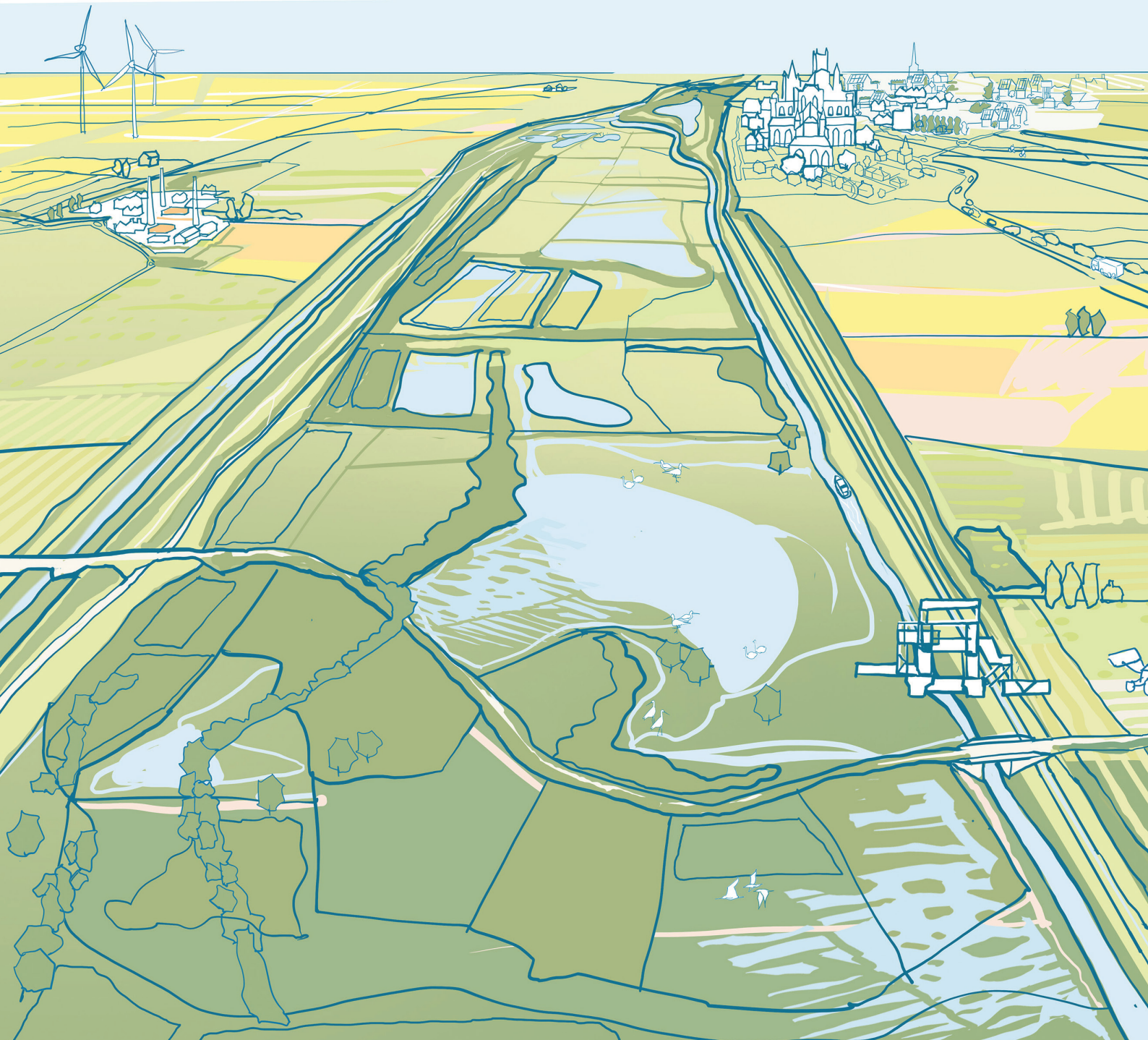
Fens 2100+

Lower Nene

Baseline evidence report

2025



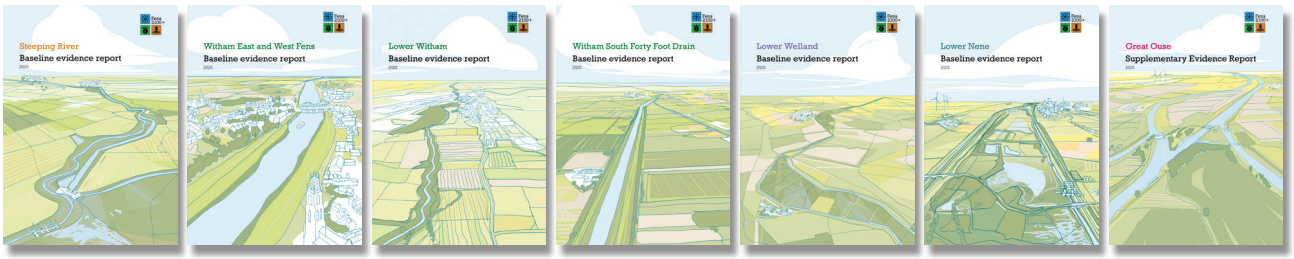
Find out more

Summary baseline evidence report

Discover key findings from across the Fens.

Catchment baseline evidence reports

View the full suite of reports, for more detail on each catchment.



Technical appendices

Explore the evidence, detailed in technical appendices for each catchment report:

– Flood risk baseline
– Baseline economic appraisal report
– Assets baseline report
– Environmental and agricultural baseline
– Natural capital register and account

For more information contact:

Fens2100@environment-agency.gov.uk

This document has been produced by Arup in collaboration with the Environment Agency, Rivelin Bridge and the Fens 2100+ Partners as part of a wider programme of work, drawing from engagement across the area and sector.

The report in context

A robust evidence base

This report provides a comprehensive picture of flood risk and asset performance across the Lower Nene catchment.

This report was compiled in collaboration with Internal Drainage Boards (IDBs) and local partners.

It forms part of a suite of catchment reports offering a robust evidence base to support the Fens 2100+ Partnership in transforming the approach to investing in flood and coastal resilience, including:

- Maintaining and managing critical assets, which are ageing and under increasing pressure from climate change.
- Addressing how the area will function in the future, balancing flood risk, water supply, sustainability and economic growth.

Each report brings together data and insights from key Risk Management Authorities (RMAs) on their experience of managing the catchment. Information includes the historical and environmental context, the function of flood risk assets and their economic impact, current and future flood risks and investment challenges and opportunities.

Securing the future of the Fens

Located in eastern England, the Fens is one of the UK's most distinctive landscapes. Significantly influenced by human activity, it has evolved over centuries from marshland into fertile farmland through drainage systems, embankments and pumping stations. Today, it is a vital region for food production and manufacturing and environmental value, contributing significantly to the UK economy.

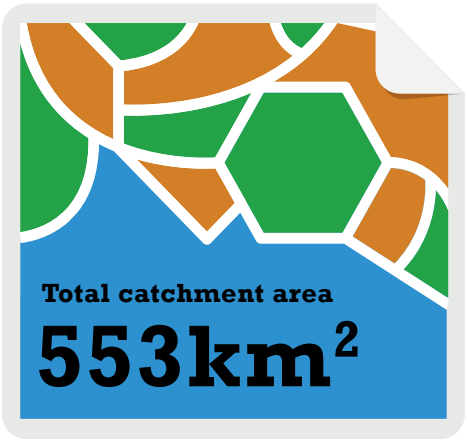
Lying largely at or below sea level, this highly vulnerable region faces increasing risks from rising sea and river levels driven by climate change and land subsidence caused by drying peat soils.

Without constant water management, large areas of the Fens would become uninhabitable, with the lives and livelihoods of over 600,000 being impacted by flooding from the rivers and the sea.

Yet, many of the 17,000 flood risk management assets that sustain the region are being affected by reliability and performance issues caused by their age. Many were built in the post-war period, with some dating back to the 1600s.

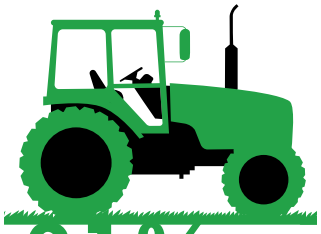
If these critical assets fail, the consequences would be catastrophic, risking lives, land, businesses and infrastructure.

Lower Nene



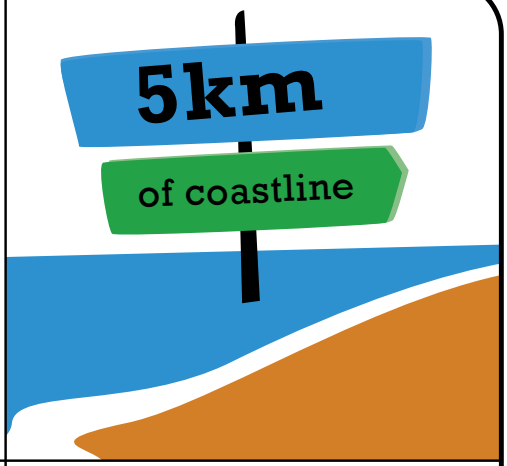
Total catchment area

553km²



91%

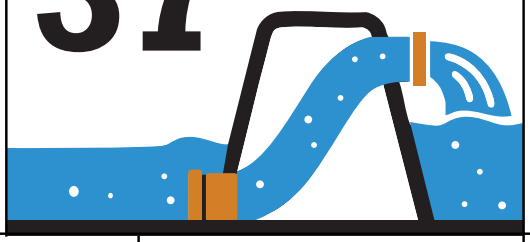
of land classified as Grade 1 & 2 agricultural land



Estimated total population

87,599

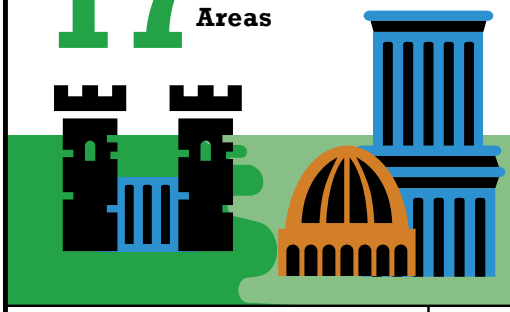
37 pumping stations



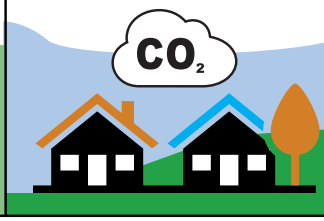
3 Internal Drainage Boards

42 Scheduled Monuments

17 Conservation Areas



47,000 tonnes of CO_2 equivalent emitted by degraded peatland in the catchment each year



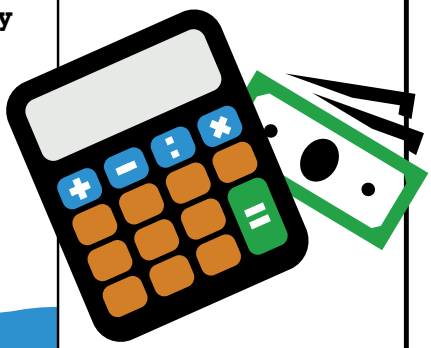
16 designated sites for nature conservation

£54.4 million total annual value from natural capital

85% Total length of embankments managed by the Environment Agency

Environment Agency maintenance expenditure spent on embankments

82km



£13bn economic benefits of current flood defences

Introduction

The evidence is clear: without urgent investment to maintain and upgrade flood risk assets across the Lower Nene catchment, £13 billion of damages could be sustained to land, homes and livelihoods.

A landscape worth protecting

Covering 553km^2 (55,300ha) of South Lincolnshire and Cambridgeshire, the Lower Nene catchment is an area of national agricultural importance. Its healthy agricultural economy contributes £187.4 million a year to the UK economy.

There are 16 designated nature conservation sites, including Whittlesey (Nene) Washes, an important flood storage area and wetland for wading and migratory birds.

Natural capital delivers £54.4 million of benefits a year, including food production, flood risk management, carbon sequestration, clean water and recreation. Around 4% of land is underlain by rich peat deposits.

What's the challenge?

Continuous land drainage and flood defences are all that protect low-lying areas from permanent inundation. 453km^2 (45,300ha) of land and 19,295 homes are at risk. Yet, 91% of flood risk assets are being affected by reliability and performance issues caused by their age.

Approximately 32% of assets are rated 'Poor', 'Very Poor' or 'Unknown', including critical sluice and flood gates. This complex system of assets requires significant resources and collaboration between RMAs.

Repeated flooding events highlight the catchment's vulnerability, including severe tidal flooding in 1978 and river flooding in 2023 and 2024. Climate change will intensify this risk, even if current defences are maintained.

What's needed?

£0.7-£1.1 billion

of investment

to sustain the current Standard of Service for 100 years

To maintain

£13 billion

of benefits

through reduction of damages to properties, agriculture, transport and the environment

Catchment overview map

The river in context

The Lower Nene catchment covers 553km^2 (55,300ha) of primarily rural, highly productive agricultural land. The catchment is situated in across Lincolnshire and Cambridgeshire bordering the Lower Welland catchment to the north and Great Ouse catchment to the south.

The catchment stretches from Peterborough in the south-west to its outflow into The Wash downstream of Sutton Bridge.

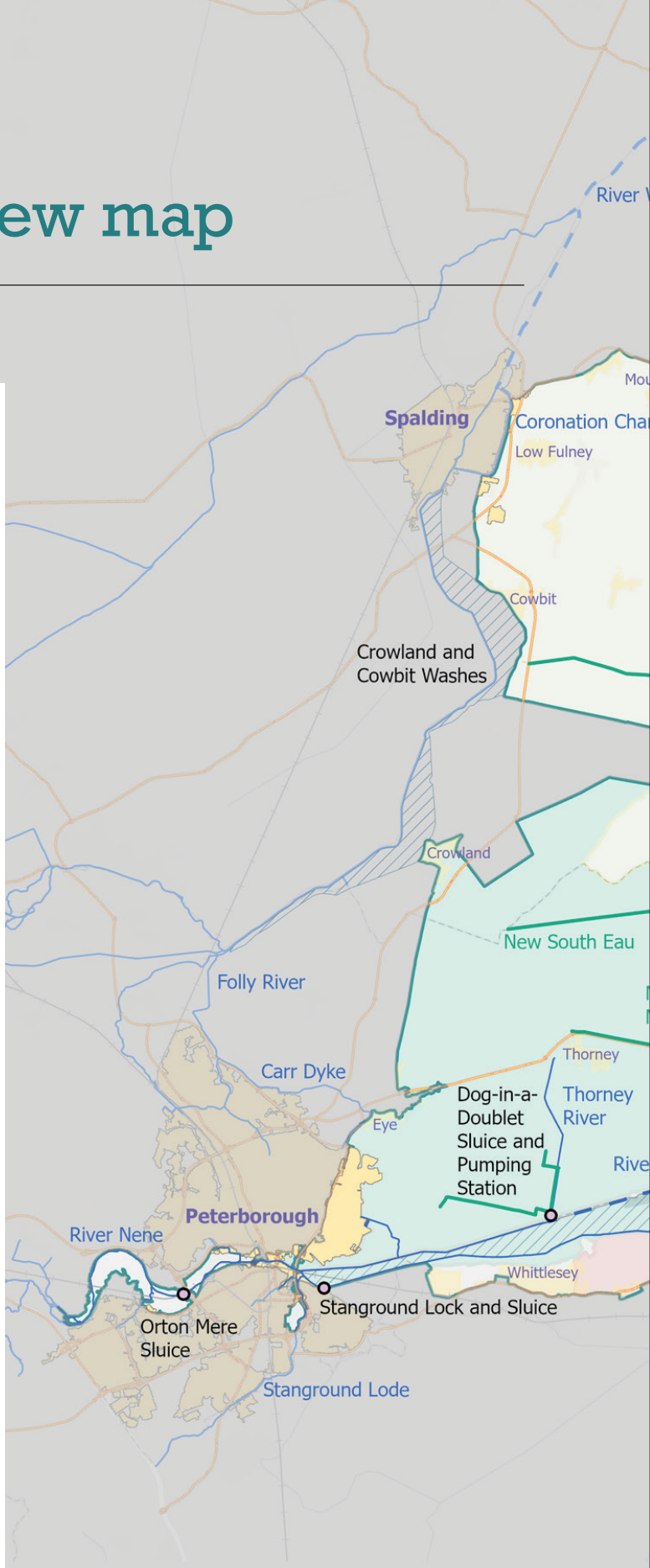
The catchment is comprised of two drainage systems: a network of Main Rivers managed by the Environment Agency, and a network of drains managed by North Level District, South Holland and Feldale IDBs.

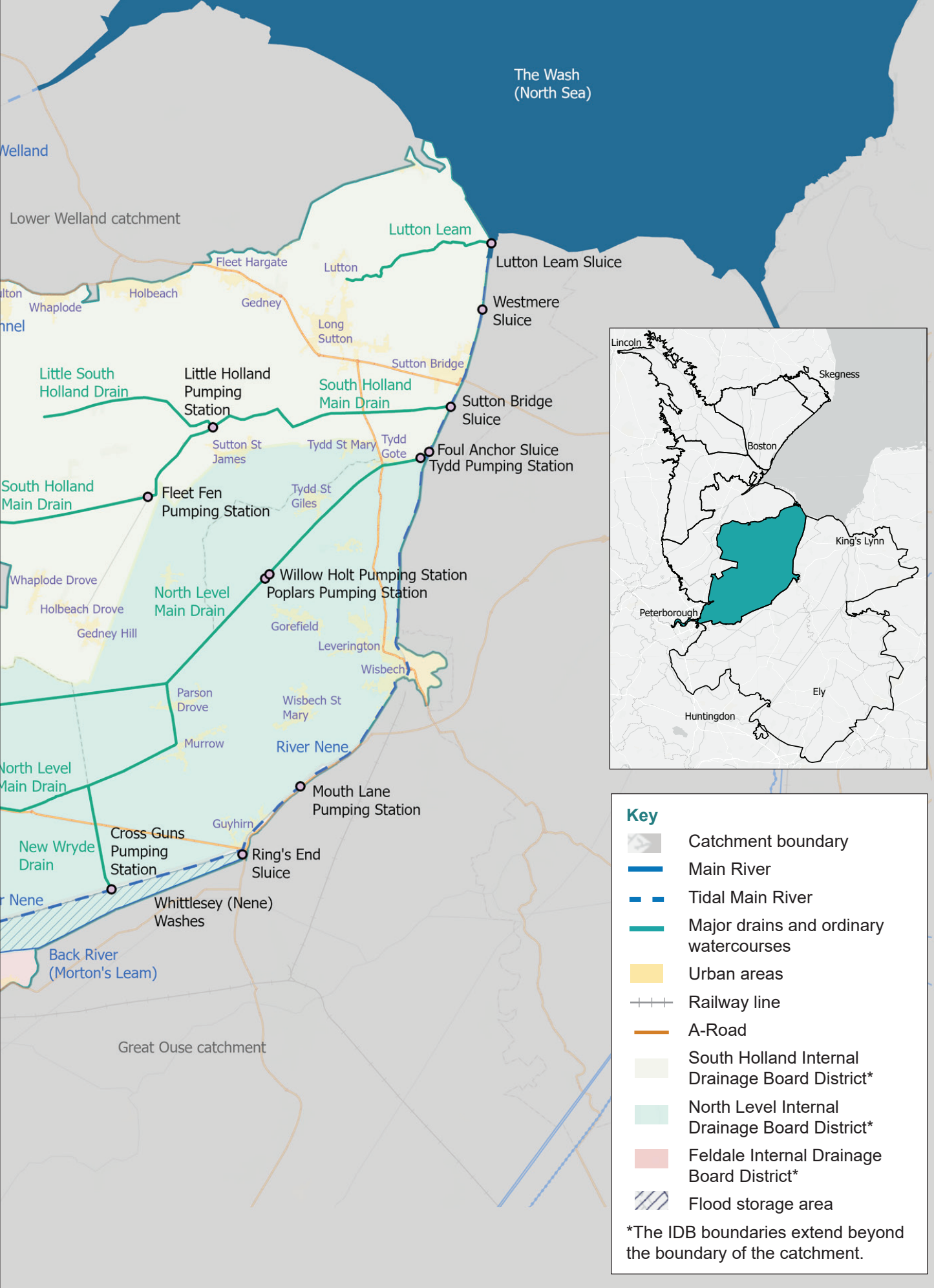
Three other IDBs (Hundreds of Wisbech IDB, Waldersey IDB and King's Lynn IDB) discharge water into the River Nene from land to the south, beyond the catchment study area boundary. Refer to the River Great Ouse catchment baseline report for further details. Land within the Lower Nene catchment may also be at risk of flooding from other sources including the River Welland.

The Lower Nene catchment covers approximately

553km^2

of Lincolnshire and Cambridgeshire




The Wash
(North Sea)
Welland
Lower Welland catchment
Lutton Leam
Lutton Leam Sluice
Fleet Hargate
Lutton
Holbeach
Whaplode
Gedney
Westmere
Sluice
Long
Sutton
Sutton Bridge
Little South
Holland Drain
Little Holland
Pumping
Station
South Holland
Main Drain
Sutton Bridge
Sluice
Sutton St
James
Tydd St Mary
Tydd
Gote
Foul Anchor Sluice
Tydd Pumping Station
South Holland
Main Drain
Fleet Fen
Pumping Station
Tydd St
Giles
Whaplode Drove
Holbeach Drove
Gedney Hill
North Level
Main Drain
Willow Holt Pumping Station
Poplars Pumping Station
Gorefield
Leverington
Wisbech
Parson
Drove
Wisbech St
Mary
Murrow
River Nene
North Level
Main Drain
Mouth Lane
Pumping Station
Guyhirn
New Wryde
Drain
Cross Guns
Pumping
Station
Ring's End
Sluice
Nene
Whittlesey (Nene)
Washes
Back River
(Morton's Leam)
Great Ouse catchment
Lincoln
Skegness
Boston
King's Lynn
Peterborough
Ely
Huntingdon
Key
Catchment boundary
Main River
Tidal Main River
Major drains and ordinary watercourses
Urban areas
Railway line
A-Road
South Holland Internal Drainage Board District*
North Level Internal Drainage Board District*
Feldale Internal Drainage Board District*
Flood storage area
*The IDB boundaries extend beyond the boundary of the catchment.

Catchment overview

The Lower Nene catchment is dominated by the tidal stretch of the river, which extends 45km inland to Dog-in-a-Doublet Sluice.

The primary watercourse within the catchment is the River Nene. From Wansford the River Nene takes a meandering course towards Peterborough, with Orton Sluice being used to manage water levels, for navigation and flood risk management.

Downstream of Peterborough, during periods of high river flow, water is diverted into Morton's Leam via Stanground Sluice and into the Whittlesey (Nene) Washes.

The Whittlesey (Nene) Washes are a critical flood management asset, registered under the Reservoirs Act (1975), which comprise a flood storage area covering 15km^2 (1,500ha) and extending 20km in length. The Washes are also an important nature reserve for wildlife. Flow of water from the Washes back into the River Nene is controlled by Ring's End Sluice, some 20km downstream.

The tidal limit of the River Nene is 8km downstream of Peterborough at Dog-in-a-Doublet Lock and Sluice. The Dog-in-a-Doublet Sluice allows the controlled release of water into the Tidal River Nene. Much like the fluvial section of the River Nene within the Fens, the Tidal River Nene is a highly engineered channel with embankments along its 45km length. It flows north-east through the catchment, through the town of Wisbech, eventually discharging into The Wash downstream of Sutton Bridge.

The surrounding catchment is drained by three IDBs, with an extensive network of drains including the North Level Main Drain, South Holland Main Drain, New South Eau and the Little South Holland Drain.

Water management in the lower catchment is supported by a system of pumping stations and sluices which discharge water from IDB drainage areas into the River Nene. These include Tydd Pumping Station, Sutton Bridge Sluice and Lutton Leam Sluice.

Although largely rural, the catchment includes several key urban areas, such as Peterborough, Holbeach, Long Sutton, Sutton Bridge and Wisbech.

The catchment has an estimated total population of 87,599. Railway networks further connect Peterborough with March and Spalding, with major roads such as the A47, A17, and A1101 supporting both local and regional connectivity.

Approximately 41.4% of the catchment is highly productive Grade 1 agricultural land. The catchment is low-lying, with over a third of the catchment lying below sea-level. The lowest lying areas sit just south-west of Tydd St Giles, and further south in the vicinity of the A47 between Thorney and Guyhirn.

The catchment has an estimated total population of

87,599

41.4%

of the land classified as Grade 1 agricultural land.

Dog-in-a-Doublet Lock and Sluice

Flood management system

1 **River Nene**

Main River

The study area encompasses around 60km of the River Nene's lower course, which is tidal downstream of Dog-in-a-Doublet Sluice.

2 **Orton Mere Sluice**

Environment Agency

Helps to control water levels on the River Nene and includes a navigation lock.

3 **Stanground Sluice**

Environment Agency

In flood conditions, water is diverted out of the River Nene and into Morton's Leam through Stanground Sluice so that the Whittlesey (Nene) Washes can start to fill. Water can also enter the Whittlesey (Nene) Washes by spilling over the Cradge Bank via Northey Gravel Weir on the southern bank of the River Nene.

4 **Northey Gravel Weir**

Environment Agency

The original inlet structure for the Whittlesey (Nene) Washes. Water flows over the weir during winter flood conditions.

5 **Dog-in-a-Doublet Sluice**

Environment Agency

Marks the tidal limit of the River Nene. It controls water levels from the fluvial to the tidal section and includes a navigation lock. In flood conditions it can become tide-locked, resulting in the operation of the Whittlesey (Nene) Washes.

6 **Dog-in-a-Doublet Pumping Stations**

North Level District IDB
Environment Agency

Pump water from the areas of land between Peterborough and Thorney into the River Nene.

7 **Morton's Leam**

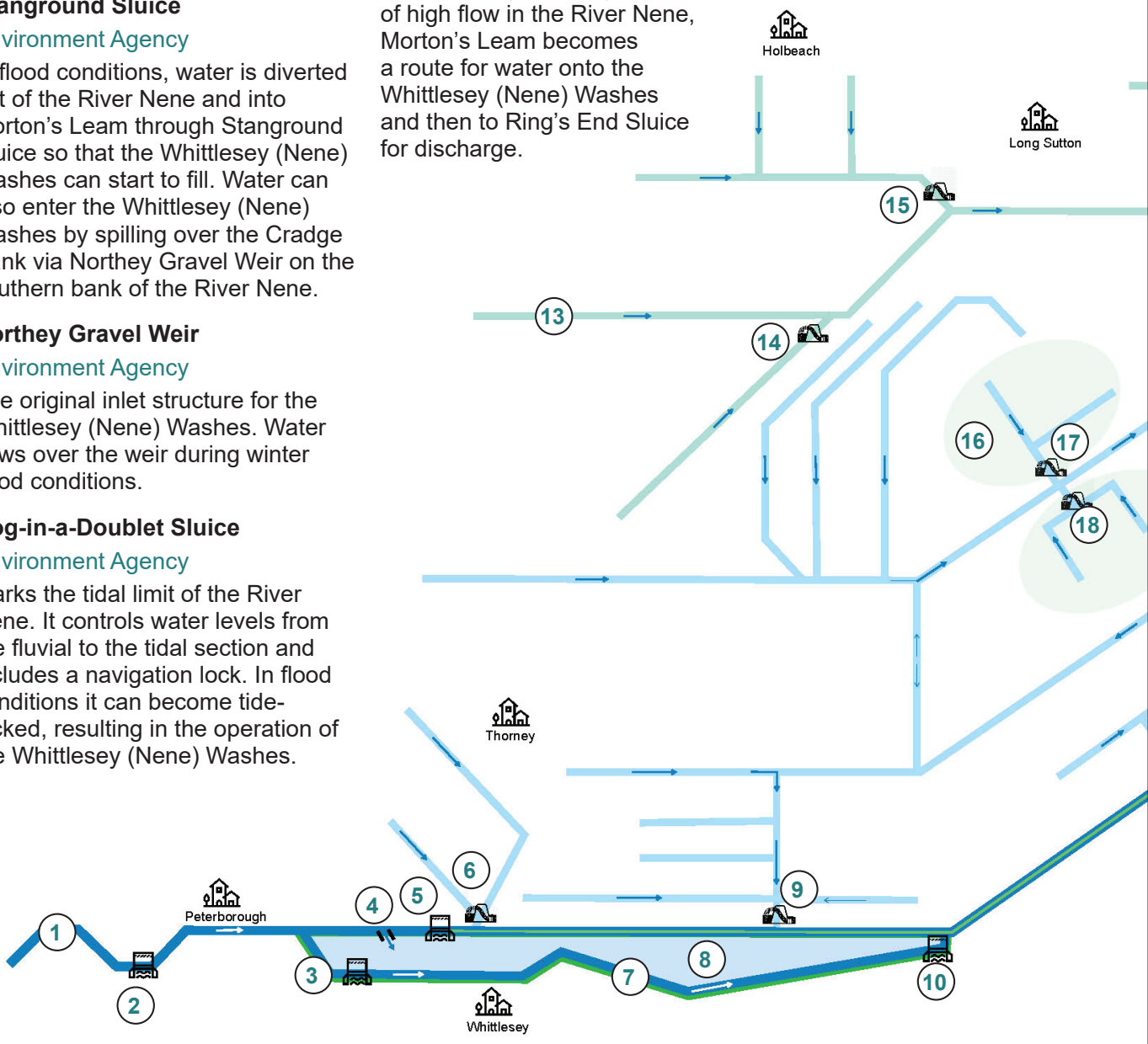
Main River

Flows through the Whittlesey (Nene) Washes along its southern edge. During periods of high flow in the River Nene, Morton's Leam becomes a route for water onto the Whittlesey (Nene) Washes and then to Ring's End Sluice for discharge.

8 **Whittlesey (Nene) Washes**

Environment Agency and partners

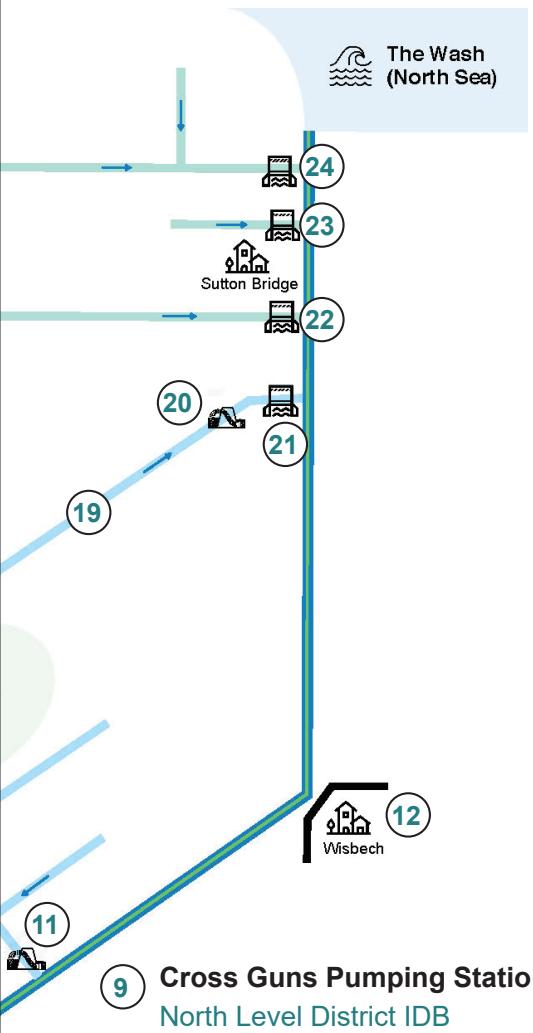
Registered under the Reservoirs Act 1975 and operated by the Environment Agency, the Whittlesey (Nene) Washes function as a flood storage area for the equivalent of 14,000 Olympic-sized swimming pools of water. The storage area is contained by the Cradge Bank to the north and the South Barrier Bank.



Key

- Main River
- South Holland IDB Drain
- North Level District IDB Drain
- Flood storage area
- Tidally-influenced Main River
- Flood defence

Navigation and other water level control structures are not shown.



9 Cross Guns Pumping Station

North Level District IDB

Pumps water into the River Nene from land to the north. The network of drains across the North Level District are connected so that water can be drawn south towards Cross Guns to take pressure off Tydd Pumping Station.

10 Ring's End Sluice

Environment Agency

Water is released from the Whittlesey (Nene) Washes back into the River Nene through Ring's End Sluice.

11 Mouth Lane Pumping Station

North Level District IDB

Pumps water from a small sub-catchment into the River Nene.

12 Wisbech flood defences

Environment Agency

Flood walls protect properties in Wisbech from high flows in the River Nene.

13 South Holland Main Drain

South Holland IDB

Carries water from smaller drains to the outfall at Sutton Bridge Sluice.

14 Fleet Fen Pumping Station

South Holland IDB

Pumps water out of the Fleet Drain into the South Holland Main Drain towards Sutton Bridge Sluice.

15 Little Holland Pumping Station

South Holland IDB

Pumps water out of the Little Holland Drain into the South Holland Main Drain.

16 Poplars and Willow Holt sub-catchments

North Level District IDB

These are especially low-lying.

17 Poplars Pumping Station

North Level District IDB

Pumps water out into the North Level Main Drain. This water is pumped upwards again into the River Nene at Tydd Pumping Station.

18 Willow Holt Pumping Station

North Level District IDB

Pumps water out into the North Level Main Drain.

19 North Level Main Drain

North Level District IDB

The main carrier of water from the southern portion of the Lower Nene catchment to Tydd Pumping Station.

20 Tydd Pumping Station

North Level District IDB

The largest pumping station in the Lower Nene catchment. It removes the majority of water from the North Level IDB system into the River Nene. Pumped water can be held in the water-storage pond upstream if Foul Anchor Sluice is tide-locked.

21 Foul Anchor Sluice

North Level District IDB

A Grade II listed structure. Controls tidal influences on the North Level Main Drain from the Tidal River Nene.

22 Sutton Bridge Sluice

South Holland IDB

Controls discharge of the South Holland Main Drain into the Tidal River Nene. Although a network of pumps move water into the South Holland Main Drain upstream, there are no pumps. Water can only be discharged through the sluice at low tide.

23 Westmere Sluice

South Holland IDB

Outfall for Westmere Creek into the Tidal River Nene.

24 Lutton Leam Sluice

South Holland IDB

Outfall of Lutton Leam into the Tidal River Nene.

History of the catchment

Many of the historic drainage works in the catchment have been driven by the need to maintain navigation to the port of Wisbech.

Efforts to manage the Lower Nene in the Roman era involved the construction of the 12m wide Carr Dyke. This still runs along the base of the Kesteven Uplands between the River Nene at Water Newton and the Witham Valley.

In the 1200s, the Great Ouse was diverted to King's Lynn, separating it from the River Nene with which it previously shared an outfall. Over time, the River Nene deteriorated through siltation, branching into several channels which made it difficult for ships to reach the port of Wisbech. In 1480 a new straight channel was constructed from Stanground to Guyhirn to restore navigation from Wisbech to the sea. This redirected the main flow of the River Nene and allowed for reclamation of riverside land.

During the 1500s, the Whittlesey (Nene) Washes were constructed for flood storage. In addition, agricultural expansion and coordinated drainage projects were supported by the enactment of the General Drainage Act in 1600.

Throughout the 1600s, there were great reclamations of land across the Fens, including across much of the Nene catchment. Beginning as early as 1632, a wealthy group of entrepreneurs known as 'The Adventurers' began to reclaim the northern catchment and enclose it for agriculture.

The parish of Tydd St Mary was the first to be enclosed in 1632. Over the next 30 years more than 100km^2 (10,000ha) of land was enclosed in Long Sutton, Lutton, Gedney, Holbeach and Moulton Marsh. However, progress was slowed by the hostility of local Fenmen to the drainage.

In 1728 the cutting of Smith's Leam led to straightening of the River Nene channel and easing of flows, but drainage of the catchment was far from complete. Even by 1779, nearly the whole area from Sutton St Edmund to Cowbit was an un-reclaimed Fen.

The South Holland Drainage Act of 1793 was a turning point for the northern catchment, when efforts to move water uphill using wind engines were abandoned, and the 23km South Holland Main Drain was cut to allow gravity drainage. Key technological advancements in the 1800s included the introduction of steam pumps. These allowed for much more efficient drainage and water management. By 1830 the Second North Level Major Improvement Scheme was underway, led by John Rennie and Thomas Telford.

As part of this scheme, a new straightened outfall channel for the River Nene was cut, with an outfall sluice at Foul Anchor. This was cut 2.4m lower than before to create a steeper gradient to flush water out into The Wash and scour the channel. This aimed to ensure a secure shipping channel for Wisbech, which by 1840 was the largest grain-shipping port in the country.

Following the Land Drainage Act (1930), the Nene Catchment Board took control of the river due to the declining condition of its tidal section. This led to the rebuilding of 38 locks and the installation of sluice gates. These prevented tidal waters from entering Peterborough and improved navigation at Wisbech.

Diesel pumps were first installed in the Lower Nene catchment in 1936 as part of the Third North Level Major Improvement Scheme. The stations at Tydd Gote, Dog-in-a-Doublet, and Cross Guns helped to drain an additional 18km^2 (1,800ha) to support food production during World War 2. These pumps were vital for dealing with the flooding in the north-western catchment, when water from the River Welland to the north burst through a breach of the Crowland and Cowbit Washes which lie just beyond the northern boundary of the Lower Nene catchment.

Many new pumping stations were constructed in the mid to late 1900s, such as Lords Drain, and ten new electric and diesel pumping stations under the Fourth North Level Major Improvement Scheme.

The increasing use of roads and rail services reduced the dependency on river navigation in the 1900s. However, Sutton Bridge and Wisbech still remain valuable economic centres for the region.

In 1996 the Environment Agency became the navigation authority for the River Nene upstream of Wisbech St Mary. Downstream of this point, the navigation authority is the Wisbech Harbour Authority (Fenland District Council).

In recent years extreme tidal, fluvial and rainfall events have increased in intensity and frequency making effective management of the water within the Lower Nene catchment more important than ever.

Photograph of Wisbech Port in 1899

Photograph of the 1947 flooding of the North Level District caused by heavy rain and a breach in the Crowland and Cowbit Washes

History timeline

Pre-1800s

Circa 1043

The Romans constructed the Carr Dyke from the River Nene to the Witham Valley.

1231

The Great Ouse was diverted away from the outfall it shared with the River Nene.

1470

Bishop Morton of Ely straightened the Great Wisbech River, creating Morton's Leam. This channel redirected the River Nene back through Wisbech, which had lost access to the sea after the river silted-up.

1500

Whittlesey (Nene) Washes were established as a flood storage area.

1632

The 'Adventurers' enclosed the parish of Tydd St Mary from the marshland, followed over the next 30 years by Long Sutton, Lutton, Gedney, Holbeach and Moulton Marsh.

1649

The first North Level outfall sluice was built as part of drainage works proposed by the Dutch engineer Cornelius Vermuyden.

1728

Smith's Leam cut to improve the flow of the River Nene.

1753

First North Level Act of Parliament.

1763-1770

Major breaches in River Nene Bank (Smith's Leam), led to significant flooding in 1770, with areas of water 8ft (2.4m) deep.

1773

Kinderley's Cut constructed to improve River Nene outfall.

1793

South Holland Main Drain Cut, and an embankment was constructed parallel to the coast between the Welland and the River Nene.

1800s

1800s

Steam pumps introduced throughout the Lower Nene catchment.

1827-1830

New Nene Outfall channel constructed.

1831

The East and West Lighthouses were built on the banks at the mouth of the River Nene.

1829-1834

Second North Level Major Improvement Scheme led to a new outfall sluice at Foul Anchor.

These works finally gave Wisbech a secure shipping channel and by 1840 it was the largest grain-shipping port in the country.

1858-1859

North Level Act of 1858, led to construction of a new sluice at Foul Anchor. The base of the new sluice was 5ft (1.5m) lower than the 1830 sluice, which further enhanced drainage efficiency by increasing the channel gradient.

1868

Significant flooding occurred, leading to the Clark Scheme of Major Improvement.

1900s

1912

Major flooding in August of 1912 was caused by heavy rainfall. Most of the North Level District was inundated and many crops failed.

1930

The Land Drainage Act established catchment boards across England, including the Nene Catchment Board.

1936

Four diesel pumping stations installed in the catchment as part of the Third North Level Major Improvement Scheme. This included Tydd Pumping Station.

The Dog-in-a-Doublet Sluice and Lock were constructed at Whittelsey, moving the tidal extent of the River Nene out of Peterborough.

1938

Sutton Bridge Sluice was replaced with the present-day structure.

1942

Main Drain Improvement Scheme commenced, driven by the need for greater agricultural production during World War 2. This included the widening and deepening of the South Holland Main Drain and Little South Holland Drain.

1947

Failure of the southern barrier of the Crowland High Wash led to severe flooding of the North Level District, as water spilled over into the catchment from the River Welland to the north. Diesel pumps installed in 1936 played an essential role in the management of flooding during this incident.

1978

Multiple tidal flood events in Ingleborough, Sutton Bridge and Wisbech led to raising of the River Nene's banks and instillation and update of other flood defences.

2000s

2010

The River Nene Catchment Flood Management Plan (2010) set out long-term policies for sustainable flood risk management.

2013

In December 2013, a major tidal surge occurred in the North Sea. Wisbech was protected from major flooding by the recently raised flood defence walls.

2021

Anglian River Basin District River Basin Management Plan (2021-2027) updated. Developed under the Water Framework Directive, it outlines the baseline conditions and the pressures affecting the Nene water body.

2023

Heavy rain in Storm Babet led to flooding along the River Nene in the vicinity of Peterborough and extensive use of the Whittlesey (Nene) Washes.

2024

Heavy rainfall leads to flooding of the Whittlesey (Nene) Washes and other areas in the catchment.

Managing flood risk

Across the Lower Nene catchment, flood risk is managed by multiple organisations.

Roles and responsibilities

The Environment Agency have permissive powers to carry out flood and coastal risk management activities and regulate activities on Main Rivers.

The South Holland, North Level District and Feldale IDBs are responsible for managing the complex network of drainage channels and pumping stations which drain the land within their district. They also regulate water levels on ordinary watercourses (non-Main Rivers).

Riparian Landowners have the main legal responsibility for maintaining all watercourses.

Lincolnshire County Council (LCC) acts as both the Lead Local Flood Authority (LLFA) and the local Highway Authority. The Highways department is responsible for maintaining highway drainage assets, while the LLFA has overall responsibility for local flood risk matters. Lincolnshire was one of the first areas in England to publish and implement a Local Flood Risk Management Strategy and was forward looking in the way all the relevant risk management authorities were involved in the strategy's development.

Peterborough City Council, East Northamptonshire District Council, South Holland District Council and Fenland District Council have a responsibility to promote sustainable development in their role as the Local Planning Authority. They have responsibilities under the Land Drainage Act (1991) to undertake flood risk management works on ordinary watercourses outside IDB areas.

Anglian Water is the main water and sewerage company within the Lower Nene catchment and have a role in managing the risk of flooding posed by public drainage infrastructure.

Legislation

The roles and responsibilities of these RMAs are set out in the Flood and Water Management Act (2010). The Flood and Water Management Act is national legislation developed in response to the widespread flooding experienced across England in 2007. The Act re-established the roles and responsibilities of the risk management authorities related to flood risk. This Act is supported by local policies and plans that outline the management of local issues.

Local groups and partnerships

Under the FWMA (2010), Regional Flood and Coastal Committees (RFCCs) were established by the Environment Agency. RFCCs guide flood and coastal erosion risk management activities within their river catchments and along the coastline. The Lower Nene is within the Anglian (Northern) RFCC boundary.

The Lincolnshire Flood Risk and Water Management Partnership was set up to improve the management of flood risk and water resources in the region. This is comprised of the Environment Agency, LCC, the district and borough councils and IDBs across Lincolnshire, as well as Lincolnshire Resilience Forum and Natural England. This partnership provides co-ordinated management and delivery of flood risk and drainage functions across Lincolnshire.

The Nene Rivers Trust is dedicated to promoting green infrastructure and raising the profile of the catchment through the delivery of sustainable design and development.

Future Fens Integrated Adaptation (FFIA) is a strategic partnership initiative, with the aim of working together across sectors to determine the actions that partners involved in managing water across the landscape can jointly take to secure a vibrant future for the Fens.

National strategies

In 2020, the Environment Agency published the latest National Flood and Coastal Erosion Risk Management Strategy. It contains 'Measure 1.5.4', which requires development of a long-term plan for managing future flood risk in the Fens.

Local policies, strategies and plans

The key local policies, strategies and plans that directly influence how flood risk management is undertaken in the catchment are;

Anglian River Basin District Flood Risk Management Plan 2021-2027

This plan encourages a partnership to explore the resilience measures that will help the district be more resilient and informs the delivery of existing flood programmes.

Joint Lincolnshire Flood Risk and Drainage Management Strategy 2012-2025

This provides a framework for flood risk management across Lincolnshire linking to all the RMAs.

Joint Lincolnshire Strategic Flood Risk Assessment (2017)

This outlines how development should consider flood risk at every stage of the development process including assessment and mitigation measures, based on Flood Zones and vulnerability to flood risk.

River Nene Integrated Catchment Management Plan (2014)

This plan was developed by the Nene Rivers Trust as part of the Nene Valley Catchment Partnership and provides a clear framework for effective partnership working in the catchment.

Gibraltar Point to Hunstanton Shoreline Management Plan 4 (2010)

Shoreline Management Plans (SMPs) outline a strategic approach to managing flood and coastal erosion risks through to 2105. The Policy Development Zone (PDZ) of particular relevance to the Lower Nene catchment is PDZ1 Gibraltar Point to Wolfreton Creek, where the intention is to hold the position and function of existing coastal flood defences. In the medium and longer term, managed realignment may be required.

River Nene: Catchment Flood Management Plan (2010)

This plan provides an overview of the flood risk across the river catchment and recommended ways of managing the risk. Under Policy 4 of the management plan the Lower Nene catchment is defined as an area where flood risk is already being managed, but where climate change is expected to lead to significant increases in flood risk.

The role of critical infrastructure

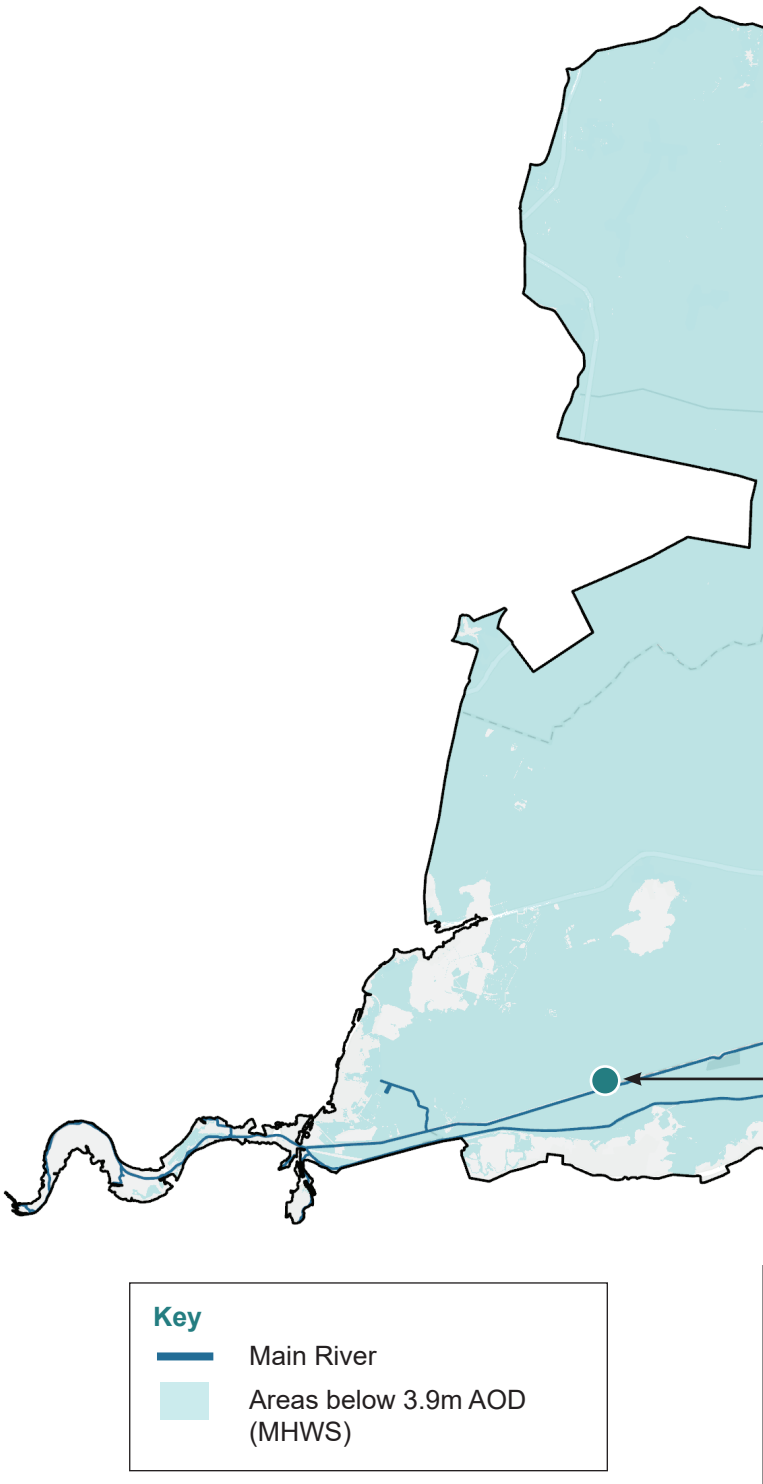
Only the continuous operation of flood risk assets can protect the low-lying areas of the Lower Nene catchment from severe and long-term flooding. Parts of the catchment lie below sea level.

Before human intervention, much of the Lower Nene catchment was a waterlogged landscape, covered by freshwater and intertidal marsh. Over centuries, huge effort and investment has enabled the transformation of the area into a habitable and productive landscape. If flood risk assets were abandoned, and constant management of water levels were to cease, then the landscape would soon be inundated, becoming an uninhabitable inland salt lake.

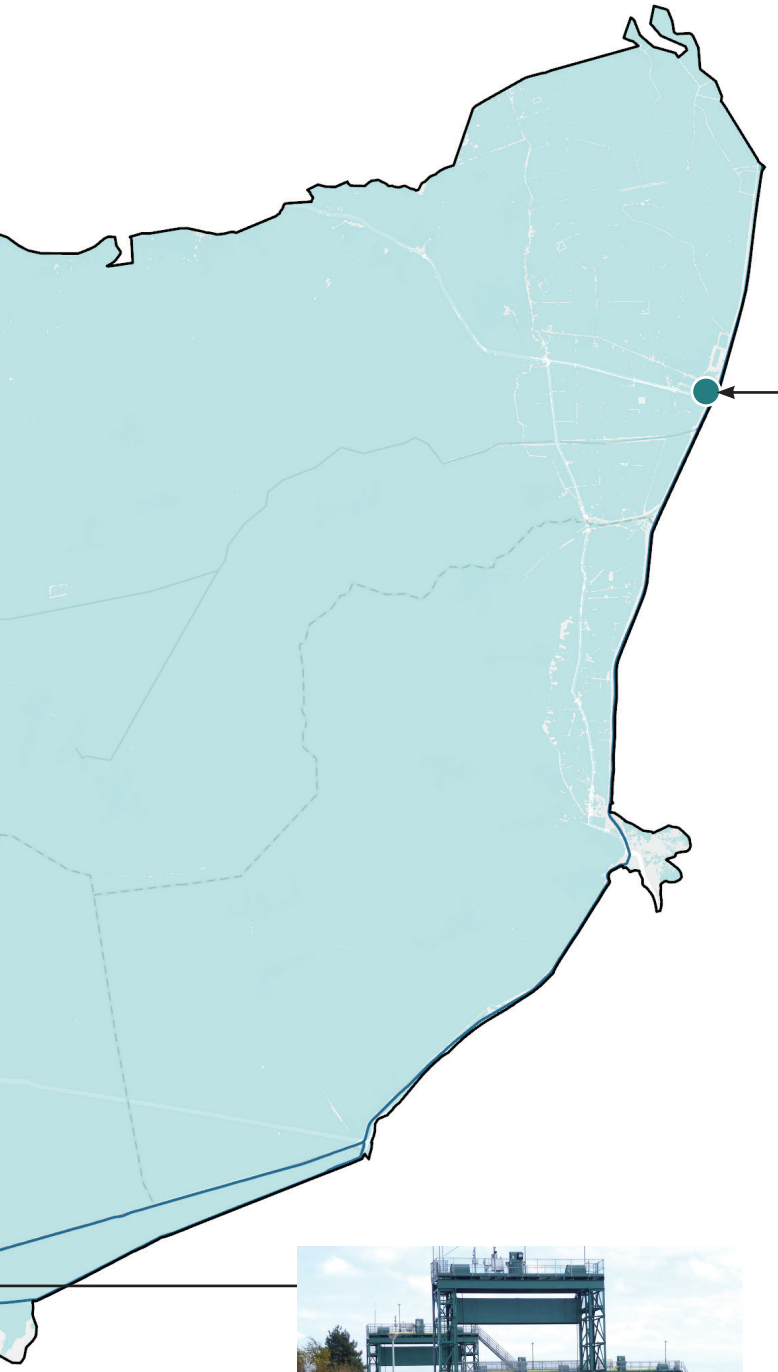
To demonstrate the existential risk of flooding to the catchment in the absence of defences, the map of tidal inundation from the Mean High Water Spring (MHWS) tide shows the tidal inundation that would occur on a regular basis in the absence of tidal flood defences. In this scenario, the tide would inundate the land to a level of 3.9m AOD. Whilst some areas of the catchment would drain as the tide recedes, the frequency of tidal inundation would mean the land was essentially uninhabitable.

A low-lying catchment

The catchment functions as a bowl-shaped basin, with slightly elevated land located at the south-west of the catchment. The lowest point of the Lower Nene catchment would be flooded to a depth of 4.9m in the MHWS tidal event. The topography makes it difficult for water to drain naturally from these lower-lying areas and if flooding occurs, the lack of gradient allows floodwaters to spread over a large area.



Sutton Bridge Sluice



Dog-in-a-Doublet Sluice and Lock

Reliance on flood risk assets

The effective removal of water from the land drainage system into Main Rivers relies on the operation of pumping stations. Defence of the land against tidal flooding relies on the presence of tidal defences. Water management assets are monitored and adjusted all year round to maintain water levels and minimise flood risk. Without these assets, water levels would rise rapidly leading to widespread flooding. The catchment would become uninhabitable within weeks, with agricultural land and properties submerged.

Any deterioration or failure of water management assets due to age, lack of maintenance and extreme events would severely compromise drainage and could result in the inundation scenario depicted on the map.

Extreme events

Even with current flood risk assets in place, tidal and fluvial flooding pose a significant risk to the Lower Nene catchment, as evidenced by major flood events in 2012, 2023 and 2024.

Current flood risk

The impact of permanent inundation is mitigated by the operation of flood risk management assets.

Hydraulic modelling is used to understand the risk of flooding in an area. The hydraulic model used to assess flood risk is the 2021 Tidal River Nene Model. This represents tidal flood risk, assumes existing tidal defences are in place, are fully functional and maintained at their current Standard of Service and does not consider breach risk. There are no suitable fluvial flood models for the Lower Nene catchment. Therefore the flood map opposite only shows tidal flood risk from overtopping of defences. Fluvial models for the Lower Nene are being updated at the time of writing.

Tidal

Currently, tidal flood risk for a 0.5% AEP event is minimal due to the existing defences, limited to small parcels of agricultural land near the mouth of the river. Only 0.6km^2 (58ha) of the total catchment area is at risk under this scenario, and no properties are affected.

Even in an extreme 0.1% AEP event, the area at risk of flooding does not increase significantly, and is limited to isolated areas close to the river at Tydd Gote, Sutton Bridge and Guy's head.

Fluvial

There are no suitable models to represent the risk of fluvial flooding in the Lower Nene catchment. However, the catchment is currently protected from fluvial flooding by existing defences. These defences include the embankments along the entire length of the tidal River Nene (except at Wisbech which is protected by raised concrete floodwalls) and the Whittlesey (Nene) Washes which can store excess water when river flows are high.

However, recent flood history indicates that areas further upstream are currently at risk of fluvial flooding. There have been flood events recorded in 2012 and 2023 around Orton Mere bank, located upstream of Dog-in-a-Doublet Sluice, and at Whittlesey (Nene) Washes in 2024.

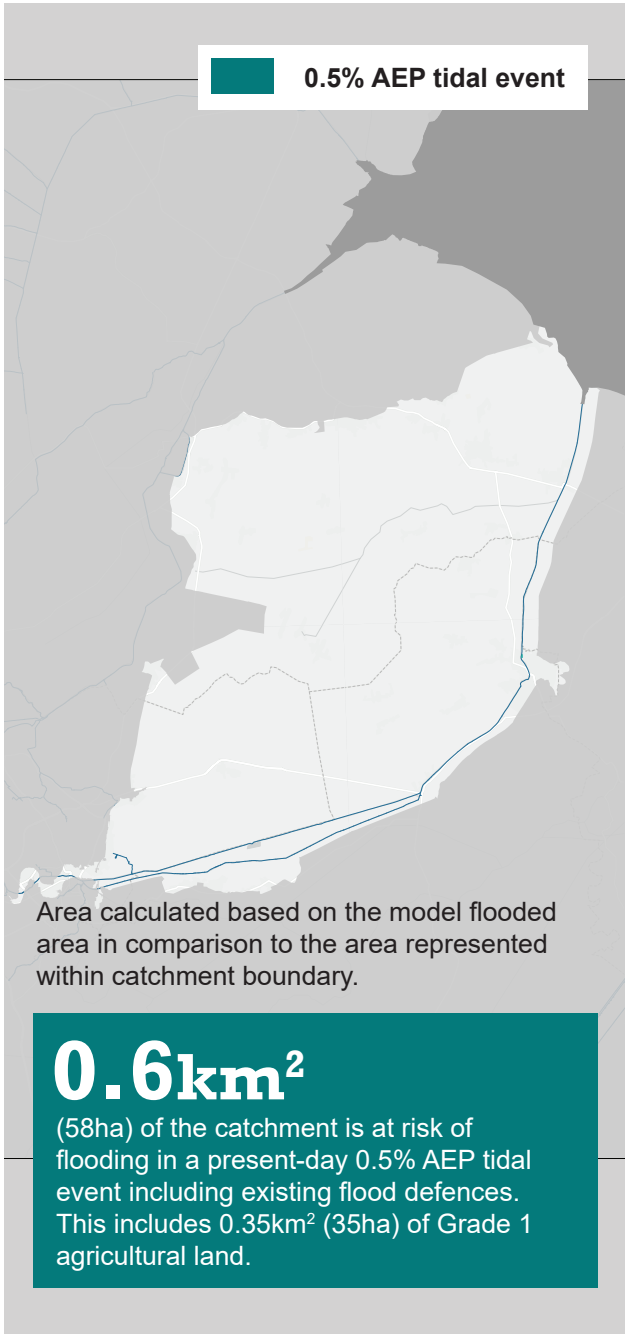
Other sources

Other sources of flood risk not included in the hydraulic models include:

Surface water flooding. This describes when the volume and intensity of rainfall overwhelms local drainage systems. The risk of this is likely to increase across the catchment if settlements continue to expand.

Groundwater flooding. This occurs when the water table rises to meet the ground surface. The Peterborough Flood Risk Management Strategy outlines how the permeable alluvial deposits of sand and gravel on the Nene floodplain can allow water from rivers to infiltrate and cause groundwater levels to rise.

Reservoir flooding. This is rare and happens when a reservoir's impounding structure fails. The 'Risk of Flooding from Reservoirs' dataset shows that there is a risk of flooding from the Whittlesey (Nene) Washes, and the Crowland and Cowbit Washes. The flooding caused by the failure of the southern barrier of the Crowland High Wash in 1947 is an example of reservoir flooding. Provisions introduced as part of the Reservoirs Act (1975) have helped to reduce the risk of reservoir flooding.



Area calculated based on the model flooded area in comparison to the area represented within catchment boundary.

0.6km²

(58ha) of the catchment is at risk of flooding in a present-day 0.5% AEP tidal event including existing flood defences. This includes 0.35km² (35ha) of Grade 1 agricultural land.

AEP = Annual Exceedance Probability.
The probability of a certain sized flood event being equalled or exceeded in a given year.

Case study: Overtopping

Peterborough is upstream of the Dog-in-a-Doublet Sluice, which provides protection to the city from tidal flooding. However, flood events have occurred upstream of the sluice. In 2012, heavy rainfall led to the overtopping of the Orton Mere bank, located upstream of the Dog-in-a-Doublet Sluice along the River Nene. There was no recorded commercial or residential flooding associated with this fluvial flood event. Similar out-of-bank flooding was observed around Orton Mere in 2023.

Downstream of Dog-in-a-Doublet Sluice, the Whittlesey (Nene) Washes has been inundated a number of times, including in January 2024 following heavy rainfall. Although these events result in significant flooding of agricultural land, the Whittlesey (Nene) Washes function as a flood storage reservoir and is intentionally inundated during high flow conditions. Therefore, are not classified as flood events.

River Nene flooding at Orton Mere in 2012.
© Peterborough Images Archive 2012

Future flood risk

Tidal and fluvial flood risk is expected to increase over the next 100 years, even if defences are maintained to the current level of protection.

Future tidal and fluvial flood risk will rise due to the increasing height and frequency of tidal surges and river flows driven by climate change. These changes pose a growing threat to agricultural land and residential properties, with more frequent and severe overtopping events and failure of defences becoming more likely.

Tidal

Tidal flood risk will increase significantly over the next 100 years as sea levels rise in response to climate change.

The 2021 Tidal River Nene Model assumes that sea levels will rise by 1.2m up to 2125, in line with the UK government higher central allowance for climate change.

Under this scenario tidal flood risk, when existing defences are in place, increases significantly compared to the present day. Approximately 20.9km^2 (2,091ha) of the catchment would be at risk of inundation, representing a 37-fold increase compared to the current flood risk. This would be due to the overtopping of the River Nene embankments. The total area at risk covers 20.9km^2 (2,091ha) and includes 18.9km^2 (1,890ha) of Grade 1 agricultural land, which can be damaged by extended periods of saltwater inundation. Large residential areas of Wisbech and Sutton Bridge would also be at risk of flooding, as well as sections of the A17 where it crosses the River Nene at Sutton Bridge.

Higher sea levels will also likely increase the risk of tide-locking at key outfalls such as Dog-in-a-Doublet Sluice and Sutton Bridge Sluice.

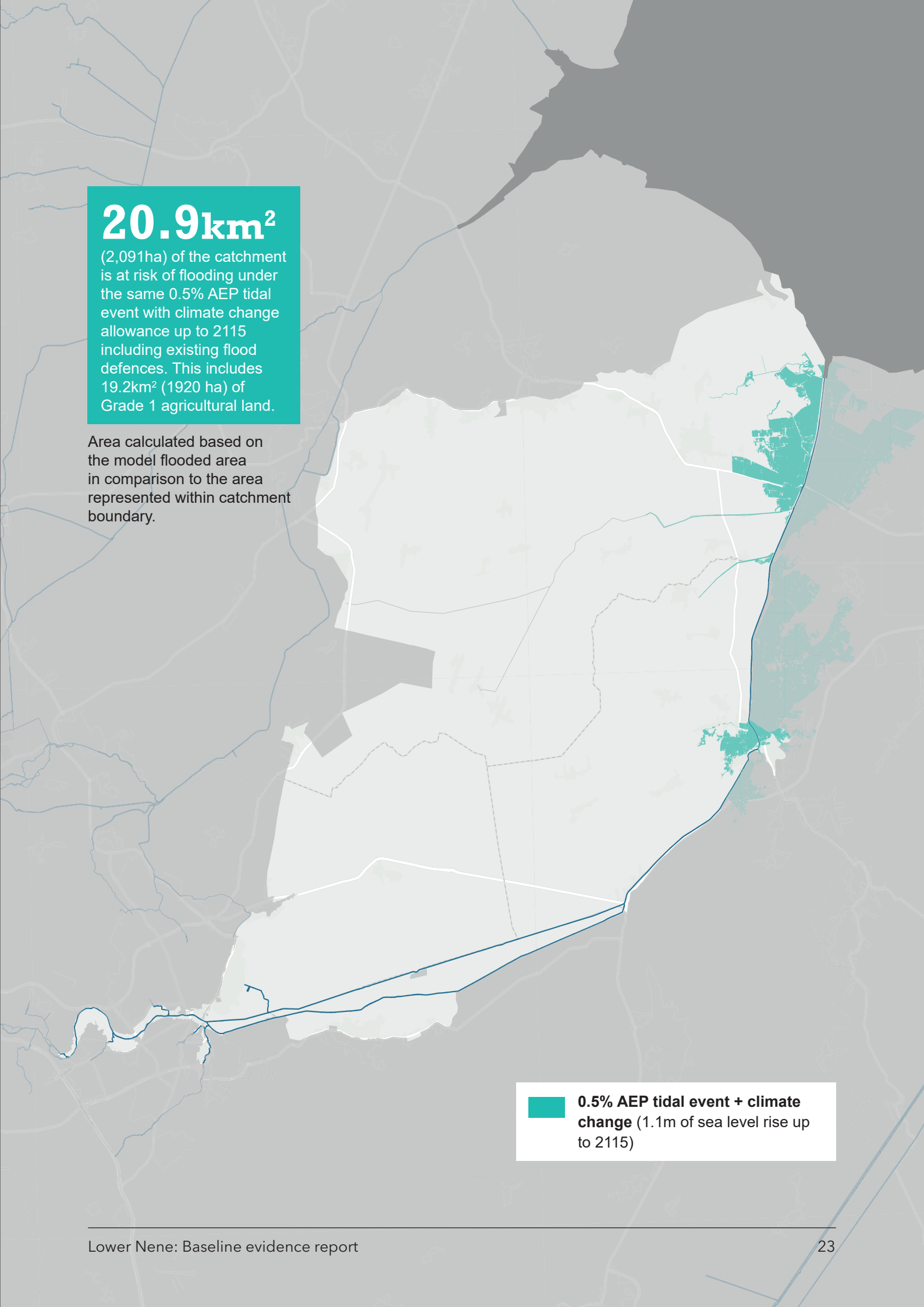
Tide-lock means that water cannot be discharged from the river system during periods of high tide, causing it to back-up in the catchment, leading to flooding along the River Nene.

Fluvial

No fluvial model is available to understand future flood risk, however extreme rainfall events are likely to become more common. Current government allowances for climate change indicate that river flows in the Lower Nene may increase by as much as 36% by the 2080s. Downstream of Dog-in-a-Doublet Sluice, the flood embankments and Whittlesey (Nene) Washes will still provide a degree of protection in the future to increased fluvial flows. Nevertheless, it is likely that in extreme fluvial events such as the 1% AEP event there will be fluvial flooding of properties and agricultural land at and around Sutton Bridge and Wisbech, as these are areas that flood during the tidal climate change scenarios.

Climate change

Assessment of climate change scenarios are based on government guidance and best available data at the time of writing, or model production. This guidance is revised as climate change projections are revised. Irrespective of the predicted magnitude of change, climate change will increase the frequency and severity of flood events over time. Longer term climate change scenarios have been considered within a Fens Climate Change Risk Assessment undertaken by FFIA.


20.9km²
(2,091ha) of the catchment is at risk of flooding under the same 0.5% AEP tidal event with climate change allowance up to 2115 including existing flood defences. This includes 19.2km² (1920 ha) of Grade 1 agricultural land.
Area calculated based on the model flooded area in comparison to the area represented within catchment boundary.
0.5% AEP tidal event + climate change (1.1m of sea level rise up to 2115)

Flood risk management assets

Site visits and workshops were undertaken with asset owners and operators, alongside data analysis, to understand key asset challenges.

Key catchment challenges

Assets are ageing

59% of embankments and 20 flood gates have reached the end of their foreseeable design life which will represent an urgent need for short term investment. Additionally 21% of assets within the catchment have 1-15 years foreseeable design life representing further potential short to medium term investment required.

Dog-in-a-Doublet Sluice and Stanground Sluice are both critical for managing water levels and face serious condition challenges. Additionally, Tydd Pumping Station is approaching the end of its foreseeable design life.

Pumping station challenges

Key assets such as Tydd Pumping Station and Sutton Bridge Sluice are struggling with demand. This is likely to be exacerbated by climate change impacts.

Investment needs

There is planned capital expenditure within the catchment on pumping station refurbishment however this is unlikely to increase system capacity, which is currently an issue. This challenge will be further exacerbated by the impacts of climate change.

Flood storage area risks

High water levels in the River Nene can prevent the release of water from the Whittlesey (Nene) Washes after a flood. There is ongoing discussion between the Whittlesey (Nene) Washes' designation as a protected environmental site and its role as a flood storage area.

Data availability and quality

Data analysis is based on an export of the Environment Agency's Asset Information and Maintenance dataset (AIMS) from October 2024. This includes other RMA assets, but not all. The Environment Agency has advised that some data within AIMS may be outdated, potentially underestimating the number of assets currently under stress.

Additional data and insights have been collated through site visits and workshops with IDBs.

Asset ownership

Within AIMS, the Environment Agency own 27% of assets, for 48% the owner has been reported as 'Unknown' and the remainder is owned by other RMAs.

Asset age profile

A large proportion of the assets within the catchment were installed between 1950 and 1999, making them 25-75 years old. Further to this, just over a quarter of assets are beyond their foreseeable design life and 21% will reach this point in 1-15 years.

There are 20 flood gate assets which have reached the end of their foreseeable design life. Given their criticality in flood risk management this could represent an investment need.

Asset condition profile

Approximately 32% of active assets have a current condition score of 'Poor', 'Very Poor' or 'Unknown' in the Environment Agency's AIMS. Despite their age, 85% of the 190 embankment assets recorded in AIMS are in 'Fair' or 'Good' condition. Control gates and piers have a high proportion of assets which are below required condition which might warrant further investigation. Flood gates with an 'Unknown' condition score might also represent a vulnerability.

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Ring's End Sluice © Richard Humphrey. Licensed for reuse under the Creative Commons Licence.

Poplars Pumping Station © Jonathan Thacker. Licensed for reuse under the Creative Commons Licence.

Tydd Pumping Station © Arup 2024.

Dog-in-a-Doublet Sluice and Lock © Richard Humphrey. Licensed for reuse under the Creative Commons Licence.

Mouth Lane Pumping Station © Jonathan Billinger. Licensed for reuse under the Creative Commons Licence.

Operating challenges

Tydd Pumping Station is over 85 years old and has only required the use of all six of its pumps four times, two of which occurred in the last four years. There is concern the station could become overwhelmed in the future. North Level District IDB have expressed they would like to increase the capacity of the station to improve resilience to climate change and rising water levels.

At Sutton Bridge Sluice there have been a few occasions in the last ten years where due to tide locking, which is becoming an increasing issue with climate change, the system was unable to discharge water. This resulted in levels in the South Holland Main Drain rising by 0.3m.

Stanground Sluice is considered to be at the end of its foreseeable design life. Scoping works are underway, aiming to extend asset life by 25 years.

Dog-in-a-Doublet Sluice is an old asset that is in need of replacement due to frequent mechanical failures caused by wear and tear, partly resulting from of constant adjustments to cope with tidal inflows. Currently parts, which are difficult to source, are replaced like for like. If there is a fault and the sluice fails to close as intended, the river levels in Peterborough can suddenly drop, causing concern for navigation, water supply and agricultural stakeholders.

Many flood risk assets are experiencing defects on a regular basis. Public safety control systems have the highest defect rate in the catchment. Embankments also have a high number of defects, and these assets often suffer multiple or recurring defects. The implication of frequently occurring defects is an increased maintenance liability which results in higher costs and potentially loss of function at key times, risking local communities and the environment. Asset capacity is a key issue within this catchment, which is expected to be exacerbated by climate change.

Current asset maintenance

Based on analysis of Environment Agency revenue programme dataset:

Environment Agency maintenance expenditure

£2.6M was spent on embankment maintenance between 2022 and 2024, representing 85% of maintenance expenditure for the catchment.

£164k was spent on wall assets between 2022 and 2024, 7% of the total maintenance expenditure in the catchment.

IDB maintenance and expenditure

Across the three IDBs, maintenance expenditure on drains is greater than on Water Level Control Structures (WLCS).

Drain expenditure is relatively stable with a slight increase over time. WLCS expenditure appears to vary more year on year. South Holland IDB's expenditure on pumping stations varies significantly between stations. Maintenance expenditure for all three IDBs has been consistent between financial years 2017-2022, £9.4k for Feldale IDB, £1.04 million for North Level IDB and £1.58 million for the South Holland IDB. It is noted that South Holland IDB's expenditure increased sharply between 2022/23 and 2023/24.

Across all RMAs, substantial investment in capital and maintenance will be required to ensure all assets are in 'Fair' condition or better, as well as enabling new construction schemes to improve the area's resilience. Funding requirements will increase as climate hazards place greater strain on asset systems.

Little South Holland Pumping Station © Jonathan Bye. Licensed for reuse under the Creative Commons Licence.

Poplars Pumping Station © Jonathan Thacker. Licensed for reuse under the Creative Commons Licence.

Foul Anchor Sluice © J.Hannan-Briggs. Licensed for reuse under the Creative Commons Licence.

Environment

Mapping shows environmental features such as the Whittlesey (Nene) Washes which are a vital habitat for wildlife, and contain the majority of the deep peat soils in the catchment.

The catchment is located almost wholly within The Fens National Character Area (NCA) – these are areas of distinct and recognisable character.

The Fens NCA is notable for its large-scale, flat, open topography with extensive vistas to level horizons. The Historic Landscape Character Areas within the catchment include Peterborough, The Fens and The Wash. These help to explain the relationship between heritage features and how the landscape has evolved over time.

Peaty soils cover 4.2% of the catchment area.

They are deepest and most extensive in the Nene Washes but are also present in a small area south-west of Tydd St Giles.

The Eye Gravel Pit is designated as a geological Site of Special Scientific Interest (SSSI).

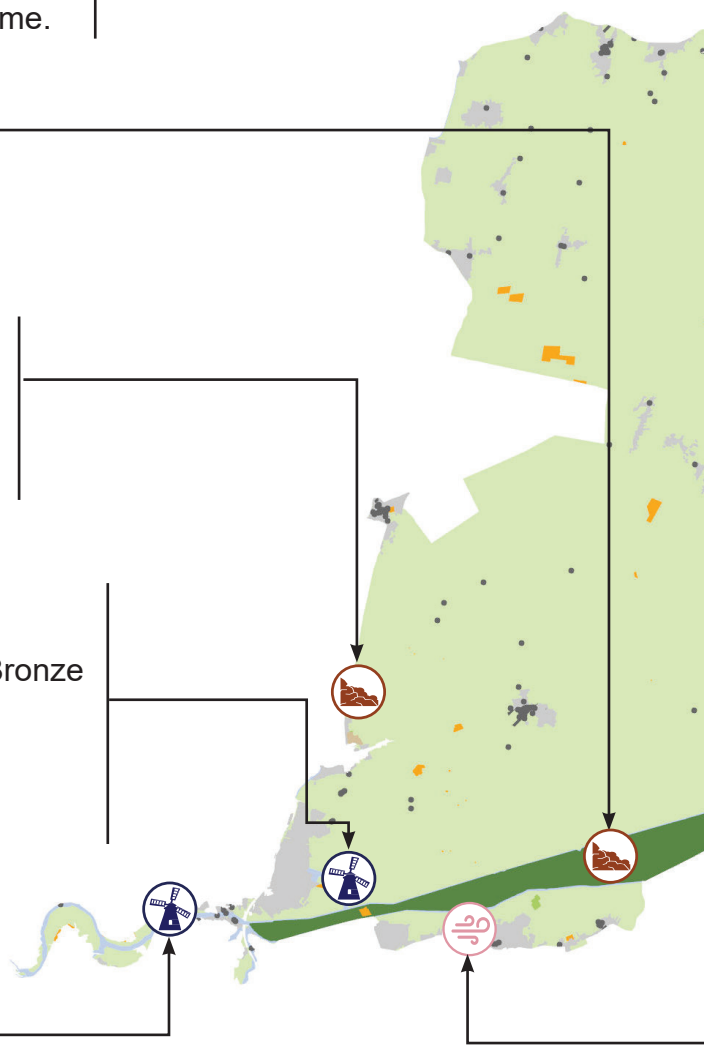
A former gravel quarry, the site is known for its exposures of Fen Gravel (March Gravel) and lies at the interface between fluvial and glacial deposits.

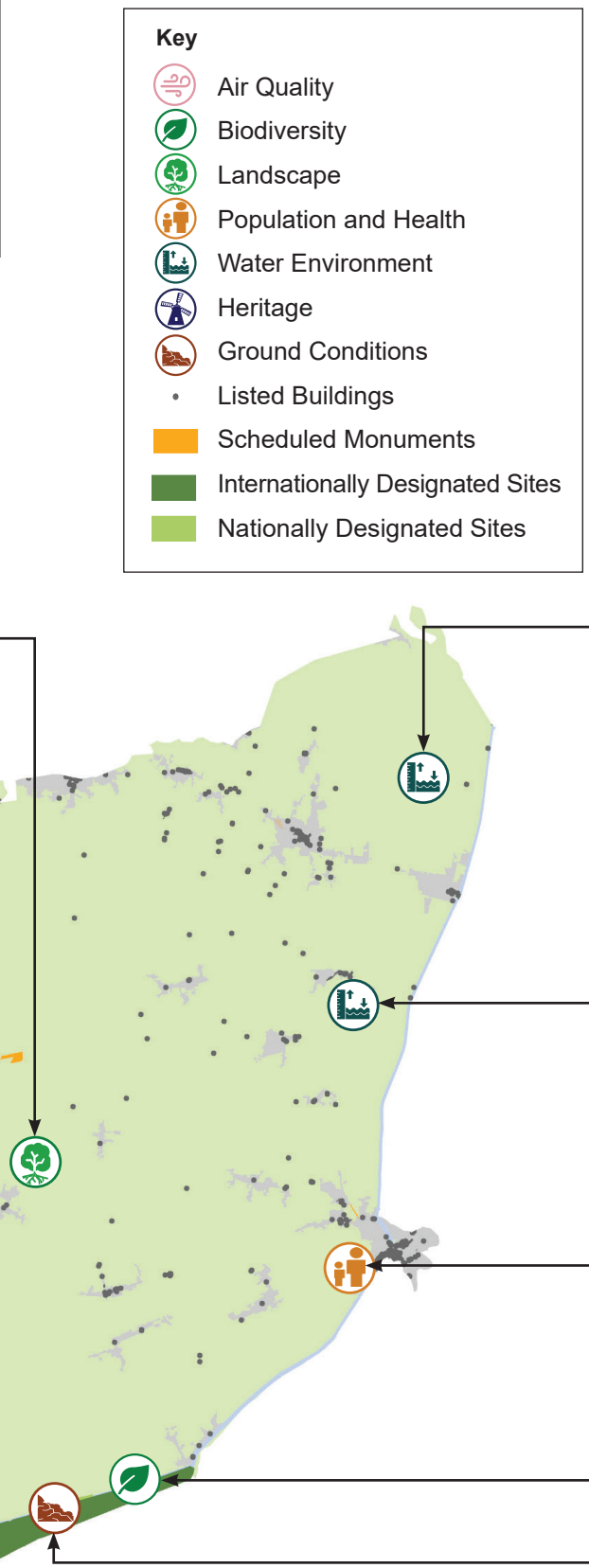
There are 42 Scheduled Monuments within the catchment including Flag Fen and Must Farm.

Flag Fen located east of Peterborough, features a Bronze Age post alignment and timber platform constructed between 900 and 1400 BC. Must Farm dates back to the Late Bronze Age (1000 – 800BC) and has yielded log boats, fish traps and a wooden platform.

The cathedral city of Peterborough has a long history of settlement and development.

There are 17 Conservation Areas within the catchment including a large area of Peterborough City Centre. Conservation Areas possess special architectural or historic interest.





The network of drainage channels and embankments such as the North Level Main Drain, created to drain the fenland, is one of the most notable historic landscape features in the catchment.

This represents the complete transformation of this area in the post-medieval period. Structures associated with this landscape also include bridges, sluices, pumping stations and windmills.

The Nene is classified as a modified water body under the Water Environment Regulations / Water Framework Directive.

This waterbody is currently impacted by physical modifications and pollution from rural areas as well as towns, cities and transport.

Communities located around Wisbech include some of the most deprived areas in England.

Three Lower Layer Super Output Areas (LSOAs) clustered in Wisbech are amongst the 10% most deprived neighbourhoods in England in terms of overall deprivation. This considers domains such as income, employment, education, health, crime, barriers to housing and services, and living environment.

The Whittlesey (Nene) Washes are a flood storage area designated as a Special Protection Area (SPA), Ramsar site, SSSI and a Special Area of Conservation (SAC).

As native fenland, intermittent flooding supports a diverse range of wildlife, and the high water table has helped preserve the peaty soils. This coastal washland habitat and wet grassland supports various bird species including internationally important populations of Bewick's Swan, gadwall, garganey, shoveler and black-tailed godwit.

There are three Air Quality Management Areas (AQMAs) within the catchment including the Whittlesey AQMA No.1.

The Whittlesey AQMA was declared in 2007 by Fenland District Council due to exceedances of sulphur dioxide.

Roddons (palaeochannels), such as those documented in the Peterborough district, are an influential feature within the catchment.

Roddons are former river channels, typically filled with silt, which now sit proud of the land and potentially funnel surface waters. Due to their composition, they may impact structures and assets through differential settlement, compaction and peat wastage.

Agriculture

The Lower Nene catchment is an area of national agricultural importance due to its rich peaty soils. Farming is critical to the local economy within the catchment.

Soilscape

The majority of the catchment contains loamy and clayey soils of coastal flats with naturally high groundwater supporting different cropping regimes. Areas around the Whittlesey (Nene) Washes are associated with less productive soils with 'impeded drainage', with small areas of lowland peat identified. It should be noted that the condition of peat within the catchment is likely to be degraded.

Agricultural Land Classification (ALC)

Approximately 91% of land in the Lower Nene catchment is classified as Grade 1 and 2. Grade 1 land is predominately located to the north and east of the catchment. This is high-yielding land with little or no limitations for agricultural use.

Water availability

The Nene Catchment Abstraction Licensing Strategy notes restricted water availability across much of the catchment during higher flows. These are the flows equalled or exceeded least 50% of the time, with water restricted or not available at other times.

Additionally, the catchment contains level dependent environments, characterised by a network of river channels flowing above the level of the surrounding land. These are used to remove water from low lying land into the main river channels during high flows and provide an irrigation source during low flows.

Value of agriculture in the catchment

Land use within the catchment is primarily agricultural, focused on arable and higher value cropping. Some livestock enterprises are also present, including a commercial dairy unit, grazing livestock and intensive poultry and pig operations.

The whole agri-food chain employs people at different stages of food production, from agriculture to food processing, packing and retail. The estimated overall economic output of farm crop and livestock within the catchment is in the region of £187.4 million annually (in 2023 values). Additional economic output is produced through farm diversification activities, for example, renewable energy generation and tourism.

	Area (km^2)	Area (ha)	Percentage of farmed land (%)	Estimated annual value* (£)
Cereals	218.0	21800	39.7%	£31.5 million
Arable crops (excluding cereals)	118.9	11890	21.5%	£27.7 million
Fruit and vegetables	33.3	3330	6.0%	£63.6 million
Grassland	28.8	2880	5.2%	Grassland does not directly create economic value, but instead supports the grazing of sheep and cattle, or the production of livestock feed.

*Key land use, crop areas and livestock populations on commercial agricultural holdings and estimated annual value (£) for the Lower Nene catchment. Data provided by Collison & Associates. Based on 2023 land and livestock data available from Defra.

Environmental stewardship

Over a third of the land area is managed under government funded agreements such as the recently introduced Countryside Stewardship scheme (part of Defra Environmental Land Management schemes), or the historic Entry Level Stewardship scheme. Stewardship covers 36% of the area.

Climate change

Climate change will increase the risks of fluvial and coastal flooding, as well as drought. Flooding and drought events can restrict the ability to establish new crops, reduce crop yields and quality, or destroy crops once ready for harvest leading to direct agricultural damages and wider economic consequences for landowners.

Examples of agricultural stakeholders and businesses

A farming business, based near Wisbech is one of the UK's first regenerative farms. Regenerative farming systems aim to minimise soil disturbance and enhance soil health, with wider benefits for biodiversity.

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There are a number of large food and drink supply chain businesses including warehousing, cold storage, and distribution centres located around Spalding.

There are a number of large farming businesses based in the north of the catchment, concentrated on Grade 1 agricultural land. Key produce in this area includes wheat, vining peas, sugar beet, mustard and potatoes.

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Similar to other areas across the Fens, farmers and landowners are diversifying to invest in renewable energy projects. There are several solar parks in operation, situated within Thorney, Sutton Bridge, Sutton St James and Murrow.

Wisbech is home to some of the largest food processing sites in the UK, which provides employment opportunities for local residents.

Holiday parks, including fishing lakes, have been constructed close to Eye, providing diversified income streams to landowners.

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Natural capital

Natural capital refers to elements of the natural environment that provide valuable goods and services to people, underpinning wellbeing and economic prosperity.

The benefits provided by natural capital assets such as freshwater, soils, air, and species of plants and animals are known as 'ecosystem services'.

These ecosystem services are vitally important for human wellbeing, and include provision of raw materials, food production, carbon sequestration, temperature regulation, crop pollination, as well as enabling recreation and cultural activities. Some of the services provided by nature do not directly benefit humans, but support the provision other ecosystem services, for example in the case of water and nutrient cycling, and soil formation. Together these services provide many benefits to society and the economy including improved physical and mental health through recreation; temperature regulation; flood protection; and provision of clean water.

The monetary value of benefits provided from ecosystem services can be estimated using information about the quantity, quality and location of natural capital assets, as well as societal use. Values may be underestimated due to lack of information, or complexity in assigning a monetary value.

Key ecosystem services that are difficult to quantify include biodiversity; pollination and seed dispersal; soil quality; and cultural benefits from education, volunteering, amenity, aesthetics and a sense of place. The financial value of these services is difficult to quantify but they are nevertheless vitally important for underpinning our economy, society and the natural world.

Natural capital in the Lower Nene catchment has an annual value of

£54.4 million

Climate regulation

In some cases, the poor condition of the environment can compromise the benefits that it would otherwise provide. For example, peaty soils in healthy condition can continue to form peat and therefore sequester carbon, but when degraded through drainage, mineralisation and erosion under intensive agriculture they start to release carbon back to the atmosphere.

Enclosed farmland, woodland and saltmarsh within the catchment sequesters a total of 7,932 tonnes of CO_2 equivalent per year. However, this is far outweighed by the 54,962 tonnes of CO_2 emitted by the degraded peatland in the catchment, making the land a net source of carbon.

The impact of climate change driven by this process gives a negative value (or cost) for climate regulation.*

Overall, the net release of CO_2 equivalent across the catchment has an annual **cost** of

£13.6 million

*This assessment only takes account of land-based emissions, and therefore excludes emissions from industry, transport or other sources.

£3.9 million
Recreation

The welfare value of approximately 1.0 million visits by adults each year to publicly accessible green spaces within the catchment. The welfare value of a further 255,000 visits made by children each year cannot be quantified but is likely to be significant.

£1.0 million
Physical health

£970,000 in healthcare treatment costs can be avoided every year due to improved physical health through approximately 517,000 active visits to publicly accessible green spaces in the catchment. Active visits involve at least 30 minutes of exercise.

£47.7 million
Agriculture

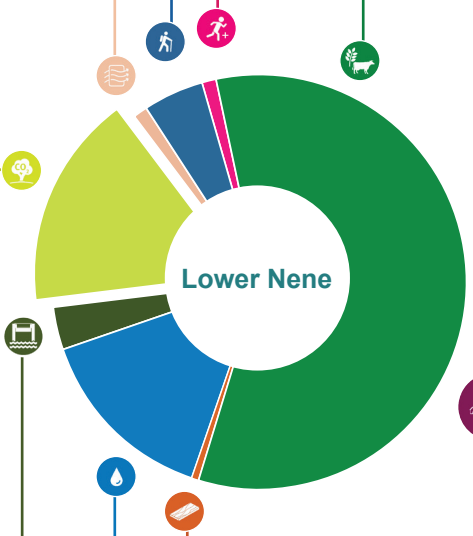
The 494.1km^2 (49,407ha) of enclosed farmland in the catchment provides several ecosystem services, but the service with the largest annual value is food production. Arable and livestock yields from the catchment have a combined annual value of £47.7 million.

£0.9 million
Air Quality

The removal of approximately 2,840 tonnes of air pollutants by vegetation in the catchment avoids the costs of damages to health. This has an annual value of £895,000 per year.

£0.0 million
Water quality

The annual value of 'Good' or high water quality is £9,451 per km^2 for transitional and coastal waterbodies, or £83,210 per km for river waterbodies. However, none of the waterbodies in the catchment meet these standards, giving a value of £0 for water quality.



£-13.6 million
Climate regulation

The value of climate change regulation in the catchment is negative because the habitats across the catchment release more carbon than they sequester overall. Each year, approximately 47,030 tonnes of CO_2 equivalent are released overall, costing around £13.6 million per year through the detrimental effects of climate change.

£0.0 million
Hazard regulation

The assessment does not provide a monetary value for this benefit. However, in the catchment it is estimated that 64,000m^3 of floodwater is temporarily stored in areas of woodland.

£2.7 million
Renewable energy

An estimated 195,300MWh of renewable energy, predominantly from wind and solar, is generated each year within the catchment. This has an annual value of approximately £2.7 million.

£11.8 million
Water supply

The annual value of approximately 2.6 million m^3 of water which is abstracted from the catchment each year, for public water supply and other uses such as irrigation.

£0.6 million
Timber

National data can be applied to the Lower Nene catchment to estimate a yearly timber production volume of 1,675m^3, which is valued at approximately £56,500 per year.

Flood economic damage scenarios

To understand the potential economic impact of flooding over the next 100 years, two scenarios have been explored which describe different approaches to managing flood risk assets. These are the 'Maintain' and 'Do Nothing' scenarios.

Maintain

The 'Maintain' scenario represents the continued maintenance of the existing flood defences. All flood defences would continue to provide the same level of service that they currently offer. There is no allowance for increasing the Standard of Protection offered by existing assets or for climate change adaptation, such as increasing the height and resilience of flood defences or increasing the capacity or performance of pumping stations.

In a 'Maintain' scenario, flooding would occur in events which exceed the height of existing flood defences or the capacity of pumping stations. The resulting damage to properties and infrastructure has been used to determine the scale of economic losses which might be expected over the next 100 years. The flood risk in this scenario is represented with the modelling results from the 2021 Tidal Nene model. Refer to page 20-21 for the mapped results of this model.

£13 billion

the economic benefits of current flood risk management activities

Do Nothing

The 'Do Nothing' scenario is a hypothetical scenario, used to understand the benefits of investment in flood defences by considering the consequences of investment being withdrawn. In this scenario, all flood risk management activities would stop, including pumping and maintenance of existing flood defences. Sluices on the Main Rivers would no longer operate, increasing flood risk as river water backs up behind these sluices. Without pumped outfalls to the Main Rivers and The Wash, water would be unable to drain from the land.

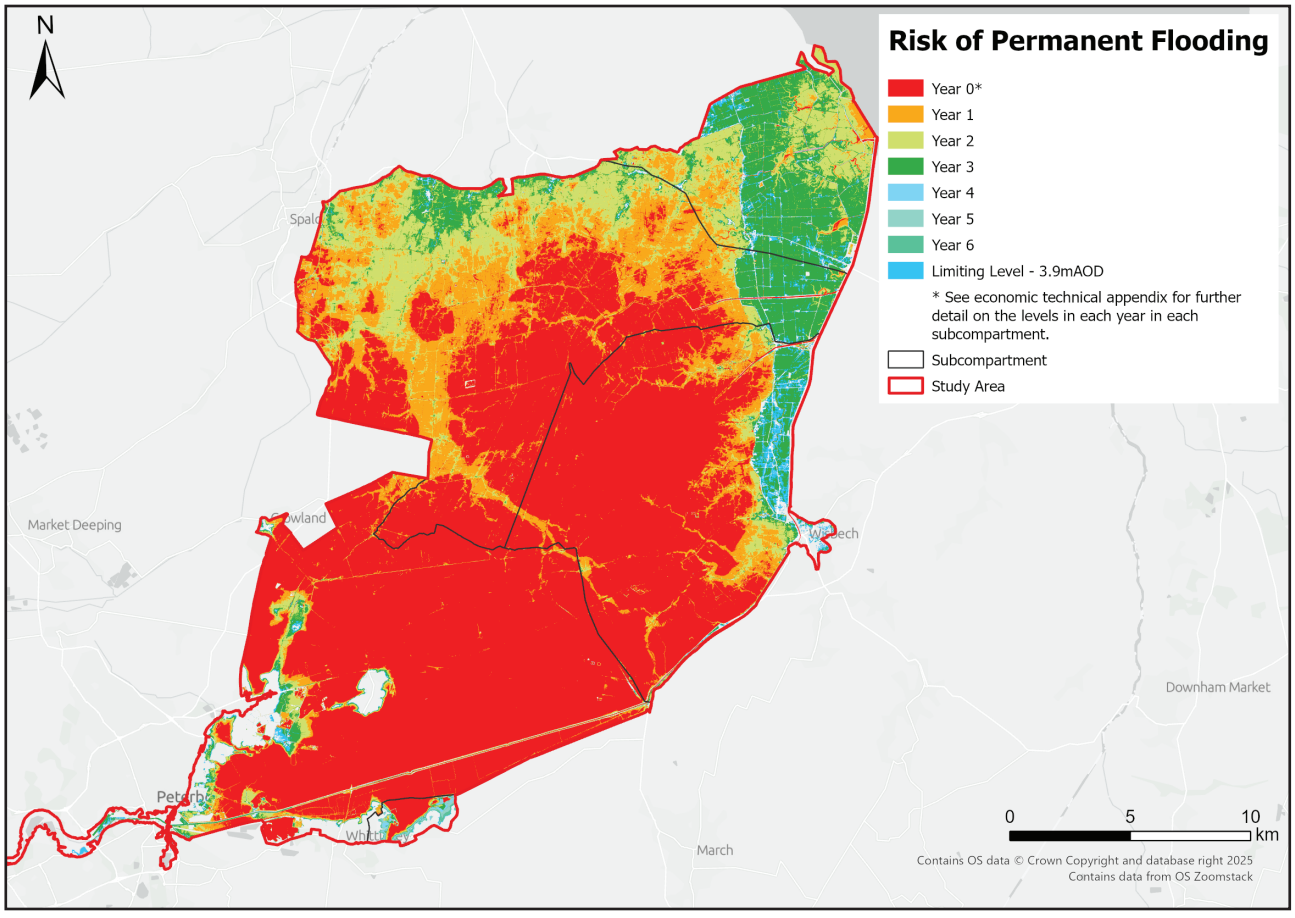
For the purposes of the economic scenario, the catchment is assumed to act as a basin, which fills water to the 'limiting level' (the maximum level that the catchment would be able to fill with water).

Due to topographic differences within the Lower Nene catchment, it has been split into several subcompartments, each with their own limiting level (see map to the right). Whilst there would be some loss of water over summer due to evaporation and transpiration, the water levels in each area would be expected to rise steadily over a few years, filling the catchment. To represent this, it is assumed that each of the areas would fill by 0.5m per year up to the limiting level. The resulting damages are used to determine the economic losses over the next 100 years, if all flood risk management activities ceased.

The economic analysis estimates the damages that would be expected to occur in each of the 'Do Nothing' and 'Maintain' scenarios. The economic benefit of maintaining the existing flood defences is the damages avoided in the 'Maintain' scenario compared to 'Do Nothing'.

The Total Impact framework to the left shows the range of damages considered.

The results of the assessment show that there is a total of £13 billion of economic damages in a 'Do Nothing' scenario (excluding losses to the local economy), compared to only £13,000 of economic damages in a 'Maintain' scenario. As such, the economic benefits of current flood risk management activities are valued at just over £13 billion.



Risk of permanent flooding over time, in a 'Do Nothing' scenario

Economic damages and benefits of flood protection

If all flood risk management activities ceased ('Do Nothing'), total damages in the catchment over the next 100 years would exceed £13 billion, with just under £13 billion of this in the first ten years.

£1.2 billion
Agriculture

Flooding to farmland will lead to immediate and long-term crop losses. Damages capture loss of crops and livestock and associated loss of profits.

453.3km² (45,330ha)
of agricultural land written off in the 'Do Nothing' scenario.

£9.4 billion
Properties

Captures the impacts of flooding on residential and non-residential buildings, through damage to building fabric and structure.

19,295
residential properties written off in the 'Do Nothing' scenario, costing
£8.4 billion

1,633
non-residential properties written off in the 'Do Nothing' scenario, costing
£966 million

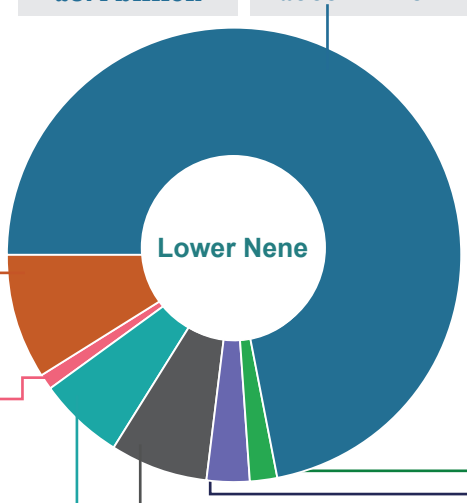
£301.9 million
Environment and recreation

Loss of 14.9km² (1,487ha) of designated environmental sites across the catchment will lead to losses of ecosystem services such as carbon sequestration, flood regulation, biodiversity, recreation and non-use values.

Recreational damage would arise through loss of 19km² (1,898ha) of recreational sites and 146km of Public Rights of Way.

£96.1 million
Heritage

Cost of the loss or damage of 263 heritage assets as a result of flooding. The catchment contains 537 Listed Buildings and 42 Scheduled Monuments.



£421.5 million
Utilities

Captures the impacts of flooding to power, water supply, and gas networks. This includes damage to more than 1,000 substations, 4,300 pole towers and 93km of gas pipelines.

£6.5 billion
Losses to the local economy

Losses to the local economy have been considered in terms of Gross Value Added (GVA). This considers the cost to the local economy of 25,517 jobs being lost across the catchment under a 'Do Nothing' scenario. GVA is a local / regional benefit so cannot be included in application for Grant in Aid funding.

£726.6 million
Transport

The cost of the loss of road infrastructure, and railway network as a result of permanent flooding.

Loss of
34.5km
of road infrastructure, costing
£724.7 million

Loss of
329m
of rail infrastructure, costing
£1.9 million

£881.6 million
Isolated land

The consideration of isolated land and properties is unique to the 'Do Nothing' scenario which considers permanent inundation of the catchment, rather than infrequent extreme flood events. It accounts for areas of land which may not be directly flooded, but are abandoned because flood waters cut-off the area from the existing road network.

Lower Nene	Do Nothing Damages	Maintain Damages	Maintain Benefits
Damages to properties and associated indirect damages	£9.4 billion	£13,000	£9.4 billion
Agricultural losses	£1.2 billion	-	£1.2 billion
Environment and recreational losses	£301.9 million	-	£301.9 million
Heritage losses	£96.1 million	-	£96.1 million
Transport damages	£726.6 million	-	£726.6 million
Utilities damages	£421.5 million	-	£421.5 million
Land lost due to isolation	£881.6 million	-	£881.6 million
TOTAL Excluding losses to the local economy	£13 billion	£13,000	£13 billion
Losses to the local economy	£6.5 billion	£3,000	£6.5 billion

£13 billion

total benefits of maintaining current flood defences for the next 100 years

Total investment needed:

£0.7-£1.1 billion

to sustain the current Standard of Service for 100 years (excluding the impact of climate change).

The investment needed to sustain the existing flood defences has been estimated with no allowance for improvements in protection or adaption to the impacts of climate change. These investment needs have been developed based on three types of assumed costs:

- Ongoing and routine maintenance and operational costs;
- Infrequent asset refurbishment costs; and
- End of life asset replacement costs.

The costs have been developed based on data for various assets across the wider Fens 2100+ study area, collated from the Environment Agency and IDBs.

All damages and benefits are shown for a 100-year period, except for GVA, which is for 10 years.

These have been used to determine the average costs for each type of asset, including for maintenance, operation and asset replacement. Asset refurbishment costs are only included where these have been provided for specific assets.

The range of costs reflects the uncertainty in the assumptions made at this stage.

The flood risk, asset condition, economic and total investment analyses given within this baseline report demonstrate the critical importance of a strategic plan for the future of flood risk management within the Lower Nene catchment. Future stages of the Fens 2100+ Partnership will build on this evidence to set out an investment strategy for the region.

Details of the assessment of economic damages and benefits are provided in the technical appendix.

Glossary of terms and acronyms

Agricultural land Grades 1 and 2

Land classified as Grade 1, using the UK's Agricultural Land Classification (ALC), has little or no limitations and will consistently achieve high yields for most crops. Grade 2 has reduced flexibility compared to Grade 1 and yields are generally high but can be more variable compared to Grade 1.

Agri-environmental schemes

Agri-environment schemes provide funding to farmers and land managers to farm in a way that supports biodiversity, enhances the landscape, and improves the quality of water, air and soil.

Annual Exceedance Probability (AEP)

This is the probability of a certain sized flood event occurring in a single year.

Asset Information Management System (AIMS)

A database with information about flood defence assets currently owned, managed and inspected by the Environment Agency.

Benefits

The positive quantifiable and unquantifiable changes that a flood risk management scheme is expected to produce, i.e. damages avoided.

Capital funding

Funding secured for the creation of new assets or the major refurbishment of existing assets to maintain or increase current standards of protection.

Carbon sequestration

The process of capturing and storing greenhouse gases from the atmosphere. In the context of natural systems this is via plant vegetation and soil processes.

Catchment

For the purposes of the Fens programme, the catchment study area has been defined by land at or below the 6m AOD contour, which may differ slightly from the hydrological catchment.

Climate mitigation

Actions taken to limit the effects of climate changes by reducing carbon emissions or enhancing carbon sinks.

Damages

The value of negative social, economic and environmental impacts caused by flooding.

Ecosystem services

Services provided by the natural environment which benefit people. They provide outcomes that provide positive benefits to human wellbeing.

Flood risk management assets

In the context of this report this refers to a structure built and maintained specifically for flood risk management purposes, for example embankments, flood defence walls and pumps.

Main River

A statutory designation of watercourse, usually applied to larger streams and rivers. The Environment Agency have permissive powers to carry out maintenance, improvement and construction works on these watercourses, although usually the main responsibility for these lies with the riparian owner.

Maintenance funding

Funding secured for maintenance activities to existing assets to sustain the existing standard of protection. Sometimes this is referred to as revenue funding.

Maladaptation

Actions or strategies that, while intended to address a problem, ultimately increase vulnerability or harm, either in the short or long term.

Mean High Water Spring (MHWS)

The average height of high-water level during spring tides, placing this area at risk of permanent inundation.

Natural capital

Refers to elements of the natural environment that provide valuable goods and services to people, underpinning wellbeing and economic prosperity.

Ordinary watercourse

Any watercourse which is not designated as a Main River. Within the Fens the IDBs manage these watercourses on behalf of the riparian owners.

Ordnance Datum (OD)

The Ordnance Datum is the basis for all the land heights that appear on Ordnance Survey maps. It is essentially the mean sea level at Newlyn in Cornwall, and is sometimes called Ordnance Datum Newlyn (ODN).

Resilience

The capacity for people and places to plan for, protect, respond to and positively recover from flooding and coastal change.

Risk Management Authorities (RMAs)

Refers to the authorities which take a strategic lead on the management of flooding and have permissive powers to carry out the works. These authorities include the Environment Agency, LLFAs, district councils, IDBs, highway authorities and water companies.

Soilscape

A classification used to describe the broad regional differences in soil types and their distribution across a landscape.

Standard of Protection (SoP)

At a given point in time, the AEP of a flood event which an asset is able to withstand. SoP will vary over time.

Standard of Service (SoS)

Defined physical characteristics that a flood risk infrastructure asset is required to achieve. For example, the height of a protective barrier or throughput of a pump.

Fens 2100+