging Infrastructure Projects



Coast and Defence System

Photo of beach nourishment along Lincolnshire

Coast and Defence System

Introduction

Where did it all start?

As explained in section 01, the Lincolnshire coastal flood plain has had a long history of flooding from the sea and various forms of defences are now in place including sand dunes, seawalls, rock/timber structures and beaches to provide coastal erosion and flood risk management.

What changed things?

The key event affecting the management of this coastline in modern times was the storm surge of 31 January 1953. During this surge, beaches were stripped of sand, defences were destroyed and breached in several locations and sand dunes were washed inland.

The floods caused devastation across the east coast. 307 people lost their lives, 42 in Lincolnshire. Following this, new sea defences began to be constructed.



Photo of 1953 Flood Event

What came next?

Sea defences were hastily rebuilt in the aftermath of the 1953 storm surge with locally available resources. Some of these defences have subsequently been improved and refurbished over time, however, still form part of the flood risk management system that is managed today.

Between 1984 and 1997, 70% of the defences between Mablethorpe and Skegness were upgraded. Since then, although works have continued to maintain the existing defences, without maintaining the beach levels there would be no consistent defence against coastal erosion and flooding.



Photo of Sea Defences being built in the 1980s

Coastal monitoring has observed the foreshore between Mablethorpe and Skegness to be volatile and vulnerable to sudden major drops in beach level, which would leave the seawalls exposed to increased wave action and consequently an increased risk of failure and breach.

In 1994 a change to coastal flood risk management was introduced in the form of beach nourishment campaigns as a methodology to provide increased resilience from the risk of coastal erosion and flooding. This was achieved by sustaining the beach levels at predetermined profiles to protect the seawalls from wave exposure and to prevent erosion of the clay foreshore at the toe of the defences.

What is happening now?



Photo of Beach Nourishment Operations

The integrated coastal defence system supported by various management activities continues to provide resilience against the risk of coastal flooding along the Lincolnshire coastline. This requires significant investment to monitor, assess and undertake works to maintain their function.

As the defences have aged their overall health has deteriorated and their resilience and reliability as sea defences has decreased. A recent study has identified that even with the current beach nourishment, 84.6% of the assets are predicted to fail within the next 20 years and therefore will require significant additional investment. This leads to an increased risk of a failure and breach.

Regardless of the current measures in place, there is also a risk that an extreme surge event may exceed the current standard of protection provided, this risk will increase over time due to the affects of climate change and sea level rise. Again, placing increased importance on the need for continued coastal erosion and flood risk management investment.

Coast and Defence System

Current and Future Coastal Flood Risk

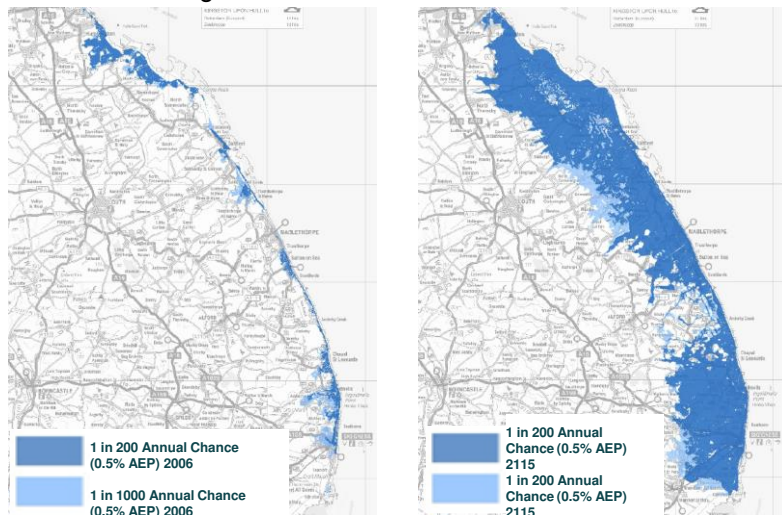
What is the actual risk of coastal flooding?

A significant proportion of the study area is located within Flood Zone 3 which is considered to have a high probability of flooding. This means without consideration of flood defences the land located within Flood Zone 3 is predicted to flood during a 1 in 200 year tidal flood event.

In other words, there would be a 0.5% chance of flooding from the sea in any given year. Fortunately, the existing sea defences reduce the risk of flooding.

Based on available modelling predictions the risk of flooding from a surge tide combined with waves is presented below. In the current day (2006) scenario, the defences significantly reduce the risk of coastal flooding, however a risk remains in localised locations directly by the coastline.

When the effects of climate change and sea level rise are taken into consideration the risk of flooding significantly increases during the 2115 scenario due to sea level rise.



Model Predicted Flood Extents 0.5% & 0.1% AEP (2006 Scenario)¹¹

Model Predicted Flood Extents 0.5% & 0.1% AEP (2115 Scenario)¹¹

The presence of flood defences does not completely stop the chance of flooding and during any given day of the year there is the chance that a surge event may occur with a larger magnitude than the defences which would lead to flooding. This is referred to as an exceedance event.

There is also a risk that as a raised defence ages it may not function as originally intended due to deterioration of the structure. Gradual deterioration over time, or overloading could result in a sudden failure and breach of the defences. As discussed on page 57, 84.6% of the assets are predicted to fail within the next 20 years based on a residual life study.

The consequence of a breach has been modelled along the coastline to predict the severity of a breach. This is represented by a hazard rating based on the predicted maximum flood depth and maximum flow velocity of the flood water.

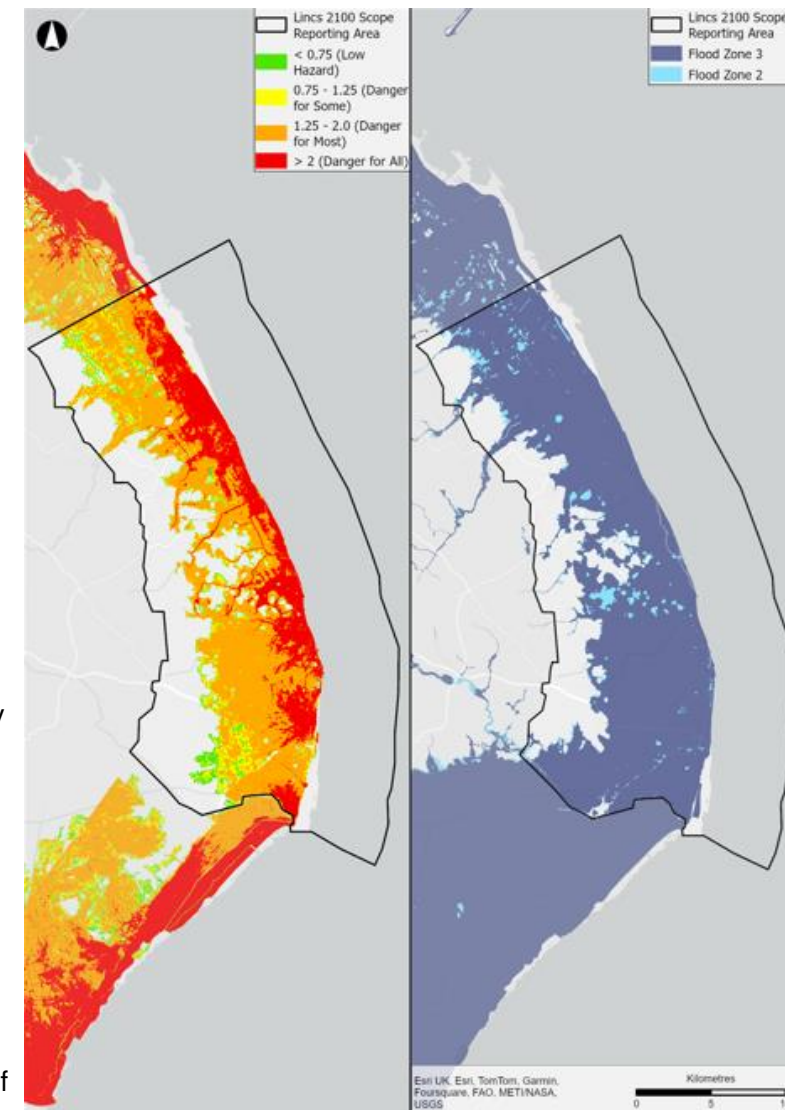
Due to the relatively flat nature of the catchment the majority of areas located within flood zone 3 are also within an area considered to present a 'danger to some' or 'danger to most' hazard with a 'danger to all' in areas in close proximity to the coastline. Where:

Danger for some: includes children, the elderly and the infirm.

Danger for most: includes the general public.

Danger for all: includes emergency services.

This corresponds with predicted maximum flood depths of between 0.5m in depth to 2m along the coastline if a breach occurred today, and over 2m in depth in some isolated locations. For context, this is flooding would be to the height of a typical static caravan. It should also be noted that once a breach starts it can progress very quickly, giving limited time to move to a place of safety.



Model Flood Hazard Rating for 1 in 200yr tidal event (2100)

Flood Zone 2 and Flood Zone 3 Extents

Coast and Defence System

Who is at risk?

The Lincolnshire Coast 2100+ study area comprises of over 20,000 residential homes, 1,700 businesses, 26,000 static caravans, 30,000 hectares of farmland and a bustling tourist industry of over 4,000,000 visitors per year.¹

Flood risk management work in this area is vital for the continued success of Lincolnshire's coastal communities, its bustling tourism industry, and its strong agricultural sector.

The sea defences currently prevent high tides from flooding the low-lying land behind. Without the integrated coastal flood defence systems, this land would flood regularly.

What measures are in place to manage this residual risk of a breach?

The Lincolnshire Local Resilience Forum works very closely with the Environment Agency and many other professional partners both in planning to reduce the effects of flooding and in the response to an incident.

In partnership with the Met Office the Environment Agency monitor the weather and advise when a surge event is predicted to travel down the north sea and hit the Lincolnshire coastline of a severity that could result in flooding affecting people.

The timing of making a decision is critical to enable people to be evacuated. The ideal timeframe is 36 hours before the surge hits, however certainty of the exact timing when the surge will hit the coastline only becomes more accurate within 12 hours of when the surge will hit the coastline, which does not provide sufficient time to enable an evacuation.

The exact timing is of critical importance as a high tide combined with a surge could have catastrophic consequences whereas a surge with a low tide would just appear like a slightly higher tide.

If the flood warning data suggests there is a risk of flooding, the mass evacuation plan can be triggered within the flood warning area. Throughout the flood risk area there are designated emergency evacuation routes, which are marked by 'ER Out' signage on the highways network and an evacuation is coordinated with the emergency services.

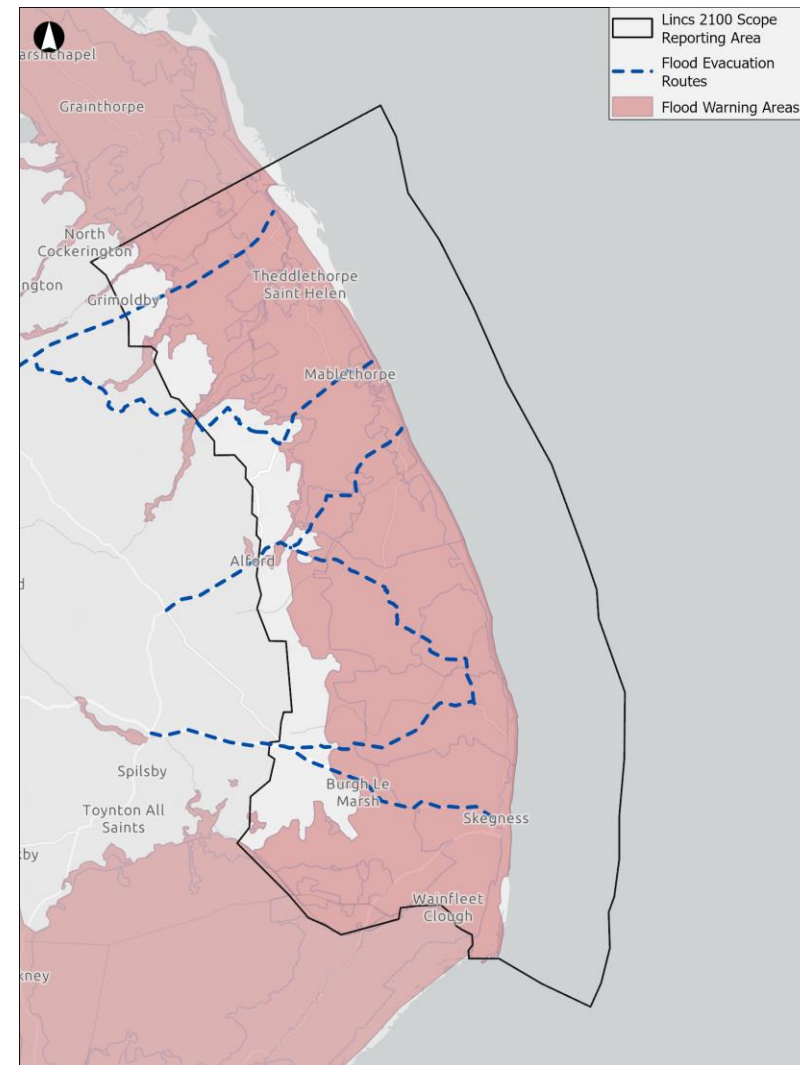
The mass evacuation plan was activated during the surges in 2013 and again in 2017, however only a limited number left their homes. Fortunately, the surge in 2013 was not as severe as predicted and the surge during 2017 (predicted to be nearly 2m higher than the flood defences) hit during low tide which meant the potentially catastrophic consequence of the surge was not realised. These events showed that a cultural change is required in responding to flood warnings.

What impact does this have on regional investment and growth?

Due to the residual risk of a breach and risk of exceedance, caravans located within the catchment are only allowed to be occupied between March and October.

This was challenged in a planning application that went to public enquiry in 2021, where it was found that the use of 'warn and inform' was not suitable mitigation against the residual flood risk to allow year-round occupation of caravans. Local Plan policy SP19.8 states that the council will not support all year round occupancy or permanent living in caravans in the coastal area.

The local plan recognises the importance of coastal flood risk to both property and life and how this needs to be balanced against investment into the economy whilst not putting more people at risk from flooding. Local Plan policies (SP17 to SP21) are based upon an approach of limiting housing growth within areas at risk of flooding.



Current Flood Warning Area and Flood Evacuation Routes

Coast and Defence System

Lincolnshire's Hard and Soft Defences

What forms the integrated coastal defence system?

The coastline is divided into three distinct zones. Throughout these zones, there is a combination of different hard and soft flood defence features, which collectively form the flood defence system and offer a varying standard of protection and resilience from coastal erosion and flooding.

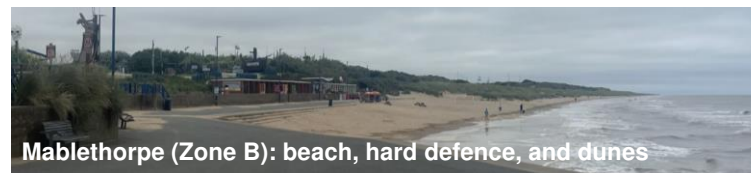
Hard defences including vertical sea walls and stepped sea walls create an engineered feature which is fixed within the landscape. These features typically influence the natural coastal processes, however, are effective at providing coastal erosion and flood risk management on a smaller footprint.

Soft defences including beaches and dunes provide a more natural protection and work with the natural environmental processes, however as a consequence are more vulnerable to being eroded during a storm and typically have a much larger and wider footprint.

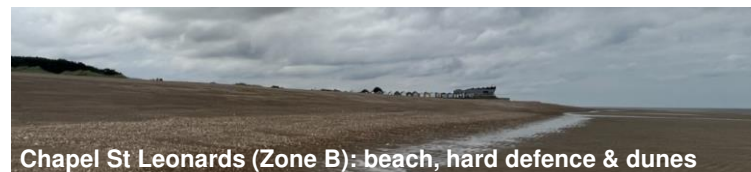
Zone A and Zone C comprises soft defences in the form of natural dunes and a managed beach, there are also earth embankments at Steeping Haven in Zone C. In contrast, **Zone B** typically has the presence of hard defences weaved between a beach and dunes. These areas typically correlate with more urbanised areas where land availability is squeezed.



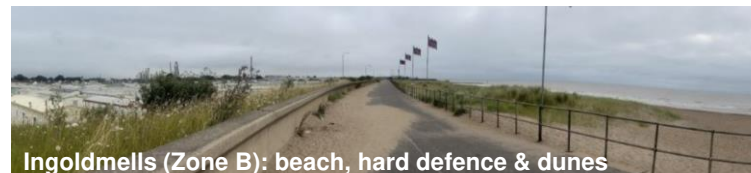
Saltfleet (Zone A): beach, saltmarsh, dunes, and flood walls



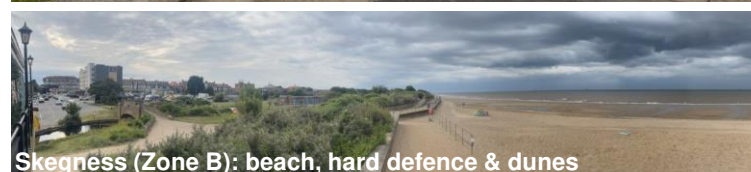
Mablethorpe (Zone B): beach, hard defence, and dunes



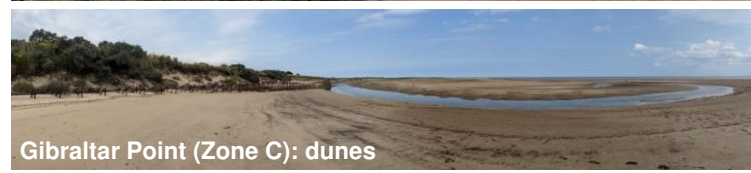
Chapel St Leonards (Zone B): beach, hard defence & dunes



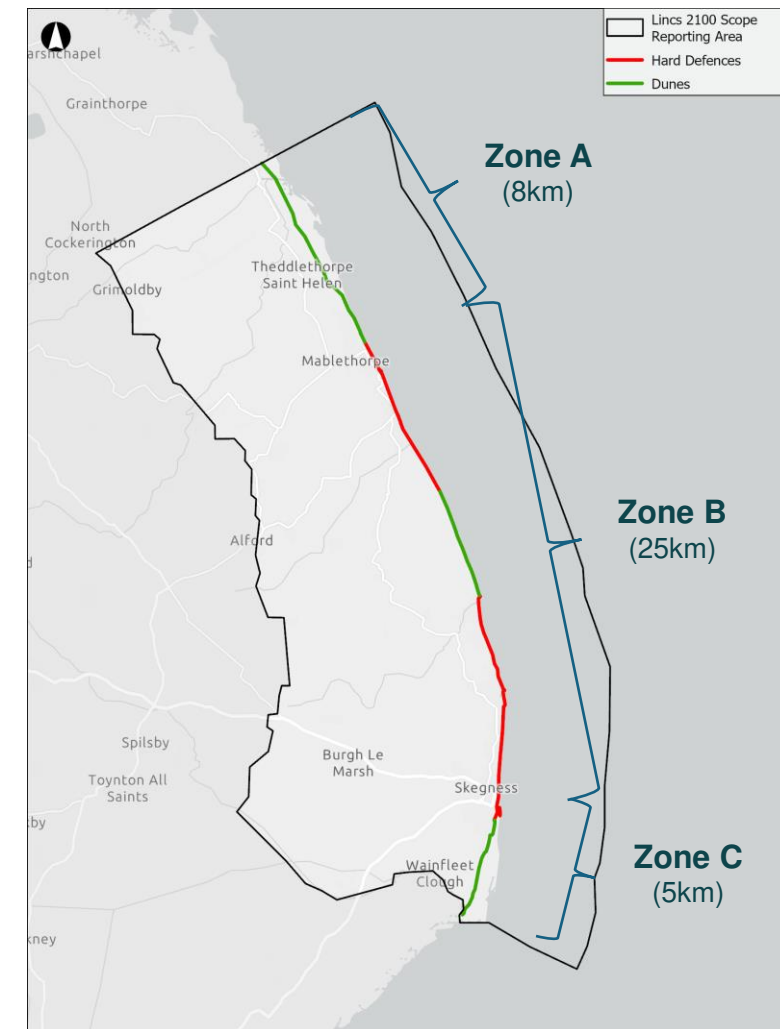
Ingoldmells (Zone B): beach, hard defence & dunes



Skegness (Zone B): beach, hard defence & dunes



Gibraltar Point (Zone C): dunes



Distribution of natural defences and hard defences in the Lincolnshire Coast 2100+ scope reporting area

Coast and Defence System

Current Management Activities

Asset Management

Defra has overall national responsibility for policy on flood and coastal erosion risk management (FCERM) in England and provides funding to the Environment Agency who supervise and work with other organisations to manage the risk of flooding and coastal erosion in England, with permissive powers to maintain the flood defences.

Currently the Environment Agency undertake various activities to maintain the existing flood defences.

As part of the asset inspection, monitoring and repair programme, a study was conducted to better understand the residual life of the assets and the influence the beach nourishment has upon this. The primary motivation of this study was to ratify the assumptions of the Saltfleet to Gibraltar Point (SGP) Strategy² as all options considered in the strategy relied on the residual life of the hard defences being adequate over the next 100 years.

Alongside the current development of a business case to continue existing asset management and beach nourishment from 2028 up to 2040, other studies are also in development to improve the understanding of risk and where the placement of sand during beach nourishment campaigns could be refined.³

Beach Nourishment

Beach nourishment activities take place along the Lincolnshire coastline on an annual basis. In a typical year, beach profiles are monitored during the spring, summer and autumn months whilst the next nourishment campaign is planned. Nourishment activities then top up areas where sand has been lost after the winter storms have passed the following spring.

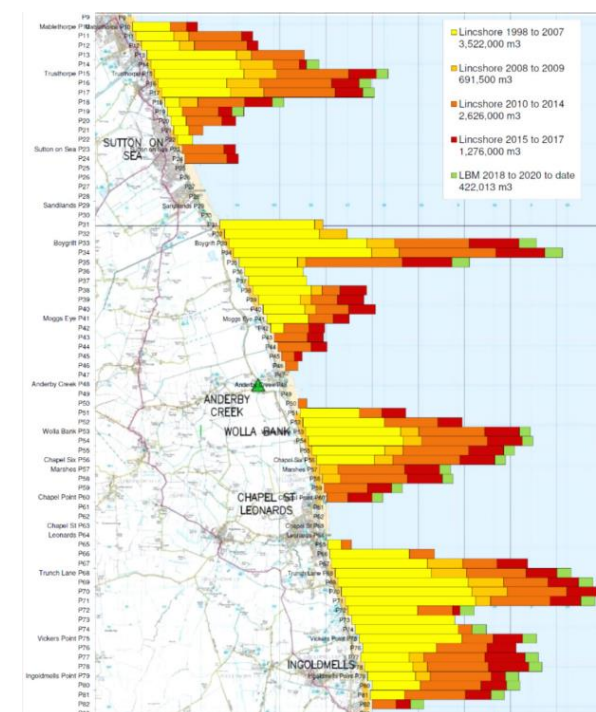
Since 1994, annual beach nourishment has delivered almost 17 million cubic metres of sand (dredged from offshore licensed sites) to the Lincolnshire beaches. This has radically changed the appearance of the shoreline between Mablethorpe and Skegness and continues to be a fundamental component in providing resilience to coastal erosion and flood risk. The nourished beach profile reduces the impacts of waves and limits overtopping in comparison to a natural beach.

The most recent beach nourishment campaign took place in the summer of 2024, as 400,000m³ of sand was used to nourish the beaches at Mablethorpe, Trusthorpe, Sutton on Sea, Boygriff, Huttoft, Wolla Bank, Chapel Six Marshes and Ingoldmells.

Monitoring and Surveys

In 2023, six radar masts with advanced CoastSense technology were installed along the Lincolnshire coast to help improve the understanding of the coastal geomorphology (evolution of coastal and marine bedforms and landscape).

These masts monitor waves, tides, currents and weather and are intended to help understand how the coastline is changing to inform how best to respond from a coastal erosion and flood risk management perspective. For example, by monitoring waves, narrowing of the beach could be detected. Monitoring is a key component to build an evidence base to support future investment decision making whilst helping to reduce costs, carbon emissions, and supporting sustainable coastal management.



Beach Nourishment volumes placed at 'hotspot' areas²

Coast and Defence System

Cause of coastal flooding and influence of climate change

Cause of Coastal Flooding

Coastal flooding, in the UK, is caused by a combination of 3 elements coming together: high tides, low pressure weather systems and surge conditions from strong winds blowing large waves and higher water levels towards the shore. This causes an increased risk of the sea spilling, spraying and overtopping the defences, and more devastatingly, an increased risk of a breach of the defences.

Tides

The tidal levels are astronomical predictions. The actual recorded water level can differ from the tidal predictions due to storm surges. When storm surge conditions combine with spring high tides, the risk of coastal flooding is at its highest.

Combining the astronomical tidal prediction and the storm surge predictions result in the estimated Extreme Still Water Level (ESWL).

The surge event on the 6th December 2013, caused by storm

“Xaver”, had a water levels of +5.21 mODN (at Immingham which equated to a 1 in 787 year return period event)⁴. Almost 0.7m higher when compared to a water level during the 1953 storm event which reached +4.52 mODN (at Immingham)⁵.

In 2017 a storm surge was predicted to hit the Lincolnshire coastline and overtop the defences by almost 2m, however fortunately the surge hit the coastline during low tide and therefore did not result in widespread flooding.

Extreme Still Water Levels (ESWL) with sea level rise

Over the next century, sea levels across the coastline are predicted to rise as a consequence of climate change. At Skegness sea levels are predicted to rise by almost 1m (between now and 2100). This means that a 1 in 1 year tidal event would increase from a +4.03m ODN in 2024 to +5.01m ODN in 2100. Similarly, a 1 in 200 year tidal event would increase from +4.98m ODN in 2024 to +5.96m ODN in 2100. These predictions are based on the latest climate change

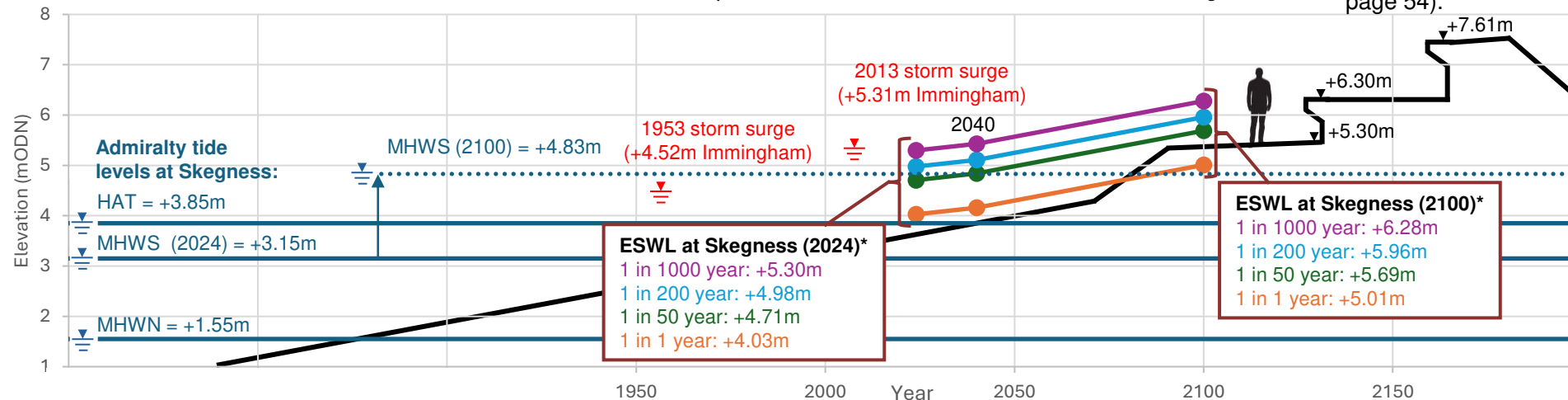
guidance and represent the UKCP18 RCP8.5 95th percentile climate change allowances for sea level rise.⁶

Wave Heights

A combination of wind and wave conditions give significant wave heights with probabilities independent of ESWL. Wave heights are in addition to ESWL which can cause overtopping of defences when high waves combine with storm ESWL.

Impact on Lincolnshire Coast

Water levels were shown to exceed MHWS on average 105 times each year between 2002 and 2023. With sea level rise of almost 1m by 2100, MHWS at Skegness will increase to 4.83m ODN increasing the frequency of tides and associated waves interacting further into the flood defence system. In combination with increased storm surge and an increased wave climate the existing defences will provide less resilience to flooding events for future events of the same probability of occurrence and magnitude (see Figures on page 54).



Illustrative cross section of historic, current and future predicted water levels at Skegness all levels relative to Ordinance Datum Newlyn

* Coastal Flood Boundary Extreme Sea Levels at Chainage 3860 (Environment Agency, 2018)⁷ and UKCP18 RCP8.5 95th Percentile Projections 1981-2000 baseline (Met Office, 2018)⁸



Beach cross section location (250 m north of Skegness pier)

— Beach cross section

Coast and Defence System

Sea Defence Deterioration

Flood Defence Residual Life

An Environment Agency study investigated the estimated residual life of the existing sea defences based on their current condition.

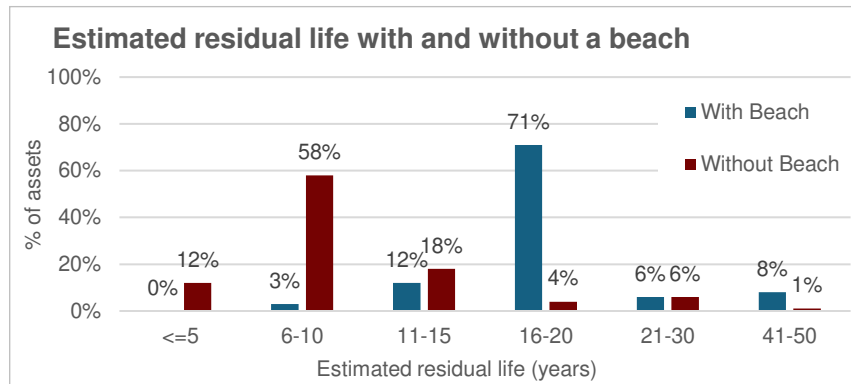
The study concluded that 84.6% of the assets are predicted to fail within the next 20 years. Furthermore, if a beach was not maintained approximately 70% of the assets are predicted to fail within the next 10 years, supporting the case to continue beach nourishment up to 2040.

Without a beach the seawalls would be exposed to larger waves, with increasing potential for damage, threatening the structural integrity of the seawall, and ultimately leading to the increased risk of the defences failing.

A full breakdown of this split is shown on the right.

Flood Defence Failure Mechanisms

The residual life study identified four key mechanisms in which the flood defences are likely to fail. If failure was to occur the risk of the sea defence collapsing and causing flood water to breach behind the defence significantly increases.



Consequence of Asset Deterioration

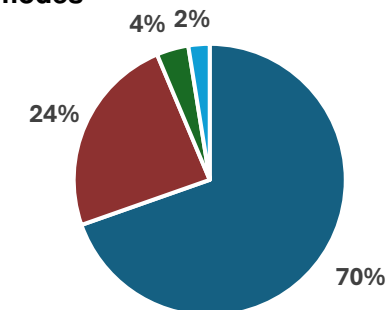
As these assets continue to age and get closer to the end of their serviceable life the risk of failure is expected to increase.

Furthermore, climate change, in the form of increased storminess, is expected to increase the risk and rate of deterioration leading to an increased risk of failure.

Larger waves and lower beaches would also result in higher levels of overtopping, which sea level rise will further exacerbate, leading to reduced resilience in coastal erosion and flooding.

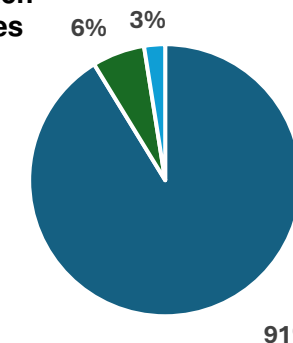
Ongoing loss of sand may also expose and lead to erosion of the clay foreshore, which could lead to further undermining and collapse of the seawall.

With beach failure modes



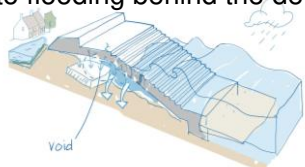
■ Condition ■ Undermining ■ Overtopping ■ Geotechnical Instability

Without beach failure modes



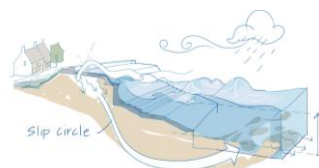
Undermining/ washout

Waves and tides cause material supporting the foundation of the defence to be washed out from under the concrete surface, causing instability and risk of collapse leading to flooding behind the defence.



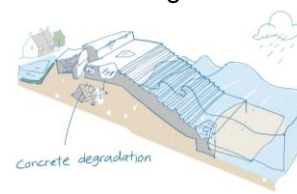
Geotechnical Instability

Loss of supporting material both in front and behind the wall could cause defence to rotate and collapse leading to flooding behind the defence.



Condition

Ageing concrete and steel are unable to perform as designed and may collapse under loading from wave energy, which may lead to flooding behind the defence.



Overtopping

Waves or sea levels exceed the level of the defence resulting in water spraying or spilling behind the wall, which may cause further geotechnical instability, collapse and flooding behind the defence.



Coast and Defence System

What investment in flood risk management infrastructure is available?

Where does funding come from?

In England, the Department for Environment, Food and Rural Affairs (Defra) leads on flood and coastal erosion risk management (FCERM) and provides funding for projects. The Environment Agency disburses funding and delivers FCERM projects.⁹

By the end of the 2017-19 Parliament, the government committed to investing £2.6 billion in capital funding for flood defences between 2015/16 and 2020/21. Final spending during this period was £2.8 billion. In March 2020, the government announced that in the next six-year investment programme the total capital budget would double to £5.2 billion.

Funding for flood risk management is complex. The Environment Agency receives some funding from the government to spend directly on FCERM activities. Additionally, risk management authorities can apply to the Environment Agency to fund local projects, although these projects may also require top up partnership funding from other sources.

Current Investment Delivery?

The current Saltfleet to Gibraltar Point Strategy has investment up to 2028 to continue existing beach nourishment campaigns and asset management. The current measures are further discussed on page 56.

Investment from 2028 up to 2040

There is currently a business case being developed to secure this existing management approach to continue from 2028 up to 2040. Over this duration it is proposed to increase the width of the beach to maintain the existing standard of protection against the risk of flooding.

Investment after 2040

From 2040 and beyond it is less certain how the coastal frontage can be sustainably maintained.

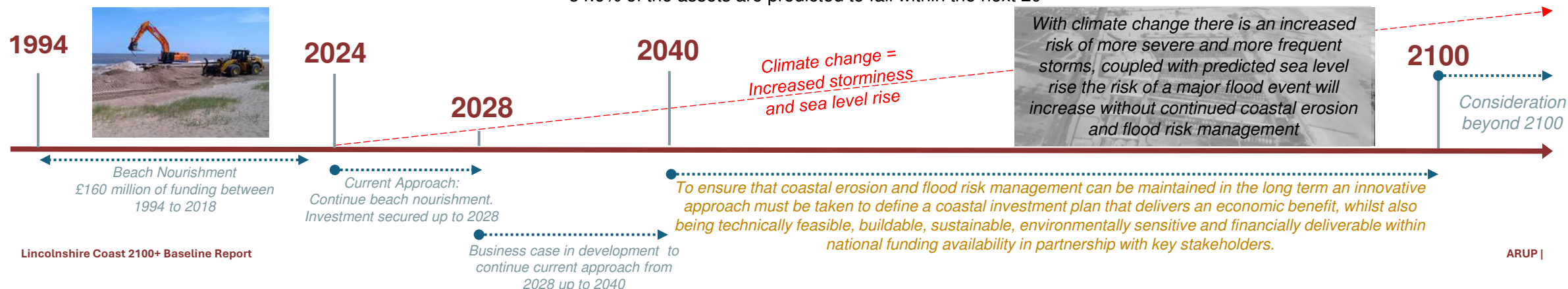
Whilst previous strategy reviews concluded that maintaining an open beach with regular nourishment was the most economic, technically feasible and environmentally beneficial management regime, further research has concluded that in the long-term this approach will become unsustainable.

84.6% of the assets are predicted to fail within the next 20

years based on a residual life study and therefore need replacement (see page 57 for further details).¹⁰

To address expected climate change impacts, such as sea level rise, and continue to provide flood risk management with rising costs of construction projects, there will be increasing pressure on national funding resources across the United Kingdom. The SGP Strategy, published in 2020, estimated that FCERM investment for the area could be between £0.7 bil to £1.5 bil for the 100-year period between 2020 and 2120. However, this was prior to current uncertainties arising from the residual life study published in 2023. Therefore, it is currently unclear what the overall scale of FCERM investment required is, in relation to maintaining the current FCERM practices (e.g. maintaining and enhancing the existing coastal defences and beach nourishment).

To ensure that coastal erosion and flood risk management can be maintained in the long term an innovative approach must be taken to define a coastal investment plan that delivers an economic benefit, whilst also being technically feasible, buildable, sustainable, environmentally sensitive and financially deliverable within national funding availability in partnership with key stakeholders.



Coast and Defence System

Strengths, Weaknesses, Opportunities and Threats

Strengths

- **Existing Coastal Erosion and Flood Risk Management:** Various studies and investigations continue to inform ongoing FCERM investment decisions, including ongoing beach nourishment which protects vulnerable aging assets behind the beach whilst providing coastal erosion and flood risk resilience in line with the current Shoreline Management Plan policies.
- **Natural Defences:** System of dunes and beaches provide natural resilience to coastal erosion and flood risk whilst working with natural environmental processes. Nearshore sand banks may also provide some level of wave attenuation.
- **Advanced monitoring:** High-tech radar masts have been installed recently along the coastline, which should help to inform future FCERM investment decisions.

Weaknesses

- **Inconsistent (current day) standard of protection:** The overall integrated coastal defence system comprising natural dunes, beaches, and hard defences provide resilience to coastal flooding in the current day however its complex nature means it is difficult to establish its resilience is against a statistical tidal event throughout the entire frontage.
- **Deteriorating coastal defences:** Up to 84.6% of the coastal flood defences are expected to fail within the next 20 years, with the timeline accelerating if beach nourishment activities cease.
- **Topography:** The low-lying nature of the coastal zone is at risk of severe flooding if a breach occurred. Increasing

pressure is placed on the current permanent coastal features to deliver coastal erosion and flood resilience.

- **Evacuation to place of safety in a flood event:** There is limited access to a place of safety if an emergency flood incident occurred. Whilst the current evacuation routes provide a route to safety, there are bottlenecks and rely upon a mass coordinated effort to safety get everyone to a place of safety (for example some people will need to be moved in an ambulance).
- It is also challenging to predict with 100% confidence the exact timing of a surge hitting the coastline to understand if it would coincide with a high tide and cause the most catastrophic flood impact.

Opportunities

- **Re-use and rebuild:** Utilise advancement and innovation within engineering practices to use parts of existing FCERM assets, where practicable, to contribute towards the 2100+ strategy.
- **Capitalise on natural flood risk management:** Enhancement to the natural coastal systems to deliver erosion protection and flood resilience whilst also delivering carbon sequestration and bio-diversity improvements.

Threats

- **Rising sea levels and coastal squeeze:** Anticipated sea level rise will further threaten already vulnerable coastal defences and put additional pressure on the natural coastal frontage through squeezing its footprint impacting the function as a flood defence system whilst also impacting upon the extent and function of the

associated natural coastal and intertidal habitats.

- **Increased storm intensity and frequency:** Future severe storms are likely to accelerate asset deterioration and beach erosion, leading to greater exposure and risks of asset failure and flooding.
- **Cessation of beach nourishment:** Studies have highlighted the critical nature of the beach as part of the current flood defence system.
- **Complacent attitude of communities toward flood risk:** Recent evacuation orders in 2013 and 2017, which fortunately did not result in significant flood incident, have fostered a sense of complacency among local communities, diminishing their perception of the imminent and actual risk to life associated to coastal flooding. The nature of the coastline and physical barrier created between communities and the sea from the raised dunes can cause a false sense of security and comfort as the destructive power of storms cannot be seen on the landward side.
- **Environmental pollution:** There are a number of landfill sites within close-proximity to the coastline. These present a credible risk to the environment if they are flooded.



A wide, shallow river flows through a grassy landscape under a cloudy sky. The river is the central focus, winding through the scene. The banks are covered in tall, dry grasses. The sky is filled with soft, grey clouds. The overall tone is muted and naturalistic.

Inland Rivers and Drainage System

Inland rivers and drainage system

Drainage catchments and fluvial flood risk

Drainage Catchments

The drainage catchments in the Lincolnshire Coast 2100+ study area are within the Witham management catchment which is part of the Anglian river basin district. The Lincolnshire Coast plain sits within the Steeping and Eaus operational catchment. This operational catchment is predominantly rural with small settlements including the historic market towns of Alford and Spilsby.

To the west of the catchment, chalk streams rise from the outcrop in the Lincolnshire Wolds, an area of elevated ground roughly 50 m above sea level. To the east, the operational catchment becomes a coastal floodplain with very flat terrain that is between 2m and 3m above sea level. The watercourses flow into the North Sea. There are protected areas in the catchment including bathing waters, Natura 2000 sites and urban wastewater directive sensitive sites.

Fluvial & Pluvial Flood Risk

The East Lindsey Strategic Flood Risk Assessment (SFRA)¹, published in 2017, states that the fluvial flood risk within the Lincolnshire Coast 2100+ area is assessed in the Louth Coastal Catchment Flood Management Plan (CFMP)² published in 2009. The CFMP area extends to Louth in the east and North Cotes in the north. It identified river flooding at Louth, Mablethorpe and Chapel St Leonards as a potential flood risk. It also highlighted the risk of potential embankment breaches from the upland rivers flooding lower lying areas of the catchment. In 2009 it was estimated that, 2,750 people, 1,250 properties and 440 caravans were at risk from a 1% annual probability river flood across the CFMP area².

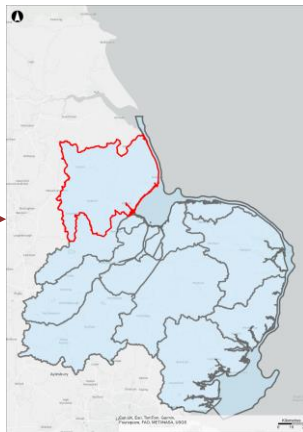
Around half of the people and property at risk from the 1% annual probability river flood in the CFMP area are in Mablethorpe, Skegness and Chapel St Leonards.

For climate change up to 2100, the Louth Coastal CFMP tested a 20% increase in peak flow in all watercourses and a total sea level rise of 900 mm. This modelling estimated that 5,800 people and 2,800 properties would be at risk from the 1% annual probability river flood. This represents an increase in flood risk by over a factor of two compared to 2009.

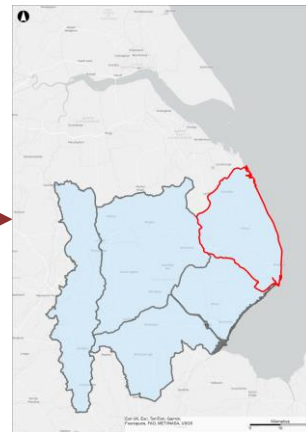
In addition to fluvial flood events, surface water flooding can occur as a result of heavy rainfall (pluvial flood risk) and overland flows/run-off. This overwhelms the drainage capacity of the local area and was the cause of flooding in the summer of 2007. The SFRA states that this flood event led to the establishment of the Lincolnshire Flood Risk and Drainage Management Partnership with Lincolnshire County Council as the Lead Local Flood Authority (LLFA). The partnership completed a joint management strategy in 2012 which was one of the first of its kind in England³.



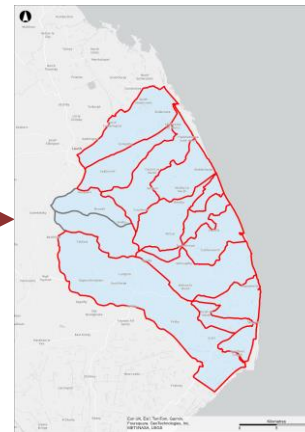
River basin district: Anglian



Management catchment: Witham



Operational catchment: Steeping and Eaus



Lincolnshire Coast 2100+ Sub-Catchments



Wainfleet Flooding⁴, June 2019

Inland rivers and drainage system

Inland Drainage Infrastructure

There are 12 sub-catchments in the Lincolnshire Coast 2100+ study area, all of these are in the Steeping and Eaus Operational Catchment. The 12 sub-catchments have been grouped into four regions (Northwestern, Northern, Middle and Southern) and include main rivers and inland drains.

The relatively flat Lincolnshire coastal plain is drained by a network of inland drainage systems. The inland drains and respective pumping stations in the Lincolnshire Coast 2100+ study area are operated and maintained by the Lindsey Marsh Drainage Board (LMDB). The LMDB is a statutory land drainage authority which manages water levels in the area. The LMDB aims to maintain their drains to a standard of flood protection of between 1 in 10 years for agricultural land and 1 in 75 years for urban areas¹.

The flat nature of the catchment results in a very low hydraulic gradient; water is less able to flow naturally to the sea under the influence of gravity. Therefore, the drainage system is reliant upon pumping stations to enable the system to drain out into the North Sea. The pumping stations are powered by either electricity or diesel.

The drainage systems all flow into the sea through tidal outfalls, these are at risk of tide locking. Tide locking occurs when the elevated sea level at high tide stops water from draining into the sea via gravity.

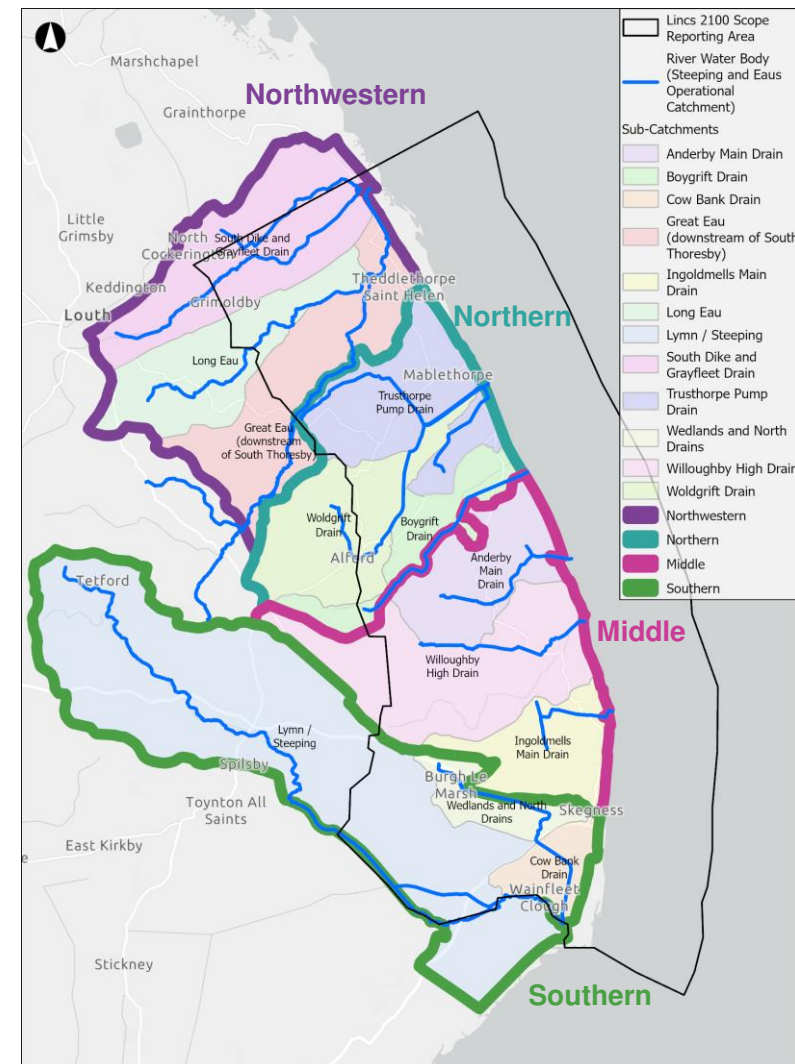
Climate change is a threat to the inland drainage infrastructure due to sea level rise and more severe rainfall events. Higher sea levels will result in longer periods of tide locking whereby the inland drainage cannot drain into the North Sea. The increased frequency and intensity of rainfall

events will increase the demand on the drainage network and its pumping stations. The drainage channels are at risk of reaching capacity and breaching their banks due to greater volumes of water entering the drainage network. The higher demand on the pumping stations will increase energy usage and operational costs.

Inland Drainage Sub-catchments:

Pages 65-69 provide an overview of the associated sub-catchments and key drainage infrastructure:

1. South dyke and Greyfleet Drain
2. Long Eau
3. Great Eau
4. Trusthorpe Pump drain
5. Woldgrift Drain
6. Boygrift Drain
7. Anderby Main Drain
8. Willoughby High Drain
9. Ingoldmells Main Drain
10. Wedlands and North Drains
11. Cow Bank Drain
12. Lymn/Steeping



Northwestern Catchments

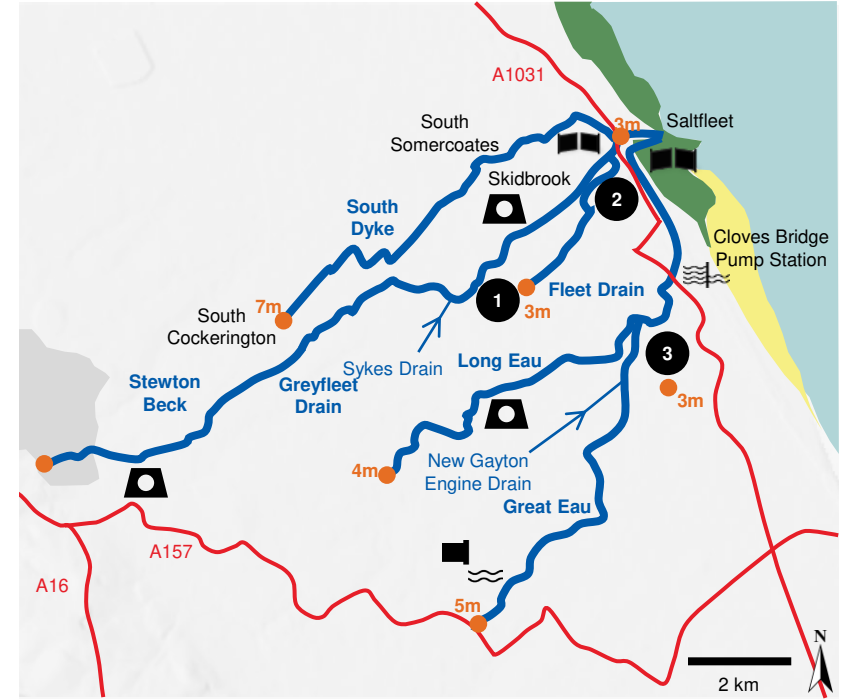
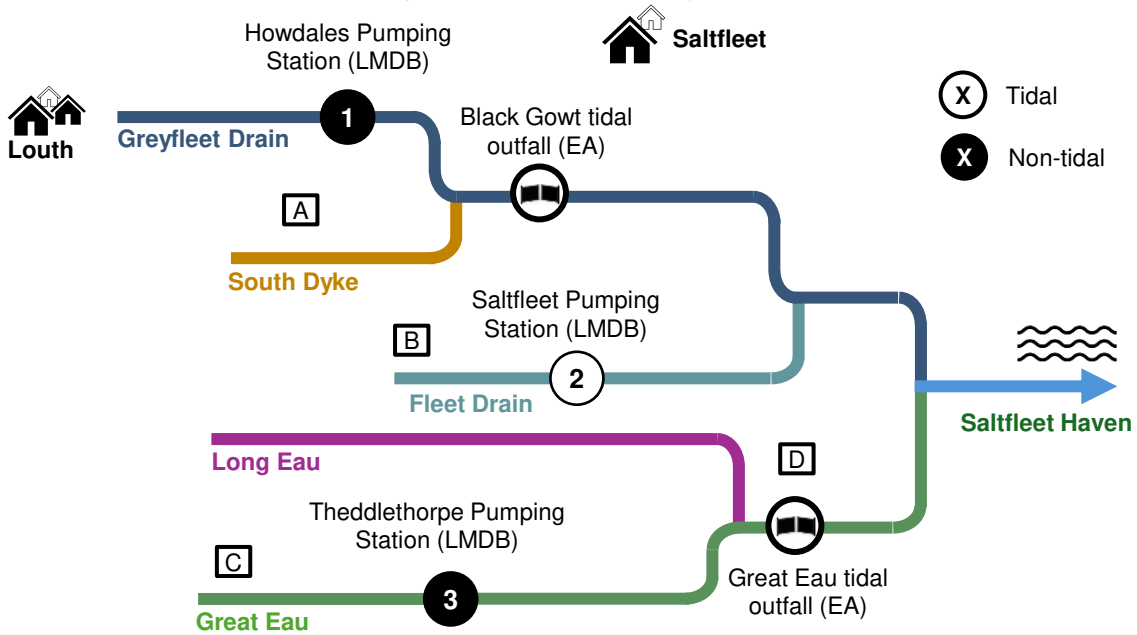
South dyke and Greyfleet Drain, Long Eau & Great Eau

The Stewton Beck has culverted sections in the town of Louth before it becomes the Greyfleet Drain at South Cockerington. Engineered structures, such as earth embankments, reduce the likelihood of flooding. South Dyke and the Greyfleet Drain merge at Saltfleet and discharge through the Black Gowt tidal doors. The dominant flow from the pumping station may prioritise flows into Saltfleet Haven for the LMDB. There is a guillotine gate upstream of the tidal doors to manage summer water levels.

The Long Eau and Great Eau exist as chalk streams in the headlands and are fed by ground water from the Wolds. Historic modification of the Long Eau and Great Eau by

constructing embankments and channelisation aimed to protect adjacent agricultural land from flooding. A scheme was completed in 1995 at Manby to restore floodplain connectivity through bank reprofiling and setting back flood banks.

The Long Eau merges with the Great Eau at Theddlethorpe and discharges through a set of pointing doors into the Saltfleet Haven. Siltation is less of an issue due to being far enough downstream of the Saltfleet pumping station. A low-level guillotine gate maintains river levels in the drier summer period.



Legend

Culvert	Outfall	Trash Screen	LMDB: Lindsey Marsh Drainage Board
Tidal Gate	Weir	Sluice Gate	
Pumping Station	Sea		

Northern Catchments

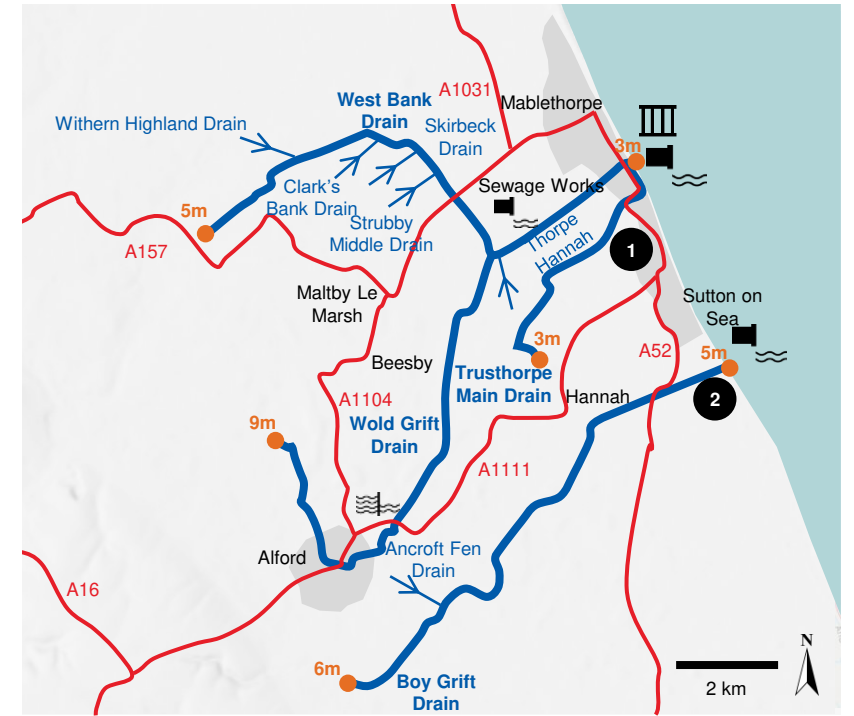
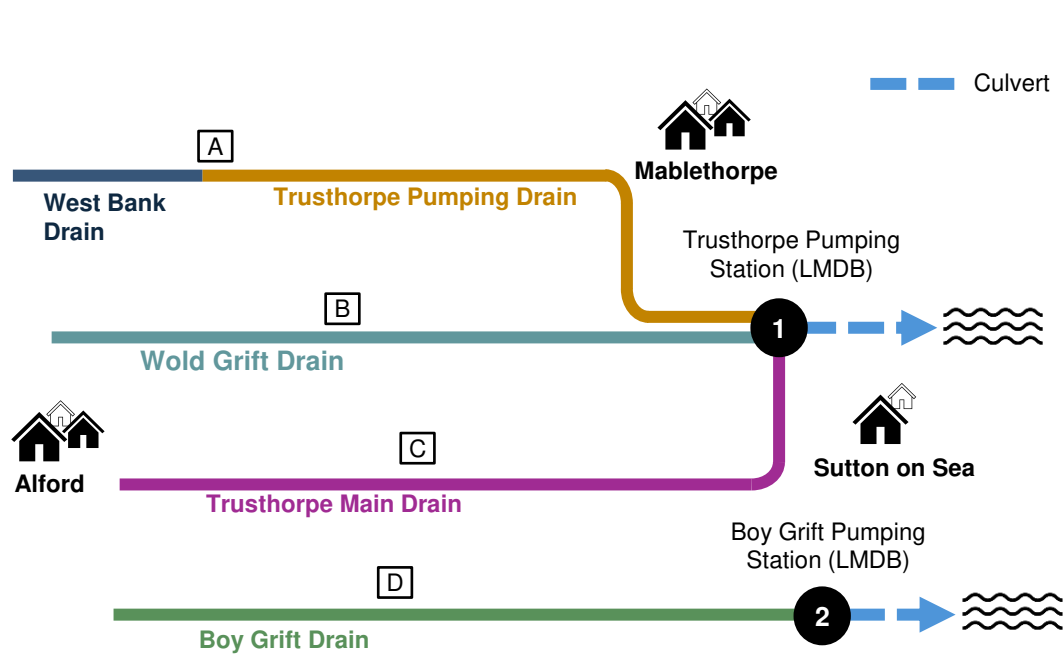
Trusthorpe Pump Drain, Wold Grift Drain & Boygrift Drain

The Wold Grift Drain is not embanked as it passes through Alford. From Alford, it passes through agricultural land with raised earth embankments beginning at Maltby le Marsh as the hydraulic gradient of the system reduces on the coastal floodplain. From the Mablethorpe Sewage Works, the Wold Grift Drain continues parallel to the LMDB Trusthorpe Pumping Drain system. The Wold Grift Drain discharges through a screened gravity outfall at Trusthorpe and into the Trusthorpe tunnel under the sea defences. The Wold

Grift drain has a spill weir, so that if the drain is in tidelock or is over capacity, the LMDB receive the water into the Trusthorpe Pumping Station.

The Boy Grift Drain discharges through a pumped outfall via a culvert onto the beach south of Sandilands.

Mablethorpe has been identified as a flood risk area (FRA) by the Environment Agency, covering an area from Mablethorpe to Sutton on Sea.



Legend			
			LMDB: Lindsey Marsh Drainage Board

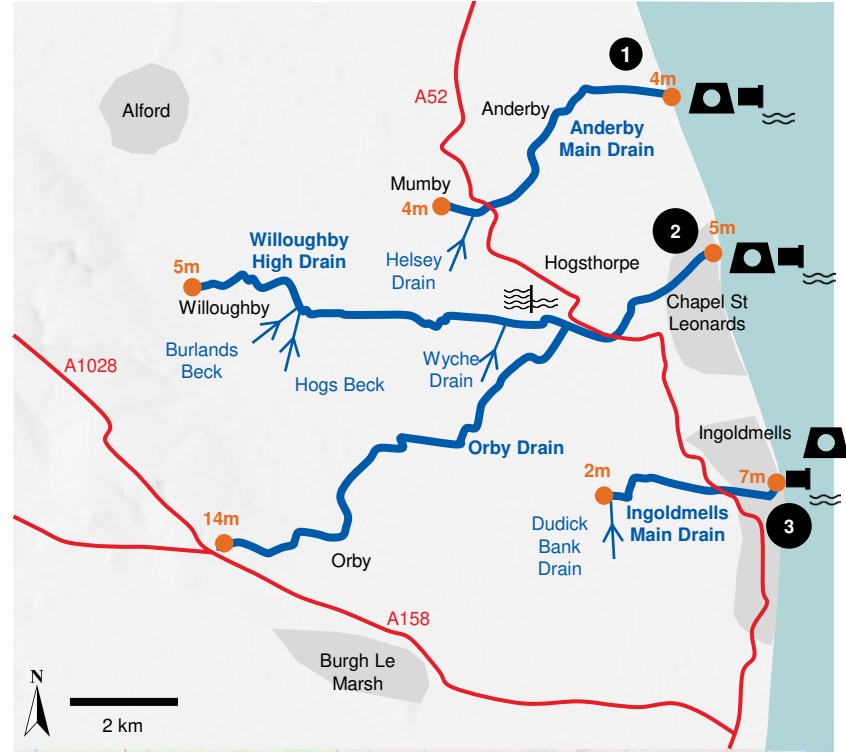
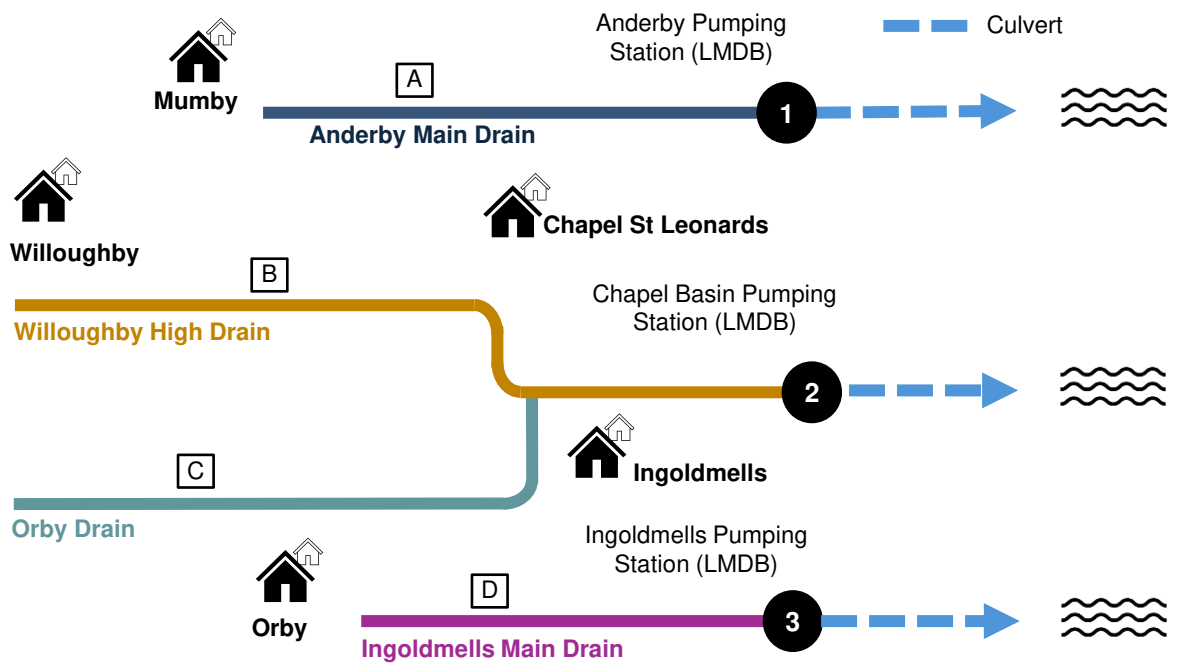
Middle Catchments

Anderby Main Drain, Willoughby High Drain, Ingoldmells Main Drain

The Willoughby High Drain has no embankments over its entire fluvial length and serves as agricultural drainage. At Chapel St Leonards, encroachment from gardens has left much of the channel inaccessible, reducing maintenance options. There is a small weir before the confluence with the Orby Drain. The Willoughby High Drain terminates at the Chapel Pumping Station which discharges into a tidal basin. Gravity discharge through timber pointing doors is possible if

the beach levels are sufficiently low and there is a guillotine gate before the gravity outfall to artificially set water levels in the Willoughby High Drain.

The Ingoldmells Main Drain passes through the Ingoldmells Pumping Station, there is a tidal basin (embanked to tide levels) downstream of the pumping station. The water then discharges through an outfall on the beach at Ingoldmells Point.



Legend

Culvert	Outfall	Trash Screen	LMDB: Lindsey Marsh Drainage Board
Tidal Gate	Weir	Sluice Gate	
Pumping Station	Sea		

Southern Catchments

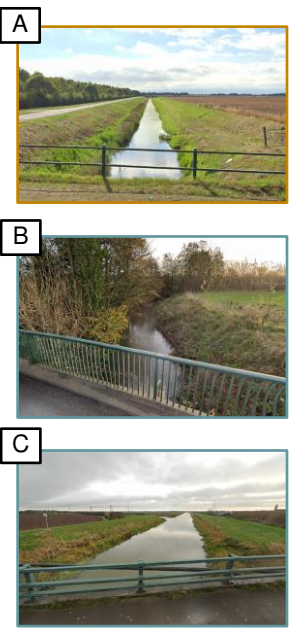
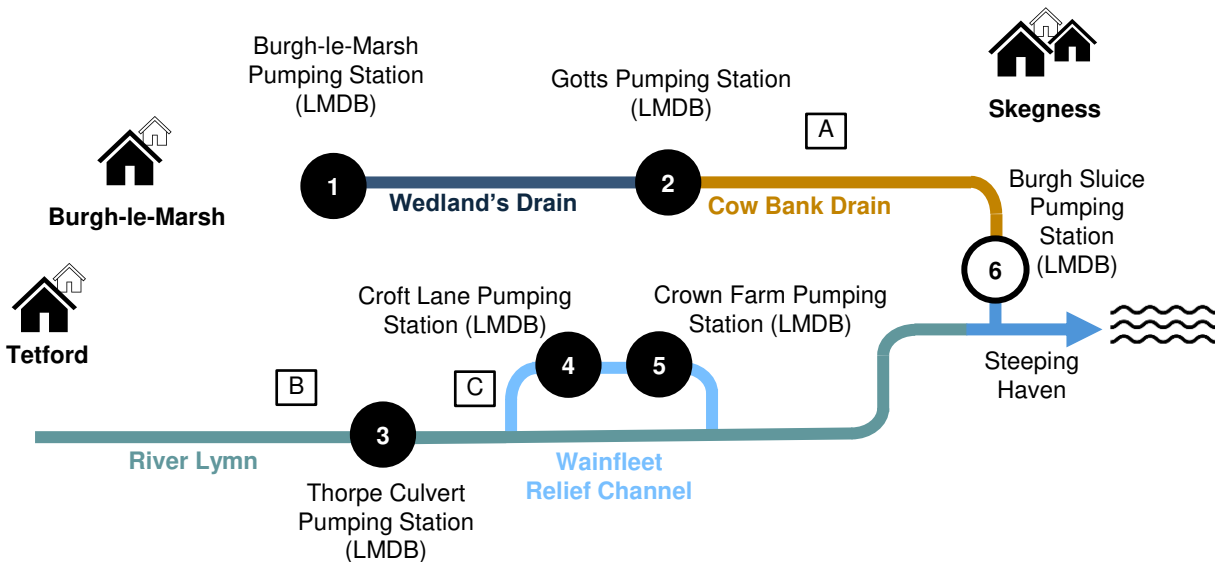
Wedlands and North Drains, Cow Bank Drain, Lymn/Steeping River

The River Lymn begins on the eastern slope of the Lincolnshire Wolds. It flows south-eastwards to the Lincolnshire Marsh where it becomes known as the Steeping River at the village of Great Steeping. The Steeping River drains almost 200 km² of the Wolds with extensive areas of reclaimed peat and marshland. In the 1970s, the Wainfleet flood relief channel was built to reduce the risk of flooding. When river levels are high, the relief channel splits the flow of the Steeping River. In June 2019, significant rainfall caused extensive overtopping which resulted in a breach in the bank of the relief channel⁵.

The river system contains syphons that pass under the main river and sluices which constrict the flow; there are

also periods of tide locking. Siltation is caused by agricultural sediment entering the river, if the silt is below the cill level at Burgh Sluice, then it is immaterial to system performance. Dredging was carried out in 2020 to remove silt from the riverbed. Water levels are kept at a higher-level during summer to facilitate water abstraction. Areas of the riverbank are grazed by cattle which can weaken the bank, causing erosion and susceptibility to breaching.

The Steeping River splits into a tidal river channel and the Burgh Sluice Relief Channel. The Cow Bank drain discharges into Steeping Haven though the Burgh Sluice Pumping Station further downstream into a channel through the saltmarshes at Gibraltar Point.



Legend

Culvert	Outfall	Trash Screen	LMDB: Lindsey Marsh Drainage Board
Tidal Gate	Weir	Sluice Gate	
Pumping Station	Sea		

Tidal Outfalls

Main rivers and inland drainage discharging into the sea

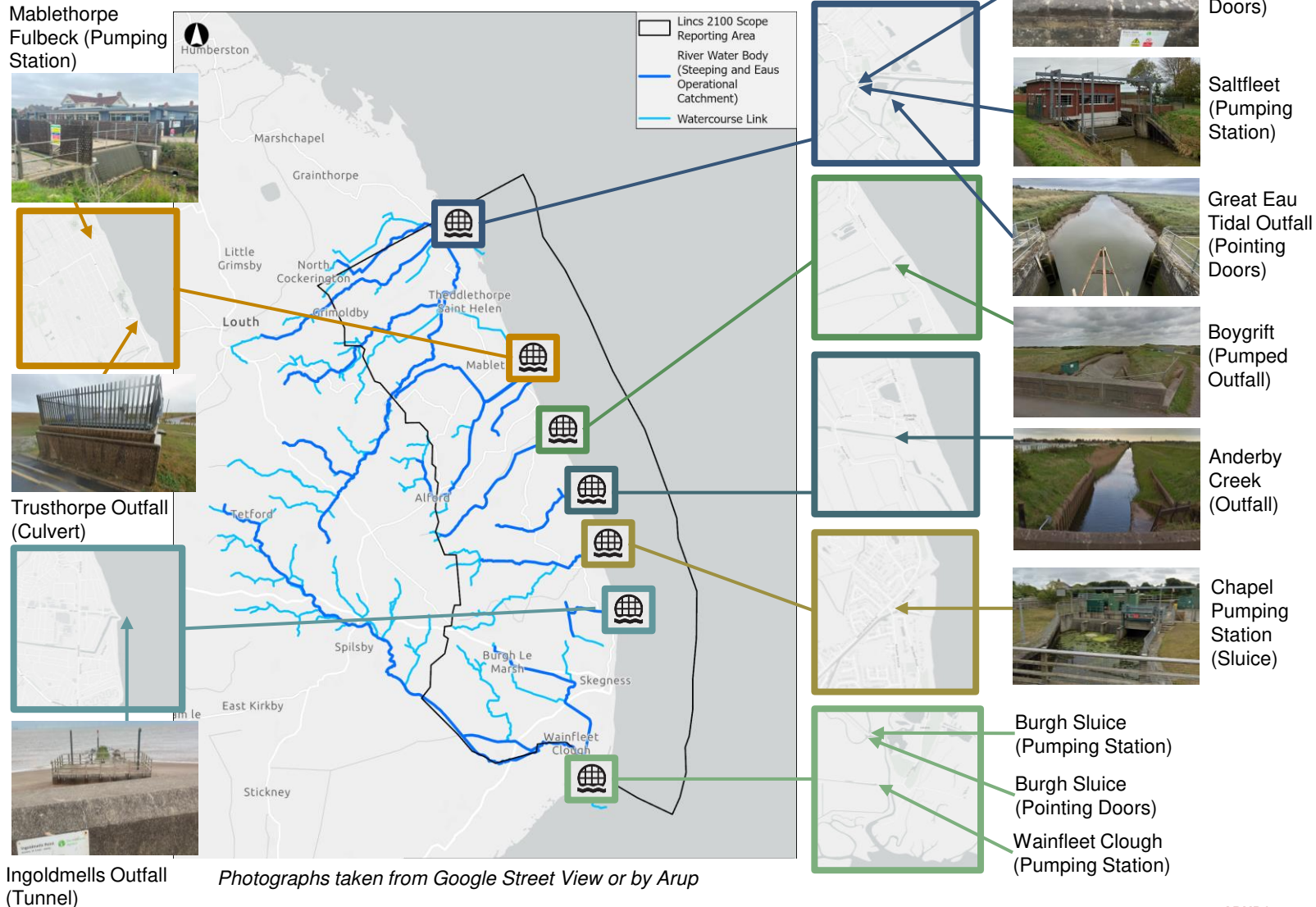
There are 12 tidal outfalls along the Lincolnshire coast. The outfalls are where the main rivers and inland drainage network flow into the North Sea. Ten of these assets are maintained by the Environment Agency, the remaining two (Burgh Sluice, Saltfleet Pumping Station) are maintained by the Lindsey Marsh Drainage Board (LMDB).

There are different types of outfall structures depending on the surrounding environment at each outfall location. Pointing doors close together to form a point to resist the pressure of water (also known as mitre gates). At several locations, the water enters a culvert before discharging into the sea closer to the low water mark.

Tidal locking occurs when the elevated sea level at high tide prevents the water to flow into the sea. With sea level rise, the duration of tidal locking will be longer.

The Environment Agency has completed schemes at tidal outfalls to improve their capability based on previous performance:

- The 'Trusthorpe Outfall Improvements' project, completed in 2021, included the installation of a new electronically operated control structure to prevent sea water flooding inland. This was after the Trusthorpe airshaft was overtopped in the 2013 storm surge.
- The 'Ingoldmells Outfall Chamber Improvements', completed in 2020, was undertaken to prevent sand ingress which could have blocked the outfall and prevented the fluvial system discharging to the sea. The tidal basin embankments were also refurbished following blockage of the tunnel in 2017.



Conclusion

Strengths, Weaknesses, Opportunities and Threats

Strengths

- **Established drainage network:** the drainage system is maintained effectively by the well-established LMDB.
- **Drainage optimised for agriculture:** drainage of fields has been optimised to ensure crops survive, minor drains border fields and flow into major drains.
- **Permeable ground conditions:** rural landscape with small settlements, very few impervious urban surfaces.

Weaknesses

- **Drainage channel embankments:** the channels are often embanked by the excavated material which may not offer the same protection as modern flood defences.
- **Siltation in the drainage system due to constrictions and tide locking:** constrictions such as syphons and sluice gates and the low hydraulic head slow water flow. Tide locking reduces the discharge time window.
- **Little tree coverage:** the county of Lincolnshire only has 4% tree cover⁶, compared to the national average of 13%, this results in saturated ground and rapid surface run-off during rainfall events.
- **High cost of internal drainage for councils:** in 2023, for every £1 East Lindsey District Council received in council tax, 65p was spent on internal drainage boards⁷.
- **Drainage dependent on engineered infrastructure:** pumping stations are energy intensive and use non-renewable energy sources (e.g. diesel).

- **Standing charges for energy:** costly for pumping stations that are used infrequently but are vital during heavy rainfall events.

Opportunities

- **Nature-based solutions:** rural landscape is well suited to the implementation of nature-based solutions, but these may require a steeper hydraulic gradient to capture and slow water.
- **Tree planting:** planting trees would increase interception and infiltration rates, but tree cover should be considered with the Local Character Area and consideration should be made of the impact on peat layers in the soil.
- **Increasing biodiversity:** the use of nature-based solutions will increase biodiversity in the rural environment where it can thrive.

Threats

- **Climate change:** sea level rise will increase duration of tide locking and more severe rainfall events will increase demand on the drainage network.
- **Rising costs for internal drainage boards (IDBs):** costs for IDBs have risen by an average of 28% from 2022-23 to 2023-24⁸, due to higher energy and fuel prices, increasingly extreme wet weather events and inflationary increases.
- **Cuts to other council services due to rising internal drainage costs:** councils are unable to increase tax in

line with increasing costs for IDBs due to government restrictions which could lead to cuts to other services. Government subsidies have mitigated this in the past.



Great Eau Tidal Outfall (photograph by Arup)



Hydrogeology

Photo of chalk stream in Lincolnshire

Hydrogeology

Geological setting

The Lincolnshire Coastline is characterised by sequences of Jurassic and Cretaceous aged bedrock units overlain by Quaternary Glacial and Estuarine sediments.

Superficial Deposits

Nearest the surface, the Lincolnshire Coast study area is underlain by Quaternary aged sediments that were deposited during previous ice ages, and which comprise of Glacial Till and Glacial Sand and Gravel Deposits. Nearer to the coast, these Glacial sediments are overlain by more recent Estuarine and Tidal flat deposits which typically comprise of silty material and peat beds.

Directly along the coast, recent wind-blown sand and beach deposits are present. In some areas these coastal deposits form part of SSSI (Gibraltar Point, Saltfleetby-Theddlethorpe Dunes) and Ramsar sites (Humber Estuary).

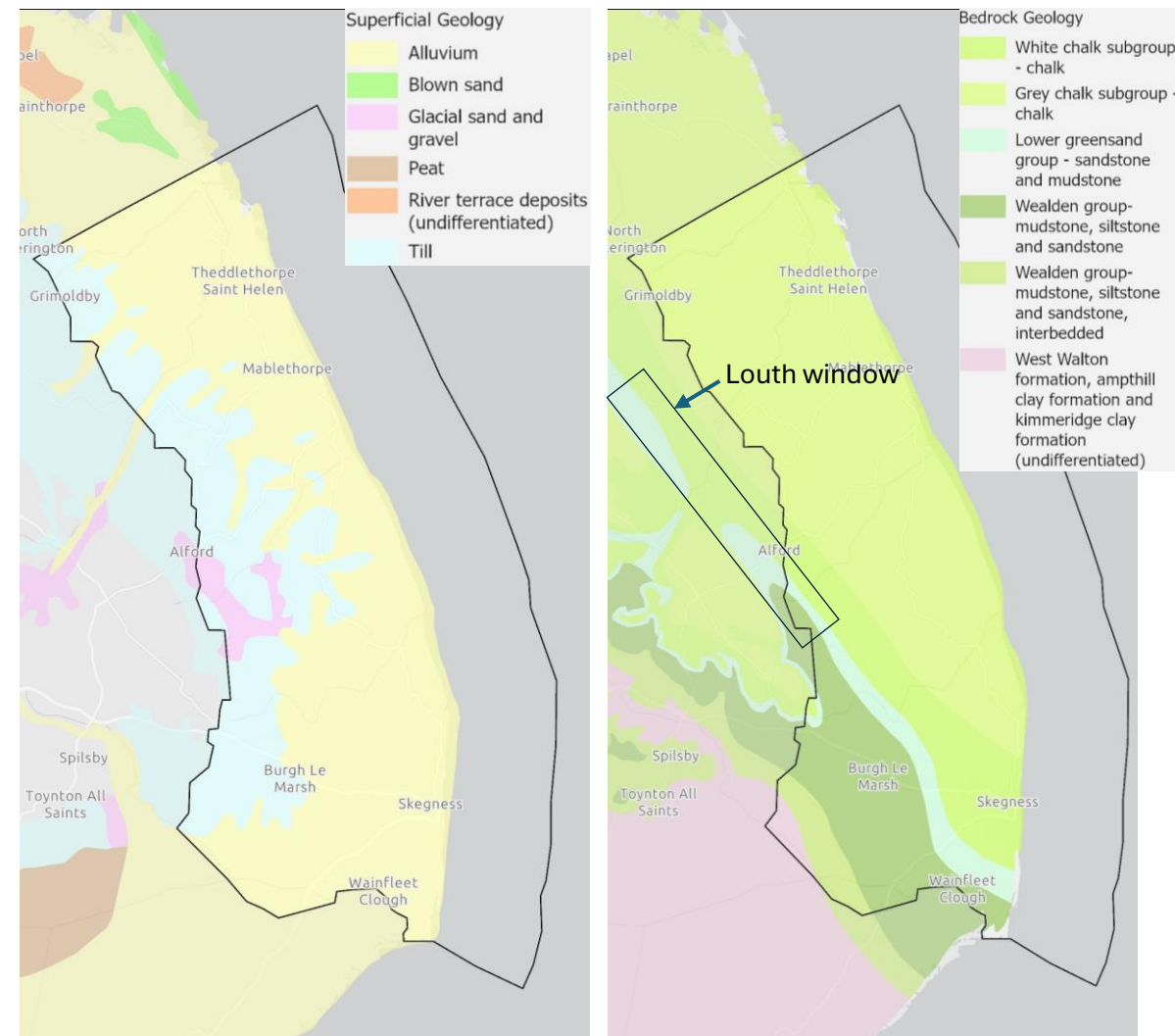
Bedrock Geology

Beneath the superficial deposits, most of the Lincolnshire Coast study area is underlain by the Cretaceous aged Lincolnshire Chalk which comprises of Ferriby, Welton, Burnham, and Flamborough Chalk Formations.

To the south of the study area, West of Skegness and North of Wainfleet All Saints, the Chalk is absent and older strata underly the Superficial Deposits. These strata comprise of the Roach and Carstone Sandstone, the Claxyby Ironstone and the Spilsby Sandstone Formations. Jurassic aged Kimmeridge Clay is found along the very southern edge of the study area. These strata are also present below the Chalk strata elsewhere in the study area.

The bedrock structural geology is relatively simple resulting from uplift during the Cretaceous and Palaeogene. This resulted in a gentle tilting of the bedrock leading to a regional dip of bedrock units to the northeast at an angle of around one to two degrees. Minor folding and faulting are common throughout the Chalk bedrock.

During the Quaternary the land surface was modified significantly by glacial erosion and deposition. Erosion during this period has led to the chalk underlying much of the study area becoming disconnected from the Chalk Formation further west. This feature known as the Louth window has a significant bearing on the hydrogeology within study area.



1:625k Geological Mapping - Superficial (left) and Bedrock (right) Geology ¹

Hydrogeology

Aquifer systems

Principal Aquifers

Principal aquifers are defined as those which provide significant quantities of drinking water, and water for business needs. They may also support rivers, lakes and wetlands.

The Lincolnshire Chalk system forms a Principal aquifer unit beneath most of the Lincolnshire study area. The Spilsby Sandstone and Carstone Sandstone Formations located to the south of the study area (and below the chalk elsewhere) are also classified as a Principal Aquifers.

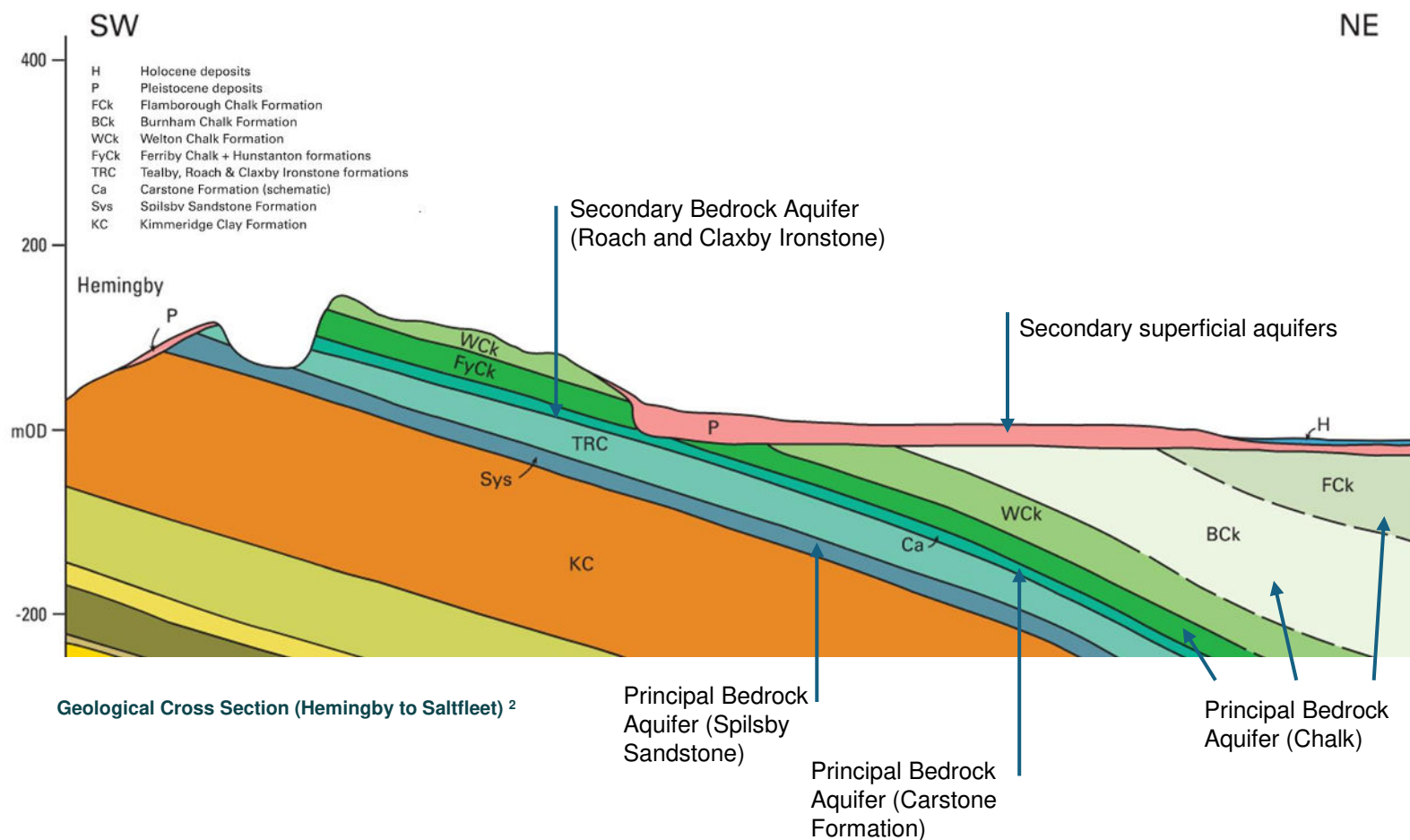
Secondary Aquifers

Secondary A Aquifers are those which comprise permeable layers that support local water supplies. Secondary A aquifers beneath the Lincolnshire Coast study area include the Roach Formation (bedrock), Glacial Sand and Gravels (superficial), and wind-blown sand (superficial).

Secondary B Aquifers are lower permeability layers that may store and yield limited amount of groundwater. Secondary B aquifers include the Roach and Claxby Ironstone Formation (bedrock)

Glacial Till (superficial) and Beach Deposits (superficial) are classified as Secondary undifferentiated aquifers.

Estuarine and tidal flat deposits are classified as unproductive strata owing to their fine-grained low permeability nature.



Hydrogeology

Aquifer systems

The Chalk groundwater system which includes the Chalk Formation and adjacent permeable strata such as the Carstone and Roach Formations, are a highly transmissive aquifer system which are utilised for public and private water supplies at many locations within the study area.

The Chalk aquifer system is confined in the study area because of the overlying lower permeability superficial deposits. Recharge to the Chalk aquifer generally occurs to the west, in the Lincolnshire Wolds, where the Chalk outcrops. Chalk streams form on the Lincolnshire Wolds and discharge from these streams continues across the lower lying Lincolnshire Marshes.

In the study area the Chalk aquifer system is disconnected from the Chalk outcrop to the west because of historic erosion of the chalk along a former shoreline (Louth Window). Where groundwater would typically flow laterally eastwards through the aquifer towards the coast it is thought that in the disconnected Chalk block, groundwater may be transferred through recharge from the underlying formations or through overlying Quaternary deposits via spring flows³.

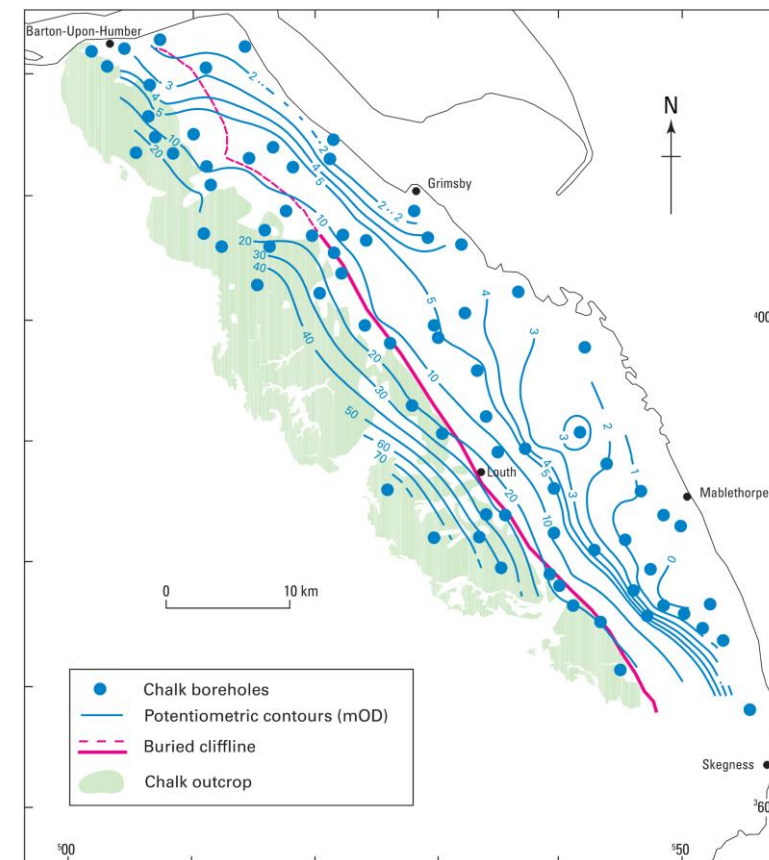
Groundwater discharge from the aquifer ultimately occurs through upward diffuse seepage to spring-fed wetlands, submarine groundwater discharge to the North Sea, and to groundwater abstractions from the Chalk. Blow wells are a feature of the Lincolnshire lowlands and occur where Chalk groundwater flows upward through thinner superficial deposits and discharges at the surface⁴. There are no mapped blow well locations within the study area with most

being located to the north of the study area. Running sands may be present in superficial deposits due to the upward flow of water from the underlying aquifers.

Groundwater levels in the Chalk aquifer (inset) are close to sea level around the coastal areas with the groundwater level (piezometric level) increasing in a westerly direction². Groundwater levels across most of the study area are likely to be lower than 10mOD but are likely to be seasonally variable. Groundwater levels will also be affected by groundwater abstraction from the aquifer.

The quality of groundwater in the Lincolnshire Chalk system is variable. Generally, the water quality is good however there are issues with elevated nitrate concentrations resulting from agriculture sources, and elevated arsenic and iron concentrations exist in some parts of the aquifer. Closer to the coast, groundwater may be affected by salinity because of interaction with seawater².

Groundwater levels and quality within Secondary superficial aquifers is expected to be highly variable due to the variable extent of the sediments and material types.



Chalk Aquifer groundwater levels ²

Hydrogeology

Groundwater management and risks

WER status

The Lincolnshire Coast study area is located within the South Lincolnshire Chalk Unit (Water Environment (Water Framework Directive) Regulations). Based on the Cycle 3 (2021) classification the groundwater body has a Poor overall status. The groundwater body has Good quantitative status and Poor chemical status. The reason for not achieving good status is given as pollution from agriculture and rural land management from diffuse pollution⁵.

Groundwater availability

The Steeping, Great Eau & Long Eau Abstraction Licensing Strategy⁶ indicates that the groundwater unit balance shows more groundwater has been abstracted based on recent amounts than the amount available. This means that the Environment Agency will not grant further consumptive groundwater abstraction licenses within the Lincolnshire Chalk and Spilsby Sandstone groundwater body.

Groundwater vulnerability and saline intrusion

The vulnerability of groundwater within the study area is generally low to medium-high⁷. Areas classified as low vulnerability generally correspond to low permeability superficial deposits which buffer the underlying Principal Aquifer from the risk of contamination. Areas of medium and medium –high vulnerability correspond to higher permeability superficial deposits such as Glacial Sand and Gravels and Blown Sand deposits. Much of the study area has source protection zones denoting areas of additional protection around public supply groundwater abstractions (inset).

Saline intrusion is a significant issue for parts of the

Lincolnshire Chalk aquifer system, particularly along coastal areas. The principal causes of saline intrusion historically was from increased groundwater abstraction in coastal towns such as Grimsby, resulting from rapid industrial growth between the 1950s and 1970s. Lowering of groundwater levels near to the coast led to the movement of saline water into the aquifer leading to the salinisation of groundwater in some areas³.

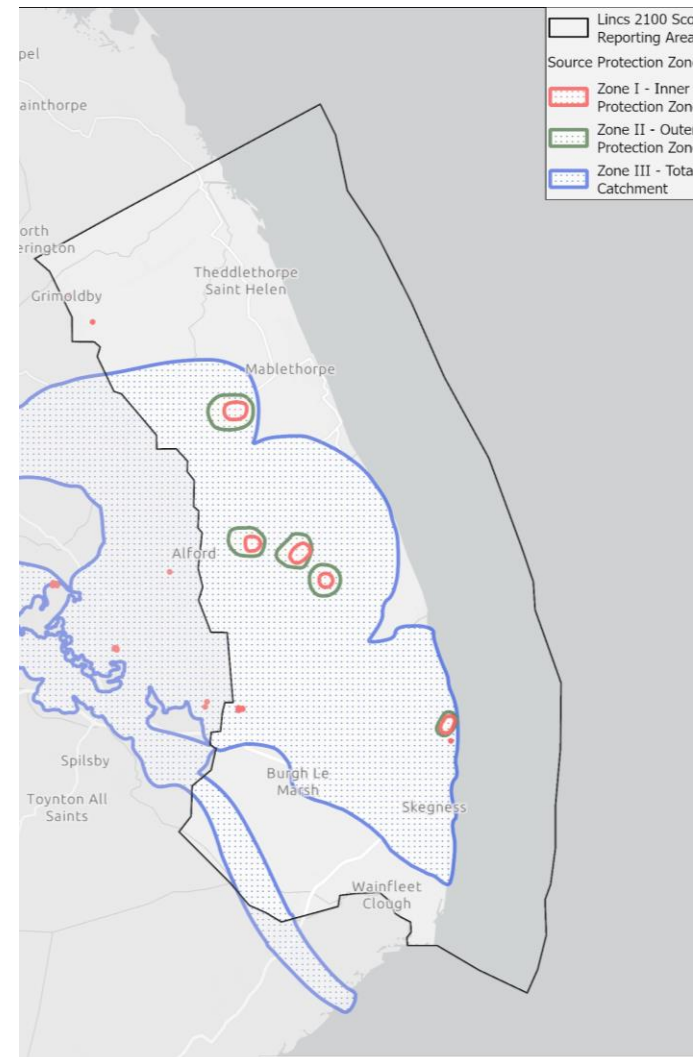
Management strategies were introduced in the 1960s onwards to encourage more efficient use of groundwater and to limit the impact of over abstraction and saline intrusion of the aquifer. Saline intrusion poses a risk to freshwater resources, agricultural productivity, and biodiversity of aquatic ecosystems.

Climate Change

The impacts of anthropogenic climate change are likely to have direct impacts on groundwater in the study area. Modifications to the patterns of rainfall and evapotranspiration are likely to impact recharge to groundwater systems which may lead to changes in groundwater levels and quality.

Changes in precipitation and recharge are projected to decline significantly in summer and autumn and increase in winter and spring⁷. The overall impact on groundwater levels as a result could lead to declining groundwater levels.

Additionally, changes to sea level which are projected to increase because of climate change could potentially lead to increased risk of saline intrusion to the chalk aquifer and saline inundation of shallow groundwater due to coastal flooding. These impacts are likely to be greatest in coastal areas.



Public Water Supply Source Protection Zones⁸

Hydrogeology

Strengths, Weaknesses, Opportunities and Threats

Strengths

- **Groundwater resource** - most of the study area is underlain by Principal bedrock aquifer systems which provide access to high yielding and good quality groundwater resource.
- **Low groundwater vulnerability** – The Principal aquifer system within the study area is covered by significant thickness of superficial deposits reducing the vulnerability of the groundwater resource to surface contamination and pollution.
- **Potential groundwater dependent habitat** – Potentially groundwater dependent SSSI and Ramsar sites within study area that are valuable natural habitats.

Weakness

- **Groundwater resource availability** – Groundwater resource management indicates that groundwater is currently over abstracted within the groundwater unit. This means that the EA will not approve any new consumptive groundwater abstraction licences.
- **Water Framework Directive classification** – the groundwater body currently has a poor overall classification as a result of its poor chemical status, resulting from agricultural and rural diffuse pollution.
- **Proximity to coast** – large proportions of the groundwater resource are close to the coast and are likely to be sensitive to changes to water balance between freshwater recharge and sea level.

- **Nature based solutions** – protection of chalk fed streams and rivers, wetland creation and benefit to shallow groundwater systems, improvements in quality of recharge to groundwater systems.
- **Protecting groundwater dependent habitats** – Protection of potentially groundwater dependent habitats (Ramsar and SSSI sites)
- **Groundwater resource management** – improving water efficiency and reduction of groundwater abstraction to manage impacts from saline intrusion.
- **Groundwater resource utilisation** – opportunities for non-consumptive groundwater use for heating and cooling (ground energy), managed aquifer recharge.

Threats

- **Climate Change** – climate change has the potential to affect groundwater levels and quality of aquifers in the study area resulting from changes to rainfall and evapotranspiration patterns.
- **Salinity threats** – The risk of saline intrusion impacting groundwater quality. Shallow aquifers are also at risk from saline inundation from coastal flooding and sea level rise.
- **Over abstraction** – continued over abstraction in the groundwater unit impacting on groundwater levels and quality
- **Contamination** – Impacts on groundwater quality from diffuse agricultural pollution (nitrates, pesticides).



Water Supply

Water Supply

Overview

The Lincolnshire Coast 2100+ study area is supplied in its entirety by Anglian Water. The Lincolnshire Coast 2100+ area is specifically within Anglian Waters Lincolnshire East Water Resources Zone (WRZ) (inset).

Anglian Water's latest Water Resources Management Plan (WRMP) is referred to as WRMP24 and covers the planned activities in the period 2025 to 2030, with a forward look to 2050.

According to WRMP24, the Lincolnshire East WRZ covers an area of 2,785 km², which stretches from the Humber to the Wash and is based on the water supply systems for Grimsby, Louth, Skegness, and Boston.

The plan also states that the supplies are primarily groundwater abstractions from the Lincolnshire Chalk, Lincolnshire Limestone and Spilsby Sandstone. There is also a surface water abstraction from the Louth Canal into the Covenham pumped storage reservoir which is located about 10 km inland.

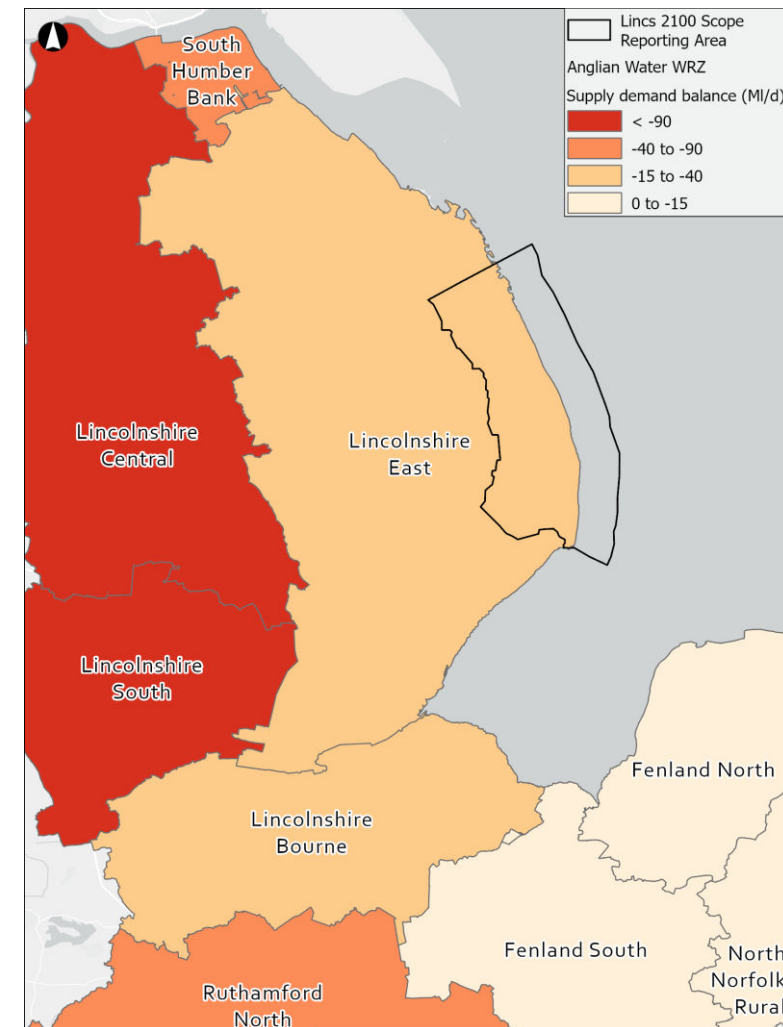
Anglian Water's WRMP24 identifies five key drivers for its WRMP24 across its supply area. These are:

1. Growth in demand, primarily due to population and housing.
2. The impacts of climate change on both water supply and water demand.
3. A water sector requirement for all water companies to be resilient to a 1 in 500-year drought.

4. Water supply abstraction licence reductions, for environmental reasons (referred to as Sustainability Reductions).
5. Environmental destination requirements, which take a longer-term planning approach to help drive cost efficient water resources solutions and avoid environmental damage before it occurs.

Of the five drivers, only 1, 4 and 5 apply to Lincolnshire East WRZ.

Anglian Water's WRMP24 indicates that the Lincolnshire East WRZ is likely to have a supply deficit of 15 – 40 MI/d that needs to be addressed through the company's plan.



Anglian Water WRZ showing Supply demand balance (MI/d)¹

Water Supply

Supply-Demand Balance to 2050¹

It is estimated that water available for supply in Lincolnshire East WRZ in the baseline and final planning scenarios ranges from 131 to 115 MI/d respectively. Both are forecast to reduce by 2050, by 33% and 11% respectively. Licence reductions for environmental reasons will reduce water available for supply by 33 MI/d by 2050, while abstraction reductions to achieve environmental destination will contribute to a 17 MI/d loss of water supply.

Over the WRMP24 period, the population in Lincolnshire East WRZ is forecast to grow by 8.8% from about 394,000 in 2025 to about 428,000 by 2050. Similarly, the number of properties Anglian Water expects to serve in the WRZ will grow by about 14% by 2050, from about 188,600 in 2025.

Population and housing growth will both increase the domestic water supply required over the 25 years to 2050.

On the other hand, Anglian Water projects non-domestic demand in Lincolnshire East WRZ to fall from about 37 MI/d in 2025 to 33.5 MI/d by 2050, a 9.96% reduction.

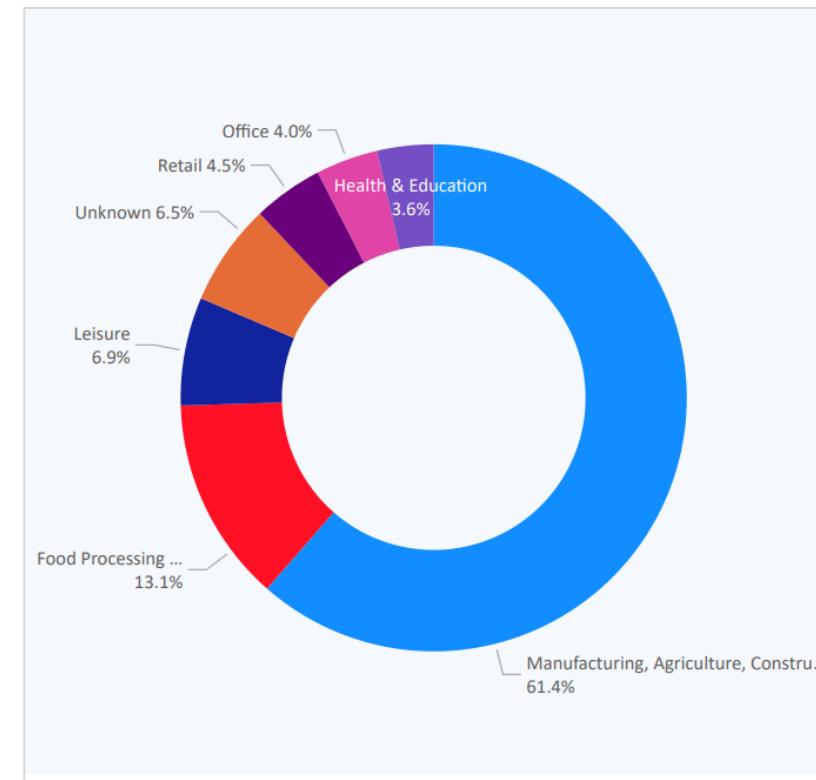
The following are the key water supply interventions that Anglian Water is planning for the WRZ between 2025 and 2050 to maintain the supply-demand balance:

- Groundwater resource enhanced options
- Adjustment to surface water export to Lincolnshire Central WRZ
- New 60 MI/d non-potable water desalination plant
- Potential new 50 MI/d potable water desalination plant at Mablethorpe (subject to WINEP investigations).

The proposed Lincolnshire Reservoir in South Lincolnshire could also support water supply needs in Lincolnshire East WRZ, although it is primarily being constructed to meet water demands further south.



Planned water supply interventions in Lincolnshire East WRZ to 2050¹



Breakdown of existing non-domestic demand in Lincolnshire East WRZ ¹

Water Supply

Strengths, Weaknesses, Opportunities and Threats

Strengths

- Single supply company covers the area, so there are fewer interfaces required within the water sector.

Weakness

- Local groundwater sources are over abstracted, and licence reductions are expected between 2025 and 2050 (up to 50 MI/d)
- Anglian Water's plans for non-domestic water supply are less developed than plans for domestic supply.
- Anglian Water's WRMP24 estimates a 9.9% decrease in non-domestic demand by 2050, whereas anecdotal evidence suggests there is significant potential for growth, particularly in the South Humber.

Opportunities

- Lincolnshire Reservoir – Proposed strategic water supply reservoir located near Sleaford and Boston, helping to provide a local source of supply.
- Potential to consider the use of drained water for water supply (toxins from agriculture dependant).
- Proposed 50 MI/d desalination plant in Mablethorpe by 2040.
- Proposed 60 MI/d desalination plant to meet non-domestic water needs (2040)
- Potential to utilise inland drainage water that currently drains to the North Sea.

Threats

- New water resources – competing demand for water from southern areas of AW supply area
- Local growth in domestic demand.
- Local significant growth in non-domestic demand, primarily industry
- Anglian Water is one of most affected companies in England in terms of Sustainability Reductions and Environmental Destination aspirations.
- Anglian Water forecasts a significant deficit of 593 MI/d by 2050.
- Water companies have a legal obligation for provision of water for domestic supply, but not for non-domestic supply.



Wastewater

Wastewater

Overview

Wastewater and drainage network

Anglian Water manages the wastewater network in this region. Twelve wastewater catchments are fully or partially within the study area. These twelve wastewater catchments have a total population of 76,356 as of 2021. These catchments drain to water recycling centres (WRC).

The sewerage network is required to remain functional to drain sewage away from homes and businesses and treat it. Flooding threatens this by overwhelming sewer systems and locking outfalls, as well as increasing the risk of electrical and mechanical failures of pumps and treatment plant.

The Cycle 1 Drainage and Wastewater Management Plan (DWMP) published in 2023 sets out catchment-scale risks and plans for the sewer network.¹

Relevant risks

Anglian Water has identified key risks within their sewer catchments. Relevant risks:

- Escape from sewers, including:
 - Storm overflows – diluted, untreated sewage spilling from the sewer into culverts, rivers and the sea. This would be in periods of heavy or sustained rain. These can have adverse ecological impacts and increase the health risks to those bathing or surfing on the beaches.
 - Sewage flooding from manholes and into homes or businesses, again in periods of heavy or sustained rain and flooding. This can have significant impacts on people, with potential health risks as well as the emotional and financial impact.

- Increased risk of tide locking outfalls – in a combination event of heavy rainfall and a high spring tide, treated or spilling sewage would not be able to exit the sewer system. This could lead to operational failures at the WRC, sewer flooding, and pollution incidents.
- Compliance with permits – failure to comply would increase the environmental impact of the water recycling process.

Flood risk protection strategy

Anglian Water's company-wide flood protection strategy focuses on collaborative working. Long-term solutions are planned to redirect rainwater from the sewer system, based on the water industry national environment plan (WINEP) and funding agreed by the economic regulator (OfWat). Sewer unblocking and reducing infiltration reduces flood risk in the short term.

Ingoldmells WRC (which takes sewage from Skegness) has been identified as a top 34 surface water management catchment, designated to remove surface water from sewers to reduce the flood risk.² Significant investment has gone into assessing the flood risk at all of Anglian Water's sewerage assets and implementing risk reduction measures on a priority basis.

Total – based on wastewater catchments fully or partially within study area	Value
2021 population- sewage treatment (total)	76,356
2035 population (total)	78,875
2050 population (total)	82,922
Number of high-risk WRCs identified in DWMP C1	2
Number of medium-risk WRCs identified in DWMP C1	3
Number of lower-risk WRCs identified in DWMP C1	7

Wastewater

Strengths, Weaknesses, Opportunities and Threats

Strengths

- Anglian Water have carried out detailed flood risk analysis and are planning for flood risk protection strategy in 2025-2030 period.
- Investment in surface water removal, increasing resilience of sewer network to heavy rainfall
- Emergency response plans at key assets
- Risk tool to assess real-time flooding and pollution risk

Weakness

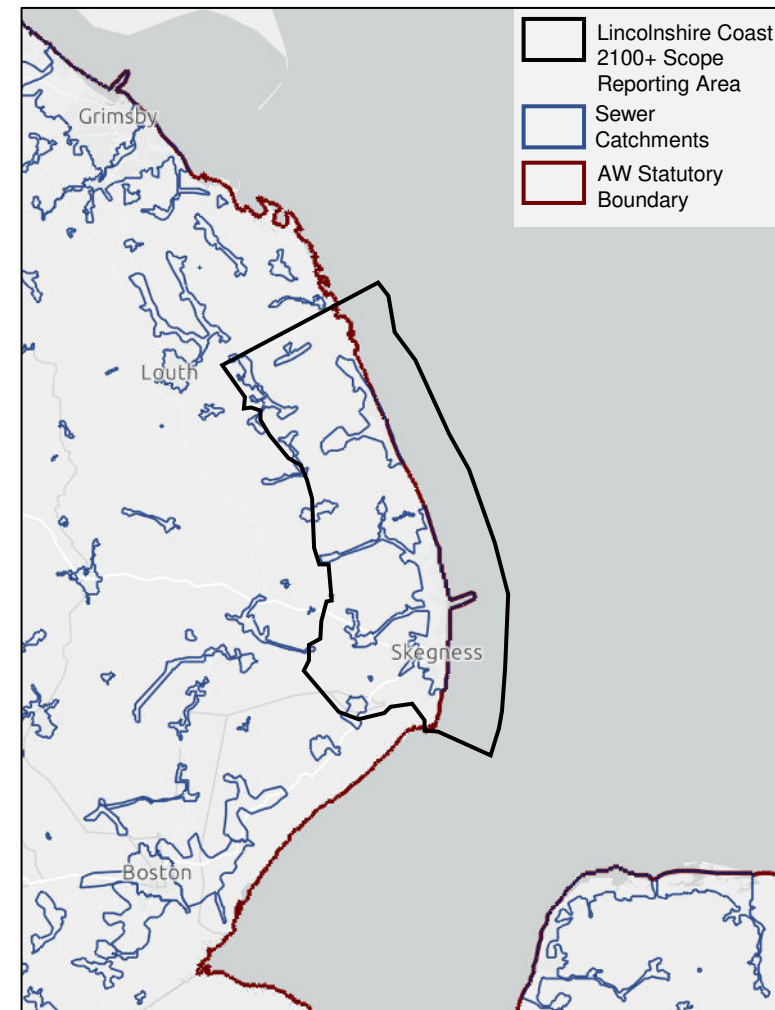
- Tourist nature of catchment – challenging operational environment
- Flat nature of catchment – reliance on pumping – increased risk from flooding
- Five-year nature of funding – decisions made for majority of spend until 2030
- Most sewage treatment above ground and susceptible to flooding

Opportunities

- Increased funding in 2025-2030 period and onwards – large focus on reducing use of storm overflows will increase capacity and resilience in networks and reduce risks from hydraulic overload
- DWMP Cycle 2 (carried out over next two years) mandated to consider flooding and coastal erosion

Threats

- Additional connections to the sewer system with local development
- Not all manholes and assets can be sealed/flood-proofed – given number of and access to manholes, as well as system design
- Likelihood of infiltration into sections of sewer network – continued overload even after flooding recedes
- Flood planning generally not taking into account saline water flooding – long-term damage to equipment and treatment processes



Anglian Water (AW) Sewer Catchments in Lincolnshire Coast 2100+ area³



Transport

Access

Road network

Overview

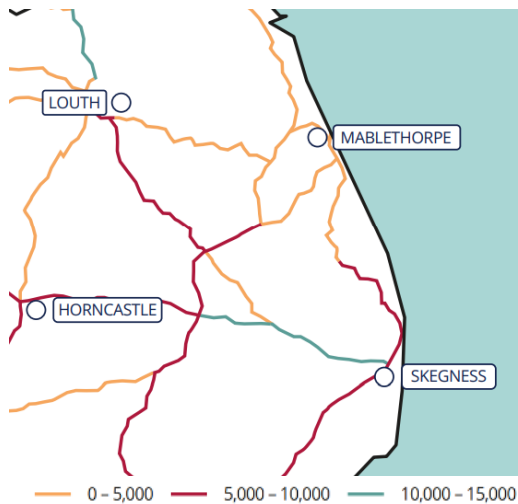
The study area includes several A-roads, with the A158 and A52 being the primary routes linking coastal towns to larger inland cities. The A158 connects Skegness with Spilsby, Horncastle and Lincoln, while the A52 continues along the coast, connecting Skegness to Boston and beyond. These roads provide vital access for local residents and are key to the local economy as they facilitate the movement of goods and access for tourists.

The A16 is a strategic route that lies beyond the study area and provides an important economic function for the agri-food sector, with broader connections to Grimsby, Louth and Boston. The A16 currently experiences peak hour congestion and delays, resulting in unreliable journey times, agricultural traffic with few passing locations, and high accident rates on the A16¹. In 2023, up to £20 million from the Levelling Up Fund was allocated to improve the A16 corridor between Boston and Spalding^{2,3}.

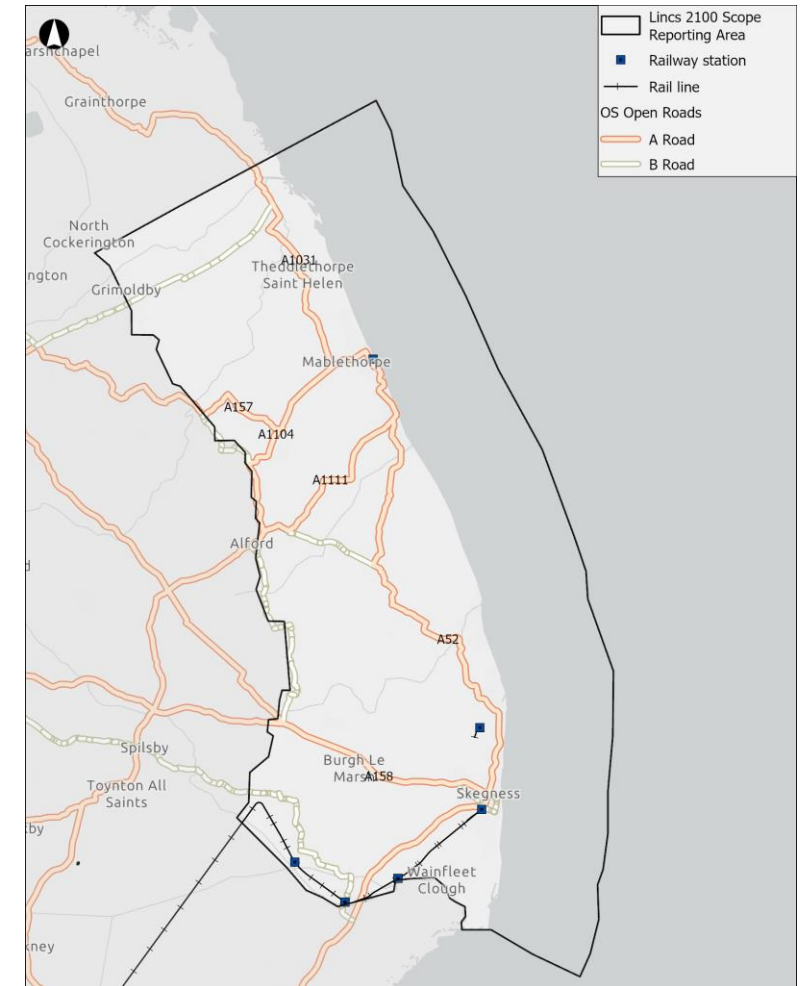
The area is not served by the Strategic Road (SRN), with the closest routes being the A180 which ends at Grimsby and A46 which ends at Lincoln. Many smaller B-roads and local routes connect rural towns and villages within the study area. Outside the main coastal areas, much of Lincolnshire is rural, roads are typically two-lane single carriageways. Some roads, however, can be narrow and winding in places making them prone to slower traffic, particularly on banks along the coast. However, they do provide scenic routes across the Lincolnshire Wolds.

The map below shows the 24-hour Annual Average Daily Traffic (AADT) flow for 2023⁴. The map shows the A158 is the most trafficked road in the area with traffic volumes of 10,000 – 15,000 in a day while traffic on roads surrounding Skegness to Chapel St Leonards record traffic volumes of 5,000-10,000.

The study area has a strong visitor economy that see over 1.68 million visitors during the summer months of July, August and September (2023)⁵. The road network is essential to support and facilitate this economy. During these months, there are reports of congestion and heavy traffic in the area, especially in towns such as Skegness and Mablethorpe.



24-hour AADT in 2023



Road network in the study area

Access

Highway improvements, EV's and Parking

Highway improvements

In December 2023, Lincolnshire County Council announced a total of £360M will be spent over the following five years on new infrastructure and road improvements. Two major projects have been identified within the study area:

1. Lincolnshire Coastal Highway⁶

This route comprise the A46 west of Lincoln and along the A158 to Skegness. It also includes the A57 from the County boundary to where it joins the A46 in Lincoln. The project aims to improve transport corridors to the Lincolnshire coast, support a range of economic sectors, both across the county and locally, and assist with supporting balanced growth, securing development and providing access and connectivity.

2. Coastal Carriageway Improvements⁷

The Coastal Carriageway improvement project will see the full carriageway reconstruction of the Roman Bank (from the A52 at Sandilands to the North Sea Observatory in Chapel St Leonards), including replacing streetlights, widening the road where possible, adding passing bays and the full carriageway reconstruction of A1104 between Mablethorpe and Malty-Le-Marsh.

Works aims to be completed by Spring 2025.

Electric Vehicle charging points (EVCP)

The Lincolnshire Electric Vehicle Strategy⁸ has identified that although there are EVCPs spread throughout the county, gaps exist, particularly in the more rural areas, such as the

current study area. There are 81 existing EVCP (2024) in East Lindsey and the strategy aims to increase this to 468 by 2030.

There is currently a relatively sparse provision of EVCP's with 23 within the study area⁹, all of these are within villages and towns, including 10 in Skegness, seven in Ingoldmells, two in Sutton on Sea, and four in Mablethorpe. This provision includes a mix of rapid, fast and slow chargers.

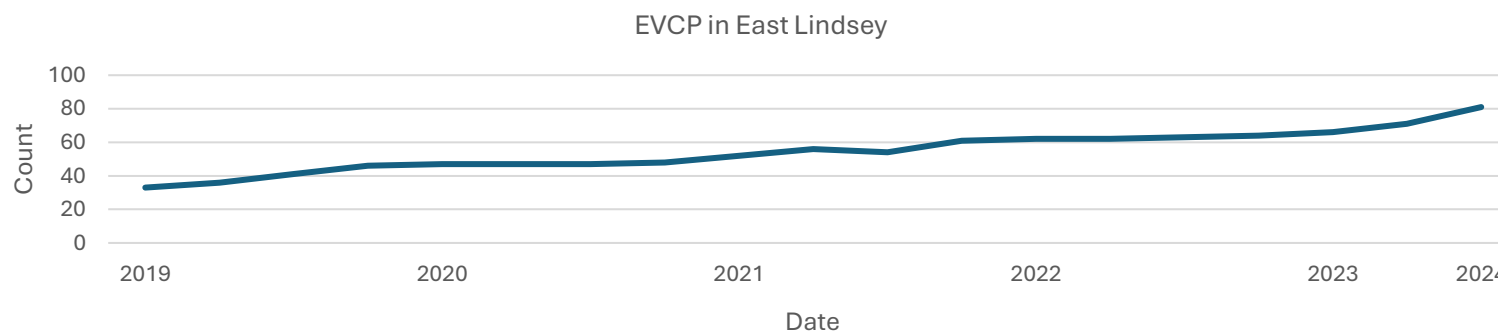
East Lindsey District Council installed EVCP's in response to the increase in electric vehicle ownership across the UK and district wide. It also aims to encourage more residents to explore the possibility of owning an electric vehicle, as well as making the area more accessible to visitors who drive electric vehicles.

In addition to EVCP, local authorities in the area will also explore other alternative low carbon fuels, such as hydrogen, which has been highlighted as potentially playing an important role, particularly for large vehicles that require longer ranges and faster refuelling.

Parking

East Lindsey District Council owns and maintain several paid car parks in the study area. There 10 in Skegness, two in Ingoldmells, three in Chapel St Leonards, two in Sutton-on-Sea and seven in Mablethorpe¹⁰.

As part of the Local Plan evidence, a car park survey¹¹ was conducted in Skegness in August 2018. The survey recorded that on-street car parking closer to the coast such as Scarborough Avenue, Rutland Road, and South Parade all recorded at over 90% full during the day for both weekend and weekday. Scarborough Avenue was the most consistently close to capacity throughout the day, with an average used capacity of 94%. The survey also highlighted that public car parking was busier on the weekends than on the weekdays, correlating strongly to Skegness' role as a leisure destination. It is worth noting that this numbers are pre-covid and travel patterns have changed since and more recent data is needed.



Access

Rail

Overview

The only rail service in the study area runs to Skegness, with services operated by East Midlands Railway. Skegness is the end of the line, and therefore is only served by trains towards Nottingham, which run only once per hour via Boston and Grantham. The average journey time by train from Skegness to Nottingham is 2 hours 4 minutes. There are up to 15 trains per day from Skegness to Nottingham. The first and last train leaves from Skegness to Nottingham at 07:07 and at 21:20, respectively¹².

Passenger rail usage data¹³ provided by the ORR (Office of Rail and Road) shows that there are circa 350,000 rail passengers in 2022/23 at Skegness. This number is similar to the numbers reported for 2018/19, indicating that passenger rail numbers have returned to pre-covid19 levels.

During summer, EMR (East Midlands Railway) runs the Skegness Summer Special services every Saturday from July to September¹⁴. These services provide additional capacity, luggage space and options for customers who want to travel to the seaside town over the summer. Journey times between Leicester and Skegness are also reduced.

There are also railway stations in Cleethorpes and Grimsby in the north and Lincoln in the west, just outside the study area. From these stations there are direct connections to Liverpool, Sheffield and Leicester. Lincoln Central Station, for example, provides regional connectivity with journeys to London St Pancras within 3 hours. However, there are no direct services from Skegness to these rail stations, with

most journeys having an interchange at Sleaford, Grantham or Nottingham. Both rail and bus journeys from Skegness to Lincoln takes approximately 2 hours and 30 minutes.

Other coastal towns like Mablethorpe and Sutton on Sea lack any rail links and infrastructure, making bus services or driving the only modes of access.

Skegness Interchange

In February 2023, the EMR announced an investment package of over £3.3 million to transform Skegness railway station, with funding being provided from the Government Town Deal Fund¹⁵.

The Connected Coast Town Deal is working alongside EMR to oversee the Town Deal projects and Towns Fund investment in Skegness, accompanying East Lindsey District Council and Network Rail, to completely reconfigure the layout of Skegness station, thus accommodating improved passenger flow.

Station improvements will be continued outside the station, seeing improved configuration of the Taxi / drop off area, a new pedestrianised route into the station, improved access to the adjacent bus station and a reconfiguration of concourse and cycle facilities. These transport links for the station will remove the barriers that could lead to transport related social exclusion.



CGI of Skegness Interchange station improvement proposals

Access

Bus and Coaches

Overview

The main local bus services are provided by LincsBus, operated by several operators in the region including Stagecoach, Centrebus, Coaches of Lincoln and Brylaine. These bus services connect coastal towns with larger hubs like Skegness, Grimsby, and Lincoln¹⁶.

Callconnect is an on-demand bus service serving the hamlets, villages and towns in the study area such as Skegness and Chapel St Leonards.

The study area is inaccessible by coach. The nearest town accessible by coach is Louth which has direct services to Leicester and Birmingham, provided by National Express. From Louth, coach services to London takes approximately 6 hours and 45 minutes, with a change at Leicester.

The bus services in the study area operate based on seasons, where timetables differ in summer and winter months. Winter season for the bus services is largely defined as the period of time between October to March, while the rest of the year is considered as summer season. During winter season, less buses are available across the town and some services stop altogether.

During summer, on top of increased service frequency and coverage, Stagecoach also runs Skegness Seaside, the local open top bus services that runs at 10-minute frequency and stops at all key attractions in the town¹⁷.

Integration with rail

In Skegness, the improvements proposed at Skegness Rail station will also improve the connection and access to the

adjacent bus station. The project will offer an enhanced experience, an improved welcome to the town and coast, and it will promote better connectivity with Skegness and the coastline.

There are plans to develop this bus-rail connection into a mobility hub that brings together different transport modes and facilities¹⁸.

Bus service improvements

In early 2024, several bus routes have become more frequent and more accessible due to an injection of Bus Service Improvement Plan funding (BSIP) made available by Lincolnshire County Council¹⁹. Under these improvements, Route 2, which serves Skegness town centre, runs more frequently – up to every 15 minutes – and serves additional areas, including several stops with direct access to the sea front. The buses previously ran every 30 minutes in the summer months.

Other BSIP project improvements include doubling the frequency of Service 59 from Skegness to Mablethorpe. This service now runs every 30 minutes from Monday to Saturday from July 20, 2024²⁰.

A refresh of the BSIP for Lincolnshire was also published in June 2024²¹. In the plan, several improvements were identified within the study area, which includes bus stop infrastructure upgrades in Skegness and temporal provision improvements. Improvements in the bus services may see increase in use of buses as a means for travelling daily.



Skegness Seaside service during the summer months



Bus station at Skegness

Access

Walking and Cycling

Overview

As a tourist destination, leisure walking and cycling are important to the area. To support this, the local councils and district have launched several programmes and made numerous improvements to the walking and cycling infrastructure in the area.

Several identified routes for leisure walking and cycling in the area include Chapel St Leonards – Coastal Country Park Walks, Mablethorpe Promenade, and Chapel St Leonards Promenade²². Walking and cycling routes in the study area are very localised and mainly used for recreation (e.g. coastal promenades) and are likely to provide limited utility function.

Go Skegness

In 2016, the Go Skegness project was launched to ease town centre congestion and encourage more people to travel sustainably by walking, cycling or using buses^{23,24}. The programme of work included improvements to the A52 Roman Bank, improvements to cycle paths, footpaths, and links, enhanced Skegness to Gibraltar Point footpath and cycle path, improved public transport facilities, and improved information and signs.

Multi-user trail

A new multi-user trail between Chapel St Leonards and Ingoldmells was opened in June 2023 to make it easier for people to walk, cycle, and enjoy the outdoors around Skegness²⁵. The new one-mile-long path, which is located next to the A52, joins up with other footpaths to create a four-mile-long circular route that leads to the beach and promenade.

The trail also links to public transport, offering, safe and sustainable routes between resorts and more travel options for local people and visitors. This project anticipates an increase of 11,250 visitors to the trail²⁶.

England Coast Path

The King Charles III England Coast Path runs through the study area, along the coastline. Three stretches are in the study area:

1. Sutton Bridge to Skegness
2. Skegness to Mablethorpe
3. Mablethorpe to Humber Bridge

The stretches from Sutton Bridge-Skegness and Skegness-Mablethorpe are now open, whilst the stretch from Mablethorpe to Humber Bridge is approved in full but not yet open²⁷.

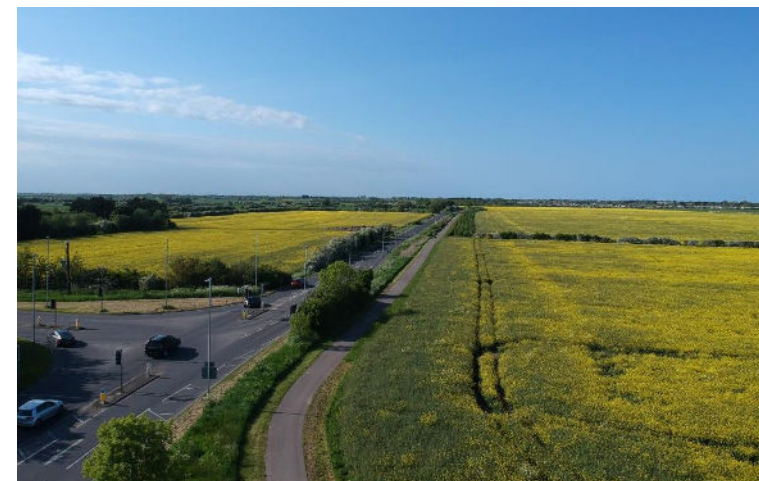
Airport

There are no airports in the study area. The nearest airport to the study area is Humberside Airport which is approximately 77km away from Skegness. It provides connections to Amsterdam, Palma de Mallorca and several airports in the UK. The airport can be reached via a 1-hour drive or via a range of combination of train and bus rides that takes about 4 hours.

East Midlands Airport is the next closest airport, located approximately 150km away from Skegness. It serves regional and international flights. The airport can be reached via a 2-hour drive or 3-hour journey by rail and bus from Skegness.



England Coastal Path for walking and cycling



Multi-user trail along A52 between Chapel St Leonard and Ingoldmells

Travel patterns

Vehicle travel patterns

Car dependency

Vehicle ownership data is only available down to district level. In East Lindsey, the number of licensed vehicles registered has been steadily increasing to 108,500 vehicles in 2024, despite a small dip in 2020²⁸. This represents a 17% increase from 2010 numbers.

The uptake of electric vehicles has exponentially increased since 2020, with 1,830 EVs registered in the district. However, this still represents a very small proportion of the total vehicles licensed in the district (at around 1.98%). With the move to phase out combustion engine vehicles, this number is expected to continue its exponential increase.

Based on Census data (2021), the area is heavily car-dependent with most Output Areas recording more than 90% of households having one or more cars or vans²⁹.

Additionally, Census Travel to Work data also shows high rates of driving, with most Output Areas recording more than 80% journeys to work are made by car³⁰.

The Lincolnshire County's Transport Monitoring Report states that traffic volumes across the county have gradually increased over recent years, doubling since 1985. With traffic volumes quickly returning to pre-covid 19 levels since 2023³¹. This reflects the popularity and high-level of car dependence within the area.

However, it is noted that the level of car dependence may be driven by necessity, rather than being indicative of affluence.

Seasonal traffic

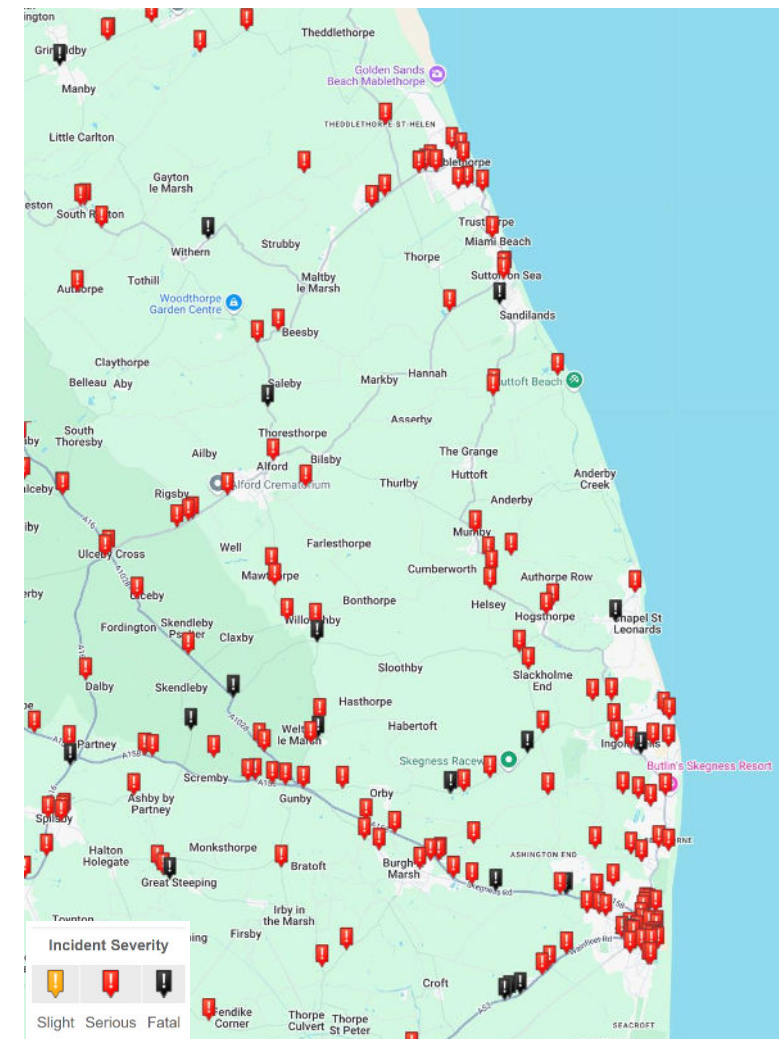
The study area sits within the East Lindsey District and has a strong and growing visitor economy, with the value of the visitor economy increasing year on year. There are approximately 26,099 caravans in the study area, the highest concentration in Europe. This results in highly seasonal traffic, especially in the towns of the study area, Skegness, Mablethorpe, Sutton on Sea, Chapel St Leonards and Ingoldmells.

In peak times, there are vast numbers of pedestrians combined with a high volume of traffic. Traffic speeds at these times are very slow and often at a standstill.

Road safety

A total of 12 fatal collisions were reported in the study area between 2018 to 2022, with two fatalities involving pedal cycles³². While there is no obvious concentrations of fatalities, the overall concentration of all types of collisions can be observed to occur in more urban areas. Skegness, in particular can be observed to have a higher concentration of road collisions than the other towns, with a total of 232 collisions occurring between the years 2018 to 2022. Out of that, three were fatal, 42 were serious and the rest were slight.

Road casualty numbers are available at county level³³. An analysis of casualty numbers of Lincolnshire shows that there is fluctuations across the year, with the summer months recording slightly higher numbers than the rest of the year. This is in line with the increase of traffic and people walking and cycling in the area due to the holiday season.



Casualty distribution (extracted from Crashmap)

Emergency access

Evacuation routes

The Lincolnshire Resilience Forum (LRF) has published their Coastal Mass Evacuation and Shelter Plan (2020)³⁴ that sets out the process of mass evacuation during the east coast flooding risk scenario.

During an evacuation, it is desirable to have at least 85% of the affected population self-evacuating and making their own arrangements with family or friends. There would remain a dependency on assisted evacuation for the old, infirm and unable to move on their own. As most of the evacuation is expected to take place by car, the road network must be equipped to accommodate this movement.

13 main evacuation routes were identified to remove people to outside of the flood risk extent areas efficiently. Routes relevant to the study areas are plotted on the map on the right. Research has also been carried out into active traffic management, potential congestion points and the best location in which to deploy support services (such as roadside assistance, first aid and refuelling points).

Most of the evacuation routes are two lane, single carriageways that do not generally experience congestion, aside from at local junctions and town centres. These routes would turn into one way (ER Out) to support safe traffic movement. However, some constraints have been identified at the following links:

1. Coastal Highway (A158)

This route has some of the most congested junctions which currently impacts journey time reliability. The road is often heavily congested when there is an accident. This highway is a key route for the coast as it connects it to the West mainland and is the most heavily trafficked in the area³¹.

Lincolnshire Coast 2100+ Baseline Report

2. Roman Bank

This route is a narrow carriageway with limited capacity that sits between two key flood evacuation routes, linking Sandilands and Chapel St Leonards. It provides the only vehicular access to the coastal resorts. The road has faced degradation in its running surface over many years.

In September 2024, works to improve the road started³⁵. This will see the reconstruction of the main carriageway from the ground up, resurfacing of footways in Sandilands, replacement of streetlights, widening of some stretches of the road and constriction of passing bays.

In addition, this area is densely occupied with static caravans. There are concerns that caravan residents are under-recorded, which causes issues with flood warning and evacuation as residents may be inaccessible and hard to reach³⁶.

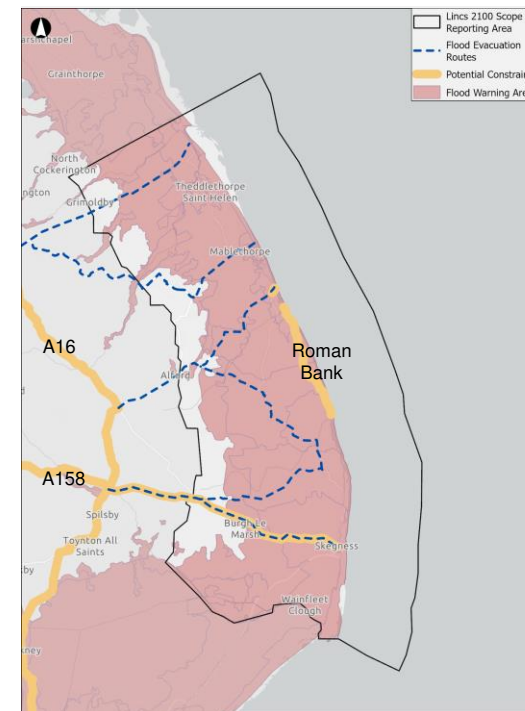
3. A16 Highway

This is the principal link connecting towns and key flood evacuation routes. The route generally has fast traffic which slows down at connecting junctions and roundabouts. This has the potential to cause bottleneck congestion during evacuation as it links multiple emergency routes.

The A16 also functions as a connection for agri-food sector delivery vehicles and experiences traffic increase during summertime linking several towns to the east coast (through Boston). There is risk of conflict between drivers evacuating from the coast and others using the highway for other purposes, in an evacuation scenario.

The plan³⁴ also urges the consideration of all forms of

available transport that can be diverted from normal services and be used during evacuation, including local authority transport, school buses, and social care vehicles. In addition, Lincolnshire County Council has arrangements in place with bus and coach transport operators and a large number of taxi service providers and consideration can be made to withdraw transport from established duties to use during evacuation. The plan also states the potential to use the rail network to relieve the strain on the road network and allow the transport of large numbers of people.



Emergency routes and identified potential constraints in the road network

Conclusion

Strengths and Weaknesses

Strengths

- Anecdotally, congestion occurs primarily at junctions suggesting that **local junction improvements** could potentially address capacity issues. However, traffic survey data is needed to verify this, especially to capture traffic seasonality across the year.
- **Quality walking and cycling routes** in strategic locations support the town's function as a leisure destination. However, there is opportunity to widen this network to serve both utility and recreation, integrate with public transport and ultimately offer alternative to car mobility.

Weakness

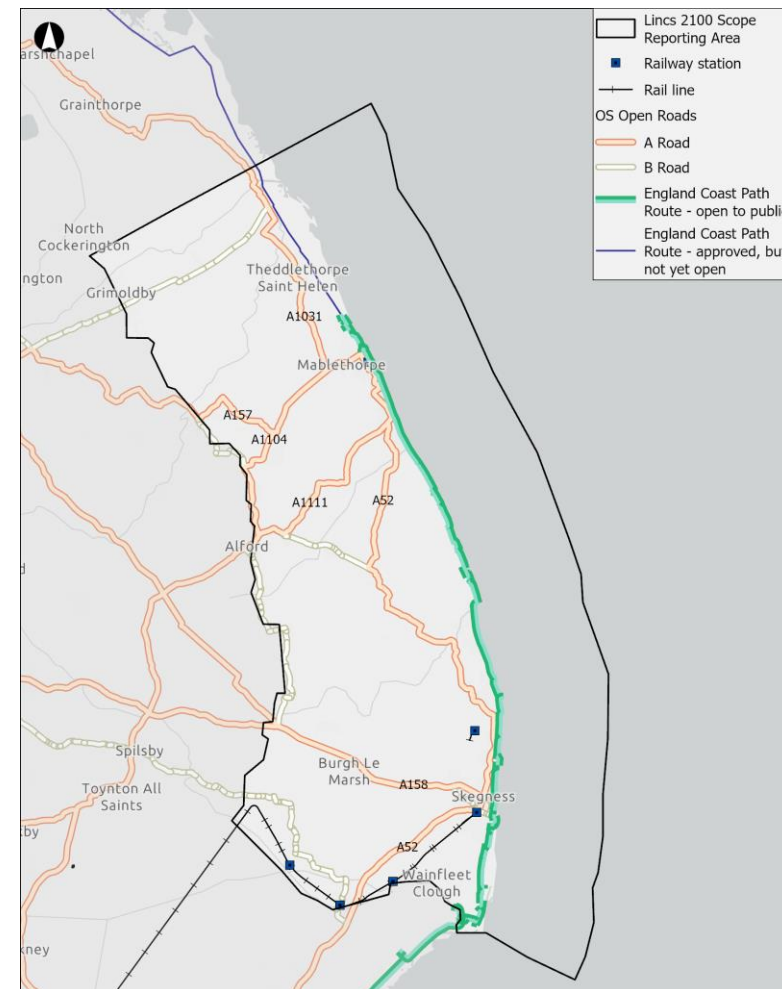
- **Uncertainty around capacity and resilience of flood evacuation routes.** Most primary roads are two-lane single carriageway roads which have the potential to cater to increased traffic in an evacuation scenario if both lanes are temporarily made one way. However, there is a need for modelling of traffic flow during emergency responses to verify actual road capacity and performance.
- **High car dependence** in the area as population grows and tourism activity increases, there will be an increased strain on the road network and associated carbon emissions. It also suggests that any evacuation will most likely be by car.
- **Poor rail connectivity**, especially in towns other than Skegness. There is also lack of rail connectivity to Lincoln which provides further regional connectivity.
- **Walking and cycling networks are very localised** and not continuous and are unlikely to be used during emergencies.

Opportunities

- **Highway improvements planned** in the area especially radial routes that connect inland areas have the potential to be improved to address heightened flood risks. Further infrastructure improvements can be planned if emergency modelling deems necessary.
- **Service improvements in bus and rail as well as improved connectivity in cycle and walking networks** present opportunities to increase uptake of sustainable modes in daily mobility and for local transport decarbonisation. Increasing access to walking and cycling also has positive impacts on health and wellbeing.

Threats

- Potential of **flooding coinciding with high tourist season** means that additional traffic from holidaymakers needs to be considered in evacuation scenario planning and any traffic modelling, to ensure resilience.
- Coastline lined with holiday homes which is a popular holiday destination. **Presence of tourist during evacuation** would present challenges in communicating emergency response procedures to those unfamiliar with the area as well as add stress onto the roads to accommodate additional traffic volume.
- The numbers living for part or all of the year in caravans and chalets along the coast are significant. There is **concern of under-reporting of the scale of residential living in holiday caravans** and mobile home parks across the area. This may cause issues during emergency evacuation as they may be hard to reach.



Overview of transport network in the study area



Energy

Energy

Overview

Introduction

Currently, local electricity, gas and telecoms networks extend into the study area. The majority of the current infrastructure serves local communities with some nationally significant gas and electricity infrastructure including the decommissioned Theddlethorpe gas facility as well as operational offshore wind farms, some of which connect into the region alongside the Viking electricity interconnector.

Opportunities to repurpose the decommissioned gas infrastructure as part of the UK's carbon capture and storage process have been identified. This development will support neighbouring areas such as the Humber Industrial Cluster.

Strategic electricity infrastructure projects are also planned in the region. For example, East Green Link 3 and 4 are electricity Transmission Network Upgrades will connect Lincolnshire to Scotland and the Grimsby to Walpole upgrades will see new overhead lines pass through the study region, to support the UK's development of renewable generation

and support the transmission of electricity.

These projects are key in the UK's transition to Net Zero carbon and there is potential to take a holistic view of developments in the region, ensuring opportunities and investments are aligned to the region and UK's goals, whilst protecting infrastructure required to build resilient and sustainable communities.

In addition to the significant infrastructure in the area, local residents in rural communities and caravans rely on other forms of fuel such as bottled gas (LPG). In 2035, the installation of new gas boilers will be banned across the UK, including in off-grid, remote homes. However, the LPG industry is exploring biofuel alternatives and government grants are available to support homeowners transition to alternative fuels (e.g. electrification through heat pump installations).

Further information for all these schemes is captured in the Appendix.

101MW of onshore embedded renewable generation connected within the region (only includes projects greater than 1MW).

1.5GW gas or hydrogen generation facility with carbon capture and storage near Theddlethorpe.

Viking Pipeline planned to take carbon from Theddlethorpe to depleted offshore gas reservoirs.

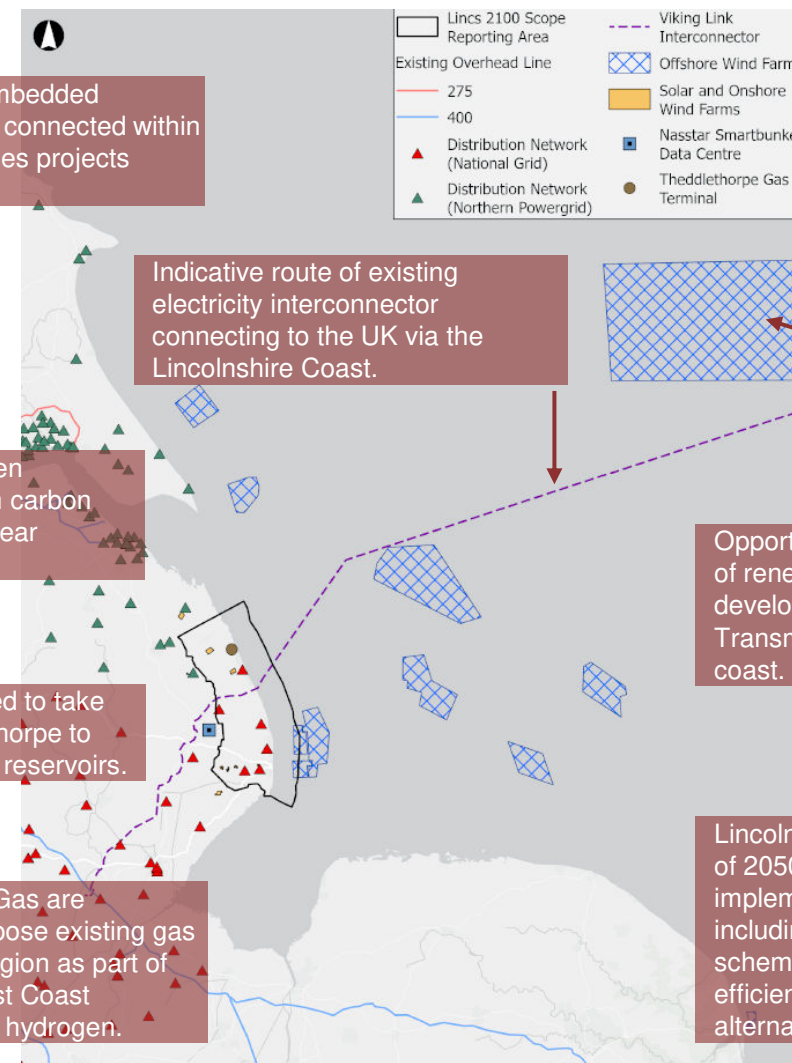
Cadent and National Gas are collaborating to repurpose existing gas infrastructure in the region as part of Project Union and East Coast Hydrogen to transport hydrogen.

Indicative route of existing electricity interconnector connecting to the UK via the Lincolnshire Coast.

New offshore wind farm and extension of Triton Knoll offshore wind farm.

Opportunity to reduce curtailment of renewables through the development of the Electricity Transmission Network along the coast.

Lincolnshire has a Net Zero goal of 2050 and the region is implementing multiple strategies including energy reduction schemes, improving energy efficiency and low carbon alternative energy supplies.



Map of energy infrastructure.

Energy, Net Zero, Digital & Data

Electricity Transmission, Distribution and Generation

England's Electricity System

England's electricity system is split into two integrated networks. The first part of the system is the Transmission Network, which is effectively the spine of the network, carrying electricity at high voltages (400kV-132kV) over significant distances and connecting large scale generation to the distribution network. The Transmission Network is operated by National Grid Electricity Transmission (NGET).

The Distribution Network is responsible for connecting the Transmission Network to consumers and embedded generation, operating between 132kV to 400V. The distribution network is divided into multiple regions, run by individual Distribution Network Operators (DNOs) or Independent Network Operators (IDNOs).¹

Transmission Network

National Grid's Transmission Network does not currently run through the area in question. However, as the UK strives to reach Net Zero, the Transmission Network is changing to support the transfer to renewable energy. As part of this work, National Grid are conducting the Great Grid Upgrade which will see Eastern Green Link (EGL) 3, EGL 4 and the Grimsby to Walpole Upgrades bringing the Transmission Network into the study region. Further Information, including the routing of these projects can be found in the Appendix.²

Distribution Network

There are two DNOs operating across Lincolnshire, Northern Powergrid in North Lincolnshire and National Grid

Electricity Distribution (formerly Western Power Distribution), in the South. The primary substations in each network are shown in the adjacent figure.⁴

Generation

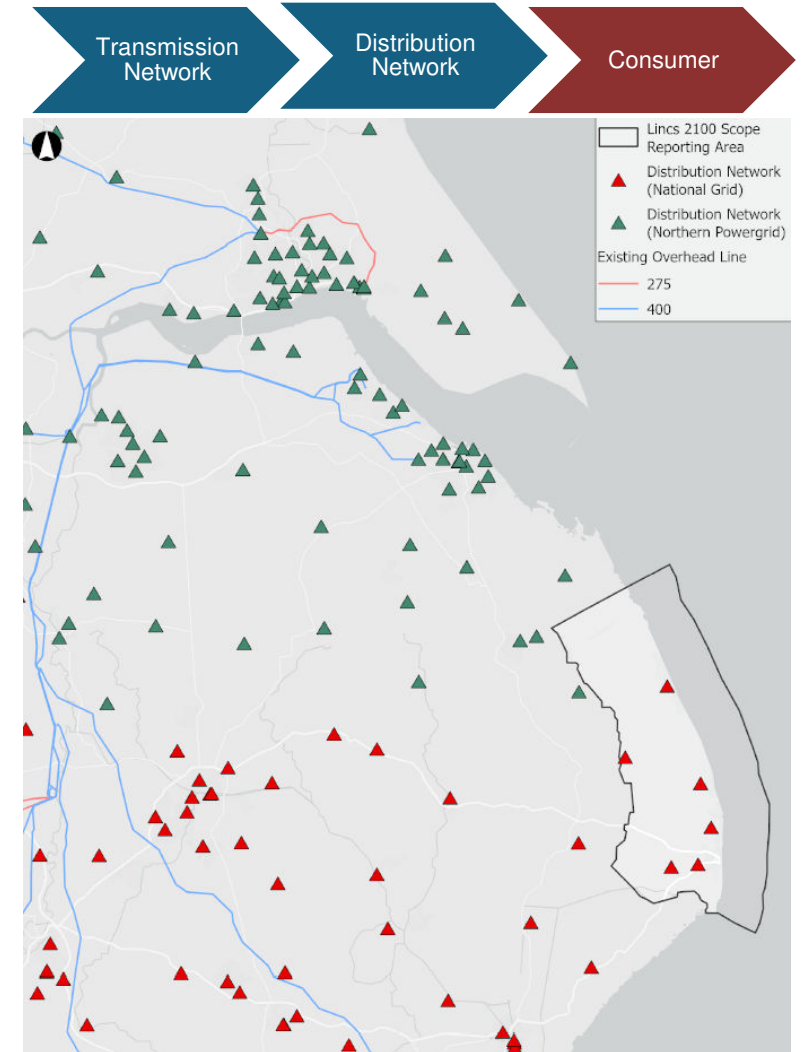
There are currently multiple sources renewable electricity generation in the search area. This includes 101MW of onshore embedded renewable electricity generation. Further information on the embedded generation can be found the appendix.

There are multiple offshore wind farms off the Lincolnshire coast including, Triton Knoll whose connection to the Transmission Network runs through the search area. As well as The Lynn and Inner Dowsing Lincs offshore wind farms which also connect into the search area.

Triton Knoll and Outer Dowsing Offshore wind farms are in the process of expanding, increasing renewable electricity connecting in the search area.

Interconnectors

The Viking Link is a HVDC interconnector that connects the UK's Transmission Network, via the study region, to Denmark. Originally the interconnector had a capacity of 800MW, but this is being upgraded to 1,400MW.



National Grid's Transmission Network and Local Distribution Substations.

Energy, Net Zero, Digital & Data

Gas, Hydrogen and Carbon Networks

England's Gas Networks

The Gas Network across England is divided in similar way to the electricity network, with a central Transmission Network acting as the spine, serving local Distribution Networks.

Existing Gas Transmission Network

National Gas owns and operates England's Transmission Network, which extends into the study region.

Existing Gas Distribution Network

Cadent owns and operates the Distribution Network in the region and across the East Midlands. A map of this network is not available in the public domain but the network spreads throughout the study region, serving homes and businesses.

Future Gas Transmission and Distribution Networks: Hydrogen Vision

Both Cadent and National Gas are exploring methods to support the UK's transition to Net Zero and are collaborating across infrastructure projects.

In September 2024, Cadent published a report outlining 3 key roles the gas network will play in the future, as we transition to Net Zero. Further information around Cadent's role in the future can be found in the appendix.

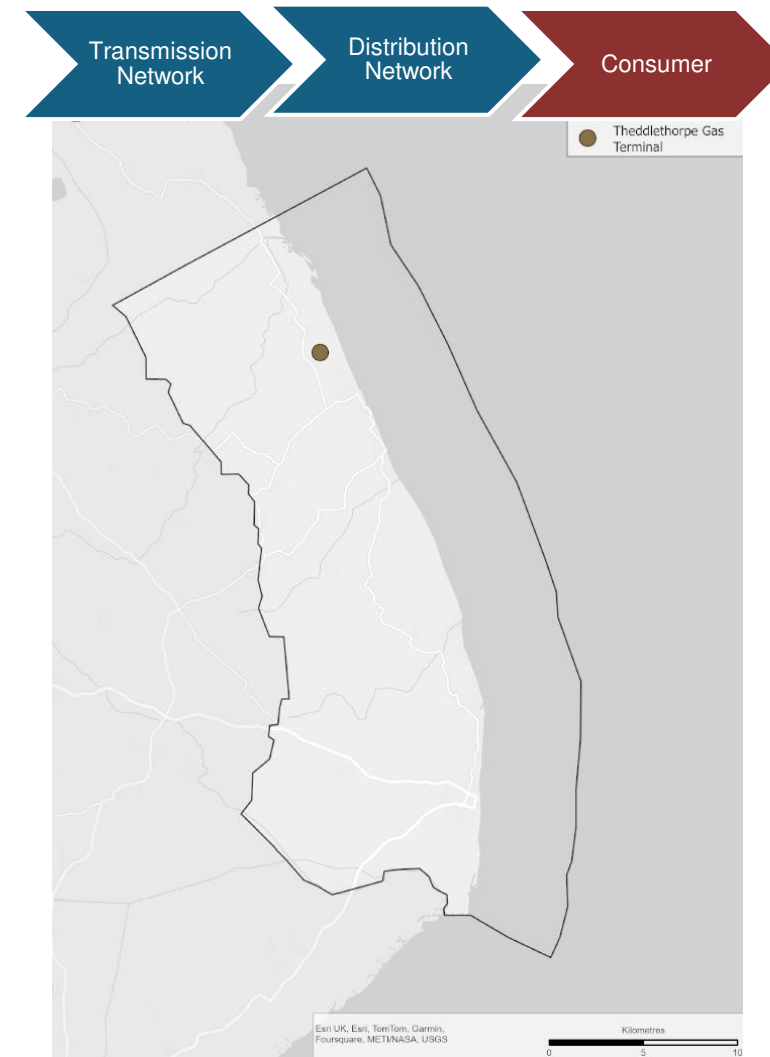
National Gas and Cadent are also collaborating with Northern Gas Networks, to develop East Coast Hydrogen, a series of low-carbon hydrogen pipelines, as outlined in the

appendix. The project plans to utilise Theddlethorpe Gas Terminal as part of the UK's carbon capture, utilisation and storage projects, transporting carbon to depleted gas reservoirs, 140km of the Lincolnshire coast where it can be stored.

National Gas are also working to develop a hydrogen 'back bone' for the UK, through Project Union which will see parts of the existing network transition to support hydrogen, connecting up key areas of the UK. Theddlethorpe is a key part of this project, with Project Union connecting a hydrogen pipeline to Theddlethorpe, as illustrated in the adjacent figure.

Future Gas Generation

The National Infrastructure Consenting Database shows the only new large-scale generation planning to be connected in the area is Theddlethorpe Flexible Generation Project. This is a 1.5GW gas or hydrogen generation project with carbon capture that is currently in the pre-application planning phase and is aiming to submit planning in the first quarter of 2027.



Map showing the location of Theddlethorpe Gas Terminal.

Conclusion

Strengths and Weaknesses

Strengths

- There is 101MW of renewable generation embedded in the region (excluding offshore wind), supporting Lincolnshire and the wider UK's transition to Net Zero.
- There is also existing connections to offshore renewable energy developments including The Lynn and Inner Dowsing Lincs offshore wind farms.

Weakness

- Potential flooding in the region could affect the infrastructure in the region, impacting the regions generation, electricity supply, connectivity and significant energy transmission projects.
- The development of hydrogen in the region is dependent on the supply chain and demand also developing.
- Currently the electricity Transmission Network runs through the region but is not connected into it. Therefore, no significant renewable generation is connected into the region and instead passes through and connects to the Transmission Network further inland.
- The current electricity network does not have the capacity to support the expected connections however the upgrade works in the region will make this possible.

Opportunities

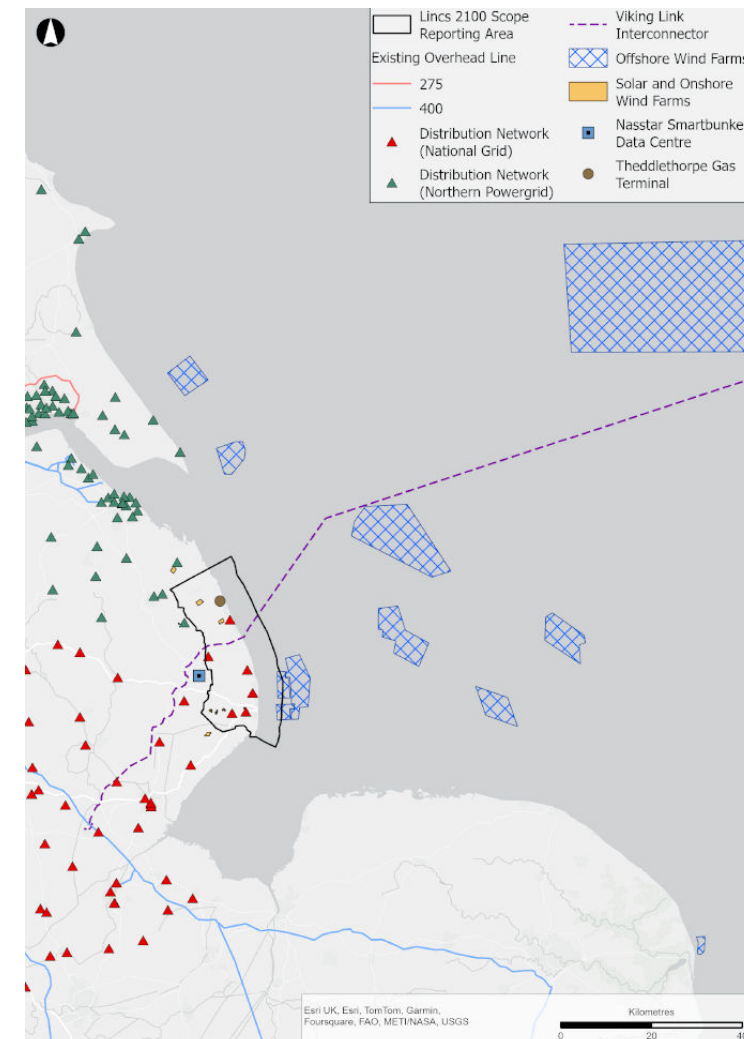
- The development of the Grimsby to Walpole electricity Transmission Network will support the expansion of renewable generation in the region as well as reducing renewable curtailment, supporting the regional and

national Net Zero goals whilst bringing job opportunities into the region. There could be an opportunity for co-investment into flood protection with National Grid as well as an opportunity to connect renewable generation into the area, via the new Transmission Network infrastructure. This could be an opportunity to share asset protection responsibilities, whilst moving towards the local area and the UK's climate goals.

- The gas network in the region has been identified as key infrastructure in the development and transition to a hydrogen network with Theddlethorpe Gas Terminal being repurposed to support the transition and supporting carbon capture and storage projects.
- There is a co-investment opportunity as the electricity and gas networks are developed, to protect energy infrastructure in the region.
- The potential development of the Geological Disposal Facility could attract additional investment to flood and sea defences.

Threats

- There is significant risk and uncertainty around the role, scale and timeline of hydrogen across the UK. This could impact the development and transition to hydrogen across the region, subsequently impacting the councils Net Zero goal as well as jobs and investment in the region.
- There is also risk around the development of carbon capture and storage off the Lincolnshire Coast as this has not yet been rolled out at scale across the UK.



Overview of the energy infrastructure in the study area.



Digital Communications

Digital Communications

Overview

Digital communications infrastructure provides a vital lifeline, to connect residents, businesses, state institutions and visitors to each other, and to services and locations outside of Lincolnshire. In the event of emergency situations, such as those related to flood events or adverse weather patterns, digital communications are vital in managing and coordinating an effective response. The requirement to sustain and maintain functionality of digital communications, therefore, is vital. To understand the availability and capacity of existing digital communications infrastructure, and analysis has been undertaken of existing mobile and fixed line communications networks in the study area. In addition, a summary of other available communication and data sharing technologies is presented, along with a view on the potential to develop and augment existing communications networks in future.

Mobile network coverage

Looking at coverage for the four major network operators, there is good availability for both outdoor and indoor services, when viewed across all four providers in aggregation. A search of Ofcom's UK mobile coverage tracker for the study area reveals areas where cellular coverage is weakest, and where supplementary technologies or alternative communications methods may be needed to infill gaps. Further detail on Outdoor, Indoor and 5G coverage is provided below.

Outdoor mobile voice coverage

Outdoor mobile network coverage is strong across the study area, with likely coverage in most areas. The exceptions to this identified in the review are:

1. Limited Vodafone coverage in a small section north of Sea lane, on the east side of Roman bank

Outdoor mobile data coverage

Overall data coverage is good, with likely coverage across aggregated network providers. The move to greater network sharing and integration via open RAN technology will likely improve this in future. Exceptions are:

1. Limited O2 data coverage in parts of Sutton on Sea, east of the A52 and sea Lane.

Outdoor 5G coverage

5G coverage is slightly more restricted across the study area, with availability being highest in and around major towns and conurbations, like Skegness, Mablethorpe. There is low coverage and along the A52, from Sea Lane to Skegness, and other routes including the B1449, A111 and B1449. This may create problems for any cellular connected vehicle applications.

Fixed fibre Broadband coverage

This is summarised on the next page. There may be submarine communication cables off the coast of the study area, but this has not been assessed at this stage.

LEO and GEO satellite coverage

Low Earth Orbit satellite coverage suggests that these networks should be more than sufficient to provide back-up communications to mobile networks, with both OneWeb, and particularly Starlink, featuring dense constellations in orbit.

From a high-level review, it appears that satellite rotation patterns are sufficient to provide satellite communications coverage for the full study area. GPS coverage is supplemented by GALILEO and GLONASS network transmitters and receivers, so there is a level of resilience in place for triangulation for satellite navigation and satellite communication devices and technologies.

AIS and shipping information

The Automatic Identification System provides accessible global data on shipping locations, which could be a useful source of information in early identification of any potential threat or impact to the degradation of the seabed and beaches from coastal shipping movements within the study area.

Subsea sensors and submarine monitoring devices

The Lynn and Inner Dowsing offshore wind farms off the coast of Lincolnshire present an opportunity to leverage real-time condition monitoring devices to understand analogous patterns in tidal flow and range, as well as impacts on biodiversity and marine vegetation, that may be predictors of damage to the coastline too.

Digital Communications

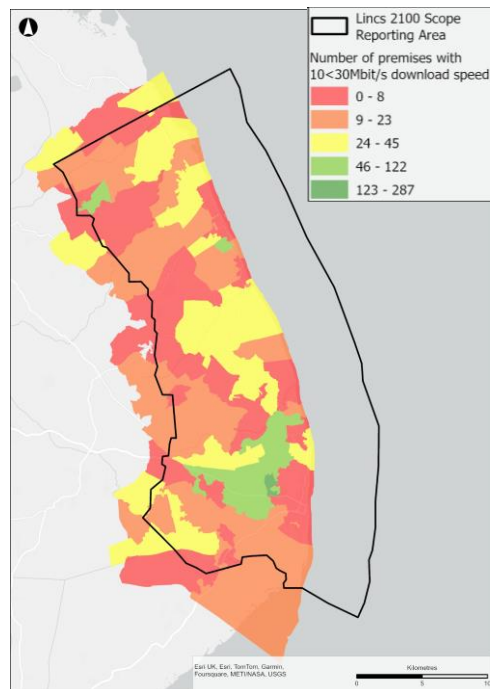
Fixed fibre Broadband coverage

Fixed Broadband coverage throughout the study area is generally of a good standard of download speed, with speeds meeting fast and superfast levels of (above 60Mbps) connectivity across large geographical spans of the study area.

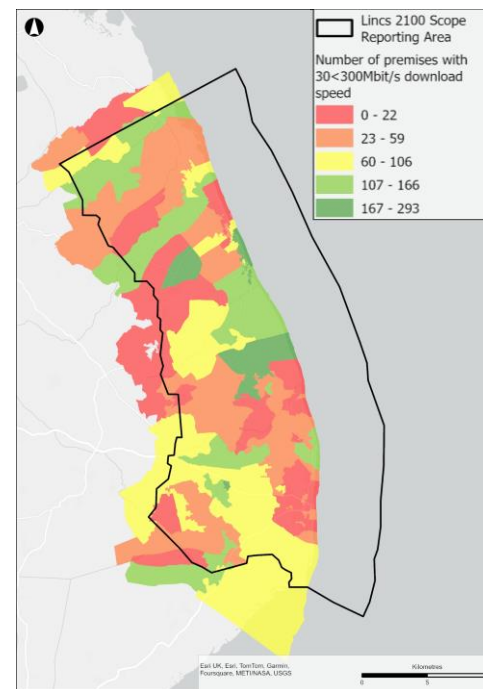
The images opposite show heat maps of the number of premises with maximum download speeds above 10 Mbps (right) and above 30 Mbps (middle right). However, there are several areas with download speeds at the lower end of the scale, below 10 and 20 Mbps, which represents an opportunity for fixed-fibre enhancement in future but may also impact any need for high-speed data exchange services in these affected areas.

The map shown far right illustrates the ultra-fast broadband coverage, and, in an inversion of the low-speed rates shown for urban conurbations in the first two images, there is a high concentration of ultra-fast broadband users with access to ultra-fast services. This correlates with deployment patterns for major broadband providers, however the prevalence of households accessing slower speeds in these same areas may suggest some degree of inequality in residents' access to procure and subscribe to the higher bandwidth services. This is consistent with areas of high deprivation, as shown in the succeeding section on socio-economic baseline.

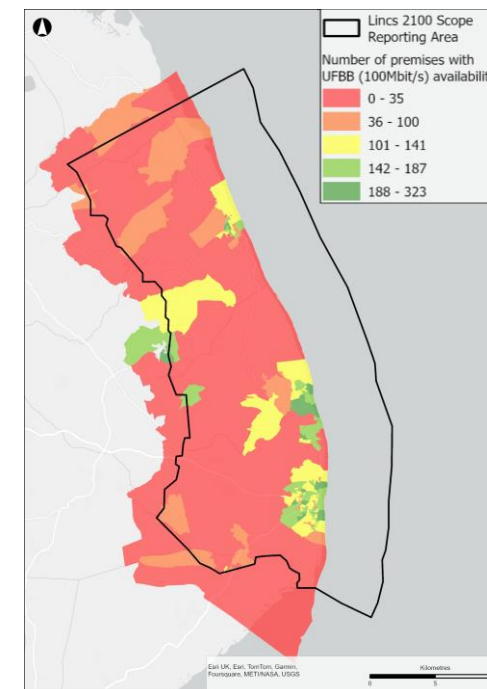
Note: the boundary used for the map images produces polygons based on geographical areas that have a minimum of either 100 people or 40 households, with the average being 310 people.



Number of premises that have access to a maximum download speed between 10 and 30 Mbit/s



Number of premises that have access to a maximum download speed between 30 and 300 Mbit/s



Number of premises that have access to ultra-fast broadband (100 Mbit/s or more)

Conclusion

Strengths, Weaknesses, Opportunities and Threats

Strengths

Good existing coverage of mobile networks for outdoor locations, with 5G availability around the major towns and conurbations.

A generally good level of fast or superfast Broadband connections exist across the study area, though there are pockets of geographical locations where low-speeds are still visible. Some of these include the more urban, built-up areas, with high numbers of residential occupation, which may suggest a lack of equitable access to high-speed services for these socio-economic groups. Contrarily, these are also the areas where ultra-fast coverage is more established, which would align with the broadband deployment and installation strategies of the major broadband providers.

Weakness

There are gaps in 5G data services in some parts of the study area, particularly along and adjacent to key highway routes, which may be a restrictor for future connected vehicle and IoT type applications.

There are a number of – mainly rural – areas with download broadband speeds below 10mbps. Though this speed was the original target for 4G services, by modern fixed broadband standards it is relatively low.

Opportunities

There is an opportunity to utilise digital communications to identify early flood threats and notify affected residents. This could be explored as part of any contracts to renew or refresh fixed fibre coverage in the study area.

The Lynn and Inner Dowsing Lincs offshore wind farms can utilise subsea sensors, to monitor structural integrity and enable predictive maintenance to be carried out. Sensor clusters can be supplemented with instruments to detect adverse fluctuations in tidal range and wave speed and height, to help monitor the off-coast sea state and pre-empt any abnormalities, perhaps as a result of severe weather events, that may impact on coastal defences and the land mass beyond. Drones can also be used to provide an aerial monitoring capability.

Threats

Threats to communications infrastructure could occur from adverse weather conditions and storms, and satellite networks, both geostationary and Low Earth Orbit, present an opportunity to provide resilience in the face of terrestrial communications being lost.

Socio-economic Baseline

Introduction

Approach

The following section provides an overview of the economy and communities that live within the study area and East Lindsey District.

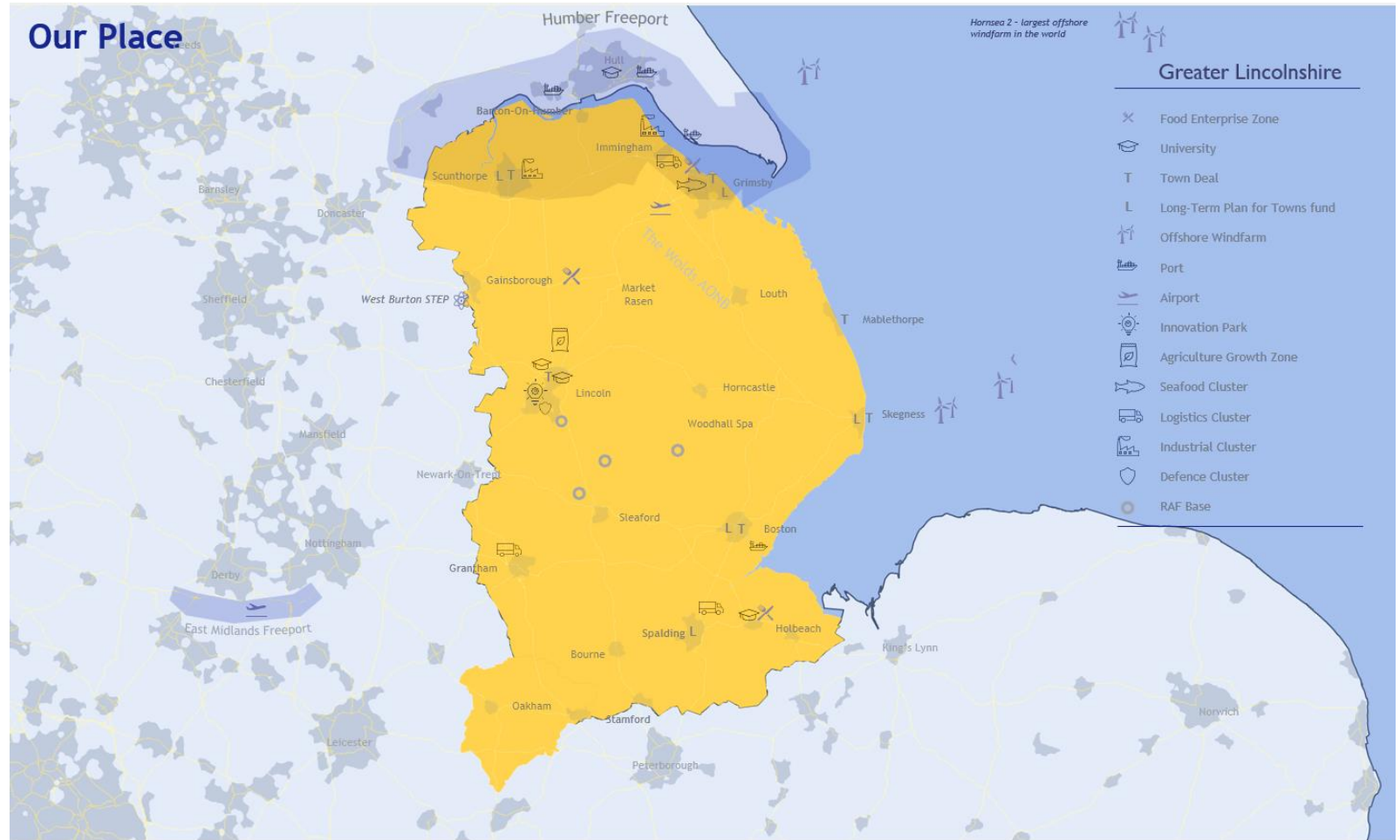
The study area is located within East Lindsey District, one of the seven districts in Lincolnshire and one of ten that make up the Greater Lincolnshire region. East Lindsey is within the Greater Lincolnshire Local Enterprise Area (GLLEP) and the forthcoming Greater Lincolnshire Mayoral Combined Authority (with a Mayoral election set for May 2025). The Greater Lincolnshire area, as shown in yellow, has a varied economy with strengths in food, tourism, logistics and energy transmission.

This section will highlight key economic centres and trends in the study area and East Lindsey District, to provide the context for objective setting, key success criteria and study area segmentation.

To note, not all data is available at the local level Lower Super Output Area (LSOA). LSOAs consist of four or five groups of Output Areas comprised of between 400 and 1,200 households and a resident population between 1,000 and 3,000 persons. This level is required to group areas together to form results on the study area. Hence, the following chapter presents both grouped local data alongside local authority (East Lindsey District) level data.

The following section has four main sub-sections:

- 1) **People**
- 2) **Skills and Employment**
- 3) **Business and sectors**
- 4) **Study area segmentation and SWOT analysis**



Greater Lincolnshire Economic Overview, 2023. Source: Greater Lincolnshire LEP

People

Overview - an older seaside population with additional health needs

The majority of the 61,000 residents in the study area live in semi-rural settlements, clustering around seaside towns of Skegness, Mablethorpe, Ingoldmells and the inland town of Alford. The study area has a relatively low population density (119.7 per km²) with many small villages and countryside areas. As of 2021, East Lindsey was the least densely populated local authority area in the East Midlands¹.

East Lindsey also has a significantly older population, with a median age 13 years above the national average. Between the 2011 and 2021 censuses, the population of people aged 75 to 84 years increased by 3,600, a 31% rise. In contrast, the number of residents aged 35 to 49 years decreased by 4,600, an 18% drop². The area is particularly popular amongst older individuals for holidays and retirement, with a particularly focus on repeat visiting and generational tourism. This contributes to a higher-than-average number of residents over the age of 60.

Despite an older population, the local area is expected to grow at a faster rate than the rest of England, increasing 14% by 2043 (10% for England). This is likely driven by net inflows of people aged 50 and above, moving to the area for retirement⁵⁰. Migration from adjacent local authorities including Leicester, Sheffield and Nottingham has been an important element of population growth in East Lindsey⁵⁰. However as highlighted by the East Lindsey Local plan, the District faces significant issues regarding the shortage of affordable and good quality housing⁵⁷.

Migration from adjacent local authorities including Leicester, Sheffield and Nottingham has been an important element of

population growth in East Lindsey⁵⁰. Pockets of very high deprivation exist, particularly in Skegness, Ingoldmells and Mablethorpe. However, on average, the district experiences lower rates of deprivation than the national average. The area has very limited ethnic diversity with 96% of the resident population identifying as 'White British', 14% higher than the national average. As a rural and coastal area, the region has not attracted as much non-British migration as compared to larger cities³.

Poorer health outcomes exist for residents in the study area, with 71% either overweight or obese, 7% higher than the national average. In Skegness, it is reported there is a very high prevalence of highly processed 'fast food' which is contributing to poorer health outcomes⁴. Physical activity rates are lower than the national average with only 60% of adults meeting the recommended guidelines of 150 minutes of moderate activity per week⁵. The study areas significant older population and higher rates of health conditions such as cardiovascular disease reduce the ability to engage in physical activities⁵. Louth and Horncastle (covering Mablethorpe) and Boston and Skegness report higher rates of General Practice appointments than the national average⁶.

Suicide rates are notably higher than the national average (16.0 per 100,000 in East Lindsey compared to 10.7 for England) with rural isolation and limited access to mental health services being potential contributors⁷. Life expectancy is slightly below the national average, with a greater gap for women than men. The combination of deprivation, health issues, and lifestyle factors makes it challenging to maintain

good health and longevity in the study area.

There is a very high prevalence of caravans and mobile homes with 37,000 reported in East Lindsey District by the local council and 26,099 in the study area. Just 733 have been reported as domestic residences in the immediate study area on the latest Census (1,367 in East Lindsey). There is a concern of an under-reporting of the scale of residential living in holiday caravans and mobile home parks across the area. A study conducted by East Lindsey District Council in 2011 used thermal imaging to uncover a hidden community of around 6,600 people living in seasonal caravans along the Lincolnshire coast⁵⁸.

House prices and rents in the area are below the regional and national average. Research indicates that a 1% increase in flood risk can decrease property prices by 0.07% to 0.11%⁵¹. Additionally, higher flood risk leads to increased insurance premiums, which can deter buyers and further reduce property values⁵².



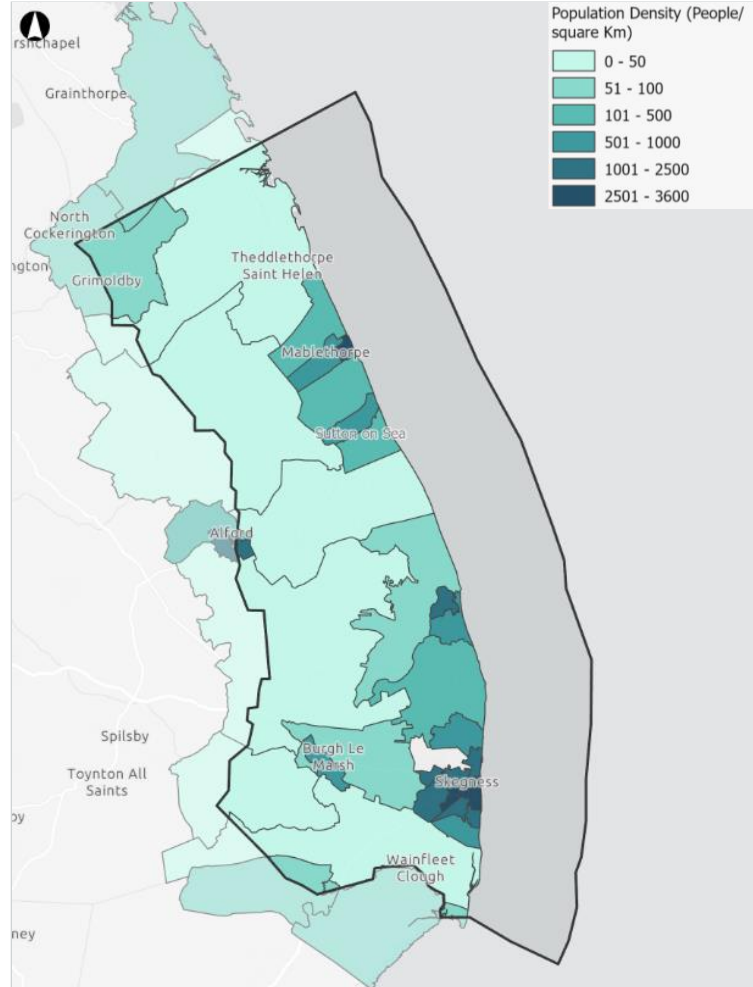
Sutton-on-Sea Vintage Festival, 2021 Source: Lincolnshire World

People

Demographics - an ageing, non-diverse population with strong population growth expected

The below figures provides an overview of key demographics relating to the people who live in the study area and East Lindsey. The data comes from Census 2021 and a mix of ONS sources.

Population Density



61,430
Total Residents
 (43% of East Lindsey, 2022⁸)



54.1 years old
Median age
 (52.2 East Lindsey and 40.5 for England⁹)



65.4 years old
Highest median age
 (Top 0.01% Highest Median Age of an LSOAs in England and Wales¹⁰)



119.7 per km2
Population density
 (East Lindsey 81 per km and England 279 per km^{9 10})



14.9%
Projected population increase by 2043
 (England 10.3%¹¹)



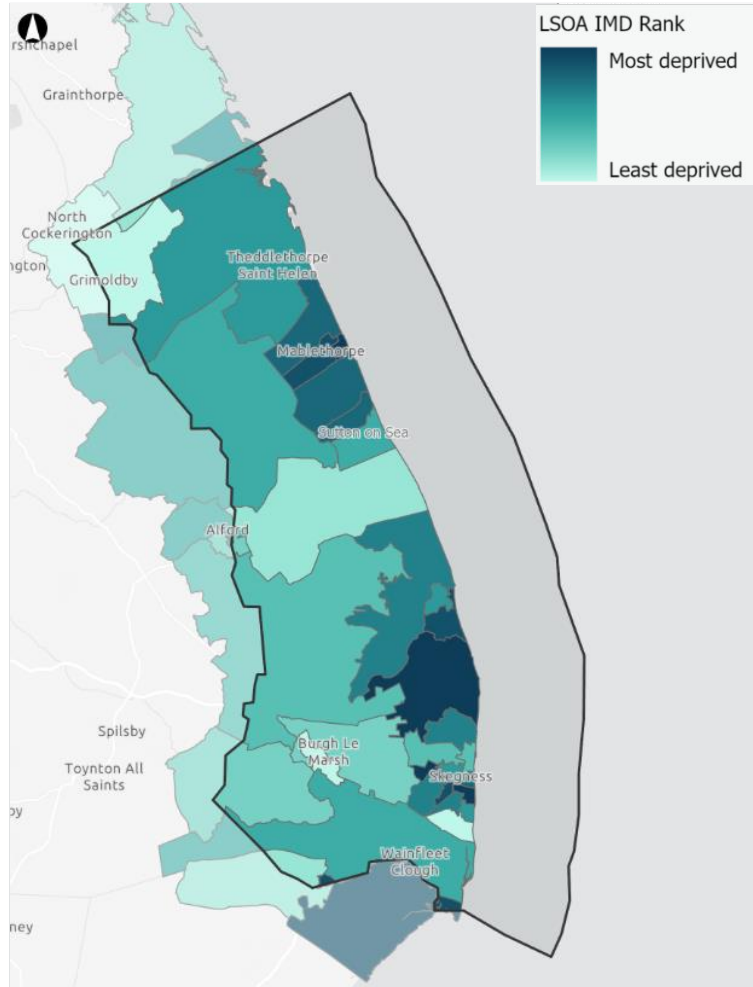
95.6%
% identify as White British
 (England and Wales 81.7%¹²)

People

Health and Well-being - an ageing population with high rates of overweight and physical inactivity

The below figures provides a summary of key health and wellbeing indicators relating to the study area East Lindsey. The data comes from Census 2021, ONS sources and Department for Health and Social Care local authority health profiles.

LSOA IMD Rank



77.9 years old
Life expectancy (Males)
 (-1 years than English average¹³)



80.8 years old
Life expectancy (Females)
 (-2 years than English average¹³)



71.1%
Adults overweight (including obese)
 (Lincolnshire 67.3% and England 64.0%¹⁴)



16.0 per 100,000
Rates of suicide
 (Lincolnshire 14.0 and England 10.7¹⁴)



36.9%
Household in at least one dimension of deprivation
 (51.7% England¹⁵)



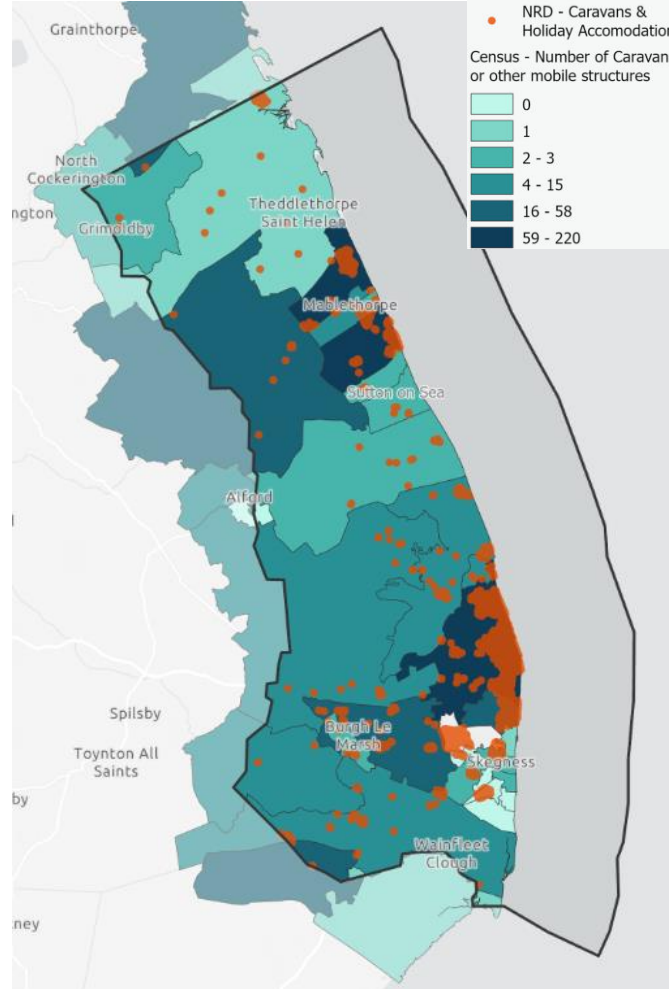
25.5%
Adults physically inactive
 (England 22.6%¹⁶)

People

Housing - lower, more affordable housing and large presence of caravans/mobile homes

The below figures provides a summary of notable housing statistics in East Lindsey. The data comes from a variety of ONS sources.

Number of caravans or other mobile structures



733

Number of formal residential caravans

(26,099 caravans in study area, and 37,000 in East Lindsey¹⁷)



£216,000

Average House Price

(£225,000 in Lincolnshire and £285,00 in England¹⁸)



19.3%

Households with Oil Central Heating

(3.5% of households in England⁶⁰)



7.2

Housing Affordability ratio

(Lincolnshire 7.41 and England 8.26²⁰)



D

Average Energy Performance Certificate (EPC)

(West midlands D and England D²¹)



50.3%

Accommodation Type: Detached Homes

(Lincolnshire 42.7% and England 22.9%²²)

Skills and Employment

Overview - increasing employment levels but lower formal skills attainment

Historically, East Lindsey has consistently under performed in employment and unemployment rates compared to the regional and national averages. The areas high proportion of older residents in retirement and lack of diverse industries has contributed to the historic low employment rates. However, there has been a strong upswing in recent years with employment rates rising from 58% in 2021 to 74% in 2023 and unemployment rates now inline with the national average (4% in 2023)²³. This could be explained by growth of the visitor economy and the recovery from COVID-19 leading to a resurgence in local businesses, especially those catering to tourists⁵³. Programs aimed at upskilling local residents have also helped fill employment gaps, particularly in the hospitality and service sectors⁵⁴. There has also been a strong upward trend in female employment, particularly in hospitality and tourism. Although, it should be noted that high variance across years is expected due to the sampling with the data.

The economic inactivity rate for adults aged 16 to 64 in East Lindsey is greater than the national average at 24% (21% in England). According to the 2021 Census, East Lindsey had the highest proportion of economically inactive adults out of all local authorities in England and Wales²³. Economically inactive are not actively contributing to the labour market for various reasons such as retirement, ill health/disability, family responsibilities or other factors. The economic inactivity rate in East Lindsey is also influenced by its unique characteristics, including rural geography and demographic composition. We observe pockets of very high working-age adult economic inactivity specifically in the

coastal towns of Skegness and Mablethorpe.

Average travel to work time is significantly longer in East Lindsey than the national average (10.3 minutes compared to 7.6 minutes). East Lindsey's large rural economy with scattered towns and villages, as well as the lack of major urban centres often travel longer distances to access employment. The study areas relatively remote location off the Coast reduces the availability of services and increases the time it takes to reach the core services²⁴.

The percentage of residents within the study area that have no qualifications in East Lindsey is 25% compared to 18% nationally. This translates to roughly 1 in 4 people over the age of 16 who have no qualification. In some small areas around Chapel St Leonards, Mablethorpe and Skegness the level of no qualifications can be as high 50% or 1 in 2 adults. While apprenticeships and other qualifications are slightly above average this is not large enough to overcome the lower formal education attainment levels. In addition, GCSE attainment in East Lindsey (Attainment 8) is below the East Midlands and English average²⁵.

The proportion of children achieving a Good Level of Development (GLD) is in line with the regional and national average. 1 in 5 (22%) adults have Level 4 qualifications or above in East Lindsey, compared to 1 in 3 (34%) in England. Limited highly skilled job opportunities in the study area may discourage individuals from pursuing higher education. Additionally, East Lindsey faces pockets of deprivation and individuals from disadvantaged backgrounds may have fewer resources and support to

pursue higher qualifications.

A new technical college is due to open in Skegness in 2025, see picture below, receiving £14 million of funding through Skegness' Towns Fund application with aim to improve education outcomes and reduce youth outward migration.



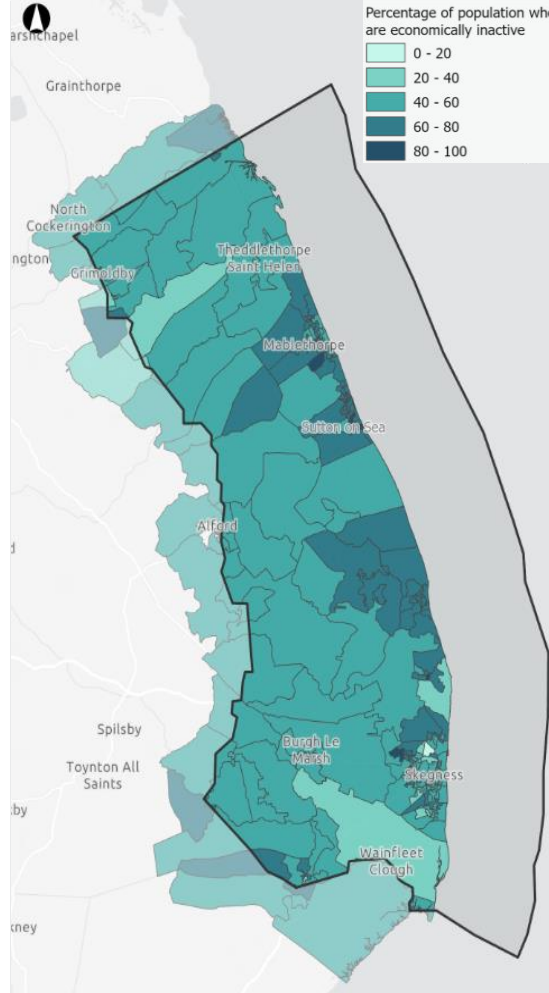
New Skegness Technical Education College (TEC) Campus, 2024

Skills and Employment

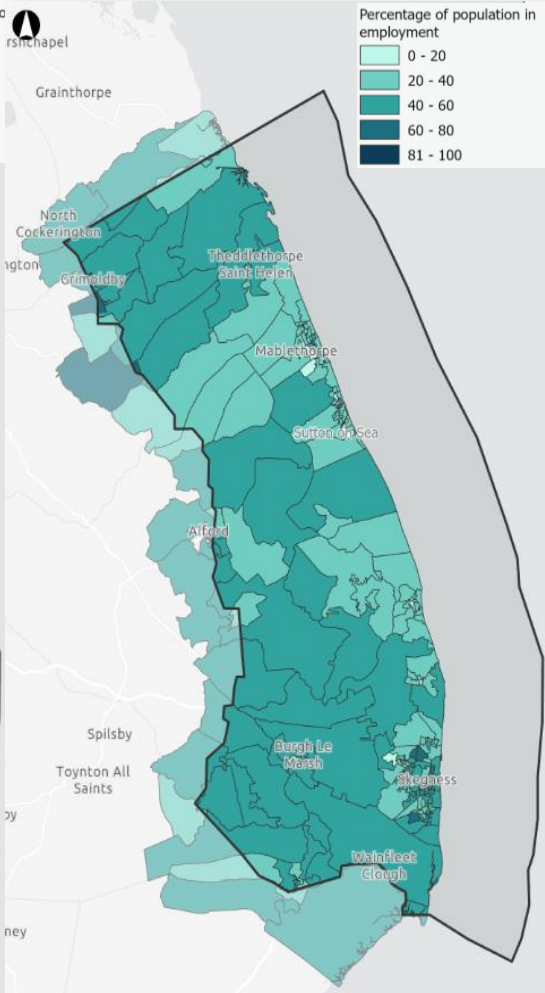
Economic Activity - low earnings per resident, high economic inactivity and low job density

The below figures provides a summary of the key data relating to economic activity. The data comes from Census 2021, ONS sources other national data sets.

Percentage people economically inactive



Percentage people in employment



76.0%

Employment Rate
(Lincolnshire 73.7% and England 75.7%²⁶)



24.0%

Economic Inactivity Rate
(Lincolnshire 22.4% and England 21.2%²⁶)



3.7%

Unemployment Rate
(Lincolnshire 4.1% and England 3.9%²⁶)



£575

Earnings by resident
(Lincolnshire £634 and England £683²⁶)



10.3

Travel Time to Work (minutes)
(Lincolnshire 9.1 and England 7.6²⁷)



0.72

Job Density
(Lincolnshire 0.77 and England 0.88²⁶)

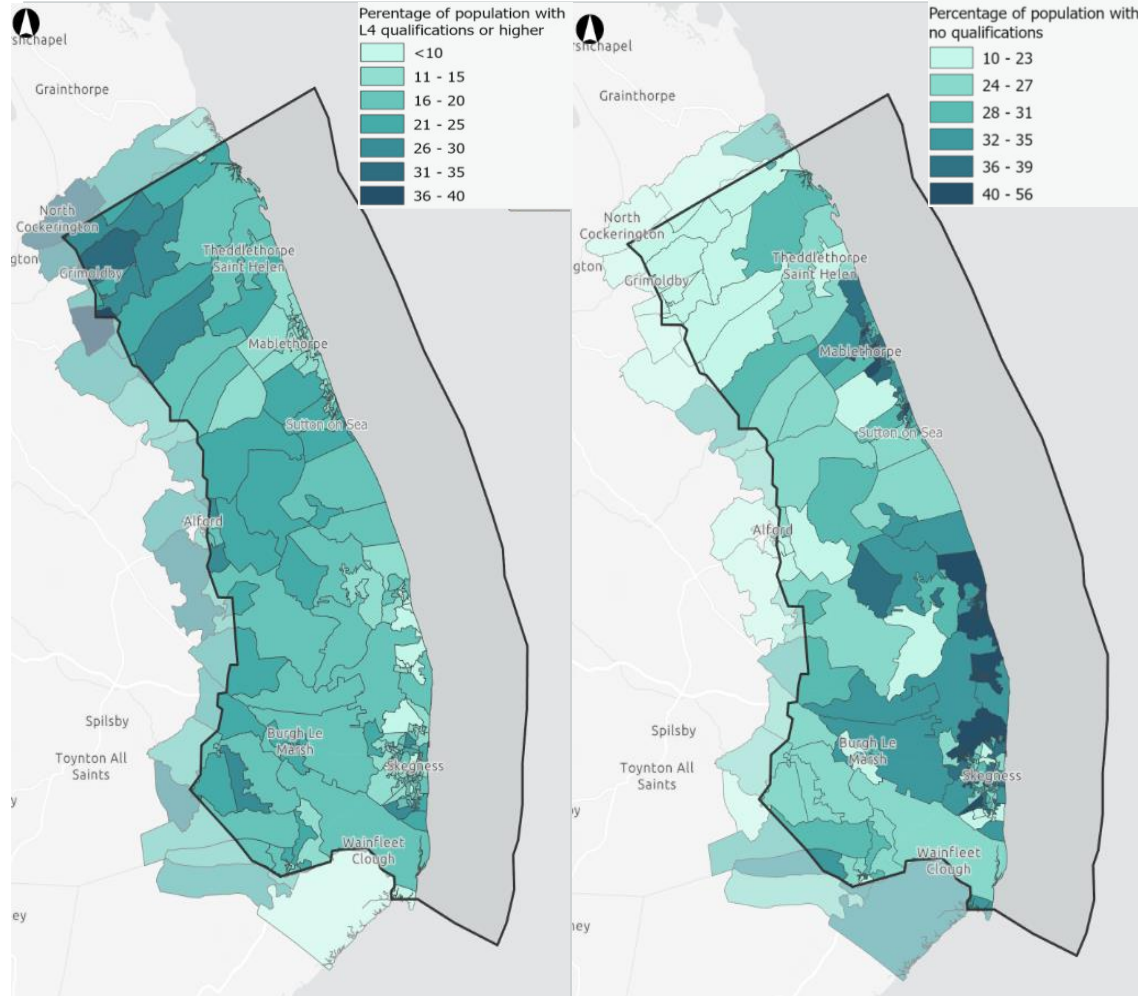
Skills and Employment

Attainment and qualifications - High levels of no qualifications but good level of development in younger children

The below figures provides a summary of the different levels of qualifications within East Lindsey and the rest of England. The data comes from Census 2021 and a mix of ONS sources.

Highest level of qualification: Level 4 and above

No qualification



25.2%

No qualifications
(18.2% in England²⁸)



22.0%

**Level 4 Qualifications
(Degree or above)**
(33.8% in England²⁸)



3.0%

**Out-of-work benefit
claimant count**
(Lincolnshire 3.0%, 3.8% in
England²⁹)



67.6%

**Children achieve Good
level of development**
(67.2% England³⁰)

Business and sectors

Overview - low productivity with above average survival rates

Productivity in East Lindsey is around 11% lower than the rest of the UK. Gross Value Added (GVA) per hour worked in East Lindsey £35.2, while the national average £39.7. Lower GVA is likely explained by the lower average earnings in East Lindsey driven by the high prevalence of tourism, accommodation and agriculture sectors. There is also a high share of part time employment and pockets of very high economic inactivity.

In the study area, there is a high prevalence of occupations in caring and leisure (12%), accommodation and food service activities (8%) and retail and repairs (17%) sectors. Caring and leisure jobs are prevalent around the key towns of Skegness, Ingoldmells, Sutton on sea and Mablethorpe. The area's significant proportion of older residents, which drives higher demand for healthcare and social care services, could be contributing to this trend. Additionally, the tourism-based economy, which emphasises hospitality and service-oriented jobs, plays a crucial role.

There is a higher prevalence of skilled trade occupations in East Lindsey (15%) which includes those employed in manual roles requiring significant work-place based training. There is a lower proportion of administrative and professional occupations which typically require a higher level of formal education such as doctors, lawyers or engineers. Only 1% of the working population are employed in finance and insurance activities compared to 4% in England³¹. The proportion of workers employed in scientific and technical activities is 4%, below the national average of 7%³¹.

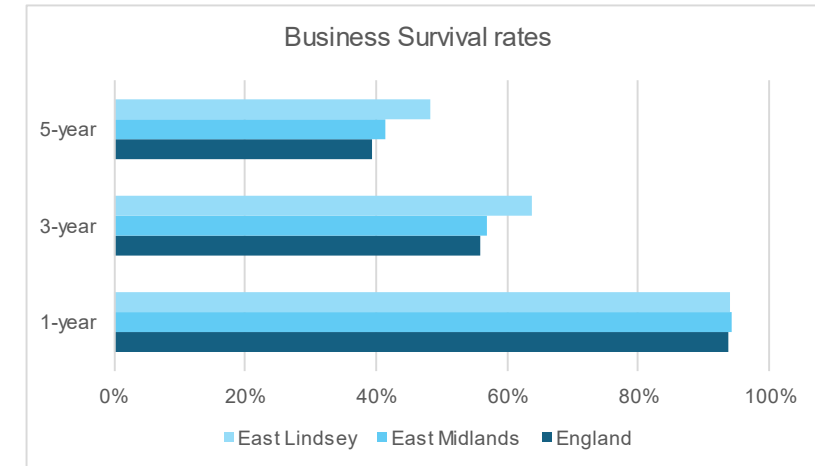
Additionally, the high number of small businesses and self-

employed individuals, are less likely to require extensive financial services than urban areas with larger firms, could be contributing factors.

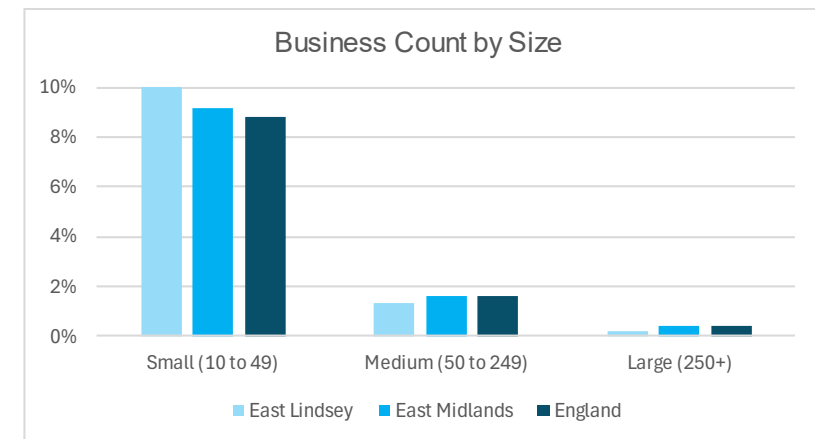
There are a variety of business support programs available to businesses in the district. This includes £10 million of investment in community development, Grants4Growth project which aims to stimulate growth within the economies of East Lindsey³². Skegness and Mablethorpe have also secured £48.4 million from the Government's Towns Fund scheme³³.

Results from the East Lindsey Council business survey identify having access to customers as the most positive aspect of the area as a place to do business. Low rents/business rates and access to suppliers are also viewed fairly positively by companies in the district. The survey also highlights obstacles to business growth such as lack of skilled staff and poor transport infrastructure³⁴.

There is a lower prevalence of medium and large sized businesses within the region, reflective of the economy being largely rural and tourism focused, which tends to support smaller, locally owned businesses rather than larger corporations. East Lindsey businesses are resilient with a higher percentage 3-year (64%) and 5-year (48%) survival than the regional and national rate³⁵.



Business survival rates. Source: ONS (2023)



Business count by size. Source: ONS (2023)

Business and sectors

Tourism - a caravan and holiday park dominated sector

Tourism and leisure plays a central role in the study area and East Lindsey district. The STEAM report findings showed that in 2022 tourism generated £824 million of economic impact in East Lindsey, the highest since data was first recorded in 2011³⁶. The report also found that 4.5 million people visited in 2022, up 19% from the previous year, supporting almost 9,000 jobs³⁶. In 2022, almost £173 million of economic value was generated in the district's shops and over £163 million in cafes, restaurants and bars. The number of tourism related jobs also continued to slowly increase, to 8,918 in 2022³⁶.

Evidence shows that holiday spending per head in Lincolnshire is generally lower compared to other regions in the UK^{37,40}. This could be attributed to the lower cost of accommodation or availability of free or low-cost attractions. It could also be due to the built-in attractions and services in holiday parks and resorts in the area and the prevalence of self-catering accommodation, where visitors bring food with them. Tourism in East Lindsey also has a strong generational aspect with the same families visiting year after year³⁸.

OrVAL tool, commissioned by University of Essex, assigned a recreational value of £11 million per annum to the recreational assets in the study area. A key draw to these seaside towns are the variety of family friendly attractions including bowling and putting greens, crazy golf, amusement arcades, miniature railways and cafes. New tourism activities such as Lincolnshire Wolds Outdoor Festival, Horncastle Horse Fair and Louth Food and Drink Festival are also attracting people to the area.

Beaches bring a total of 1,149,590 visitors per year to the study area, and public footpaths an estimated 1,198,645 tourists per year⁵⁵. Recreational sites including parks and green spaces attract a total of 1,149,590 visitors annually⁵⁵.

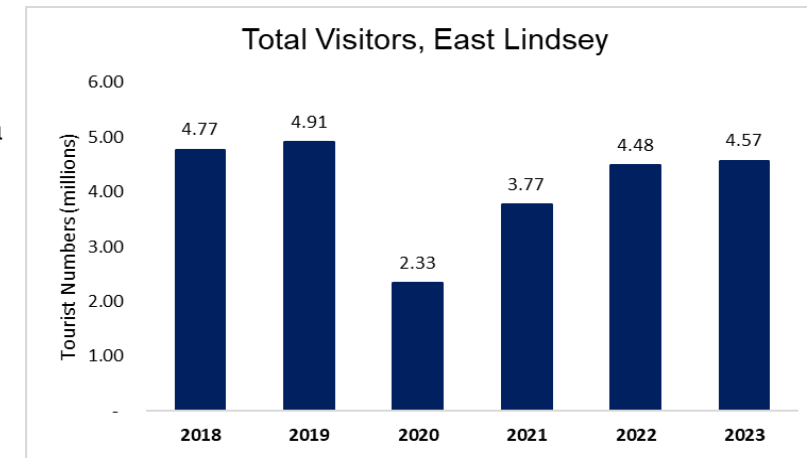
Domestic travel represents 75% of global travel and has recovered at a faster pace than international travel post COVID-19³⁹. There is evidence the tourism sector in East Lindsey has benefitted from 'staycations' post COVID-19 with a noticeable preference for non-serviced holiday accommodations like holiday cottages and self-catering options. According to a 2023 survey, half of respondents visiting Mablethorpe were from Sheffield (15%), Lincolnshire, (14%) from Nottingham (12%) from Doncaster/Grimsby (10%)⁶¹.

The figure on bottom right shows that during the summer months non serviced accommodation took up the largest share of visitors and that visitor numbers for 2023 were highest between May and September, peaking at 720,000 in August.

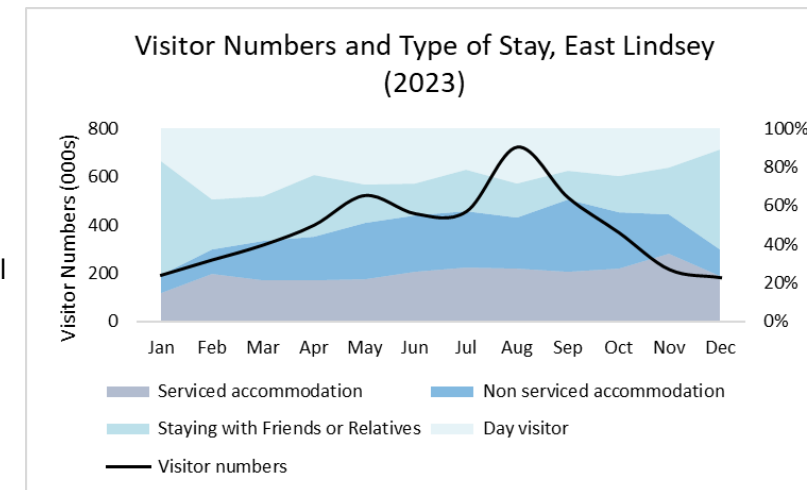
Looking at the five individual sectors that compose the visitor economy in East Lindsey, we observe that the shopping sector contributes the greatest economic impact at 29% followed by food and drink at 27.4%³⁶. The accommodation sector is also a major contributor particularly caravan parks and campsites. Local transport services including taxis and public transport also see a boost from tourism activities (12.9%).

East Lindsey has a higher proportion of visitors staying in the area for their whole trip, when compared to other British coastal resorts⁴⁰. Evidence shows that visitors to UK holiday parks and campsites stayed up to 74% longer than the national tourism average⁴¹. Postcode analysis shows visitors are most likely to be local to the wider area, coming from North-East, Yorkshire and East Midlands. Skegness and Springfields currently attract a more family orientated visitor demographic than other areas and visitors are more likely to be of a lower income level⁴¹.

26,099 caravans and mobile homes are located in the study area. 255 large caravan sites within East Lindsey located in five distinct clusters which make up 63% of all sites⁴¹.



Total visitors, East Lindsey. Source ELDC (2023)



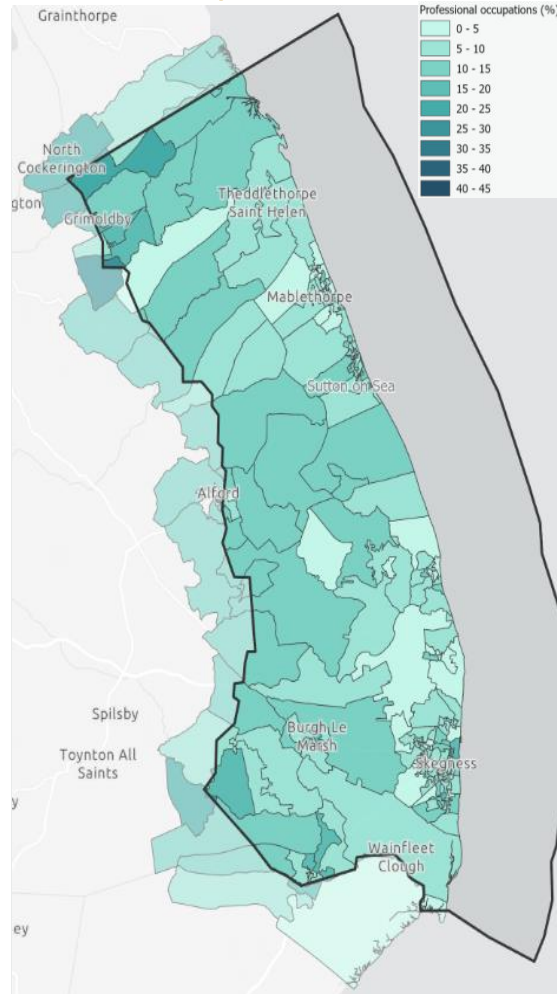
Visitor numbers and type of stay. Source ELDC (2023)

Business and sectors

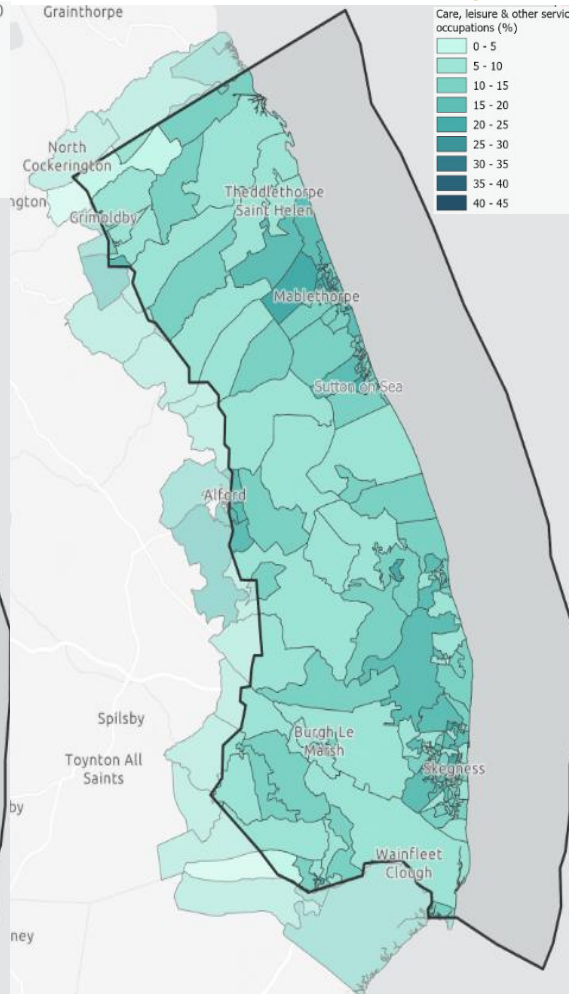
Sectors - high prevalence of skilled trade and caring and leisure businesses

The below figures provides a summary of occupational sectors within in East Lindsey. The data comes from ONS.

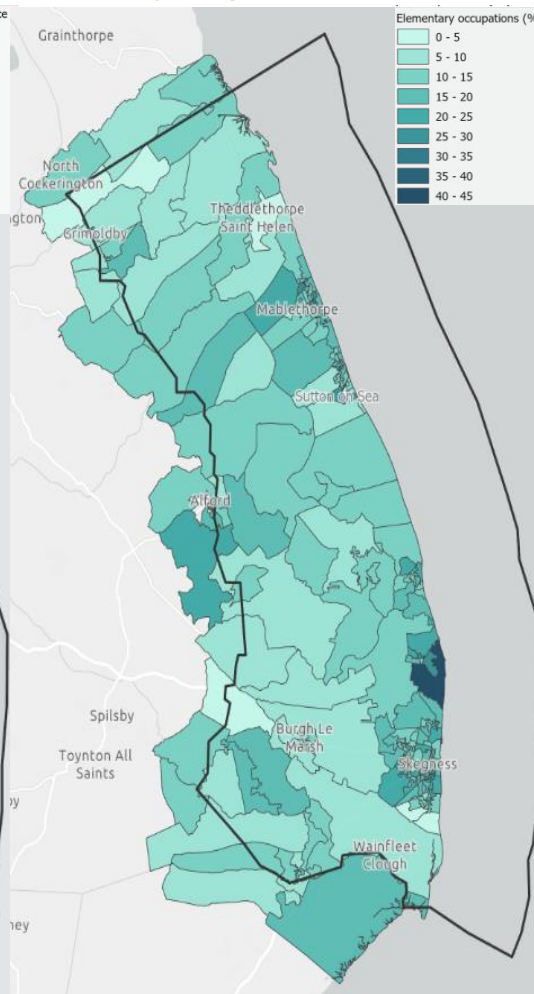
Professional occupations



Care, leisure and other services occupations



Elementary occupations



11.9%

Caring and leisure
(9.5% in East Midlands, 9.3% England⁴²)



14.5%

Skilled trade occupations
(10.8% in East Midlands, 10.2% England⁴²)



8.5%

Administrative and secretarial
(9.1% in East Midlands, 9.3% England⁴²)



12.2%

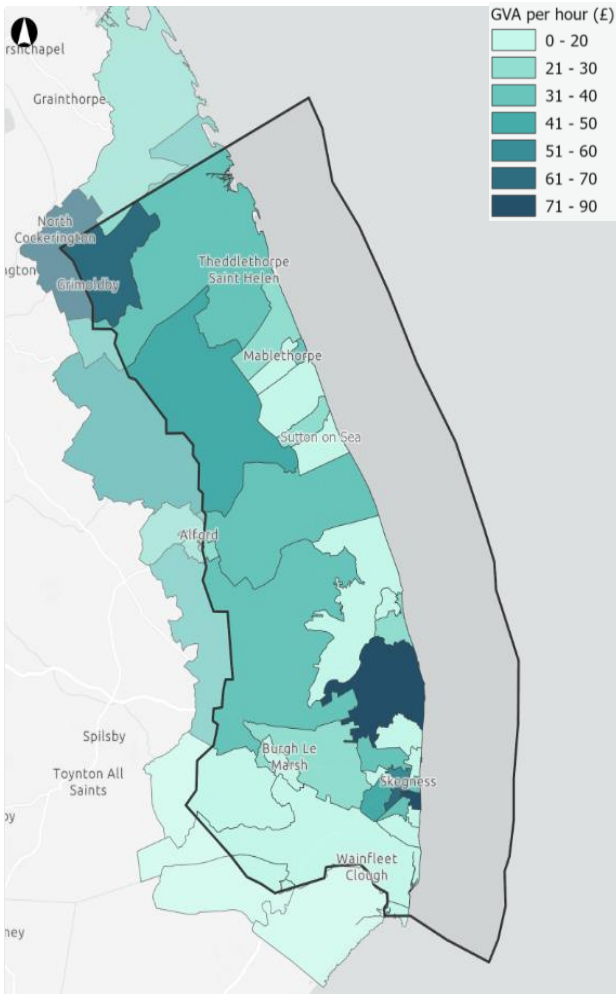
Professional trade occupations
(17.5% in East Midlands, 20.3% in England⁴²)

Business and sectors

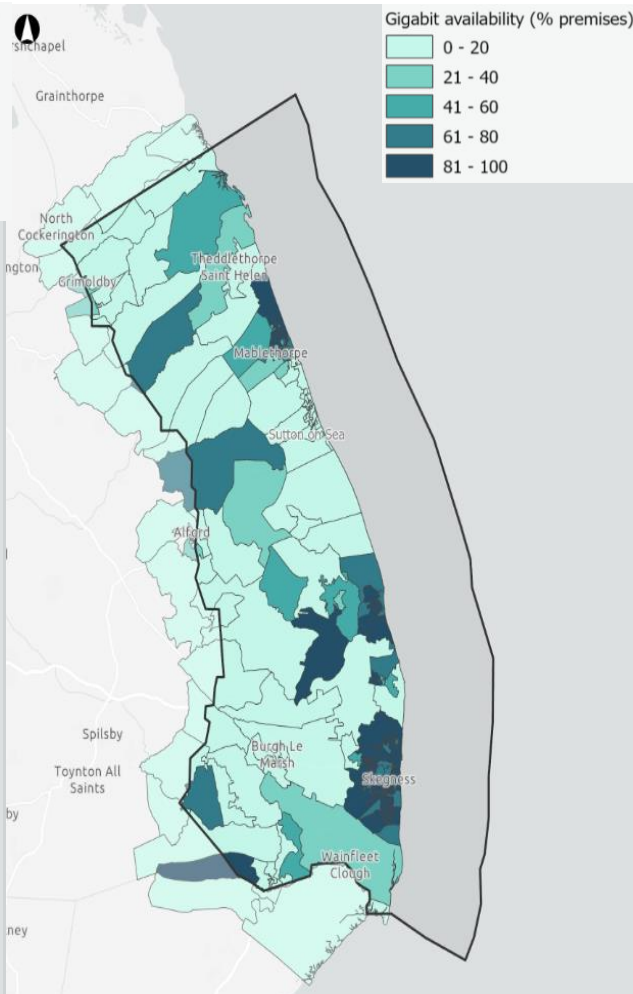
Types and productivity - Pockets of very low productivity and high rates of part time employment

The below figures provides a summary of the key data relating to key business and associated infrastructure activity. The data comes from Census 2021, ONS sources and Nomis.

GVA per hour



Gigabit availability



4.57
Number of Visitors to East Lindsey in millions, 2023
 (7% reduction since 2019⁴³)



1.00
Business startup/ death ratio
 (1.04 Lincolnshire, 0.97 England⁴⁴)



93.44%
Superfast Internet
 (East Midlands 98.4% and 98.3% England⁴⁵)



40.9%
Part time jobs
 (East Midlands 31.2% and 29.8% England⁴⁶)



£35.2
GVA Per hour worked
 (£39.7 per hour for UK⁴⁷)



98.6%
Micro/small enterprises (<50 employees)
 (England 97.6%⁴⁸)

Summary Socio-Economic Character Areas

Five socio-economic areas

The below high-level study area spatial analysis identifies five distinct areas characterised by shared socio-economic qualities. The spatial analysis helps summarise the baseline by grouping the study area into different, functional socio-economic spaces.

Area 1: Largest Economic Centre 'Skegness'

Skegness, the largest built-up area in the region, is a key economic hub. It attracts many visitors with attractions like Pleasure Beach, Skegness Pier, and the shopping centre, supporting a strong hospitality sector. The town has a high number of outlets per person (4.1) compared to the national average (2.0), including restaurants, bars, pubs, and sports facilities. Good transport links, including rail and road connections, enhance accessibility and support businesses. However, Skegness faces varying degrees of deprivation, with many residents lacking qualifications. Louth and Boston are also notable economic centres, just outside the study area, offering diverse sectors and employment opportunities for residents in the north and south of the study area.

Area 3: Seaside retirement 'Mablethorpe and Sutton on Sea'

The area has a very high prevalence of older adults, with some ranking among the top 0.5% oldest in the country. There is a high proportion of residents without qualifications, significant economic inactivity, and many care and leisure jobs. The town also faces high rates of ill health. Despite these challenges, the area is a popular tourist destination, known for its beautiful beach, promenade, food stalls, and clusters of caravan parks.

Area 5: Inland Rural 'Grimoldby, Alford and Burgh Le Marsh'

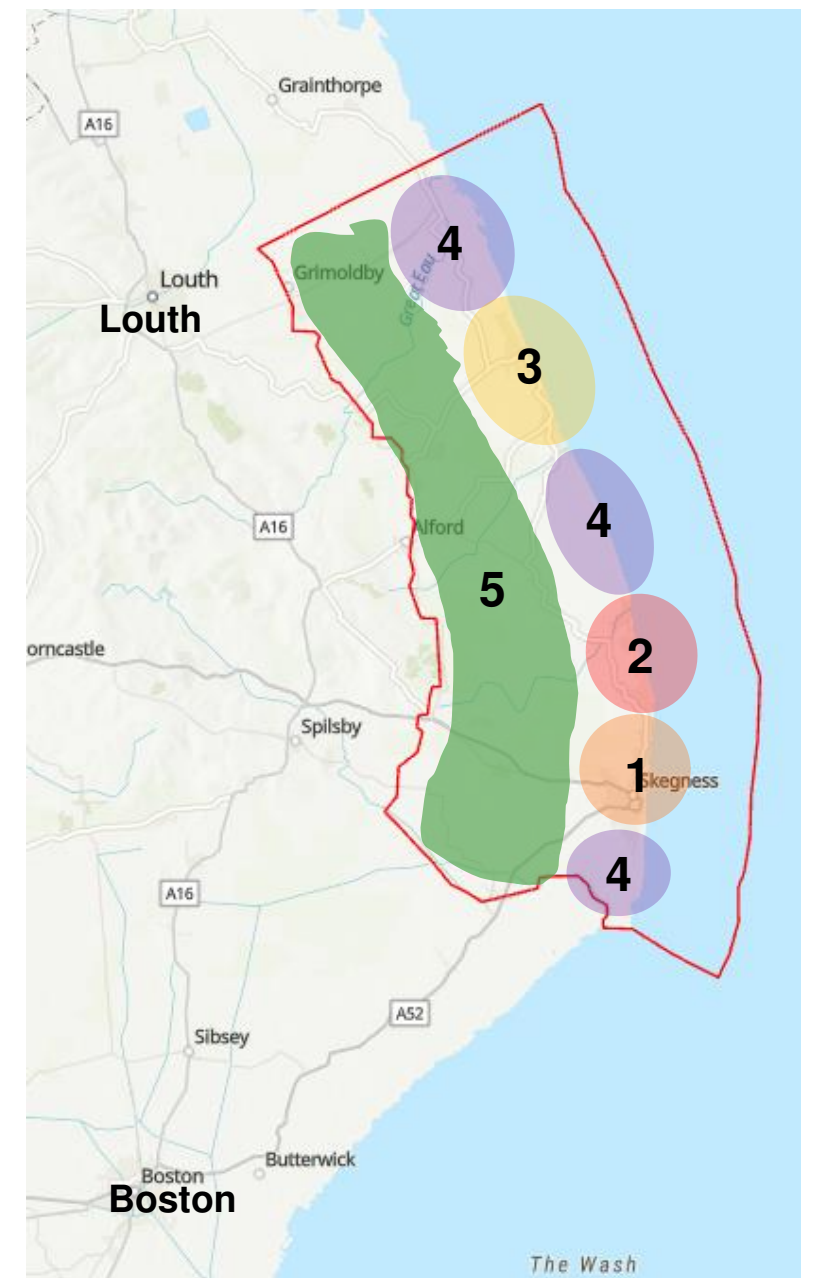
Small hamlets and villages experience lower relative deprivation and more agricultural jobs. There is a higher prevalence of NVQ Level 4+ attainment. Residents tend to live in detached, larger dwellings with poor broadband speeds. Employment rate is more agriculture focused and fewer accommodation and leisure jobs, with the latter still an important sector. Regular bus services operate between these towns, connecting them to Louth, which offers essential services, shopping, and employment opportunities for rural communities.

Area 2: Built visitor attractions 'Ingoldmells and Chapel St Leonard's'

There is a high concentration of caravan parks and holiday homes, such as Coastfields Holiday Village and Seaview Caravan Park, due to their proximity to large attractions like Fantasy Island theme park and Butlins. There is a significant share of residents without qualifications. The local economy features a large number of hospitality jobs. Manual, lower-skilled occupations are significantly higher here than in the rest of the study area. The area also plays a significant role in the local economy, particularly through contributions to the tourism sector. Efforts to extend the tourist season aim to create more year-round employment opportunities.

Area 4: Isolated coast and natural environment attractions 'Saltfleet and Seacroft'

Very low levels of population density with a focus on the natural environment, tourism and some agriculture. Higher value biodiversity and natural ecosystems. In the peak season, visitors come to enjoy the nature reserves and beaches in this area.



Lincolnshire Coastal Investment Plan – Socio-economics study area analysis. Source: Arup.

Conclusion

Strengths, Weaknesses, Opportunities and Threats (SWOT)

Strengths

- **Visitor Attractions:** Long coastlines, nature reserves coupled with holiday parks, theme parks and historic seaside towns. The area has been attracting repeat holiday makers for generations. Lower overall cost of living compared to south-west coastal towns. More affordable restaurants, transportation and sports and leisure activities⁵⁶.
- **Employment:** Employment in East Lindsey has been increasing in recent years. Of people aged 16 to 64 years, 74.3% were employed in the year ending December 2023, an increase from 61.8% in the year ending December 2022²³. Specialisms in accommodation and food and agricultural sectors when compared to the rest of England²⁸.
- **Entrepreneurship:** Viewed positively as a place to do business according to the East Lindsey Council business survey. Low cost of premises/rents/business rates and access to customers and suppliers is viewed positively by companies³⁴. Higher rate of 5-year business survival than the East Midlands and the UK³⁴. The agriculture, mining, and utilities sector has the highest proportion of businesses (19.8%), followed by business, finance and professional services (16.9%) and wholesale and retail at 15.8%³⁴.

Weaknesses

- **Deprivation:** Pockets of high deprivation, high percentage of households in Mablethorpe, Saltfleet, Sutton on Sea and Skegness deprived in two or more dimensions of deprivation²⁸. In East Lindsey 16.2% of the population was income-deprived in 2019, and it ranked 56th most income-deprived out of the 316 local authorities in England⁴⁹.
- **Low visitor spend :** Spending per night and per trip is lower compared to other coastal destinations like Cornwall, Great Yarmouth, and North Norfolk⁴⁰.

- **Transport connectivity and broadband speed:** East Lindsey has no motorways, high prevalence of single carriageway A-roads and a limited rail network and bus service. Limited public transport is also a challenge for those exploring the natural environment. Average broadband download speed lags behind other urban areas. In East Lindsey 93.44% of broadband coverage is classed as superfast, compared to 98.3% of coverage in the whole of England⁴⁵.
- **Low formal skills:** Lower proportion of residents aged 16 to 64 with a degree level qualification or higher and a higher proportion of people with no qualifications than East Midlands and the UK. Youth outward migration is an issue.

Opportunities

- **Growing Population:** East Lindsey's population is expected to increase by 14.9% by 2043, and at a faster rate than the rest of England. Opportunity to diversify the economy beyond tourism, larger workforce providing local businesses with a wider pool of talent and higher tax revenues for the local government. There needs to be a shift in ambition and entrepreneurial spirit to attract and retain a young, diverse workforce.
- **Quality of environment:** Adjacent to the Lincolnshire Wolds, the only Area of Outstanding National Beauty (AONB) in the East Midlands. Existing promenades at Mablethorpe and Skegness are accessible to less physically able visitors. There is ample opportunity to use the natural environment to help local communities get active, improve well-being and learn new skills.
- **Focus for regeneration investment:** East Lindsey successful in securing more than £40million of funding from the Government's Towns Fund, with £24.5million being awarded to Skegness and £23.9million being awarded to

Mablethorpe³⁴. Opportunities to enhance the town centre and offer training to improve skills provision in the area.

- **Visitor Economy:** Opportunities to benefit from new tourism trends, including wellness, outdoor adventures, sustainable/eco tourism and cultural experiences. Focus on nature tourism, particularly birdwatching and the England Coast Path. Opportunity to develop high quality accommodation catering to bird watchers. There is an opportunity to make the Lincolnshire coast a year-round destination (see Visitor Economy Appendix for more detail).

Threats

- **Reliance on tourism:** East Lindsey's economy is reliant on tourism with 9,000 jobs supported by the 4.8 million people visiting per year⁴⁰. It has a seasonal nature with demand peaking between May and September.
- **Ageing population and pressure on public services:** Between 2011 and 2021, the number of people aged 75 to 84 increased by 31.1%. An ageing population will increase the demand for health and social care services which could strain local hospitals and clinics. More retirees and fewer working age individuals could create labour shortages and a reduction in economic output. An ageing population could also mean fewer opportunities in fields that typically attract younger professionals, such as technology and innovation.
- **Ageing infrastructure:** Significant areas of under investment in seaside resorts and associated attractions make it challenging to attract higher-spending segments of the market⁴⁰. Many roads in the study area are in need of repair and modernisation, suffering from worn surfaces, potholes and outdated drainage systems⁵⁹. There is a lack of cycling infrastructure with few dedicated cycle lanes and bike parking⁵⁹.

05

Environmental Baseline

Introduction

Environment

The Lincolnshire coast (Lincolnshire Coast 2100+) study area possesses a rich and varied built and natural environment, primarily characterised by its flat, lowland topography dominated by agriculture, and its extensive surface water and drainage network. This Environmental Baseline aims to inventory and describe the current state of the environment within the study area and its wider regional context. It aims to identify:

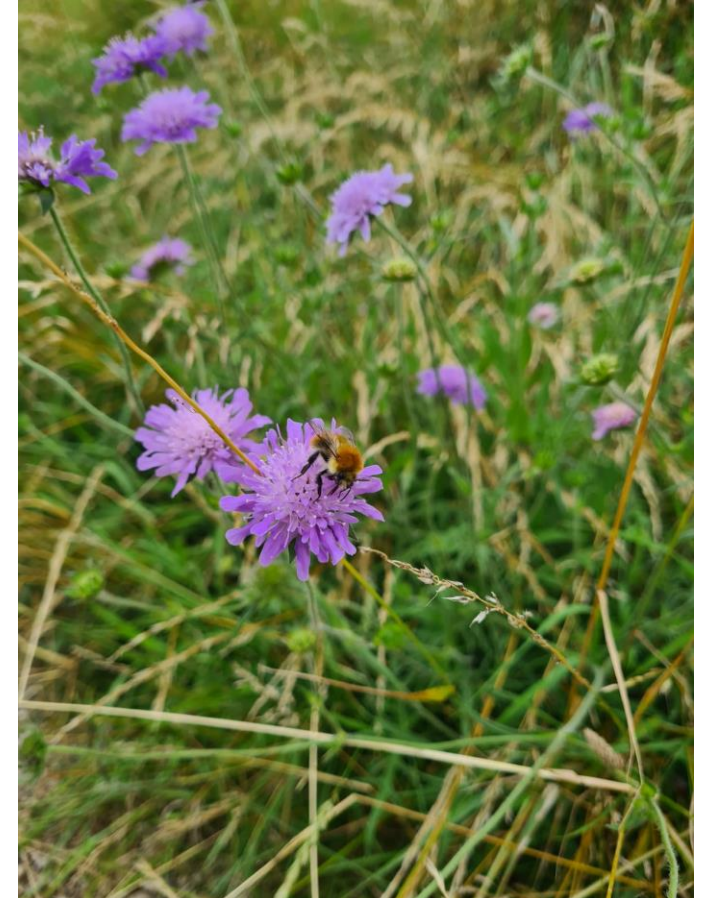
- Key environmental features, including natural environment and landscape, land use, historic and cultural heritage.
- Where appropriate, any designations, condition status, or assigned importance to a feature.
- Any existing environmental pressures, pollutants or other adverse impact sources.
- Mapped locations of key environmental features identified.

This report section links in closely with the associated Natural Capital Assessment, which addresses specifically those elements of the natural environment deemed to provide valuable goods and services to people and communities – offering a quantification of the economic value of a natural feature or system. The NCA in particular addresses topics surrounding Ecology and Biodiversity, as well as land use.

Data sources

A number of further data sources have been drawn upon in the production of this report, including:

- Anglian Water – Water Framework Directive Assessment¹
- Department for Energy Security & Net Zero – 2022 Local Authority and Regional GHG Emissions (dataset)²
- EA Catchment Data Explorer³
- EA Coastal Morphology Report – Lincolnshire (2011)⁴
- East Lindsey District Council Air Quality Annual Status Report 2024⁵
- East Lindsey District Council Sustainability Report 2016⁶
- Place Based Carbon Calculator⁷
- UK Soil Observatory⁸



Flora and fauna at Saltfleetby-Theddlethorpe Dunes Nature Reserve

Water

Catchments & Status

Local Catchments

The project area is situated wholly within the **Steeping and Eaus** operational catchment as defined by the Environment Agency's River Basin Management Plans. The RBMP breaks down the catchment location as follows:

River basin district: Anglian

Management catchment: Witham

Operational catchment: Steeping and Eaus.

Steeping and Eaus is described as predominately rural with small settlements and historic market towns. It is dominated by the Lincolnshire Wolds AONB within the project area and contains a significant number of important chalk streams – possessing unique and distinctive aquatic biodiversity.

The eastern boundary is coastal floodplain and all watercourses flow east to the North Sea. Some are natural, while many others are manmade drainage channels, which combine to for linkages with other semi-natural habitats There are protected areas including important bathing waters, Natura 2000 sites, and urban wastewater directive sensitive sites.

WFD Status

The Water Environment (Water Framework Directive) (England and Wales) 2017 transposes the terms of the EU Water Framework Directive (WFD) into law in England and Wales. It requires that protection and improvement of all rivers, lakes, estuaries, coastal waters and groundwater within the project area.

The key aspects for which objectives and targets for improvement must be set are:

- Aquatic ecology and water chemistry;
- Impacts of physical modification of water bodies;
- Specific unique and valuable habitats;
- Drinking water resources;
- Bathing waters and coastal waters used for shellfish aquaculture

The catchment of Steeping and Eaus contains 15 WFD named water bodies, all of which intersect the project area. There are a number of watercourses failing, or at risk of failing **WFD** targets, and river quality is generally classified as 'Moderate' overall.

Status	Definition	WFD Water body	Status
High	Near natural conditions. No restriction on the beneficial uses of the water body. No impacts on amenity, wildlife, or fisheries.	Anderby Main Drain	Moderate
		Boygrift Drain	Moderate
		Burwell Beck	Moderate
Good	Slight change from natural conditions as a result of human activity. No restriction on the beneficial uses of the water body. No impact on amenity or fisheries. Protects all but the most sensitive wildlife.	Cow Bank Drain	Moderate
		Great Eau (downstream of South Thoresby)	Poor
		Great Eau (upstream of South Thoresby)	Bad
Moderate	Moderate change from natural conditions as a result of human activity. Some restriction on the beneficial uses of the water body. No impact on amenity. Some impact on wildlife and fisheries.	Ingoldmells Main Drain	Moderate
		Long Eau	Moderate
		Lymn / Steeping	Moderate
Poor	Major change from natural conditions as a result of human activity. Some restrictions on the beneficial uses of the water body. Some impact on amenity. Moderate impact on wildlife and fisheries.	Sea Bank Clay Pits (lake)	Good
		South dyke and Grayfleet Drain	Moderate
		Trustthorpe Pump Drain	Moderate
Bad	Severe change from natural conditions as a result of human activity. Significant restriction on the beneficial uses of the water body. Major impact on amenity. Major impact on the wildlife and fisheries with many species not present.	Wedlands and North Drains	Moderate
		Willoughby High Drain	Moderate
		Woldgrift Drain	Moderate

Definition of status: Water Framework Directive

Water Framework Directive Status

Water

Water Quality & Resource

Water Resources

The entirety of the project areas' potable water supply is provided and managed by Anglian Water.

Water resource and supply has been assessed, taking account of forecasted growth, and is not currently considered to be under pressure. As of 2016, ELDC had 230 potential housing development sites as part of their *Strategic Housing Land Availability Assessment (SHLAA)*. Various studies and reports were undertaken, including a Water Cycle Study (JBA, 2016), a Water Resource Management Plan (WRMP), and Anglian Water's Water Resource Assessment (WRA), which collectively concluded that adequate water resource provision has been made for the housing growth forecast for the region.

Saline Intrusion

However, saline intrusion along the Lincolnshire coast is a growing concern due to a combination of factors including groundwater extraction (for potable supply), sea level rise, and permeable geological conditions. This poses a risk to freshwater resources, as well as agricultural productivity, and biodiversity of aquatic ecosystems. Without proactive management strategies, the impact on coastal communities here is likely to increase in line with future climate change.

Water Quality

Surface: Water quality overall has been noted to have been improving (2001-present). This may, in part, be due to reductions in abstraction licensing increasing the dilution ratio of surface water to groundwater (from blow wells).

These blow wells are commonplace across the East Lindsey District, feeding the **significant number of designated nationally important chalk streams**, known for their exceptionally high standard of water quality, and entitled to special legal protection and enhancement clauses.

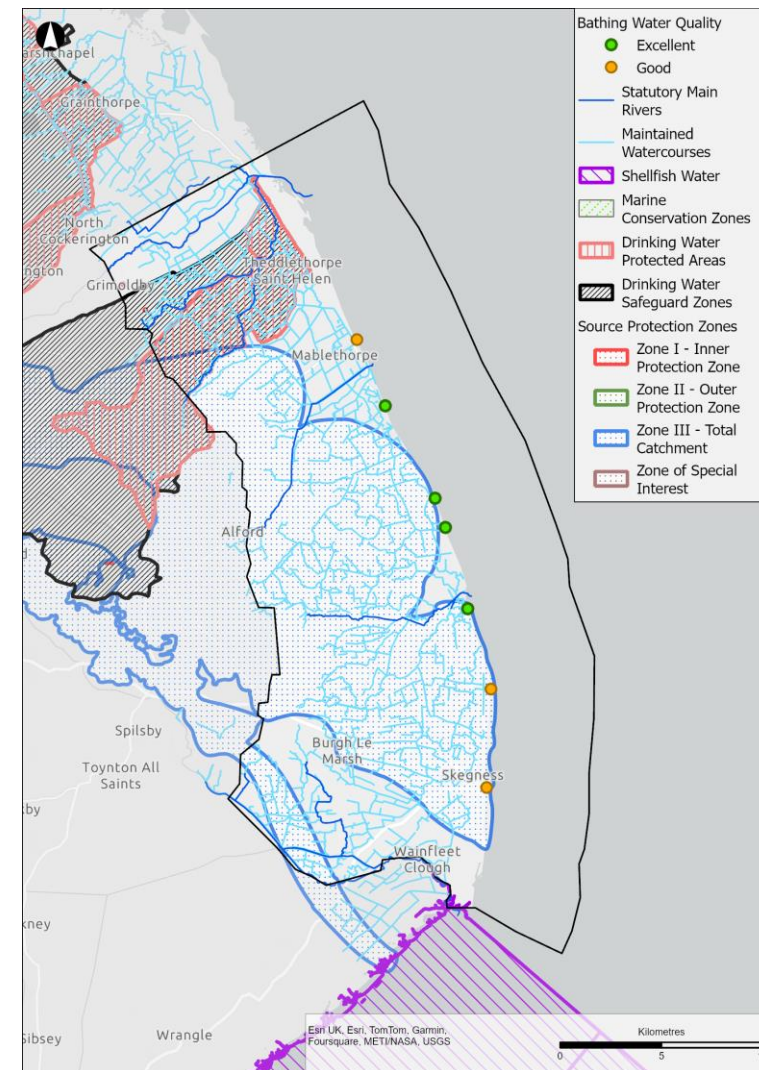
Groundwater: The approximate eastern half of the district is comprised of chalk bedrock classified as '**Principal Aquifer**', with a small southern area classified as '**Secondary B Aquifer**'. There is a **Source Protection Zone 1 (SPZ)**, sensitive to contamination, intersecting the north of the project area.

The project area falls within the **South Lincolnshire Chalk Unit (WFD)**. The overall status of this groundwater body in 2019 was **Poor**. The *Groundwater Bodies Quality (England) map* further indicates the quality of groundwater bodies as defined by both chemical status and a trend assessment. The project area falls wholly within the '*There is an existing problem*' category, due to the diffuse phosphorus and nitrate pollution from agricultural runoff.

Designated Bathing Waters

There are 6 coastal bathing water locations within the project area - All bathing water designations achieve an 'excellent' classification (2019):

- Anderby
- Chapel St Leonards
- Ingoldmells South
- Moggs Eye
- Skegness
- Sutton-on-Sea



Water environment - quality and resource mapping.

Landscape Character & Land Use

Types & Classification

Land Use Types

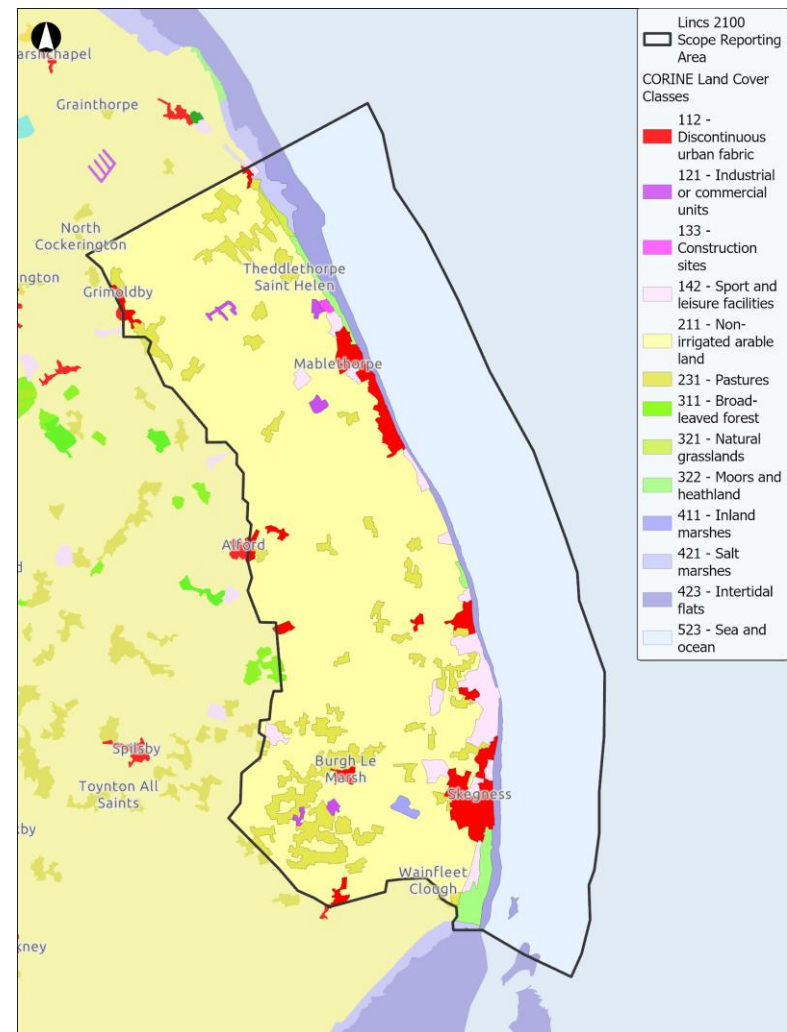
More than 95% of East Lindsey is classified as rural with a predominantly versatile and high-quality agricultural landscape, with a widespread settlement pattern born from a history of small farming communities and local markets. It contains a number of broad-leafed forests, primarily situated in the west of the district and within the Lincolnshire Wolds; one site is situated within the project area and is further designated as an 'Ancient Woodland' priority habitat (falls within Corine class 311).

There are two distinctive **National Character Areas (NCA)** within and the study area:

Lincolnshire Coast and Marshes: Situated north of the River Steeping and characterised as a flat, expansive area containing hedge-lined fields with some localised treescapes. The area has an extensive network of drainage ditches managed by internal drainage boards.

Lincolnshire Wolds: Bordering the western boundary of the study area, the Wolds are characterised by wooded valleys, large arable fields, and large open plateaus of rolling hills.

The Perimeter boundaries of the Wolds are additionally classified as an **Area of Great Landscape Value**.



CORINE Land Cover Classes

Landscape Character & Land Use

Types & Classification

Agricultural Land Classification

Approximately 30,000Ha of land within the Lincolnshire Coast 2100+ study area is classified as agricultural. The Agricultural Land Classification (ALC) is a grading system that assesses and compares quality of agricultural land in England and Wales, as determined by the climate, topography, and soil characteristics. The ALC aims to be indicative of:

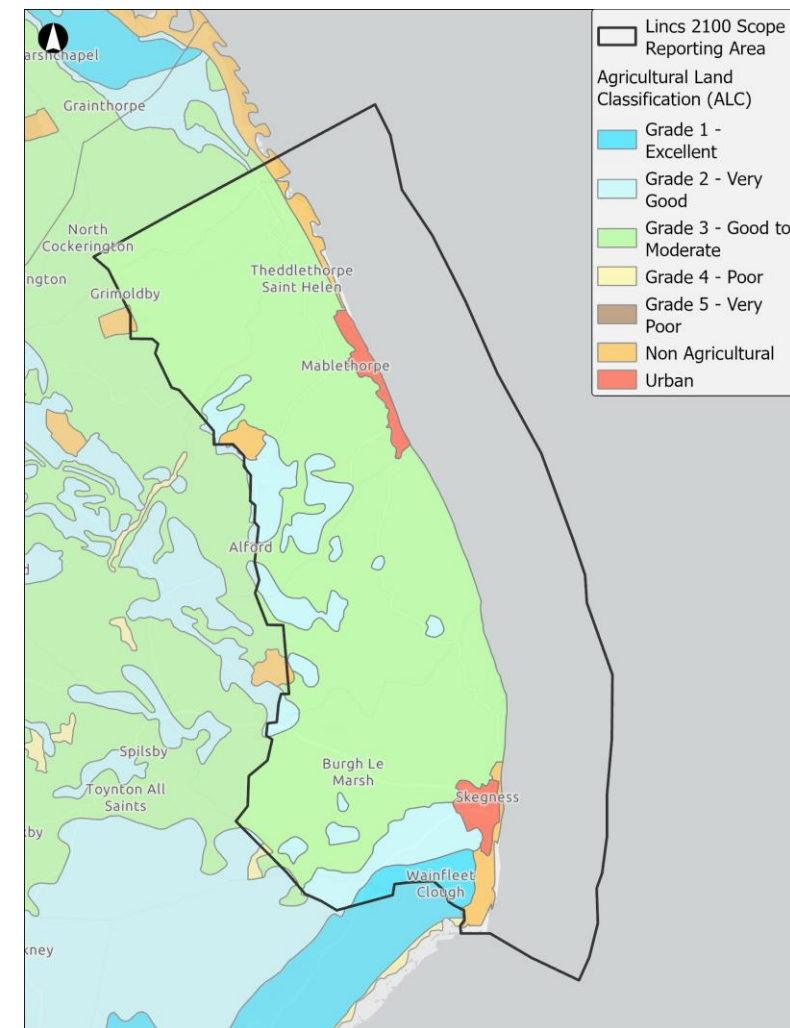
- Range of crops that can be grown
- Yield of crop
- Consistency of yield
- Cost of producing crops.

There are some areas of ALC grade 1 ('excellent quality') inland from the Wash and Humber coastal areas. The Lincolnshire Wolds, the central, and the south regions have areas of ALC grade 2 ('very good quality'). However, the project area is predominantly covered by grade 3 ('good to moderate').

Government policies and legislation provide protections to the **best and most versatile (BMV) agricultural land** from 'significant, inappropriate, or unsustainable development proposals. BMV land includes grades 1, 2, and 3a. While ALC maps do not differentiate between grade 3 sub-categories, predictive spatial analyses suggest that the majority of G3 within the project area is likely to be BMV. To confirm this locally, site surveys would generally be required.

Key Local Issues

- Decline and loss of chalk grasslands (falls within Corine class 211/231/321 in map) and quality hedgerows.
- Decline of beech clumps and woodlands.
- Potential adverse impact to archaeological features from agriculture.
- Abandonment of remote farms and cottages.
- Lack of awareness of the unique geomorphology in the area.
- Threats to visual landscape.



Agricultural Land Classifications

Ecology & Biodiversity

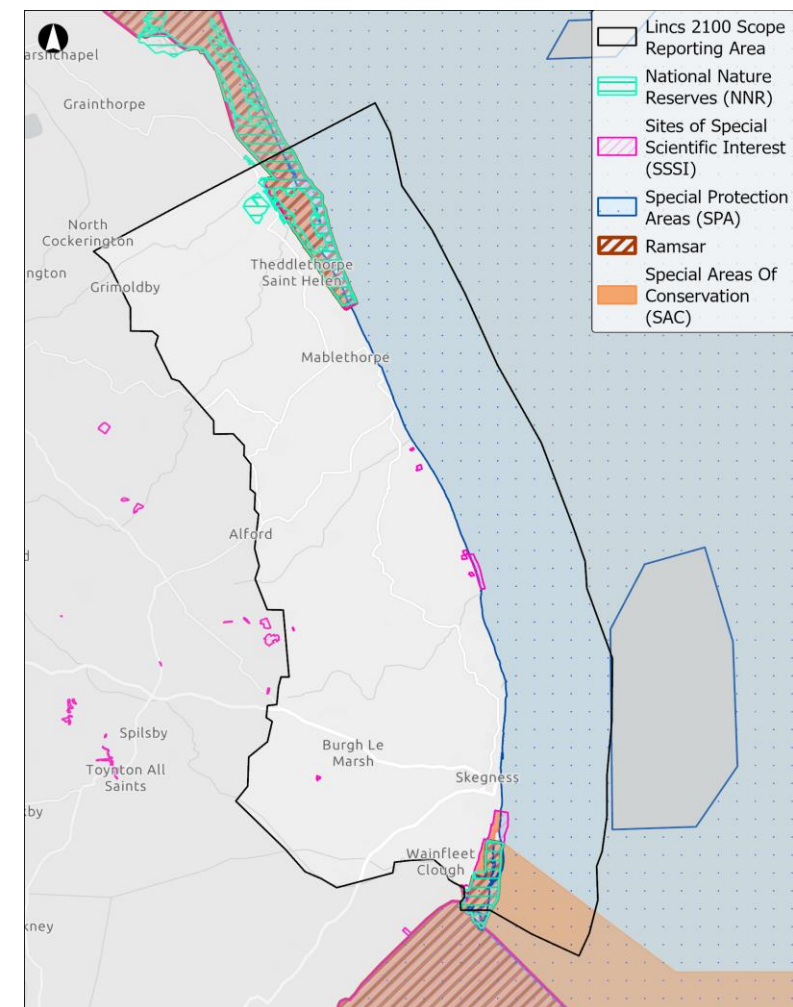
Designations

Designated Biodiversity Sites

Within the district there are a number of designated habitats of local/regional/national/international importance for their perceived nature conservation value.

However, away from the coastline, the district has below national average coverage of protected sites. The Lincolnshire Coast 2100+ study area contains approximately 22,600Ha of protected statutory designation coverage pertinent to biodiversity conversation, equating to 40% of the total project area. However, the vast majority – approximately 20,000Ha, are marine habitats.

Tier	Designation	Total #	Area (ha)
International	Ramsar	2	2,480
European	SPA	2	2,480
National	SAC	3	2,570
National	NNR	3	1,095
National	SSSI	47	2,706
Local	Wildlife Site	220	
Local	LNR	4	



Statutory Designated Sites

Ecology & Biodiversity

Designations

Priority Habitats

Approximately 1,300Ha of priority habitats – including coastal saltmarshes, mudflats, deciduous woodland, semi-improved grassland, and coastal floodplain grazing marsh are present, the majority of which is situated within designated areas. Biodiversity is considered to have a low baseline condition overall.

Other notable habitat types within the project area are:

- Shellfish waters
- WFD Higher Sensitivity Habitats (saltmarsh, chalk reef, and biogenic reef).
- Ancient Woodland

Lincolnshire Chalk Streams

Chalk streams are internationally rare habitats unique to South and East England and Normandy in France. They have a history of neglect due to long-standing land use practices.

Lincolnshire's chalk streams are fed predominantly by blow wells, a type of groundwater spring of which, on the British isles, is unique to the coastal margins of Lincolnshire. Highly purified, clear water emerges from them at a constant temperature of 10C, making it ideal aquatic conditions for rare and threatened plants and animals such as water crowfoot, water vole, otter, European eels, and brown trout. Additionally, the highly seasonal variation in flow

characteristic of chalk streams, creates 'winterbourne' stretches at their headwaters, further providing uniquely biodiverse invertebrate communities adapted to these conditions.

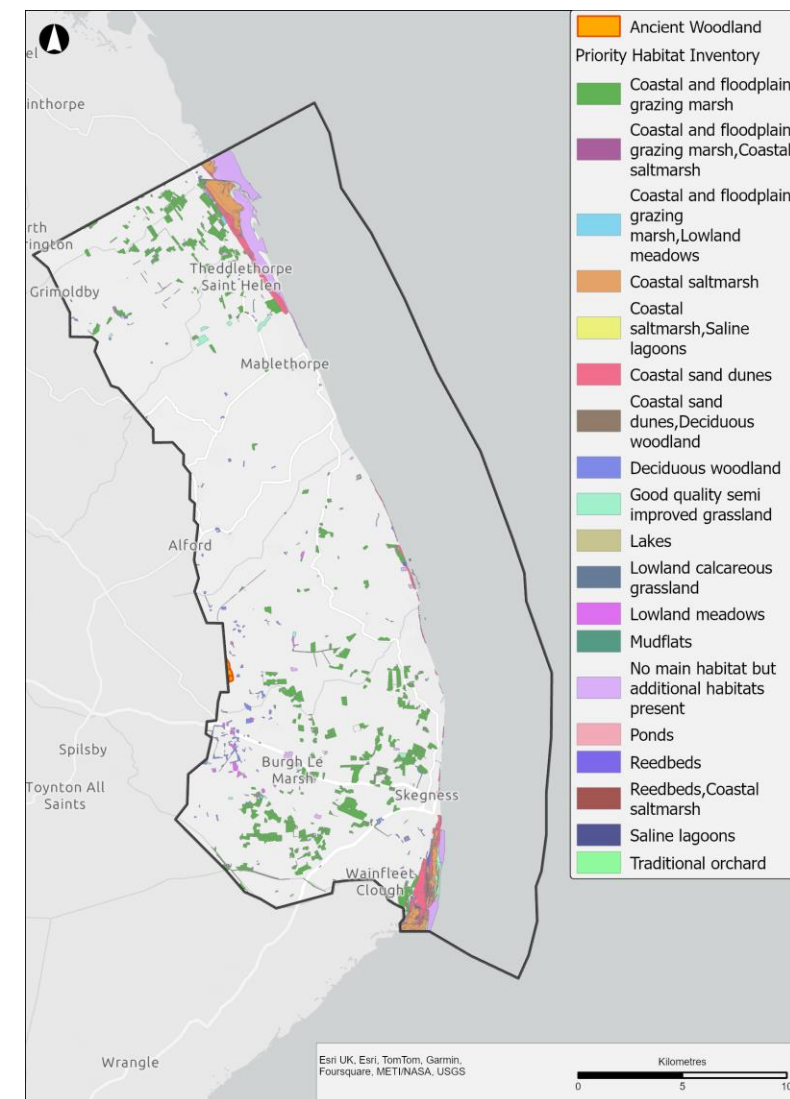
Since 2011, habitat restoration and improvement works have taken place across >18km chalk stream in Greater Lincolnshire via the **Greater Lincolnshire Nature Partnership** primarily through Natural Flood Management (NFM) and Nature Based Solutions (NbS) focussed-projects.

Designated Ancient Woodland

Designated ancient woodland sites are prevalent across the Lincolnshire Cliff area, to the west of the project boundary. The project area itself contains over 1 designated ancient woodland site (Welton Low Wood), situated on the western project boundary, north of Welton le Marsh. The designated area is situated approximately 10km inland and as such is not considered to be a key environmental constraint.

Local Nature Recovery Strategy (LNRS)

LNRS aim to build the Nature Recovery network and improve natural locally for the benefit of wildlife and people. The Greater Lincolnshire LNRS is in its infancy, commencing in Q4 2023. It aims to map local habitats, NFM and conservation opportunities, and biodiversity recovery priorities. East Lindsey Council is not currently part of this LCC led partnership – which presents a potential opportunity for future collaboration in guiding BNG aims and actions.



Geology & Soils

The Lincolnshire Coast provides a rich variety of geological environment. The lowlands are underlain by clays and mudstones, bordered primarily of red and white cretaceous chalk with a limestone coastal hinterland, sandstone southern boundary. These formations were created during the Middle Jurassic period and are usually only a few metres thick.

More recently, during the Quaternary period at the end of the last glacial, gravel and clay deposits formed alongside a very fine sand which was blown across large parts of greater Lincolnshire forming the well-known ‘Coversands’ – which are now quarried for glass manufacture and foundry sand. There are additional superficial deposits or glacial till, fluvial sands and gravels, peat and estuarine/marine silts, offering unique variety of character along the coast and hinterland. The soils are characterised as fertile and loamy, slowly permeable, and seasonally waterlogged.

Designated Geological Sites

The project area contains 3 sites with designations pertinent to their geological features:

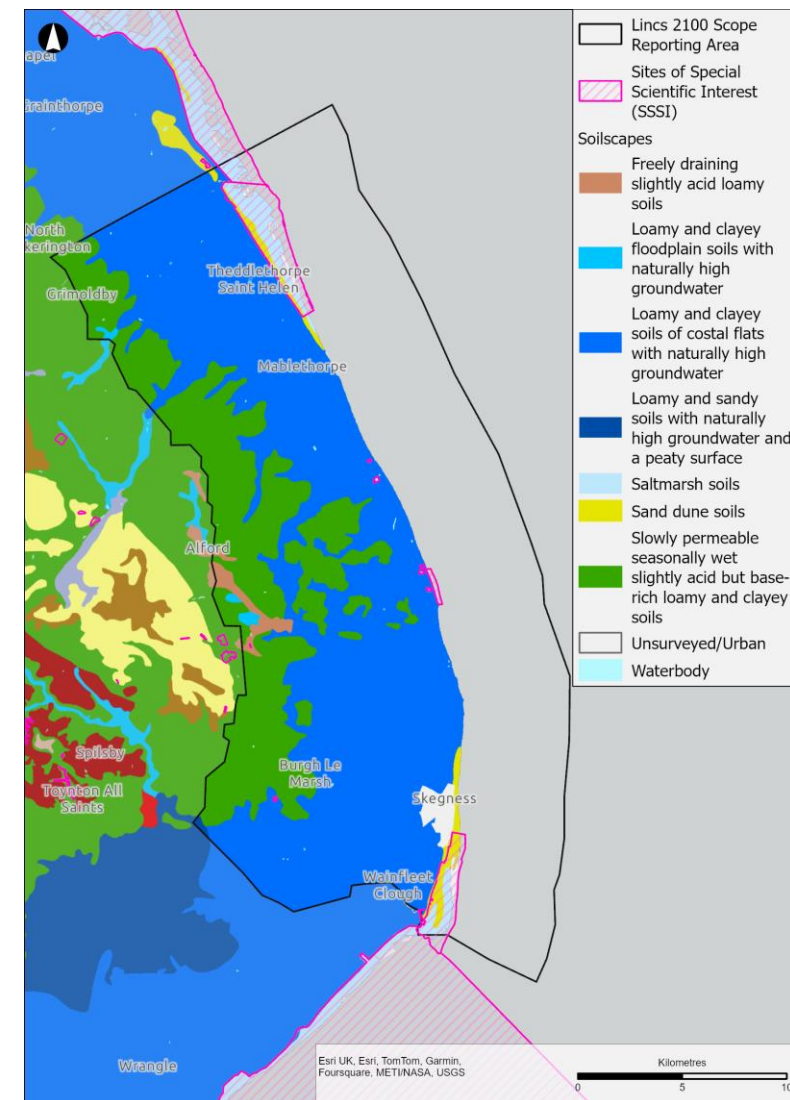
- Chapel Point to Wolla Bank SSSI⁹
- Humber Estuary SSSI¹⁰
- Gibraltar Point SSSI¹¹

Coastal Erosion

The Lincolnshire Coast is defined by its diverse mixture of dune and flood plain, saltmarsh, and soft cliffs. Due to the absence of ‘hard rock’ coastal area, large proportions of the coast are highly vulnerable to marine flooding and erosion. The region is well characterised by significant and ongoing coastal erosion which has shaped the numerous dunes and beaches in their current form. While these processes have exposed various geological formations and created vast, unique coastal landscape features, significant proportions of coastal land are being artificially supported to prevent the loss of development and infrastructure located in vulnerable areas.

It is anticipated that **climate change** and associated **sea level rise** will heavily exacerbate these existing issues in future. Vast investment has been made into coastal mitigation resilience using both hard and soft engineering solutions over the last century – resulting in a coastline heavily reliant on artificial support to prevent further loss of built and natural environmental assets.

The regional coastline is subject to ongoing detailed monitoring and beach nourishment by the EA since 1991. This activity, known as the ‘Lincshore Project’, is one of the largest beach nourishment programs currently running in the UK, covering the coastline from Mablethorpe to Skegness.



Air Quality & Pollution

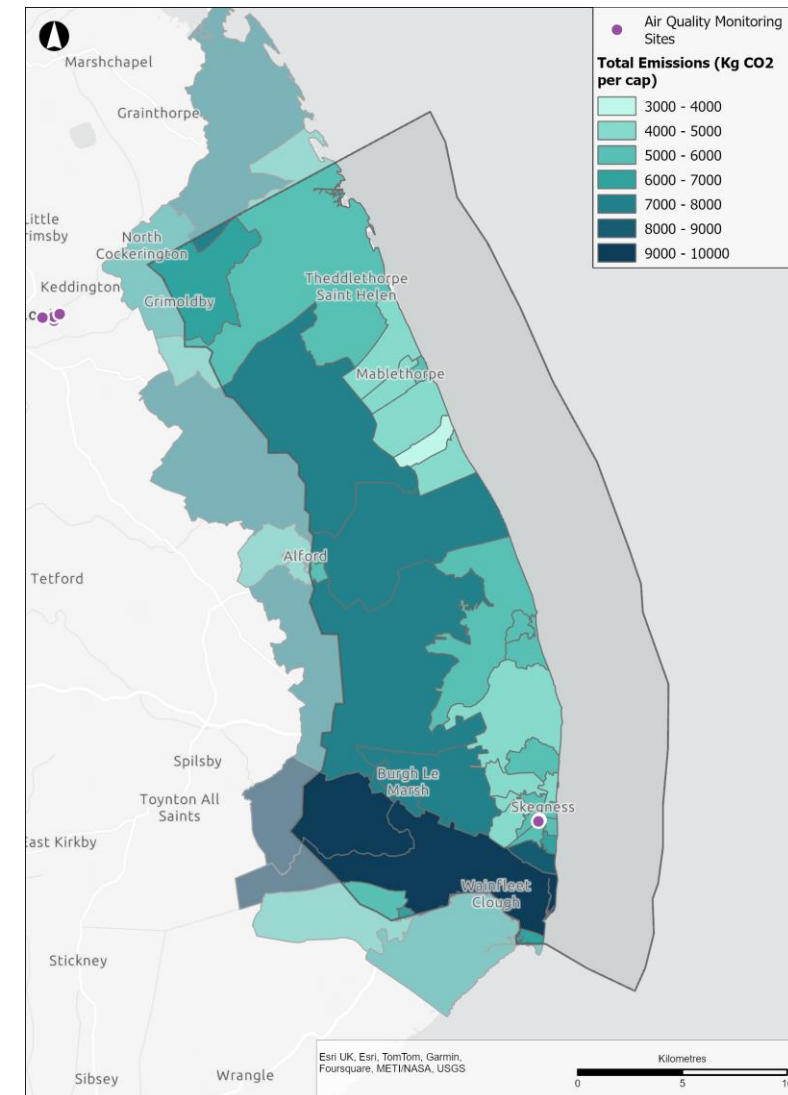
Sources, Monitoring & Management

The primary source of air pollution in the East Lindsey district is from **vehicular emissions**, concentrated around road networks (A158, A52, A16, A1028) leading into the main urban areas of Louth, Horncastle, and Skegness. However, only Skegness is situated within the project area. NO₂ monitoring was conducted at these locations in 2023, and concentrations deemed to be significantly below the AQ objectives upper thresholds. As such, there are currently **no designated AQMAs** within or adjacent to the project area. Further, ELDC have declared that monitoring data indicates there is minimal risk of any AQ threshold objectives being exceeded in coming years and so there are no plans to introduce any AQMAs in the short-term future. Instead, their existing diffusion tube network will be maintained and reviewed around these urban areas to ensure objectives continue to be met. Monitoring site **H1** (Horncastle, outside project area) has consistently recorded the highest annual mean NO₂ concentration (2019-2023), most recently at 25.5ug/m³, well within English AQ objective limits of 40ug/m³.

Management & Mitigation

ELDC participates in the DEFRA funded Lincolnshire Clean Air Project in collaboration with LCC and 6 other district councils¹². It focuses on awareness raising, public education, and guidance on air quality and links to health and how the public can help reduce air pollution. The project also partners and collaborates with 8 local Lincolnshire schools and some local businesses. Additionally, **ELDC** are undertaking an Air Quality Strategy in 2024 (ongoing).

Pollutant	Description
Nitrogen Dioxide (NO ₂)	Nitrogen dioxide is a gas which is generally emitted from high-temperature combustion processes such as road transport or energy generation.
Sulphur Dioxide (SO ₂)	Sulphur dioxide is a corrosive gas which is predominantly produced from the combustion of coal or crude oil.
Particulate Matter (PM10 and PM2.5)	Particulate matter is everything in the air that is not a gas. Particulates can come from natural resourced such as pollen, as well as human made sources such as smoke fires, emissions from industry and dust from tyres and brakes. PM10 refers to particulates under 10micrometres. Fine particulate matter or PM2.5 are particles under 2.5 micrometres



Carbon

Targets and inventories

Context

The UK is legally committed by the Climate Change Act to bring all greenhouse gas emissions to Net Zero by 2050. East Lindsey has a responsibility to reduce greenhouse gas emissions within the district and contribute to the UK's wider goal of Net Zero.

Department for Energy Security & Net Zero (DESNZ) GHG reporting

The DESNZ have published their latest estimates for greenhouse gas (GHG) emissions for local authorities in the UK for 2005-2022¹³. From this document, GHG (carbon equivalent) emissions have been summarised for each sector pertaining to East Lindsey for 2022 (see table). The following slide shows how GHG emissions have changed over time.

Key reflections on this data include:

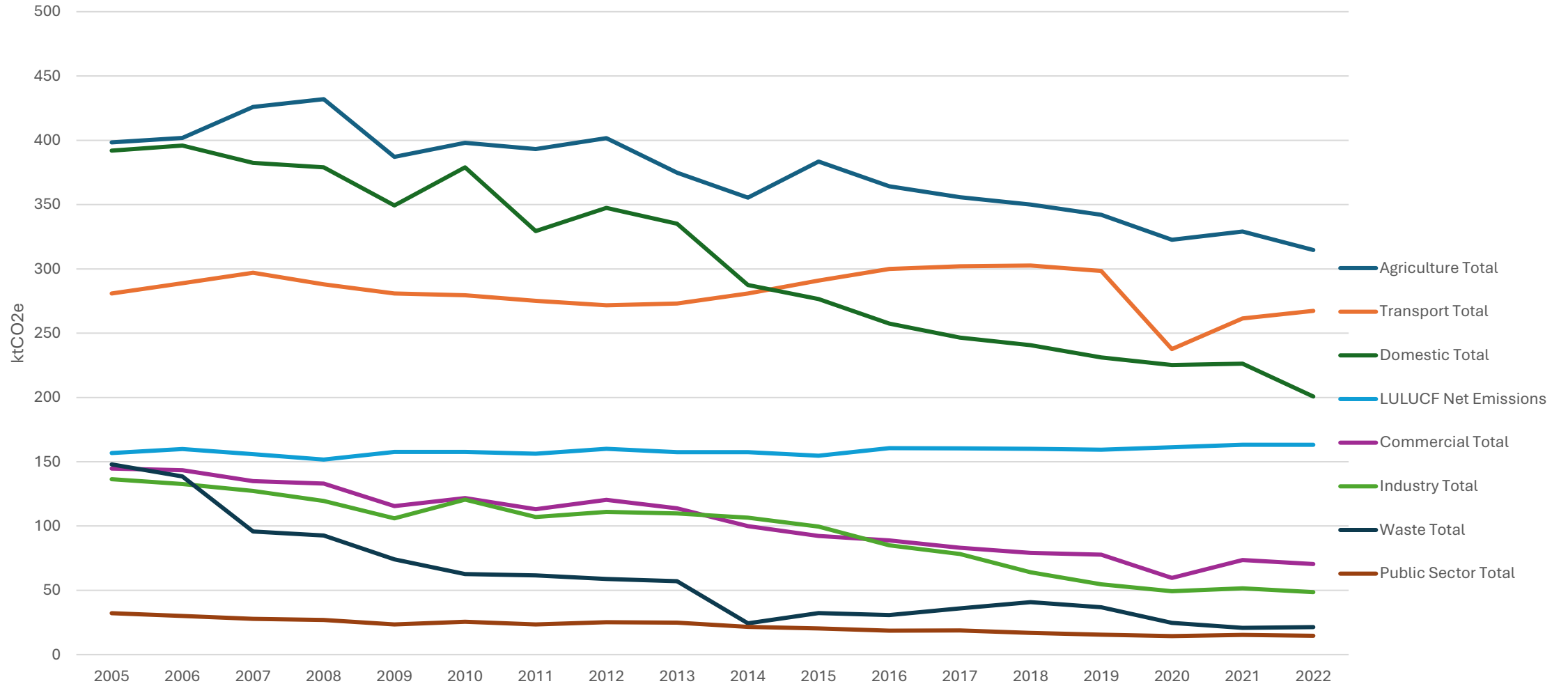
1. East Lindsey had greater emissions per capita than the national average, however significantly less emissions per square kilometre.
2. Agriculture and Transport emissions make up the highest share, but LULUCF and Domestic emissions are also significant.
3. Domestic emissions have reduced significantly, but this is likely largely driven by reduced emissions intensity of electricity production. Similarly for commercial emissions.
4. Significant further action is required to reach net-zero and contribute to the UK's net-zero journey more broadly.
5. The presence of nitrous oxide and methane is significant in Agriculture and Waste, whereas the overall GHG emissions for the other categories are dominated by the emissions of carbon dioxide.

Category	Emissions Definition	GHG Emissions 2022 (ktCO ₂ e)	Proportion
Agriculture	The emissions within the agriculture sector consist of GHGs produced by agricultural machinery, livestock, and agricultural soils.	315	29%
Transport	Includes freight and passenger transport for private and business use, with road transport as the main source of UK GHG emissions. Estimates are based on traffic distribution, therefore some emissions within local authorities will represent 'through traffic', or partial trips, by residents and non-residents.	267	24%
Domestic	Represents residential energy consumption, but not activities by private individuals elsewhere, such as personal travel. This can be influenced by fuel types used, type and condition of the housing, average temperature of area, average household size, type of household and so forth.	201	18%
Land Use, Land Use Change and Forestry (LULUCF)	Consists of both emissions and removals (sequestration) from forests, cropland, grassland, peatlands, and settlements. This sector includes emissions removals as some habitats act as carbon sinks.	163	15%
Commercial	The emissions in this sector predominately arises from the use of electricity and gas by businesses. The amount of carbon emitted in this sector is sensitive to an increase or decrease in the use of renewables.	70	7%
Industry	This includes emissions from gas and electricity used in industrial processes, along with including a separate sub-category for Large Industrial Installations.	49	4%
Waste	Allocated to local authorities based on the locations where the waste occurs, rather than where the emissions occurred.	21	2%
Public Sector	This category includes emissions from public sector buildings, typically from the gas and electricity used to operate these buildings.	15	1%
Total		1,101	

Carbon

Targets and inventories

East Lindsey Greenhouse Gas Emissions Estimate 2005 - 2022¹³



Carbon

Existing strategies and plans

South Holland District Council, Boston Borough Council and East Lindsey District Council have (in 2022) produced a joint Climate Change Strategy. The vision is described as:

*“The areas covered by South Holland District Council, Boston Borough Council and East Lindsey District Council achieve net zero emissions **in advance of the UK Government**. In doing so, action supports social, economic and environmental outcomes that help adapt to and mitigate the impacts of climate change and build a more sustainable future for our local communities.”¹⁴*

The strategy describes a framework for action for their geographic area, with three ‘golden threads’:

1. *Innovation*
2. *Education*
3. *People*

There is a discussion of how focus areas and key themes link together. The strategy also includes a high-level action plan, with a delivery plan proposed.

Key theme	Context summary	Challenges / opportunities summary
Transport	<ul style="list-style-type: none"> Large contributor. Notes existing plans for promotion of sustainable travel 	<ul style="list-style-type: none"> Mentions Town deal for Skegness to enhance railway station and active travel options Agri-food reliance on road network for transport Rural nature means limited travel connectivity and poor public transport
Built Environment	<ul style="list-style-type: none"> Predicted emissions increase without action Numerous off-gas grid properties 	<ul style="list-style-type: none"> Need to also reduce embodied carbon of new/retrofit homes Compromise with conservation
Energy/ renewables	<ul style="list-style-type: none"> Highest emissions source when taken across different sectors. 	<ul style="list-style-type: none"> Network capacity is presenting a barrier to renewable generation and storage. Small scale renewables solutions can contribute to achieving net zero
Business	<ul style="list-style-type: none"> Greatest employment sectors in East Lindsey are Public admin, education & health, and Accommodation & food services. 	<ul style="list-style-type: none"> Since COVID, there has been less business travel, presenting an opportunity to cut employment related transport emissions. Increased pressure from consumers on businesses to reduce waste and protect natural resources.
Agriculture/ food	<ul style="list-style-type: none"> This sector can influence both emissions and sequestrations of GHG's. Nitrous oxide and methane make up the majority. 	<ul style="list-style-type: none"> Nitrous oxide and methane have a much higher global warming potential than CO₂, but trickier to address due to involvement of natural processes. Innovative solutions can offer multiple benefits to society.
Water resources	<ul style="list-style-type: none"> Includes consumption, resource management, and also flood risk from coastal inundation, rivers, and surface water. 	<ul style="list-style-type: none"> Managing water supply will be a challenge as climate change brings warmer and drier summers, along with milder and wetter winters.
Nature-based solutions	<ul style="list-style-type: none"> Notes wider importance of the natural environment expanding beyond designated sites. 	<ul style="list-style-type: none"> Solutions can achieve carbon sequestration whilst delivering a range of societal benefits, e.g. green tourism. Restoring peatland sites can increase the presence of carbon sinks.
Visitor Economy	<ul style="list-style-type: none"> Rural nature of the region means high proportion of visitors arrive by car. 	<ul style="list-style-type: none"> Anticipates greater number of domestic visitors. Local infrastructure must be able to cope with visitor's needs. Accommodating electric vehicle charging noted as key part of tourism industry planning.

Carbon

Environmental Carbon Sequestration (from Natural Capital Baseline)

Carbon Sinks and Sequestration

Saltmarsh plays a significant role in mitigating climate change by absorbing and storing greenhouse gases in plants and sediment. The Lincolnshire saltmarsh coastline is a highly productive net carbon sink due to its ability to efficiently capture and store carbon for long periods. This form of carbon captured by coastal and marine ecosystems is known as 'blue carbon'. Newly restored marshes have a high rate of C sequestration estimated at 13.3 ± 15.0 t CO₂e/yr/ha.

However, there is a lack of data on how and at what rate both restored and older saltmarshes capture and store carbon. In April 2024, The EA announced that it would be installing two coastal flux research towers in The Wash, just south of the project areas southern boundary. The tower systems will quantify the quantity and rate of capture from the atmosphere, and ultimately the research aims to have saltmarshes included in the UK GHG inventory. The research will strongly support the case for further coastal restoration efforts across the project area and offer a host of holistic environmental and ecological benefits well beyond carbon capture and storage.

These habitats are however, increasingly at risk due to the impacts of climate change. Enclosed farmland within the project area projects a high carbon sequestration rate however there are caveats to the data used for this. The natural Capital Baseline Report discusses this in further detail.

Natural Capital Register and Account Tool

The table below has been taken from the Natural Capital Baseline Report and provides a summary of the various sequestration rates categorised by habitat type. The carbon flux values provided by the EA NCRAT offer valuable insight into the key carbon sequestration habitats within the project area. The data highlights coastal saltmarshes and intertidal mudflats as critical carbon sinks, sequestering over 4700 tCO₂e/yr combined.



EA Carbon flux monitoring tower – The Wash

Habitat type	Area (ha)	Carbon sequestration rate (tCO ₂ e/yr, central value)	Carbon Sequestration rate per hectare (tCO ₂ e/yr/ha)
Enclosed farmland	30,029	3,213	0.107
Freshwater habitats	76	0	0
Marine	20,132	0	0
Mountains, moorlands and heaths	526	355	0.675
Semi-natural grasslands	166	66	0.397
Urban	3,056	0	0
Woodlands	197	1,320	6.700
Coastal saltmarsh	263	1,365	5.190
Intertidal mudflats	1,717	3,399	1.980

Carbon

Contrasting DESNZ data and Natural Capital Baseline

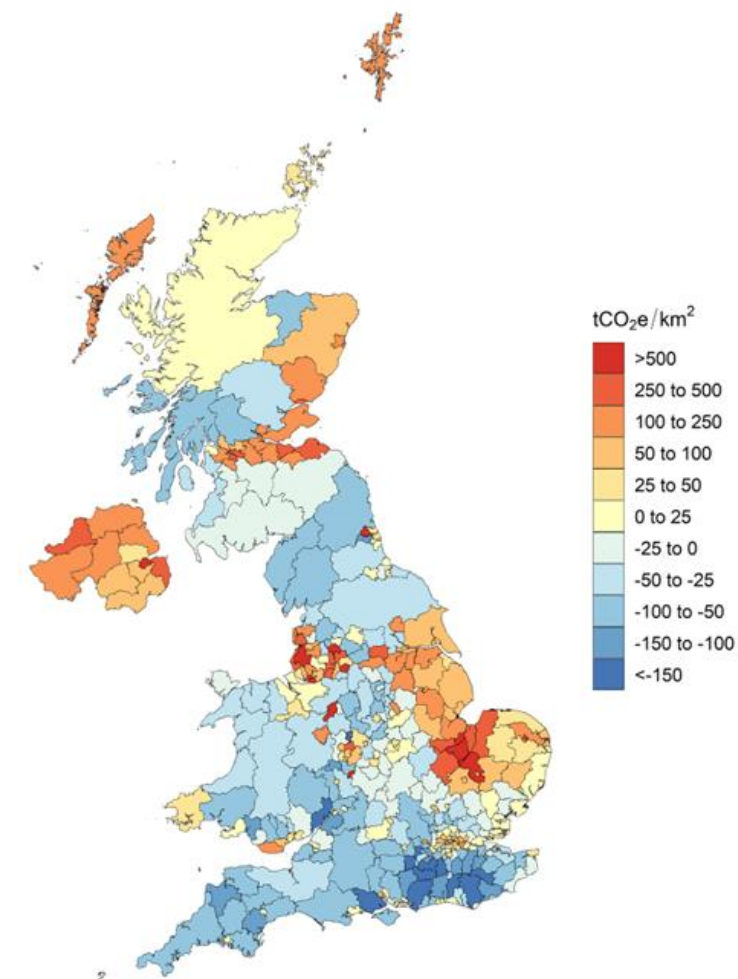
The Natural Capital Baseline report and summary map presented on this slide suggest the presence of carbon sinks within the study area. We note that this appears to contradict the DESNZ information previously presented, which shows **Land Use, Land Use Change, and Forestry (LULUCF)** and agriculture as significant emitters in the East Lindsey region as a whole.

The DESNZ Mapping greenhouse gas emissions & removals

for the land use, land-use change & forestry sector, June 2024 report shows East Lindsey as a significant net emitter of LULUCF emissions at a national scale (see image on the right). This is reported as being driven by cropland drained peatland, amongst other sources.



Drained peatland is a source of LULUCF emissions



Emissions or removals of GHGs from land use, land-use change and forestry per local authority area (tCO₂e.km²) in 2022¹⁵

Cultural Heritage

The Lincolnshire coastline and East Lindsey district is known for its vast cultural heritage and high concentration of archaeological assets ranging from single artefacts to complex multi-period settlement sites, as well as a legacy imprint of past industrial activity. The earliest known habitation evidence is around 10,000 years old, at Welton le Wold, where indications suggest people inhabited here during the last interglacial. In more recent history, there was a significant Roman settlement presence – best characterized by the fort at Wainfleet All Saints.

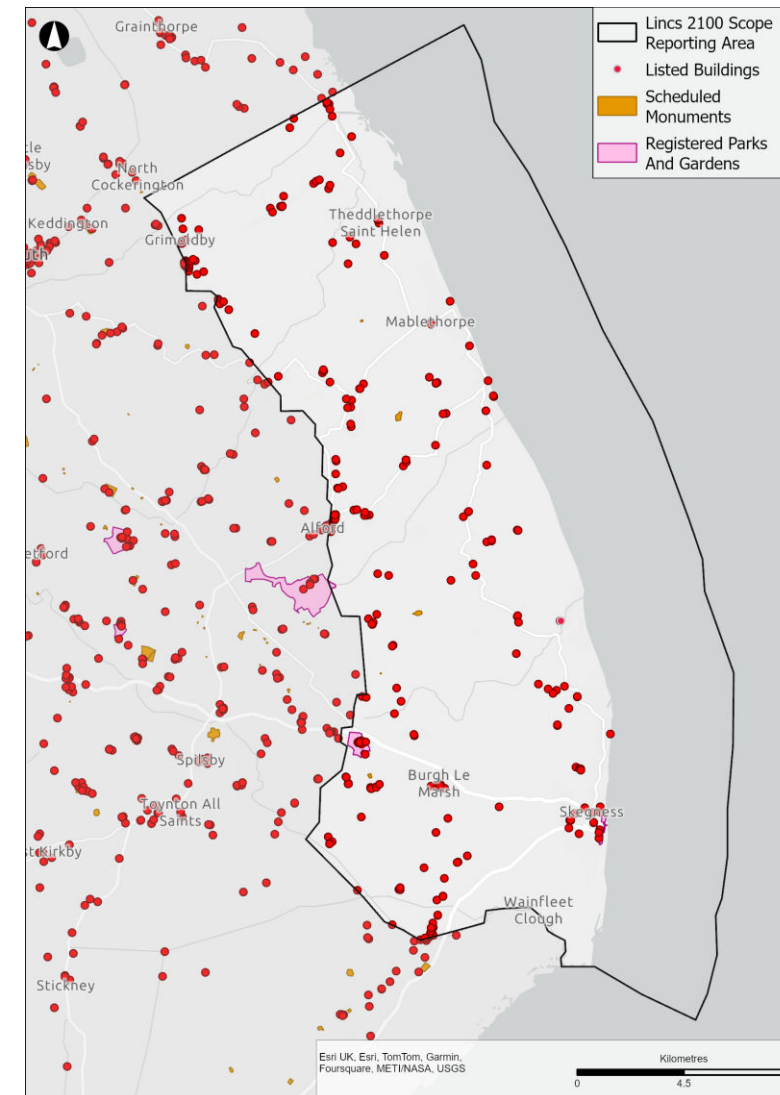
Almost all of the modern settlements are built over previous occupation, and most retain historic cores and areas where the remains of historical activity is encountered and preserved. Further, there are many more deserted medieval villages surviving under the grasslands and reclaimed marshland contains traces of ridge and furrow as well as evidence of ancient saltworks.

The Lincolnshire Historic Environment Record¹⁶ contains over 57,000 features including:

- Archaeological sites and finds;
- Historic buildings and structures;
- Legally designated and protected sites;
- Historic parks, gardens, and ancient woodlands;
- Battlefields and legends.

Across the wider region there are:

- 160 **Scheduled monuments**: requiring consent from the Secretary of State for any works affecting a monument.
- 1,428 **Listed buildings (grade 1: 91; grade 2*: 114; grade 2: 1223)**.
- 6 **Parks and gardens of special historic interest**: included within the English Heritage National Register of Parks and Gardens of Special Historic Interest.
- 1 **Registered battlefield** situated at Winceby.
- 'Thousands' of **registered sites of archaeological findings**, with the **Lincolnshire Wolds** identified as an area of particularly high concentration, including many prehistoric sites, medieval villages, long and round barrows. The area also has a close cultural association with Alfred Lord Tennyson, playing a factor in the AONB designation.
- Many more **unlisted heritage assets** of local value.



Conclusion

Strengths, Weaknesses, Opportunities and Threats (SWOT)

Strengths

- **'Blue carbon storage'**: carbon sequestration capacity and potential of natural and restored of saltmarshes. Links into ongoing EA research and monitoring.
- **Chalk streams**: Disproportionately high concentration of chalk streams – unique aquatic environments with very high biodiversity value.
- **Bathing waters**: 'Excellent quality' coastal bathing waters with a high concentration of assessed locations.
- **Air quality**: AQ is considered generally good throughout the region, with no need for any AQMAs/additional emissions monitoring at present or in the near future.
- **Agriculture**: Some areas of high agricultural land quality and productivity (G1), while the majority of the coastal hinterland agricultural land is designated G3 ('good to moderate').

Weaknesses

- **Flood risk**: Ongoing high flood risk affecting the majority of the project area, which is vulnerable to further exacerbation by urban development and/or a retreating coastline.
- **Artificial coastal defence**: Coastline heavily reliant on artificial defences and artificial nourishment of material to prevent loss of potentially valuable land (e.g. saltmarshes for their habitat value and carbon sequestration capacity).
- **Vulnerable agricultural land**: Highly productive agricultural land is at risk from retreating coastlines, saline intrusion, and coastal flood risk.

- **Vulnerable high biodiversity areas**: Species diverse habitats (e.g. chalk streams) and designated conservation areas are at risk from retreating coastlines, saline intrusion, and coastal flood risk.

Opportunities

- **Carbon sequestration & emissions reduction**: Boost 'blue' CCS on coastal saltmarshes, increasing capacity and rate of carbon sequestration and build upon existing and ongoing research in this field. Opportunity to collaborate with ongoing EA research and monitoring. Additionally, the Coastal Investment Plan could influence carbon beyond land use, supporting UK journey to Net Zero. Transport infrastructure (electrification, sustainable transport networks) could significantly reduce transport-related emissions.
- **Habitat preservation & restoration**: Coastal habitat preservation and restoration of dunes, salt marshes, and other distinctive biodiversity zones, contributing to BNG goals.
- **Natural Flood Management**: Abundant opportunities to partner up sustainable agricultural practices with NFM and other NbS to reduce reliance on 'grey' flooding infrastructure and associated embedded carbon.
- **Transportation**: Potential for enhancement of sustainable transportation network and connectivity along the coastline. Ties in closely with supporting and enhancing tourism and conservation of natural environments. Opportunity to further improve **air quality** (from vehicular emissions) and **water quality** (less contaminated road runoff entering watercourses). Electrification and sustainable transport networks could significantly reduce transport-related emissions (largest

contributor category for East Lindsey).

- **Climate change adaptation and resilience**: Opportunity to plan strategically at regional level to provide long-term resilience and adaptation to climate change and associated sea level rise through a combination of interventions and improvements.

Threats

- **Climate change driven altered agricultural practices**: Due to drought, flooding, longer growing seasons that do not align with holistic, catchment scale environmental strategies and practices. This could create resource pressures and negatively impact land, air and water quality. DESNZ reporting indicates that cropland drained peatland is a significant driver of net carbon emissions from LULUCF.
- **Water resources/saline intrusion**: The underlying chalk aquifer is sensitive to over-abstraction, and potentially at risk from saline intrusion and agricultural runoff pollution (phosphorus, nitrates). Sea level rise increases the local saltwater table, along with the potential for intrusion of Lincolnshire's permeable geology and freshwater aquifers, putting potable water supply and agricultural land at risk. It can also disrupt freshwater aquatic ecosystems and **reduce biodiversity** and decrease **agricultural productivity**.
- **Degradation of carbon sinks**: Flood and climate-related risk threaten to degrade carbon sinks, impacting overall carbon sequestration in the project area. Further, sub-optimal agricultural practices further hinder soil's capacity for carbon sequestration.

Next steps

Findings from the baseline analysis will be used to help guide and inform the next stage 'Masterplanning Framework.' In this next stage a catalogue of coastal adaptation measures will be developed, design objective workshops and design charrettes will be held with the partners. The outcomes of these, along with the strengths, weaknesses, opportunities and threats identified in the baseline will inform the development of the conceptual design strategies.

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	Lincolnshire Coast 2100+ Scope Reporting Area	\\global\gis\UK\300000\300665-00\Lincs2100		
	Local Authority Districts 2022	Admin_boundaries	Open Government Licence	
	Railway Stations	https://osdatahub.os.uk/downloads/open/OpenRoads	Open Government Licence	© Ordnance Survey 2024
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	Areas of Outstanding Natural Beauty	https://www.data.gov.uk/dataset/8e3ae3b9-a827-47f1-b025-f08527a4e84e/areas-of-outstanding-natural-beauty-england	Open Government Licence	© Natural England copyright. Contains Ordnance Survey data © Crown copyright and database right 2024.
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02 Spatial Baseline	Statutory Main Rivers	https://environment.data.gov.uk/dataset/6fd0120f-d465-11e4-abee-f0def148f590	Open Government Licence	© Environment Agency copyright and/or database right. Contains OS data © Crown copyright and database right (2023)
	WFD River Water Bodies Cycle 1	https://www.data.gov.uk/dataset/db84096f-5da0-4e6d-b4cf-8ce930b6abb4/wfd-river-water-bodies-cycle-1	Open Government Licence	Contains Environment Agency information © Environment Agency 2017. All rights reserved. Based on digital spatial data licensed from the Centre for Ecology & Hydrology, © NERC (CEH), © Contains Ordnance Survey data © Crown copyright and database right 2013.
	Maintained Watercourses	Data from LMDb		
	LIDAR Composite Digital Terrain Model (DTM) 10m	https://environment.data.gov.uk/dataset/ce8fe7e7-bed0-4889-8825-19b042e128d2	Open Government Licence	© Environment Agency copyright and/or database right 2022. All rights reserved
	Important Buildings (Emergency Services, Education)	https://osdatahub.os.uk/downloads/open/OpenMapLocal	Open Government Licence	© Ordnance Survey 2024
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	Flood Map (Rivers and Sea) - Flood Zone 3	https://www.data.gov.uk/dataset/bed63fc1-dd26-4685-b143-2941088923b3/flood-map-for-planning-rivers-and-sea-flood-zone-3	Open Government Licence	© Environment Agency copyright and/or database right 2023. All rights reserved. © NERC (CEH)	
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	Statutory Main Rivers	https://environment.data.gov.uk/dataset/6fd0120f-d465-11e4-abee-f0def148f590	Open Government Licence	© Environment Agency copyright and/or database right. Contains OS data © Crown copyright and database right (2023)	
	River Basin District: Anglian	https://environment.data.gov.uk/catchment-planning/	Open Government Licence	© Environment Agency 2024	
	Management Catchment: Witham	https://environment.data.gov.uk/catchment-planning/RiverBasinDistrict/5	Open Government Licence	© Environment Agency 2024	
	Operational Catchment: Steeping and Eaus	https://environment.data.gov.uk/catchment-planning/ManagementCatchment/3116	Open Government Licence	© Environment Agency 2024	
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	Anglian Water Resource Zone - Supply demand balance	https://www.anglianwater.co.uk/corporate/strategies-and-plans/water-resources-management-plan/water-resources-market-information/tables-and-zones/	Open Government Licence? (Ofwat require water companies to publish data)	© 2023 Anglian Water Services Limited	
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	Flood Evacuation Routes	Made by Arup Transport team - Interpretation from EA map, provided as a screenshot by EA Client Contact - Contact Transport Hazeerah Hashim			
	Potential Constraint	Made by Arup Transport team - Contact Transport Hazeerah Hashim			
	Flood Warning Areas	https://environment.data.gov.uk/dataset/87e5d78f-d465-11e4-9343-f0def148f590	Open Government Licence	© Environment Agency copyright and/or database right 2024. All rights reserved.	
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References

GIS Data Sources

04 Economy	National Receptor Database (England)	Environment Agency https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/datasets/lowersuperoutputareapopulationdensity	Permission Required - Partner Licence	© Crown copyright and database rights 2024 OS 100024198 and © Improvement and Development Agency for Local Government copyright and database rights 2024.	
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