Fens 2100+: System Insights

Final
March 2025

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This document was completed and approved in November 2024 and represents the status of the Fens 2100+ programme at that time. It has been reformatted for final issue in March 2025, but this did not include any changes to the content of the document.

Document verification is available upon request.

Fens 2100+ is an Environment Agency led partnership programme.

Introduction: Overview

Introduction

This Systems Insights report for Fens 2100+ has been developed to support stakeholder conversations, specifically around the wider system implications of flood risk management investment in the Fens. It draws out information and insight that illustrates the Fens wide characteristics to encourage stakeholders to 'zoom out' and consider the wider impact of their decisions, and to consider where there are opportunities for collaborative decisions which could achieve more than one organisation could realise.

It is intended to be used alongside other evidence and insight for the following purposes:

- To provide a selection of present-day baseline and future projections viewed through four lenses:
    - Communities;
    - Nature;
    - Food and agriculture; and
    - Infrastructure.
- To help partners and stakeholders in the Fens to engage more clearly with the Fens as a system and connect with landscape scale, system-wide collective decision making;
- Provide an evidence base for building a partnership at this landscape scale with stakeholders, shows value in operating/working at this scale.

Insights

This product sets out key insights across the Fens 2100+ area which are underpinned by data and evidence. These system-wide insights draw in spatial and non-spatial data, supplemented with lived experience, and research from other organisations. The information within this product draws upon information that helps us to observe what has happened or is projected to happen, while considering it within the Fens system.

Shaped by systems thinking

The Fens system is made up of interconnected parts that produce its own patterns of behaviour over time. Systems thinking is a way to view the interconnections in a system and a discipline for seeing and understanding the relevant aspects of the whole system – issues and opportunities can be viewed as a collection of components that interact and change in response to different interventions. This product uses the four key lenses to review the information available, to start to consider how choices may influence each other. For example, how choices for agriculture impact employment, which is also underpinned by transport choices and access to work, which help to direct flood risk choices.

Note: The data and evidence provided is based on the most up to date information available at the time of production. It is therefore a snapshot of the baseline, intended to provide an emerging understanding of the Fens 2100+ area as a whole. It is envisioned that this document will have a lifetime of around 5 years from production.

Introduction: The Fens System

The Fens system

When viewed through the frame of Flood and Coastal Erosion Risk Management (FCERM) investment, land use becomes a key decision point for investment choices to unlock outcomes for the Fens. Within this document, we've used four key lenses to consider the system, which consider the impacts on people's lives from different land uses.

The illustrative systems map on this page indicates ways that these four lenses of land use interact, alongside the water management sphere. The feedback loops identified can determine what land use can be enabled or blocked by investment choices in another sphere. For example: changes in water management impact agriculture, biodiversity, and flood risk. Recognising these loops will allow for designing interventions that address multiple aspects simultaneously.

Climate change

Systems thinking also facilitates the consideration of resilience as a core goal and can assist in identifying robust strategies to enhance resilience. For example: How can the Fens withstand shocks like extreme weather events or sea level rise which leads to flooding? The purple text within the diagram opposite illustrates how a climate hazard such as flooding impacts the feedback loops across the system. This shows that investment decisions in flood risk management have direct impacts on the functioning of the other spheres of the system.

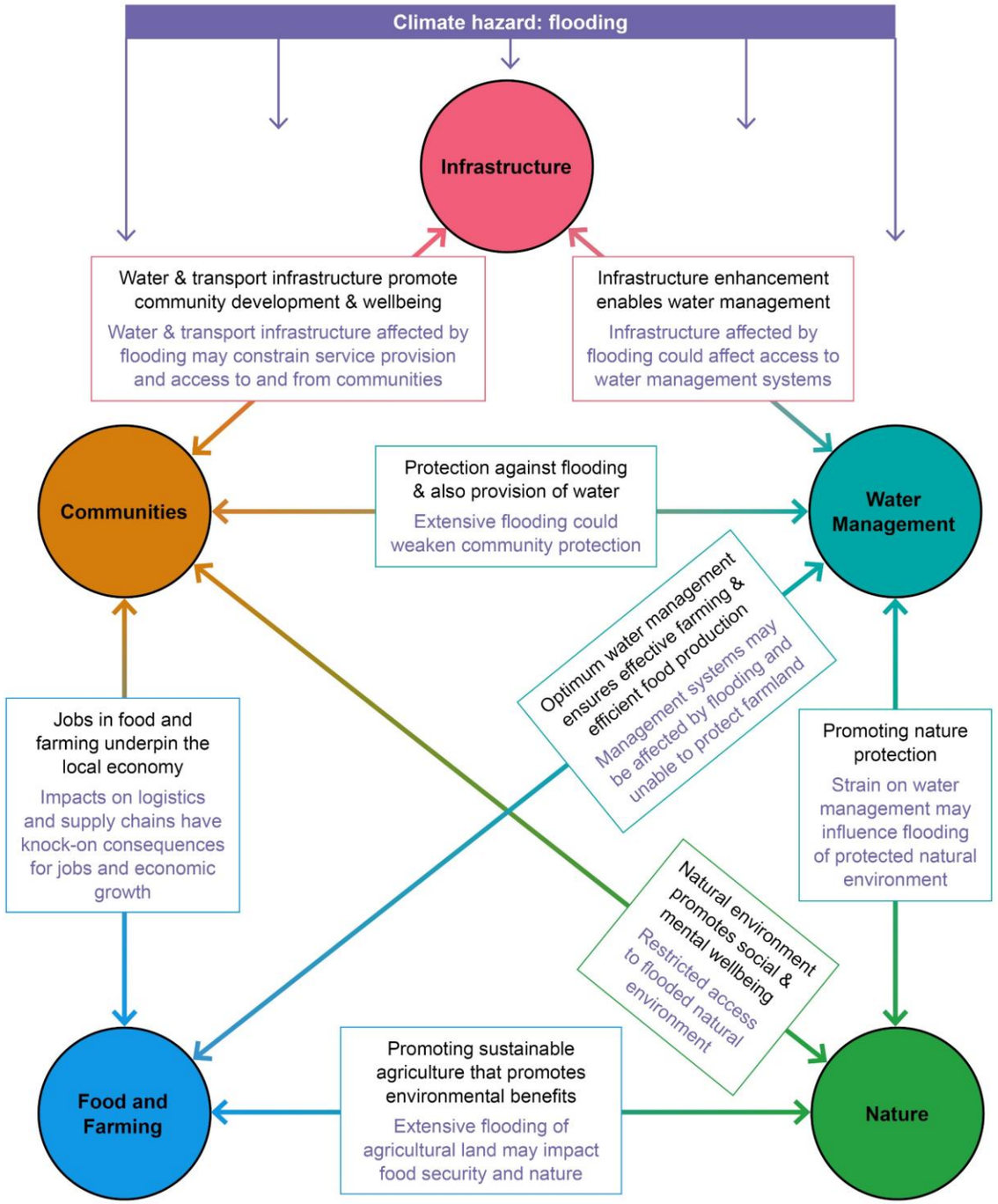
Impact of FCERM costs

Flood risk management can have direct impacts on people and nature in the Fens through flood risk, but the costs of running the system can also influence the availability of other choices. In 2023/24 the impact of increased pumping due to the long, wet winter coupled with rising energy prices led to significant increases in Integrated Drainage Board (IDB) operating costs. For the local authorities in ratable areas, a significant proportion of council tax collected gets paid to the IDBs.

Recently, authorities in Boston, South Holland and East Lindsey said they are handing over almost £10m a year, up to 65% of their council tax income to pay for land drainage [1]. For every £1 Boston Borough Council receives in council tax, 58p goes to local IDBs. The figure is 65p in East Lindsey and 54p in South Holland. In one interview, councillors from King's Lynn and West Norfolk stated that the rise in IDB payment for 2023/24 was equivalent to their entire homelessness budget [2].

This transfer of money is essential for the safe operation of the area, but also represents a limiting factor on local authorities' ability to invest in other areas to drive outcomes for the Fens.

Finding ways to invest differently could support opportunities to invest in a wider range of interventions to support people and nature in the Fens, and lead to different choices and outcomes. These changes could in turn influence the data presented herein.



Introduction: Key organisations

Working together

There will be a variety of partners delivering FCERM interventions. There is an even wider group of interested parties that have influence over the wider levers of change that can help our FCERM investments lead to successful outcomes for The Fens.

The stakeholders set out here are an initial consideration of those with interest and influence over data used to collate these insights. Organisations across the system use this data to support a variety of interventions from policy and incentive setting, to directly supporting projects. The stakeholders in the Fens have complex reporting and influencing relationships. Many of the organisations work across different geographic levels and have several roles e.g. Anglian Water are a core member of Water Resources East and the Future Fens Integrated Adaptation task force (FFIA), with accountability into OFWAT and therefore Defra.

Some stakeholders in the system are applicable here in a way that they aren't in other parts of the country, for example the 72 IDBs in the Fens represent 64% of all IDBs in England. IDBs in the Fens are generally smaller than elsewhere, with those 72 covering 36% of the total area drained by IDBs [3], making relationship management more complicated.

Data

Many of these stakeholders are also data holders – public data (as used here) or more detailed in-house data to support specific interventions. Understanding the data that potential partners and stakeholders have, and could share, can help long-term monitoring and evaluation to shape investment and outcome focus, as well as important tipping points beyond.

Data is stored and managed in different ways across the systems, although there are initiative to improve this, such as Association of Drainage Authorities (ADA) good practice guides [4].

Policy and influence

The insight within this product can create a powerful evidence led narrative to shape further intelligence gathering and insight development, to be used to influence policy which can act in an interconnected way across stakeholder organisations, speaking to their collective challenges and opportunities.

Introduction: Flood risk

Flood risk in the Fens

The Fens landscape is largely below sea level, and it is protected by a complex system of FCERM and water management/land drainage assets. The entire Fens area is a heavily modified and managed system, which is reliant on these assets, not just during extreme flooding events.

Being below sea level, the Fens is at the forefront of climate change, particularly in terms of sea level rise. Additionally, wet periods are getting wetter, dry periods are getting dryer and weather patterns are changing. This is putting increasing pressure on the essential drainage and flood risk management systems.

Sustainable, long term flood risk management is needed for people, homes, infrastructure, businesses, agriculture and nature. Any changes to the existing flood risk management system will impact land use in the Fens, and so have the potential to impact the economy, livelihoods and lives across the Fens.

Future flood risk

Within this document, future flood risk considerations are based on a Fens 2100+ specific data set from Future Flood Explorer (FFE) as well as other data including the Environment Agency's Risk of Flooding from Rivers and Sea and Reduction in Risk of Flooding from Rivers and Sea.

The Fens 2100+ FFE dataset considers the risks associated with coastal, fluvial and surface water flooding. In addition to a present day scenario, it considers these risks under two climate change scenarios, two population growth projections and two adaptation scenarios.

FFE uses a baseline modelled scenario year of 2018 to illustrate the current potential damages from the existing risk of flooding, which can then be compared to other scenarios to illustrate changing risk.

A wider exploration of the FFE data is included in the System Maps. Within this document, some insights consider potential future flood risk alongside wider considerations.

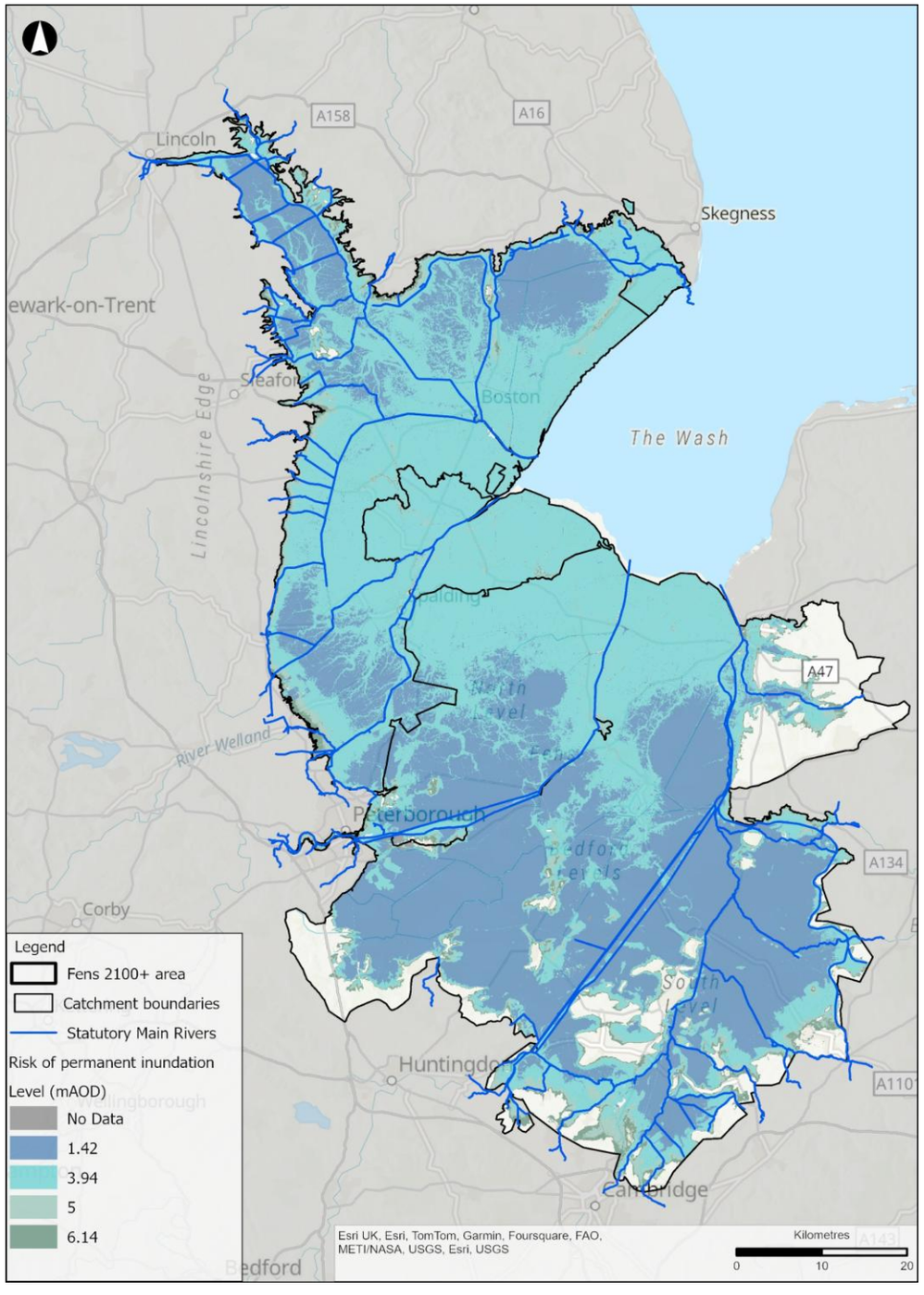
If management stopped

As the Fens is a wholly managed system, in a hypothetical situation where all flood risk and water management activity was stopped (sometimes referred to as the 'do-nothing' scenario), defences would deteriorate over time and complete failure would eventually occur. If failed defences were not repaired, a breach in defences would lead, initially to sudden, widespread flooding. Over a period of years, the complex system of land drains in the area would become inoperable as water continues to enter the catchment through the breaches, and water would begin to pool across the landscape. Eventually the area would revert to the marshy landscape it once was.

The map illustrates the theoretical impact of flood risk and water management activities ceasing over time. A number of scenarios have been assessed, considering the peak of a tide cycle - mean high water spring (MHWS):

- Based on a water balance model [5] for the Fens, it was estimated that in the absence of fluvial flood defences, the long-term average water level in the area would be 1.42mAOD within a few years.
- Present day MHWS of 3.9m AOD would inundate the area as a tidal peak.
- 5m representing the MHWS tidal peak level, plus 1.06m of sea level rise, as predicted by the RCP8.5 70th percentile scenario by 2120.
- 6.14m representing the MHWS level, plus 2.21m of sea level rise, as predicted by the H++ scenario by 2120.

Due to the topography of the Fens, there is not a significant increase in extent when the water level is greater than 3.94mAOD (MHWS).



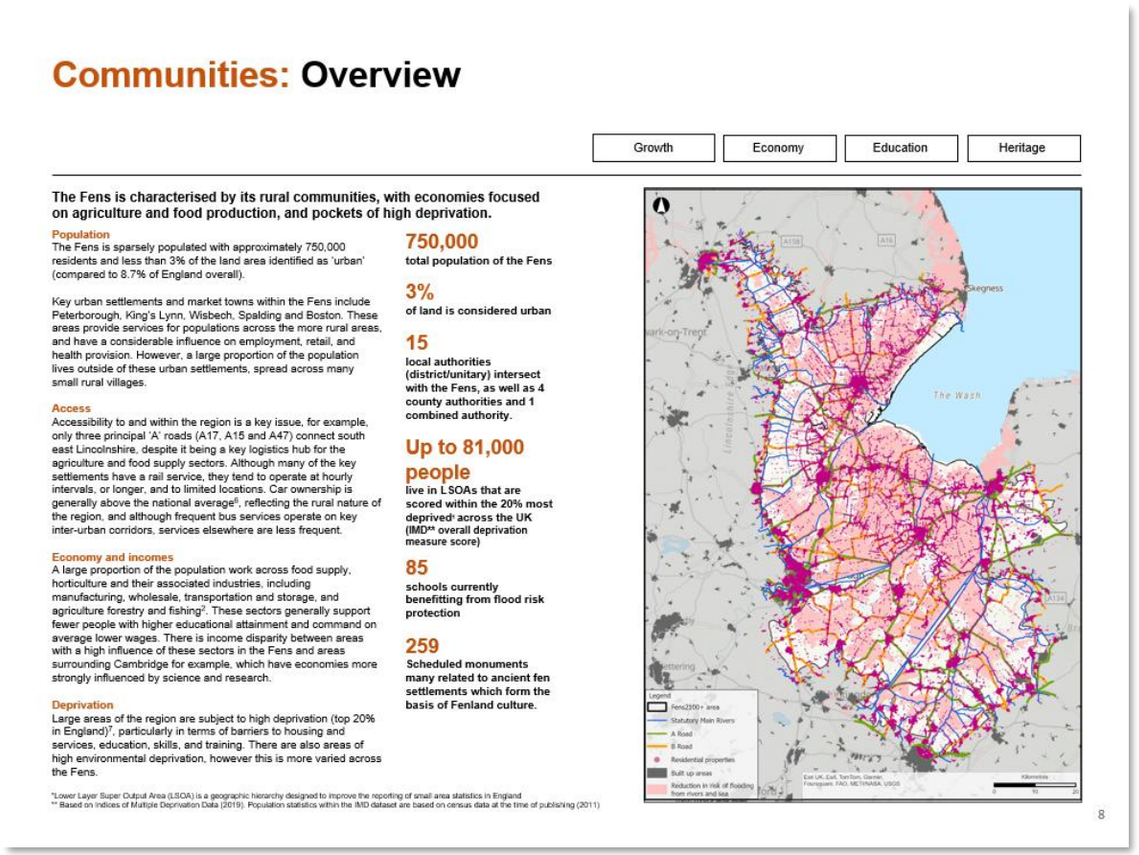
Introduction: User guide

Navigating this document

This document is split into 5 colour coded sections, representing the lenses within the wider systems:

1. Introduction
2. Communities
3. Nature
4. Food and agriculture
5. Infrastructure

Each section begins with an overview, which provides an overarching summary of a number of key considerations within the topic, as well as some key facts and figures. The data map includes a selection of data used across the maps in the following pages. Each section then explores 4 drivers to delve into the next level of detail.



Communities: Overview

Growth | Economy | Education | Heritage

The Fens is characterised by its rural communities, with economies focused on agriculture and food production, and pockets of high deprivation.

Population
The Fens is sparsely populated with approximately 750,000 residents and less than 3% of the land area identified as 'urban' (compared to 8.7% of England overall).

Key urban settlements and market towns within the Fens include Peterborough, King's Lynn, Wisbech, Spalding and Boston. These areas provide services for populations across the more rural areas, and have a considerable influence on employment, retail, and health provision. However, a large proportion of the population lives outside of these urban settlements, spread across many small rural villages.

Access
Accessibility to and within the region is a key issue, for example, only three principal 'A' roads (A17, A15 and A47) connect south east Lincolnshire, despite it being a key logistics hub for the agriculture and food supply sectors. Although many of the key settlements have a rail service, they tend to operate at hourly intervals, or longer, and to limited locations. Car ownership is generally above the national average[6], reflecting the rural nature of the region, and although frequent bus services operate on key inter-urban corridors, services elsewhere are less frequent.

Economy and incomes
A large proportion of the population work across food supply, horticulture and their associated industries, including manufacturing, wholesale, transportation and storage, and agriculture forestry and fishing[7]. These sectors generally support fewer people with higher educational attainment and command on average lower wages. There is income disparity between areas with a high influence of these sectors in the Fens and areas surrounding Cambridge for example, which have economies more strongly influenced by science and research.

Deprivation
Large areas of the region are subject to high deprivation (top 20% in England)[7], particularly in terms of barriers to housing and services, education, skills, and training. There are also areas of high environmental deprivation, however this is more varied across the Fens.

750,000
total population of the Fens

3%
of land is considered urban

15
local authorities (district/unitary) intersect with the Fens, as well as 4 county authorities and 1 combined authority.

Up to 81,000 people
live in LSOAs that are scored within the 20% most deprived[5] across the UK (IMD[5] overall deprivation measure score)

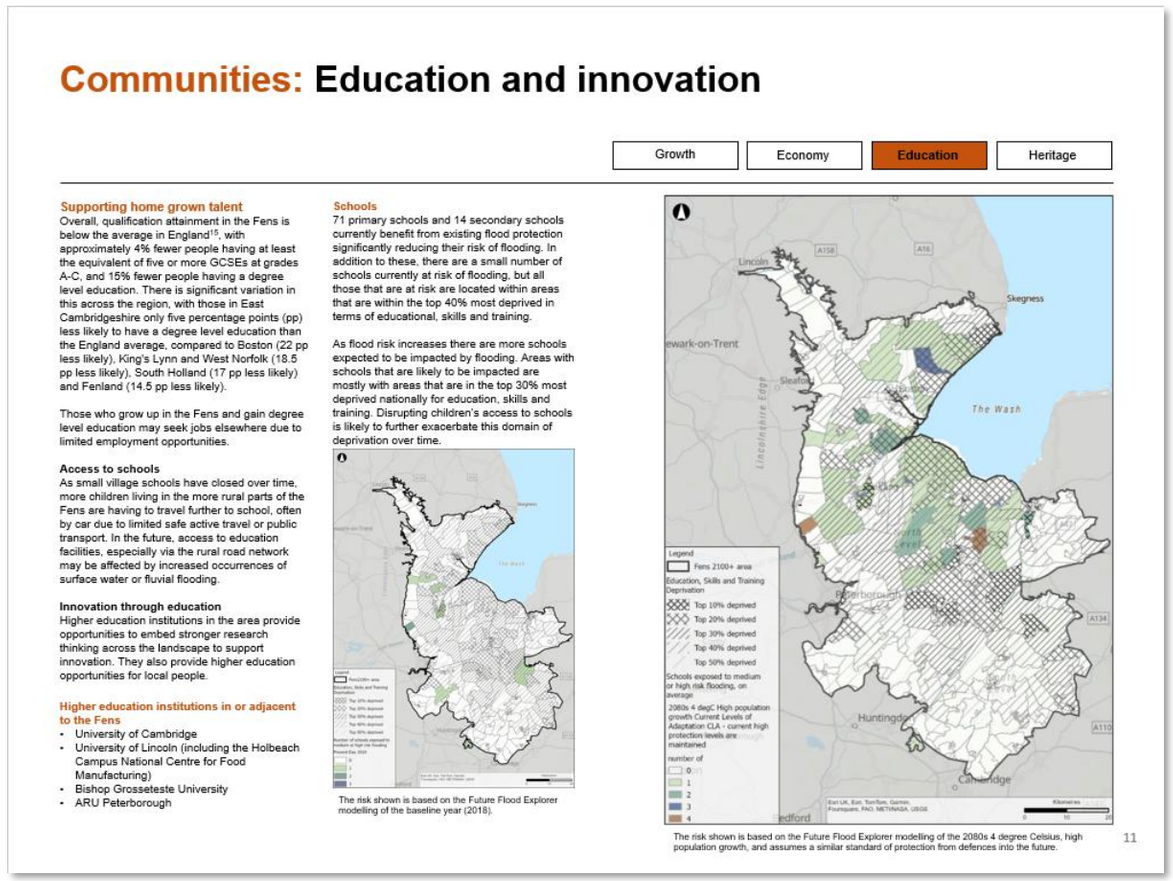
85
schools currently benefitting from flood risk protection

259
Scheduled monuments many related to ancient fen settlements which form the basis of Fenland culture.

[5]Lower Layer Super Output Area (LSOA) is a geographic hierarchy designed to improve the reporting of small area statistics in England
[6] Based on indices of Multiple Deprivation Data (2019). Population statistics within the IMD dataset are based on census data at the time of publishing (2011)

8

Lens summary: This provides information on the current baseline, with supporting facts and figures



Communities: Education and innovation

Growth | Economy | Education | Heritage

Supporting home grown talent
Overall, qualification attainment in the Fens is below the average in England[15], with approximately 4% fewer people having at least the equivalent of five or more GCSEs at grades A-C, and 15% fewer people having a degree level education. There is significant variation in this across the region, with those in East Cambridgeshire only five percentage points (pp) less likely to have a degree level education than the England average, compared to Boston (22 pp less likely), King's Lynn and West Norfolk (18.5 pp less likely), South Holland (17 pp less likely) and Fenland (14.5 pp less likely).

Those who grow up in the Fens and gain degree level education may seek jobs elsewhere due to limited employment opportunities.

Access to schools
As small village schools have closed over time, more children living in the more rural parts of the Fens are having to travel further to school, often by car due to limited safe active travel or public transport. In the future, access to education facilities, especially via the rural road network may be affected by increased occurrences of surface water or fluvial flooding.

Innovation through education
Higher education institutions in the area provide opportunities to embed stronger research thinking across the landscape to support innovation. They also provide higher education opportunities for local people.

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71 primary schools and 14 secondary schools currently benefit from existing flood protection significantly reducing their risk of flooding. In addition to these, there are a small number of schools currently at risk of flooding, but all those that are at risk are located within areas that are within the top 40% most deprived in terms of educational, skills and training.

As flood risk increases there are more schools expected to be impacted by flooding. Areas with schools that are likely to be impacted are mostly with areas that are in the top 30% most deprived nationally for education, skills and training. Disrupting children's access to schools is likely to further exacerbate this domain of deprivation over time.

The risk shown is based on the Future Flood Explorer modelling of the baseline year (2018).

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11

Lens x drivers: These pages explore specific intersects in greater detail**.**

Data sources

Where spatial data has been analysed and presented in maps, data sources are listed in the accompanying data guide. Where data has been quoted within the text either the original source, or a published report is included at the end of this document.

Further information

The data and information considered in this document is by no means exhaustive and has been curated to illustrate some key aspects of the Fens. It is expected that additional or alternative information will be highlighted through the engagement process around these insights, which may adjust our understanding of the Fens.

Communities: Overview

Growth | Economy | Education | Heritage

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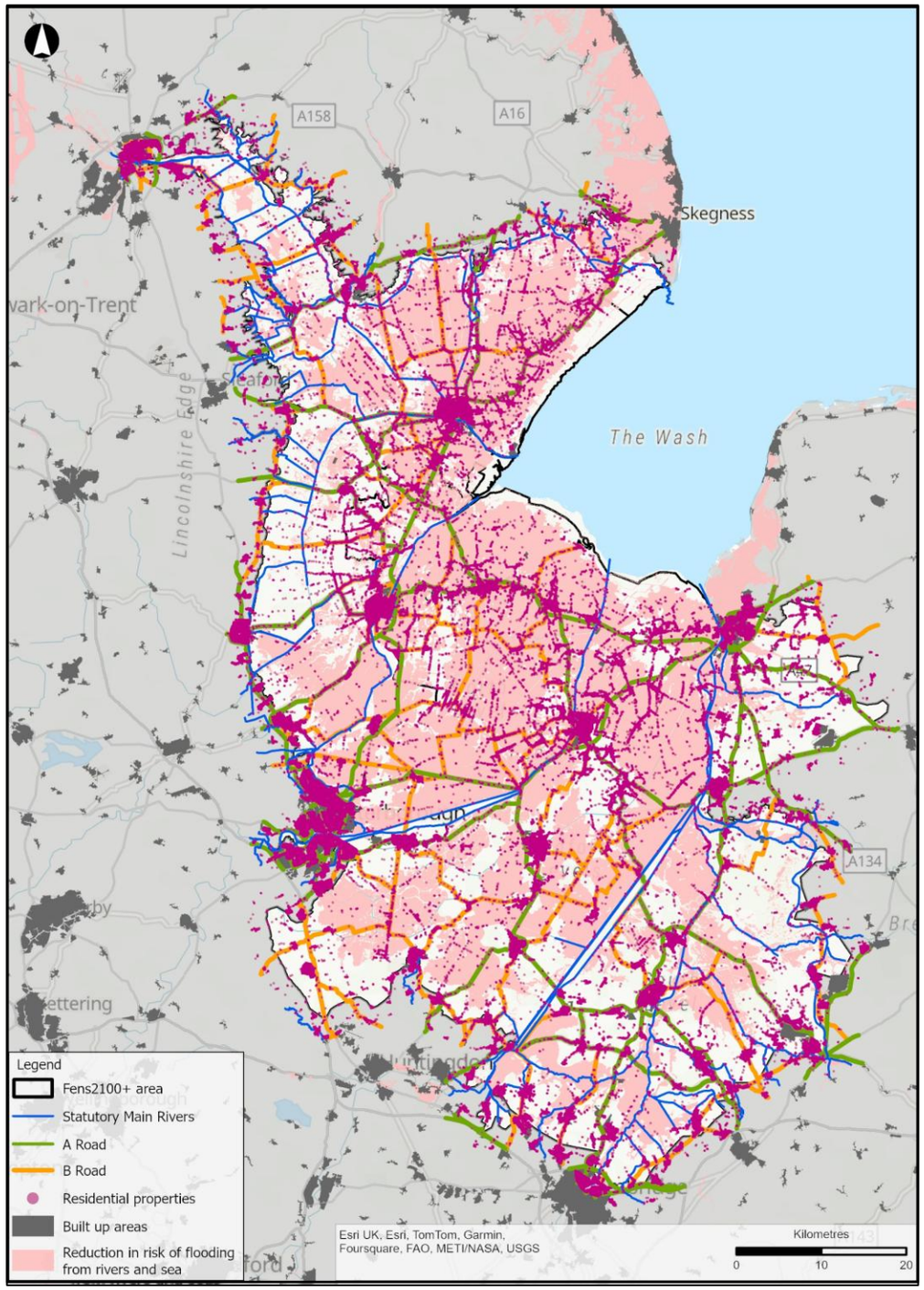


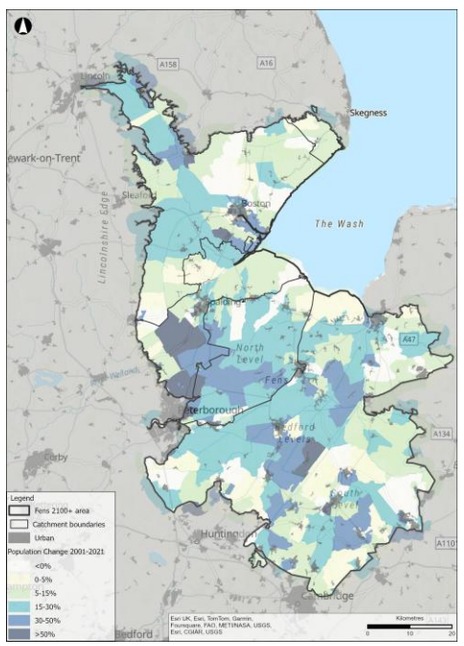
*Lower Layer Super Output Area (LSOA) is a geographic hierarchy designed to improve the reporting of small area statistics in England
** Based on Indices of Multiple Deprivation Data (2019). Population statistics within the IMD dataset are based on census data at the time of publishing (2011)

Communities: Growth

Changing populations

Between the 2001 and 2021 census, the Fens has seen a large increase in population, on average approximately 20%* [8]. Across England the population grew by approximately 6.6%. The East of England was the region with the highest growth, which increased by 8.3% from 2011-2021. The East Midlands had 7.7% of growth over the same period. Much of this population increase related to freedom of movement from EU citizens taking up agricultural and food related jobs across the Fens.

Boston, North Kesteven (around Sleaford) and South Cambridgeshire (the area surrounding Cambridge) all had over 25% growth between 2001 and 2021, and the largest increase was observed in Peterborough (38%). The Fens grew at a much faster rate over the last 20 years than England, or the wider region. Much of this growth was accommodated through conversion of buildings into Houses of Multiple Occupancy**, and therefore didn't result in equivalent requirements for new land for housing.



Population projections

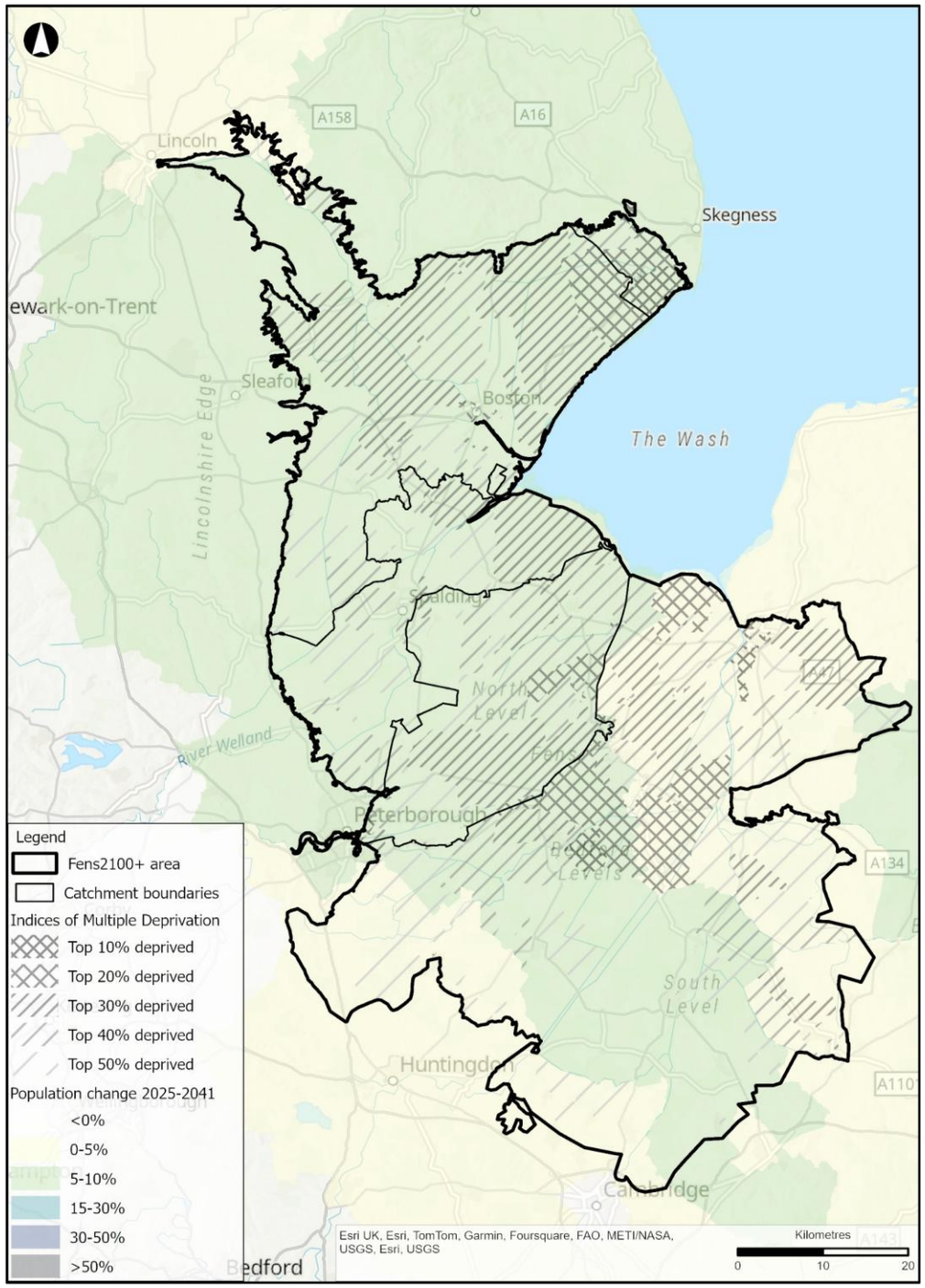
Future population projections [9] (available to the local authority level only) show this rate of growth slowing, with average population growth of 6% between 2025 and 2041. Population growth is projected to slow most significantly in South Cambridgeshire, with future growth projected to be around just 2%. Highest levels of population growth (8-10%) are projected in Boston, East Lindsay, North Kesteven, South Holland, Fenland, Breckland and Peterborough. The impacts of Brexit and more restricted EU movement are likely to result in very different growth demographics than the last 20 years. Future changes to agriculture, jobs, investment and wider considerations will all impact population growth in the Fens.

Local plans

Local plans currently in place across the Fens have a plan period that ends within the 2030s. Future housing growth numbers within each plan area have not yet been defined for the majority of the first investment period considered by Fens 2100+ (2033-2050). There are no long-term (10 year+) housing projections. The next iteration of local plans will need to identify suitable locations for housing to meet projected population growth; which may be defined by a new standard method (pending National Planning Policy Framework (NPPF) consultation outcomes). Flood risk is and will continue to be a significant constraint to identifying suitable locations for housing. Consideration of flood risk investment may need to go beyond traditional processes of considering static flood maps.

Future Residential Flood Risk

The FFE data shows annual damages for residential properties increase significantly by the 2050s. However, this still sits within the middle range for annual damages nationally, therefore other areas may be prioritised due to greater damages. This may make it even more difficult to secure appropriate investment in the Fens based on current value and protection.



*Calculated based on the population growth of the Local Authorities within the Fens, not just those within the Fens 2100+ area. Between 2001 census and 2021 census.

** The way that shared properties data was collected changed between the 2011 and 2021 census, and therefore there is no data available to support this comparison.

Communities: Economy

An economy built from agriculture

A large proportion of the population work in industries that have origins in the area's agricultural history. The NFU [10] identified that the agriculture and food production sector supports 80,000 jobs (38% of all jobs [11]) in the Fens, across a number of sectors. Manufacturing is the largest industry, accounting for 16% of all jobs in the Fens [11]. A large proportion of this relates to food products, but also wider associated manufacturing such as paper and paper products. The manufacture of food products is a key specialised employment area in the Fens, being six times more prevalent here than in the UK as a whole.

The region attracts a large number of seasonal workers, and a high proportion of the growth seen over the last 20 years can be linked to European migration to the area for work.

Incomes

Average total annual incomes are lower in the north of the region, with average incomes in East Lindsey 53% lower than East Cambridgeshire (near Ely) [11]

Innovation

Future agricultural innovation is expected to be at the heart of any change to the way that land is used in the Fens. The 2023 UK Innovation Survey [12] found that the manufacture of food, clothing, wood, paper and printing was the third most innovative sector, with 54.5% of businesses being 'innovation active' in the 2020-2022 period. This has grown from 46% in the 2016-2018 period. Agriculture was not a sector that was part of the survey.

Regional rates of innovation broadly in line with the England rate (35.1% East Midlands 38.9% East of England, 37.1% in England overall), but these rates are likely to be heavily dominated by the university aligned businesses around Cambridge and Lincoln.

Pockets of employment deprivation

There are two small areas which are within the top 10% most deprived for access to employment [13], showing a high proportion of the working age population who are involuntarily excluded from the labour market. This includes people who would like to work but are unable to do so due to unemployment, sickness or disability, or caring responsibilities.

Employment spread across the Fens

Although there are clusters of employment within the bigger settlements, there are a variety of employment locations across the region. Many of these are linked to the food processing and agricultural servicing industries based around farms.

Access

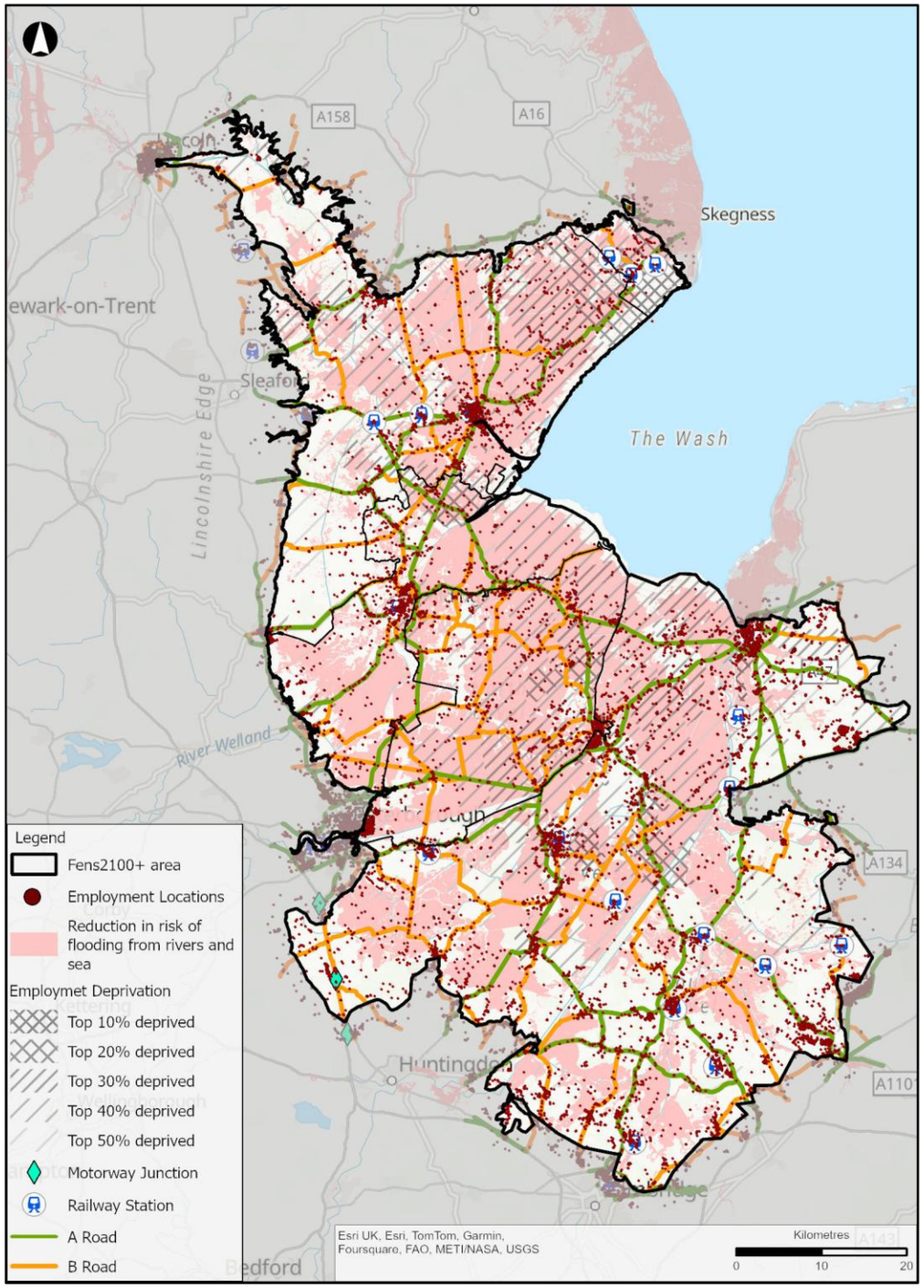
There is heavy reliance on the private car and the road network for access to employment. Although there are railway stations in many of the larger settlements, they do not often connect to the surrounding villages where many employees live.

Many of the key sectors in the Fens rely on efficient road freight transportation to function, particularly businesses such as FreshLinc, Gist, Fowler Welch, Flora Linc, etc. who work to just in time delivery schedules for chilled food and horticulture products.

Tourism

It is difficult to identify figures for Fens related tourism, but a 2016 report by the Greater Lincolnshire Nature Partnership estimated the potential value of all countryside-based recreation and leisure across Greater Lincolnshire at £325 million [14].

Projects like the Fens Waterways Link project or Great Fen restoration linked to nature-tourism could form a key part of an expanded sector.



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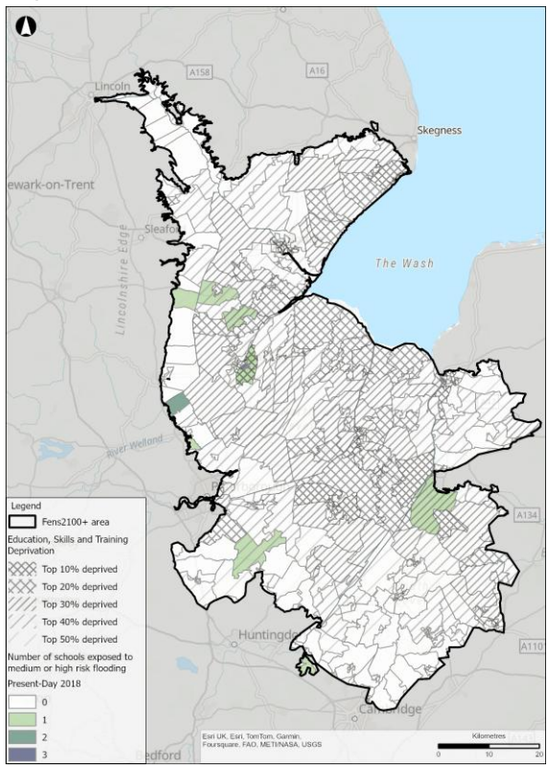

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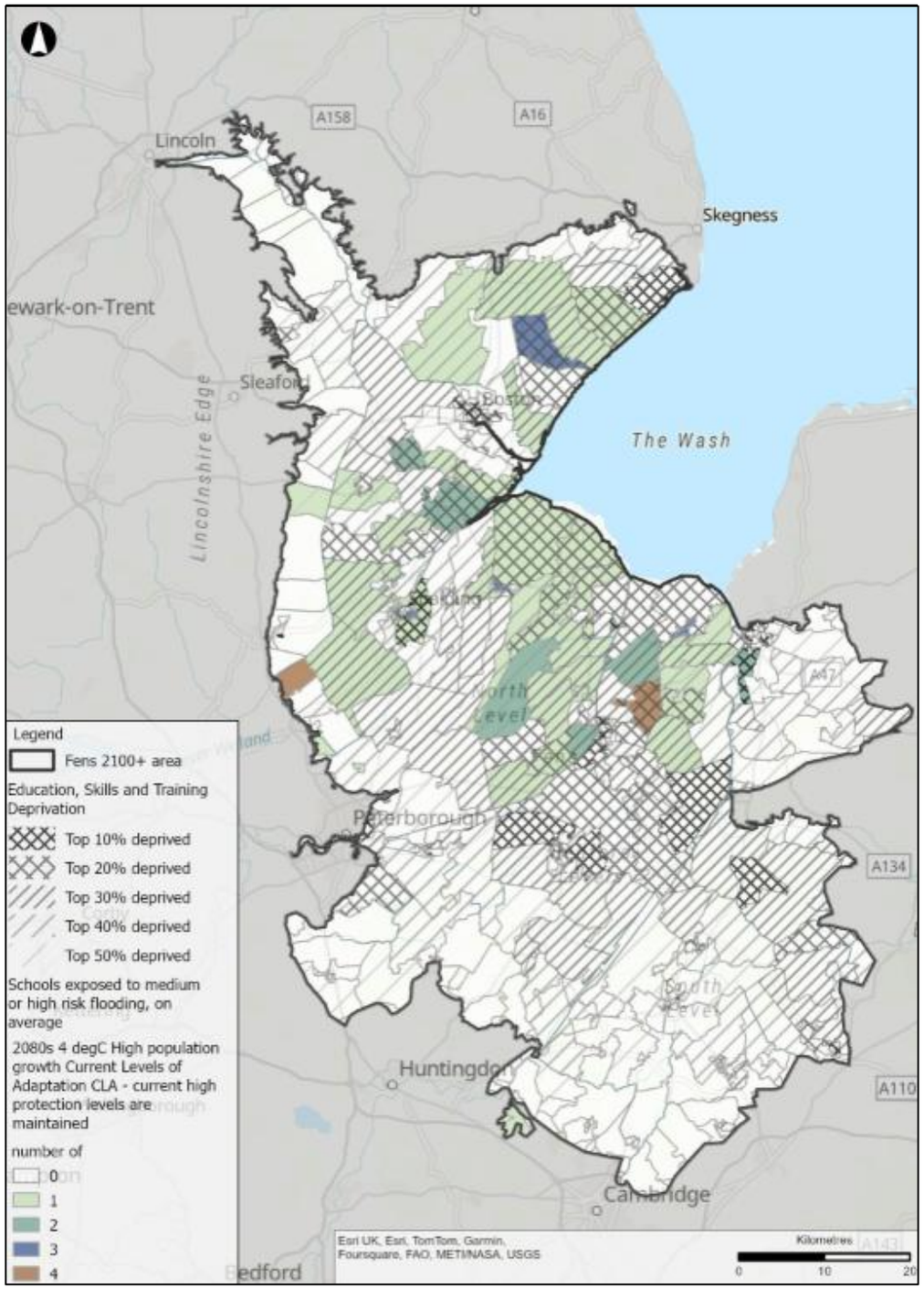

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Communities: Heritage

A man-made historic landscape

The region is well known for its fenland landscape, which consists of a unique and historic networks of drainage channels and watercourses, shaped over time by the combined actions of climate, wildlife and human activity.

For many hundreds of years this area of England was regularly under water for long periods. Attempts to drain the Fens began as long ago as Roman times and continued throughout the Middle Ages. The fenland character we see today was mostly created from the 17th century when cuts and dykes were built into the landscape to reclaim land, predominantly for agriculture and to support trade. Pumped drainage was added resulting in shrinkage of the peat soils as they dried, creating the man-made pumped drainage system that is still present today.

A key challenge and opportunity for the future is how to how to conserve, manage and enhance the Fens landscape and increase educational opportunities to access its geodiversity, archaeology and cultural heritage.

Historic features

There are 3,829 listed buildings in the Fens [16]: the majority Grade II (89%). There are 175 Grade I listed buildings including Ely's cathedral, Tattershall Castle, and the tallest windmill in the country dating from the 1800s, as well as over 100 churches. Climate change is likely to impact the historic environment, with extreme weather fluctuations including increasing temperatures (heatwaves or fires), precipitation and flooding impacting asset condition and integrity.

Cultural heritage

The Fen culture does not currently have strong brand appeal, but there are organisations looking to capitalise on the history of working with and on the land to support tourism and other economic endeavours. There have been proposals to capitalise on this, such as the Fens Biosphere, but so far none have taken hold.

Archaeology

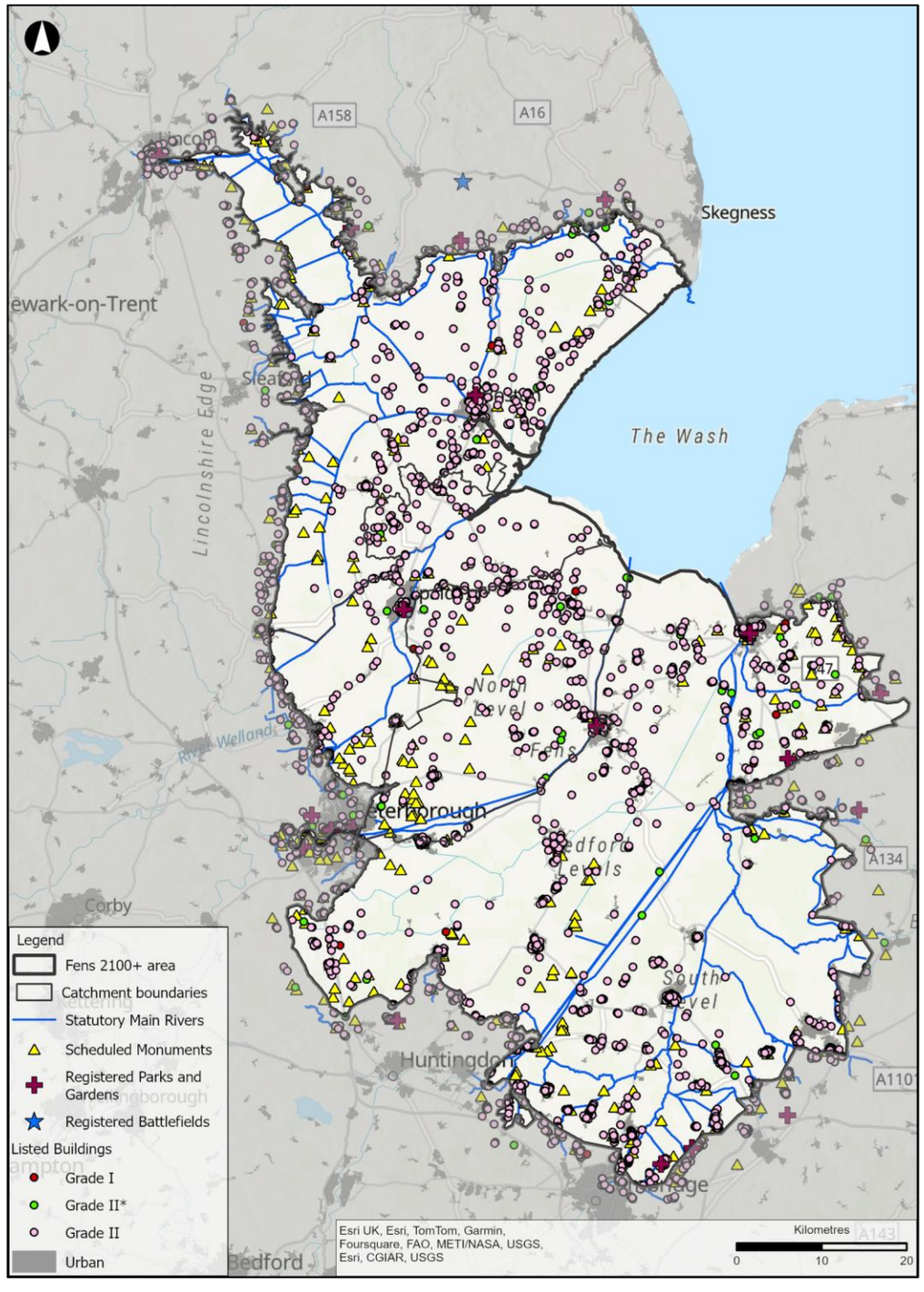
There is a long history of human occupation in the Fens from as early as Mesolithic times. There are 259 scheduled monuments[16] across the Fens. Early archaeological evidence is being exposed as shrinking peat levels and new developments open up historic remains that have been well-preserved though anaerobic and wet conditions.

Flag Fen

Flag Fen is a Bronze Age site constructed around 3,500 years ago and is scheduled under the Ancient Monuments and Archaeological Areas Act 1979. It was discovered in the 1970s during excavation for the development of Peterborough new town. It revealed an almost intact landscape that ran along the edge of a drained Fen. The site contains settlements, farms, barrows, and cemeteries in addition to preserved wooden river causeways. The Flag Fen Archaeology Park includes a visitor centre and museum with local exhibits [17].

Bog oak

Bog oak has long been an important feature of the Fen landscape and is present due to trees that fell thousands of years ago, buried and preserved in peat bogs. Bog oak wood has historically been used for fuel and carved into decorative items and furniture.



Nature: Overview

Access | Nature recovery | Peat and carbon | Water management

The Fens is home to a mosaic of semi-natural wetland habitat, formerly constituting the largest wetland area in England.

Nature supported by water

The region features an extensive network of fenland, river catchment corridors, and waterways, including major rivers such as the River Nene and Great Ouse. The majority of the watercourses are classified as 'artificial' or 'heavily modified' [18] but still provide key ecological networks and opportunities to functionally link important habitats.

Peatland and soil conservation

There are a range of soil types including mineral, organo-mineral and peat soils, each with varying properties and agricultural uses. Fertile lowland peat soils, located predominately within the Great Ouse catchment, have been historically drained and managed and peat wastage is now a key issue. The mapping available is widely considered out of date, and much of the peat designation in the Fens is likely to no longer be classified as a peat soil.

Biodiversity

- The Wash is the largest estuarine system in Britain, supporting internationally important intertidal and coastal habitats. The mud and salt flats support high concentrations of shellfish, over 300,000 wintering birds and the largest harbour seal colony in the UK. The Wash supports 8.5% of the UK's saltmarsh (3,049ha) and 6% of the UK's mudflat and sandflats (18,000ha) [19].
- Flood storage areas in the Whittlesey (Nene) and Ouse Washes provide significant biodiversity interest and are internationally important for species including Spined Loach and European eel [20, 21].
- Habitats including mudflats, saltmarshes, grasslands and wet woodlands are crucial for biodiversity, however habitat loss and degradation is continuing to threaten ecosystems and species.

Woodland

Woodland cover is sparse, with pollarded willows characteristic along drainage ditches. New tree and woodland planting mainly takes the form of small isolated blocks throughout the inland open fen area and the extension of existing woodlands.

Geodiversity

Geodiversity is important in determining the landscape and character of the Fens. The Jurassic clays are significant for palaeontology and Quaternary deposits contain important records of climate and environmental change [22].

4
Local Nature Recovery Strategies are being produced across the Fens 2100+ area

9
National Nature Reserves*

c.70km
of coastline

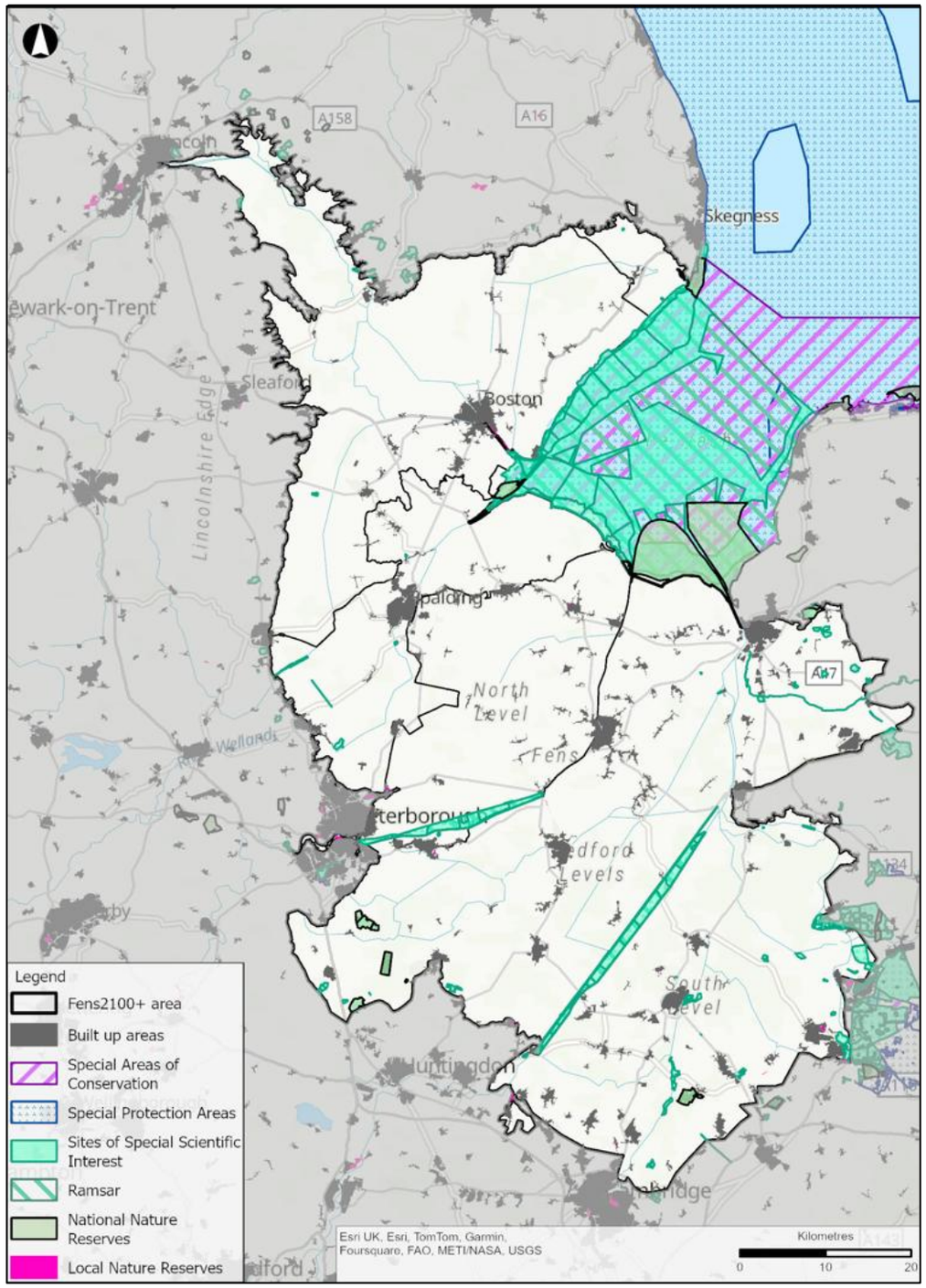
c.6,260ha
total area of Special Protection Areas (SPA)

c.8,400ha
total area of Sites of Special Scientific Interest (SSSI)

785ha (18%)
of ground levels across the Fens are at, or below the mean sea level.

333,184ha
Area of Nitrate Vulnerable Zones (areas designated as being at risk from agricultural nitrate pollution)

86
Water Framework Directive catchments (surface water)



*Note, there is considerable geographic overlap between sites for nature conservation, for example, many sites are designated as SAC, SPA and NNR. Almost all Ramsar sites are underpinned by the SSSI designation, and most Ramsar sites are also SPAs.

Nature: Access to nature

Human connections to nature

Access to good quality greenspace has an important role to play across both urban and rural environments for improving health and wellbeing, along with addressing issues of social inequality and environmental decline. Creation of new green infrastructure and permissive access can help attract green investment into the economy, creating local opportunities for employment through the recreation and tourism industries, leveraging the Fens' natural and cultural heritage.

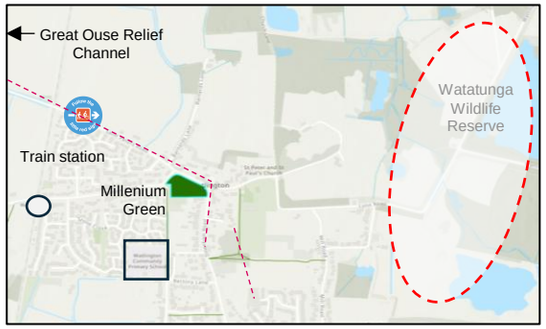
Public rights of way

The Fens lacks connectivity to nature sites by active travel routes when compared to surrounding areas such as the East Midlands and Norfolk. Many public rights of way run alongside watercourses or across farmland, where access can be limited in winter or during flood events. Access within the waterways can provide an alternative view of nature, but it is also limited.

Once complete, the King Charles III England Coast Path will be the longest managed coastal path in the world and the majority of the Fens coastline will be accessible. Currently, the completed sections run from the coast near Sutton Bridge to King's Lynn, and into Norfolk.

Inequality of access

Public Health England's 2020 review [23] found that the groups who most infrequently access green spaces were older people; those in poor health; people of lower socioeconomic status; those with a physical disability; ethnic minorities; and people living in deprived areas, among others. Wainfleet All Saints is within the 10% most deprived in England (overall deprivation), and although located adjacent to the Gibraltar Point National Nature Reserve there are no public footpaths or bridleway access.



Watlington, North Norfolk

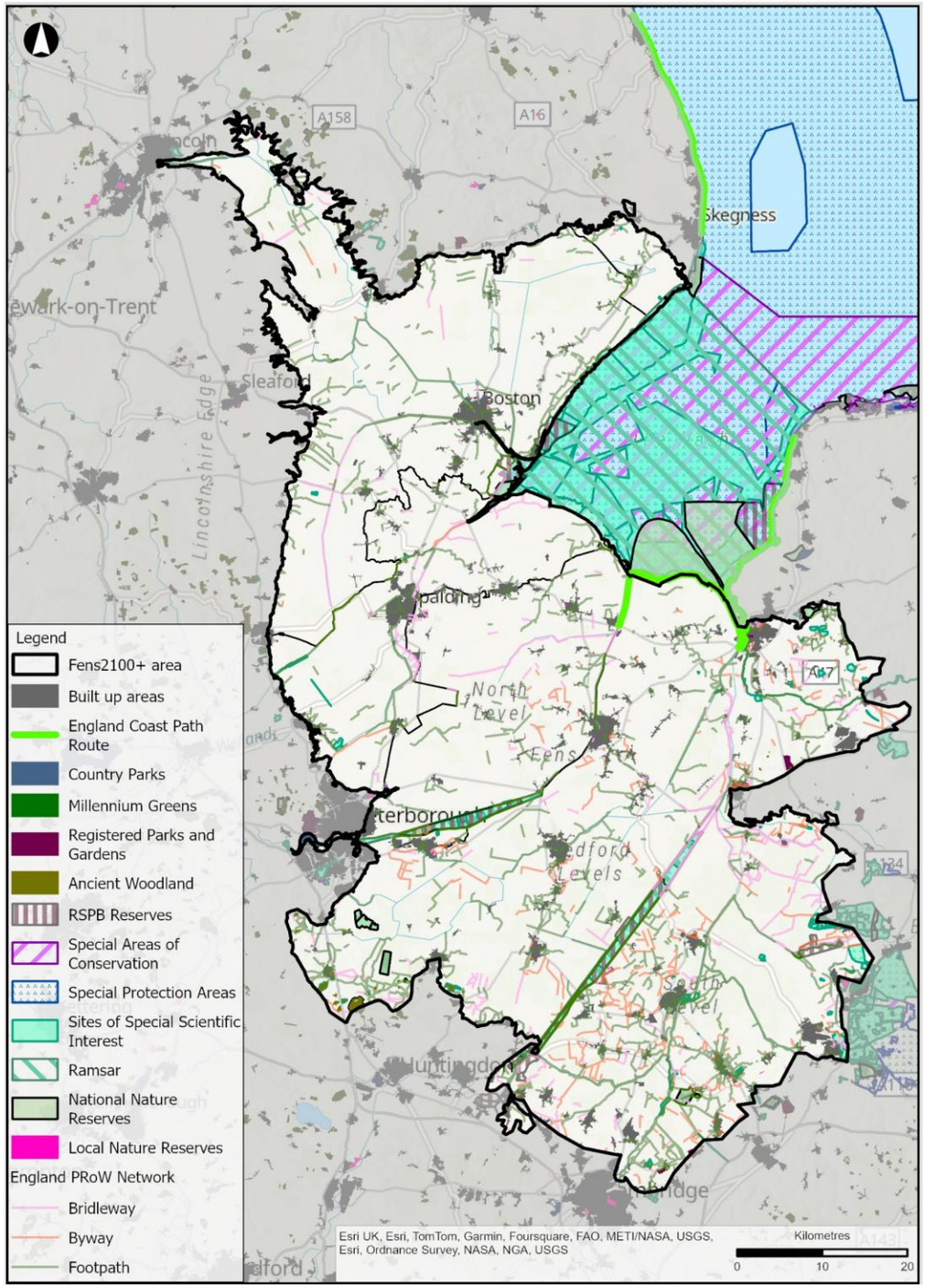
Watlington is located between King's Lynn and Downham Market, accessible from the A10. It is a good example of a small village with access to transport, public rights of way and greenspace. National Cycle Route 11 passes through the village, the Millenium Green provides community green space; and nearby Watatunga Wildlife Reserve is an example of nature-based tourism in the area.

RSPB reserves and WWT wetland centres

There are 6 RSPB nature reserves across the Fens, many of these designated as Ramsar sites (wetlands of international importance). Investment in nature recovery at these reserves has resulted in the reestablishment of Fens species populations that were at risk.

Frampton Marsh, the Ouse and Nene Washes are three of the largest reserves in the Fens. They provide parking and accessible access for visitors. Frampton Marsh and the Ouse Washes also have visitor centres, nature trails and picnic areas.

The WWT Welney Wetland Centre provides access to the Welney Nature Reserve at the northern end of the Ouse Washes and Lady Fen. Lady Fen provides an important bird refuge site when the washes are flooded. The centre is a key nature tourism draw. It provides habitat alongside visitor tours, school visits, a café, and accommodation.



Nature: Nature recovery

Local nature recovery

The Environment Act (2021) requires all regions in England to create Local Nature Recovery Strategies (LNRSs) to shape the direction of nature and environmental improvement. They will identify local priorities for nature recovery, including their spatial extent where appropriate. There are four LNRSs being prepared across the Fens:

- Greater Lincolnshire LNRS
- Norfolk LNRS
- Cambridgeshire and Peterborough LNRS
- Suffolk LNRS.

Many of the nature priorities in the Fens are likely to be underpinned by water – availability, storage and quality.

Nature restoration projects

Across the Fens it is estimated that there are around 13,500 species [24], but many are confined to fragmented and small areas.

There are a number of landscape-scale partnership projects across the Fens aiming to restore habitats and connect some of the last fragments of wild fen in the UK. This includes:

- The Great Fen [25], connecting Woodwalton Fen and Holme Fen - two National Nature Reserves.
- Ouse Washes Landscape Recovery Project [26] - wetland habitat creation and landscape-scale restoration across 4,000+ha of land within and adjacent to Ouse Washes SSSI with a clear water storage and resilience aim.
- Fens East Peat Partnership [27] are working on plans to rewet and restore peatland sites in low-lying areas of Lincolnshire and Cambridgeshire.

Irreplaceable habitat

In the mouth of the Great Ouse there are areas of spartina and med, saltmarsh and lowland fen. These habitats are very difficult (or take a long time) to restore, recreate, or replace once destroyed, and so all reasonable efforts should be made to maintain and protect them.

Protected areas

The areas with the highest levels of designation in the Fens (Ramsar, SSSI, Special Protection Area (SPA), Special Area of Conservation (SAC), NNR), are almost all sites that are important due to the way that they interact with water. Water levels and the movement of water through the land are key to the types of habitat that they support, and therefore the species who use those areas.

Environment Agency priority habitat projects

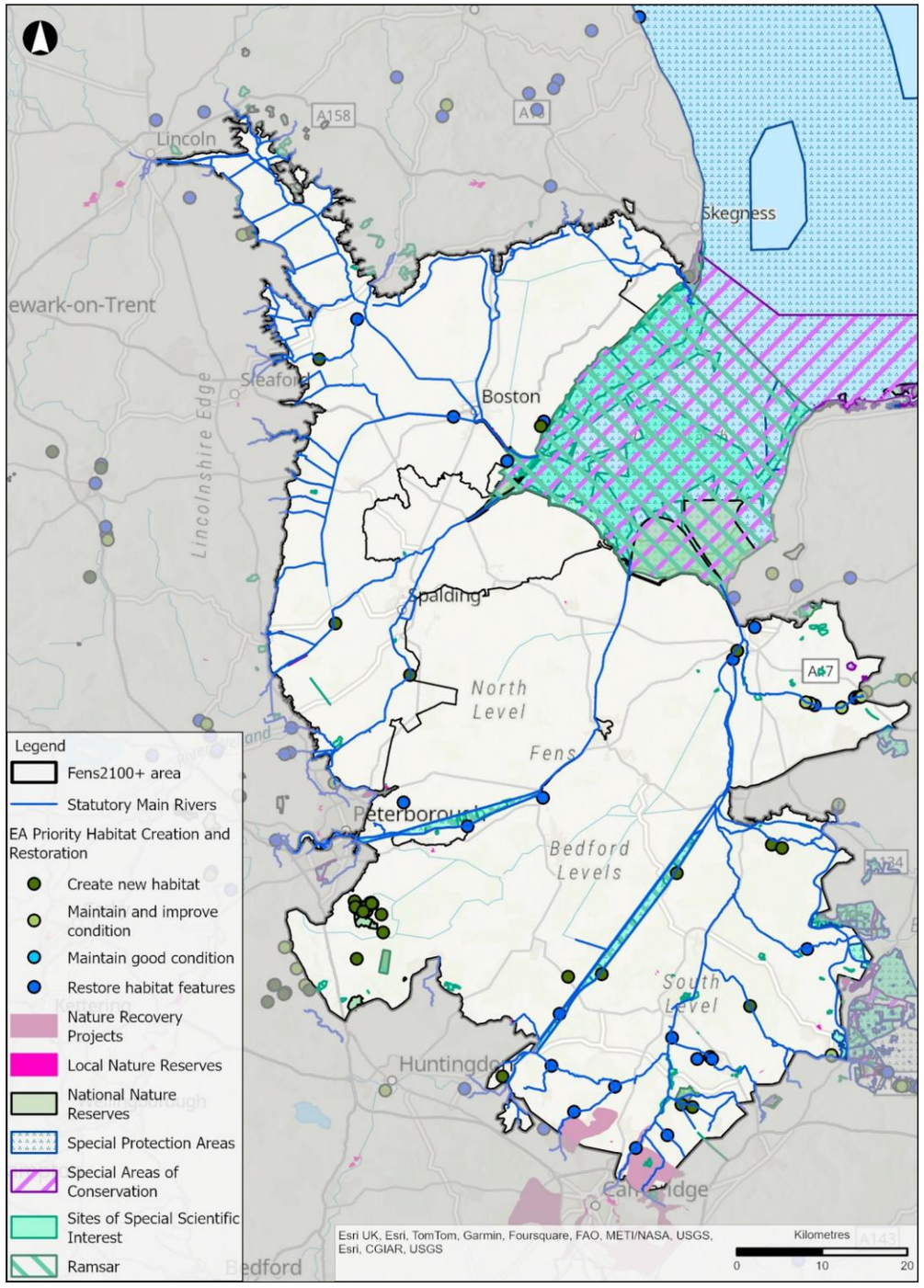
The Fens features an extensive network of fenland, river corridors, and waterways. Despite their ecological importance, many waterways have undergone extensive channelisation which has impacted their resilience. The Environment Agency has made a commitment to create or restore 20,000ha of priority habitats, through their own projects and working in partnership with others [28]. This helps contribute to the government's Environmental Improvement Plan [29] target to: "restore or create 140 000ha of wildlife-rich habitats by 2028".

There are a number of Environment Agency funded projects across the Fens 2100+ area that are creating new priority habitat including:

- Saline lagoons
- Coastal and floodplain grazing marsh
- Reedbeds
- Intertidal mudflats
- River restoration
- Lowland meadow and hedgerows

Environmental Land Management Schemes

ELMs will provide public payments to farmers and land managers to provide environmental goods and services alongside food production. A key focus for the Fens is on the improvement of areas of grassland to make them more attractive for wildfowl and waders and the installation of arable field margins to provide food and cover for populations of farmland birds. Due to the highly agricultural landscape, to increase biodiversity and access to nature - farmers, landowners and land managers are particularly important stakeholders.



Nature: Peat and carbon

Peat: A key Fens asset

Peatlands are carbon-rich wetlands which occupy 3% of the global land surface and 12% of UK land area [30]. Peatland covers around 3,000,000ha in the UK. 155,000ha of this are within the Fens (approximately 5% of the UK's peat), mostly represented by lowland peat.

Degradation

Fertile lowland peat soils have been historically drained to support agriculture. This has led to degradation of the peat, including land sinkage and carbon release. Although lowland peat accounts for approximately 14% of UK peatland, it is responsible for approximately 56% of peatland emissions [31]. Available mapping is widely considered out of date. Land designated as peat is unlikely to now meet the criteria, but even so, the degraded soils continue to hold much more carbon than mineral soils elsewhere.

Restoration

Peatlands can provide benefits including carbon sequestration, supporting biodiversity, improving water quality and natural flood management. Central to peat restoration is rewetting.

Peat restoration schemes across the Fens are mainly located within existing nature reserves, or in land recently taken out of cultivation. Just over 5,000ha of the peaty soils in the Fens are within land that has a designation for nature.

Research

There is a key challenge to balance peat restoration and its associated benefits, with agricultural production. For example, the UK Centre for Ecology & Hydrology and Fenland SOIL is involved in research into how peatland can be managed sustainably, to provide economically viable, lower-emission agricultural options. Within the Fens, there are trials of different cultivation techniques including paludiculture and switching to crops like celery.

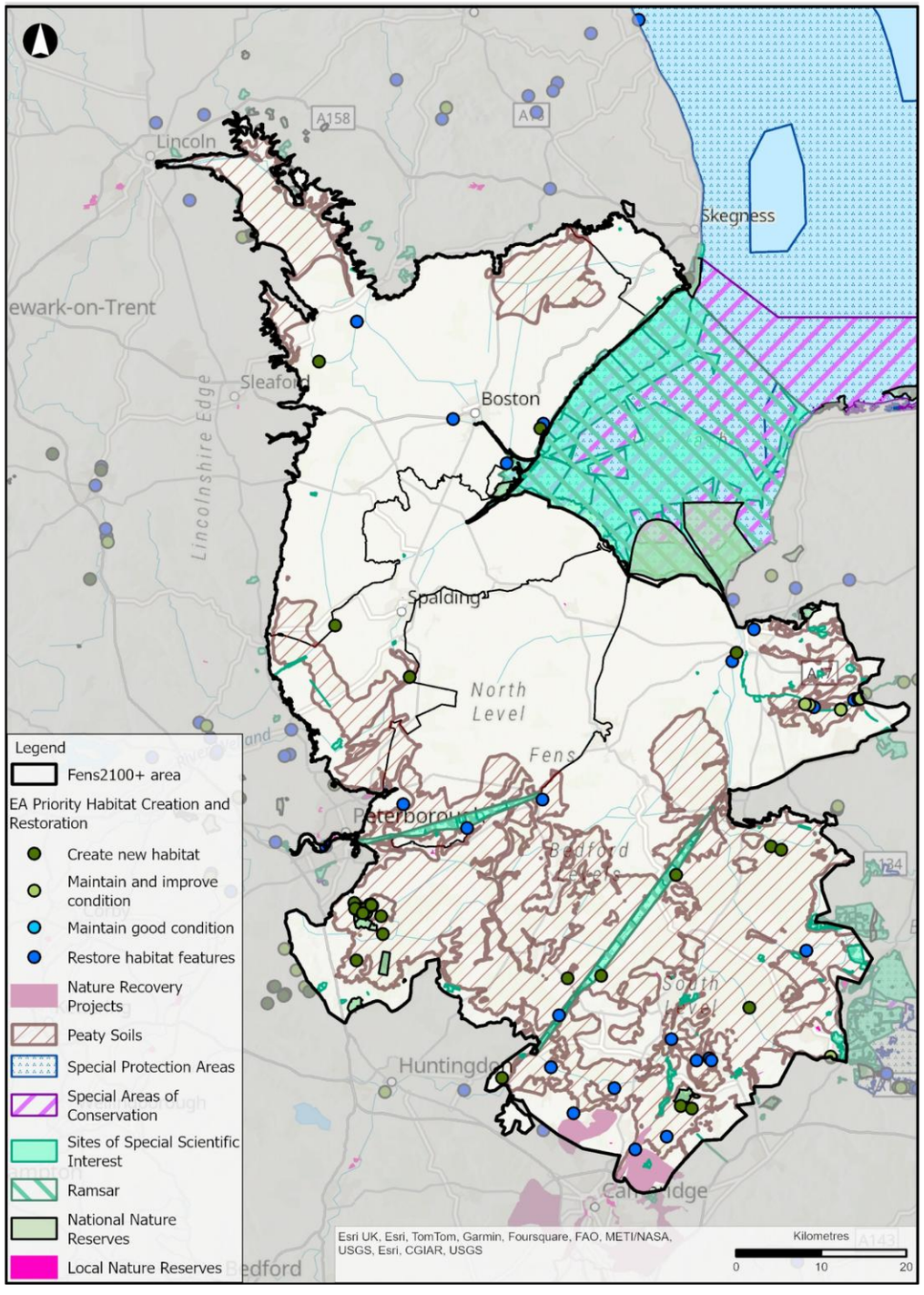
Lowland peat partnership projects

Public funded grant schemes have recently been introduced to support IDBs to install new small-scale water level management infrastructure and monitoring technology within drainage districts containing lowland peat:

- Bourne North Fen Tilting Weirs project is looking to install two tilting weirs, each with associated telemetry, powered by solar energy, to enable fine control of water levels in two key watercourses to reduce risk of the peat drying out.
- Horsey Toll Sluice Replacement Project – project to decommission a manually operated gate and replace with an automated one, aiming to support a new water management regime which will benefit downstream land managers.

Holme Fen

At 2.75m below mean sea level, Holme Fen in the south west of the Great Ouse catchment is the lowest land point in Britain. In the 1800s, William Wells realised that draining the area would cause the peat to shrink. In 1848, he decided to install a timber gauging post into the clay layer beneath the peat to measure the subsidence. At that time there was about 22 feet (6.7m) of peat from the surface to the clay. Since installation of the original post, records show around 4m of ground subsidence in total]32].



Nature: Water management

Managing water levels across the Fens

Many of the designated sites for nature conservation are reliant on specific water levels to support sensitive flora and fauna. Changes in water levels can influence short and long-term sediment deposition, impacting habitat and species composition.

IDBs have legal requirements to collaborate on environmental management and conserve and enhance biodiversity and designated sites (e.g. SSSI, SPA, SAC, Ramsar) whilst carrying out their water-level management responsibilities.

Drought

The current (2018) modelled scenario indicates the likelihood of a drought event is moderate for most of the region, with between 0.7-1.5 occurrences per year typically experienced. The number of incidences of drought events is projected to increase by the 2050s when most of the region is projected to experience between 1.3 -1.9 occurrences per year. This has the potential to have significant and long-lasting impacts on nature, particularly if it impacts breeding seasons, or multiple years without recovery periods.

Under the Flood and Water Management Act 2010 [33], IDBs can flood land or raise water levels for the purpose of nature conservation, where certain criteria are met. In times of drought, nature reserves are given priority water supply.

Water quality

Agricultural inputs and sewerage effluent are both major sources of pollution and can influence the quality of watercourses and drains across the Fens. Nitrate and phosphorous are key chemicals which affect the quality of freshwater. Small waterbodies are also more vulnerable to changes in water quality. Just over 340,000ha (77%) of land within the Fens is designated as being at risk from agricultural nitrate pollution (Nitrate Vulnerable Zone) either to ground or surface water.

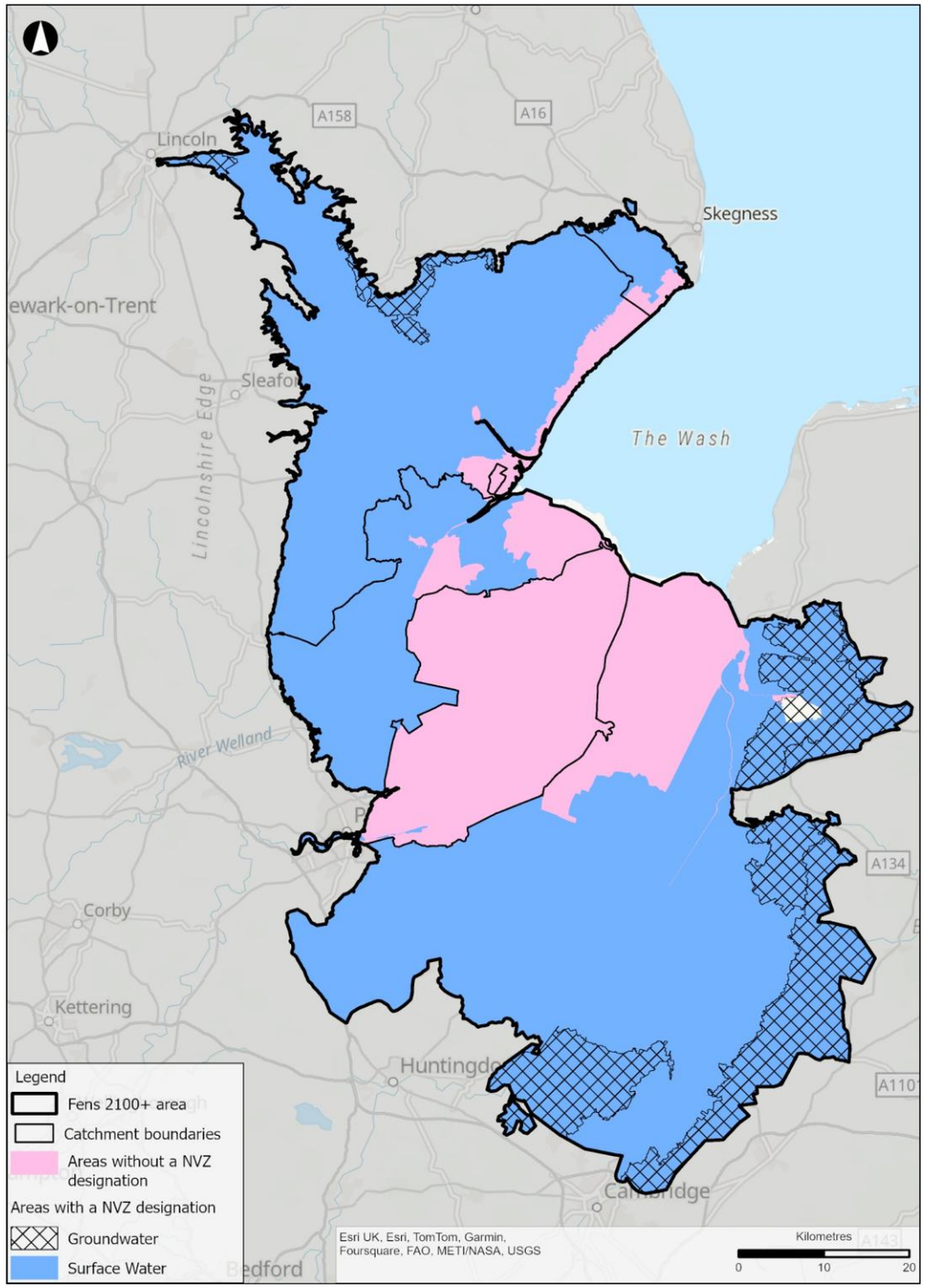
Ouse Washes water levels

The Ouse Washes flood storage area, registered under the Reservoirs Act 1975 [34], is one of the country's largest flood defence systems and an internationally important nature reserve attracting visitors for wildlife and recreation.

During 2022, the Ouse Washes bank raising works project extending from Earith to Welmore Lake Sluice was undertaken. This project also improved bridleway access, installed new bird hides and added erosion protection along section of Mepal and Welches Dam. The project team worked collaboratively with key stakeholders including schools, local communities and nature organisations to unlock wider benefits. Work was restricted to during the summer months to avoid disturbing breeding and over-wintering birds. Early engagement and careful planning with Natural England was required to negotiate a longer working window to carry out haul road work.

Water Framework Directive

The WFD seeks to restore the natural functioning of water bodies, secure the sustainable use of water resources, protection of water uses and high-quality habitats for wildlife. The Fens is split across 86 Water Framework Directive catchments for surface water, 36% of which are categorised as moderate, bad or poor. There is only limited data for groundwater WFD status for the Fens.



Food and agriculture: Overview

Productivity | Stewardship | Food processing | Climate

The Fens is of national agricultural importance due to its productivity from rich peaty soils. Agriculture provides a critical underpinning to the local economy.

Agricultural land

A combination of climate, topography and soil characteristics and their unique interaction determines the limitation and grade of agricultural land across England. There are currently over 405,000ha of Grade 1, 2 or 3 agricultural land (Grades 1-3a is known as Best and Most Versatile land) in the Fens, much of which is at flood risk now and will be at increased risk in the future. Almost half (48%) of all of the Grade 1 classified agricultural land in England is located within the Fens, despite the Fens representing just 4% of England's farmed area. For this reason, it far outperforms other areas.

Grade of Land	Area in the Fens (ha)	Area in the UK (ha)	% of UK stock in the Fens
Grade 1	169,106	354,585	48%
Grade 2	179,186	1,849,074	10%
Grade 3	57,180	6,290,210	1%

Much of the best Grade 1 land coincides with the historical peat deposits in the south of the Fens, or the reclaimed estuary areas near The Wash following the rivers. In the future there may be difficult choices to make to balance agricultural production and rewetting peat to support carbon sequestration.

The agricultural sector

The agricultural sector in the Fens includes farming and horticulture, with more than one fifth of England's water intensive crops grown in the Fens [35] including celery (which has protected name status). The area around Spalding is traditionally famous for producing ornamental bulbs and flowers. Commercial glasshouse production is also prevalent, with new technology providing opportunities to develop more circular systems and improve the carbon footprint of the sector. Not all crops are routinely irrigated, however without access to secure water supplies, there will be implications for the viability of the sector in the future.

Farming and the food industry

Farming is critical to the local economy and the sector supports a large and diverse range of businesses with thousands of people permanently and directly employed. The agriculture and food production sector supports 80,000 jobs in the Fens [35]. From farm to fork it generates around £3 billion annually for the Fens economy.

c.3,700 farms
across the Fens

96.5%
of land in the Fens is in agricultural use

405,472ha
of Best and Most Versatile (Grade 1, 2 or 3) land.

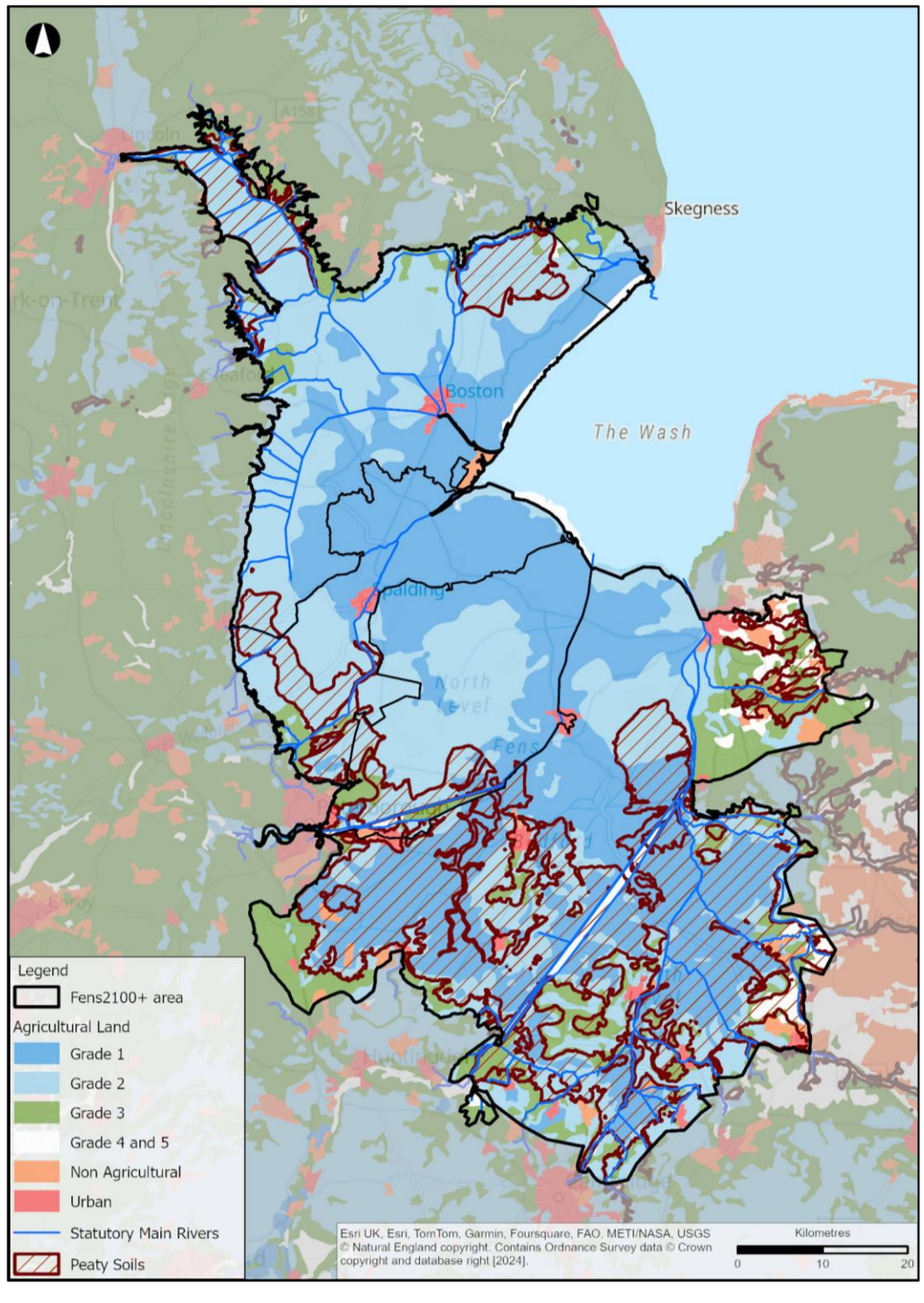
48%
of England's Grade 1 land is located within the Fens.

7%
of England's total agricultural productions is grown in the Fens, despite covering only 4% of England's farmed area [35].

£3 billion
a year generated by the food supply chain for the Fens' economy. [35]

80,000
jobs supported by the food supply chain [35].

A fifth
of England's potatoes are grown in the Fens [35].



Food and agriculture: Productivity

Productivity

Studies by the NFU [35] found the Fens produces a third of England's fresh vegetables, 20% of England's potatoes and almost 20% of England's sugar beet, as well as cereals, oilseed rape and protein crops.

Remote sensing data (2020)* indicates most of the land in the Fens is covered by cereal crops, which include wheat, barley, oats and rye. There are also scattered areas where leguminous crops such as peas and beans were identified.

Changing crop patterns

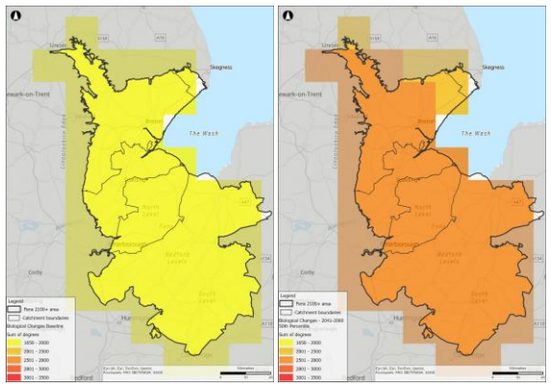
Crop	Fens % of total English land area for production 2006 [36]	Fens % of total English land area for production 2016 [35]
Potatoes	24%	20%
Sugar beet	17%	20%
Vegetables	37%	32.8%
Plants & Flowers	38%	21.4%

Throughout the 20th century, South Holland District was known for horticulture, particularly tulips and bulb growing. A key tourist draw was the Spalding tulip parade. A cluster of horticulture-related businesses remain in the area, however cropping trends are changing. Many businesses around Spalding have pivoted towards pumpkins, celebrated through an annual pumpkin festival [37].

Although the land quality could support higher value crops, concerns around risk and investment due to potential waterlogging have been a concern for farmers in recent years. Anecdotally, it is believed that crop patterns have changed significantly since 2016, driven by volatility in the food markets, additional requirements post-Brexit, and limited appetite for risk in higher value crops due to water availability.

Growing days

Annual Growing Degree Days (GDD) [38] provides the annual sum of degrees for days where the mean temperature is over 5.5 °C. It is the number of degrees above this threshold that counts as a GDD (e.g. an average temperature of 10.5°C would contribute 5 Growing Degree Days). It indicates if conditions are suitable for plant growth. An increase in GDD, as is expected in the Fens, can indicate larger crop yields due to increased crop growth from warm temperatures, but would also be limited by other factors (e.g. rainfall, sunlight, day length, wind), which aren't considered in this indicator.



Annual Growing Degree Days 2018 (left) future 2041-2060 (right). Future scenarios based on UKCP18 Regional 12km data, and show an RCP8.5, 50th percentile projection.

Innovation

Organisations like the Lincoln Institute for Agri-Food Technology [39] aim to work with the food and farming industry on research and through a knowledge exchange programme. Research into robotics and automation are being applied to the soft fruit sector, creating a 24/7 labour pool. National Institute of Agricultural Botany [40] (NIAB) works with over 100 farms in the Fens, supporting better understanding of plant genetics and crop science innovation to boost yields.

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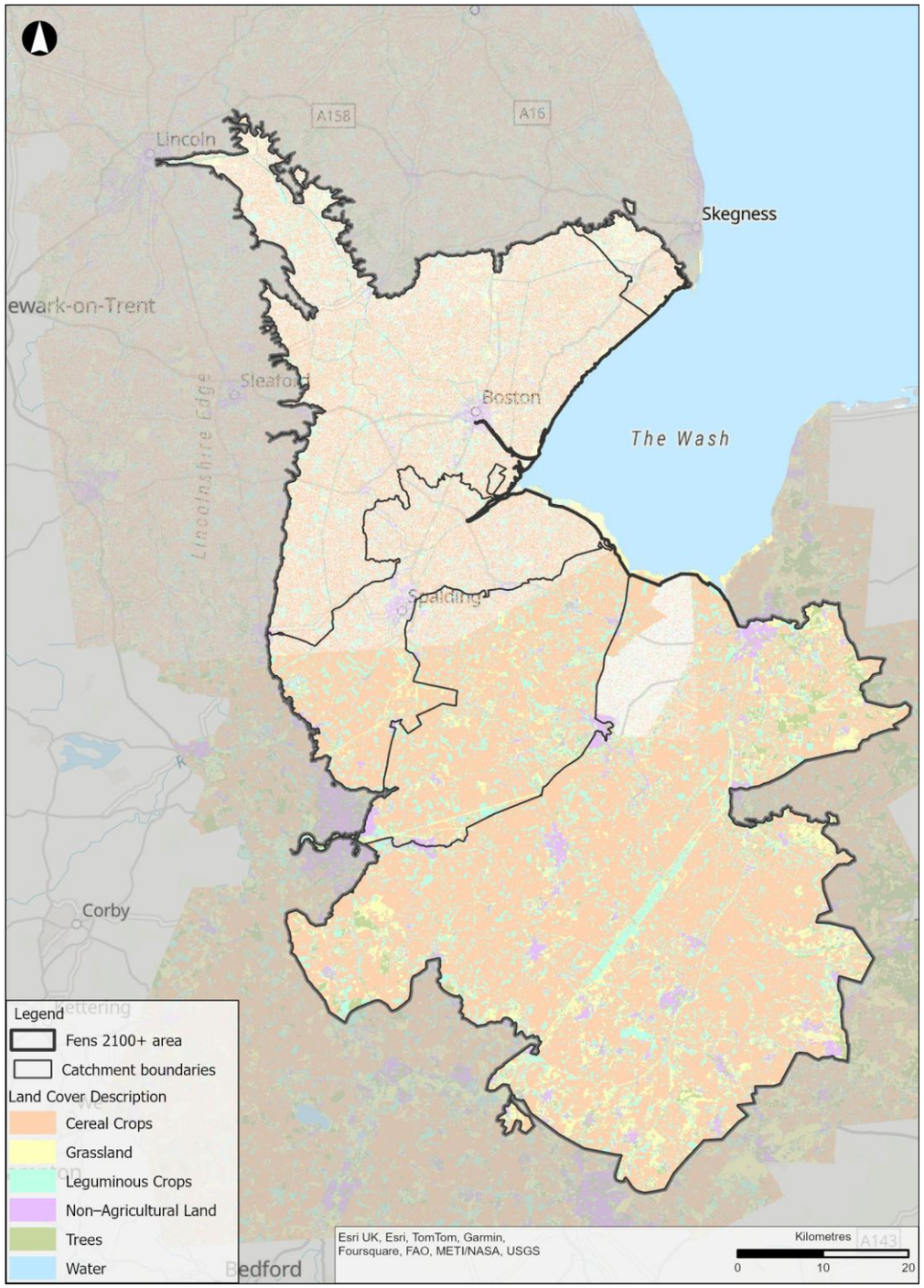


* As illustrated on this map. Within this data there are some grid cells with unassigned land cover, creating interspersed gaps. The dataset was created from a trained model using remote sensing data and where there is poor/low resolution imagery cells haven't been populated, making it look lighter in general

Food and agriculture: **Stewardship**

Productivity | **Stewardship** | Food processing | Climate

Farming with nature

The modern Fens is an industrial farming landscape, characterised by large open fields and limited trees and field boundary features. A large amount of field boundaries are delineated by ditches, dykes and drains rather than hedgerows or trees.

Overall, the abundance of all UK species studied has declined on average by 19% since 1970 [41]. The evidence from the last 50 years shows that climate change and the intensive way in which we manage our land for farming or seas for fishing are the biggest drivers of nature loss.

Farmland birds

Agricultural intensification from the 1970s onwards has involved a widespread shift from spring to autumn-sowing, a loss of mixed farming, and increases in the use of agrochemicals including herbicides, pesticides and fertiliser which has impacted farmland bird populations.

Peat

Without a change to how peatlands are managed, we will continue to lose valuable agricultural soils, leading to loss of agricultural land and greater challenges to food security. The degradation of peatlands has a negative impact on soil health over time, affecting the long-term viability of agriculture in those areas. There is also the challenge of rewetting lowlands to provide benefits for nature and carbon without compromising agricultural production and profitability [42].

Peat subsidence due to drainage also increases the need for expensive pumping to maintain conditions suitable for crop growth (as the land falls below the water table) and increases the risk of flooding. Raising water levels could benefit farmers by extending the productive lifetime of the soil, as well as reducing both CO_2 emissions and flood risk.

Stewardship schemes

The map indicates the extent and locations of all land under management within Countryside Stewardship Agri-Environmental Schemes from January 2016, last revised in 2023.

Overall, 106,661ha of agricultural land within the Fens is within a Countryside Stewardship scheme, equivalent to 38.4% of the farmed area. Just over 85% of the schemes relate to Middle Level stewardship.

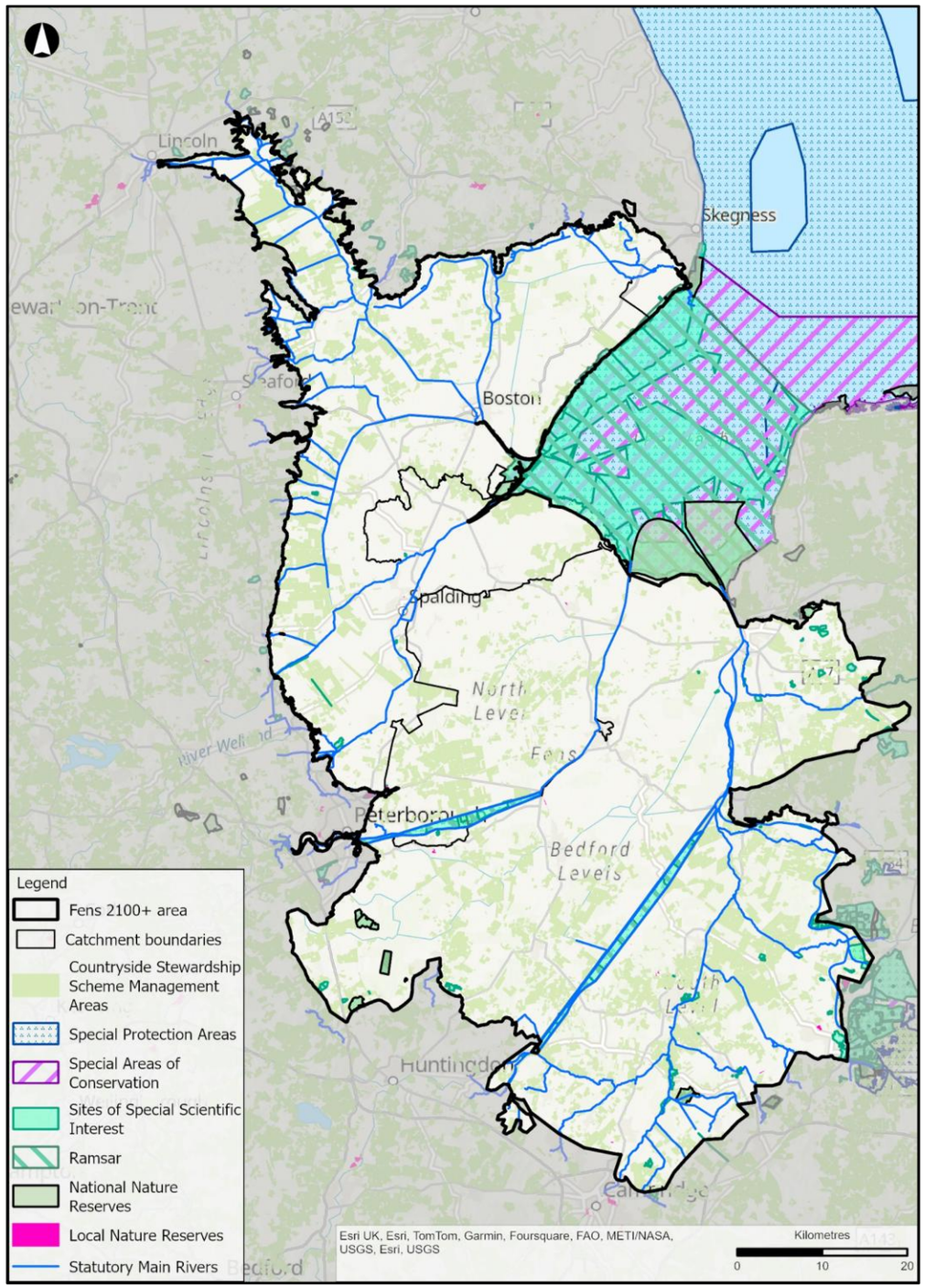
Uptake of grants and schemes varies from year to year, and this will likely change as further details on the Environmental Land Management Schemes (ELMs) are released and new and innovative farming methods become eligible for funding, e.g. precision farming and agroforestry.

Environmental Land Management Schemes

ELMs will provide public payments to farmers and land managers to provide environmental goods and services alongside food production. ELMs seeks to fund schemes that improve water quality, habitat creation and adaptation to climate change from farm scale through to landscape scale. In the Fens, the key focus is on the improvement of areas of grassland to make them more attractive for wildfowl and waders and the installation of arable field margins to provide food and cover for populations of farmland birds.

Ouse Washes Landscape Recovery Project

One early ELMs project sets out to deliver long-term resilience through wetland habitat creation and landscape-scale restoration across 4,000+ha of land within and adjacent to the Ouse Washes SSSI. The project aims to create 1,000ha of target habitat and to form a continuous wetland habitat from the Ouse Washes, Fen Drayton, and Ouse Fen to form 1,900ha of continuous wildlife rich habitat.



Food and agriculture: Food processing

A centre for food processing

The Fens' strong farm production base supports the UK's largest fresh produce logistics hub and a sophisticated commercial food chain, crucial for both the commercial food chain and food retailing and catering sectors. Overall, the food supply chain in the Fens creates over £3 billion in Gross Value Add (GVA) and supports almost 80,000 jobs [43].

Stage of chain [43]	Employees	GVA £m
Agriculture	13,414	432
Agriculture & supply industry	2,968	170
Professional services	1,288	49
Commercial food chain	26,040	1634
Food retailing and catering	36,000	800

There is a varied food processing supply chain within the Fens, with farmers often doing early processing of produce. For example, Branston Ltd operates across three sites in the Fens, and supplies most of Tesco's fresh and prepared potatoes [44]. They are supplied by over 100 growers in producer groups, handling 350,000 tonnes of potatoes a year. Many go direct to retail, but those that are too large or small (based on retail standards) go into prepared lines such as ready to roast, while the 'ugly' potatoes are peeled in their ingredient factory and are sold to ready meal manufacturers; many of whom are also based in the Fens. Water availability is key to much of this processing.

Logistics

The road network is key to the functioning of the fresh food distribution network that supports the food processing industry in the Fens. For example, Spalding includes a hub of logistics businesses distributing fresh food and flowers, focused around the A16. These businesses place heavy reliance on the limited number of A-roads in the Fens, which could present a resilience risk.

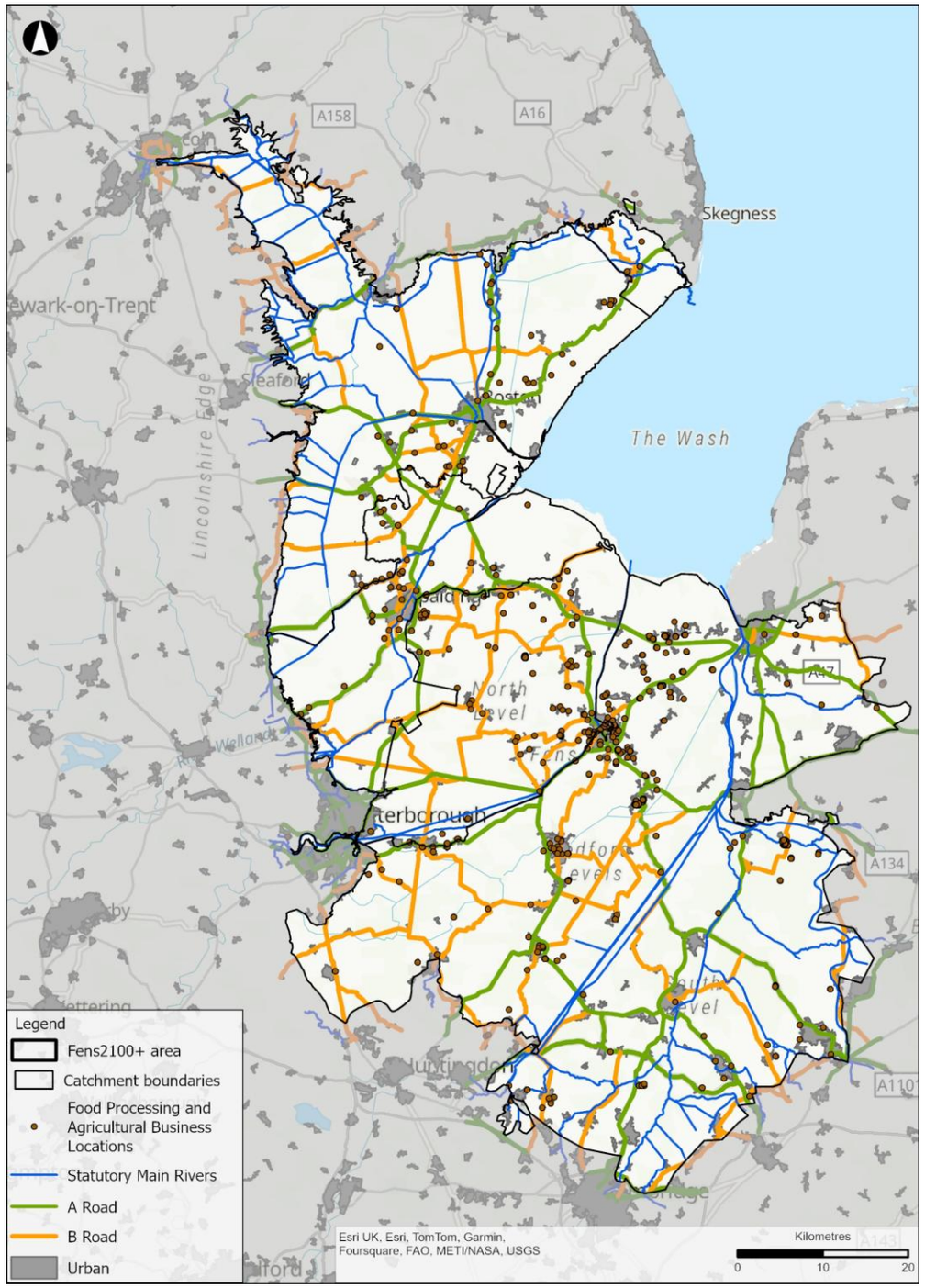
South Lincolnshire Food Enterprise Zone

The South Lincolnshire Food Enterprise Zone [45], based in Holbeach includes the Centre of Excellence in Agri-Food Technology and the National Centre for Food Manufacturing. It is a core asset in modernising the food manufacturing system nationally, with research and development tested in the Fens.

The National Centre for Food Manufacturing is part of the University of Lincoln. It is the UK's largest provider of education for the food chain. Through research, the centre aims to advance the food industry across the supply chain, supporting digitalisation to optimise productivity, support industry sustainability agendas and use academic methods to unlock challenges relating to food quality, safety and nutrition.

Within the overall centre there is also an Innovation Centre with labs, test kitchen, sensory suite, teaching rooms, and a Digital Food Manufacturing Technologies Centre. Across the Zone there are partnerships with schools and colleges, supporting local education and development.

Innovation has an important role in the Fens to support the growing part of the food processing supply chain, helping to create resilience to increase land salination, changes to cropping regimes, or impacts of disease.



Food and agriculture: Climate

Changing risk to farming

Increasing flood risk can have several impacts on highly productive arable farmland, which can have long reaching consequences over and above other farming types.

Salination

Inundation by saltwater (from the sea or tidally influenced areas) can impact soil fertility for multiple years (5+) [46], and soil salinity can restrict crops that will grow effectively. Research [47] indicates that financial losses range from £1,366/ha to £5,526/ha per inundation, but that these losses would be reduced by between 35% and 85% if alternative, more salt-tolerant, cropping regimes were implemented post flood.

Drought

Salinity can also increase through drought periods, as less freshwater moves through the tidally influenced areas. Prolonged periods of drought, also result in growing pressures on groundwater for drinking, irrigation growing and industry processing, further exacerbating salination. This process can also lead to direct crop failure as irrigation reservoirs are exhausted.

Waterlogging

Conversely, periods of high rainfall and storms also damage crops, particularly where they haven't been long planted. Any crop submerged for more than 15 days is likely to be damaged and lost [48]. Over wet soils are also more difficult to work, impacting the type of machinery and processes that are available.

Winter 2023/24 challenges

The long, wet winter of 2023/24 presented a significant challenge for growing crops in the Fens. Winter potato and cereal crops were severely damaged with many left to rot in the ground. This increased the reliance on secondary spring crops, which in some locations were also subject to water damage. Harvests were estimated to be down by 21% across England [49].

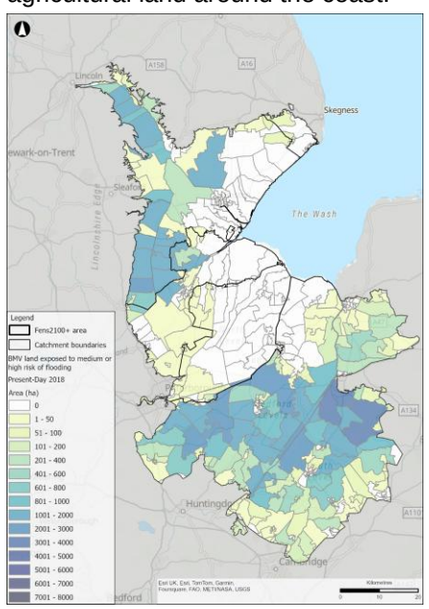
*See the Systems Maps for all FFE definitions.

Flood risk to BMV land

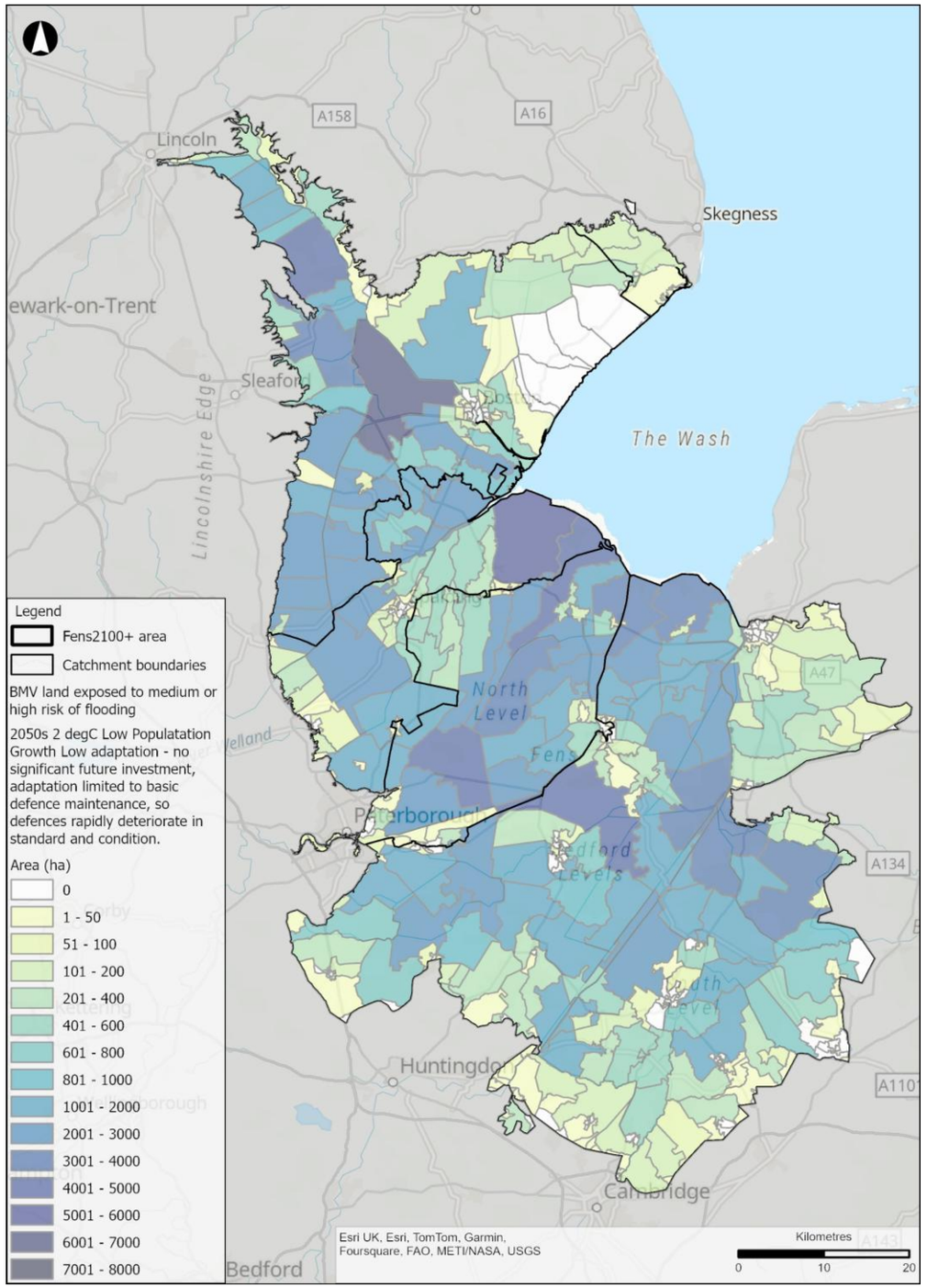
The current baseline scenario (2018) estimated that around 77,000ha of BMV land could be exposed to medium or high risk fluvial and coastal flooding (more frequent than 1% Annual exceedance probability (AEP)*). This equates to approximately 17.5% of the farmland in the Fens being at risk of flooding. The majority of this land coincides with the peaty soils.

By the 2050s, (2°C low-population, under low levels of adaptation scenario) approximately 195,000ha of BMV land could be exposed to medium or high risk of fluvial and coastal flooding (more frequent than 1% AEP). This equates to approximately 44% of the farmland in the Fens.

Areas already at risk now remain at a similar risk in the future, however a large amount of the additional area at risk is within the Grade 1 agricultural land around the coast.



Area of BMV (ha) land exposed to medium or high risk flooding, on average
FFE - Fluvial and Coastal | 2018 baseline



Area of BMV land (ha) exposed to medium or high risk flooding| FFE - Fluvial and Coastal 2050 scenario | 2° C | low population| Low levels of adaptation

Infrastructure: Overview

Road & Rail | Active Travel | Energy | Water

Road infrastructure is key to accessibility in the Fens. The area is at the forefront of new energy and water resource investment.

Roads

Roads are the main method of transport connectivity in the Fens. The area has a limited number of strategic and A-roads (A47, A15, A16, A17 being the primary roads) which connect the larger towns. There is a vast network of C-roads and unclassified roads which give access to the rural parts of the Fens. Many roads follow watercourses and are located on the top/crest of flood risk embankments, including the section of the A47 between Guyhirn and Wisbech alongside the River Nene.

Rail connections

There are 21 train stations across the Fens, serving most of the main towns. Some of the stations are 'end of line' destinations, such as King's Lynn. There is very limited inter-Fens connectivity by train e.g. to get from King's Lynn to Peterborough you need to travel via London or Cambridge. Key interchanges are located at Peterborough. Peterborough station is a key connection onto the East Coast Mainline, providing frequent connections to destinations across the UK.

Active travel

Active travel routes in the Fens are disjointed, and do not currently provide access to the countryside in a way that would support a wide-ranging eco-tourism industry. There are plans to increase active travel routes alongside rivers and flood risk management infrastructure, which could impact flood risk management in the future, for example through greater risk of disturbance, more regular citizen inspection etc.

Energy

Decentralised energy developments, particularly solar and wind, are becoming increasingly common in the Fens as the UK moves towards net zero. New energy transmission is planned in the area, including the Great Grid Upgrade projects, linked to the North Sea wind farms and international interconnectors.

Water resource

There are 49 Waste Water Treatment Works within the Fens, discharging into a variety of watercourse types. There is mounting pressure to increase public and on-farm water storage in the Fens to both support water supply and reduce the burden on the flood risk management system during times of heavy rain.

630km
of A-road

2,773km
of public rights of way

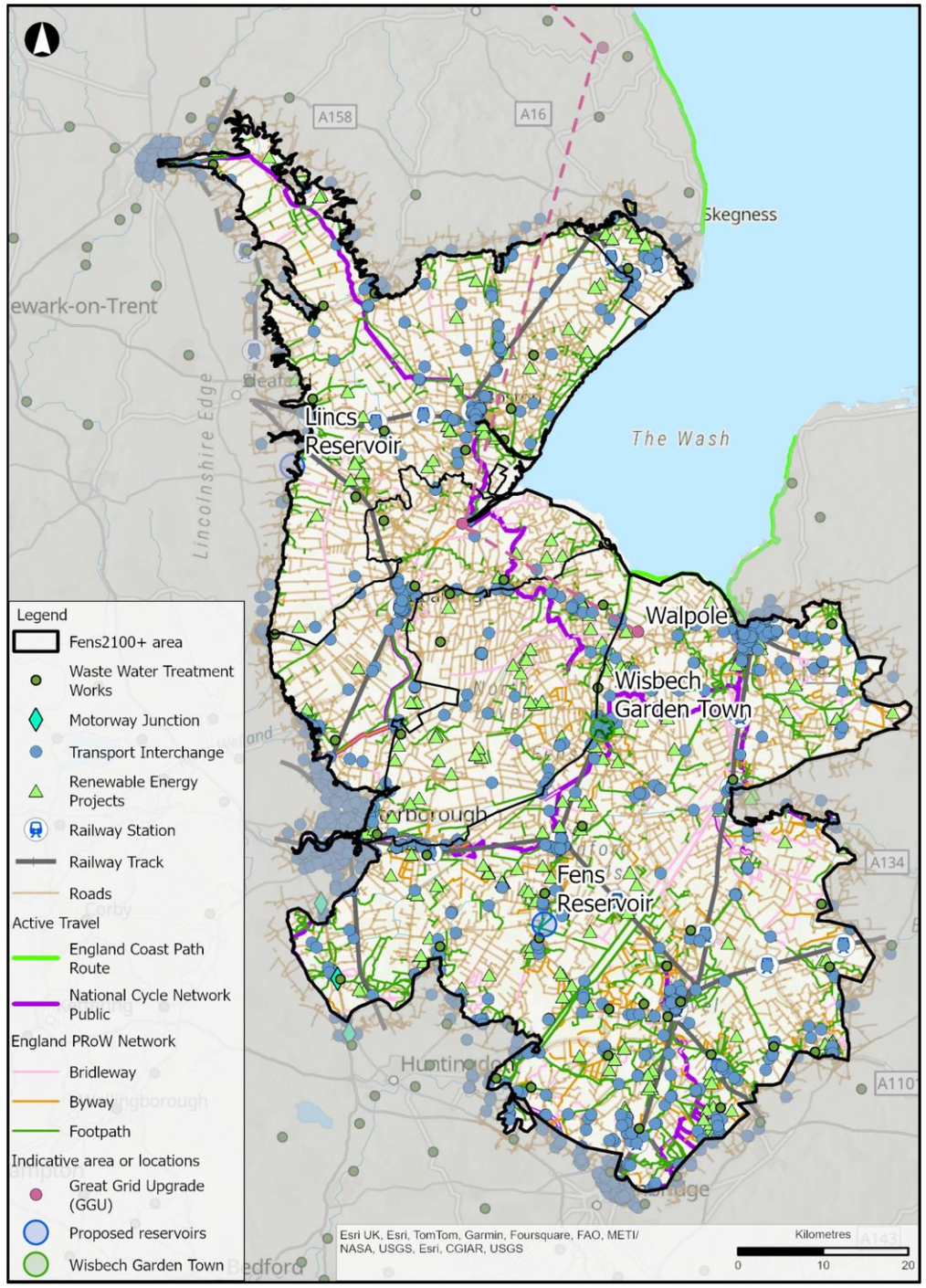
356km
of local cycle routes used for everyday travel

21
train stations, over 275km of rail lines. There is limited inter-Fens connectivity

1
new grid connection planned across the Fens, as part of the Great Grid Upgrade, so far from Grimsby to Walpole.

2
new strategic reservoirs planned

49
Waste Water Treatment Works



Infrastructure: Road and rail

Roads are key connectors

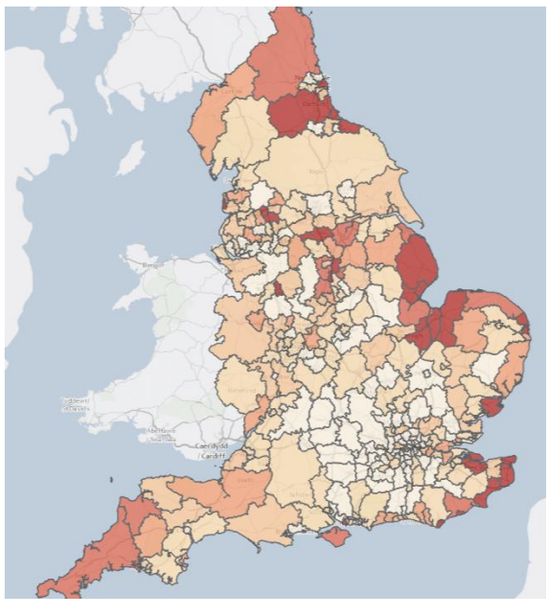
Transport is vital social infrastructure, providing access to work and education opportunities, key services, community life, leisure, and recreation.

Currently there is a heavy reliance on the road network, particularly the rural road network due to the spread of population and employment. Within the Fens, there are over 9000km of road, made up of:

- 630km of A-road (7% of road in the Fens)
- 658km of B-road (7% of road in the Fens)
- 7,720km of C or lower classified road (86% of road in the Fens)

In comparison there is just 275km of rail.

Any impacts on the road network from flooding are highly problematic for people in the Fens. For many, access by road is the main or only method of travel available to them. Transport options currently available already exclude many from easy access to employment, education, access to healthcare and other basic services.



Extract from Transport for the North's Transport Related Social Exclusion tool. The darkest red area represent local authority areas within the 10% highest risk of TRSE

Roads on flood embankments

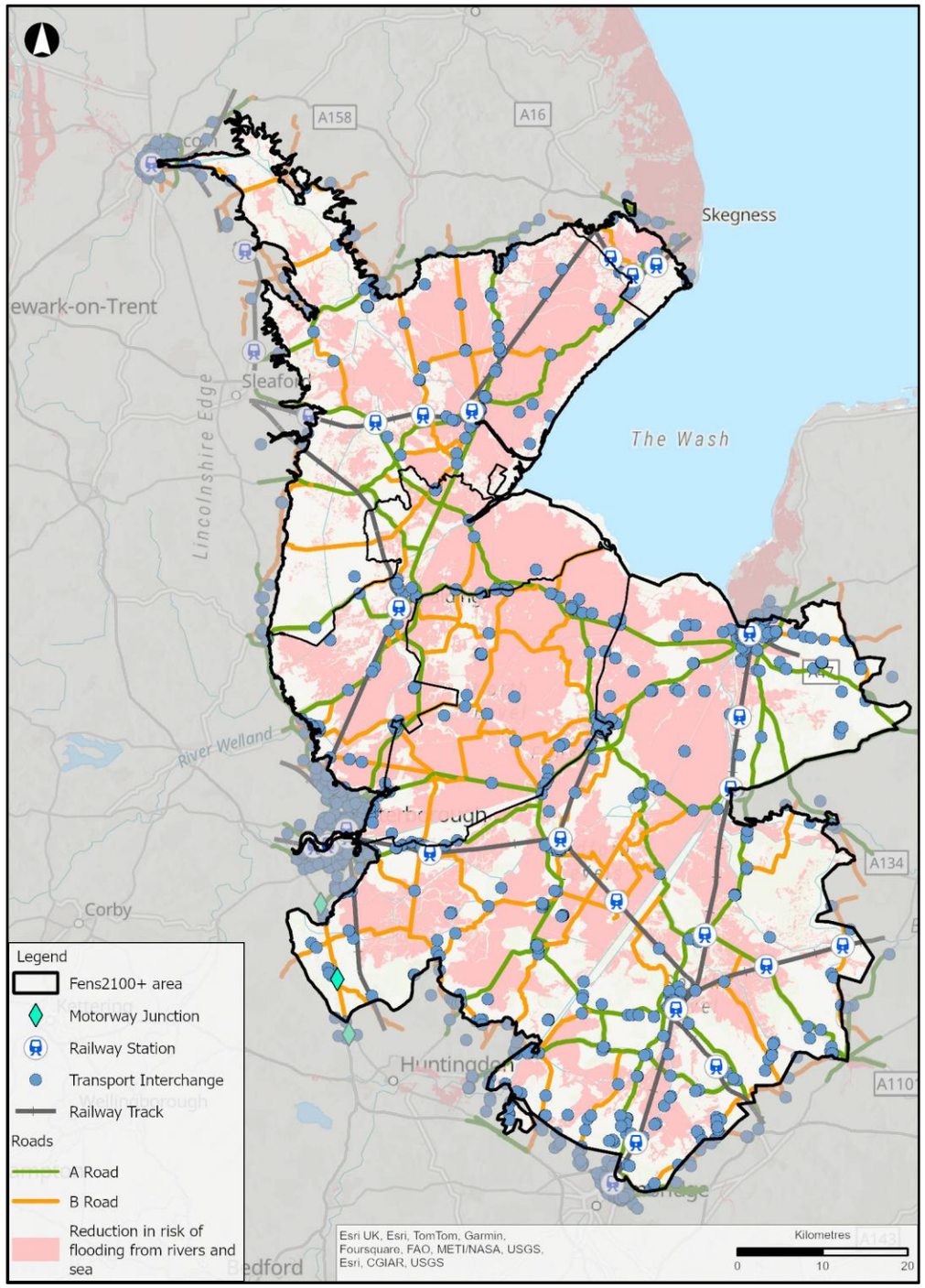
There are just over 9,000km of road network in the Fens. Approximately 165km (1.8%) of these are estimated to be located on top of flood risk embankments, therefore the maintenance of the flood risk system directly impacts these connections.

Transport Related Social Exclusion

There are very high levels of Transport Related Social Exclusion (TRSE) [50] in the Fens, compared to the rest of England. There are approximately 40 lower super output areas (LSOAs) within the Fens that are within the top 5% highest risk of TRSE across England. One LSOA in King's Lynn is the 16th most transport related socially excluded area in England, out of over 32,000.

TRSE means being unable to access opportunities, key services and community life as much as needed and facing major obstacles in a fulfilling life due to the impacts of travel. These impacts can contribute to a vicious cycle of poverty, isolation and poor access to basic services. TRSE has a disproportionate effect on people with disabilities and long-term health conditions, people with caring responsibilities, and those on low incomes and in insecure work.

There is a high levels of car dependency including likely forced car ownership due to lack of alternative travel options. 84% of the Fens households have a car, compared to the national average of 77% [51].



Infrastructure: Active travel

Road & Rail | **Active Travel** | Energy | Water

An inaccessible rural space

Unlike rural idyll expectations, the land away from key settlements is generally poorly served by active travel routes across the Fens. The waterways, and their embankments, have the potential to be key connecting features, and are already often informally used for local recreation such as dog walking.

Seven national cycle routes cross through the Fens, including the Dover-Shetland route that connects the eastern coast. The National Cycle routes are disjointed, with sections that do not connect into any other active travel resource.

Investment in a more comprehensive formal active travel network is unlikely to be a viable prospect, unless it links to a wider push for strategic eco-tourism across the region.

Active travel resource type	Length in the Fens (km)
England Coast Path	27
National Cycle Network	357
Bridleway	544
Byway	392
Footpath	1837

Cygnet Bridge, Peterborough

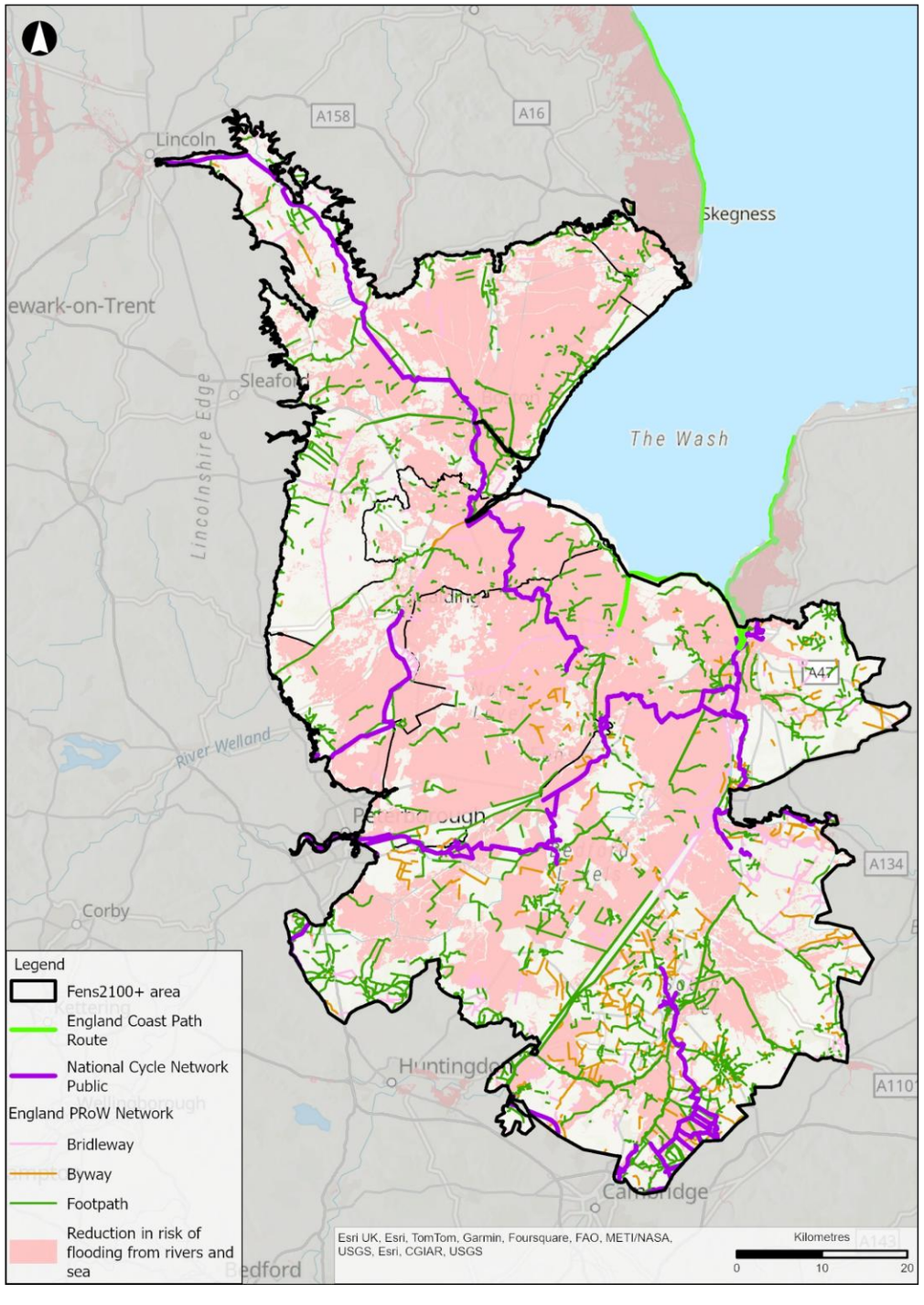
As part of the Towns Fund application for Peterborough, a new pedestrian bridge has been proposed across the River Nene between the Embankment, Fletton Quays and the City Centre [52]. It aims to provide a new pedestrian crossing between the riverbank areas to reduce pressure on congested vehicle routes, to improve the riverfront and create landscape features which increase biodiversity. This project aims to draw more people into the riverside area, which may change considerations for flood risk management.

Sir Peter Scott Way

The Sir Peter Scott Way is an example of a recreational footpath which uses FCERM infrastructure. It follows the top of the outer sea defence bank along the coast, offering views of The Wash and the open landscapes, including birdlife. Naturalist and painter Sir Peter Scott lived at the lighthouse on the east bank of the River Nene at Sutton Bridge in Lincolnshire.

Navigation

As well as providing commerce routes to the ports in Boston, King's Lynn, Wisbech and Sutton Bridge, the navigable waterways provide a key recreation opportunity. In recent years there has been growing interest in recreational canoeing and paddleboarding in the Fens. There have long been plans for expansion of the Fens Waterway link (now called the Boston to Peterborough Wetland Corridor) [53], connecting via the IDB network. It was launched in 2004 by the East Anglian Waterways Association and Fens Tourism, with the first phase opening in 2009, but progress has since stalled.



Infrastructure: Energy

A new energy frontier

The energy system in the UK is undergoing a wide-ranging overhaul to support the transition to net zero. Energy generation is becoming decentralised (more sites) and in recent history, offshore (as opposed to the historic energy generation around major cities and coal belts).The east coast is also proposed as the landing site for a number of international interconnectors. This means that there is increasing need for strategic connections into the energy network through the Fens.

Energy production

There are 274 energy production facilities, mostly onshore wind and solar. Currently there are 78 applications for new energy production, mostly solar, which have been granted planning and are awaiting construction. Onshore wind farms are centred around the River Nene through the Lower Nene catchment. Solar is evenly spread through the area. Changes to the policy and legislative environment, and new grid connections are expected to accelerate the number of onshore renewable and battery storage projects across the Fens.

Transmission

Currently there are two high voltage strategic transmission lines within the Fens, running south east to north west, all overground. They represent 135km of transmission infrastructure out of 7,000km in England and Wales.

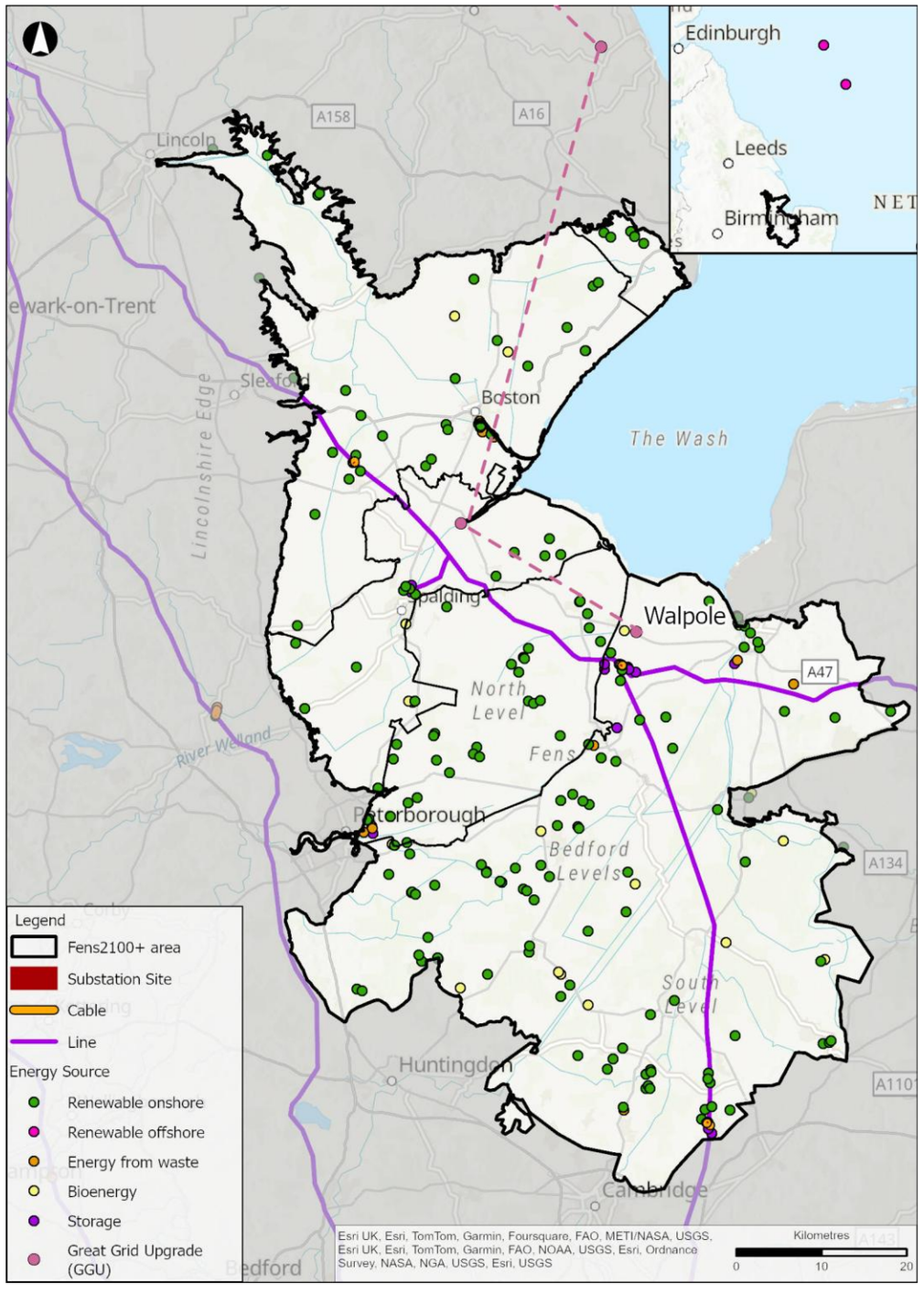
The current plans for the Great Grid upgrade include the proposed Grimsby to Walpole line [54] which will terminate within the Fens. This is perceived as a big change in the landscape for communities and has been subject to significant adverse reaction.

Grouping	Energy Source	No.
Renewables Onshore	Wind Onshore	48
	Solar Photovoltaics	121
Renewables Offshore	Tidal Stream	0
	Wind Offshore	3
	Shoreline Wave	0
Energy from Waste	EfW Incineration	5
	Landfill Gas	2
	Advanced Conversion Tec hnologies	3
Bioenergy	Biomass	5
	Anaerobic digestion	15
Storage	Pumped Storage Hydroelectricity	0
	Battery	31

Energy development pressures

There is a large amount of planned energy infrastructure connecting across and through the Fens. These will include new assets which will be dependent on a level of protection that currently exists. These connections are predominantly located in rural areas, which are unlikely to attract high levels of Grant in Aid. New energy infrastructure is expected to go through the sequential test, like other development types, and so should avoid the areas most at risk.

Work to install the planned new energy production sites, energy transmission upgrades, and interconnectors will lead to increased pressure on the existing road network, particularly rural roads closest to the development sites. There may be long term implications of any change of risk to the rural road network, which could impact the site operator's ability to maintain critical assets.



Infrastructure: Water

Wastewater treatment

There are 49 Waste Water Treatment Works in the Fens, which play crucial roles in managing waste water and maintaining water quality. 19 of these discharge into ordinary watercourses, whilst the remaining 30 discharge into Main Rivers. Alongside agriculture, these sites have the potential to be a key source of water pollution, particularly as storm events become more frequent and severe, and wider water storage systems lack capacity to hold water. These sites are likely to be a key focus for the public in the next few years.

Water storage

Storage of freshwater supports water supply to homes but is particularly important in the Fens to support agriculture and the food processing industries which are water intensive. In some parts of the Fens, particularly around Cambridge, housing development and growth is constrained by water resources [55].

Organisations involved in pumping, primarily IDBs, would like to see more in-farm and industrial water storage which can remove it from the drainage system to reduce the burden on pumping during high rainfall periods. Currently this is fairly limited with perceived barriers due to license processes and limited outside funding assistance.

Farm water storage reservoir at Middle Farm, Feltwell Anchor

The Fens Reservoir

Anglian Water and Cambridge Water are proposing a new reservoir in the Fens to help meet the growing demands on water supply in the East of England [56].

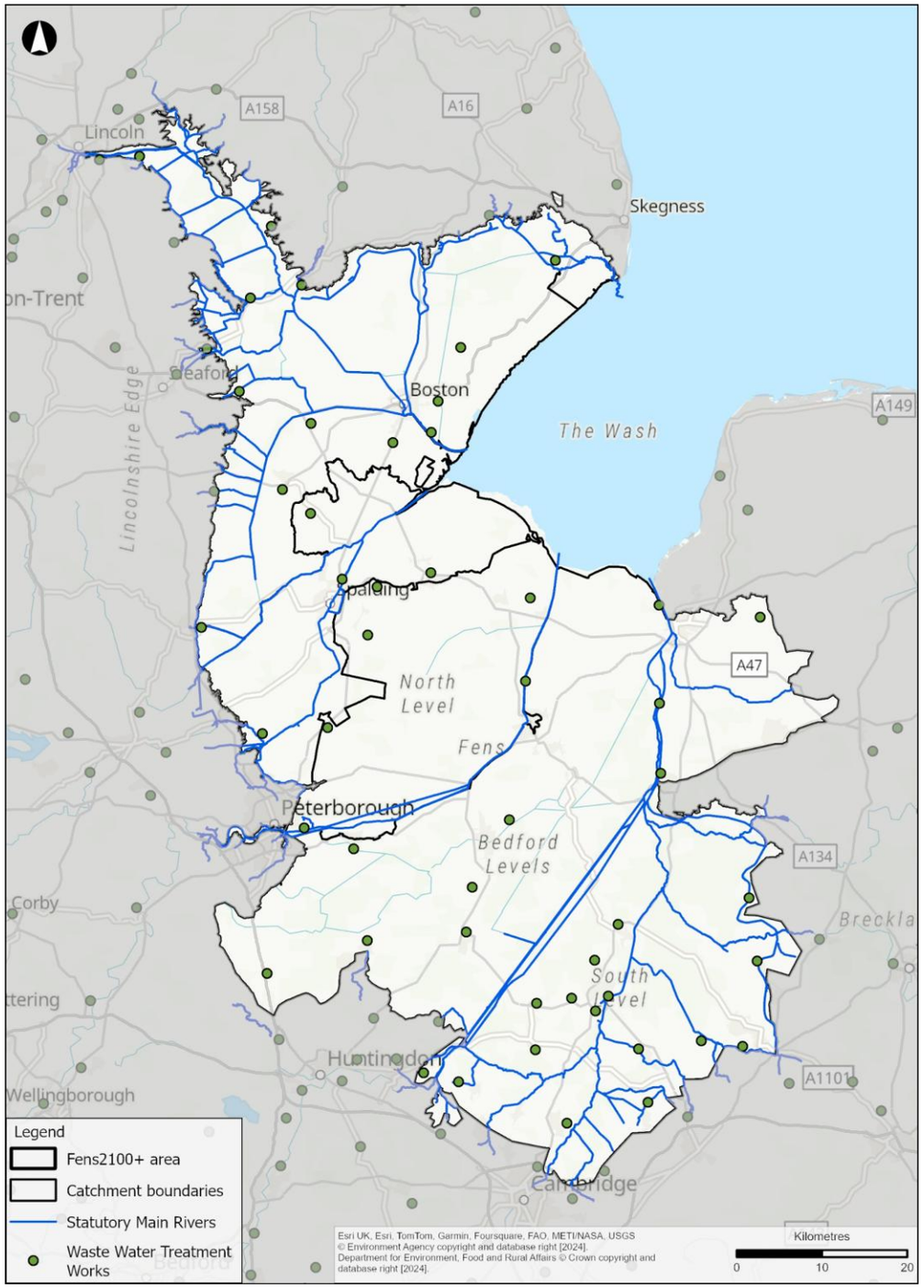
There are potential proposals to use channels that form part of the overall flood risk management and land drainage system as open water transfer features to support the reservoir. This is likely to impart restrictions on the way that these features can be operated, maintained or potentially changes in the future.

Wider benefits

The proposals are considering how they can enhance the environment and how navigation opportunities might be unlocked.

Emerging opportunities include places for recreation both on the water and land, with other areas focused on nature to create calm, quiet spaces. The developing plans include potential connections to the surrounding communities and around the reservoir itself with opportunities for walking, cycling and horse riding.

The area closest to the Ouse Washes proposes a focus on wetland habitat and limited public access, which could support wider flood storage and nature recovery ambitions.



Appendix: Acronyms

Acronym	Meaning
ADA	Association of Drainage Authorities
AEP	Annual Exceedance Policy
BMV Land	Best and Most Valuable
ELMs	Environmental Land Management Schemes
FCERM	Flood and Coastal Erosion Risk Management
FFE	Future Flood Explorer
FFIA	Future Fens Integrated Adaptation task force
GDD	Growing Degree Days
GGU	Great Grid Upgrade
GVA	Gross Value Add
IDB	Internal Drainage Board
IMD	Indices of Multiple Deprivation
LNRSs	Local Nature Recovery Strategies
LSOA	Lower Layer Super Output Area
NFU	National Farmers Union
NIAB	National Institute of Agricultural Botany
NNR	National Nature Reserves
NPPF	National Planning Policy Framework
NRD	National Receptor Dataset
NVZ	Nitrate Vulnerable Zones
SAC	Special Area of Conservation
SPA	Special Protection Areas
SSSI	Sites of Special Scientific Interest
TRSE	Transport Related Social Exclusion
WFD	Water Framework Directive

Appendix: References

Page	Endnote	Source
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