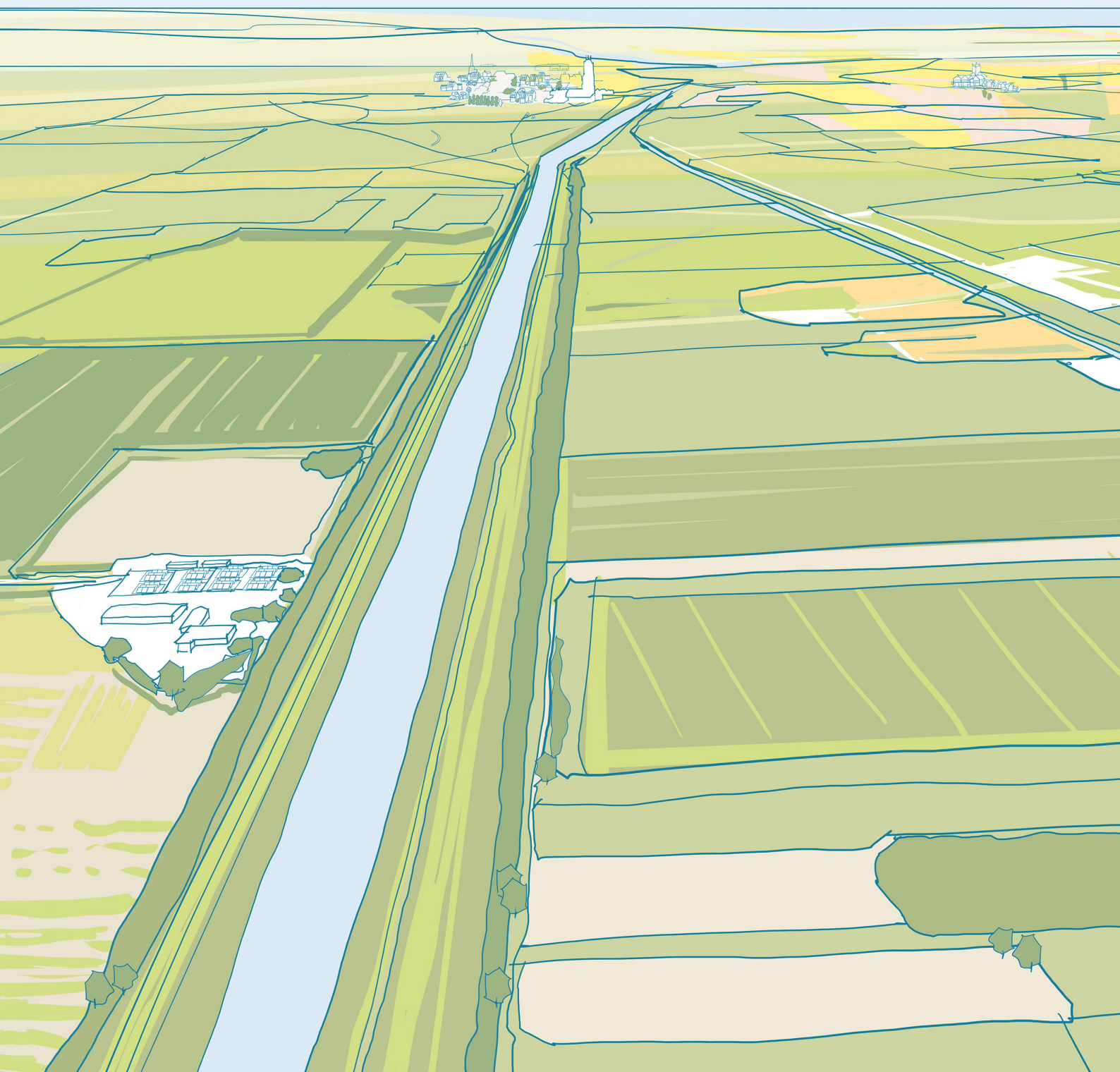


Witham South Forty Foot Drain

Baseline evidence report

2025



Find out more

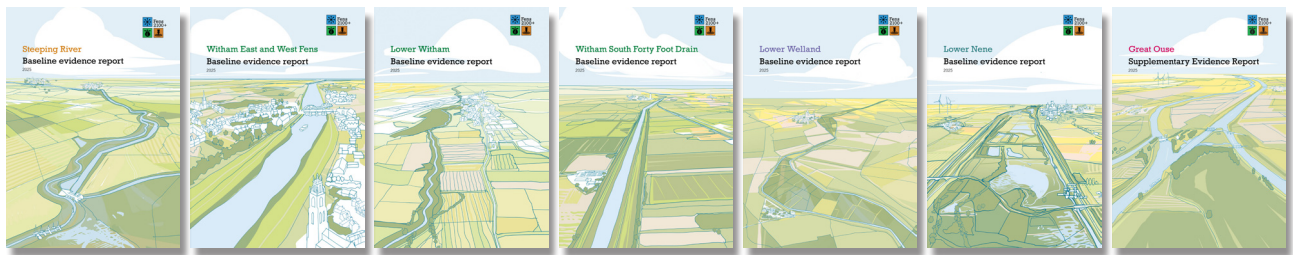
Summary baseline evidence report

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, for the first time, a comprehensive picture of flood risk and asset performance across the South Forty Foot Drain 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.

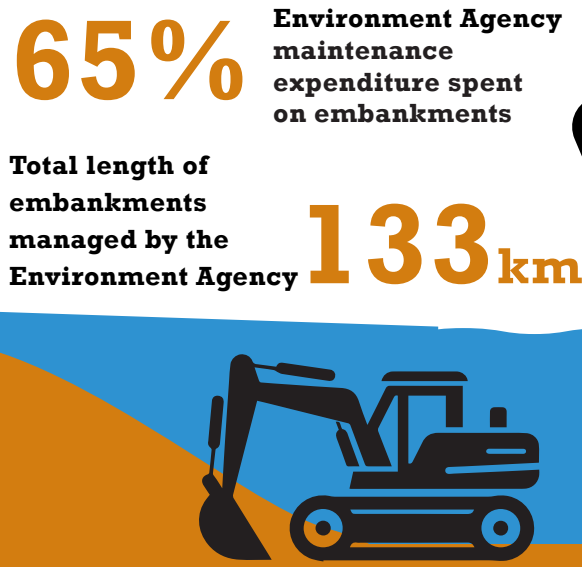
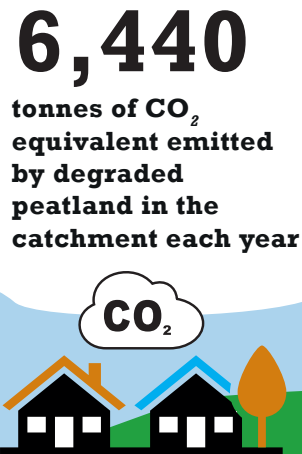
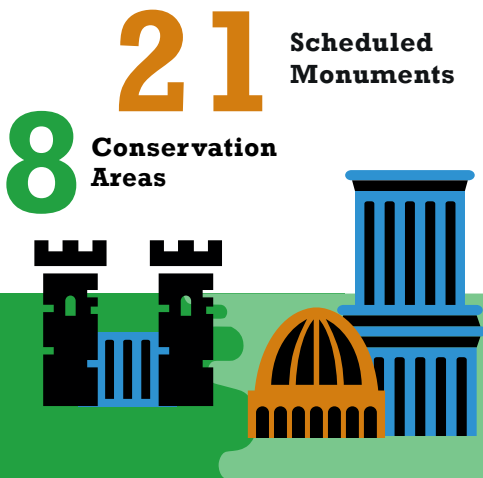
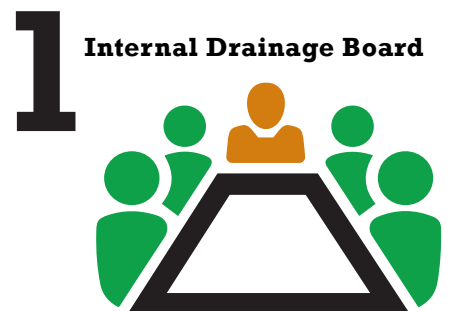
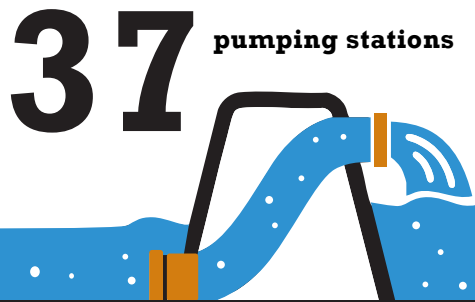
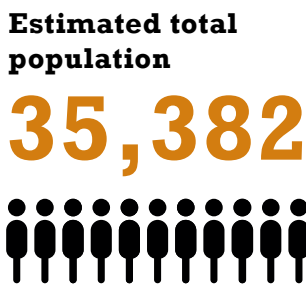
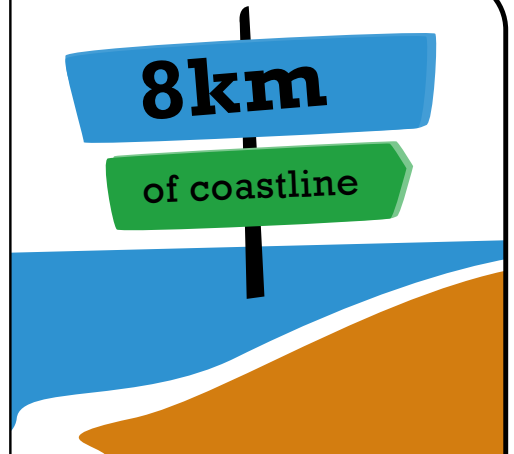
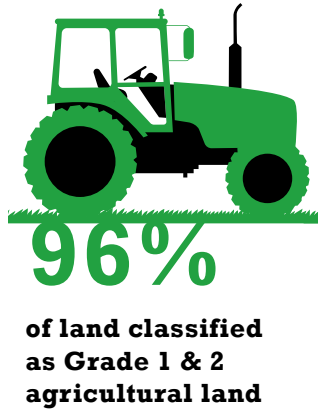
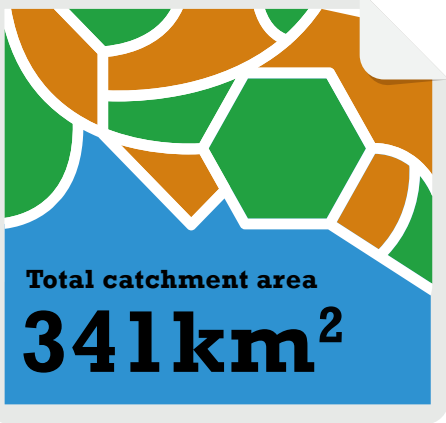
Lying largely at or below sea level, this highly vulnerable region faces increasing risks from rising sea and river levels driven by climate change and land subsidence caused by drying peat soils.

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.

Witham South Forty Foot Drain



Introduction

The evidence is clear: without urgent investment to maintain and upgrade flood risk assets across the South Forty Foot Drain catchment, £5.3 billion of damages could be sustained to land, homes and livelihoods.

A landscape worth protecting

Covering 341km² (34,100ha) of southern Lincolnshire, the South Forty Foot Drain catchment is an area of national agricultural importance. Its healthy agricultural economy supports more than 1,500 local jobs and contributes £120.4 million a year to the UK economy.

There are six designated nature conservation sites, including The Wash, an internationally important site for wading and migratory birds, shellfish and seals. Artificial watercourses are central to the area's character and heritage.

Natural capital delivers £45 million of benefits a year, including food production, flood risk management, carbon sequestration, clean water and recreation. Around 9% 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. 289km² (28,900ha) of agricultural land and 11,023 homes are at risk. Yet, many of the critical assets in the catchment are being affected by reliability and performance issues caused by their age.

Approximately 24% of all active assets are rated 'Poor', 'Very Poor' or 'Unknown' and several key structures, such as outfalls and bridges are at an age where significant repairs or even replacement will be required soon. This complex system of assets requires significant resources and collaboration between RMAs.

Repeated flooding events highlight the catchment's vulnerability, most recently at Billingborough, Boston and Pointon in January 2025. Climate change will intensify this risk, even if current defences are maintained.

What's needed?

**£440-£710
million**

of investment

to sustain the current Standard of Service for 100 years

To maintain

**£5 billion
of benefits**

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

Catchment overview map

The catchment in context

The South Forty Foot Drain catchment covers an area of approximately 341km² (34,100ha), located in southern Lincolnshire. It is a sub-catchment of the River Witham. It is bounded by the higher ground to the west, the River Welland catchment to the south and east, and the Lower Witham and East and West Fens catchments to the north.

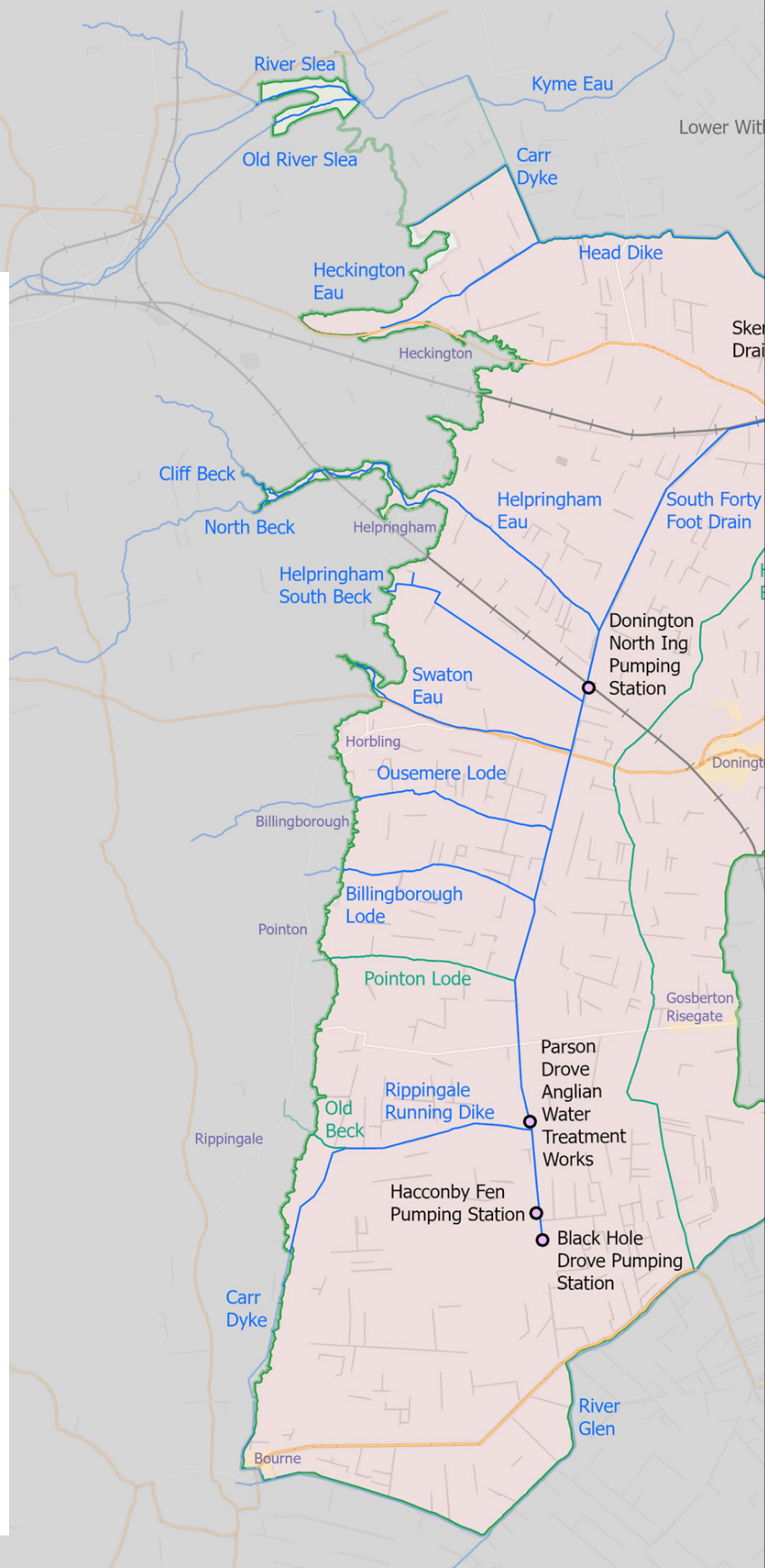
The catchment is comprised of two drainage systems: a network of Main Rivers managed by the Environment Agency, and a network of drains managed by Black Sluice IDB.

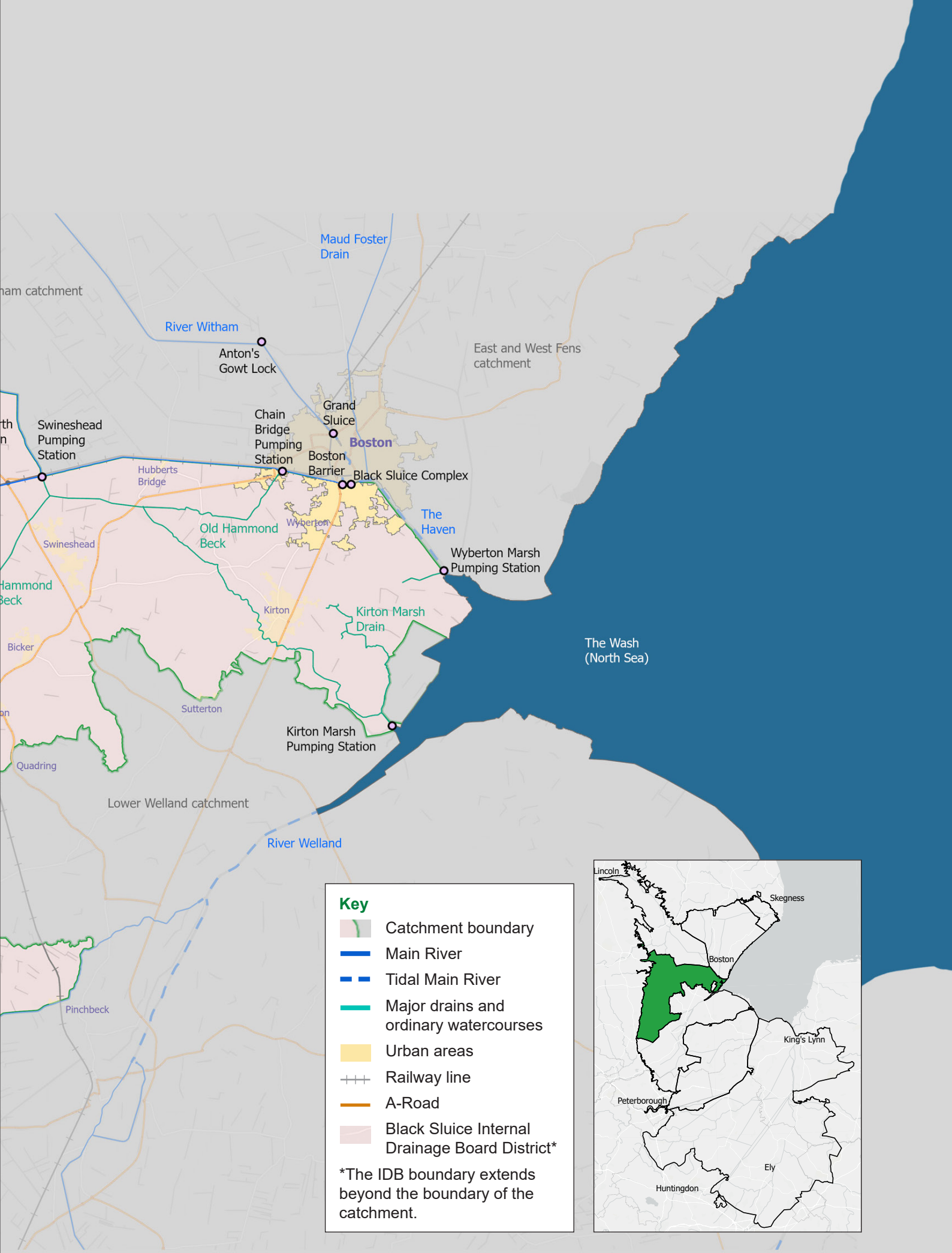
The Main River system includes South Forty Foot Drain, Rippingale Running Dike, Ousemere Lode, Swaton Eau, Helpringham South Beck, Helpringham Eau and Skerth Drain. These watercourses represent a high-level carrier system that accepts water from the more elevated land to the west and conveys this water to the South Forty Foot Drain.

The South Forty Foot Drain catchment covers approximately

341km²

of southern Lincolnshire.

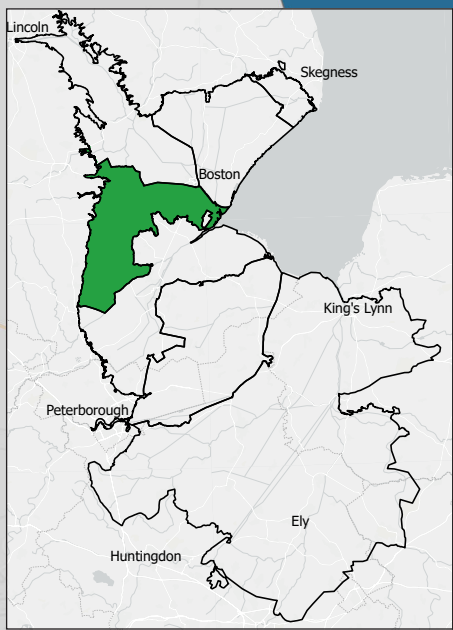




Key

- Catchment boundary
- Main River
- Tidal Main River
- Major drains and ordinary watercourses
- Urban areas
- Railway line
- A-Road
- Black Sluice Internal Drainage Board District*

*The IDB boundary extends beyond the boundary of the catchment.



Catchment overview

Drainage of the catchment is achieved by a combination of gravity and pumping, protecting large areas of valuable Grade 1 agricultural land.

The South Forty Foot Drain discharges into the River Witham at the Black Sluice. Black Sluice Pumping Station was used to manage water levels in the South Forty Foot Drain between 1946 and 2013. A decision was taken in 2018, by a partnership of RMAs, to decommission the asset. Modelling and economic appraisal showed the asset to be economically unviable, with the value of its benefits lower than the cost to refurbish and run the station. Water levels are now controlled using gravity only, both through a sluice, and through the Black Sluice Lock, which can be operated as a gravity discharge sluice to provide additional capacity during high flows.

Boston Barrier, built in 2020 to protect Boston from tidal flooding, is located immediately downstream of the confluence of the South Forty Foot Drain and the River Witham. The Grand Sluice, located upstream of the Boston Barrier, marks the transition into the tidal reach of the River Witham, known as The Haven.

Black Sluice IDB operates 37 low lying subcatchments. These discharge into the South Forty Foot Drain via approximately 600km of drains and ditches. The majority of the subcatchments are able to drain by gravity, with the pumps improving the flow rate. In total, 34 of the sub-catchments are pumped.

Assets operated and maintained by Black Sluice IDB include Swineshead Pumping Station and Wyberton Chain Bridge Pumping Station, both of which have been highlighted as critical assets by the IDB.

Most of the land within the South Forty Foot Fens lies just above sea level at approximately 4m Above Ordnance Datum (AOD), with some land close to sea level. Today 42.6% of the catchment is highly productive Grade 1 agricultural land.

The area is home to several small settlements, including Kirton, Donington, Swineshead, Wyberton, Quadring and Gosberton and the southern portion of Boston. The catchment has an estimated total population of 35,382.

Major transportation routes include the A151, A16, A17 and A52, as well as local rail services linking to Boston, with stations at Hubberts Bridge and Swineshead.

The catchment hosts the nationally significant 400kV National Grid Bicker Fen Substation near Boston, which connects the UK to Denmark via the £1.7bn Viking Link interconnector. Additionally, the Bicker Fen Wind Farm, comprising 13 turbines, is situated nearby and contributes to the region's renewable energy production.

Parson Drove Water Treatment Works, located in the south of the catchment, is an important asset operated and maintained by Anglian Water. It is the main water supply treatment facility for Boston and the surrounding area. It was flooded in 1999 and was close to being inundated during the 2023/2024 winter flooding.



The catchment has an estimated total population of

35,382



42.6%

of the land classified as Grade 1 agricultural land.



View of South Forty Foot Drain upstream of the Black Sluice in Boston
© Arup 2024

Flood management system

1 South Forty Foot Drain

Main River

Almost all water entering the catchment is directed into the South Forty Foot Drain, either via gravity or by pumping. The drain discharges into the tidal Boston Haven.

2 Black Hole Drove Pumping Station

Black Sluice IDB

One of 22 pumping stations lifting water into the South Forty Foot Drain along its length. In total, Black Sluice IDB own 34 pumping stations within the catchment.

3 Main River Highland Carrier Drains

Main River

All of the Main River highland carrier drains to the west carry flows from the higher ground of the Southern Lincolnshire Uplands to the South Forty Foot Drain. There are no structures controlling these 'junctions' so water enters the South Forty Foot Drain freely by gravity. From north to south, they are the Helpringham Eau, Helpringham South Beck, Swaton Eau, Ousemere Lode, Billingborough Lode, and the Rippingdale Running Dike.

4 Pointon Lode

Black Sluice IDB

Previously designated as Main River, it was re-designated as an ordinary watercourse in 2018, giving Black Sluice IDB permissive powers for channel maintenance.

5 Hammond Beck

Black Sluice IDB

Receives flows from the wider Black Sluice IDB drainage network and allows water to flow parallel to the South Forty Foot Drain.

6 Donington North Ings Pumping Station

Black Sluice IDB

Lifts water into the South Forty Foot Drain. It can relieve pressure on Swineshead Pumping Station downstream by pulling water southwards down the Hammond Beck.

7 Skerth Drain

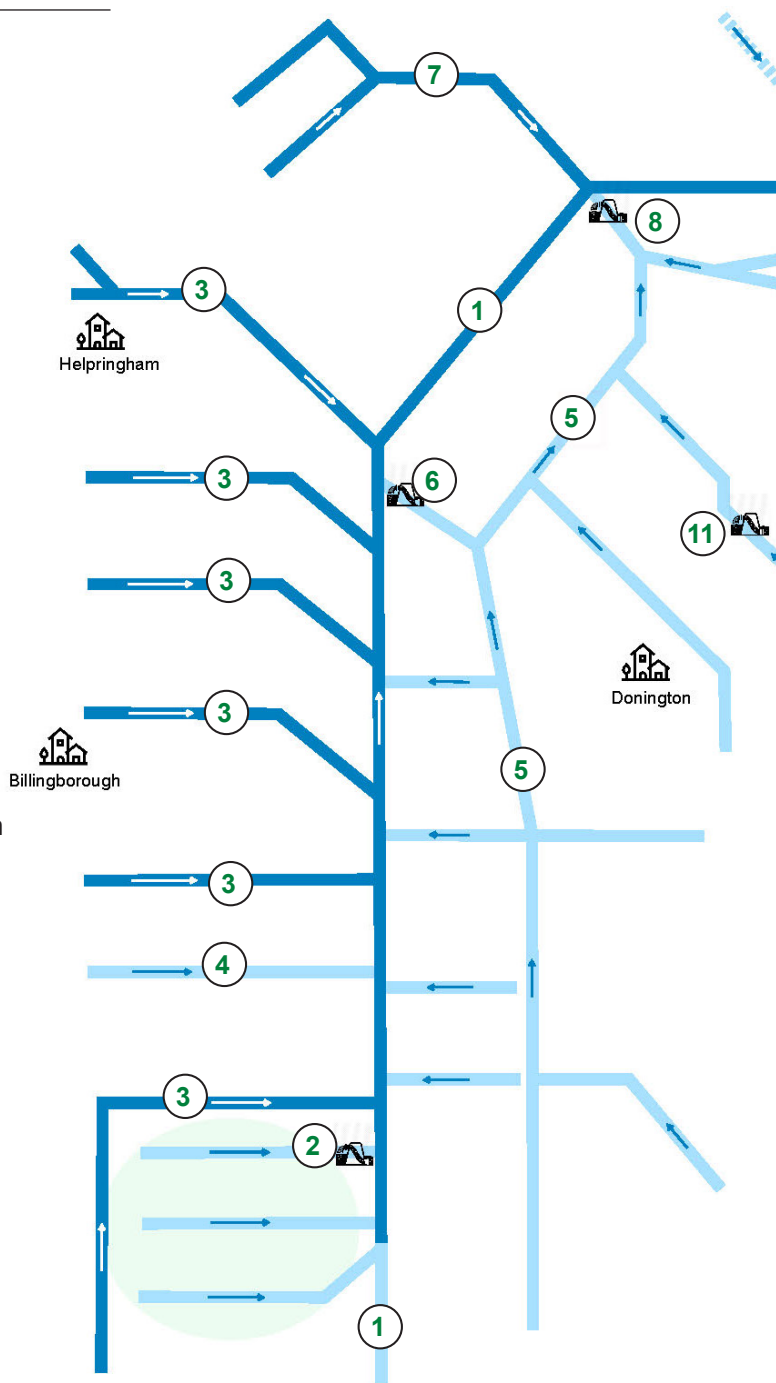
Main River

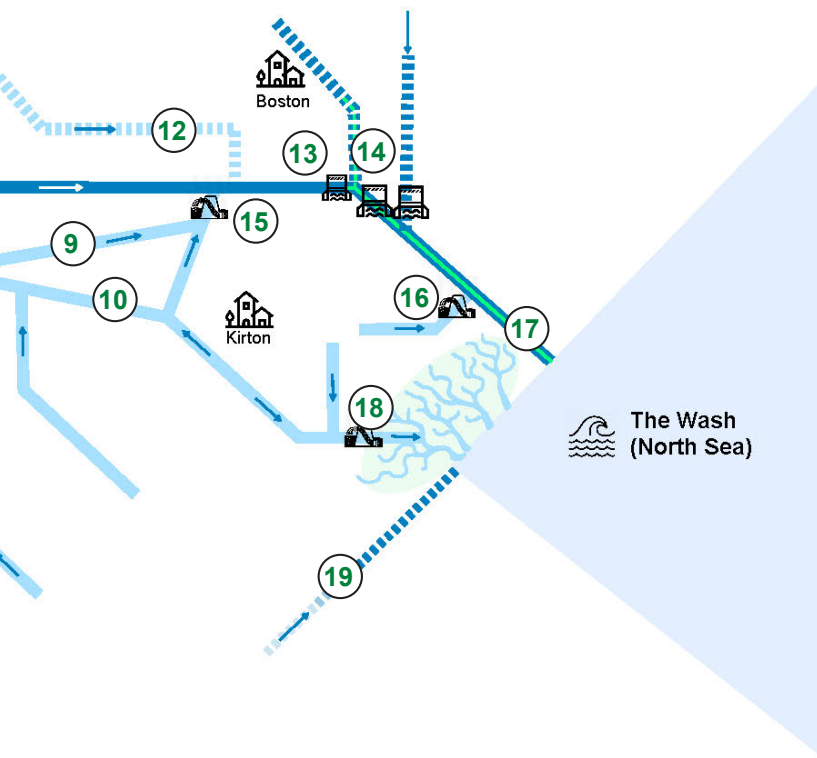
Four IDB pumping stations discharge water into this watercourse, which enters the South Forty Foot Drain uncontrolled by gravity.

8 Swineshead Pumping Station

Black Sluice IDB

The most powerful pumping station managed by Black Sluice IDB. It pulls water from the Hammond Beck and Old Hammond Beck and lifts it into the South Forty Foot Drain.





Key

- █ Main River
- █ IDB Drains
- - - Watercourses outside the study area
- █ Tidally-influenced Main River

Navigation and other water level control structures are not shown.

- 9 New Hammond Beck**
Black Sluice IDB
A straightened channel carrying water to Chain Bridge Pumping Station.
- 10 Old Hammond Beck**
Black Sluice IDB
Water in this drain can move in either direction, depending on the relative power of the pumping stations at Swineshead and Chain Bridge.
- 11 Bicker Eau Pumping Station**
Black Sluice IDB
One of four booster stations owned by Black Sluice IDB which help to convey water from inland areas towards other pumping stations where it is pumped for a second time into the Main River system.
- 12 North Forty Foot Drain**
Black Sluice IDB
One of several Black Sluice IDB drains bringing water to the South Forty Foot Drain from Holland Fen outside the catchment area to the north. This additional water means that IDB pumps downstream have to work harder to move water into the Main River.

- 13 Black Sluice Complex**
Environment Agency
The site consists of a non-operational pumping station, and two tidal sluices (one of which operates as a navigational lock) that allow water from the South Forty Foot Drain to flow out into the Boston Haven during low tide.
- 14 Boston Barrier**
Environment Agency
Completed in 2020, the Boston Barrier protects over 13,000 homes and businesses in the town.
- 15 Chain Bridge Pumping Station**
Black Sluice IDB
Lifts water from Old Hammond Beck and New Hammond Beck into the South Forty Foot Drain. It can be used to relieve pressure on Swineshead Pumping Station upstream.
- 16 Wyberton Marsh Pumping Station**
Black Sluice IDB
Pumps water out into the Boston Haven.
- 17 Boston Haven**
Main River
The tidal section of the River Witham.
- 18 Kirton Marsh Pumping Station**
Black Sluice IDB
Pumps water from Kirton Drain out into the coastal saltmarsh, where it can drain into The Wash.
- 19 River Welland**
Main River
The River Welland's tributary the River Glen forms the southern boundary of the catchment further inland. All water falling on land north of the River Glen (even very close to it) is diverted northwards via the South Forty Foot Drain, and the Black Sluice IDB network.

History of the catchment

Attempts to drain the South Forty Foot Drain catchment began between 1635 and 1638.

Before the 1600s, the catchment was an undrained wetland providing the local community with rich fenland resources. An initial drainage scheme involved the construction of the first Black Sluice (Skirbeck Sluice) and the initial 13km of the South Forty Foot Drain (1635-1638). The local community took direct action against this activity as it disrupted their livelihoods, so they burned the sluice, leading to the naming of the structure as the 'Black Sluice'. This led to a hiatus in major drainage activity for the next 100 years.

The Great Flood of 1763 revived interest for major land drainage improvements. This resulted in the Black Sluice Drainage Acts (1765 and 1770). Under these Acts the Black Sluice Commissioners was created, a replacement Black Sluice was constructed and another 21km of the South Forty Foot Drain was cut.

In addition, the Boston Port Act (1766), established the Boston Harbour Commissioners who undertook works to improve navigation within The Haven.

An extreme tidal event in 1810 resulted in raising of the existing sea banks to 0.6m above the 1810 level of 5.89m AOD in and around Boston.

Pumping stations were installed across the South Forty Foot Drain catchment throughout the 1800s and 1900s. By 1935, when the Black Sluice IDB was formed, there were 15 oil powered pumps lifting water into the South Forty Foot Drain from surrounding field drains.

In 1946, 18km of the South Forty Foot Drain was widened and the Black Sluice Pumping Station came into operation. Before this, the catchment discharged by gravity alone to The Haven through the Black Sluice.

The existing tidal defences successfully protected the majority of the catchment against the 1953 tidal event, an event which caused damage and loss of life along the east coast of the UK.

Throughout the 1960s, pumps were installed across the catchment to increase drainage of the catchment. This included providing additional capacity at Black Sluice Pumping Station in 1966. Many of the pumping stations operating in the catchment today date from this period.

A tidal flood in 2013 reinforced the case for the construction of the Boston Barrier on the River Witham, downstream of the South Forty Foot Drain, as recommended by the Boston Combined Strategy (2008). This was completed in 2020.

Following a review by RMAs, a decision was taken in 2018 to decommission Black Sluice Pumping Station. Water is now discharged solely through the gravity sluice, and navigational lock when extra capacity is required.

The winter storms of 2023/2024 put tremendous pressure on the entire drainage system, RMA staff and their budgets. In January 2025 high water levels caused flooding in Boston, Billingborough and Pointon, including in locations where river embankments were awaiting repair from the winter 2023/2024 floods.

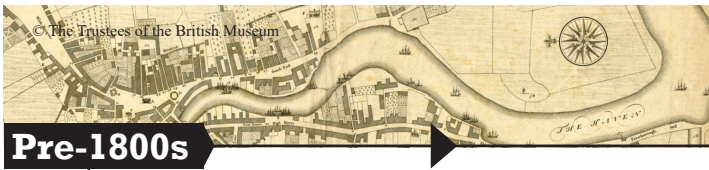


Drain cutting in the Black Sluice District
© Black Sluice IDB



Chain Bridge Pumping Station is typical of the pumping stations built across the catchment in the 1960s © Black Sluice IDB

History timeline



Pre-1800s

1635-1638

An initial scheme to drain low-lying land to the west of Boston involved construction of the first Black Sluice and the first 13km of the South Forty Foot Drain. Local opposition prevented further works until 1720.

1720

Earl Fitzwilliam attempted to drain Holland Fen by cutting the North Forty Foot Drain and linking it to South Forty Foot Drain at Lodewick Gowt. This is located to the north of South Forty Foot Drain study catchment.

1763

The 'Great Flood' of 1763 inundated 237km² (23,700ha) to the south and west of Boston. This event resulted in a new vigour to drain and protect the land from flooding.

1765-1770

The Black Sluice Drainage Acts resulted in the construction of a new Black Sluice and an additional 21km of the South Forty Foot Drain and other works.

The Boston Port Act (1766), created the Boston Harbour Commissioners who undertook straightening and deepening of The Haven for improved navigation.



1800s

1810-1820

Extreme tidal events in 1810 and 1820 led to the raising of sea banks to 0.6m above the level attained by flood waters in the 1810 event.

At around the same time, the Boston Harbour Commissioners carried out further works to The Haven.

1846

The Black Sluice Commissioners constructed the third Black Sluice at Boston.

1858-1859

The Boston and Sleaford railway line was constructed, running along the North Bank of the South Forty Foot Drain from Boston to Swineshead.

1880

The River Witham Outfall Improvement Act enabled further works along the outfall of The Haven.



1900s

1935

The Black Sluice IDB was created under The Land Drainage Act (1930). At this time the catchment included 15 oil powered pumps lifting water into the South Forty Foot Drain.

1946

The first Black Sluice Pumping Station came into operation together with the widening of approximately 18km of the South Forty Foot Drain.

1953

Existing defences in Boston safeguarded the majority of the South Forty Foot Drain catchment from inundation during the 1953 major tidal surge.

© Richard

2000s

1950-1958

Between 1950 and 1958, the Black Sluice IDB constructed six electrical and one diesel pumping station to improve the drainage of approximately 44.5km² (4,450ha) of low-lying land.

1960-1968

A large programme of works was undertaken to bring the drainage of the area in line with modern agricultural requirements. The scheme involved the pumping of an additional 283km² (28,300ha) of land within South Forty Foot Drain and raising of banks along the highland drains.

1999

A breach occurred on the right bank of the South Forty Foot Drain, just downstream of the Black Hole Drove Pumping Station. The breach washed out 10m of bank and caused the localised flooding of agricultural land.

2008

Boston Combined Strategy aimed to determine a long-term approach to flood risk management and navigation improvements for the next 100 years.

2013

The Black Sluice Pumping Station was severely damaged by the tidal surge that caused significant flooding within Boston including approximately 800 properties. The 2013 tidal surge highlighted the urgent need for the strategy's main component, the Boston Barrier.

2018

A joint performance review of the Black Sluice Pumping Station indicated that using the gravity lock system was a more efficient way of managing water levels and so a joint decision was made to decommission the asset.

2020

Construction of the Boston Barrier completed by the Environment Agency.

2023/2024

The winter flooding across Lincolnshire and the East Midlands put tremendous pressure on assets, budgets and staff members of all RMA's in the catchment.

2025

In January 2025, the highest ever recorded levels were reached in the South Forty Foot Drain. Agricultural land was flooded, along with 38 properties in Boston, 13 in Billingborough and 2 in Pointon.

Managing flood risk

Across the South Forty Foot Drain catchment, flood risk is managed by multiple organisations.

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

Black Sluice IDB 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 of the relevant risk management authorities were involved.

Boston Borough Council, South Holland District Council, North Kesteven District Council and South Kesteven District Council have a responsibility to promote sustainable development in their role as the Local Planning Authority. They also 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 company within the South Forty Foot Drain catchment and has a role to manage 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 (FWMA) (2010). This national legislation was developed in response to the widespread flooding experienced across England in 2007. The Act re-established the roles and responsibilities of the RMAs related to flood risk. This Act is supported by local policies and plans that outline the management of local flood issues.

Local groups and partnerships

Under the FMWA (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 South Forty Foot Drain catchment 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.

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 within the South Forty Foot Drain catchment are outlined below.

Anglian River Basin District Flood Risk Management Plan 2021-2027

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

Joint Lincolnshire Flood Risk and Drainage Management Strategy 2019-2050

This provides a framework for flood risk management across Lincolnshire linking 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.

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 South Forty Foot Drain 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 depending on the potential loss of foreshore.

Witham Catchment Flood Management Plan (2009)

This plan guides the Environment Agency and its partners in planning and determining the most effective strategies for managing future flood risks. This report is largely superseded by the more recent River Basin Flood Risk Management Plan.

The Boston Combined Strategy (2008)

This plan seeks to reduce the risk of tidal flooding to the town over the next 100 years. This strategy included recommendations for the construction of Boston Barrier which was completed in 2020, and the raising of flood banks along The Haven.



The role of critical infrastructure

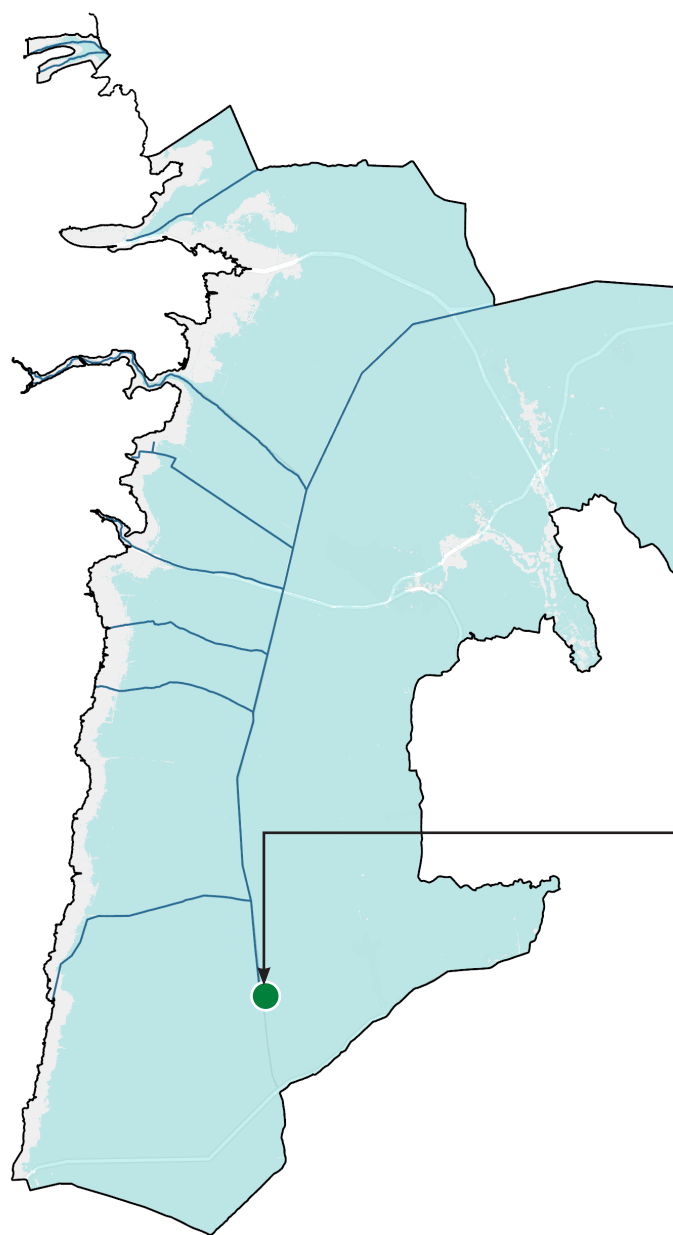
Only the continuous operation of flood risk assets can protect the low-lying areas of the catchment from severe and long-term flooding. Parts of the catchment are below sea level.

Before human intervention, much of the South Forty Foot Drain 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 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 topography is low lying and flat, with slightly elevated land extending along the far west of the catchment and near the communities of Swineshead, Bicker and Donington in the centre of the catchment. The lowest point of the South Forty Foot Drain catchment would be flooded to a depth of 4.3m in the MHWS tidal event. The topography makes it difficult for water to drain naturally from these lower-lying areas. Whenever flooding occurs, the lack of gradient allows floodwaters to spread over a large area.

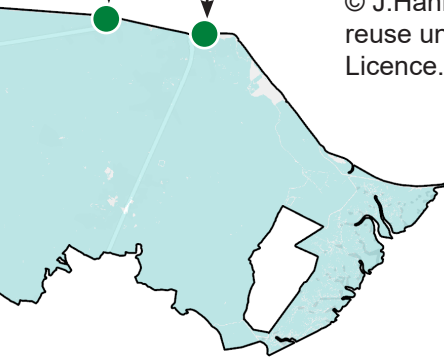




Chain Bridge Pumping Station
 © Alan Murray-Rust. Licensed for reuse under the Creative Commons Licence.





Black Sluice Pumping Station (now disused)
 © J.Hannan-Briggs. Licensed for reuse under the Creative Commons Licence.



Black Hole Drove Pumping Station
 © Alex McGregor. Licensed for reuse under the Creative Commons Licence.

Key

-  Main River
-  Areas below 3.9m AOD (MHWS)

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. In turn, the pumped system relies on other assets to prevent extra water entering the catchment which would have to be pumped out. Some of the most important are the embankments which contain the Main River system including the tidal reaches of The Haven.

Water management assets are monitored and adjusted all year round to maintain water levels and prevent permanent inundation. If these assets were not present, or if existing defences were allowed to deteriorate through age or lack of maintenance, extreme events would severely compromise drainage. This would result in inundation from surface water and fluvial sources, as well as the tidal inundation depicted on the map. This would lead to uninhabitable conditions over a short timeframe.

Extreme events

Even with current flood risk assets in place, tidal and fluvial flooding poses a significant risk to the South Forty Foot Drain catchment, as evidenced by flood events in 1999, 2013, 2023, 2024 and 2025. To date the South Forty Foot Drain has been the main source of fluvial flooding. For example, overtopping and seepage of the drain in January 2025 caused internal flooding to 34 residential properties in Wyberton, south-west of Boston.

Current flood risk

The South Forty Foot Drain catchment is at risk of flooding from the sea and from rivers. Areas of Boston have flooded three times since 2023.

Hydraulic modelling is used to understand the risk of flooding in an area. The hydraulic models used to assess flood risk are the 2010 Northern Area Tidal Model representing tidal events and the 2017 Black Sluice Catchment Model. The latter represents fluvial events on Main Rivers but not the IDB system. These models include existing flood defences at the time of model production, and assume that all assets are fully functional and maintained at their current Standard of Service. The models pre-date the Boston Barrier and The Haven bank raising completed in 2020. The flood map opposite is used to highlight areas of residual risk where flood events would exceed the protection offered by the defences. This might include the risk of overtopping. The models used herein do not include breaching (failure) of the embankments.

Tidal

The catchment is protected by significant tidal defences. The tidal flood risk for a 0.5% AEP event would impact approximately 2.2km² (224ha) of the total catchment area with existing defences in place. The whole affected area is Grade 1 agricultural land. This includes a significant proportion of Frampton Marsh RSPB Nature Reserve. No properties are predicted to flood during this event.

Fluvial

Model results show that with existing river defences in place, a proportion of the catchment, 41.7km² (4,169ha) is at risk of fluvial flooding during a 1% AEP event.

This includes 40.9km² (4,088ha) of Grade 1 and 2 agricultural land. Under a more extreme 0.1% AEP event, flooding will cover 19.9% of the catchment area. The present-day fluvial flood risk impacts large areas of high-grade agricultural land.

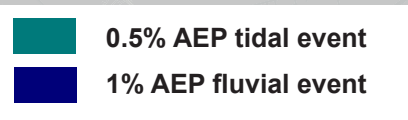
Other sources

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

Groundwater flooding. This occurs when the water table rises to meet the ground surface, it is not identified as a significant source of local flood risk. The catchment is underlain by sediments that do not support significant volumes of groundwater. The Strategic Flood Risk Assessment (SFRA) for South East Lincolnshire identifies no recorded incidents of groundwater flooding.

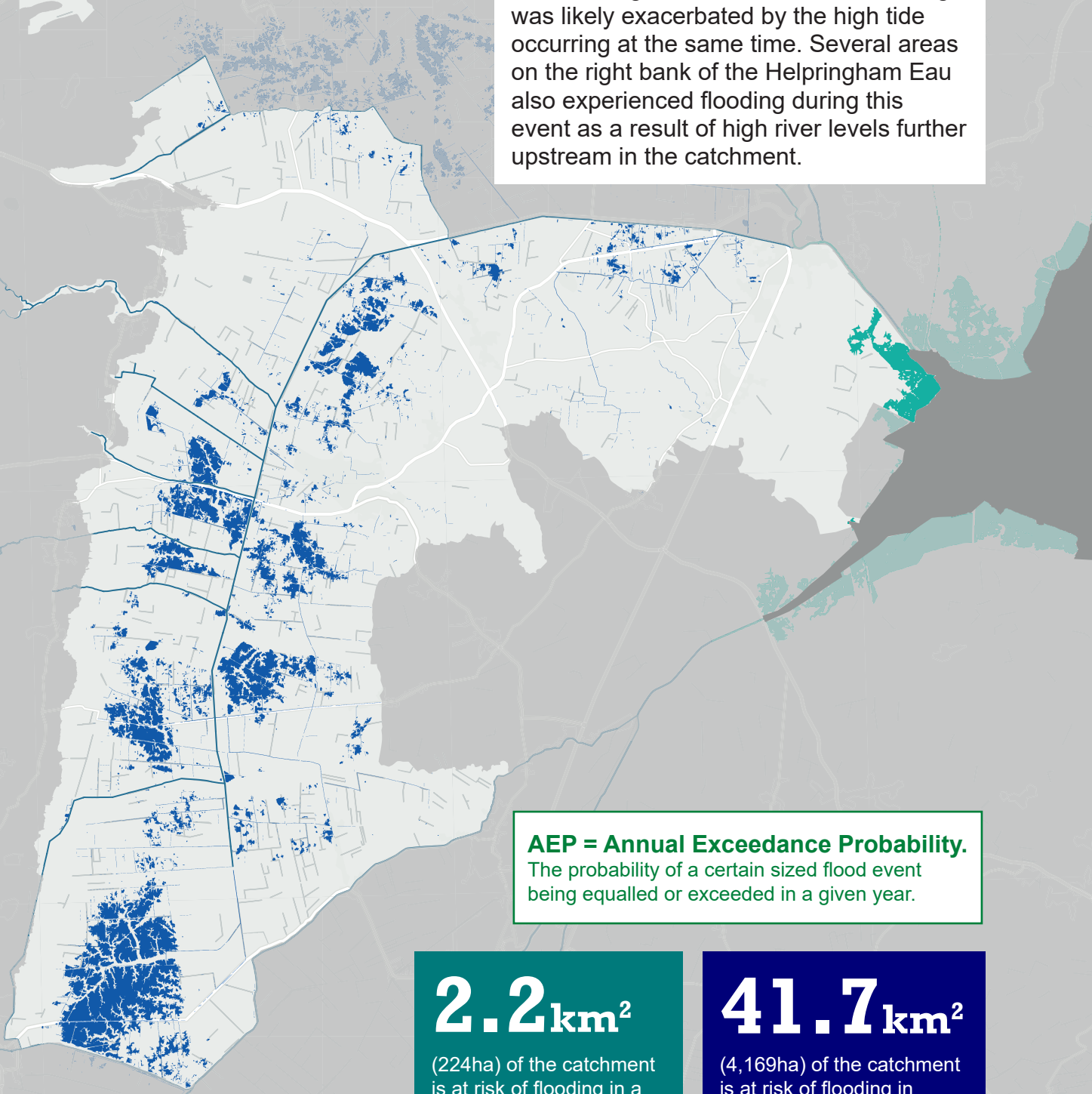
Surface water flooding. This describes when the volume and intensity of rainfall overwhelms local drainage systems. There are areas of surface water flood risk in a band along the western margin of the catchment villages at the foot of the South Lincolnshire Edge.

Reservoir flooding. This is rare and happens when a reservoir's impounding structure fails. Reservoir flood risk, based on the 'Risk of Flooding from Reservoirs' dataset is concentrated to the west of Donington, Bicker and Swineshead related to a reservoir to the west of Heckington and a series of reservoirs at Culverthorpe Park. The likelihood of reservoir flooding is considered to be very low due to the provisions of the Reservoirs Act (1975), so the overall risk remains low.



**Case study:
Embankment overtopping**

In January 2025, 34 residential properties were flooded in Boston due to overtopping and seepage of embankments of the South Forty Foot Drain. River levels were the highest ever recorded. Flooding was likely exacerbated by the high tide occurring at the same time. Several areas on the right bank of the Helpringham Eau also experienced flooding during this event as a result of high river levels further upstream in the catchment.



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

2.2km²
(224ha) of the catchment is at risk of flooding in a present-day 0.5% AEP tidal event including existing flood defences. The whole area affected is Grade 1 agricultural land.

41.7km²
(4,169ha) of the catchment is at risk of flooding in a present-day 1% AEP fluvial event including existing flood defences. This includes 40.9km² (4,088ha) of Grade 1 and 2 agricultural land.

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

Future flood risk

Tidal and fluvial flood risk will 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

It is expected that tidal flood risk will increase significantly over the next 100 years as sea levels rise in response to climate change. The 2010 Northern Area Tidal Model assumes that sea level will rise by 1.1m up to 2115. Under this scenario, approximately 17.2km² (1,718ha) of the catchment is at risk of inundation during the 0.5% AEP event. This represents a seven-fold increase, compared to existing conditions. This includes Frampton Marsh RSPB Nature Reserve and 16.4km² (1,635ha) of Grade 1 agricultural land. The flooding would be caused by the overtopping of embankments downstream of the Boston Barrier. Property flooding would be expected to affect the community of Wyberton, situated south-west of Boston.

Since the modelling was undertaken in 2010, sea level rise estimates have been revised upwards, and under the UK government's upper end allowance, sea level could rise by between 1.2m and 1.6m by 2125, meaning that flood risk could be even greater in the future.

There is a risk that higher sea levels will increase tide-locking at key outfalls. Tide-lock leading to overtopping or bank failure, means that water cannot be discharged from the river system during periods of high tide, causing it to back-up in the catchment and put increasing pressure on the river embankments.

Fluvial

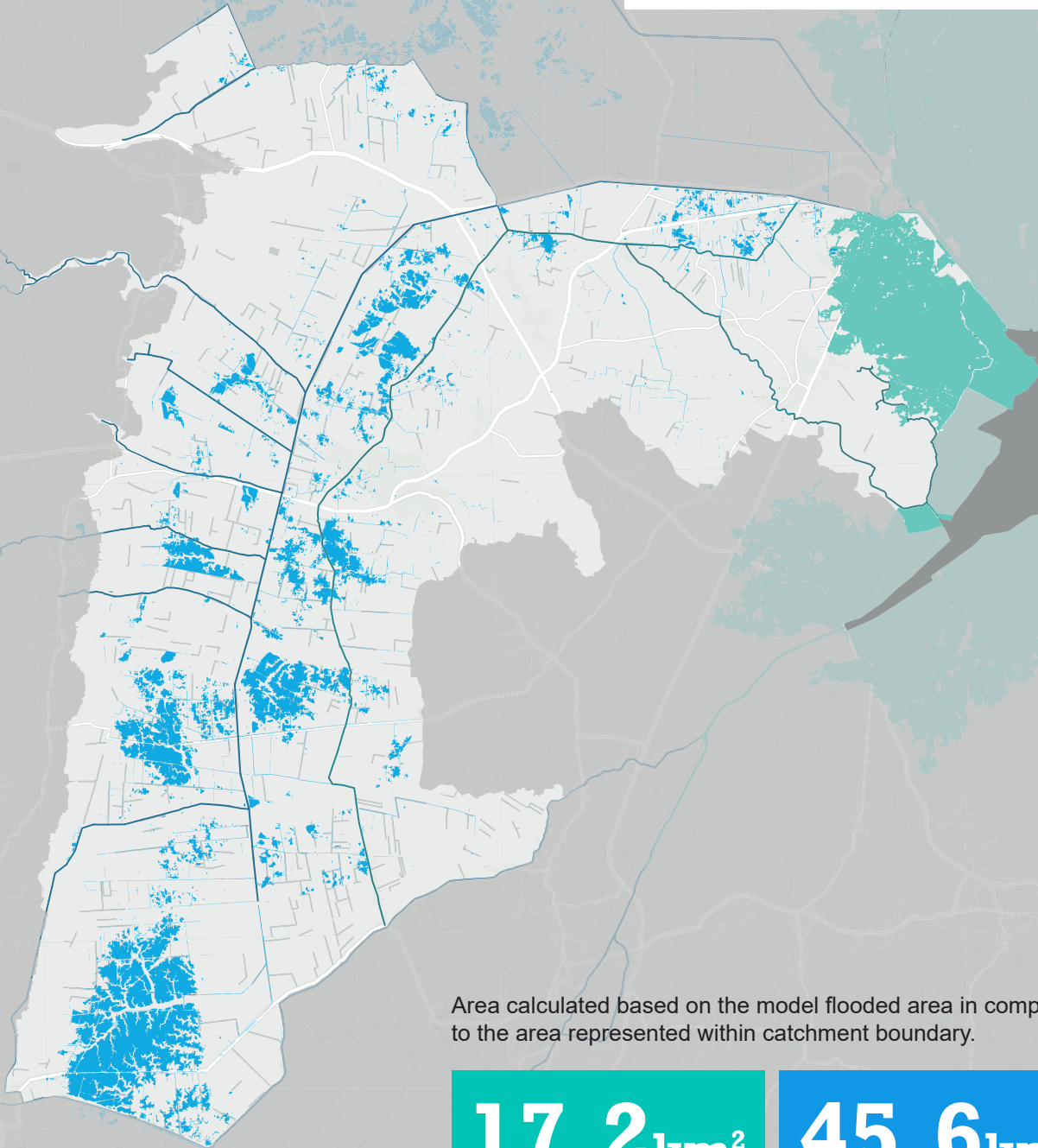
Modelling predicts a small increase in fluvial flooding when climate change predictions are applied to the 1% AEP event, with current flood defences still in place. This scenario assumes a 20% increase in river flows leading to 45.6km² (4,558ha) of the total catchment area being inundated. This includes 44.7km² (4,473ha) of Grade 1 and 2 agricultural land. This is a slight increase against current flood risk. Since modelling has been undertaken fluvial flow increases have not been revised significantly.

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.

0.5% AEP tidal event + climate change (1.1m of sea level rise up to 2115)

1% AEP fluvial event + climate change (20% increase in river flows by the 2080s)



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

17.2km²

(1,718ha) of the catchment is at risk of flooding under the 0.5% AEP tidal event with climate change allowance including existing flood defences. This includes 16.4km² (1,635ha) of Grade 1 agricultural land.

45.6km²

(4,558ha) of the catchment is at risk of flooding under the 1% AEP fluvial event with climate change allowance including existing flood defences. This includes 44.7km² (4,473ha) Grade 1 and 2 agricultural land.

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

Many pumping stations including those at Swineshead and Chain Bridge were constructed over a short period in the mid-1960s, so are affected by reliability and performance issues caused by their age.



Embankments are vulnerable

95% of the embankments in the catchment are over 125 years old and poorly constructed due to many being poorly constructed, with many being constructed without a clay core. They experience damage from animals and from toe erosion. There are known seepage issues which have caused localised flooding.



Channel risk

Sedimentation and weed growth has impaired the operation of Chain Bridge Pumping Station. The need for much larger machinery here to handle sediment and weed build up has been identified.



Pumping station challenges

Critical assets, such as Swineshead Pumping Station, are being called to operate at full capacity more often as the frequency and intensity of rainfall events increases. This is putting a strain on the pumps and the operational staff required to maintain them.

Black Sluice Pumping Station has been non-operational since three of the diesel pumps were damaged by the 2013 tidal surge. The asset is yet to be formally decommissioned. The cost of decommissioning was estimated as part of a consultation exercise undertaken in 2015, to be £2 million.



Investment needs

Embankment condition has been identified as a key vulnerability in the catchment, which requires capital investment.

Black Sluice IDB has planned investment for its pumping stations which are affected by reliability and performance issues caused by their age.

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 24% of assets, with 64% reported to be of 'Unknown' ownership and the remainder is owned by other RMAs.

Asset age profile

Approximately 95% of embankments within the catchment have a recorded asset age of over 125 years. Many key structures such as outfalls and bridges are at an age where their performance and reliability is reducing.

Asset condition profile

Approximately 24% of all active assets have a current condition score of 'Poor', 'Very Poor' or 'Unknown' in AIMS. Despite their age, 87% of the 337 embankment assets have a 'Fair' or 'Good' condition. The remainder are in 'Poor' or worse condition, with 40 embankments being 'Below Required Condition'. Wall assets have the worst relative condition profile of all asset types.



South Forty Foot Drain at Donington High Bridge
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Haconby Fen Pumping Station © J.Hannan-Briggs.
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Black Hole Drove Pumping Station. © J.Hannan-Briggs. Licensed for reuse under the Creative Commons Licence.



Swineshead Pumping Station © Arup 2024



Chain Bridge Pumping Station © Alan Murray-Rust. Licensed for reuse under the Creative Commons Licence.



Old Hammond Beck © J. Hannan-Briggs. Licensed for reuse under the Creative Commons Licence.

Operating challenges

Black Sluice Complex consists of a gravity-controlled sluice which operates alone during normal flows and a combined navigation lock and sluice which only operate during flooding periods. It also includes a disused pumping station which requires a formal, costly decommissioning.

Swineshead Pumping Station manages the most significant quantities of water in the catchment and has been described as being life expired by the IDB. The electric pumps are not variable which is not cost effective. If the pumps are in use for long periods of time, the circuits can break. Mitigation of this has been attempted by reducing heat build up but this hasn't solved the issue. The pumps are described as overworked by the IDB, the volume of water is increasing year on year and will continue to do so with rising water levels due to climate change. There is a risk the station could become inundated with water.

Chain Bridge Pumping Station has ongoing challenges surrounding weed build up, which could lead to flooding if it were to prevent the station from working during flood events. There is a weed grabber installed here, however it only operates when the pump is in use, which includes flood events or at pre-set times.

Parsons Drove Anglian Water Works sits on lower ground than the adjacent South Forty Foot Drain and doesn't incorporate any flood protection. This site has almost been inundated in the past. The risk of increased rainfall during periods when weed growth is high poses a vulnerability in the catchment. This site services approximately 100,000 people in Boston with clean water.

During storm events such as Storm Henk and Babet (2023/24), there was seepage and leakage through **embankments**, which are in poor condition. Flooding increases the probability of breaching or bank failure.

Current asset maintenance

Based on analysis of Environment Agency revenue programme dataset:

£145k was spent on embankment maintenance between 2022 and 2024, representing 65% of total maintenance expenditure.

£55k was spent on open channels between 2022 and 2024, and a further £8k on bridges.

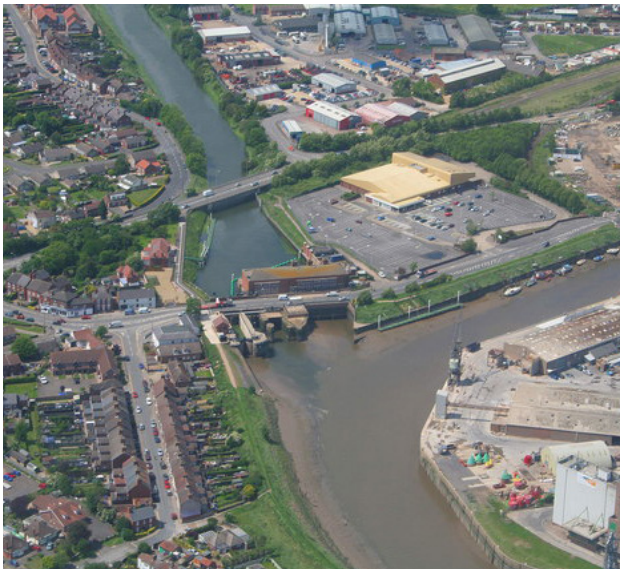
Black Sluice IDB maintenance expenditure

Maintenance expenditure has been generally consistent at around approximately £1.4 million between financial years 2017-2022, with dredging taking place every 10 years. Most of the pumping stations were constructed around the same time and are reaching the end of their foreseeable design life concurrently. Therefore, the annual reactive maintenance costs of these assets could be expected to rise with increasing defects.

Across all RMAs, substantial investment in capital and maintenance will be required. This will be to keep or improve the existing assets to a condition of 'Fair' or better, as well as new construction schemes to improve the area's resilience. The funding required will increase due to the vulnerability of flood risk assets to future climate hazards.



Grand Sluice and Lock © Bob Harvey. Licensed for reuse under the Creative Commons Licence.



Black Sluice Complex from above © Chris. Licensed for reuse under the Creative Commons Licence.



Dunsby Fen Pumping Station © Bob Harvey. Licensed for reuse under the Creative Commons Licence.

Environment

Mapping shows environmental features such as artificial watercourses. These are heavily modified and score poorly for ecological value, but are central to the catchment's character and heritage.

There are 21 Scheduled Monuments within the catchment including Swineshead Abbey.

Swineshead Abbey, founded in the early 1100s was a Cistercian monastery known for its wool export. Scheduled Monuments throughout the catchment reflect the agricultural and building practices specific to the Fens.

The network of dykes and embankments such as the South Forty Foot Drain, created to drain the fenland, is one of the most notable historic landscape features in the catchment.

This resulted in 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 'Black Sluice IDB draining to the South Forty Foot Drain' is classified as a modified water body under the Water Environment Regulations / Water Framework Directive.

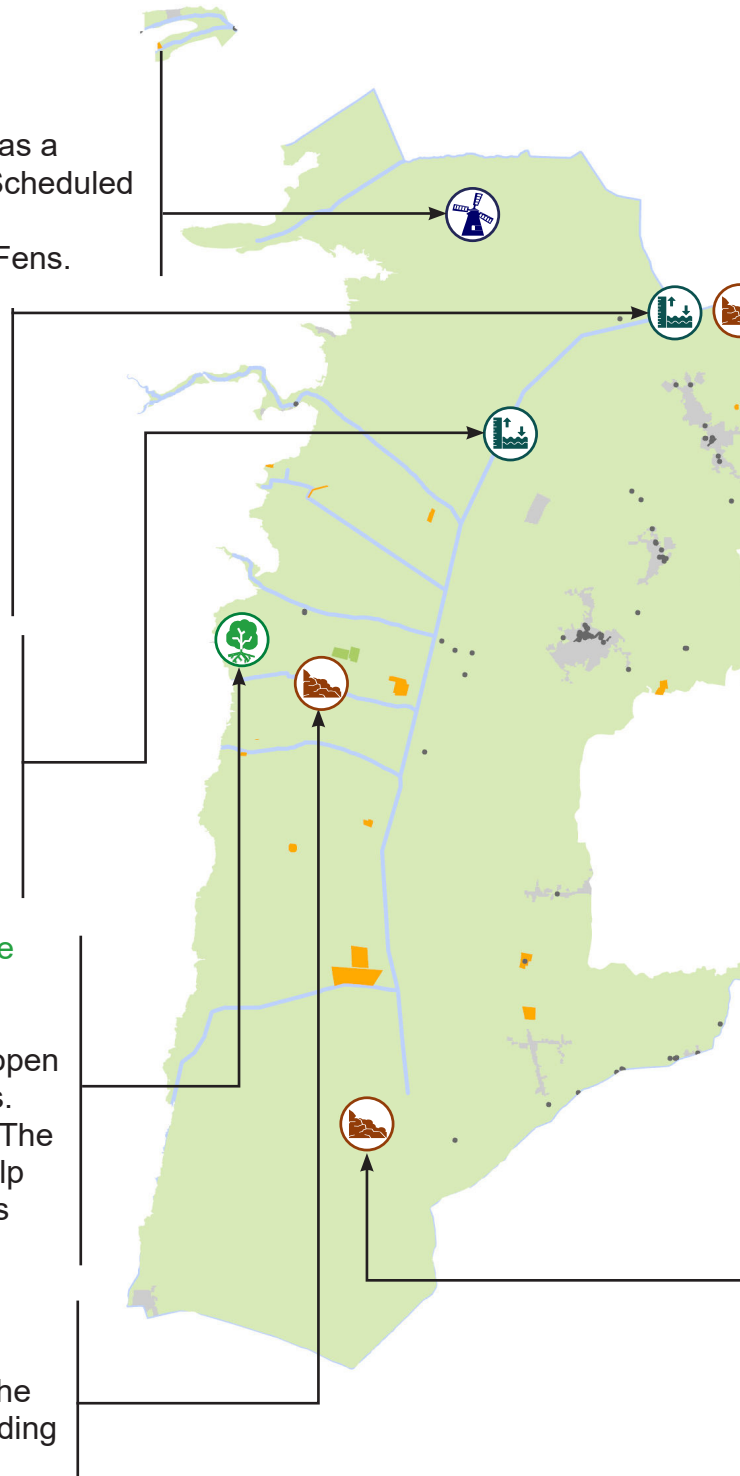
This waterbody is currently impacted by physical modifications associated with land drainage and pollution from waste water and rural areas.

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 include The Southern Cliff, The Fens and The Wash which help explain the relationship between heritage features and how the landscape has evolved over time.

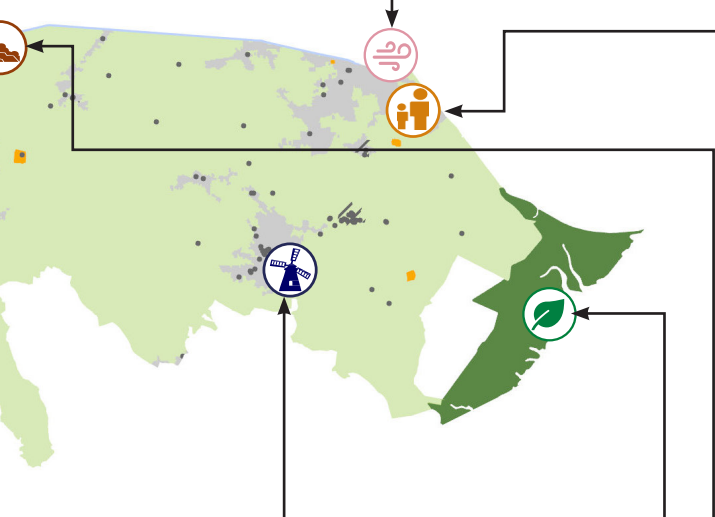
Horbling Fen is designated as a geological Site of Special Scientific Interest (SSSI).

The site contains sediments deposited between the end of the last Ice Age and the present day, providing records of sea inundation during this period.



Key

-  Air Quality
-  Biodiversity
-  Landscape
-  Population and Health
-  Water Environment
-  Heritage
-  Ground Conditions
- Listed Buildings
-  Scheduled Monuments
-  Internationally Designated Sites
-  Nationally Designated Sites



There are no Air Quality Management Areas (AQMAs) within the catchment.

The closest is Haven Bridge AQMA, located approximately 700m north-east of the catchment. The AQMA was declared in 2001 by Boston Borough Council due to exceedances of annual mean nitrogen dioxide.

Boston, a historic market town and inland port, is the largest settlement within the catchment.

The catchment is also home to several small settlements, including Kirton, Donington, Swineshead, Wyberton, Quadring and Gosberton.

Coastal communities within the catchment are amongst the most deprived areas in England.

The Lower layer Super Output Area (LSOA) Boston 007A, which includes Sutterton and Algakirk, is within the top 30% most deprived neighbourhoods nationally in terms of overall deprivation. This considers domains such as income, employment, education, health, crime, barriers to housing and services, and living environment.

Roddons (paleochannels), such as those documented in the South Forty Foot Drain, are an influential feature within the catchment.

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

The Wash is designated as a Special Protection Area, Ramsar site and SSSI.

It is a wetland of international significance, particularly for migrant wildfowl and wading birds, supports a shellfish fishery and is home to the largest breeding colony of the common seal in Europe.

There are six statutory designated nature conservation sites within the catchment, some overlap entirely or partially with other designations.

There are eight Conservation Areas in the catchment including two within the town of Kirton.

Conservation Areas possess special architectural or historic interest. The settlement of Kirton has existed since the year 850.

Peaty soils cover 8.7% of the catchment area.

They are concentrated in a band running parallel to, and west of, the South Forty Foot Drain.

Agriculture

The South Forty Foot catchment is an area of national agricultural importance with 96% of the land classified as Grade 1 or 2.

Soilscape

The majority of the catchment contains loamy and clayey soils of coastal flats with naturally high groundwater supporting different cropping regimes. Along the western boundary, soils are generally less productive due to 'impeded drainage'.

Small areas towards Bourne, in the south of the catchment, are identified as peat, however it should be noted that any remaining peat is likely degraded to 'wasted' peat soils.

Agricultural Land Classification (ALC)

Approximately 96% of land in the catchment is classified as Grade 1 and 2. Grade 1 land is predominately located to the east of the catchment. This is high-yielding land with little or no limitations for agricultural use.

Water availability

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

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 can provide an irrigation source during low flows.

Value of agriculture in the catchment

Land use within the catchment is primarily agricultural, focused on the production of cereals and vegetables. There are smaller areas of grassland surrounding settlement and across smaller land parcels supporting grazing livestock such as sheep or cattle. Some farms have also invested in controlled environment agriculture enterprises and greenhouse cropping techniques.

The whole agri-food chain employs people at different stages of food production, from agriculture to food processing and packing and retail. The estimated overall economic output of farm crop and livestock within the catchment is in the region of £120.4 million annually (in 2023 values).

	Area (km ²)	Area (ha)	Percentage of farmed land (%)	Estimated annual value* (£)
Cereals	144.5	14450	49.1%	£20.8 million
Arable crops (excluding cereals)	67.7	6770	23%	£15.8 million
Grassland	30.1	3010	10.2%	Grassland does not directly create economic value, but instead supports the grazing of sheep and cattle, or the production of livestock feed.
Fruit and vegetables	28.3	2830	9.6%	£54.2 million

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

Environmental stewardship

Approximately 54% of the catchment area is managed under government funded stewardship agreements, particularly in the west and north-east of the catchment. These agreements, such as the Countryside Stewardship scheme or the historic Entry Level Stewardship scheme, are designed to financially support farmers and other land managers to enhance the natural environment.

Climate change

Climate change will increase the risks of fluvial and coastal flooding, as well as drought. Flood events can restrict the ability to establish new crops, reduce crop yields and quality, or destroy crops once ready for harvest. This leads to direct agricultural damages and wider economic consequences for landowners. The rural location of the catchment means disproportionate impacts may be felt within the local supply chain.

Examples of agricultural stakeholders and businesses

There are a number of large farming businesses based in the north of the catchment, aligned with the areas of Grade 1 agricultural land. Key produce in this area includes wheat, barley, peas, sugar beet, potatoes and berries.

The catchment is home to holiday parks and tourist accommodation sites, including a mix of caravan, camping, holiday let cottage and hotel accommodation. For example, Westwood Lakes, in the outskirts of Boston, offers fishing holidays.

There are a number of small and medium food supply chain businesses which are located within the catchment. For example, one company in Boston is one of the UK's leading processing sites for frozen peas.

In common with other areas across the Fens, farmers and landowners are diversifying to invest in renewable energy projects. There are several solar parks in operation, including two at Kirton and one in Bourne. There are also active development proposals, including another solar farm in Bourne.

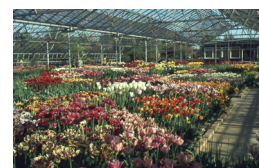


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Agri-tech and innovative farming methods are being used across the catchment. A range of trial greenhouses in Kirton are being used by controlled environment producers.



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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 of 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 society and the natural world.

Natural capital in the South Forty Foot Drain catchment has an annual value of

£45 million

Climate regulation

In some cases, degradation of natural habitats can compromise the benefits that they would otherwise provide. For example, peaty soils in healthy condition can continue to form peat and therefore sequester carbon, but when degraded they start to release carbon back to the atmosphere.

Enclosed farmland, woodland and saltmarsh within the catchment sequesters a total of 8,664 tonnes of CO₂ equivalent per year. However, this is outweighed by the 15,099 tonnes of CO₂ emitted by the degraded peatland in the catchment, making the land a net source of carbon emissions. The impact of climate change driven by this process gives a negative value (or cost) for climate regulation.*

Overall, the net release of CO₂ equivalent across the catchment has an annual cost of

£1.9 million

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



£5.8 million Recreation

The welfare value of approximately 1.44 million visits by adults each year to publicly accessible green spaces within the catchment. The welfare value of a further 366,000 visits made by children each year cannot be quantified but is likely to be significant.



£1.4 million Physical health

£1.39 million in healthcare treatment costs can be avoided every year due to improved physical health through approximately 740,000 active visits to publicly accessible green spaces in the catchment. Active visits involve at least 30 minutes of exercise.



£30.5 million Agriculture

The 317km² (31,700ha) of enclosed farmland in the catchment provide 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 £30.5 million.



£0.5 million Air Quality

The removal of approximately 1,800 tonnes of air pollutants by vegetation in the catchment avoids the costs of damages to health. This has an annual value of £488,000 per year.



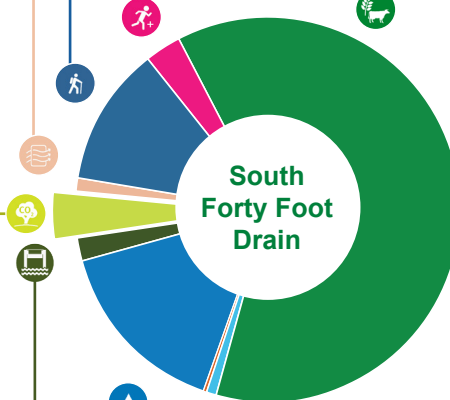
£0.0 million Hazard regulation

The assessment does not provide a monetary value for this benefit. However, in the catchment an estimated 30,400m³ of floodwater is temporarily stored in areas of woodland.



£-1.9 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, 6,435 tonnes of CO₂ equivalent are released, costing approximately £1.9 million per year through the detrimental effects of climate change.



£0.2 million Water quality

The Kirton Marsh Drain is the only river waterbody within the catchment with 'Good' water quality. Based on a willingness-to-pay approach, the 2.7km of this watercourse within the catchment is worth approximately £233,000, as an alternative to having poorer water quality.



£0.9 million Renewable energy

An estimated 62,900MWh of renewable energy, predominantly from wind and solar, is generated each year within the catchment. This has an annual value of approximately £877,000.



£7.6 million Water supply

The annual value of approximately 2.6 million m³ of water which is abstracted from the catchment each year, for public water supply and other uses such as irrigation.



£0.03 million Timber

National data can be applied to the South Forty Foot Drain catchment to estimate a yearly timber production volume of 796m³, which is valued at approximately £26,800 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 nationally available Risk of Flooding from Multiple Sources (RoFMS) dataset.

£5 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 maintenance of existing flood defences and pumping.

Sluices on Main Rivers would no longer operate increasing the risk as water backs up behind the sluices. Without pumped outfalls to the Main Rivers and The Wash, water would be unable to drain from the land. The South Forty Foot Drain catchment is assumed to be frequently or permanently inundated to the water levels defined by the limiting level. The limiting level is the rate at which the inundation is achieved based on the rainfall estimates for the whole of the Fens catchment. In this scenario, the area would essentially act as a basin, filling with rainfall up to the limiting level.

Whilst there would be some loss of water over summer due to evaporation and transpiration, the water levels would be expected to rise steadily over a few years, filling the catchment.

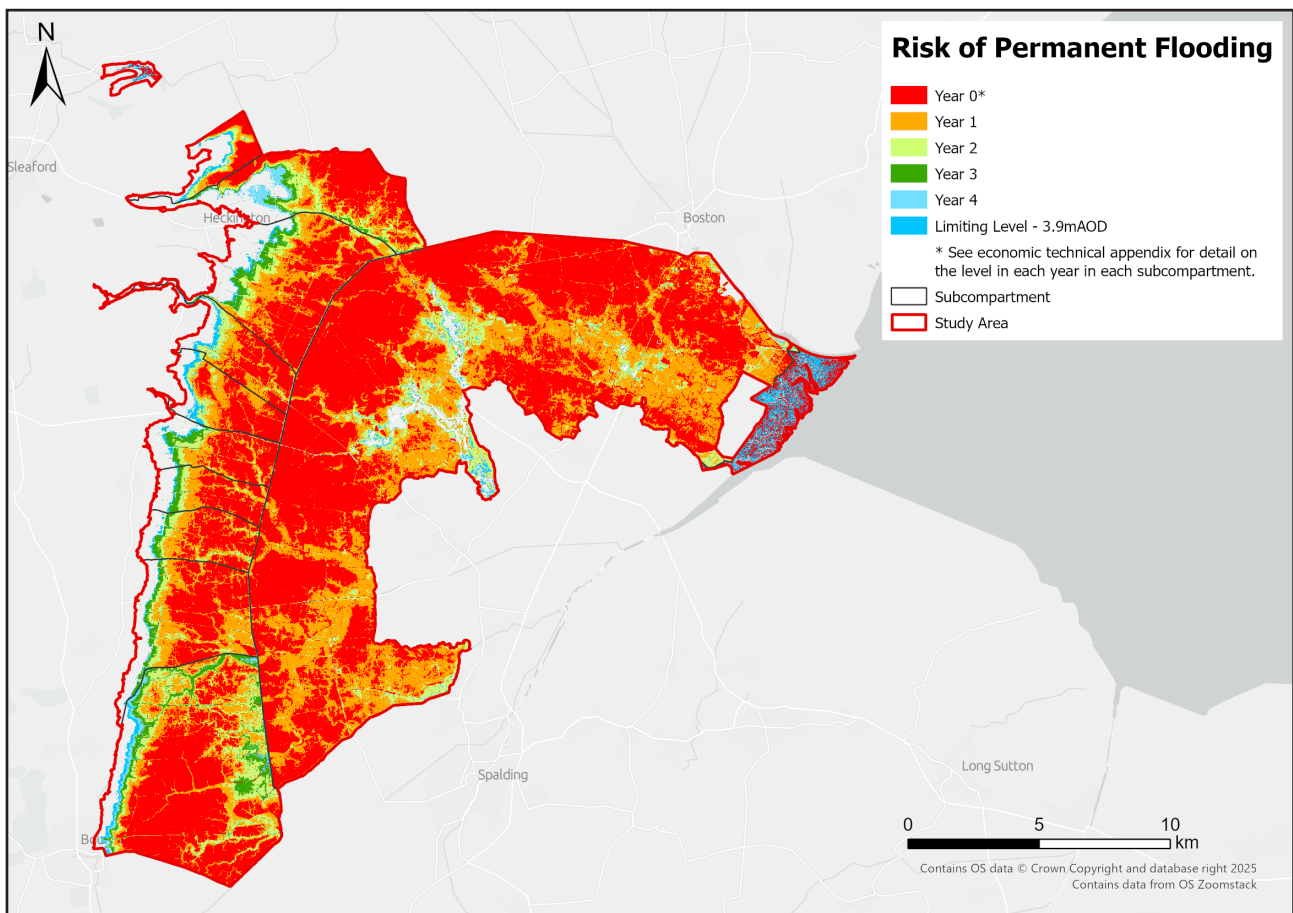
To represent this, it is assumed that each of the areas would fill by 0.5m per year up to the limiting level of 3.9m AOD. The limiting level is likely to be reached within 5-10 years. The resulting damages are used to determine the economic losses over the next 100 years, if all flood risk management 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 £5.3 billion of economic damages in a 'Do Nothing' scenario, compared to only £285.6 million of economic damages in a 'Maintain' scenario. As such, the economic benefits of current flood risk management activities are valued at £5 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 £5.3 billion, with £5.1 billion of this in the first ten years.

£818 million

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.

288.9 km² (28,891ha)
of agricultural land written off in the 'Do Nothing' scenario, costing **£818 million**

£3.1 billion

Properties

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

11,023

residential properties written off in the 'Do Nothing' scenario, costing **£2.4 billion**

1,865

non-residential properties written off in the 'Do Nothing' scenario, costing **£695 million**

£234.6 million

Environment and recreation

Loss of 6.7km² (665.3ha) 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 0.9km² (85.7ha) of recreational sites and 133.5km of Public Rights of Way.

£31 million

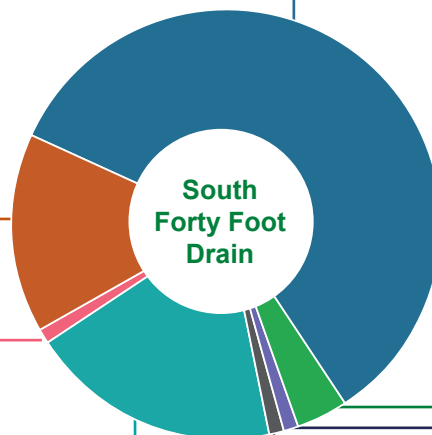
Heritage

Loss of heritage sites as a result of flooding. The catchment contains 148 Listed Buildings and 21 Scheduled Monuments.

£65 million

Utilities

Captures the impacts of flooding to power, water supply, and gas networks. This includes damage to 688 substations, 3,435 pole towers and 360km of power cables.



£5.1 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 17,687 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.

£1 billion

Transport

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

Loss of **34km**

of road infrastructure, costing **£942.1 million**

Loss of **14km**

of rail infrastructure, costing **£83.6 million**

£41 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.

South Forty Foot Drain	Do Nothing Damages	Maintain Damages	Maintain Benefits
Damages to properties and associated indirect damages	£3.1 billion	£259 million	£2.8 billion
Agricultural losses	£818 million	£22 million	£797 million
Environment and recreational losses	£234.6 million	£56,000	£234.5 million
Heritage losses	£31 million	£361,000	£31 million
Transport damages	£1 billion	-	£1 billion
Utilities damages	£65 million	£5 million	£60 million
Land lost due to isolation	£41 million	-	£41 million
TOTAL Excluding losses to the local economy	£5.3 billion	£286 million	£5 billion
Losses to the local economy	£5.1 billion	£1.7 million	£5.1 billion

£5 billion

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

Total investment needed:

£440-£710 million

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 South Forty Foot Drain 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.

