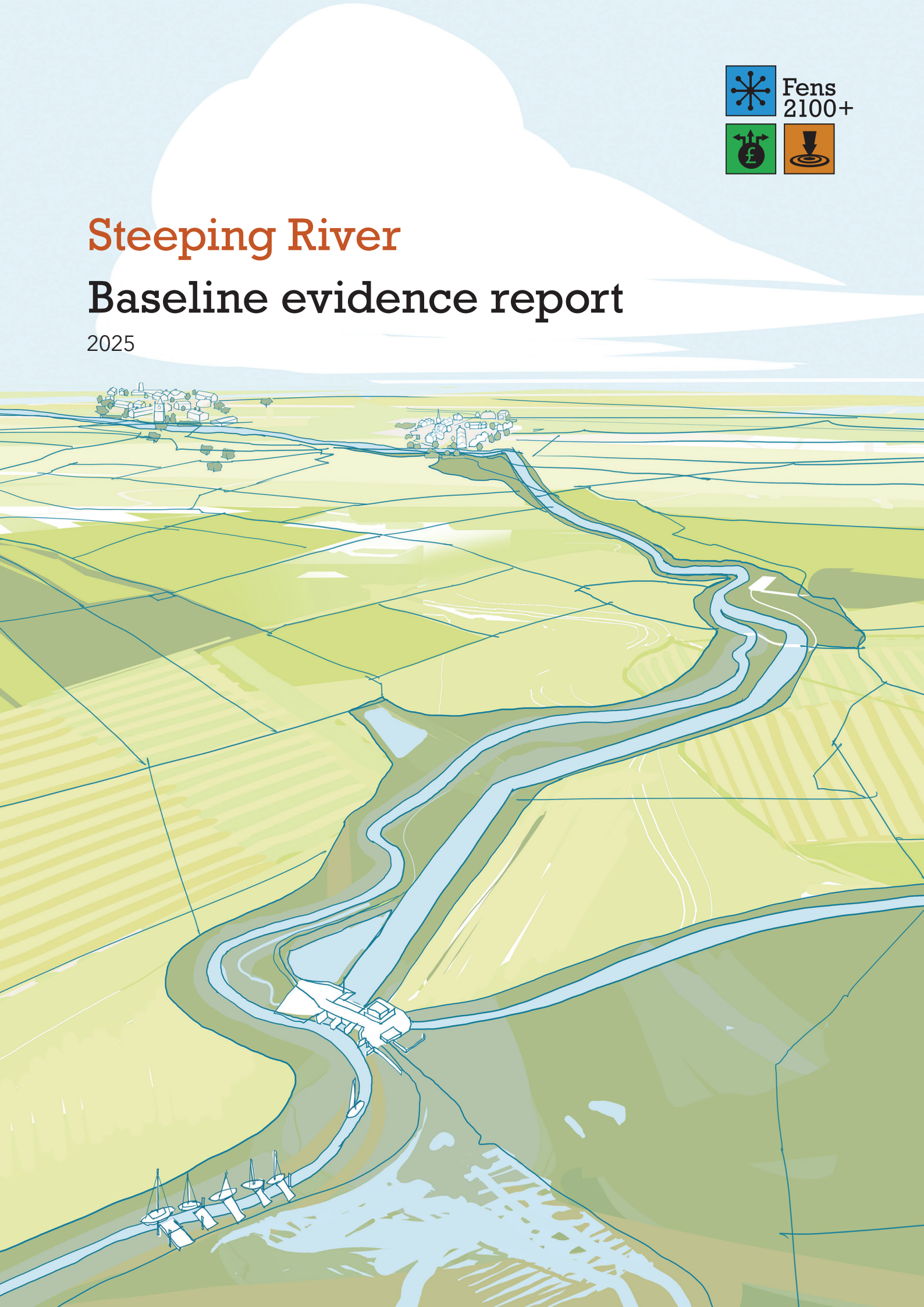
Fens 2100+

Steeping River

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 Steeping River 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.

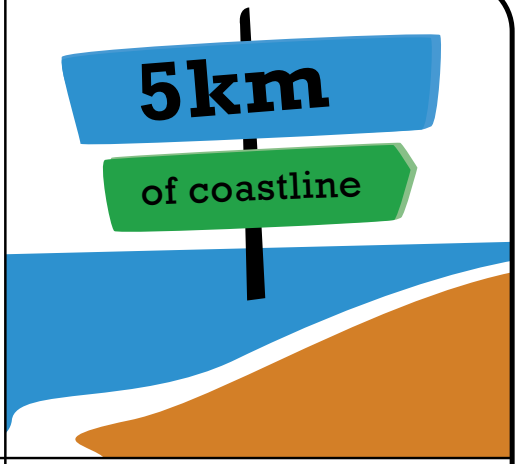
Yet, many of the 17,000 flood risk management assets that sustain the region are being affected by reliability and performance issues caused by their age. Many were built in the post-war period, with some dating back to the 1600s.

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

The Steeping River

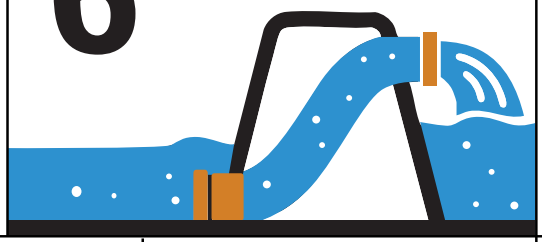
Total catchment area
63km²

56%
of land classified as Grade 1 & 2 agricultural land



Estimated total population
3,289

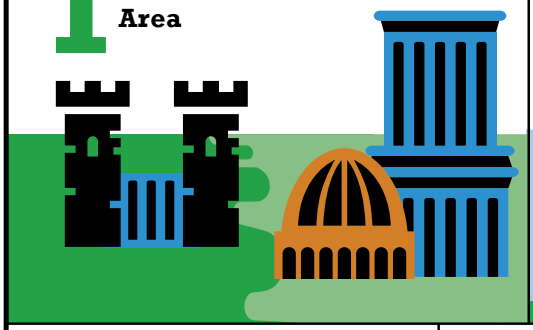
6 pumping stations



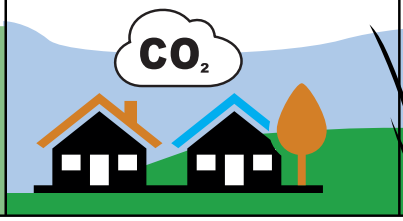
1 Internal Drainage Board

4 Scheduled Monuments

1 Conservation Area



1,900
tonnes of CO_2 equivalent emitted by degraded peatland in the catchment each year

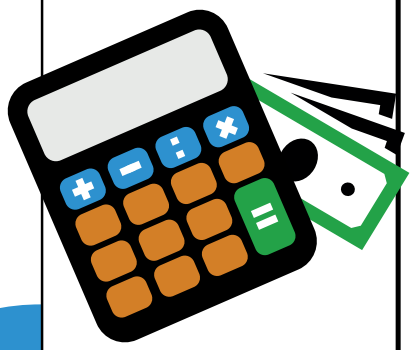


11 designated sites for nature conservation

£11.7 million
total annual value from natural capital

68% Environment Agency maintenance expenditure spent on embankments

total length of embankments managed by the Environment Agency **44km**



£546.6m
economic benefits of current flood defences

Introduction

The evidence is clear: without urgent investment to maintain and upgrade flood risk assets across the Steeping River catchment, £555 million of damages could be sustained to land, homes and livelihoods.

A landscape worth protecting

Covering 63km^2 (6,300ha) of eastern Lincolnshire, the Steeping River catchment supports a healthy agricultural economy that provides over 150 local jobs and contributes £10 million a year to the UK economy.

There are 11 designated nature conservation sites, including Gibraltar Point National Nature Reserve (NNR), an internationally important coastal reserve for wading and migratory birds, with notable breeding colonies of plovers and terns.

Natural capital delivers £11.7 million of benefits a year, including food production, flood risk management, carbon sequestration, clean water and recreation.

What's the challenge?

Continuous land drainage and flood defences are all that protect low-lying areas from permanent inundation. 48km^2 (4,800ha) of agricultural land and 1,284 homes are at risk. Yet, 25% of flood risk assets are being affected by reliability and performance issues caused by their age.

Approximately 25% of assets are rated 'Poor', 'Very Poor' or 'Unknown', including critical structures such as outfalls. This complex system of assets requires significant resources and collaboration between RMAs.

Repeated flooding events highlight the catchment's vulnerability, including the Wainfleet Relief Channel breach in 2019 and fluvial flooding in 2023, 2024 and 2025. Climate change will intensify this risk, even if current defences are maintained.

What's needed?

£160-£250 million of investment

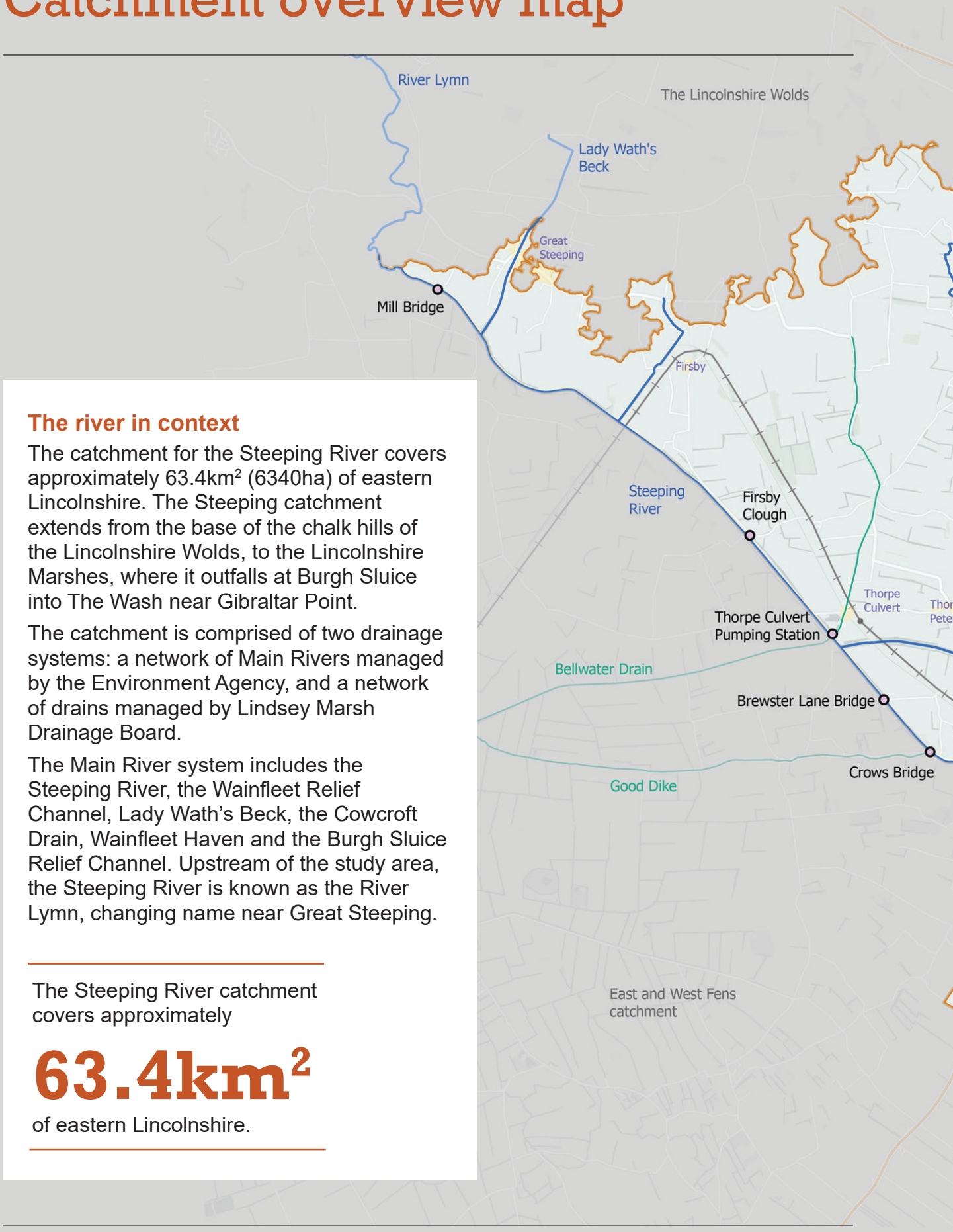
to sustain the current Standard of Service for 100 years

To maintain

£546.6 million of benefits

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

Catchment overview map



The river in context

The catchment for the Steeping River covers approximately 63.4km^2 (6340ha) of eastern Lincolnshire. The Steeping catchment extends from the base of the chalk hills of the Lincolnshire Wolds, to the Lincolnshire Marshes, where it outfalls at Burgh Sluice into The Wash near Gibraltar Point.

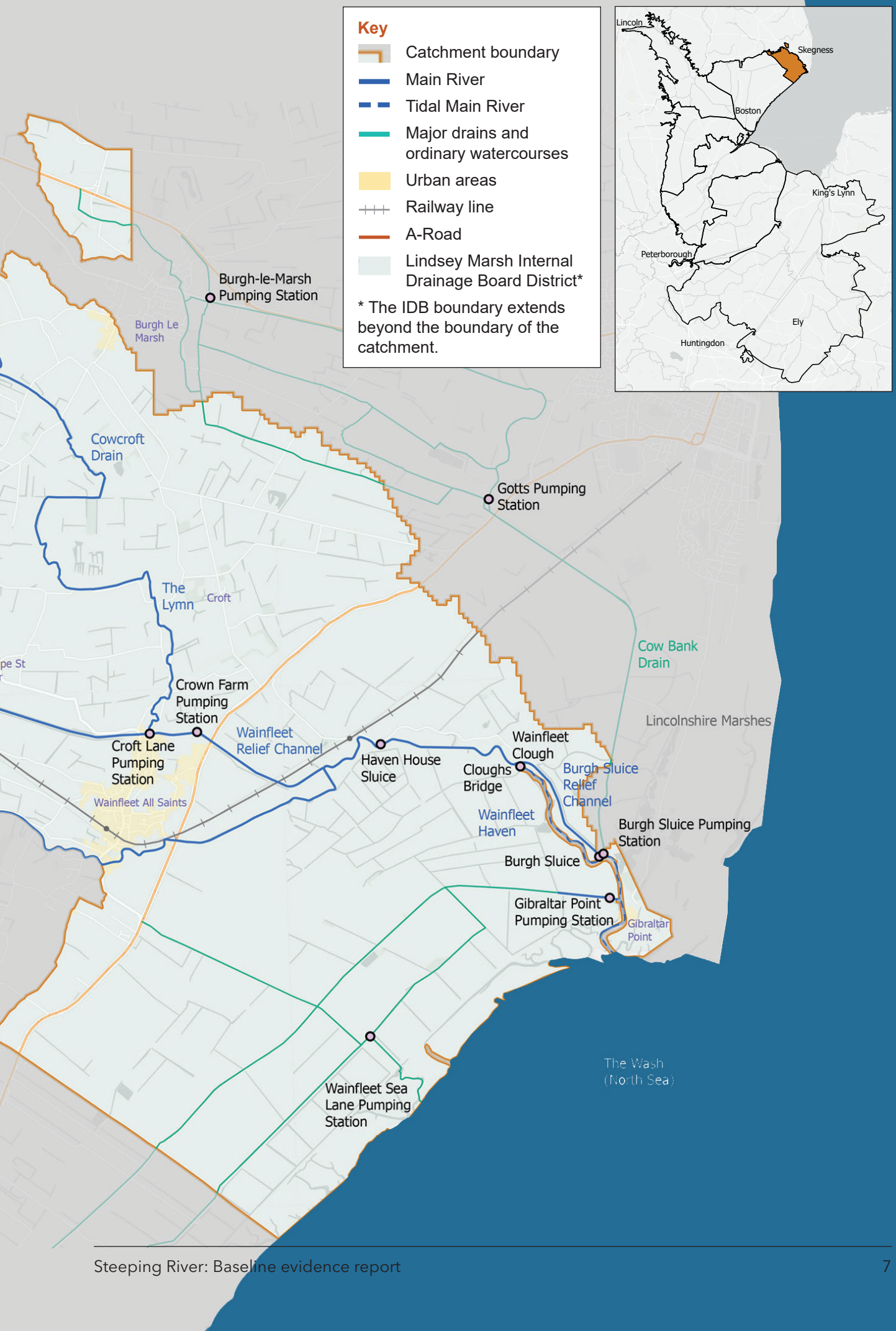
The catchment is comprised of two drainage systems: a network of Main Rivers managed by the Environment Agency, and a network of drains managed by Lindsey Marsh Drainage Board.

The Main River system includes the Steeping River, the Wainfleet Relief Channel, Lady Wath's Beck, the Cowcroft Drain, Wainfleet Haven and the Burgh Sluice Relief Channel. Upstream of the study area, the Steeping River is known as the River Lymn, changing name near Great Steeping.

The Steeping River catchment covers approximately

63.4km^2

of eastern Lincolnshire.


Key
Catchment boundary
Main River
Tidal Main River
Major drains and ordinary watercourses
Urban areas
Railway line
A-Road
Lindsey Marsh Internal Drainage Board District*
* The IDB boundary extends beyond the boundary of the catchment.
Lincoln
Skegness
Boston
King's Lynn
Peterborough
Ely
Huntingdon
Burgh-le-Marsh Pumping Station
Burgh Le Marsh
Cowcroft Drain
Gotts Pumping Station
The Lymn
Croft
Cow Bank Drain
Crown Farm Pumping Station
Croft Lane Pumping Station
Wainfleet All Saints
Wainfleet Relief Channel
Haven House Sluice
Wainfleet Clough
Cloughs Bridge
Burgh Sluice Relief Channel
Lincolnshire Marshes
Wainfleet Haven
Burgh Sluice Pumping Station
Burgh Sluice
Gibraltar Point Pumping Station
Gibraltar Point
Wainfleet Sea Lane Pumping Station
The Wash (North Sea)

Catchment overview

Much of the Steeping River has been straightened, with high flood embankments containing the channel.

In the vicinity of Thorpe Culvert, the Wainfleet Relief Channel diverts water to the north of Wainfleet All Saints, while the Steeping River continues to flow to the south of the town. From the north, Cowcroft Drain joins The Lymn (a remnant of the original River Lymn's course) and flows into Wainfleet Relief Channel at Croft Lane Pumping Station.

The Steeping River and the Wainfleet Relief Channel eventually reconnect downstream of Wainfleet All Saints near Haven House Sluice. The sluice manages water resources within the catchment, particularly in the summer months for third party abstractions.

Approximately 2.5km further downstream of the Haven House Sluice, the Steeping River splits into Burgh Sluice Relief Channel and a tidal channel known as Wainfleet Haven. Flow into the tidal channel is controlled by Wainfleet Clough, the outfall sluice. This structure is prone to tide locking and silt blockage. Burgh Sluice Relief Channel and Burgh Sluice were constructed in 1972 to help address the issues at Wainfleet Clough and now form the main outfall into The Wash.

The Lindsey Marsh Drainage Board system contains a network of low lying drains across five drainage catchments, drained by seven pumping stations. These drainage catchments outfall into the Steeping River at Burgh Sluice Pumping Station, Thorpe Culvert Pumping Station, Crown Farm Pumping Station and Gibraltar Point Pumping Station, while Wainfleet Sea Lane Pumping Station outfalls straight into The Wash.

The Burgh Sluice catchment is pumped up to Burgh Sluice Pumping Station by intermediate pumps at Burgh Le Marsh and Gotts Lane. However, these two pumping stations are outside of the study area.

The majority of the catchment lies just above sea level at approximately 3m Above Ordnance Datum (AOD), with land rising towards the north-west near the Lincolnshire Wolds. The catchment contains productive agricultural land with approximately 37% of the area classified as highly productive Grade 1 agricultural land.

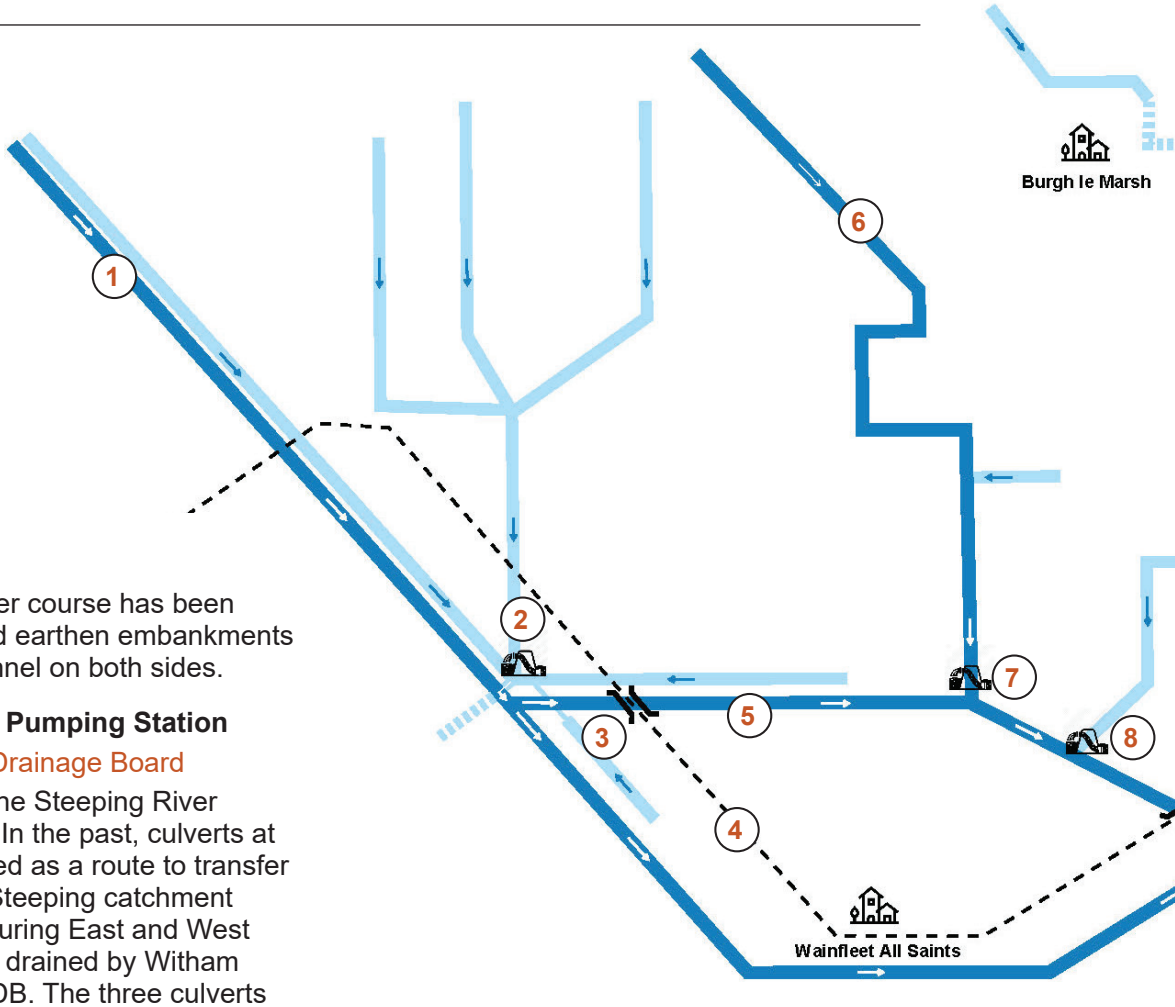
The landscape of the catchment includes small settlements and the historic market town of Wainfleet All Saints. The catchment has an estimated total population of 3,289.

Connectivity within the catchment is facilitated by two main roads, the A52 and A158, as well as local railway links with stations at Thorpe Culvert, Wainfleet and Skegness.

The settlements of Wainfleet All Saints, Thorpe Culvert, Thorpe St Peter, and Great Steeping have all been affected by flooding. Sustainably managing flood risk within these areas is crucial to maintaining agricultural productivity and ensuring long-term resilience in the face of climate change.

Downstream of Burgh Sluice, looking east towards Gibraltar Point and the coast.

Flood management system



1 **Steeping River**

Main River

Much of the lower course has been straightened and earthen embankments contain the channel on both sides.

2 **Thorpe Culvert Pumping Station**

Lindsey Marsh Drainage Board

Lifts water into the Steeping River through pumps. In the past, culverts at this location acted as a route to transfer water from the Steeping catchment into the neighbouring East and West Fens catchment drained by Witham Fourth District IDB. The three culverts carried water beneath the river channel. There is no longer a formal connection between the two catchments, and all water is now pumped into the Steeping River at Thorpe Culvert.

3 **Thorpe Culvert Syphons**

Lindsey Marsh Drainage Board

Syphons beneath the Wainfleet Relief Channel allow lowland water to flow northwards to be pumped into the Steeping River at Thorpe Culvert.

4 **Boston to Skegness Railway Line**

East Midlands Railway

There are multiple crossing points where the Wainfleet Relief Channel is conveyed beneath road and railway bridges via inverted syphons, including under the Boston to Skegness Railway Line. These locations represent low points where the river overspills during extreme flood events.

5 **Wainfleet Relief Channel**

Main River

Diverts part of the flow of the Steeping River away from the town of Wainfleet All Saints. Earthen embankments contain the channel on both sides.

6 **Cowcroft Drain**

Main River

Carries water from the northern catchment to Croft Lane Pumping Station.

7 **Croft Lane Pumping Station**

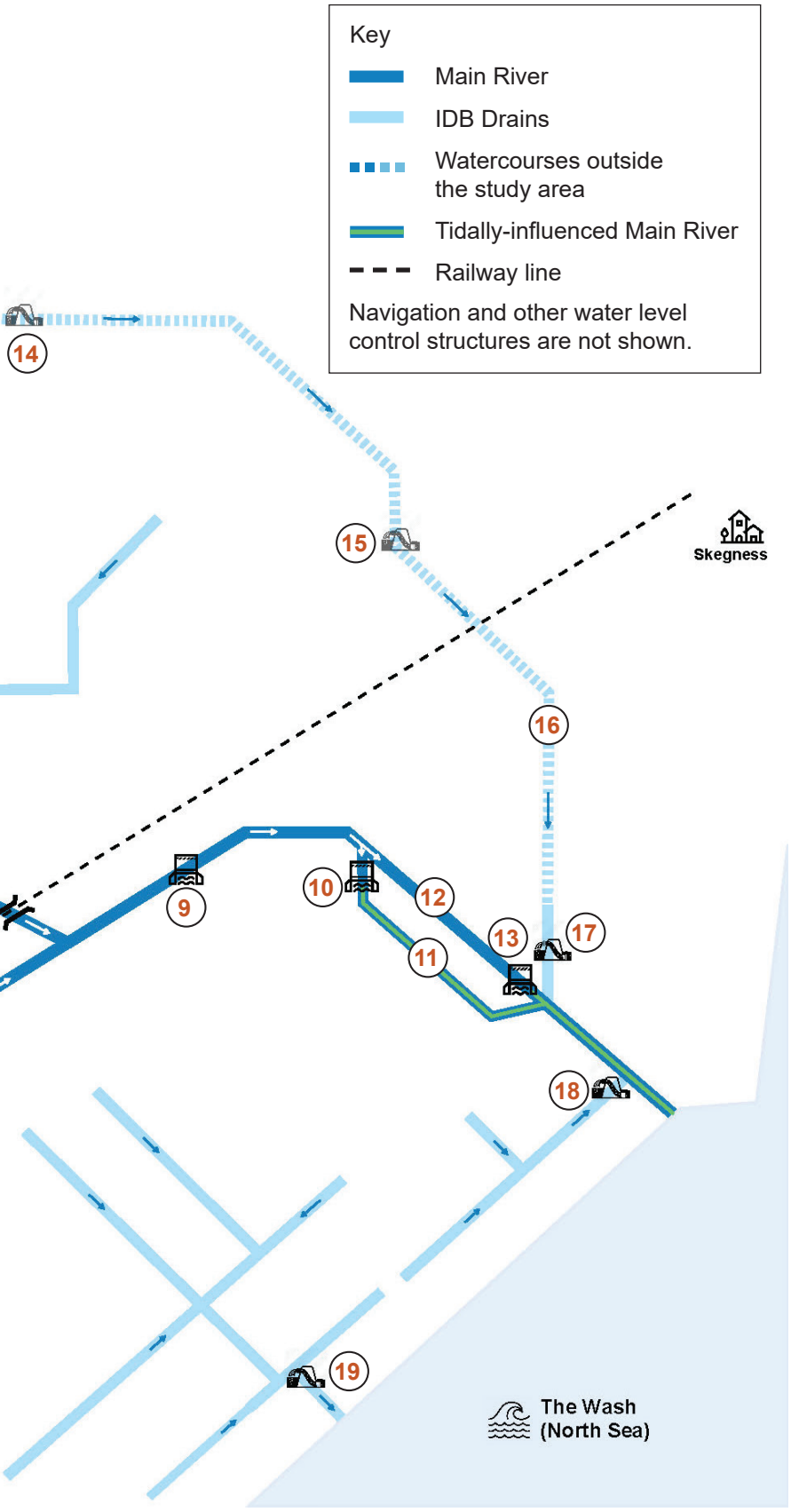
Environment Agency

Pumps water from the Cowcroft Drain into the Wainfleet Relief Channel.

8 **Crown Farm Pumping Station**

Lindsey Marsh Drainage Board

Pumps water into the Wainfleet Relief Channel.



9 Haven House Sluice
Environment Agency
Manages water levels upstream. The water level set in summer enables local abstractors to comply with their abstraction licences.

10 Wainfleet Clough
Environment Agency
The original structure which controlled flow into Wainfleet Haven. Most flow now passes through Burgh Sluice Relief Channel.

11 Wainfleet Haven
Main River
The tidal reach of the Steeping River.

12 Burgh Sluice Relief Channel
Main River
A straightened channel which conveys the majority of the Steeping River's flow in its lower reach, outfalling at Burgh Sluice.

13 Burgh Sluice
Environment Agency
The main outfall of the Steeping River, located on the Burgh Sluice Relief Channel. Pointing doors also prevent ingress of the tide into the relief channel.

14 Burgh le Marsh Pumping Station
Lindsey Marsh Drainage Board
Pumps water away from the village of Burgh le Marsh.

15 Gotts Pumping Station
Lindsey Marsh Drainage Board
Lifts water from the Main Drain into Cow Bank Drain.

16 Cow Bank Drain
Lindsey Marsh Drainage Board
Located outside of the Steeping catchment boundary, it is an important route for water from Skegness to the Wainfleet Haven outfall.

17 Burgh Sluice Pumping Station
Lindsey Marsh Drainage Board
Pumps most of the water coming from Skegness via the Cowbank Drain into the Wainfleet Haven.

18 Gibraltar Point Pumping Station
Lindsey Marsh Drainage Board
Pumps water out into the outfall of the Wainfleet Haven at Gibraltar Point.

19 Wainfleet Sea Lane Pumping Station
Lindsey Marsh Drainage Board
Drains water from the southern portion of the catchment by pumping water directly into The Wash.

History of the catchment

The lower course of the Steeping River was a key trade route, with Wainfleet serving as a port as far back as Roman times.

Flood risk management activities date back to the 1000s, when the surrounding landscape consisted of freshwater and saltwater marshes with attempts at drainage and flood defence being made by local monks.

The first of many river channel diversions began in the 1200s. This included diverting the river at Cloughs Bridge and connecting it to Good Dyke at White Cross Clough. This helped maintain the Steeping River as a shipping hub by increasing the amount of water reaching Wainfleet.

From the 1500s, changes to the river's course and reduction in flows contributed to the decline of Wainfleet as a port for shipping, although some small boats did continue to navigate up the channel from Gibraltar Point until 1914.

Until the 1800s, the main focus of water management activity was in and around Wainfleet. This involved construction of a gate to prevent saline water flowing upstream (1461 and 1483), sea banks in 1600, and embankments along the lower reaches of the Steeping in 1789.

In the 1800s, the Steeping River was straightened between Cloughs Bridge and Crows Bridge. In addition, some of engineer John Rennie's recommendations for draining the Fens were implemented. Work included construction of Thorpe Culvert which diverted water away from the lower reaches of the Steeping River.

The Witham Drainage (Steeping River) Act of 1885 enabled further drainage measures throughout the 1800s and 1900s.

This included further straightening of the Steeping River and construction of a new outfall sluice at Wainfleet Clough and a pumping station at Thorpe Culvert.

In 1953, a major tidal surge caused widespread damage along the eastern coast of the UK, including tidal areas of the Steeping catchment.

Significant investment in drainage and water management infrastructure followed throughout the 1970s and 1980s. This included construction of the Wainfleet Relief Channel in 1971, pumping stations at Wainfleet Sea Lane, Gibraltar Point and Burgh Sluice in 1972. The existing pumping stations at Thorpe Culvert and Burgh Sluice were replaced in 1984 and 1986, respectively.

A number of significant flood events occurred throughout the 2000s. The fluvial event in 2007 was a nationally significant incident. Within the Steeping catchment, this caused flooding of properties at Great Steeping and overtopping of the embankments along the Wainfleet Relief Channel.

A tidal event in 2013 devastated an area of restored freshwater marsh and the visitor centre at Gibraltar Point.

In 2019, river flows breached the Wainfleet Relief Channel. This event resulted in the formation of the Steeping River Steering Group and the publication of the Catchment Action Plan (CAP) 2020+. The catchment was affected by fluvial flooding caused by Storm Babet in October 2023, and again during the winter of 2024-25.

Construction of the Wainfleet Relief Channel
© Environment Agency

Construction of the new Thorpe Culvert Pumping Station
© Anglian Water 1982

History timeline

Pre-1800s

AD43-1086

Romans occupied the area. The earliest mention of monks undertaking land drainage activities and erecting sea banks to protect against tidal flooding dates back to 1086.

1100s

Wainfleet became a thriving port. The pre-drainage landscape was dominated by freshwater marsh to the west of Wainfleet, and inter-tidal saltwater marsh to the east.

1200s

The River Lymn was diverted south of Firsby to join the Good Dyke.

1461-1483

The Commissioners of Sewers installed a gate on the Wainfleet Haven to prevent saline incursion.

1531

Repeated flooding of the area led to the establishment of the Courts of Sewers to manage drainage of the flood prone agricultural land.

Early 1600s

Wainfleet's port began to decline due to siltation in the estuary and changes in the river's course.

1799

John Rennie's proposals to drain the East, West, and Wildmore Fens were published.

1800s

Early 1800s

Draining of the East Fen significantly diminished the flow of freshwater to Wainfleet port.

A new channel was dug between Firsby Clough and Crows Bridge.

An inverted syphon was installed at Thorpe Culvert, draining water from the Steeping catchment to Hobhole via the Bellwater Drain.

Existing parts of the Steeping River were widened, deepened and embanked. A bank was constructed at Gibraltar Point in order to reclaim an area of saltmarsh for sheep grazing.

1818

The channel of the Steeping River was straightened between Firsby and Wainfleet.

1871

Wainfleet ceased to operate as a port due to siltation and the arrival of the railway.

1885

The Witham Drainage (Steeping River) Act allowed the easing of meanders and the construction of a new sluice and outfall at Wainfleet Clough.

1900s

1914

The last commercial ship ported at Gibraltar Point.

1934

Skegness District IDB was created by the Witham and Steeping Rivers Catchment Board.

1938

Thorpe Culvert Pumping Station was constructed.

1948

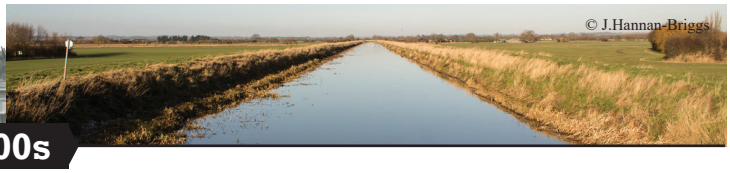
The Lincolnshire Wildlife Trust's first nature reserve was established at Gibraltar Point.

1948-1949

The Steeping River was dredged from Gibraltar Point to Great Steeping and the banks were raised.

1953

A catastrophic tidal surge devastated the local area. Its effect was felt along the entire east coast of England and other parts of Europe.



2000s

1961
A tidal surge caused localised flooding.

1967
Sluice doors that controlled the flow of water under the Steeping into the neighbouring Witham Fourth IDB area collapsed, leading to excessive amounts of water flowing into the Witham Fourth district.

1968-1969
Flooding of the area around Wainfleet caused by fluvial flooding. A tidal surge caused localised flooding in the tidal reaches of the catchment.

1971
Construction of the Wainfleet Relief Channel split the Steeping River in two and provided substantial storage capacity for water during floods.

1972
Burgh Sluice Relief Channel and Burgh Sluice were constructed.

1978
The tidal reaches of the catchment were affected by the most extreme tidal surge since 1953.

1982
A new pumping station was constructed at Thorpe Culvert. The old pumping station was retained.

1986
A new pumping station was constructed at Burgh Sluice.

2000
Lindsey Marsh Drainage Board was established.

2007
Heavy rainfall led to widespread flooding across England in June 2007. The Steeping catchment was badly affected, and several measures to reduce flood risk across the catchment were implemented as a result.

2010
The Lincolnshire Flood Risk and Water Management Partnership was created.

2013
A storm surge at Gibraltar Point devastated the freshwater marsh habitat and the visitor centre.

2018
The Steeping catchment was identified to be part of a pilot scheme called Partnership Approach to Catchment Management (PACM) which ran for a year during 2017/18. The multi-partner group was set up to develop an aligned, long-term strategy for flood risk.

2019
Heavy rain and a subsequent breach of the Wainfleet Flood Relief Channel flooded homes and businesses across the catchment, including Wainfleet All Saints, Thorpe St Peter, Firsby, and Great Steeping. More than 8km^2 (800ha) of farmland was inundated. The Steeping River Steering Group was established in response.

2023-2025
The catchment was affected by fluvial flooding during Storm Babet in October 2023. The river levels recorded at Wainfleet were the highest on record, and overtopping was recorded at Spilsby Road and the railway crossing of the Wainfleet Relief Channel.

Further heavy rainfall affected the catchment during the winter of 2024-2025.

Managing flood risk

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

Roles and responsibilities

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

Lindsey Marsh Drainage Board 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.

East Lindsey District Council (ELDC) 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 Steeping River 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 Steeping 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 Steeping River 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.

Steeping Catchment Action Plan 2020+ (2020)

This plan focuses on enhancing water flow management, building resilient communities and infrastructure, reinforcing and maintaining flood defences, and increasing floodwater storage capacity.

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 Steeping catchment is 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.

Flamborough Head to Gibraltar Point Shoreline Management Plan 3 (2010)

This SMP is also applicable to the Steeping catchment. The PDZ of particular relevance is from Seacroft to Gibraltar Point and this stretch of coastline can influence coastal flood risk within the catchment. In the medium and long term, the strategy aims to sustain the current level of flood protection by maintaining the position and function of existing defences.

The role of critical infrastructure

Only the continuous operation of flood risk assets can protect the low-lying areas of the Steeping catchment from severe and long-term flooding.

Before human intervention, much of the Steeping River 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 topography forms a bowl-shaped basin, with a slightly elevated coastal plain running between Wainfleet All Saints and the coast. The lowest point of the Steeping catchment would be flooded to a depth of 3.9m 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.

Haven House Sluice

Wainfleet Relief Channel

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 defences running along the shoreline of The Wash.

Water management assets are monitored and adjusted all year round to maintain water levels and minimise flood risk. 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 and could result in the inundation scenario depicted on the map, leading to uninhabitable conditions over a short timeframe.

Haven House Sluice

Extreme events

Even with current flood risk assets in place, tidal and fluvial flooding poses a significant risk to the Steeping catchment, as evidenced by flood events in 1953, 2007, 2008, 2013, 2019, 2023, 2024 and 2025. The primary sources of fluvial flooding are the Steeping River and the Wainfleet Relief Channel, which has overtopped several times, notably in 2007, 2019 and 2023, causing property damage and widespread inundation of agricultural land. Tidal flooding has occurred during storm surges in 1953, 1968, 1978 and 2013.

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 models used to assess flood risk within the Steeping River catchment are the 2010 Northern Area Tidal Model representing tidal events and the 2025 Steeping Model. The latter represents fluvial events on the Main Rivers but not on the IDB system. These models include existing flood defences and assume that all assets are fully functional and maintained at their current Standard of Service. 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

Model results show that with existing defences, 2.7km^2 (266ha) of the catchment, predominantly in the coastal region, would be inundated during a 0.5% AEP event. This affected area is primarily agricultural and includes approximately 0.6km^2 (64ha) of Grade 1 agricultural land. No properties are predicted to flood during this event. Flood depths for this event reach a maximum depth of approximately 0.6m towards the south-western edge of the catchment.

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

Fluvial

Model results show that with existing defences, 1.2km^2 (116ha) is at risk of flooding from rivers during a 1% AEP event. Under a more extreme 0.1% AEP event, flooding is expected to cover 7.1km^2 (710ha) of the catchment area. This is generally limited to the villages of Great Steeping and Thorpe Culvert, with some deeper flooding of lower-lying agricultural land north of Thorpe Culvert.

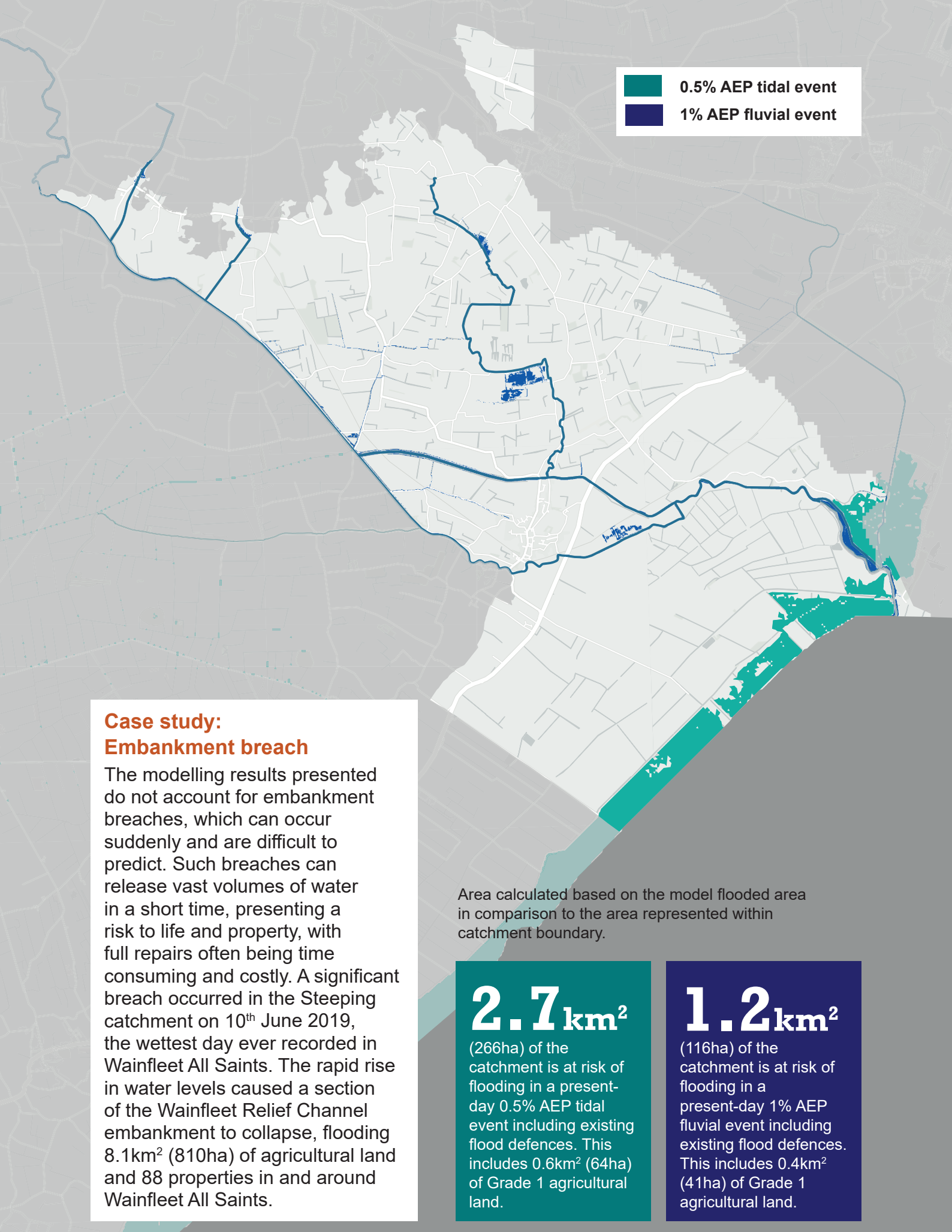
Recent flood history indicates that fluvial flood risk is higher in the present day than the modelling suggests. The embankments of the Wainfleet Relief Channel were overtopped in three recent events; in 2007, 2019 and 2023.

Other sources

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

Surface water flooding. This occurs when the volume and intensity of rainfall overwhelms local drainage systems. The Environment Agency's 'Long Term Flood Risk Service' maps indicate surface water flooding is typically highly localised with small and isolated patches and identifies a few properties at risk in Wainfleet All Saints and Wainfleet St Mary.

Groundwater flooding. This occurs when the water table rises to meet the ground surface, it is not identified as a high-risk flood source in the East Lindsey Strategic Flood Risk Assessment. There are also no recorded instances of groundwater flooding in the catchment.



Case study: Embankment breach

The modelling results presented do not account for embankment breaches, which can occur suddenly and are difficult to predict. Such breaches can release vast volumes of water in a short time, presenting a risk to life and property, with full repairs often being time consuming and costly. A significant breach occurred in the Steeping catchment on 10th June 2019, the wettest day ever recorded in Wainfleet All Saints. The rapid rise in water levels caused a section of the Wainfleet Relief Channel embankment to collapse, flooding 8.1km^2 (810ha) of agricultural land and 88 properties in and around Wainfleet All Saints.

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

2.7km^2 (266ha) of the catchment is at risk of flooding in a present-day 0.5% AEP tidal event including existing flood defences. This includes 0.6km^2 (64ha) of Grade 1 agricultural land.

1.2km^2 (116ha) of the catchment is at risk of flooding in a present-day 1% AEP fluvial event including existing flood defences. This includes 0.4km^2 (41ha) of Grade 1 agricultural land.

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

Tidal flood risk will increase significantly over the next 100 years as sea levels rise in response to climate change. Modelling scenarios assume that sea levels will rise by 1.1m up to 2115. Under this scenario, even with existing flood defences in place, approximately 30.2km^2 (3,016ha) of the catchment would be at risk of inundation. This represents an eleven-fold increase, compared to existing conditions. This includes 21km^2 (2,095ha) of Grade 1 agricultural land, which can be damaged by extended periods of saltwater inundation. Several villages would be expected to experience flooding, including Wainfleet All Saints and Croft. The railway between Wainfleet All Saints and Skegness could be cut off, isolating communities.

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. This means that flood risk, in terms of both impact and frequency, could be even greater than models predict in the future.

Higher sea levels will increase the risk of tide-locking at key outfalls such as Burgh Sluice. Tide-locking means that water cannot be discharged from the Main River system during periods of high tide, causing it to back-up in the catchment and put increasing pressure on the river embankments.

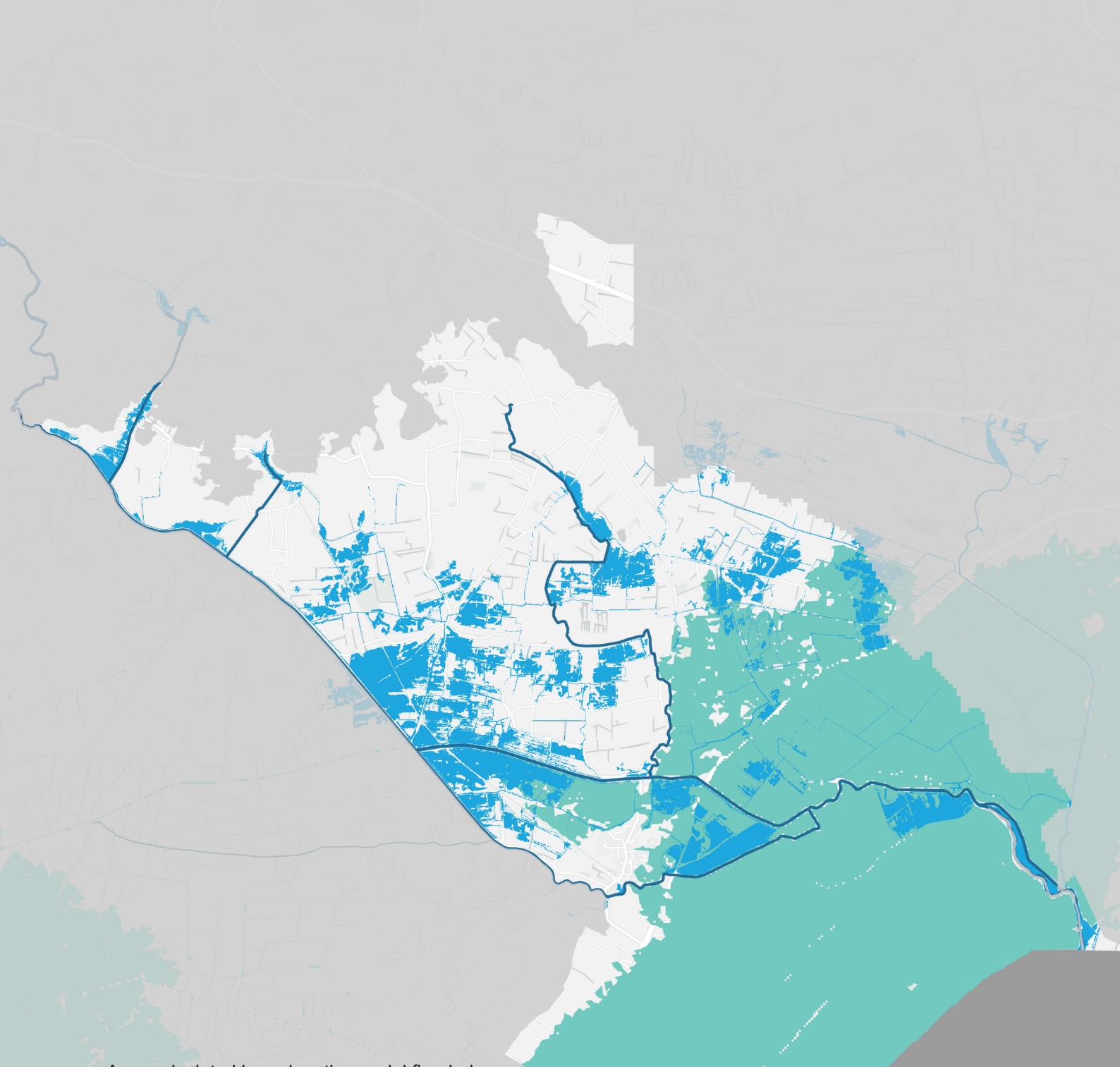
Fluvial

Extreme rainfall events are likely to become more common, increasing river flows in the catchment by as much as 57% during extreme events by the 2080s under current government climate change allowance guidance.

Modelling predicts an increase in fluvial flooding when climate change is applied to the 1% AEP event. Even with current flood defences still in place, this predicts the inundation of 7.4km^2 (744ha) of the catchment and includes 1.3km^2 (134ha) of agricultural land. This represents a seven-fold increase, compared to existing conditions. However, the risk to settlements from fluvial flooding is not significantly increased in this scenario.

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.



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

30.2km²

(3,016ha) 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 21km² (2,095ha) of Grade 1 agricultural land.

7.4km²

(744ha) of the catchment is at risk of flooding in a 1% AEP fluvial event with climate change allowance including existing flood defences. This includes 1.3km² (134ha) of Grade 1 agricultural land.

- **0.5% AEP tidal event + climate change** (1.1m of sea level rise up to 2115)
- **1% AEP fluvial event + climate change** (57% increase in river flows by the 2080s)

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

25% of all critical structures such as outfalls, walls and bridges, within the catchment are affected by reliability and performance issues caused by their age. This can increase the amount of maintenance required for them to function.

Embankments are vulnerable

61% of embankments in this catchment are over 125 years old and they are generally constructed without clay cores. These factors pose structural risks, which means they are increasingly vulnerable to erosion and overtopping, especially during storm events. This can contribute to failures such as the breach of the Wainfleet Relief Channel in 2019.

Pumping station challenges

Many of the pumping stations require extensive refurbishment or replacement due to their age and often operate at full capacity during heavy rainfall, limiting their resilience to climate change.

Investment needs

Most of the pumping stations in the catchment require short to medium term investment. Funding applications have been made in order to undertake refurbishments. These works are still outstanding and will not increase system capacity.

Catchment geology

The catchment is underlain with silty marine sediments as opposed to peat deposits prevalent elsewhere in the Fens, and has widespread clay and sand deposits. These conditions make the sediments susceptible to erosion and contribute to high sedimentation. This can lead to channel and embankment instability.

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 34% of assets, 43% are reported to be of 'Unknown' ownership and the remainder are owned by other RMAs.

Asset age profile

The embankments in the catchment are at an age where their performance and reliability is reducing. In addition, all the pumping stations managed by Lindsey Marsh Drainage Board require extensive refurbishment and / or replacement having been built in the 1970s or 1980s.

Asset condition profile

Approximately 25% of assets in the catchment have a current condition score of 'Poor', 'Very Poor', or 'Unknown' in AIMS. Despite their age, 88% of the 150 embankment assets are recorded in AIMS as being in 'Fair' or 'Good' condition. The remainder are in 'Poor' condition. Of the other key asset types, outfalls have the highest proportion (37%) below the required condition grade, approximately half of which are in 'Very Poor' condition.

Wainfleet Clough and the Burgh Sluice Relief Channel © Chris. Licensed for reuse under the Creative Commons Licence.

Gibraltar Point Pumping Station © Mat Fascione. Licensed for reuse under the Creative Commons Licence.

Wainfleet Relief Channel (left) splits from the Steeping River at Thorpe Culvert © Chris. Licensed for reuse under the Creative Commons Licence.

Croft Lane Pumping Station © Arup 2024

Haven House Sluice © Arup 2024

The Wainfleet Relief Channel, showing the crossing of the Boston to Skegness Railway Line © Chris. Licensed for reuse under the Creative Commons Licence

Operating challenges

Croft Lane Pumping Station is managed by the Environment Agency. The configuration of pumps at the site means that differently sized pumps are switched on and off frequently to pump the correct volume of water. This causes overheating and intermittent power failure. This issue is due to be addressed when the site is refurbished with new pumps in 2026-2027.

Thorpe Culvert Pumping Station, built in the 1980s, is a critical asset managed by Lindsey Marsh Drainage Board. The four diesel pumps are understood to be close to the end of their serviceable life and can become overstressed during heavy rainfall events. The station itself is vulnerable to flooding and nearly had to be abandoned by IDB staff in 2019 when water came close to entering the electrical systems.

Burgh Sluice Pumping Station has the largest capacity of any of the pumping stations managed by Lindsey Marsh Drainage Board. It receives water which has already been pumped upwards by two smaller pumping stations outside the study area to the north. Built in the 1980s, it has experienced recent failures and requires significant upgrades in the near future.

Wainfleet Clough Sluice and Haven House Sluice experience problems with siltation. Regular maintenance is required to keep them operational.

Embankments and walls are the assets with the most commonly occurring defects in the catchment, based on AIMS data. Many assets, particularly embankments, suffer multiple or recurring defects. This is particularly apparent at the Wainfleet Relief Channel around Croft Lane Pumping Station. Embankment breaches ultimately put local communities and the environment at risk.

Current asset maintenance

Based on analysis of Environment Agency revenue programme dataset:

Environment Agency maintenance expenditure

£411k was spent on embankment maintenance between 2022 and 2024 representing 68% of total maintenance expenditure.

£40k was spent on other assets between 2022 and 2024, mainly on open channels, control gates and pump houses.

Lindsey Marsh Drainage Board maintenance expenditure

The drainage board has a standard maintenance regime based on the age of each asset. All of their pumps are at or approaching the time for full refurbishment or replacement. Maintenance expenditure has been consistent between financial years 2017-2022, at around £1.2 million.

Across all RMAs, substantial investment in capital and maintenance will be required to keep or improve the existing assets to a condition of 'Fair' or better, alongside 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.

Sluice on the Cow Bank Drain

The Steeping River. Looking Downstream at Wainfleet St Mary

The Wainfleet Haven near Gibraltar Point

Environment

Mapping shows environmental features such as the designated conservation site at Gibraltar Point. The coastal habitats of the catchment are vital for wildlife and provide recreational opportunities for deprived coastal communities.

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

Bratoft Meadow Site of Special Scientific Interest (SSSI) attracts large numbers of butterflies and has 18 recorded species of terrestrial mollusc.

Wainfleet All Saints, within the East Lindsey District Council jurisdiction, is the only town within the catchment.

There are a further eight small villages and hamlets.

A large area of Wainfleet All Saints is designated as a Conservation Area.

Conservation Areas possess special architectural or historic interest. The central core of the village is largely derived from its history as a thriving port in Roman and early medieval times.

There are four Scheduled Monuments within the catchment including medieval salt workings, known as salterns.

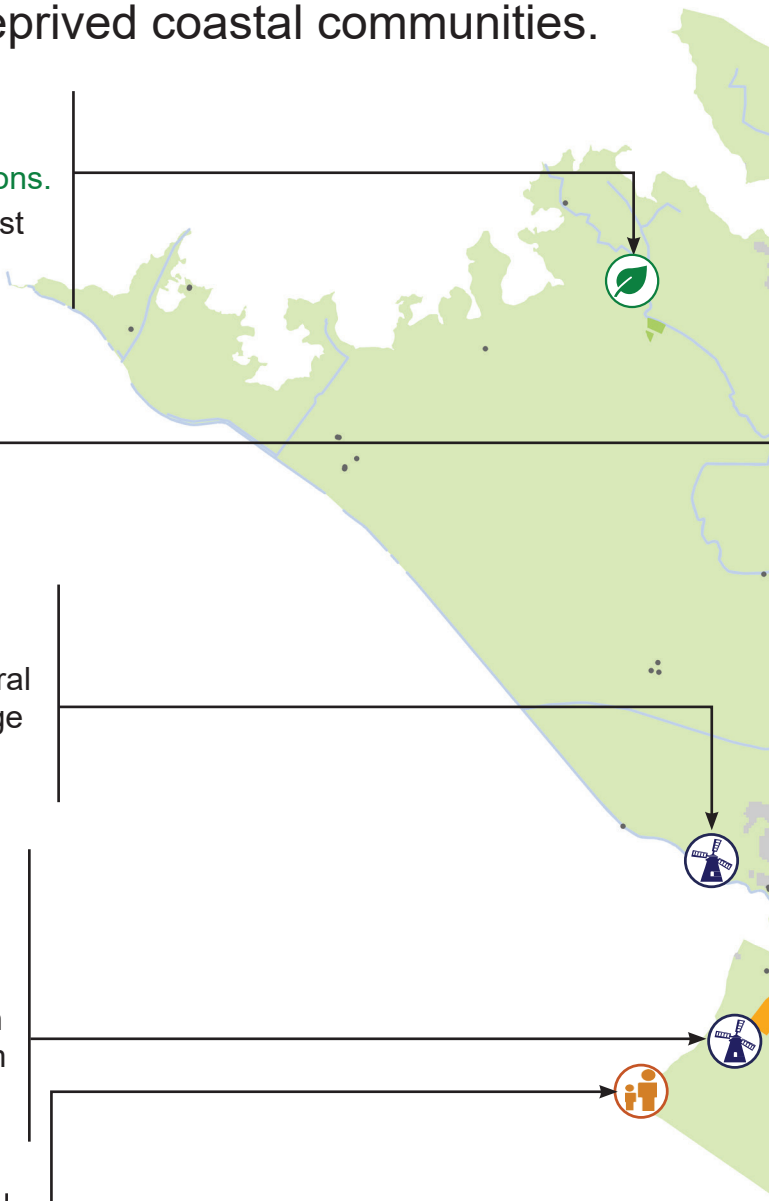
A wide band of salterns called the 'tofts', estimated to consist of approximately 96 million cubic metres of waste silt, runs south-west from Wainfleet, making it one of the single largest human-made medieval features in Britain.

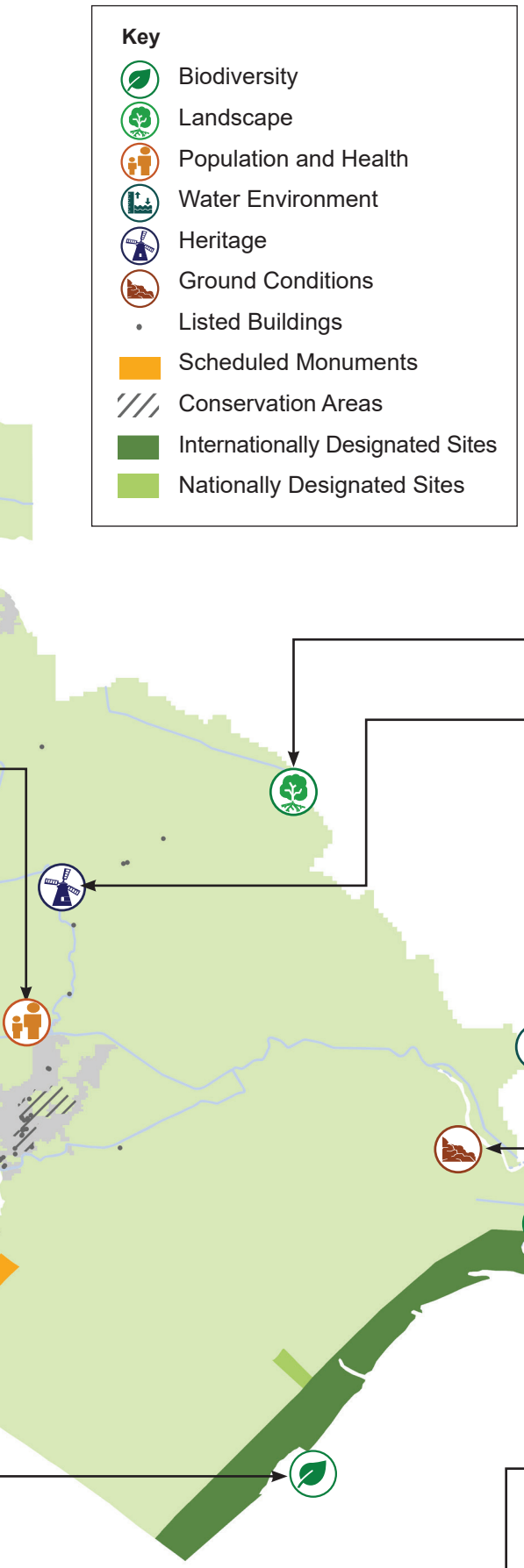
Coastal communities within the catchment are amongst the most deprived areas in England.

The Lower layer Super Output Area (LSOA) East Lindsey 017D which covers the coastal portion of the catchment including Wainfleet All Saints and Friskney is categorised as within the top 10% of most deprived neighbourhoods across all deprivation measures.

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.





The catchment is located within two National Character Areas (NCAs) – these are areas of distinct and recognisable character.

The catchment is divided between the Lincolnshire Coast and Marshes NCA, characterised by a wide low-lying coastal plain and The Fens NCA, known for its extensive vistas. The Historic Landscape Character Areas include the Wolds, the Grazing Marshes and The Wash. These help describe the relationship between heritage features and how the landscape has evolved over time.

The network of drainage channels and embankments such as the Cowcroft Drain, created to drain the Fens, are some 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 Lymn/Steeping is classified as a heavily modified water body under the Water Environment Regulations / Water Framework Directive.

The waterbody is currently impacted by diffuse pollution from agricultural and rural land management and physical modifications.

Roddons (palaeochannels), such as those identified near Wheelbridge, 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.

Gibraltar Point is designated as a Special Protection Area, Ramsar site, NNR and SSSI.

Habitats include dunes, salt marsh, freshwater pools, freshwater marshland and areas of grassland. These habitats support bird populations of European importance including overwintering waders and wildfowl and significant breeding colonies of plovers and terns.

Agriculture

The Steeping catchment is an area of agricultural importance but there is diversification into tourism and renewable energy generation.

Soilscape

The majority of the catchment contains loamy and clayey soils of coastal flats with naturally high groundwater which can support different cropping. Towards the north of the catchment, soils are generally less productive due to impeded drainage.

A small area of the catchment surrounding the Steeping River is identified as peat, however it should be noted that any remaining peat is likely degraded to 'wasted' peat soils.

Agricultural Land Classification (ALC)

Approximately 56% of land in the Steeping catchment is classified as Grade 1 and 2. Grade 1 land is predominately located to the south of the catchment. This is high-yielding land with little or no limitations for agricultural use.

Water availability

Abstraction from the Steeping River system is only available 138 days per year during higher flows. Higher flows are the flows equalled or exceeded at least 50% of the time, when the flow is lower, water is restricted or not available. Consequently, irrigated crops can only be produced in this catchment reliably using water from the on-farm reservoirs which are concentrated in the south of the catchment towards The Wash.

Value of agriculture in the catchment

The land use within the catchment is primarily arable agricultural, including the limited production of some higher value crops in rotation such as potatoes. A proportion of the land used for agriculture is used for livestock grazing, with a number of farms producing beef cattle, and/or sheep in the central and northern parts of the catchment where land quality is generally lower due to poor drainage.

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 £10 million annually (in 2023 values).

	Area (km^2)	Area (ha)	Percentage of farmed land (%)	Estimated annual value* (£)
Cereals	25.5	2250	52%	£3.69 million
Arable crops (excluding cereals)	10.75	1075	22%	£2.49 million
Grassland	7.75	775	16%	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	1.5	150	3%	£2.87 million

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

Environmental stewardship

The majority of the grazed areas across the catchment, and large areas of the Lincolnshire Wildlife Trust Gibraltar Point NNR are managed under stewardship agreements. These agreements are 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.

Climate change

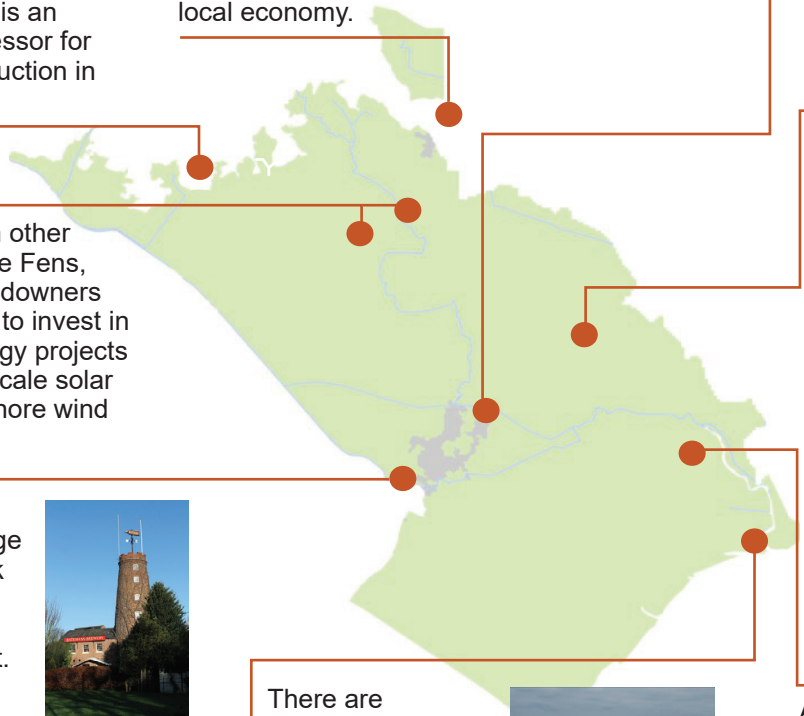
Climate change will increase the risks of fluvial and coastal flooding, as well as drought. Flood events can restrict the ability to establish new crops, reduce crop yields and quality, or destroy crops once ready for harvest. This leads to direct agricultural damages and wider economic consequences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

A family run potato merchant, located in Firsby (just north of the catchment) is an important processor for the potato production in the catchment.

The second largest egg producer in the UK has a packaging plant located in Burgh le Marsh, providing jobs and income into the local economy.

A number of family-run food and drink businesses are based in Wainfleet All Saints.



In common with other areas across the Fens, farmers and landowners are diversifying to invest in renewable energy projects such as small-scale solar farms and on-shore wind turbines.

Holiday parks comprising a mix of caravan and camping sites, are located across the north of the catchment towards Skegness. They provide diversified income streams to landowners.

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There are a number of large food and drink supply chain business in the catchment. For example, one company owns 69 public houses across Lincolnshire and neighbouring counties.

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There are ten farming businesses with active mid-tier Countryside Stewardship agreements, including Gibraltar Point National Nature Reserve.

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Agri-tech and innovative farming methods are being used across the catchment. For example, a former greenhouse nursery has recently been redeveloped into an insect farm to process food waste into protein for the livestock feed industry.

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 economy, society and the natural world.

Natural capital in the Steeping catchment has an annual value of

£11.7 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 through drainage, mineralisation and erosion under intensive agriculture, they start to release carbon back to the atmosphere.

The Steeping catchment is the only Fens 2100+ catchment which sequesters carbon overall and is therefore the only catchment where the value of climate regulation is positive*. All of the peatland in the Steeping catchment is in a drained condition (and therefore releases carbon), however it covers less than 1% of the catchment area, so the emissions are slight (281 tonnes of CO_2 equivalent per year) compared to the 2,217 tonnes of CO_2 sequestered predominantly by enclosed farmland, woodland, saltmarsh and mudflats.

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

£0.7 million
Recreation

The welfare value of approximately 172,000 visits by adults each year to publicly accessible green space within the catchment. The welfare value of a further 44,000 visits made by children each year cannot be quantified but is likely to be significant.

£0.2 million
Physical health

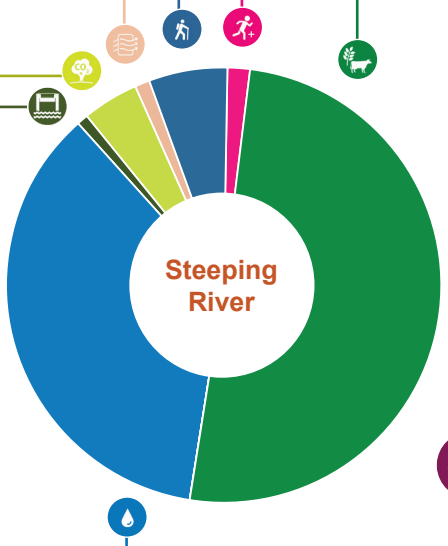
£164,630 in healthcare treatment costs can be avoided every year due to improved physical health through 88,500 active visits to publicly accessible green spaces in the catchment. Active visits involve at least 30 minutes of exercise.

£5.9 million
Agriculture

The 58.6km^2 (5,863ha) 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 over £5.9 million.

£0.1 million
Air Quality

The removal of 341 tonnes of air pollutants by vegetation in the catchment leads to an estimated avoided cost of health treatment of £60,000 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 £47,114 per km for river waterbodies. However, none of the waterbodies in the catchment currently meet these standards due to diffuse pollution from sources such as agriculture and rural land management, giving a value of £0 for water quality.

£0.6 million
Climate regulation

The value of 1,935 tonnes of carbon dioxide equivalent being sequestered by habitats in the catchment each year. Most of this climate regulation is provided by the 2.25km^2 (225ha) of coastal saltmarsh. The value is an abatement cost which is described as the cost of an intervention that will reduce greenhouse gas emissions.

£0.0 million
Hazard regulation

The assessment does not provide a monetary value for this benefit. However, in the catchment it is estimated that 9,990m^3 of floodwater is temporarily stored in areas of woodland.

£0.1 million
Renewable energy

An estimated 9,240MWh of renewable energy, predominantly from wind and solar, is generated per year within the catchment. This has a value of approximately £128,000 per year.

£4.2 million
Water supply

The annual value of approximately 830,000m^3 of water which is abstracted from the catchment each year, for public water supply and other uses such as irrigation.

£0.009 million
Timber

National data can be applied to the Steeping catchment to estimate a yearly timber production volume of 261m^3, which is valued at approximately £8,740 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. This assumes sufficient investment to maintain the existing flood defences for 100 years. 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 2025 Steeping hydraulic model (refer to pages 20-21 for the mapped results of this model).

£546.6 million

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 the risk of flooding 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 this analysis, the Steeping River catchment has been split into three areas, A, B and C, which have different topography. Further details of these sub-catchments is provided in the risk of permanent flooding figure.

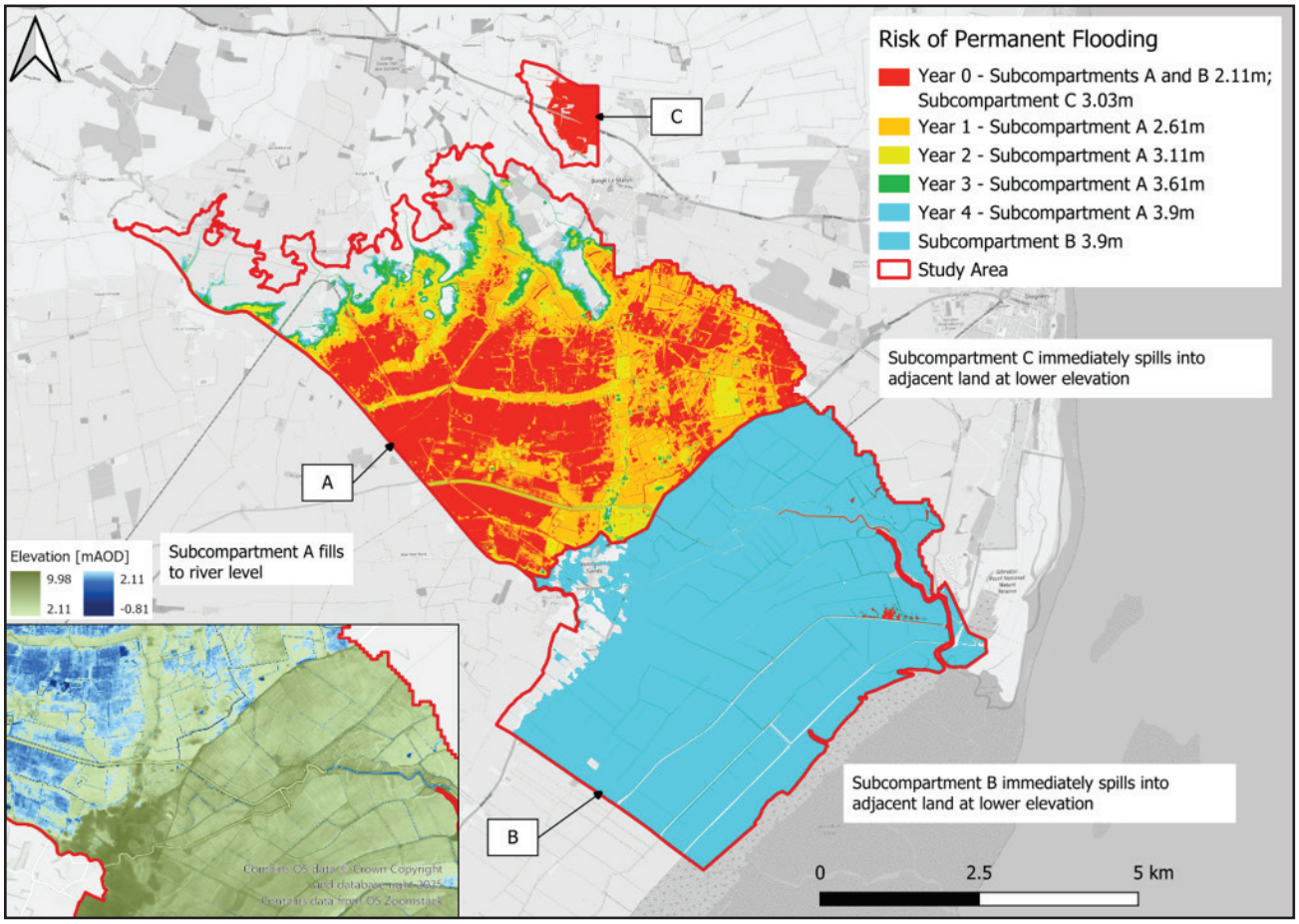
In this scenario each of the three areas would essentially act as a basin, filling with rainfall up to the limiting level. Whilst there would be some loss of water over summer due to evaporation and transpiration, the water levels would be expected to rise steadily over a few years filling the catchment. To represent this, it is assumed that each of the areas would fill by 0.5m per year up to the limiting level.

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 £555 million of economic damages in a 'Do Nothing' scenario (excluding losses to the local economy), compared to only £8.4 million of economic damages in a 'Maintain' scenario. As such, the economic benefits of current flood risk management activities are valued at £546.6 million.



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

The delineation of the subcompartments, used for this analysis, has been undertaken based on a ridge of higher ground between A and B, seen as a dark green line in the inset on the map. This inset also demonstrates that B sits on higher ground than A, with an initial water level of 2.11m AOD impacting little of B. Considered in isolation, there are no barriers to flow in or out of B to the east and west, and the level of permanent flooding would not increase in B without the influence of water in adjacent catchments. In reality B is at significant risk of flooding as illustrated on the map here and on pages 18-19, where a water level of 3.9m AOD would be expected if a 'Do Nothing' scenario is considered across the Fens as a whole.

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 £555 million, with £542 million of this in the first ten years.

£125.8 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.

47.8 km² (4,780ha)
of agricultural land written off in the 'Do Nothing' scenario

£283.5 million
Properties

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

1,284
residential properties written off in the 'Do Nothing' scenario, costing
£274.7 million

133
non-residential properties written off in the 'Do Nothing' scenario, costing
£8.7 million

£13 million
Environment and recreation

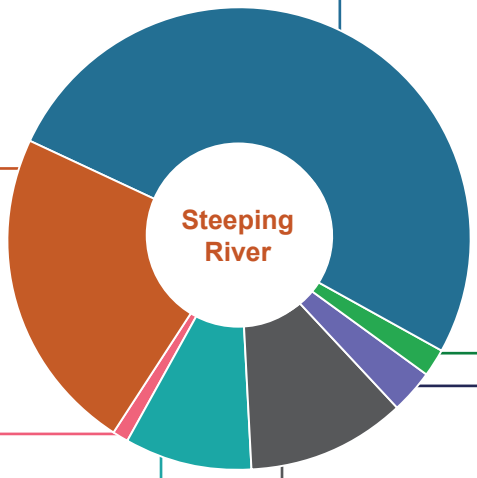
Loss of 2.4km² (243ha) of designated environmental sites across the catchment will lead to losses of ecosystem services such as carbon sequestration, flood regulation, biodiversity, recreation and non-use values.

Recreational damage would arise through loss of 0.02km² (2ha) of recreational sites and 15km of Public Rights of Way.

£3.8 million
Heritage

Loss of heritage sites as a result of flooding. The catchment contains fifty Listed Buildings and four Scheduled Monuments, with a large proportion of these located in and around the town of Wainfleet All Saints.

£3.8 million
is the cost of damage to
18 heritage assets



£14.2 million
Utilities

Captures the impacts of flooding to power, water supply, and gas networks. This includes damage to 106 substations, 667 pole towers and 87.4km of overhead conductor and underground power cables.

£62.3 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.

5 isolated communities lost

£106.5 million
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 438 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.

£52.5 million
Transport

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

Loss of
4.3km
of road infrastructure, costing
£18.5 million

Loss of
10.3km
of rail infrastructure, costing
£34 million

Steeping River	Do Nothing Damages	Maintain Damages	Maintain Benefits
Damages to properties and associated indirect damages	£283.5 million	£1.4 million	£282 million
Agricultural losses	£125.8 million	£7.0 million	£118.8 million
Environment and recreational losses	£13.0 million	-	£13 million
Heritage losses	£3.8 million	-	£3.8 million
Transport damages	£52.5 million	-	£52.5 million
Utilities damages	£14.2 million	£13,000	£14.2 million
Land lost due to isolation	£62.3 million	-	£62.3 million
TOTAL Excluding losses to the local economy	£555 million	£8.4 million	£546.6 million
Losses to the local economy	£106.5 million	£16,000	£106.5 million

£546.6 million

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

Total investment needed:

£160-£250 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 Steeping 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+