Fens 2100+

Steeping River

Baseline economic appraisal report

2025

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1. Executive Summary

As part of the Environment Agency collaborative delivery framework (CDF), Ove Arup & Partners Ltd (Arup) has been commissioned to present an economic baseline for the Steeping River catchment, with reference to current and future flood risk management (FRM). This report presents an evaluation of key receptors at risk of flooding across the catchment and focuses on defining broad economic impacts. The project focuses on the extents of the Steeping River catchment stretching from Great Steeping at the base of the Lincolnshire Wolds to the coast at Gibraltar Point. This catchment is protected using a series of raised flood defences and a complex set of water management systems operated by one Internal Drainage Board (IDB), this being the Lindsey Marsh Drainage Board.

This economic assessment has focused on quantitively defining high-level impacts to a series of the key receptors at risk, including:

- Residential Properties;
- Non-residential Properties;
- Agriculture;
- Environment & recreational sites;
- Heritage;
- Highways;
- Rail;
- Gas;
- Electricity;
- Isolated Properties;
- Mental Health;
- Emergency Service costs;
- Risk to life;
- Evacuation and temporary accommodation costs;
- Vehicle damages;
- Intangible impacts to human health;
- Utilities disruption; and,
- Local losses to the economy as Gross Value Added.

The Do-Nothing baseline scenario identifies present value damages of up to £555 million across the catchment extents over a 100-year period. This is compared to the estimated damages associated with existing FRM arrangements of £8.4 million. Based upon the analysis, the present FRM arrangements and activities across the catchment are estimated to afford a benefit of £547 million to the Steeping River catchment. Without

these activities to reduce flood risk and manage water levels in the catchment, the study area is at risk of permanent inundation – impacting across the natural, social, economic, human, intellectual and manufacturing capitals. The analysis demonstrates that there is a case for FRM in the long term, but the optimal FRM regime has yet to be determined. With a benefit cost ratio of 2.71, the Steeping catchment has a Partnership Funding score of 17% and is eligible for £34 million in Grant in Aid, which leaves a funding gap of £168 million.

1.1 Glossary

Table 1-1: Glossary of economic terminology

Terminology	Summary Definition
Scenario	A scenario is defined as a representation of what flood risk could be based on an explicit set of assumptions. This can include multiple flood mechanisms. For example, in a Do Nothing scenario all risk management authorities would walk away from operation and maintenance of their FRM assets leading to more extensive flooding of communities beyond the status quo. This could be made up of a combination of overtopping of defences, breach, or other flood mechanisms.
Standard of Protection (SoP)	At a given point in time, the Annual Exceedance Probability (AEP) of a flood event which an asset is able to withstand. SoP will vary over time.
Standard of Service	The physical attributes or output of an FCERM asset or service usually set out in a design specification. For example, the height of a wall or barrier, the pumping capacity of a pump, the scale, extent and frequency of a service. The standard of service does not change over time as a result of impacts such as climate change whereas the SoP does.
Receptor	A receptor is defined as something that is affected by a flood. For example, a residential property in the floodplain would be a receptor.
Appraisal period	The appraisal period is the length of time where damages, benefits, and costs are calculated for a particular intervention.
Discounting	Discounting is a method of converting future costs and benefits with different time spans to a common “present value” basis using a discount rate. HM Treasury discount rates are used, which adjust for social time preference, defined as the value society attaches to present, as opposed to future consumption. The rates are based on comparisons of utility across different points in time or different generations.
Present Value	Values expressed in today’s terms following relevant discounting.
Cash	Values expressed in today’s terms not discounted.
Damages	The value of negative social, economic and environmental impacts caused by flooding.
Benefits	The positive quantifiable and unquantifiable changes that a FRM scheme is expected to produce, i.e. damages avoided
Write off	Write-off is losses to an asset deemed unrecoverable

2. Introduction

2.1 Aim and purpose of this document

This document presents a catchment-scale economic baseline for the Steeping River catchment as part of the Fens 2100+ Project 3 baseline reports, with reference to the current FRM regime. This report details the baseline scenarios assessed, the methodology utilised in the economic appraisal, costs associated with maintaining the status quo within the catchment, as well as a summary of the results.

The appraisal approach follows the principles developed as part of the previous work undertaken on the Great Ouse[1] but utilising latest available data and with changes to approach following subsequent reviews and work on the Lower Witham[2]. Details of methodologies have been consulted on agreed with key stakeholders.

Along with the suite of Fens 2100+ documents, this report aims to build the evidence required to support investment certainty in the short term, clarity of actions in the medium term, and shared confidence for the long term. This will support RMAs and partners in securing the essential national and regional investment to ensure future flood resilience through delivery of the right projects, in the right places, at the right time.

This project has sought only to produce a baseline economic appraisal. At this stage, no Do Something options have been considered.

2.2 Catchment context

The Steeping River catchment (hereafter referred to as “the catchment”) covers 63.4 km^2 of east Lincolnshire, located at the far north-east of the Fens 2100+ study area (see Figure 1). It spans 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. It is noted that this is not necessarily a hydrological catchment but is defined as a catchment for the purposes of the Fens 2100+ work.

The catchment lies only slightly above sea level (mean elevation of approximately 3m AOD) with reclaimed wetlands and peatlands forming a significant part of the region. It is a highly productive agricultural area with approximately 37% of the land classified as Grade 1 agricultural land. The landscape of the catchment includes small settlements and the historic market town of Wainfleet All Saints, supporting a total population of approximately 3,289[3] in the catchment. Connectivity between settlements in the catchment and beyond is facilitated by two main roads, the A52 and A158, as well as railway links with stations at Thorpe Culvert, Wainfleet and Skegness.

Wainfleet All Saints, Thorpe Culvert, Thorpe Saint Peter, Gibraltar and Great Steeping have all been repeatedly 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.

[1] Environment Agency (May 2020). Future Fens Flood Risk Management Economic Appraisal Report

[2] Arup (September 2024). Lower Witham Flood Resilience Project Economic Appraisal Baseline Report

[3] Arup (January 2025). Steeping River Baseline Evidence Report

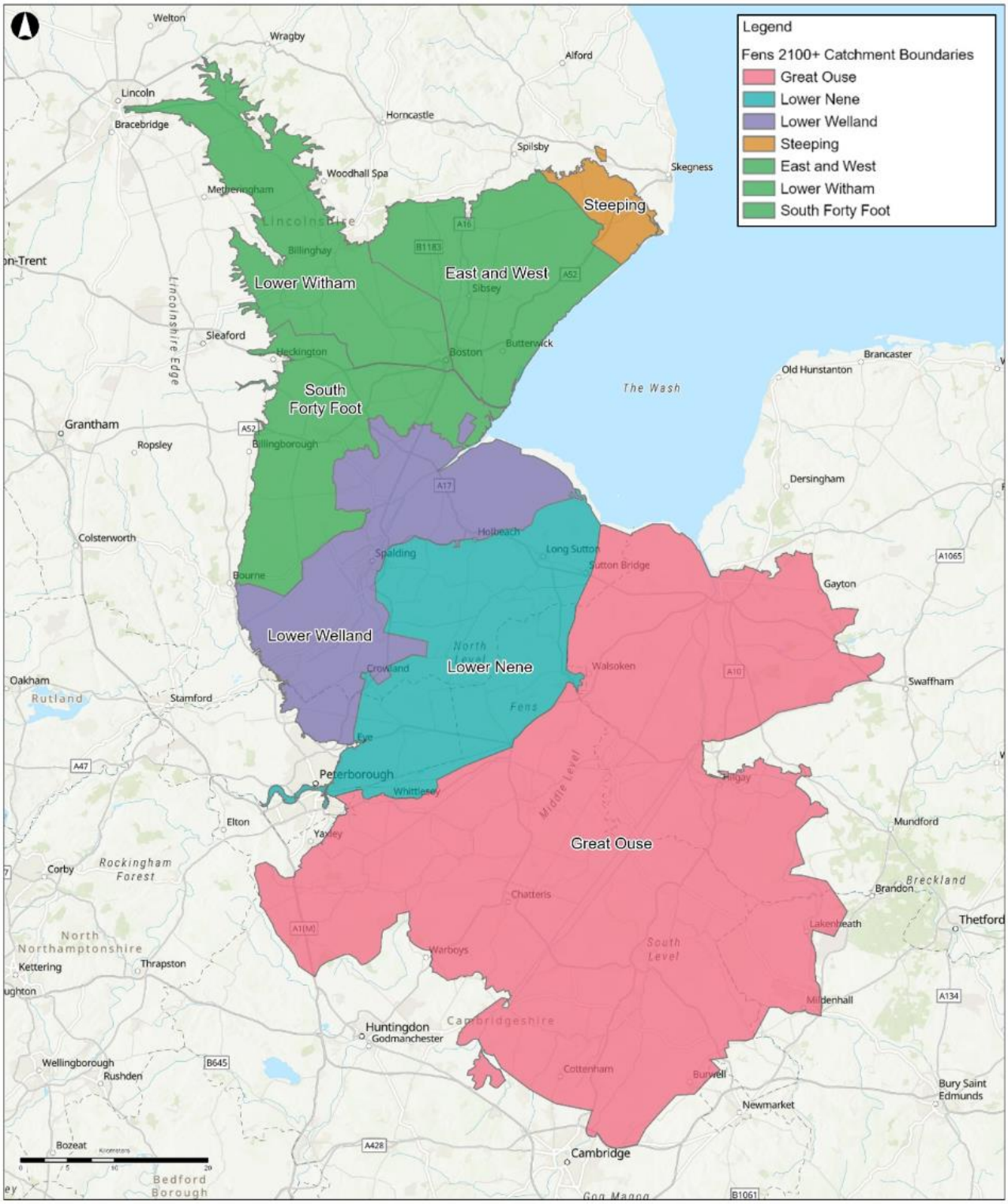

Figure 1: Catchments covered within the Fens 2100+ economic appraisal

2.2.1 Drainage network

The catchment relies on a complex network of watercourses, pumping stations and sluices to protect the land from flooding. The drainage system is shared between the Environment Agency who have permissive powers to manage and maintain Main Rivers, and Lindsey Marsh Drainage Board, who maintain a more extensive network of drains as well as a number of pumping stations.

The Main Rivers in the catchment comprise the Steeping River, River Lymn, the Wainfleet Relief Channel, and Burgh Sluice Relief Channel. The section of Steeping River downstream of Wainfleet All Saints is sometimes referred to as Wainfleet Haven or just The Haven.

The Lindsey Marsh Drainage Board system feeds water into the Main Rivers, to be discharged into The Wash. Their drainage system consists of five drainage catchments, drained by seven pumping stations.

2.2.2 Asset schematisation

A graphical schematisation of the catchment has been produced to provide additional context to this section. This is shown in Figure 2.

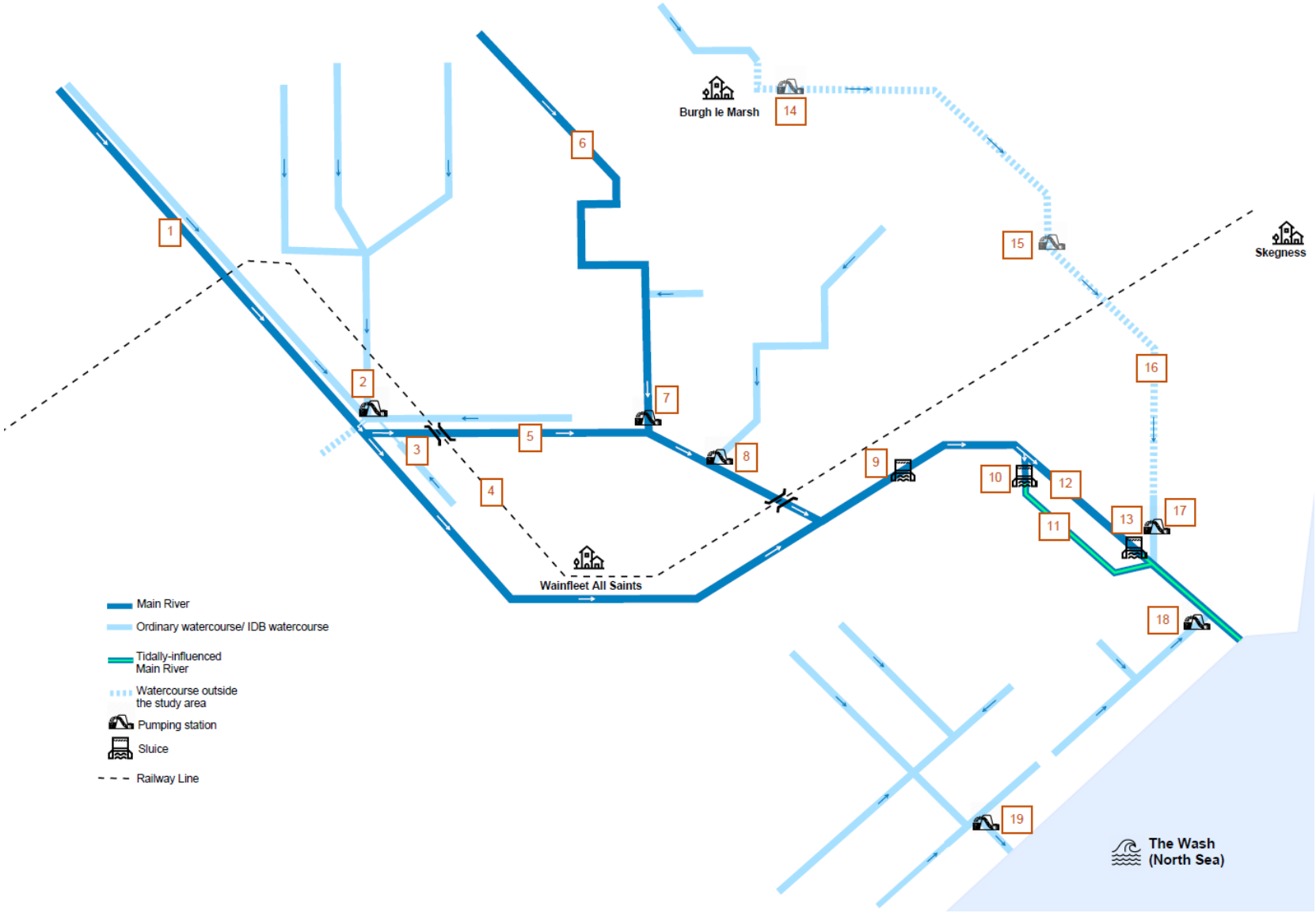

Figure 2: Schematisation of the flood risk assets in the Steeping catchment

1 **Steeping River**
Main River
Much of its lower course has been straightened and earthen embankments contain the channel on both sides.

2 **Thorpe Culvert Pumping Station**
Lindsey Marsh Drainage Board
Pumps water upwards into the Steeping River. In the past, culverts at this location acted as a route to transfer water from the Steeping catchment into the neighbouring 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**
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
This was the original outfall from the River Steeping. It discharges into the Wainfleet Haven.

11 **Wainfleet Haven**
Main River
The name of the tidal lower course of the Steeping River system.

12 **Burgh Sluice Relief Channel**
Main River
A wide straightened channel running parallel to the Wainfleet Haven. It 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.

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
Pumps water upwards from the Main Drain into Cow Bank Drain.

16 **Cow Bank Drain**
Lindsey Marsh Drainage Board
Located outside of the Steeping catchment boundary but 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 Cowcroft 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.

2.3 Study context

The catchment is heavily engineered with extensive flood defence embankments and flood defence walls, in addition to the Lindsey Marsh Drainage Board assets including pumping stations, which are essential to the drainage of large areas of the catchment. Drainage works and embanked watercourses perched above the surrounding land have enabled highly productive arable land to be farmed and communities to be established in the area. The farmland is some of the highest-grade agricultural land in the country with around one-third of land classified as Grade 1.

The defences are essential assets which are of critical importance to the sustainability of the economy of the catchment and the people that reside within the catchment. Without these defences and the Lindsey Marsh Drainage Board assets (including pumping stations which drain large areas of land), much of the area would be marshland, regularly inundated by the sea.

Figure 3: Steeping River at Brewster Lane Bridge looking towards Wainfleet All Saints

2.4 Description of flood risks

The Steeping River and its tributary the River Lymn are high-level carrier rivers to which the Lindsey Marsh Drainage Board catchments discharge via gravity and pumped drainage networks. The low-lying catchment is protected by a series of raised flood defences and tidal sluices along the Main Rivers which prevent tidal inundation, as well as a complex series of water management systems operated by the Lindsey Marsh Drainage Board. Without these activities to protect and manage the water levels in the catchment, the study area would become uninhabitable with large parts reverted to marshland.

The key sources of flood risk to the catchment are from the high-level carrier watercourses perched above the surrounding land, as well as surface water and coastal flooding. None of the ordinary watercourses in the catchment are high-level carriers, so the flood risk

arising from this source is restricted to the Main Rivers in the area, and the Wainfleet Relief Channel in particular. While current flood risk assets are operational in the catchment, the degradation of many of the embankments and walls may lead to assets failing or being overwhelmed – thus resulting in significant flooding impacts.

2.5 Historic flooding

There is a history of significant flood events across the Fens 2100+ study area. Prior to the 1600s, the wider Fens were formed of low-lying marshland with conurbations on islands of higher land. Historic flood events, within living memory, are outlined in Table 2-1. These events highlight the catchment's vulnerability in the absence of effective performance and operation of assets.

Table 2-1: Historic flood events

Date	Source of flooding	Details
1947	Fluvial	"The winter of 1946/47 was one of the coldest in living memory with long periods of freezing temperatures. This was accompanied by the worst snowfall for seventy years. Then in the second half of March came a rapid thaw and widespread flooding, which brought chaos to Lincolnshire due to overflowing rivers, dykes and ditches. There were distressing scenes in several parts of Lincoln as water swept into houses, damaging carpets, lino and furniture. Many residents found their cookers and fireplaces under water, and they moved upstairs to become bedroom dwellers. In Lincoln alone, water got into 3,000 homes and one-sixth of the city was under water."[4]
1953	Coastal / tidal	The flood of 1953 is the most devastating natural disaster recorded in the United Kingdom in the 20th Century. A severe north-westerly storm combined with a spring tide caused large parts of Britain's east coast to flood. The tidal surge and waves overwhelmed sea defences and caused extensive flooding. In Lincolnshire, flooding occurred from Mablethorpe to Skegness, reaching as far as 3 km (2 miles) inland. The Mablethorpe, Sutton-on-Sea and Skegness areas were the most seriously affected parts and forty-three people lost their lives. In addition to loss of life caused by the storm and damage to settlements the storm also devastated around 200,000 acres of farmland and hundreds of animals died.[5]
January 1978	Coastal / tidal	1978 North Sea storm surge causing extensive coastal flooding and considerable damage on the east coast of England.[6]

[4] Lincolnshire Life (2014). The floods of 1947. Available at: The floods of 1947 - Lincolnshire Life. Accessed 27/03/2025.

[5] Association of Drainage Authorities (2018) North Sea Flood 1953. Available at: North Sea Flood 1953 - Association of Drainage Authorities. Accessed 27/03/2025.

[6] Steers, J.A. et al. (1979). 'The storm surge of 11 January 1978 on the east coast of England'. The Geographical Journal, 145(2), pp.192–205.

2000	Fluvial	Widespread flooding across England and Wales had occurred in the autumn and early winter of 2000, with over 10,000 homes and businesses flooded at 700 locations. This period saw a mixture of flash flood events as well as prolonged downpours over several days, resulting in vast areas of England and Wales to receive >190% of the 1961-1990 average rainfall during that autumn.[7]
2007	Fluvial	At the time, the summer of 2007 was the wettest on record since 1766, with 55,000 homes being flooded and 13 people losing their lives across England. Across Lincolnshire, over 500 homes were flooded with 20 schools being forced to close.[8]
December 2013	Tidal surge	The tidal surge which hit the east coast of Britain has been described as the "most serious" for 60 years. This event caused the River Haven to burst its banks, and 300 homes flooded in Boston.[9]
June 2019	Fluvial	Breach of the Wainfleet Flood Relief Channel caused severe flooding after a period of heavy rains. The Steeping River Catchment Steering Group was established in response to this event.[10]
October 2023	Fluvial	Storm Babet led to the flooding of just under 600 properties across Lincolnshire, caused by bank overtopping at areas like Horncastle, Lincoln, and Wainfleet, stemming from heavy rainfall.[11]
January 2024	Fluvial	Heavy rain from storm Henk contributed to significant flooding problems, following the wet weather during autumn and December 2023. Between 1 October 2023 and 4 January 2024, parts of the East Midlands, north-east England and eastern Scotland received more than 150% of the 1991-2020 long term average rainfall for the four-month period October to January[12]. More than 70 properties were reported to have flooded in Lincolnshire.

2.6 Existing flood risk assets, operation, and maintenance

Many of the Main Rivers within the catchment are heavily engineered. For example, sections of the Steeping River have been artificially straightened in the past, with earthen embankments constructed to contain the channel. Hydraulic structures have been installed along its course, such as Burgh Sluice near The Wash, and hydraulic restrictions

[7] Met office (2012) The wet autumn of 2000. Available at: the-wet-autumn-of-2000---met-office.pdf. Accessed 27/03/2025.

[8] Lincolnshire Live (2017) It's 10 years since devastating 2007 flooding in Lincolnshire. Available at: It's 10 years since devastating 2007 flooding in Lincolnshire - Lincolnshire Live. Accessed 27/03/2025.

[9] BBC (2013) Tidal surge hits east UK coastal towns after storm. Available at: Tidal surge hits east UK coastal towns after storm - BBC News. Accessed 27/03/2025.

[10] Association of Drainage Authorities (2019) Wainfleet flooding. Available at: Wainfleet flooding - Association of Drainage Authorities. Accessed 27/03/2025.

[11] BBC (2023) Storm Babet: Nearly 600 Lincolnshire properties flooded, meeting told. Available at: Storm Babet: Nearly 600 Lincolnshire properties flooded, meeting told - BBC News. Accessed 27/03/2025.

[12] Met Office (2024) Storm Henk, 2 January 2024. Available at: Microsoft Word - 2024_01_storm_henk_v1.docx. Accessed 27/03/2025.

such as bridges. An extensive network of raised earth embankments exists along the River Steeping, supported by walls along key structures.

Upstream of the village of Great Steeping, the Steeping River is known as the River Lymn. Land either side of the river is protected by sections of raised ground and embankments. Downstream it becomes the Steeping River; much of its length has been straightened and high flood embankments contain the channel. However, there is a remnant of the original course of the River Lymn that joins the Wainfleet Relief Channel at Croft Lane Pumping Station.

Near Thorpe Culvert, the Wainfleet Relief Channel diverts water to the north of Wainfleet All Saints, while the Steeping River continues to flow around the south of the town. The Steeping River and the Wainfleet Relief Channel eventually reconnect a short distance to the east of Haven House Sluice. This structure manages water resources within the catchment, particularly in the summer months for third party abstractions.

Approximately 2.5km further downstream, the channel splits into Burgh Sluice Relief Channel and the remnant of the original river channel, known as Wainfleet Haven or just The Haven. The flow into The Haven channel is controlled by Wainfleet Clough. This structure is prone to tide locking and silt blockage which forces more water down Burgh Sluice Relief Channel. Burgh Sluice Relief Channel and Burgh Sluice were constructed in 1972 to help address the issues at Wainfleet Clough.

On all Main Rivers, the Environment Agency undertake a rolling programme of maintenance to protect and maintain the condition of the existing defences, including grass cutting and other vegetation management, and maintenance of hydraulic structures.

The IDB drains are cut into the ground surface, and over time have transformed the marshy ground of the original fen into high grade agricultural land. These ditches and drains are administered by the Lindsey Marsh Drainage Board which solely covers the study area as shown in Figure 4.

The Lindsey Marsh Drainage Board provides water level management systems and regulates the water levels in their systems through a network of pumping stations. The majority of these pumped catchments outfall into the Steeping River at Burgh Sluice Pumping Station, Thorpe Culvert Pumping Station and Gibraltar Point Pumping Station, while Wainfleet Sea Lane Pumping Station pumps water from its catchment straight into The Wash. Burgh Sluice Pumping Station receives water which has already been moved upwards by intermediate pumps at Burgh Le Marsh and Gotts Lane, to cope with the lack of gradient along the Cow Bank Drain.

These systems are maintained by the Lindey Marsh Drainage Board to ensure a high standard of drainage is afforded to the study area. Several on-going operation and maintenance activities are undertaken by the Lindsey Marsh Drainage Board, including pumping station operation, channel dredging/clearance, and reinstatement of embankments.

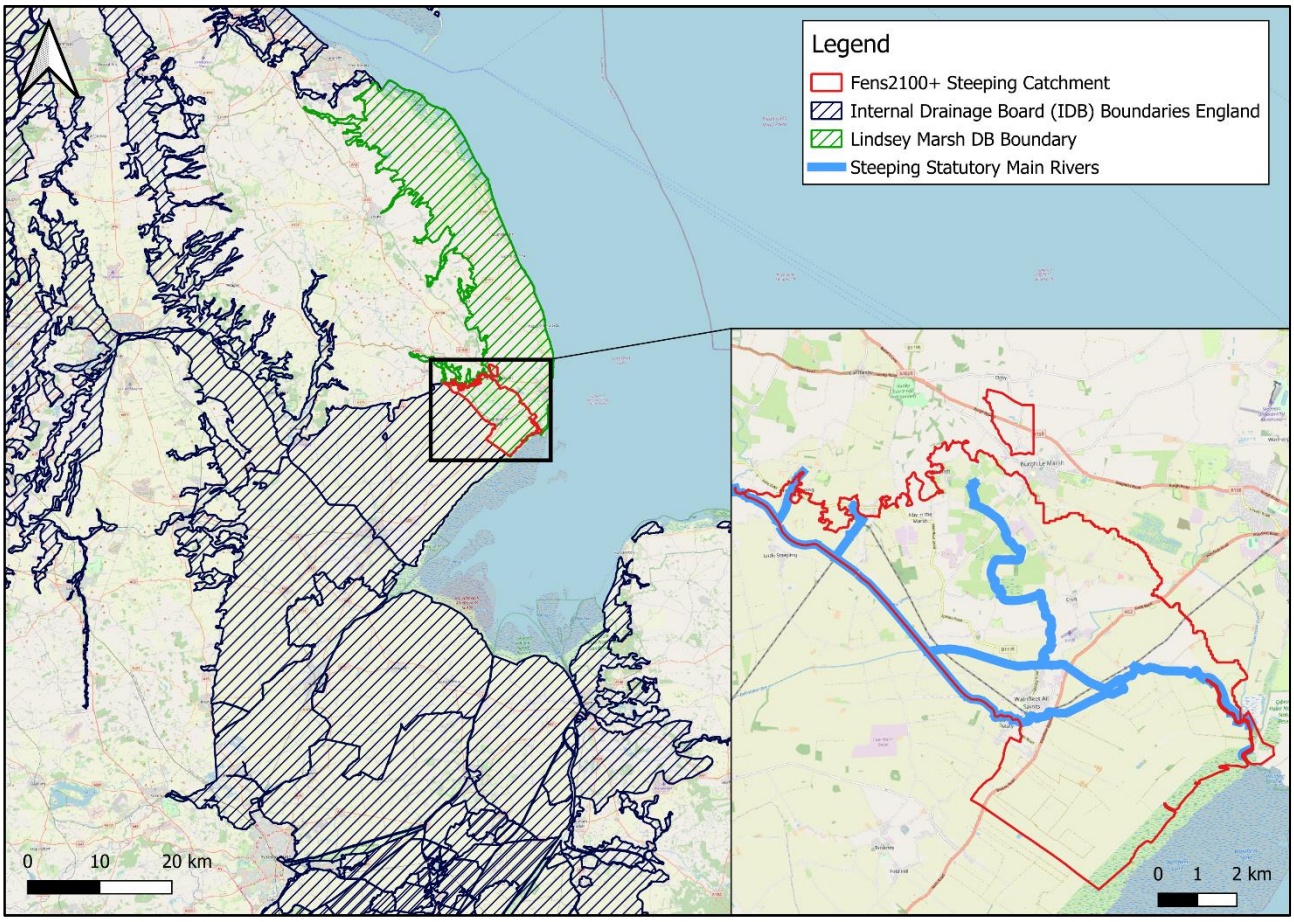

Figure 4: Internal Drainage Boards in the Steeping River catchment

As the outfall to the system at Gibraltar Point is tidal, there are periods when high tide levels prevent discharge of fluvial waters. This restricted period can be extended if surges occur in the tidal waters. There is only a very limited amount of flood storage capacity on the system outside of the river channels. The operation of the Burgh Sluice structure, owned and maintained by the Environment Agency, prevents tidal inundation of the low-lying land.

Figure 5: The tidal outfall of the Steeping River, taken at Burgh Sluice, looking east towards Gibraltar Point and the coast

Figure 6: Burgh Sluice

3. Economic Appraisal Baseline Scenarios

The objective of this economic assessment is to provide a broad assessment of key receptors at risk for the Steeping River catchment. The economic baseline is identified as the Do-Nothing scenario. Further analysis of the present FRM arrangements (the Maintain scenario) is undertaken to evaluate the existing protection and residual risk with the current flood mitigation measures in place, and the benefits of continuing to maintain the existing asset base. The scenarios to be utilised within this appraisal are described within the following sections.

3.1 Do-Nothing scenario

3.1.1 Definition

Due to interdependent activities in managing flood risk across pumped catchments, the cessation of FRM activities will lead to relatively rapid inundation of the catchment from water which is unable to drain due to the cessation of pumping to Main Rivers such as the Steeping River and Wainfleet Relief Channel.

Under the Do-Nothing scenario the pumping stations would cease operating resulting in water being unable to drain and the rainfall would start to fill the catchment. In addition, the sluices on the Main Rivers would cease to operate and cause the rivers to back-up including the gravity outfall at Burgh Sluice. Extreme flood events on the rivers will cause additional flooding that cannot drain away. There will be some loss of water over summer due to evaporation and transpiration, however the water levels would rise steadily over a few years. Coastal sea defences are assumed to be robust and unlikely to fail in the short term. When the water levels in the catchment are high enough they would spill over the sluices and embankments into neighbouring catchments or main rivers.

A rate of catchment fill of 0.5 m per year is applied for the Steeping River catchment. This has been based on the Lower Witham strategy[13]. This rate was estimated based on the average rainfall minus an allowance for evapotranspiration and infiltration. It is assumed that water levels in the catchment will increase by the net rainfall per year, and will be unable to drain, therefore resulting in permanent inundation of land, properties, and infrastructure.

The limiting level to which the Steeping River catchment fills is defined at an individual catchment level, based on barrier banks and high ground. Where subcompartments are used within a catchment, the limiting level may differ within each subcompartment. This can be observed within Figure 7.

[13] Arup (September 2024). Lower Witham Flood Resilience Project – Economic Appraisal Report

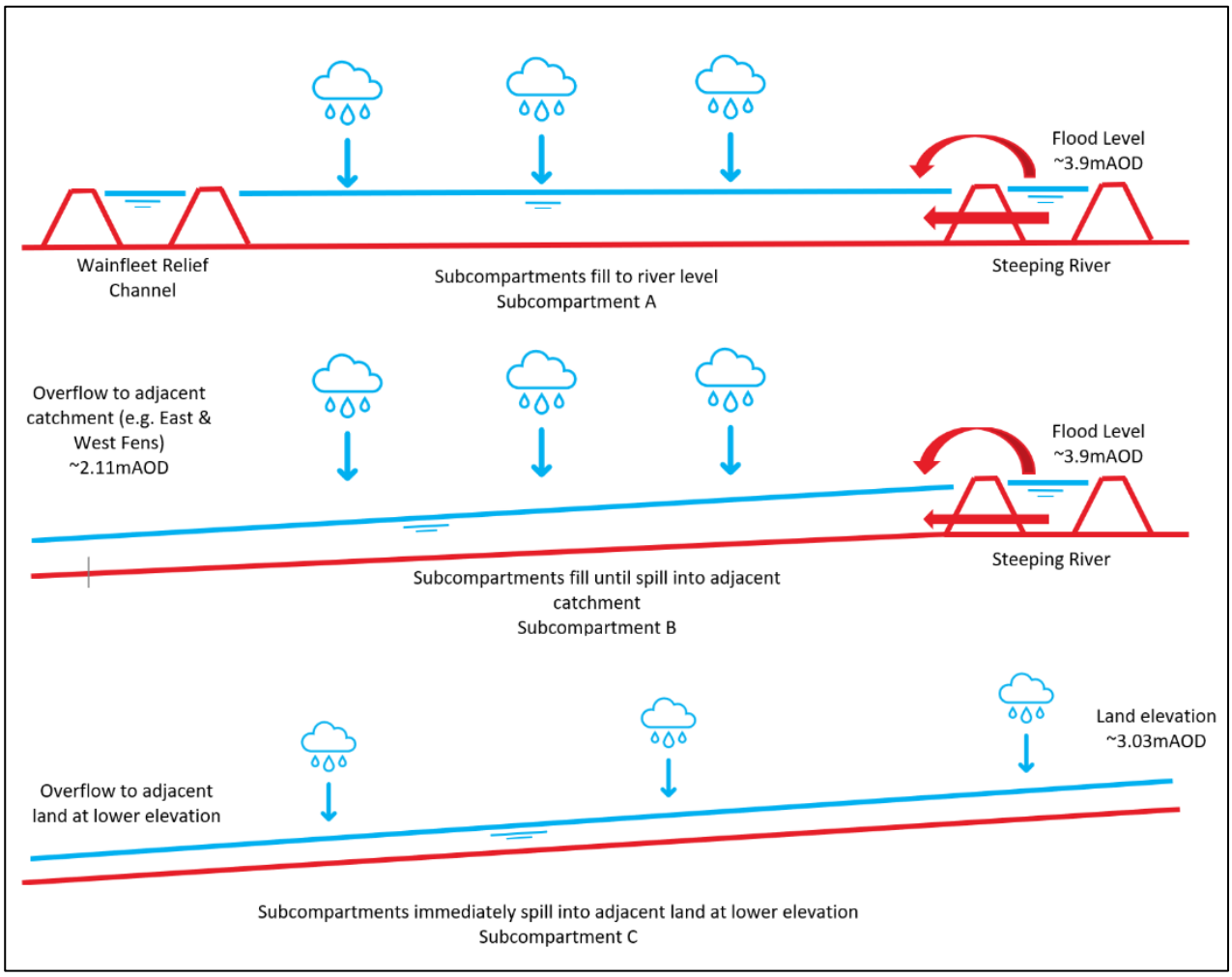

Figure 7: Illustration of the Do-Nothing scenario limiting levels for the Steeping River catchment

3.1.2 Key assumptions

For the baseline economic appraisal, the Steeping River catchment is assumed to be frequently or permanently inundated to the water levels defined by the limiting level, with the rate at which this is achieved based on the rainfall estimates for the catchment. Before properties, land, and infrastructure fall below these water levels, they will be subject to risk from extreme events. This risk is represented using the best available data for the catchment.

A local model is available and, thus, a depth damage approach as opposed to the Weighted Annual Average Damage approach for calculating damage to property is applied for the assessment of damages outside of the permanently flooded area. This approach is defined in the Multi-Coloured Manual[14]. The impacts of climate change are incorporated into the appraisal through representation of increases in peak flows in rivers. Whilst it is acknowledged that sea level rise will lead to an increase in tide locking periods preventing fluvial discharge to the sea, no allowance has been made for sea level rise in this

[14] Flood Hazard Research Centre & Environment Agency. (2013). *Flood and Coastal Erosion Risk Management: A Manual for Economic Appraisal.* Milton Park: Routledge.

assessment as it is considered the impact on the damages assessment would be marginal.

The median ground level across each subcompartment (2.11m AOD for 'A' and 'B', 3.03m for 'C') is taken from LiDAR DTM data to determine a suitable starting point from which water can be assumed to fill the catchment. The starting level of 2.11m AOD for subcompartments 'A' and 'B' has been calculated by taking the median ground level below 3.9m AOD across these subcompartments as well as some of the East and West Fens catchment (Figure 1). This has been done due to their hydraulic connectivity and similar topography with this area anticipated to fill up together. Where subcompartments are used, the starting points to be used are assessed for each subcompartment individually. The rounded starting levels for each subcompartment and subsequent fill over time to each of their limiting levels can be seen in Table 3-1. The limiting levels will vary over time. Initially the limiting levels will be determined by the height of the barrier banks on the Main Rivers; this is the level which the flood water will need to reach before it can spill back into the Main Rivers and be carried away to The Wash. However, under the Do Nothing these barrier banks on the Main Rivers will not be maintained and therefore over time will breach, removing this initial limiting level. Once the Main River barrier banks breach the limiting level will effectively revert to being the tidal level. Whilst the timing of the failure of the Main River barrier banks under the Do Nothing approach with no further maintenance or repairs will vary between locations it is likely to occur in the short to medium term.

To simplify the assessment a limiting level based on MHWS has been used which is much less than the height of the barrier banks and the 33.33% AEP event tidal level. The tidal limiting level of 3.9m AOD has been applied throughout the appraisal period. This assumption is reasonable as the limiting level is likely to be reached within 5-10 years. This 3.9m AOD MHWS level was derived specifically for The Wash using tidal levels from Boston as part of 2020 updates to the Tidal River Nene model[15].

For the subcompartment 'B', the limiting level is similar to the subcompartment median ground level (within ~0.1 m). As such, water above the median level is expected to immediately drain into the adjacent catchment areas as opposed to ponding and increasing water level overtime within the subcompartment; this will be the East & West Fens catchment area for subcompartment 'D'.

For subcompartment 'C', the limiting level is far below the median ground level (~1.0m less). Therefore, water is expected to immediately drain out of the catchment and beyond the study area of Fens 2100+.

These assumptions follow the method statement[16] agreed with the Fens teams and were communicated to key stakeholders.

3.1.3 Flood extents

Based on the assumptions described above, indicative flood extents are generated for the Steeping River catchment by GIS analysis. This involves the use of LiDAR data to define a series of flood extents for specific flooded water levels, i.e., elevation levels (m AOD). The flood extents represent the catchment gradually filling up over time in Figure 9 shows the permanent inundation levels based on this calculation for the Steeping River catchment. The figure shows the starting levels for different subcompartments as well as the limiting

[15] Arup (April 2020). River Nene Modelling Update – Derivation of Updated Tide Curve

[16] Arup (February 2025). Fens 2100+ Proposed Economic Baseline Assumptions: The Steeping

level with 86% of the catchment area inundated by the 3.9m AOD limiting level. The defined permanent inundation levels for each subcompartment are presented in Table 3-1.

Table 3-1: Do Nothing Scenario assumptions regarding water level over time

Appraisal Year (yr)	Water Level (m AOD)		
	A	B	C
Year 0: Environment Agency and IDB cease maintenance of assets (incl. pumping); fluvial water begins to pond across the catchment			
0	2.11	2.11	3.03
1	2.61	2.11	3.03
2	3.11	2.11	3.03
3	3.61	2.11	3.03
4	3.90	2.11	3.03
19	3.90	2.11	3.03
99	3.90	3.90	3.03

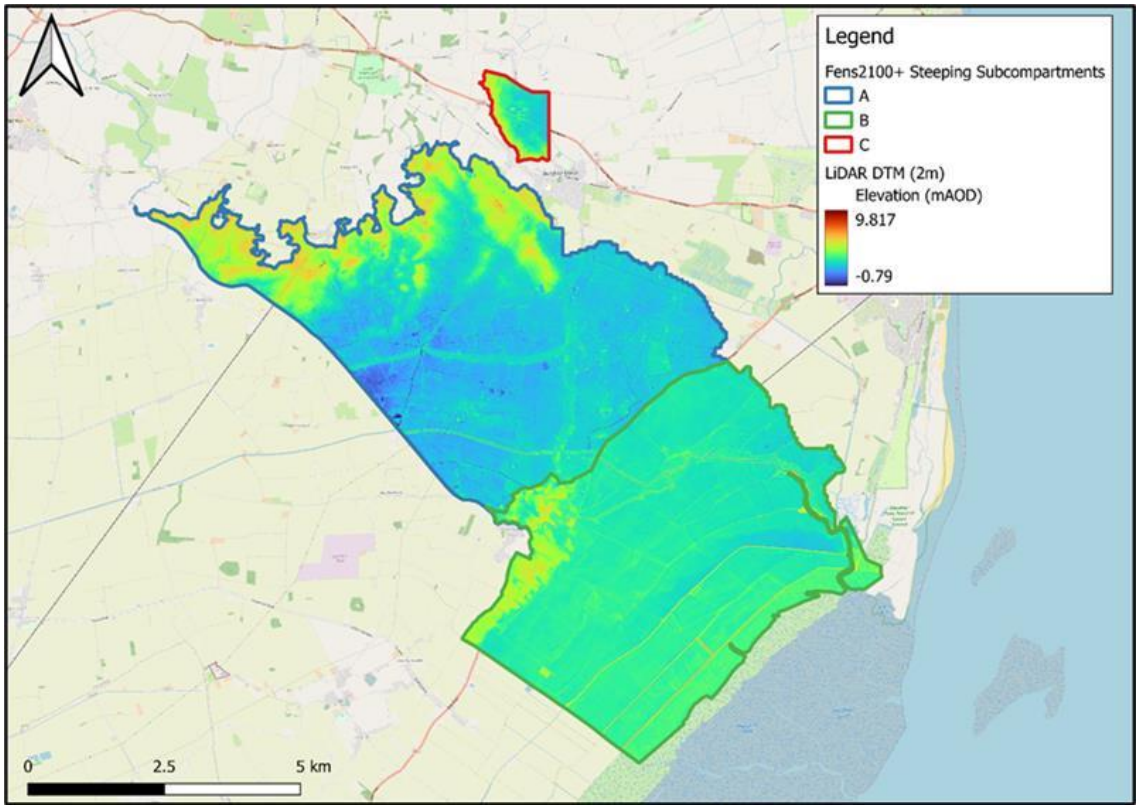

Figure 8: Subcompartments for the Steeping River catchment based on LiDAR DTM (2m) data

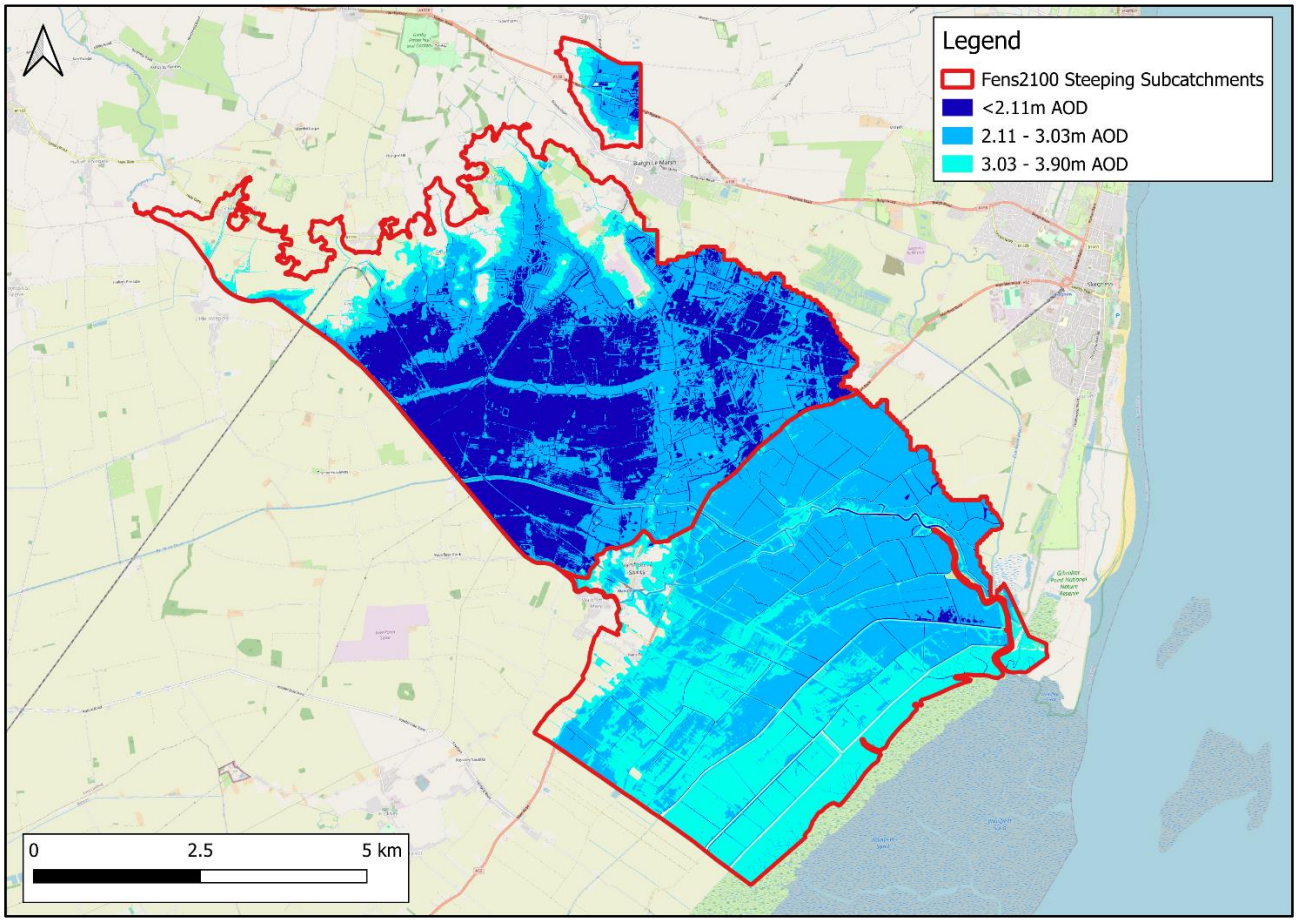

Figure 9: Do Nothing permanent flood extents for the Steeping River catchment

3.1.4 Additional information

It is recognised that under a true Do-Nothing scenario, it is likely that localised flood events would result from blockages in watercourses and FRM assets, and failure of coastal defences. However, this appraisal is focused on valuing broad economic damages using a simplified approach to the generation of the flood extents. For this reason, localised flood events from degrading assets are not included in this analysis. It is also anticipated that, due to the speed with which the catchment is assumed to fill, these events would have relatively minor impacts on the total damages in the Do-Nothing scenario.

Before write-off of land, properties, and infrastructure occurs, these receptors are subject to risk from infrequent extreme storm and tidal events. This risk is represented using the existing local model. To ensure no double counting of damages occurs, this residual risk associated with infrequent extreme events is recalculated for the assets at risk above each water level tabulated in Table 3-1 such that the damages associated with this risk reduce as the permanent water levels in the Do Nothing scenario rise.

3.1.5 Sensitivity test

Sensitivity testing of the Do Nothing scenario focuses on the rate of inundation of low-lying areas. The rate of inundation has been varied from 0.25m (lower estimate) to 0.75m (upper estimate) every year in order to better understand the potential impacts of inundation being less/more rapid than expected. In addition, an extreme scenario has been tested for potential damages if the catchment were to fill to 6m AOD.

3.2 Maintain scenario

3.2.1 Definition

The baseline economic study will also consider a maintain scenario. This scenario will represent the benefits of existing assets being maintained to continue to provide their existing Standard of Service. There will be no allowance for adaption to climate change. It is assumed that this would form the basis of a short-term approach to protecting the area whilst the longer-term strategy is developed. In a maintain scenario, the study area will remain at risk from infrequent flooding in events exceeding the design standard of the existing FRM assets.

3.2.2 Description

The Maintain scenario relates to the present “business as usual” (BAU) approach to fluvial and coastal flood mitigation for the Steeping River catchment. This scenario is based on the best available flood risk data, which indicates the flood risk associated with exceedance of the existing FRM assets. In this scenario it is assumed that the existing FRM assts are maintained in serviceable condition and embankments are maintained to their present crest level.

This scenario will be based on the modelling results from the 2024 Steeping hydraulic model, as described in the Flood Risk report supporting the Steeping Baseline Report.

3.2.3 Flood extents

Local model data is used to inform a depth damage assessment as defined in the Multi-Coloured Manual and is explained in Section 5. The Maintain scenario will be defined by the defended model results from this model.

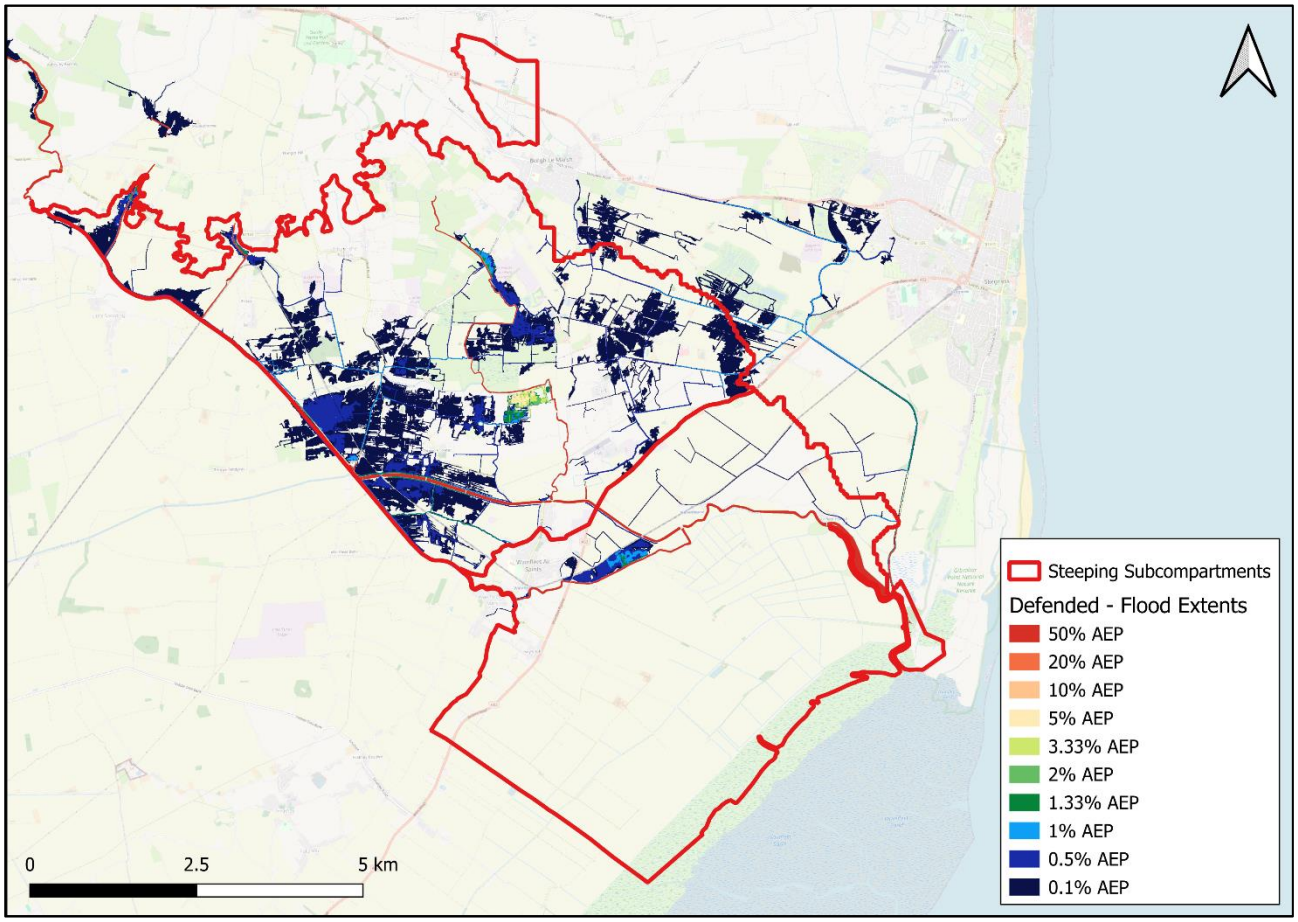

Figure 10: Defended model results from the Steeping model

4. Appraisal Receptors

4.1 Economic appraisal receptors

The Total Impact Framework in Figure 11 identifies a series of common receptors across catchments loosely mapped across the wider determinants of health. The Framework demonstrates that the flood risk across the Steeping River catchment has the potential to significantly impact the social, cultural, political, economic, commercial and environmental factors that shape the environment in which the local communities live, work and thrive.

Receptors bordered in red are those considered as part of this economic assessment.

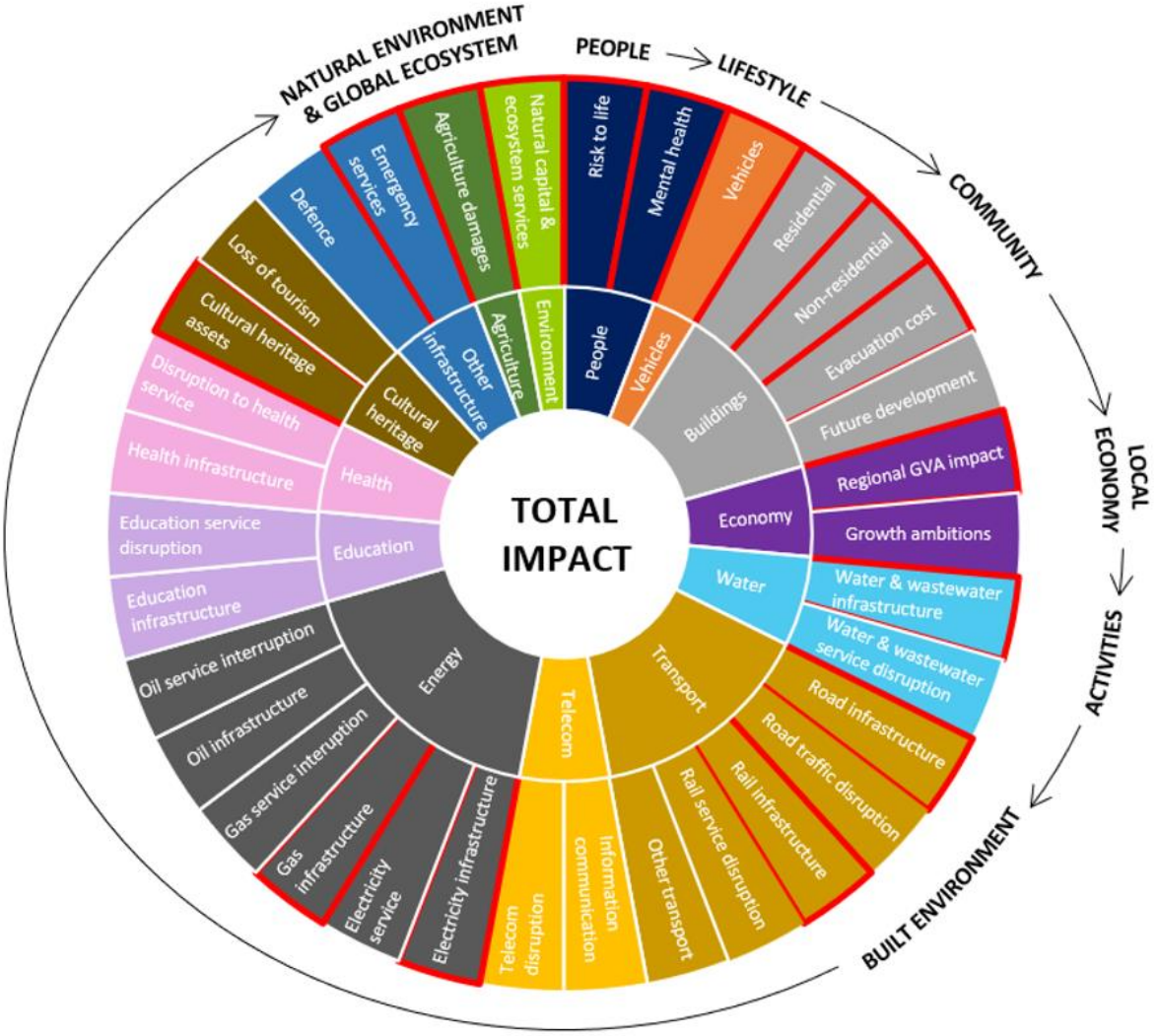

Figure 11: Total Impact Framework

5. Baseline Damages Appraisal

The baseline FCERM economic damages to the nation have been calculated in line with the standard guidance (FCERM Appraisal Guidance[17] (AG) (2022), and HM Treasury Green Book[18] (2022)) and using the Flood Hazard Research Centre's Multi Coloured Manual (MCM) (2013) methodology supplemented by the Multi Coloured Handbook (MCH) and data (2024). A 100-year appraisal period has been assessed, with results also presented for a 20-year appraisal period to inform any development of tactical plans and sustain projects ahead of more strategic long-term decisions being made.

Due to the nature of the project, the economic approach has focused towards defining 'broad-brush' economic damages for key receptors. Further detailed analysis could be undertaken in-line with the needs and requirements of any future stages of the project development and for individual investment business cases.

The following damage streams have been assessed and are described in detail in Sections as indicated:

Section 5.1	Residential and non-residential property damages
Section 5.2	Agricultural losses
Section 5.3	Environmental and recreational losses
Section 5.4	Heritage losses
Section 5.5 to 5.7	Infrastructure (transport & utilities) damages
Section 5.8	Isolated properties and land
Section 5.9	Mental health costs
Section 5.10	Emergency service costs
Section 5.11	Risk to life
Section 5.12	Evacuation and temporary accommodation costs
Section 5.13	Vehicle damages
Section 5.14	Intangible impacts to human health
Section 5.15	Utilities disruption
Section 5.16	Losses to the local economy (as GVA)

All damages have been presented in a 2025 price base, using latest available GDP data from December 2024[19]. Where historic data has been used, this has been uplifted to a 2025 price base using GDP Deflator data.

[17] FCERM appraisal technical guidance - GOV.UK

[18] The Green Book: appraisal and evaluation in central government - GOV.UK

[19] GDP deflators at market prices, and money GDP December 2024 (Quarterly National Accounts) - GOV.UK

It should be noted that in the Steeping catchment, no receptors were found to be at risk in the Maintain scenario for educational disruption or health service disruption and these damages have therefore not been included in this reporting.

5.1 Direct residential and non-residential property damages

Across the Steeping River catchment, there are several village settlements benefiting from the existing FRM activities, including but not limited to Wainfleet All Saints, Croft, Irby in the Marsh, Great Steeping, and Bratoft. Flooding to these rural communities can cause severe disruption to residents and damage to properties, with large financial costs in response and recovery activities and personal expenditure. This remains an area of significant concern for the government and the local communities at risk.

Figure 12: Aerial image of Wainfleet St Mary

5.1.1 Do-Nothing scenario approach

Direct residential and non-residential property damages are the losses to property owners and residents because of the direct inundation of their property from a flood event and considers damage to building fabric and structure. Properties at risk have been identified using the National Receptor Dataset (NRD). Noting that the refreshed 2023 NRD data contains far fewer unknown ‘999’ data points, a sensitivity analysis has been undertaken for these catchments to show the potential impact on benefits should these points be appropriate to include in the damages assessment, as described in Section 5.1.6.

Write off of property is assumed to occur at the point at which the water level in the catchment exceeds the level of the property such that it becomes permanently inundated

or becomes un-inhabitable due to frequency of flooding; the property is written off in the year in which this is assumed to occur, as per specific assumptions made per catchment. The value of that property was taken as the loss and discounted to Present Value using HM Treasury discount rates. Residential properties have been valued based on the regional property valuations for the East Midlands from the MCM Chapter 4 Table 5.9. Non-residential property has been valued based on MCM Chapter 5 Table 5.4 and Chapter 3 Table 3.4 taking rateable values for the East Midlands and using floor areas from NRD; where no floor area is available in NRD data, MasterMap building polygons have been used to determine an appropriate floor area.

Where properties have not been written off, they may be at risk of flooding due to extreme storm and tidal events, in exceedance of the Standard of Service of existing FRM assets. This risk has been assessed using the flood risk data set out in Figure 10**.**

As local model data was available, a depth damage approach was taken, as defined in the MCM. This requires an assessment of the depth of flooding at each individual property in each Annual Exceedance Probability (AEP) event modelled. This depth is cross referenced to the depth damage data in the MCH to determine the direct damages it would cause. The damages calculated from this are used alongside the probability of the events to determine Annual Average Damages for each individual property.

Residential property damages are capped at average market value for the property type. Non-Residential properties are capped based on the rateable value for the property type multiplied by the rental yield factor, and the floor area for the property. Where properties have no floor area, they have been excluded from the analysis – this is recommended as an area for further development as part of any future more detailed appraisals. Damages due to extreme storm events cease to accrue following write-off of the property due to permanent or frequent inundation.

AAD has been reassessed at each flood level as permanent flood levels within the catchment rise to ensure that damages are not double counted, i.e. properties which have been written off by permanent flooding are no longer assessed for AAD. The AAD value has then been forecast across the appraisal period and discounted to understand Present Value (PV) damages to properties.

5.1.2 Maintain scenario approach

For the Maintain scenario, properties are at risk from flooding due to extreme storm and tidal events in exceedance of the Standard of Service for existing FRM assets. Residential and non-residential property damages have been calculated based on the approach to calculating AAD as detailed in Section 5.1.1 with no reduction in AAD over time given that there is no permanent inundation assumed in the Maintain scenario. It has been assumed that there is a flood warning for this assessment. The AAD value has been forecast across the appraisal period and discounted to understand PV damages to properties.

5.1.3 Key assumptions

Table 5-1: Residential and non-residential property data and assumptions

Key assumptions:

Residential property values

Property Type	Market Value (£)
Detached	361,975
Semi-detached	231,449
Terraced	189,400
Flat	140,557
Bungalow	140,557

Source: MCM Handbook. (2024). Chapter 4, Table 4.9 Regional Residential House Prices (2024). East Midlands

Non-residential property values

Type	Market Value £/m²
Retail	1,787
Offices	1,171
Distribution / logistics	598
Leisure	1,093
Playing fields	1,093
Sports centre	1,093
Marina	1,093
Sports Stadium	1,093
Public buildings	1,093
Industry	598
Car Park	1,093
Electricity sub-station	Excluded to avoid double counting with electricity damages
Unknown (999 and 9)	Excluded from this analysis and included as a sensitivity test
Source: Based on MCM Table 5.4 for East Midlands; Savills Research	

Key datasets:

- Steeping model results
- National receptor database
- OS MasterMap
- LIDAR DTM
- MCH Chapter 3, 4, 5 data and tables.

5.1.4 Do-Nothing scenario outcomes

Table 5-2: Do Nothing – number of residential properties impacted (cumulative) and PV residential property losses (cumulative) (£k)

Appraisal year (Year)	Number of residential properties			PV Property losses (£k)		
	A	B	C	A	B	C
0	122	5	15	40,860	2,896	5,038
1	435	5	15	182,004	2,896	5,038
2	716	5	15	416,884	2,896	5,038
3	807	5	15	682,615	2,896	5,038
4	852	5	15	964,415	2,896	5,038
99	852	417	15	964,415	113,063	5,038

Table 5-3: Do Nothing – number of non-residential properties impacted (cumulative) and PV non-residential losses (cumulative) (£k)

Appraisal year (Year)	Number of non-residential properties			PV Property losses (£k)		
	A	B	C	A	B	C
0	15	-	1	1,366	-	43
1	69	-	1	6,397	-	43
2	86	-	1	8,005	-	43
3	88	-	1	8,314	-	43
4	91	-	1	8,578	-	43
99	92	40	1	8,578	142	43

A total of 1,284 residential and 133 non-residential properties are written-off due to inundation in the Do Nothing.

This amounts to a total of £268,182k and £8,621k of residential and non-residential property losses respectively over a 20-year appraisal period. Over a 100-year appraisal period, this amounts to a total of £274,713k and £8,763k of residential and non-residential property losses respectively.

5.1.5 Maintain scenario outcomes

Table 5-4: Maintain scenario – number of residential properties impacted (cumulative) and the associated cash property damages (£k)

Annual Exceedance Probability	Residential properties impacted			Cash property damages (£k)		
	A	B	C	A	B	C
50%	-	-	-	-	-	-
20%	-	-	-	-	-	-
10%	-	-	-	-	-	-
5%	-	-	-	-	-	-
3%	1	-	-	32	-	-
2%	6	-	-	209	-	-
1.33%	10	-	-	340	-	-
1%	18	-	-	591	-	-
0.5%	34	4	-	1,349	69	-
0.1%	71	5	-	4,748	261	-

Table 5-5: Maintain scenario – number of non-residential properties impacted (cumulative) and the associated cash property damages (£k) and cash indirect commercial losses (£k)

Annual Exceedance Probability	Non-residential properties impacted			Cash property damages (£k)			Cash indirect commercial losses (£k)		
	A	B	C	A	B	C	A	B	C
50%	-	-	-	-	-	-	-	-	-
20%	1	-	-	2	-	-	-*	-	-
10%	2	-	-	13	-	-	-*	-	-
5%	2	-	-	50	-	-	1	-	-
3%	2	-	-	57	-	-	2	-	-
2%	2	-	-	63	-	-	2	-	-
1.33%	2	-	-	66	-	-	2	-	-
1%	2	-	-	67	-	-	2	-	-
0.5%	4	-	-	143	-	-	4	-	-
0.1%	12	-	-	521	-	-	16	-	-

*These values are below the £1,000 threshold and therefore not reported in the table. They amount to £51 and £403 for the 20% and 10% AEP respectively.

A total of £212k and £55k is accrued in residential and non-residential PV damages respectively when discounted over the full 100-year appraisal period. In addition, £2k of PV indirect commercial losses is accumulated over the same period of time.

5.1.6 Sensitivity testing

Sensitivity analysis has been undertaken to assess the impact of NRD 999 (classified as unknown receptors) on damages. These have been excluded from the baseline analysis, but for the sensitivity analysis have been included assuming damages equivalent to the non-residential sector average values. This provides an indication of the potential additional damages which could be included if these 999 points were reclassified based on local knowledge, aerial photography or similar, to a more appropriate classification. The results of this sensitivity test are detailed in Table 5-6.

Table 5-6: Do Nothing – number of non-residential properties including MCM code 999 impacted (cumulative) and PV non-residential losses (cumulative) (£k)

Appraisal year (Year)	Number of non-residential properties			PV Property losses (£k)		
	A	B	C	A	B	C
0	125	8	15	32,597	64	9,190
1	443	8	15	106,715	64	9,190
2	728	8	15	205,015	64	9,190
3	822	8	15	414,514	64	9,190
4	870	8	15	414,514	64	9,190
99	870	426	15	414,514	56,377	9,190

5.2 Agricultural losses

The Steeping River catchment and the wider Fens 2100+ study area, which is a region of national agricultural importance due to its fertile soils. The Fens account for around half of the most productive (termed “Grade 1”) agricultural land in England, which supports a nationally important agricultural industry. With a significant proportion of agricultural land across the catchment benefitting from the present FRM activities, frequent flooding or long-term inundation of the catchment would have a significant impact on regional and national food production.

“Although it covers less than 4% of England’s farmed area, the Fens produces more than 7% of England’s total agricultural production, worth a staggering £1.23 billion. The whole food chain, from farm to fork employs 80,000 people – equivalent to the population of Peterborough – and generates more than £3 billion a year for the Fens’ economy” - (NFU, Farming Food in the Fens, 2020).

Figure 13: Agricultural land adjacent to Steeping River

Source: Google StreetView 2025, imagery dated to December 2021

5.2.1 Do-Nothing scenario approach

Flooding of farmland can lead to immediate, as well as long term, crop losses. The scale of impacts is likely to be a function of inundation depth, duration and seasonality. From a tidal perspective, even as flood waters recede, salt deposition from sea water establishes a legacy of soil salinity, negatively affecting the growth of many crops with long-term impacts on soil structure.

Due to the nature of the flooding in the Do-Nothing scenario, it is assumed agricultural land below Do-Nothing ‘write off level’ will be abandoned/written off. Where write off of agricultural land occurs, the valuation of this land has been based on survey data from Knight Frank. It has been conservatively assumed that the valuation of land can be equated to that of average arable and average pastureland from this survey, depending on

the classification of the land use taken from CEH Land Cover Plus Crops data. A value of £600 has been removed from this valuation to account for farming subsidies; whilst the payment of subsidies to farmers from the EU has ceased, the UK government has replaced them with the Environmental Land Management Scheme (ELMS). ELMS is not yet considered mature enough to determine an appropriate alternative subsidy value to use and therefore £600 has been applied as a proxy for ELMS payments.

Where agricultural land is written off, it is recognised that the conversion of land use to an area which is frequently or permanently flooded may result in alternative ecosystem services benefits being provided to the food production benefits provided when in agricultural use. However, permanent inundation is also likely to create contamination issues within the area from increasing salinity, historical land use sources and other sources such as active and disused landfill sites. Over the longer-term, there is uncertainty over whether the area would become a “naturally functioning” system due to the absence of fresh sand supply and the presence of man-made structures within the flooded area. Therefore, these benefits have not been assessed for agricultural areas at this stage. Losses and benefits generated from ecosystem services at existing environmental sites are assessed as part of the Environmental Damages and Benefits assessment (Section 5.3) for non-agricultural land, and a sensitivity analysis has been undertaken to assess potential economic benefits generated from the change in land use of agricultural land in Section 5.2.6.4.

Alongside write off, there is risk owing to extreme storm and tidal events in exceedance of the Standard of Service of the current FRM assets, as represented by the flood risk data noted in Table 5-8. Recognising the importance of agriculture within the Fens, a more detailed methodology to calculate agricultural flood damage due to these events has been used, as opposed to the standard agricultural losses detailed within the MCM (Table 9.20 in the MCM 2013; Tables 9.7 and 9.8 in MCH 2024). The approach is in-line with the detailed scheme appraisal level noted in Chapter 9 of the MCM and was developed as part of the Future Fens (Great Ouse) Economic Appraisal (2020). The approach considered land use and crop types across the catchment and the loss in crop/livestock output and associated loss of value-added (profits) due to flooding and a reduction in agricultural drainage conditions. This approach draws on techniques and analysis undertaken for the Future Fens (Great Ouse) appraisal. Engagement on the methodology with stakeholders was undertaken with a method statement produced ahead of analysis being undertaken and shared with stakeholders.

The analysis utilised the CEH Land Cover plus Crops dataset which is a geographical agricultural land dataset to define land use. This dataset contains information on 11 crop types including a category for ‘other’ crops. The areas (ha) of agricultural land by crop type which are impacted by flooding in the Do-Nothing scenario were interrogated from this dataset and were averaged across three years of recent CEH data to reflect crop rotation activities.

Estimates of annual per hectare gross output, gross margin and net margin were produced for the main crop types following reviews of key datasets and engagement with key stakeholders and farmers across the Witham and Great Ouse catchments during previous projects. The values derived for the Witham catchment have been used as proxies for the remaining catchments, except for the Great Ouse catchment which has its own estimates to account for the higher value of ‘other’ CEH category crops produced in this area. The annual Net Margins (per ha) were multiplied by the areas impacted by flooding in order to determine losses.

Damages due to extreme storm events cease to accrue following write off of agricultural land due to permanent or frequent inundation. Therefore, damages from extreme storm events have been recalculated for the area above each permanent flood level defined in the Do-Nothing scenario such that these decrease over time and there is no double counting of damages.

Appropriate soil saturation is required to successfully yield crops; for instance, if soil is too dry or wet it can result in poor conditions for crops to grow and a field's yield can be severely reduced. Recognising agricultural productivity is critically dependent on standards of land drainage and field water level control, the assessment considered the impact of poor drainage across the catchment due to the gradual filling up of the catchment under the Do-Nothing scenario. By applying a drainage freeboard above the permanent flood level, the area with sub optimal drainage conditions could be calculated. Three categories of freeboard were applied to agricultural land, as described in Table 5-7. Due to the suitability of each drainage class to different agricultural uses, the productivity of land within each drainage class is different (as highlighted in Table 5-7). The annual losses are defined by a move in land categorisation from good to bad or very bad drainage, or permanent inundation.

As the catchments are assumed to be gradually inundated in the Do-Nothing scenario, the freeboard was also assumed to rise over time relative to the assumed permanently inundated water level. This results in increasing levels of reduced productivity across the catchment.

Where land falls into the very bad drainage category, or where it is in the bad drainage category for more than five years, the land is assumed to be written off. As a result, there is a change in land use with associated potential for alternative ecosystem services to be provided. These potential benefits have been calculated as part of a sensitivity analysis due to uncertainty in the time and viability for naturally functioning habitats to develop (Section 5.30).

Table 5-7: Agricultural land drainage assumptions

Category	Freeboard	Assumptions
Permanent inundation	Water level	Agricultural activity ceases due to permanent inundation, as a result of the catchment being unable to appropriately drain.
Very bad drainage	0 – 0.5m above water level	Due to the severity of the very bad drainage conditions, it is assumed for land within this category conventional farming is not viable. Therefore, write off is also assumed for ground levels up to 0.5m above permanent water levels.
Bad drainage	0.5 – 1.5 m above water level	It is assumed that farming activities continue in bad drainage conditions – as in the short-term it is assumed farmers can cover the direct costs of production with the support of the current farm income support. Bad Drainage conditions result in negative margins (£/ha) due to the fact that low yields mean that farmers would fail to recover full costs on areas subject to Bad Drainage. Therefore, for most crops it is not considered a sustainable practice to continue farming in the longer term – as a result, farming activities are assumed to only continue for a period of five years beyond which activities cease and the land is written off.
Good drainage	+1.5m above water level	It is assumed agricultural land 1.5m above permanent water levels is not impacted.

5.2.2 Maintain scenario approach

The modelled data indicates the extents of the catchment impacted by extreme storm and tidal flood events. To define the impacts associated with these events, the losses from short term infrequent flood events for each crop type have been applied to the extents of the agricultural land impacted for each return period modelled. This has followed the same approach detailed for the Do-Nothing scenario based on Annual Net Margins for each crop type impacted. All agricultural land is assumed to have good drainage conditions in the Maintain scenario.

5.2.3 Key assumptions

Table 5-8: Agricultural assumptions

Key assumptions:

Annual Net Margin per ha by Crop Type (£ / ha)

Estimates of net margins for main crops identified in Land cover plus, including high value 'other' (vegetable). These are 'economic' values to the economy rather than financial values to farmers, expressed in 2024 prices.

(£/ha)	Good Drainage	Bad Drainage	Very Bad Drainage
Winter wheat	440	22	-396
Spring wheat	305	145	-14
Winter barley	279	-40	-359
Spring barley	264	123	-17
Field beans	272	147	22
Oilseed Rape	464	280	97
Maize	368	213	57
Beet	571	22	-14
Potatoes	3,167	22	-14
Other Crops	2,601	22	-14
Grass	129	-111	-37

Source: Analysis draws on the CEH Land Cover Plus data, Defra Farming Statistics 2010 and 2016, AgCensus 2010, and Eastern Regional Farm Business Surveys 2013/14 to 2017/18. Estimates of financial performance by crop and livestock type were expressed in 2024 values and adjusted to represent economic values.

Agricultural land valuations

(£/ha)

Crop Type	Assumed Typology	Market Value (£/ha)
Winter wheat	Arable	26,087
Spring wheat	Arable	26,087
Winter barley	Arable	26,087
Spring barley	Arable	26,087
Field beans	Arable	26,087
Oilseed Rape	Arable	26,087
Maize	Arable	26,087
Beet	Arable	26,087
Potatoes	Arable	26,087
Other Crops	Arable	26,087
Grass	Pasture	18,028

Source: Knights Frank, 2021 – Farmland Market Values for Lincolnshire

https://www.fwi.co.uk/business/markets-and-trends/land-markets/find-out-average-farmland-prices-where-you-live

Key assumptions:

Annual Agricultural Losses per Hectare for Short Term Infrequent Flooding (£)

Agricultural Losses per Hectare for Short Term Infrequent Flooding (£) – it is assumed good drainage is available throughout the catchment during the existing maintain scenario.

Crop Type	Floods over 2 weeks (£/ha) - Good Drainage conditions
Winter wheat	440
Spring wheat	305
Winter barley	279
Spring barley	264
Field beans	272
Oilseed Rape	464
Maize	368
Beet	571
Potatoes	3,167
Other Crops	2,601
Grass	129

Source: Analysis draws on the CEH Land Cover Plus data, Defra Farming Statistics 2010 and 2016, AgCensus 2010, and Eastern Regional Farm Business Surveys 2013/14 to 2017/18. Estimates of financial performance by crop and livestock type were expressed in 2022 values (uplifted to 2024) and adjusted to represent economic values.

Key datasets:

- Flood risk data used
- CEH Land Cover plus Crops

5.2.4 Do-Nothing scenario outcomes

Table 5-9: Do Nothing – Area of agricultural write off for the Do Nothing scenario (ha) (cumulative)

Appraisal year	A (ha)	B (ha)	C (ha)
0	1,708	215	64
1	1,902	215	64
2	1,985	215	64
3	2,068	215	64
4	2,129	215	64
5	2,129	2,332	78
9	2,370	2,332	78

Table 5-10: Do Nothing – Agricultural write off PV damages for the Do Nothing scenario with basin fill (£k) (cumulative)

Appraisal year	A (£k)	B (£k)	C (£k)	Total (£k)
0	42,202	8,595	1,606	52,403
1	46,902	11,366	1,612	59,880
2	48,885	14,043	1,619	64,547
3	50,869	16,630	1,625	69,124
4	52,273	19,129	1,631	73,033
5	52,373	66,694	1,920	120,987
6	52,469	66,694	1,920	121,083
7	52,563	66,694	1,920	121,177
8	52,653	66,694	1,920	121,267
9	57,067	66,694	1,920	125,681

Table 5-11: Do Nothing – Residual agricultural PV damages in Steeping model extents with basin fill (£k) (cumulative)

Appraisal year	A (£k)	B (£k)	C (£k)	Total (£k)
0	3	3	-*	6
1	6	5	-*	11
2	8	8	-*	16
3	9	10	-*	19
4	10	13	-*	23
5	12	14	-*	26
6	13	15	-*	28
7	14	17	-*	31
8	15	18	-*	33
9	15	20	-*	35
20	21	31	-*	52
99	32	57	-*	89

*The Steeping model used does not cover the area contained within subcompartment C; therefore, no residual damages for this subcompartment have been included in this assessment.

Table 5-12: Do Nothing – Total PV Damages (£k)

A (£k)	B (£k)	C (£k)	Total (£k)
57,099	66,751	1,920	125,770

5.2.5 Maintain scenario outcomes

Table 5-13: Maintain scenario – Total agricultural cash damages (cumulative) (£k)

Annual Exceedance Probability	Area flooded (ha)			Agricultural cash damages (£k)		
	A	B	C	A	B	C
50%	688	155	-*	895	267	-*
20%	688	155	-*	895	267	-*
10%	688	155	-*	895	267	-*
5%	689	155	-*	898	267	-*
3.33%	690	155	-*	900	267	-*
2%	691	155	-*	902	267	-*
1.33%	694	155	-*	907	268	-*
1%	698	157	-*	914	273	-*
0.5%	739	161	-*	968	287	-*
0.1%	896	167	-*	1,166	305	-*

*The Steeping model used does not cover the area contained within subcompartment C; therefore, no damages in the maintain scenario for this subcompartment have been included in this assessment.

Table 5-14: Maintain scenario – Total PV Damages (£k)

A (£k)	B (£k)	C (£k)	Total (£k)
5,382	1,598	-*	6,980

*The Steeping model used does not cover the area contained within subcompartment C; therefore, no damages in the maintain scenario for this subcompartment have been included in this assessment.

5.2.6 Sensitivity testing

5.2.6.1 Write off method

An alternative method for valuing agricultural write off was tested based on the approach used in the 2020 Great Ouse Fens project. Rather than writing off the land below the Do-Nothing 'write off level' based on land market valuations, agricultural land is valued based on lost productivity of the land at a field scale. The value of losses if the land is written off is assumed to be the lost productivity of the land for the remainder of the appraisal period rather than the land valuation from Knight Frank or similar. This approach was utilised in the Great Ouse following consultation with the NFU and farmers, where it was found that the process of write off was considered to undervalue the land and did not account for the significance of the agricultural sector in the Fens for national food security. The losses accrued beyond write off of land were based on net margins for good drainage conditions.

Table 5-15: Do Nothing – Total PV damages for the Do Nothing scenario using a lost productivity approach (£k)

A (£k)	B (£k)	C (£k)	Total (£k)
36,710	90,689	1,234	128,632

5.2.6.2 Subsidy payments

Agricultural land valuations used in the assessment have been reduced by £600 to account for the ELMS payments (which have replaced EU subsidies) received from the UK Government. A sensitivity analysis has been undertaken to consider the removal of this subsidy from the assessment and thus taking the full land valuation. Further to this, an assessment of an increase in the subsidy to £1,200 has been undertaken, given the uncertainty in ELMS payment rates. This helps to assess the impact of any potential future changes in subsidies and provides a range of possible agricultural damages based on changing understanding of ELMS payment rates.

Table 5-16: Do Nothing – Total PV damages for the Do Nothing scenario with no subsidy or increased subsidy (£1200) (£k)

Subsidy total of £0				Subsidy total of £1,200			
A (£k)	B (£k)	C (£k)	Total (£k)	A (£k)	B (£k)	C (£k)	Total (£k)
58,466	67,950	1,965	128,381	55,732	65,552	1,874	123,159

5.2.6.3 Land subject to bad drainage conditions converting to pasture

The assessment has assumed that land subject to bad drainage conditions will be written off after five years of these conditions (see Table 5-7). This assumption aligns with those made for the Great Ouse and Witham economic baseline assessments undertaken previously. A sensitivity test has been undertaken to assess the impact on agricultural damages should this land be used as pasture rather than written off, and therefore the loss

has been assessed based on the reduction in land market valuations from arable to pasture land (as per the values in Table 5-8).

Table 5-17: Do Nothing – Total PV damages for the Do Nothing scenario with land subject to bad drainage converting to pasture land (£k)

A (£k)	B (£k)	C (£k)	Total (£k)
53,432	29,737	1,679	84,848

5.2.6.4 Land use change – ecosystem service gains

Where permanent flooding occurs, there is the potential for the change in land use to result in alternative ecosystem services being generated. This is aligned to the assessment for environmental damages as described in Section 5.3. There is uncertainty in the viability and timescale for land to become a fully functioning natural habitat after land use change. A period of 50 years has been assumed for transition, after which, agricultural land is assumed to have converted to fully functioning Coastal habitat with ecosystem service benefits valued as per Table 5-20. The total area of agricultural land inundated is therefore multiplied by the value for coastal habitat to determine the annual benefits and is assumed to accrue for the remainder of the appraisal period from a point 50 years after the maximum water level is reached.

Table 5-18 shows the additional ecosystem service benefits which would be accrued should the area change to coastal habitat after 50 years.

Table 5-18: Do Nothing – Total PV benefits as a result of habitat created in the Do Nothing scenario (£k)

A (£k)	B (£k)	C (£k)	Total (£k)
63,471	1,027	1,863	66,361

5.3 Environment and recreational losses

The Steeping River is a distinct, historic and human influenced wetland landscape lying to the north-west of The Wash Estuary (which is a large intertidal bay of ecologically important estuarine mudflats, sandbanks, and saltmarshes). The catchment is notable for its large, flat and open topography with drainage ditches and dykes draining towards the Wainfleet Haven, which flows into The Wash Estuary close to a few distinct environmental designations including local nature reserves like Gibraltar Point, and SSSIs such as The Wash which cover a large proportion of the Steeping River catchment coastline. Permanent inundation could lead to the loss of these habitats and the associated Natural Capital benefits they provide. In addition, these sites plus Public Rights of Way and other open spaces provide significant wellbeing value to local communities and visitors.

It should be noted that the damages and benefits calculated for environmentally designated sites in this section differ from the valuation of ecosystem services presented in the Natural Capital reporting in the baseline report. This is because the Natural Capital reporting provides a total value of ecosystem services currently estimated to be provided across the catchment, whilst this analysis focuses on estimating the impacts and losses of these services, and only for designated sites.

Figure 14: Gibraltar Point National Nature Reserve

Source: VisitLincolnshire (Lincolnshire County Council 2025), Gibraltar Point Sea View

5.3.1 Do-Nothing scenario approach

Damages as a result of the loss of environmentally designated habitats, local nature reserves, Public Rights of Way (PRoW) and other open spaces have been calculated for

the Do-Nothing scenario. It is assumed damages associated with the majority of the remaining rural landscape have been captured as part of the agricultural analysis.

Environmental sites have been identified through the Natural Capital baselining work, with geospatial outputs from that work used to inform this assessment. This captured environmentally designated sites (including Natura 2000, SSSIs, RAMSAR, Local & National Nature Reserves, Special Protection Areas and WTT) for each catchment. In addition, PRoWs and other open spaces have been captured based on data in the ORVal tool (University of Exeter)[20].

Comparison with CEH Land Cover plus Crops data was undertaken to remove any areas included within the agricultural damages assessment and remove the possibility of double counting of damages. However, where agricultural land is written off, an assessment of potential benefits generated through provision of alternative ecosystem services has been undertaken as a sensitivity analysis under the agricultural damages assessment (see section 5.2.6.4).

Estimates of quantified ecosystem service benefits were calculated within the Natural Capital baselining work using the NCRAT tool (with data informing this primarily from the DEFRA ENCA services data-book[21] and ORVal tool[20]). The areas identified as providing ecosystem benefits from this work were compared with the areas of permanent inundation to determine which sites would be lost, and as a result which ecosystem services would be lost. This builds on the work undertaken for the Great Ouse which valued only the most prominent ecosystem services afforded by the designated sites, which are considered to be:

- Carbon – i.e. the sequestration of carbon dioxide from the atmosphere. This varies between types of broad habitats;
- Flood regulation – i.e. some habitats can offer FRM benefits by regulating water flow through the retention and slowing of water;
- Recreation – i.e. environmental settings providing recreational use. The analysis is based on reported visitor numbers and Willingness to Pay (WTP) (£/visit) from the University of Exeter Outdoor Recreation Valuation Tool[20] (ORVal: Version 2.0) for specific site locations, aligned with other WTP for nature conservation sites;
- Biodiversity – i.e. providing habitats to support variability among living organisms, that supports the provision of environmental goods and services to people; and,
- Non-use value – i.e. the benefit of individuals knowing that an aspect of the environment exists and is being, or will be, maintained.

The percentage of the total area of each site lost in each Do-Nothing permanent flood level has been used to determine the loss of ecosystem services based on the total ecosystem services the sites are calculated to provide within the Natural Capital baseline.

The land use will change to coastal habitat, as per the broad definitions used in the Natural Capital baselining, though existing coastal habitats will change to marine habitats. However, no ecosystem service gains are included initially for the area permanently or

[20] Day, B. H., and G. Smith (2018). Outdoor Recreation Valuation (ORVal) User Guide: Version 2.0, Land, Environment, Economics and Policy (LEEP) Institute, Business School, University of Exeter. Available online at: https://www.leep.exeter.ac.uk/orval/.

frequently flooded, as it is considered that this inundation is also likely to create contamination issues within the area, from increasing salinity, historical land use sources and other sources such as active and disused landfill sites. Over the longer-term, there is uncertainty over whether the area may become a “naturally functioning” system due to the absence of fresh sand supply and the presence of man-made structures within the flooded area, potentially limiting the quality of the habitat and the ecosystem services provided. However, it has been assumed that 50 years after the maximum water level is achieved, the change of land use will result in a naturally functioning habitat that will start to deliver ecosystem service benefits. The exception to this is subcompartment B, where it has been assumed that 50 years after the first appraisal year the habitat type will change, due to the contour level of 2.11m AOD being used for the first 99 years of the appraisal period, before rising to the subcompartment maximum of 3.90m AOD in the final appraisal year.

Table 5-19: Habitat designation type and sites impacted

Sites	Habitat Designation Type
Bratoft Meadows	Sem-natural grassland
The Wash Gibraltar Point	Coastal

For recreational losses, wellbeing values associated with the PRoWs and open spaces identified in ORVal[20] have been used to determine potential losses. A displacement factor, representing the number of visitors who would go to an alternative site, has been calculated for each site independently. However, for the Do Nothing scenario with write off across many sites and PRoWs, an average value for displacement has been taken across the entire catchment, as it is considered some of the alternative sites to which it could be assumed visitors would go will also have been lost.

5.3.2 Maintain scenario approach

Losses of ecosystem services in a Maintain scenario are considered likely to occur where flooding is sufficiently frequent that it would impair the ability of the site to deliver these services. It can reasonably be assumed that a site would therefore need to be impacted in a 50% Annual Exceedance Probability (AEP) event, or more frequently, for a habitat to be impacted in this way.

Of the catchments being considered as part of the Fens 2100+ work, only the Steeping River catchment has data to inform risk in a 50% AEP event. The other catchments have insufficient evidence to determine areas which may be affected. Within the Steeping River catchment, the extent for the 50% AEP is extremely small which would suggest that it would not be proportionate or comparable with other catchments to assess losses in a maintain scenario. Therefore, no losses as a result of environmentally designated site damages in the Maintain scenario are being considered as part of this appraisal.

For wellbeing, losses have been estimated for sites which are shown to be impacted by flood risk. It has been assumed that wellbeing value is lost for a period of disruption to the site, assumed to be one week. The losses have been converted into an Annual Average Damage based on probability of events occurring and total loss of wellbeing value as a result.

5.3.3 Key assumptions

Table 5-20: Environmental assumptions

Key assumptions:	
Environmental benefit valuations (DEFRA NCRAT, ENCA[21], ORVal[20])	Economic values drawn from research literature and the ENCA Services data book[21] created by DEFRA indicates economic values associated with a range of factors including carbon storage and residual flood storage. They include selected quantified benefits only and use cautious rates for estimating. Values for recreational benefits are based on the Welfare values taken from the ORVal tool (University of Exeter)[20].
Environmental assumptions	It is recognised that whilst habitats may be lost, permanent inundation may result in the development of new habitats (e.g. wetlands) offering additional benefits. However, inundation is also likely to create contamination issues within the area from increasing salinity, historical land use sources and any other sources such as active and disused landfill sites. Over the longer-term, there is uncertainty over whether the area may become a "naturally functioning" system due to the absence of fresh sand supply and the presence of man-made structures within the flooded area. A conservative estimate of 50 years from maximum water level being reached has been used to determine when a new land use type may start to deliver ecosystem service benefits.

Existing Habitat Type	Total Impact Value (2025) (£)	New Habitat	Change in Total Impact Value (2025) (£)
Wetlands / Freshwater	1,976	Coastal	+5,069
Woodland	2,036	Coastal	+5,010
Semi-natural grassland	462	Coastal	+6,583
Urban	-269	Coastal	+7,314
Enclosed farmland	576	Coastal	+6,470
Marine	874	Marine	-
Coastal	7,045	Marine	-6,171
Mountain, moor and heath	651	Coastal	+6,394

Recreational Asset	Displacement Factor (%)	Maintain Flood Duration (days)
Parks and other recreational sites	35	7
Public rights of way	30	7

Key datasets:

- Natural Capital Baseline assessment
- National Nature Reserves in England
- Local Nature Reserves in England

[21] Department for Environment, Food and Rural Affairs (2025) *Enabling a Natural Capital Approach*. Available online at: https://www.data.gov.uk/dataset/3930b9ca-26c3-489f-900f-6b9eec2602c6/enabling-a-natural-capital-approach.

Key assumptions:
• Site of Special Scientific Interest (SSSI) • ORVal Valuation Data (University of Exeter)[20] • DEFRA ENCA[21] • OS Greenspaces Sites[22] • Rowmaps: Public Rights of Way[23]

5.3.4 Do-Nothing scenario outcomes

The total areas impacted in hectares for the environmental and recreational sites, as well as the lengths of public rights of way, can be seen in Table 5-21, Table 5-22, and Table 5-23 respectively.

Table 5-21: Do Nothing - area of environmental sites impacted (cumulative) (ha) and PV losses from environmental sites (cumulative) (£k)

Appraisal year (Year)	Environmental sites impacted (ha)			PV Environmental losses (£k)		
	A	B	C	A	B	C
0	-*	1	-	-*	8	-
1	2	1	-	1	16	-
2	2	1	-	2	23	-
3	2	1	-	3	30	-
4	2	1	-	3	37	-
99	2	241	-	-39	311	-

*These values are below the £1,000 threshold and therefore not reported in the table. They amount to 0.22ha and £102 for subcompartment A in year 0.

[22] https://www.ordnancesurvey.co.uk/products/os-mastermap-greenspace-layer

[23] Cornelius, B. (no year). Rowmaps: Maps, KML and GPX showing rights of way. Retrieved from: https://www.rowmaps.com/

Table 5-22: Do Nothing – area of recreational sites impacted (cumulative) (ha) and PV damages to recreational sites (cumulative) (£k)

Appraisal year (Year)	Recreational sites impacted (ha)			PV Recreation damages (£k)		
	A	B	C	A	B	C
0	-*	-	-	-*	-	-
1	1	-	-	79	-	-
2	1	-	-	117	-	-
3	1	-	-	136	-	-
4	1	-	-	139	-	-
99	1	1	-	139	8	-

*These values are below the 1ha/£1,000 threshold and therefore not reported in the table. They amount to 0.04ha and £170 for subcompartment A in year 0.

Table 5-23: Do Nothing – length of public rights of way impacted (cumulative) (m) and PV damages to public rights of way (cumulative) (£k)

Appraisal year (Year)	Public rights of way impacted (m)			PV Recreation damages (£k)		
	A	B	C	A	B	C
0	1,670	76	601	1,539	70	553
1	7,655	76	601	6,951	70	553
2	10,594	76	601	9,558	70	553
3	12,314	76	601	11,057	70	553
4	13,304	76	601	11,902	70	553
99	13,304	1,134	601	11,902	75	553

The losses associated with impacted environmental and recreational sites as well as public rights of way result in total damages of £12,950k by the end of the appraisal period. Discounted over the 20-year appraisal period in line with a tactical plan period, the total environmental and recreational damages amount to £12,710k.

5.3.5 Maintain scenario outcomes

Table 5-24: Maintain scenario - area of recreational sites impacted (cumulative) (ha) and the associated cash damages (£k)

Annual Exceedance Probability	Recreational sites impacted (ha)			Cash damages (£k)		
	A	B	C	A	B	C
50%	-*	-	-	-*	-	-
20%	-*	-	-	-*	-	-
10%	-*	-	-	-*	-	-
5%	-*	-	-	-*	-	-
3%	-*	-	-	-*	-	-
2%	-*	-	-	-*	-	-
1.33%	-*	-	-	-*	-	-
1%	-*	-	-	-*	-	-
0.5%	-*	-	-	-*	-	-
0.1%	-*	-	-	-*	-	-

*These values are below the 1ha/£1,000 threshold and therefore not reported in the table. They amount to 0.04ha and £2 for the 50%-0.5% AEPs, and 0.19ha and £45 for the 0.1% AEP respectively.

Table 5-25: Maintain scenario - length of public rights of way impacted (cumulative) (m) and the associated cash damages (£k)

Annual Exceedance Probability	Public rights of way impacted (m)			Cash damages (£k)		
	A	B	C	A	B	C
50%	-	-	-	-	-	-
20%	-	-	-	-	-	-
10%	-	-	-	-	-	-
5%	-	-	-	-	-	-
3%	-	-	-	-	-	-
2%	568	328	-	-*	-*	-
1.33%	579	328	-	-*	-*	-
1%	896	328	-	-*	-*	-
0.5%	1,385	328	-	-*	-*	-
0.1%	3,323	333	-	1	-*	-

*These values are below the £1,000 threshold and therefore not reported in the table. In subcompartment A, they amount to £129, £132, £204, and £315 for the 2%, 1.33%, 1% and 0.5% AEP events respectively. In subcompartment B, they amount to £75 for the 2%-0.5% AEP events, and £76 for the 0.1% AEP event respectively.

These cash damages produce AAD losses of just £9. This gives PV losses of £470 when discounted across the 100-year appraisal period and £151 when discounted across the 20-year tactical plan period.

5.3.6 Sensitivity testing

5.3.6.1 Reduction in valuations used in defining ecosystem services

A sensitivity test has been undertaken to test a reduction in the level of ecosystem service benefits provided by each habitat type. This test has been used to account for potential for:

- double counting of benefits across different ecosystem service types
- uncertainty in the level of ecosystem services a site can provide.

The test has assessed a 25% and 50% reduction in the value of ecosystem service benefits for all habitat types.

Table 5-26: Do Nothing - area of environmental sites impacted (cumulative) (ha) and PV losses from environmental sites (cumulative) (£k) with a 25% reduction in ecosystem service benefits for all habitat types

Appraisal year (Year)	Environmental sites impacted (ha)			PV Environmental losses (£k)		
	A	B	C	A	B	C
0	-*	1	-	-*	6	-
1	2	1	-	1	12	-
2	2	1	-	1	17	-
3	2	1	-	2	23	-
4	2	1	-	3	28	-
99	2	241	-	30	233	-

*These values are below the 1ha/£1,000 threshold and therefore not reported in the table. They amount to 0.22ha and £76 for subcompartment A in year 0.

Table 5-27: Do Nothing - area of environmental sites impacted (cumulative) (ha) and PV losses from environmental sites (cumulative) (£k) with a 50% reduction in ecosystem service benefits for all habitat types

Appraisal year (Year)	Environmental sites impacted (ha)			PV Environmental losses (£k)		
	A	B	C	A	B	C
0	-*	1	-	-*	4	-
1	2	1	-	-*	8	-
2	2	1	-	1	12	-
3	2	1	-	1	15	-
4	2	1	-	2	19	-
99	2	241	-	-20	155	-

*These values are below the 1ha/£1,000 threshold and therefore not reported in the table. They amount to 0.22ha and £51 for subcompartment A in year 0, and £448 for subcompartment B in year 1.

5.3.6.2 Changes in displacement of visitors making use of alternative sites

A sensitivity test has been undertaken to determine the impact of lower or higher displacement of visitors to environmental sites. This has tested a change in displacement by ten and 20 percentage points, both as an increase and a decrease. This sensitivity test

only concerns the Maintain scenario as no displacement factor is considered in the Do Nothing methodology for recreational assets. The results of this sensitivity test are shown in Table 5-28 to Table 5-31.

As all values are below the £1,000 threshold, the following tables are all reported in £ rather than £k.

Table 5-28: Maintain – Cash damages to welfare values of recreational sites when the displacement factor is changed by 20 percentage points

Annual Exceedance Probability	Cash damages (£): +20 percentage points			Cash damages (£): -20 percentage points		
	A	B	C	A	B	C
50%	1	-	-	2	-	-
20%	1	-	-	2	-	-
10%	1	-	-	2	-	-
5%	1	-	-	2	-	-
3%	1	-	-	2	-	-
2%	1	-	-	2	-	-
1.33%	1	-	-	2	-	-
1%	1	-	-	2	-	-
0.5%	1	-	-	2	-	-
0.1%	31	-	-	59	-	-

Table 5-29: Maintain – Cash damages to welfare values of public rights of way when the displacement factor is changed by 20 percentage points

Annual Exceedance Probability	Cash damages (£): +20 percentage points			Cash damages (£): -20 percentage points		
	A	B	C	A	B	C
50%	-	-	-	-	-	-
20%	-	-	-	-	-	-
10%	-	-	-	-	-	-
5%	-	-	-	-	-	-
3%	-	-	-	-	-	-
2%	92	53	-	166	96	-
1.33%	94	53	-	169	96	-
1%	146	53	-	262	96	-
0.5%	225	53	-	405	96	-
0.1%	540	54	-	972	98	-

Table 5-30: Maintain – Cash damages to welfare values of recreational sites when the displacement factor is changed by 10 percentage points

Annual Exceedance Probability	Cash damages (£): +10 percentage points			Cash damages (£): -10 percentage points		
	A	B	C	A	B	C
50%	2	-	-	2	-	-
20%	2	-	-	2	-	-
10%	2	-	-	2	-	-
5%	2	-	-	2	-	-
3%	2	-	-	2	-	-
2%	2	-	-	2	-	-
1.33%	2	-	-	2	-	-
1%	2	-	-	2	-	-
0.5%	2	-	-	2	-	-
0.1%	39	-	-	52	-	-

Table 5-31: Maintain – Cash damages to welfare values of public rights of way when the displacement factor is changed by 10 percentage points

Annual Exceedance Probability	Cash damages (£): +10 percentage points			Cash damages (£): -10 percentage points		
	A	B	C	A	B	C
50%	-	-	-	-	-	-
20%	-	-	-	-	-	-
10%	-	-	-	-	-	-
5%	-	-	-	-	-	-
3%	-	-	-	-	-	-
2%	111	64	-	148	85	-
1.33%	113	64	-	151	85	-
1%	175	64	-	233	85	-
0.5%	270	64	-	360	85	-
0.1%	648	65	-	864	87	-

Changing the displacement factor by ten percentage points results in the PV recreational damages over the 100-year appraisal period to change by 14 percent, that is an increase to £538 and a decrease to £402 from £470. Considering the sensitivity test, which adjusts the displacement factor by 20 percentage points, the PV recreational damages change by 29 percent, which results in an increase of damages to £606 and a decrease to £335.

5.3.6.3 Land use change in the Do Nothing resulting in alternative habitat type

A sensitivity analysis has been undertaken to determine the impact of a change in the habitat type resulting from a change in land use in the Do Nothing. The baseline assessment assumes all areas will become coastal habitat, with existing coastal habitat becoming marine habitat. This sensitivity test assesses the impact on losses or benefits as a result of land use changing to wetlands/freshwater habitat instead, though coastal habitat will still change to marine habitat as previously.

Table 5-32: Do Nothing - area of environmental sites impacted (cumulative) (ha) and PV losses from environmental sites (cumulative) (£k) where non-coastal/marine habitats shift to wetlands/freshwater habitat

Appraisal year (Year)	Environmental sites impacted (ha)			PV Environmental losses (£k)		
	A	B	C	A	B	C
0	-*	1	-	-*	8	-
1	2	1	-	1	16	-
2	2	1	-	2	23	-
3	2	1	-	3	30	-
4	2	1	-	3	37	-
99	2	241	-	9	311	-

*These values are below the 1ha/£1,000 threshold and therefore not reported in the table. They amount to 0.22ha and £102 for subcompartment A in year 0.

As shown in Table 5-32, changing the habitat type from coastal to wetlands/freshwater after 50 years of reaching the maximum contour level per subcompartment (with the exception of subcompartment B, which changes 50 years after the first appraisal year), there is an increase in losses associated with ecosystem service benefits. This is entirely limited to subcompartment A, due to this being the only area that contains present non-coastal/marine habitat types.

5.4 Heritage losses

The Steeping River catchment contains several heritage sites at risk of flooding. The catchment area is covered by many listed buildings and scheduled monuments; a large proportion of these are located in and around the town of Wainfleet. These structures often include elements of timber construction that might be considered more susceptible to flood conditions. In total, there are 50 listed buildings, three being listed as Grade I, with all others being Grade II.

Figure 15: Magdalen College School, Wainfleet All Saints

Source: Dave Hitchborne / Magdalen College School / CC BY-SA 2.0

Figure 16 shows that there are a total of four scheduled monuments in the Steeping River catchment area. The four scheduled monuments are:

- The Magdalen College School;
- Wainfleet All Saints Market Cross;
- Medieval salt works south of Wainfleet All Saints; and,
- Old All Saints Church Churchyard Cross.

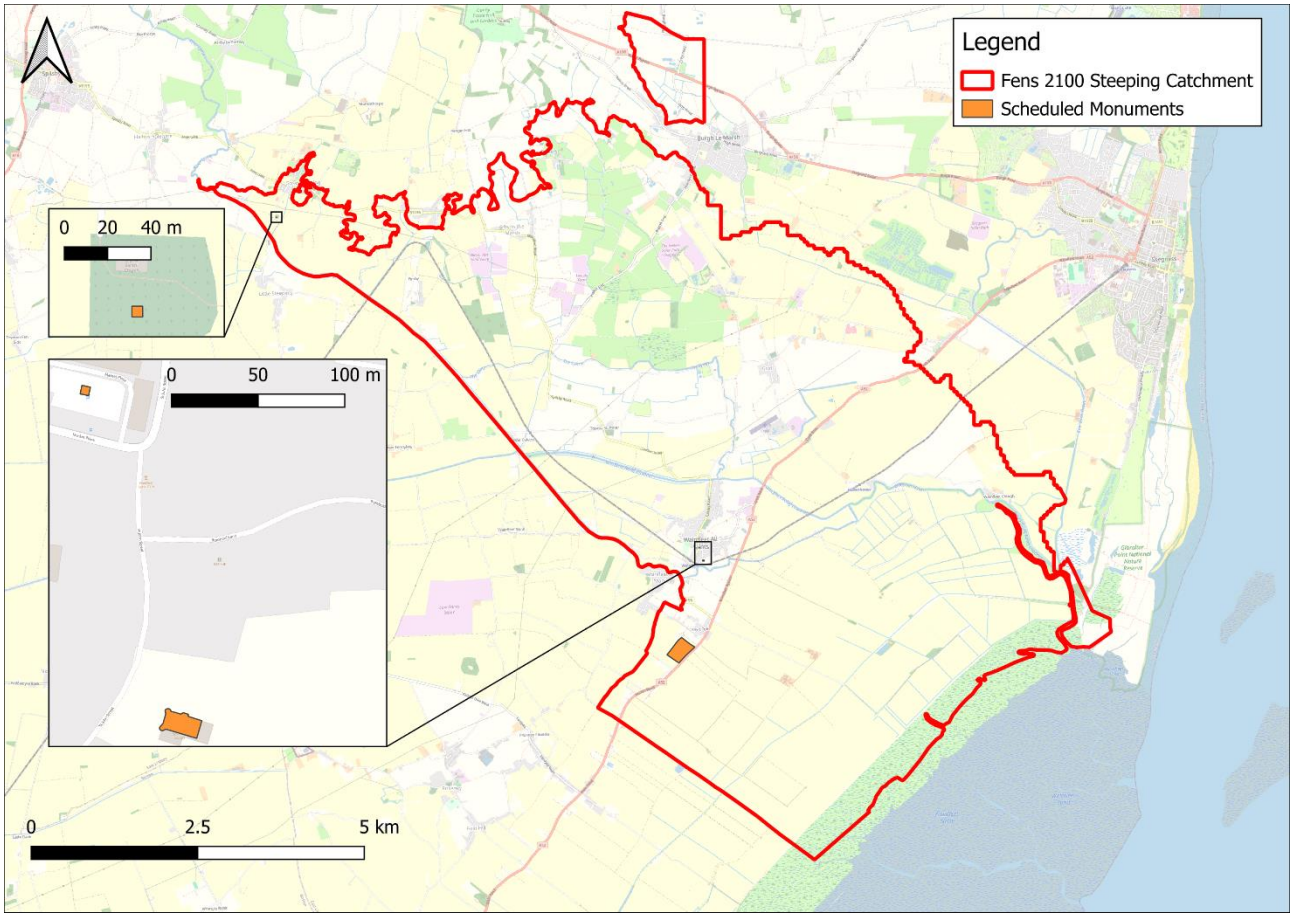

Figure 16: Location of scheduled monuments in the Steeping River catchment area

5.4.1 Do-Nothing scenario approach

Heritage assets at risk of flooding in the catchment area are identified using a range of data sources, which are outlined in Table 5-33. The value of these heritage assets will be calculated using the Department for Culture, Media and Sport (DCMS) Culture and Heritage Capital Evidence Bank[24]. This valuation approach aligns with the Social Cost Benefit Analysis methods in the HM Treasury Green Book Guidance (2020).

Heritage assets are split into broad categories and Willingness-to-pay values are used to define the benefit. These benefits are split into user benefits, for those who visit and use an asset, and non-user benefits which accounts for the value an asset provides to those in the local community who are aware of its existence, and value this, but do not necessarily visit it.

In the Do Nothing scenario write-off damages at each site will be calculated based on the total annual value of heritage capital lost for the area that is permanently inundated, forecast and discounted across the remainder of the appraisal period from the point at which it is lost. Residual AAD will not continue to be accrued for the assets that has been written off.

[24] Rapid Evidence Assessment: Culture and Heritage Valuation Studies - GOV.UK (www.gov.uk)

5.4.2 Maintain scenario approach

For the Maintain scenario the Willingness-to-pay valuations of assets are used along with estimated periods of disruption due to flood risk to determine a disruption cost for the asset being unavailable for a short period of time.

5.4.3 Key assumptions

Table 5-33: Key assumptions for heritage losses

Key assumptions			
DCMS Asset Types and Valuations	**Cultural or Heritage Asset Type**	**Mean Low Willingness to Pay (£, 2025)**	**Mean High Willingness to Pay (£, 2025)**
	Archaeological asset	8	17
	Built heritage	14	25
	Library	233	338
	Museum	36	73
Disruption time in the Maintain scenario	The valuation of heritage assets for this economic appraisal relies on a Willingness to Pay value which is assumed to be an annual value. This brings some limitations with it as some heritage assets may take a year to be fully dried and back in use, whilst others may only need months or weeks, and so when valuing disruption, there may be discrepancies in how much of the Willingness to Pay value is lost due to disruption. A single assumption of 1 year of value is used for simplicity in the assessment given the broad range of potential receptors covered.		
Key datasets: • Department for Digital, Culture, Media and Sport. (2022). Culture and Heritage Capital Evidence Bank. • Historic England. (2023). Listed Buildings. • Historic England. (2023). Scheduled Monuments. • Office for National Statistics. (2024). Lower layer Super Output Area population estimates.			

5.4.4 Do-Nothing scenario outcomes

Table 5-34: Do Nothing - number of heritage assets impacted (cumulative) and PV heritage losses (cumulative) (£k)

Appraisal year (Year)	Heritage assets impacted			PV heritage losses (£k)		
	A	B	C	A	B	C
0	-	-	-	-	-	-
1	2	-	-	576	-	-
2	6	-	-	1,615	-	-
3	12	-	-	3,121	-	-
4	15	-	-	3,819	-	-
99	15	3	-	3,819	1	-

The losses associated with impacted heritage assets in the Do Nothing are shown in Table 5-34. Approximately 18 heritage assets are impacted resulting in total damages of £3,820k by the end of the appraisal period. In addition, we have residual risk of £384 over the 100-year appraisal period in subcompartment A. Discounted over the 20-year period in line with that of a tactical plan, heritage losses amount to £3,819k with an additional residual risk of £241 in subcompartment A.

5.4.5 Maintain scenario outcomes

Table 5-35: Maintain scenario - number of heritage assets impacted (cumulative) and the associated cash damages (£k)

Annual Exceedance Probability	Heritage assets impacted			Cash losses (£k)		
	A	B	C	A	B	C
50%	-	-	-	-	-	-
20%	-	-	-	-	-	-
10%	-	-	-	-	-	-
5%	-	-	-	-	-	-
3%	-	-	-	-	-	-
2%	-	-	-	-	-	-
1.33%	-	-	-	-	-	-
1%	-	-	-	-	-	-
0.5%	-	-	-	-	-	-
0.1%	1	-	-	8	-	-

The AAD and PV losses are below £1,000 and for the purposes of this report are considered negligible and are not reported in £k. These cash damages produce AAD losses of £16. This gives a PV losses of £384 when discounted across the 100-year appraisal period and £241 when discounted across the 20-year period aligning with potential tactical plans, which is used as a sensitivity test.

5.5 Infrastructure damages

The catchment plays host to mostly minor country roads, with major roads limited to the A52 which runs through the centre of the study area and minor sections of the A158 to the north. The East Midlands Railway line, which provides the only rail connection between the major towns of Skegness and Sleaford, along with train stations such as Thorpe Culvert, Wainfleet, and Havenhouse all fall within the defined subcompartments. Other major infrastructure, such as major electrical distribution networks, also cross the catchment.

Whilst infrastructure assets are generally protected to a fairly high standard for infrequent flood events, if the catchment were to become permanently or extensively impacted, vast swathes of infrastructure would be abandoned with alternative capacities or diversions required.

There are localised areas of existing risk, which whilst not primary roads or assets, are key connections between communities. Closures of these connections leads to disruption and local financial losses for businesses such as shops and pubs with customers having to take a longer route to access them or going elsewhere. These localised risks of disruption and financial losses are not captured as part of this assessment.

Figure 17: Wainfleet Bypass (A52), which forms part of the division between subcompartments A (left) and B (right)

Source: Google StreetView 2025, imagery dated to August 2022

Infrastructure assets are assumed to be largely protected to a high standard against short term flooding from infrequent events, and as such only damages associated with the Do-Nothing permanent flooding case have been calculated. The following two sections describe impacts to transport and utilities infrastructure.

5.6 Transport damages

5.6.1 Do-Nothing scenario approach

The Do-Nothing scenario assumes gradual inundation of the catchment resulting in highways infrastructure being written off as flood levels increase across the catchment. Damages from infrequent flood events, as per MCM guidance, are typically calculated based on disruption to traffic or damage repair costs (e.g. resurfacing). In this instance, highways are assumed to be permanently inundated resulting in a loss of the asset. The damage value has been defined from the length of highway impacted at each step-change in inundation of the catchment.

A sense check on highways being written off was undertaken to ensure these were only valued where they connect settlements outside of the catchment and aren't valued where they just serve settlements within the catchment. This is because the highway would cease to have any value if the settlement it serves is lost to permanent inundation.

Further to the consideration of highways written off, the impact on rail infrastructure has also been considered. The same approach as highways is used for railways, with the length of infrastructure impacted used to define the damage value. No allowance has been made for loss of railway stations, as it is considered these would cease to have value when the communities they serve become permanently inundated.

5.6.2 Key assumptions

Table 5-36: Do Nothing transport assumptions

<table>
<tr><th colspan="2">Key assumptions:</th></tr>
<tr><td>Value of lost highway infrastructure</td><td>The value of lost roads has been based on the Future Fens (Great Ouse) economic analysis, which considered recent data from new build road schemes. No further publicly available information was considered to better the information utilised. Costs expressed in 2025 values.
<table><tr><th>Type of Road</th><th>Cost per Metre (£)</th></tr><tr><td>A Road</td><td>22,122</td></tr></table></td></tr>
<tr><td>Roads impacted</td><td>A-Roads and primary roads (such as motorways) have been identified within the catchments using OS Open Roads dataset.</td></tr>
<tr><td>Value of lost railway infrastructure</td><td>The value of lost railway has been based on the Future Fens (Great Ouse) economic analysis, which considered recent data from new build rail schemes. No further publicly available information was considered to better the information utilised. Costs expressed in 2025 values.
<table><tr><th></th><th>Cost per Metre (£)</th></tr><tr><td>Railway cost</td><td>6,301</td></tr></table></td></tr>
<tr><td>Railway impacted</td><td>Railway identified within the catchments using OS Open dataset.</td></tr>
<tr><th colspan="2">Key datasets:</th></tr>
<tr><td colspan="2">• Length and type of highway impacted defined from OS Open Roads dataset (2023)
• Length of railway impacted defined from OS Open dataset (2024)</td></tr>
</table>

5.6.3 Do-Nothing scenario outcomes

Table 5-37: Do-Nothing - length of road network impacted (cumulative) (m) and PV road network damages (cumulative) (£k)

Appraisal year (Year)	Length of road impacted (m)			PV Highways damages (£k)		
	A	B	C	A	B	C
0	7	-	240	155	-	5,309
1	11	-	240	240	-	5,309
2	13	-	240	282	-	5,309
3	146	-	240	2,935	-	5,309
4	467	-	240	9,124	-	5,309
99	467	3,563	240	9,124	4,106	5,309

Table 5-38: Do-Nothing - length of rail network impacted (cumulative) (m) and PV rail network damages (cumulative) (£k)

Appraisal year (Year)	Length of rail impacted (m)			PV Railway damages (£k)		
	A	B	C	A	B	C
0	484	5	-	3,047	32	-
1	3,704	5	-	22,654	32	-
2	4,967	5	-	30,082	32	-
3	5,276	5	-	31,837	32	-
4	5,359	5	-	32,293	32	-
99	5,359	4,930	-	32,293	1,648	-

The damages associated with impacted road and rail networks for the Do-Nothing scenario are seen in Table 5-37 and Table 5-38. Approximately 4,270m of road network is impacted, resulting in total damages of £18,539k by the end of the appraisal period. Around 10,289m of rail network is impacted over the same period, leading to an observed £33,941k of damages. When combined, these damages give us a transport damage total of £52,480k.

5.6.4 Sensitivity testing

Sensitivity testing has been undertaken to assess:

- the valuations used for roads, with variance by 25%; and,
- the valuations used for railways, with variance by 25%.

The damages associated with decreasing and increasing the valuations of roads and railways by 25% each can be seen in Table 5-39 and Table 5-40.

Table 5-39: Do-Nothing - PV road and rail network damages (cumulative) (£k) with a 25% decrease in valuations

Appraisal year (Year)	PV Highways damages (£k)			PV Railway damages (£k)		
	A	B	C	A	B	C
0	116	-	3,982	2,285	24	-
1	180	-	3,982	16,990	24	-
2	212	-	3,982	22,561	24	-
3	2,202	-	3,982	23,878	24	-
4	6,843	-	3,982	24,220	24	-
99	6,843	3,079	3,982	24,220	1,236	-

Table 5-40: Do-Nothing - PV road and rail network damages (cumulative) (£k) with a 25% increase in valuations

Appraisal year (Year)	PV Highways damages (£k)			PV Railway damages (£k)		
	A	B	C	A	B	C
0	194	-	6,637	3,809	40	-
1	300	-	6,637	28,318	40	-
2	352	-	6,637	37,603	40	-
3	3,669	-	6,637	39,796	40	-
4	11,404	-	6,637	40,366	40	-
99	11,404	5,132	6,637	40,366	2,060	-

With a 25% decrease in road valuation, there is a total damage value of £13,904k by the end of the appraisal period. This means that there was a decrease in PV damages of £4,635k, a 25% decrease. Similarly, a 25% decrease in rail valuation resulted in a decrease in PV damages of £8,485k, also a 25% decrease resulting in a total of £25,456k. When combined, these damages give us a transport damage total of £39,360k.

With a 25% increase in road valuation, there is a total damage value of £23,173k by the end of the appraisal period. This means that there was an increase in PV damages of £4,635k, a 25% increase. Similarly, a 25% increase in rail valuation resulted in an increase in PV damages of £8,485k, also a 25% increase resulting in a total of £42,426k. When combined, these damages give us a transport damage total of £65,600k.

Overall, a 25% decrease/increase in road and rail valuation results in a -/+2.3% change in total damages for the Do Nothing scenario, demonstrating the assessment has relatively low sensitivity to valuation of road and rail infrastructure.

5.7 Utilities damages

For each of the utilities damage streams, damages are assumed (conservatively) to include only the assets directly impacted by permanent inundation within the Do-Nothing scenario. This does not account for the wider impacts and disruption likely to occur as parts of the network become flooded but was considered an appropriate approach at this stage where broad representation of damages is required and the data and effort to assess wider disruption would be disproportionate.

5.7.1 Power networks

Data pertaining to power generation assets within the catchments have been obtained from partners. The costs for the construction of infrastructure generating the equivalent power impacted by the Do-Nothing scenario has been calculated based on data from the UK Energy Generation Costs report[25] (Department for Energy Security and Net Zero) and used as a proxy for the value of infrastructure lost.

Electrical distribution assets across the catchments have been identified for Western Power Distribution (WPD), UK Power Networks and National Grid. The damages have been defined by the number of their assets within the permanently inundated extents, based upon publicly available GIS asset databases. This primarily relates to substations and pole tower assets. The value assigned to these assets is detailed in Table 5-41.

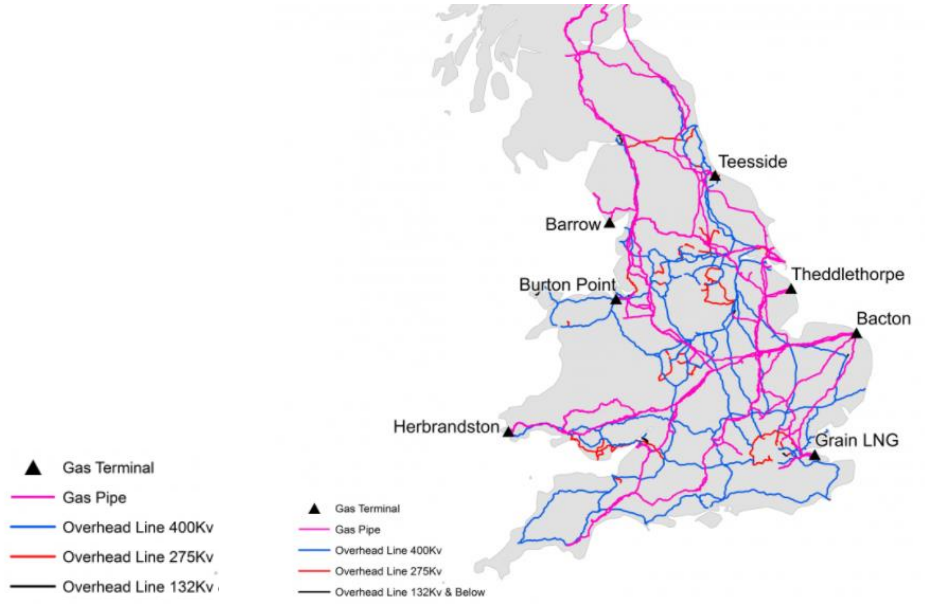

Figure 18: National Grid electricity and gas distribution network

Source: National Grid 2021

5.7.2 Water

Damages to above-ground water utility assets are assumed to have been captured through the NRD datasets, providing a proxy of the damages associated with these assets.

No further data was available from Anglian Water to understand the asset-base at risk of inundation where these assets are not represented in NRD. The value of assets not included within the NRD data is therefore excluded from this assessment.

[25] https://www.gov.uk/government/publications/electricity-generation-costs-2023

5.7.3 Gas

Damages would have been calculated for the loss of National Grid gas distribution assets based on the length (km) of gas main impacted at the permanently inundated water level, with geographically referenced data for the location of the pipeline being obtained from National Grid. However, there were no National Grid gas distribution assets found within the Steeping River catchment. As such, no damages have been calculated.

5.7.4 Key assumptions

Table 5-41: Do Nothing utilities assumptions

<table>
<tr><th colspan="2">Key assumptions:</th></tr>
<tr><td>Electrical asset replacement costs</td><td>Electrical asset replacement costs for Poles and Substations are based on stakeholder engagement undertaken by the Future Fens (Great Ouse) economic analysis with UKPN. Overhead Conductors replacement costs have been derived from data by Electrical Engineering Portal, whilst Underground Cables replacement costs are derived from data by Roadnight Taylor. These costs have been applied across the National Grid and WPD assets as a proxy. All costs are expressed as 2025 values.
<table>
<tr><th>Asset (UKPN & WPD)</th><th>Replacement cost (2025)</th></tr>
<tr><td>Pole Tower (33kV)</td><td>£3,752</td></tr>
<tr><td>Pole Tower (11kV)</td><td>£3,752</td></tr>
<tr><td>Substation (132kV)</td><td>£3,877,438</td></tr>
<tr><td>Substation (33kV)</td><td>£93,809</td></tr>
<tr><td>Substation (11kV)</td><td>£31,270</td></tr>
<tr><td>Overhead Conductors (132kV)</td><td>£144 per m</td></tr>
<tr><td>Overhead Conductors (33kV)</td><td>£58 per m</td></tr>
<tr><td>Overhead Conductors (11kV)</td><td>£23 per m</td></tr>
<tr><td>Underground Cables (33kV)</td><td>£339 per m</td></tr>
<tr><td>Underground Cables (11kV)</td><td>£169 per m</td></tr>
</table></td></tr>
<tr><td>Electricity assumptions</td><td>Costs relating to safe clearance of temporarily and permanently flooded assets have not been provided, nor have costs for a new submarine power network. Should the network become permanently inundated, the assets will be abandoned. Indirect damages from power outages outside the study area are not captured as part of this appraisal.</td></tr>
<tr><th colspan="2">Key datasets:</th></tr>
<tr><td colspan="2">• Electricity: Western Power Distribution and National Grid geographical datasets of their assets
• How close does an energy scheme need to be to an electricity network? | Roadnight Taylor
• Typical constructions of overhead lines (electrical-engineering-portal.com)</td></tr>
</table>

5.7.5 Do-Nothing outcomes

Table 5-42: Do-Nothing – number of pole towers and substations impacted (cumulative), and length of overhead conductors and underground cables impacted (cumulative) (m)

Appraisal year (Year)	Number of pole towers impacted (all)			Number of substations impacted (all)			Length of overhead conductors impacted (all) (m)			Length of underground cables impacted (all) (m)		
	A	B	C	A	B	C	A	B	C	A	B	C
0	165	6	10	20	-	1	20,947	570	595	2,581	-	42
1	380	6	10	58	-	1	44,496	570	595	9,417	-	42
2	413	6	10	68	-	1	48,150	570	595	12,602	-	42
3	437	6	10	75	-	1	50,354	570	595	13,678	-	42
4	452	6	10	77	-	1	51,594	570	595	14,384	-	42
99	452	205	10	77	28	1	51,594	18,767	595	14,384	1,996	42

Table 5-43: Do-Nothing - PV electrical network damages (cumulative) (£k)

Appraisal year (Year)	PV Electricity damages (£k)		
	A	B	C
0	3,256	36	90
1	11,975	36	90
2	13,103	36	90
3	13,682	36	90
4	13,944	36	90
99	13,944	160	90

The total lengths and counts of electrical utilities impacted for the Do-Nothing scenario can be found in Table 5-42, with damage totals for both located in Table 5-43. There is no gas pipeline located within the Steeping River catchment; therefore, no damages have been accrued. By the end of the appraisal period, around 667 pole towers and 106 substations are impacted during the final inundation level, whilst approximately 87,378m of overhead conductor and underground cables are impacted, resulting in total electricity damages of £14,193k.

5.7.6 Sensitivity testing

A sensitivity analysis has been undertaken to assess the impact of varying the valuation for electricity distribution assets by 10%, both as an increase and a decrease. The damages associated with decreasing and increasing the valuations of these assets by 10% can be seen in Table 5-44.

Table 5-44: Do-Nothing - PV electrical network damages with -/+10% valuations (cumulative) (£k)

Appraisal year (Year)	PV Electricity damages with -10% valuation (£k)			PV Electricity damages with +10% valuation (£k)		
	A	B	C	A	B	C
0	2,930	32	81	3,582	39	99
1	10,778	32	81	13,173	39	99
2	11,792	32	81	14,413	39	99
3	12,314	32	81	15,051	39	99
4	12,549	32	81	15,338	39	99
99	12,549	144	81	15,338	176	99

With a 10% decrease in electrical distribution asset valuation, there is a total damage value of £12,774k by the end of the appraisal period. This means that there was a decrease in PV damages of £1,419k, a 10% decrease. With a 10% increase in electrical distribution asset valuation, there is a total damage value of £15,612k by the end of the appraisal period. This means that there was an increase in PV damages of £1,419k, a 10% increase.

Overall, a 10% decrease/increase in electricity distribution asset valuations results in a -/+0.25% change in total damages for the Do Nothing scenario demonstrating the assessment has a low sensitivity to changes in the valuation of electricity infrastructure.

5.8 Isolated land and properties

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. This aspect looks to account for the notion that areas of elevated land may not be directly flooded, but if surrounded by water are likely to be abandoned - with similar impacts to that of the damage streams described prior.

The term 'isolated properties' includes properties that are cut-off from existing road networks due to inundation, thus properties that are not flooded but are able to access an existing road network to either leave the study area and/or navigate around flooded extents through a longer, more indirect routes are not classified as 'isolated'.

Similarly, properties that are scattered and/or are not part of a geographic cluster of isolated properties that share an existing road connection are not classified as being part of an 'isolated community'. In order to be classified as a community, a cluster of isolated properties that share a road network connection must be comprised of at least 10 NRD receptors with a non-9/999 value.

5.8.1 Do-Nothing scenario approach

In accordance with HM Treasury Green Book[26] guidance, the analysis looks to define the “lowest cost to the nation”. As such, the approach considered damages associated with isolated areas (at the point of permanent inundation) which are assumed to be abandoned; these costs were compared to cost of re-provision of services and to reconnect the isolated communities to the ‘mainland’. This has conservatively been based on the cost of a new road to the isolated community utilising the same costs as described in Section 5.6. It is assumed new services could be provided along the route of any new raised road.

Whilst abandonment is considered to be the most likely scenario or outcome if a Do-Nothing event were to occur, recognising that the community would have no wider flood defence measures and be extremely vulnerable to coastal storm events, the approach taken provides a conservative estimate of potential losses where there is uncertainty.

The analysis has focused towards identifying isolated populated communities. Each settlement’s residential and non-residential properties have been identified and values associated with their abandonment defined (as per the approach described in Section 5.1). Recognising the high-level nature of this assessment, it is assumed the majority of the losses associated with isolated agricultural land have been captured as part of the agricultural land assessment, and due to the small spatial extents, it is not considered to be proportionate to define isolated agricultural land losses. This logic also applies to the analysis of wider isolated infrastructure and environmental designations.

[26] The Green Book: appraisal and evaluation in central government - GOV.UK

5.8.2 Key assumptions

Table 5-45: Key assumptions for isolated property damages

<table>
<tr><th colspan="2">Key assumptions</th></tr>
<tr><td>Isolated community connection costs</td><td>Road connection costs are based on ‘A Road’ costs seen in Section 5.6. Costs are then multiplied by a factor of 2 to allow for uncertainty and complications of raising road above flood level. Electricity Distribution costs (per km) associated with raising roads has been provided by National Grid and Western Power Network. Likewise, water utilities costs have been provided by Anglian Water. All costs are assumed to be from 2021, with costs uplifted to 2025 values.
<table>
<tr><th>Element</th><th>Cost / m</th></tr>
<tr><td>Road</td><td>£44,244</td></tr>
<tr><td>Electricity Distribution</td><td>£1,399</td></tr>
<tr><td>Water Utilities</td><td>£1,786</td></tr>
</table></td></tr>
<tr><td>Defining isolated properties</td><td>Due to the rural nature of the catchments across the Fens, transport access through roads was used to determine isolation of properties due to the distances between rural settlements being deemed too great for pedestrian use. Whilst certain footpaths may not be inundated, we cannot assume all pedestrians have equal capability to carry out daily tasks on foot (elderly, physically disabled, etc.), even in more well-connected urban areas.</td></tr>
</table>

5.8.3 Do-Nothing scenario outcomes

The total PV costs for isolated communities are shown in Table 5-46. Isolated communities and properties were determined whilst observing the maximum contour level flood extents for a given subcompartment, these being 3.90m and 3.03m for subcompartments A and C respectively. The exception to this is subcompartment B, where the contour level of 2.11m AOD was used due to this level being used for the first 99 years of the appraisal period, before rising to 3.90m AOD in the final appraisal year.

Table 5-46: Do-Nothing - summary of which communities were reconnected or abandoned as well as the discounted costs (£k) for the preferred option

Community	Write-off costs (£k)	Distance for reconnection (m)	Reconnection costs (£k)	Reconnected	Abandoned	Total Discounted Costs (£k)
1	7,949	301	14,267	No	Yes	6,927
2	5,376	546	25,875	No	Yes	4,685
3	4,706	388	18,392	No	Yes	4,706
4	4,991	143	6,768	No	Yes	4,991
5	7,963	225	10,677	No	Yes	7,963

Across subcompartments A, B, and C, there were only 5 isolated communities identified. The location of these isolated communities is shown in Figure 19. For all 5 communities, it was found to be more cost-effective to write-off the communities than to reconnect the communities to nearby road networks through building raised roads.

Total PV Damages for communities at risk of isolation is £29,272k.

Table 5-47: Do-Nothing - summary of residential and non-residential cumulative write-off costs for isolated properties, as well as the discounted costs (£k) per year

Appraisal year (Year)	Residential write-off costs (£k)			Non-residential write-off costs (£k)			Total discounted write-off costs (£k)
	A	B	C	A	B	C	
0	-	-	3,359	-	-	6,075	9,434
1	-	-	3,359	-	-	6,075	9,434
2	-	-	3,359	-	-	6,075	9,434
3	-	-	3,359	-	-	6,075	9,434
4	22,898	-	3,359	724	-	6,075	33,056

For isolated properties not within a wider, confined community like those in Table 5-46, write-off costs for were totalled and can be seen in Table 5-47. By year 4 of the appraisal period, total discounted PV write-off costs of £33,056k are observed across subcompartments A, B, and C. The majority of this value originates from subcompartment A, whilst subcompartment B was shown to have no isolated properties due to the limited flooding observed with a 2.11m AOD contour level.

Therefore, total PV Damages for Isolated land and properties, accounting for those in communities and those not, are £62,328k.

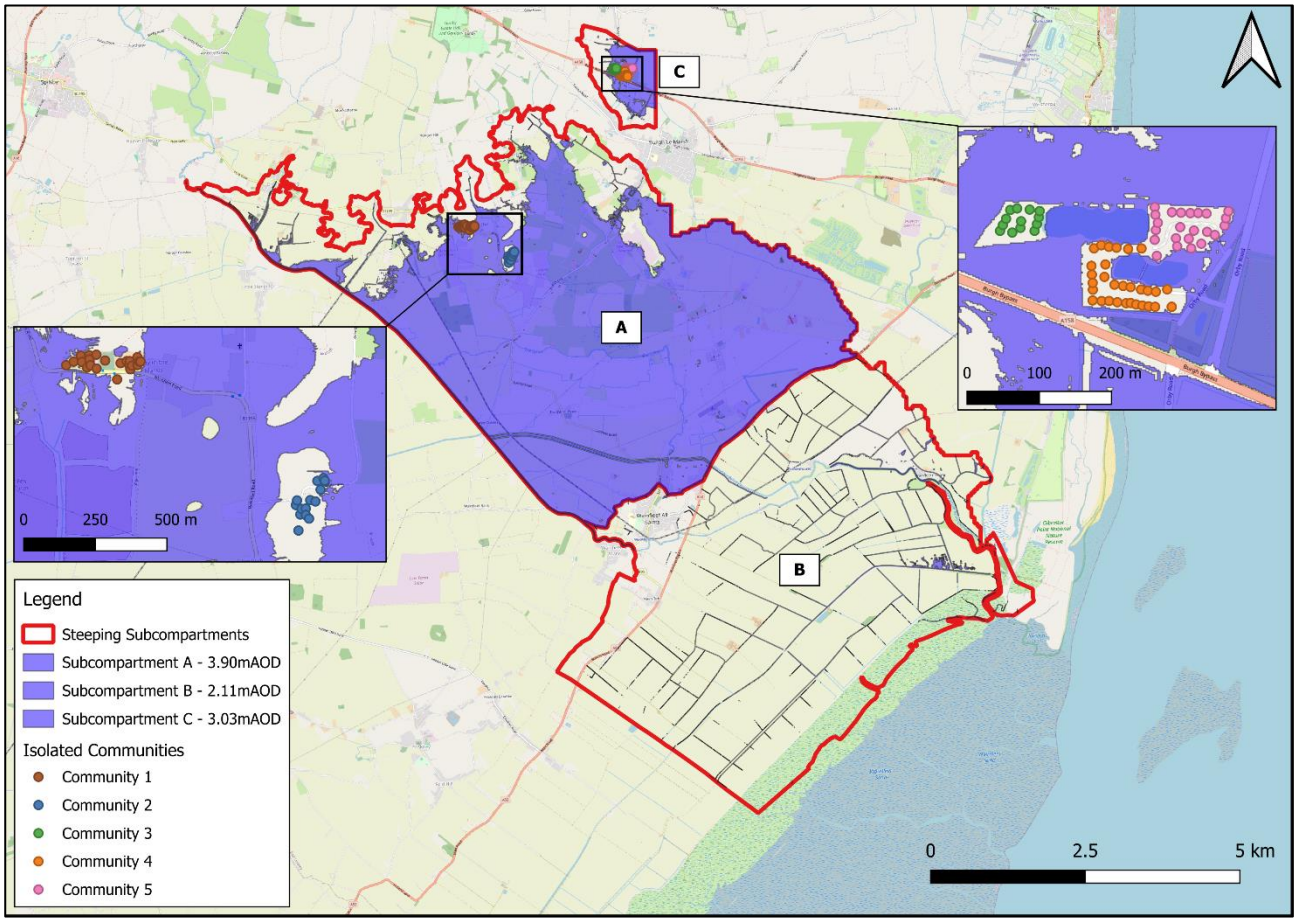

Figure 19: Location of the isolated communities

5.8.4 Sensitivity testing

Sensitivity testing has been undertaken to assess the impact of including unknown '999' NRD receptors into the calculations using non-residential sector average values. This only impacts those settlements for which the cost of property write off is lower than the cost of reconnecting the land to the 'mainland'.

The total costs for isolated communities including unknown '999' NRD receptors are shown in Table 5-49.

Table 5-48: Do-Nothing - summary of which communities were reconnected or abandoned whilst including unknown '999' NRD receptors, as well as the discounted costs (£k) for the preferred option

Community	Write-off costs (£k)	Distance for reconnection (m)	Reconnection costs (£k)	Reconnected	Abandoned	Total Discounted Costs (£k)
0	9,345	301	14,267	No	Yes	8,143
1	5,376	546	25,875	No	Yes	4,685
2	4,706	388	18,392	No	Yes	4,706
3	6,407	143	6,768	No	Yes	6,407
4	8,061	225	10,677	No	Yes	8,061

Table 5-49: Do-Nothing - summary of residential and non-residential cumulative write-off costs for isolated properties whilst including unknown '999' NRD receptors, as well as the discounted costs (£k) per year

Appraisal year (Year)	Residential write-off costs (£k)			Non-residential write-off costs (£k)			Total discounted write-off costs (£k)
	A	B	C	A	B	C	
0	-	-	3,359	-	-	6,879	10,238
1	-	-	3,359	-	-	6,879	10,238
2	-	-	3,359	-	-	6,879	10,238
3	-	-	3,359	-	-	6,879	10,238
4	22,898	-	3,359	3,385	-	6,879	36,521

5.9 Mental health costs

The impacts on mental health due to the higher rates of anxiety, depression and post-traumatic stress disorder after a flood event have been calculated using the latest guidance from the Environment Agency. The costs associated with these illnesses include treatment costs and the loss of employment. Co-morbidity and the proportion of those seeking treatment have also been considered.

This damage was only calculated for the Maintain scenario as it is assumed that under the Do-Nothing scenario residents will have left the catchment.

The number of adults in each residential property was determined and this was then multiplied by the mental health costs per adult for each flood depth band. The methodology defined in the Environment Agency's mental health costs of flooding and erosion guidance was followed.

Table 5-50: Mental health costs

	Depth	Mental health cost (£)	
Mental health losses per adult by flood depth	0 - 0.3m	£1,924	Source: Environment Agency Mental health costs of flooding and erosion guidance[27] (2025 values)
	0.3 - 1m	£3,102	
	More than 1m	£4,237	

5.9.1 Maintain scenario outcomes

Table 5-51: Maintain - PV mental health costs (£k)

Appraisal period (years)	PV Mental health costs (£k)			
	A	B	C	Total
100	19	2	-	20

Total PV mental health costs over the 100-year appraisal period are £20k.

[27] Mental health costs of flooding and erosion - GOV.UK

5.10 Emergency service costs

Emergency service costs are calculated to account for the cost of police, fire, ambulance, local authority, and Environment Agency response to flood incidents. This has been estimated at 10.7% of the total cost of direct damages to properties as befits a rural area, in line with MCM guidance. This damage was only calculated for the Maintain scenario as it is assumed that under the Do-Nothing scenario residents will have left the catchment and so do not require the emergency services.

5.10.1 Maintain scenario outcomes

Table 5-52: Maintain - PV emergency services costs (£k)

Appraisal period (years)	PV Emergency services costs (£k)			
	A	B	C	Total
100	50	2	-	52

Total PV emergency service costs over the 100-year appraisal period are £52k.

5.11 Risk to life

Risk to life assesses the potential for loss of life as a result of flooding. The analysis defines a value for the number of fatalities likely, taking into account the severity of flooding defined by the depth of flooding and hazard, as well as the demographics and characteristics of the area at risk. This value is multiplied by the valuation of a life.

This damage was only calculated for the Maintain scenario as it is assumed that under the Do-Nothing scenario residents will have left the catchments. The methodology has followed the Defra supplementary guidance note 'Assessing and Valuing the Risk to Life from Flooding' (May, 2008).

This damage was only calculated for the Maintain scenario as it is assumed that under the Do-Nothing scenario residents will have left the catchment.

Table 5-53: Risk to Life parameters and assumptions

Parameter name	Parameter	Source
Average number of people per property	~2.19	Defined using data from Census 2021 and varies between each subcompartment Office for National Statistics (ONS); Census 2021 (East Lindsey LAD)[28]
Percentage elderly (> 75yrs) (k%)	~14	
Percentage disabled or infirm (%)	~22	
Reference value of a life	£2,209,537	Reference Table A 4.1.1: Source: DfT Webtag parameters, November 2021 (2010 value), uplifted to 2025 using projected GDP deflator[29]
Flood warning	England – 2.15	Defra/Environment Agency.2006). R&D Outputs: Flood Risks to People, Phase 2, FD2321/TR1, The Flood Risks to People Methodology.[30]
Speed of Onset	2 – Gradual	
Nature of area	Typical residential area (2 storey homes); industrial & commercial properties	
Nature of catchment	Pasture / Arable	

[28] https://www.ons.gov.uk/census/maps

[29]https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fassets.publishing.service.gov.uk%2Fmedia%2F67350f5e54652d03d51610db%2Ftag-data-book-v1.24-nov-2024-v1.0.xlsm

[30]https://assets.publishing.service.gov.uk/media/602bbc768fa8f50383c41f80/Flood_risks_to_people_-_Phase_2_The_flood_risks_to_people_methodology_technical_report.pdf

5.11.1 Maintain scenario outcomes

Table 5-54: Maintain - PV risk to life (£k)

Appraisal period (years)	PV Risk to Life (£k)			
	A	B	C	Total
100	924	4	-	927

Total PV risk to life over the 100-year appraisal period is £927k. This value is disproportionately high when compared to the residential and non-residential property damages over the same period. This is due to the presence of perched watercourses within the Steeping catchment resulting in extremely high velocities during overtopping events compared to depth values which impacts the hazard rating and thus leading to a disproportionately greater risk to life damage value.

5.12 Evacuation and temporary accommodation costs

The evacuation and relocation of people from flood affected residential properties is often undertaken as a short-term emergency response to flooding. In addition to where residential properties are affected by flooding, evacuation form the property may also be necessary to allow flood damage to be repaired. In such cases, evacuation requires temporary or alternative accommodation for households affected and this incurs costs. To calculate this, the full-scale mid values stated in the MCM 2024 handbook for the cost of temporary accommodation and relocation were used.

This damage was only calculated for the Maintain scenario as it is assumed that under the Do-Nothing scenario residents will have left the catchment and so do not need to be relocated.

5.12.1 Maintain scenario outcomes

Table 5-55: Maintain - PV evacuation and temporary accommodation costs (£k)

Appraisal period (years)	PV Evacuation and temporary accommodation costs (£k)			
	A	B	C	Total
100	5	1	-	6

Total PV evacuation and temporary accommodation costs over the 100-year appraisal period is £6k.

5.13 Vehicle damages

Economic losses associated with damage to vehicles are estimated for all residential properties. Guidance suggests that flood depths of greater than 0.39m are almost certain to lead to a vehicle being written off. Damage equal to the average write-off value of a vehicle at the property are therefore assumed for all properties where flood depth exceeds this threshold, with the number of vehicles per household estimated at 1.43, representative of more rural communities.

This damage was only calculated for the Maintain scenario as it is assumed that under the Do-Nothing scenario residents will have left the catchments. The methodology defined in the MCM was followed.

Table 5-56: Data used in the vehicle damages assessment

Vehicle Data	Assumed Value	Source
Vehicles per household	1.43	Rural Town and Fringe. Household car ownership by region and Rural-Urban Classification: England, 2002/03 and 2018/19
Threshold for vehicle write off	0.39m	As recommended by MCM
Probability a car is at a household if flood warning given	75%	As recommended by MCM
Average value per vehicle	£6,444	As recommended by MCM. £5600 uplifted to 2025 using latest GDP deflators from December 2024.
Average Car damages per household	£9,215	Vehicle per household multiplied by average value per vehicle

5.13.1 Maintain scenario outcomes

There are no vehicle damages over the 100-year appraisal period as the low depth of flooding at residential properties is below the threshold for vehicle damages.

5.14 Intangible impacts to human health

Intangible health benefits reflect the longer-term personal impact of flooding on the health and wellbeing of those affected; a reduction in flood risk is correlated with an approximate equivalent financial benefit.

The MCM 2013 methodology was used to estimate intangible benefits with FRM improvements at a property level. The basis of the estimation is that flooding of residential properties causes stress, disruption, illness, and other losses that are not assigned a value in the main economic assessment. Generally, rather than increase the losses in each flood event to include this, the intangible impacts assessment provides a positive benefit that can be added to the 'damages avoided'. The magnitude of the benefit is dependent on the number of residential properties benefitting from FRM (i.e. with a reduced threshold of flooding), and the size of the change in threshold of flooding at each property. For the Fens 2100+ assessments, Intangible Benefits have been calculated based on an assumed loss at each flooded property, such that the benefits would be equal to these losses being avoided should Do Something options been appraised in future.

The total PV intangible impacts calculated for the Maintain scenario in the Steeping catchment are £122k. For the Do Nothing scenario, the residual damages for intangible impacts across the catchment were sufficiently low that it was deemed disproportionate to assess them as part of this appraisal.

5.15 Utilities disruption

Disruption to utilities at an individual property level have been calculated only for properties in the Maintain scenario and in the Do Nothing scenario where properties are not written off but are subject to residual risk. This is to avoid double counting with damages related to the distribution assets as described in Section 5.7. As a broad assessment of the potential scale of impacts, an indicative value of 5% of total residential and non-residential property AAD damages have been used to estimate utilities disruption costs in these events.

The total PV utilities disruption calculated for the Maintain scenario in the Steeping catchment are £13k. For the Do Nothing scenario, residual damages for utilities disruption across the catchment are sufficiently low that it is deemed disproportionate to assess them within this scenario.

5.16 Losses to the local economy

The Fens has a diverse economy, to which agriculture contributes significantly, as previously highlighted within Section 5.2. In addition, there are a range of retail, industrial and manufacturing businesses across the catchments which would be impacted by flooding in the Do-Nothing scenario.

5.16.1 Do-Nothing scenario approach

Losses to the local economy can be expressed in terms of Gross Value Added (GVA). GVA measures the contribution made to an economy by one individual producer, industry, sector or region. As per the HM Treasury Green Book[31] (2022), local or regional benefits cannot be included in applications for Grant in Aid funding (only those identified as losses to the nation are eligible). As such, only a high-level analysis of GVA has been undertaken to understand the regional impacts, particularly in terms of the number of jobs at risk under a Do-Nothing scenario (and thus benefiting from the existing FCERM arrangements). GVA has been calculated for the Do-Nothing scenario and Maintain scenario and is considered a broad high-level assessment.

The GVA has been defined based on DEFRA's Frontiers Toolkit[32] (2014). For each of the NRP's impacted by permanent inundation (at each write-off level), the associated floor areas have been captured. These were converted to Net Gross Floor areas, which were utilised to determine the number of jobs impacted based upon the application of the associated employment densities (as per the Employment Density Guidance, 3rd Edition (Homes and Communities Agency, 2015)) for the general business/industry type (refer to Table 5-57). The total number of jobs per non-residential property were multiplied by the gross annual average salary of the region to define the annual GVA losses. An uplift of 30% was applied (Table 4.14 Multiplier effects in HCA guidance (2000)) to account for the net indirect and induced jobs (i.e. the supply chain). As the methodology is centred around buildings and their floor area, it may not cover all agricultural jobs, some of which may be transient in nature. A 10% leakage reduction factor was applied to represent the level of benefits that are likely to go to residents who commute into the catchment. A 25% displacement reduction factor was also applied to represent the proportion of economic benefits that are displaced from elsewhere in the region.

The GVA annual losses are assumed to apply for a period of 10 years following inundation, to account for the notion that new businesses and employment opportunities will be displaced elsewhere across the nation to accommodate the loss in the provision of these services.

[31] The Green Book: appraisal and evaluation in central government - GOV.UK

[32] _FD2662_full_toolkit.pdf

5.16.2 Key assumptions

Table 5-57: Do Nothing GVA assumptions

Key assumptions:				
Assumed employment density (m^2) and Gross annual wage per head (£)		SIC Code and Description	m2 per FTE	Mean gross annual wage (2025) (£)
		A - Agriculture, forestry and fishing	36	29,723
		B - Mining and quarrying	-	56,864
		C - Manufacturing	37	42,282
		D - Electricity, gas, steam and air conditioning supply	36	60,114
		E - Water Supply; Sewerage, Waste Management and Remediation Activities	36	42,267
		F - Construction	-	44,749
		G - Wholesale and retail trade; repair of motor vehicles and motorcycles	26	31,649
		H - Transportation and storage	30	41,688
		I - Accommodation and Food Service Activities	19	20,679
		J - Information and communication	32	58,071
		K - Financial and Insurance Activities	16	80,397
		L - Real estate activities	-	36,403
		M - Professional, scientific and technical activities	45	51,632
		N - Administrative and support service activities	16	33,042
		O - Public administration and defence; compulsory social security	29	38,428
		P - Education	36	34,090
		Q - Human health and social work activities	33	33,182

Key assumptions:				
		R - Arts, Entertainment and Recreation	58	31,193
		S - Other service activities	33	30,056
		T - Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	-	16,368
		U - Activities of extraterritorial organisations and bodies	-	-
	Sources: Homes & Communities Agency (2010) *Employment Densities Guide (2nd ed.).* OBS (2025) *The economy forecast: Inflation.* ONS (2024) Earnings and hours worked, industry by two-digit SIC: ASHE Table 4.7a Annual Pay - Gross 2024 (Provisional Data)			
Net indirect and induced jobs multiplier	30% - Ready reckoners for composite multiple (regional level) (HCA guidance (section 4.5 and 5))			
Displacement	25%			
Leakage	10%			
Key datasets: • National Receptor Database				

5.16.3 Do-Nothing scenario outcomes

Table 5-58: Do Nothing high-level estimates of number of jobs impacted (GVA - direct and indirect) (cumulative) and high-level PV GVA losses (direct and indirect) (cumulative) (£k)

Appraisal period (years)	Number of jobs			Total PV GVA losses (£k)		
	A	B	C	A	B	C
10	427	-	11	104,394	-	2,091

Based on the number and area of non-residential properties impacted during the first 10 years of the appraisal period for the Do Nothing scenario, a high-level estimate of the number of jobs and associated GVA losses can be seen in Table 5-58. During this period an estimated 438 jobs are impacted whilst total GVA losses in excess of £106,485k are accrued.

5.16.4 Maintain scenario outcomes

Table 5-59: Maintain high-level estimates of number of jobs impacted (GVA - direct and indirect) (cumulative) and high-level PV GVA losses (direct and indirect) (cumulative) (£k)

Appraisal period (years)	Number of jobs			Total PV GVA losses (£k)		
	A	B	C	A	B	C
10	40	-	-	16	-	-

Based on the number and area of non-residential properties impacted during the first 10 years of the appraisal period for the Maintain scenario, a high-level estimate of the number of jobs and associated GVA losses can be seen in Table 5-59. During this period an estimated 40 jobs are impacted whilst total GVA losses in excess of £16k are accrued.

6. Economic Damages and Benefits Summary

A summary of the Do-Nothing and Maintain scenario economic damages, and Maintain scenario benefits, are provided in the tables below.

6.1 Summary of Do Nothing Damages

Table 6-1: Summary of PV Do Nothing damages (£k)

Type	Do Nothing Damages (£k)			
	A	B	C	Total
Residential properties	261,334	8,341	5,038	274,713
Non-residential properties	8,578	142	43	8,763
Agricultural losses	57,099	66,751	1,920	125,770
Environment and recreational losses	12,003	394	553	12,950
Heritage losses	3,819	1	-	3,820
Transport damages	41,417	5,754	5,309	52,480
Utilities damages	13,944	160	90	14,193
Isolated land and properties	35,234	-	27,093	62,328
Total (excludes losses to the local economy)	**433,427**	**81,543**	**40,046**	**555,016**
Losses to the local economy (GVA)	104,394	-	2,091	106,485

Total damages in the Do Nothing scenario exceed £555 million across all three subcompartments.

6.2 Summary of Maintain Damages

Table 6-2: Summary of PV Maintain damages (£k)

Type	Maintain Damages (£k)			
	A	B	C	Total
Residential properties	203	8	-	212
Non-residential properties	55	-	-	55
Indirect commercial losses	2	-	-	2
Agricultural losses	5,382	1,598	-	6,980
Environment and recreational losses	0*	0*	-	0*
Heritage losses	0*	-	-	0*
Mental health costs	19	2	-	20
Emergency service costs	50	2	-	52
Risk to life	924**	4	-	927
Evacuation and temporary accommodation	5	1	-	6
Vehicle damages	-	-	-	-
Intangible impacts	122	-	-	122
Utilities disruption	13	-	-	13
Total (excludes losses to the local economy)	**6,775**	**1,615**	**-**	**8,389**
Losses to the local economy (GVA)	16	-	-	16

*The heritage losses accrued in the Maintain fall below the £1,000 threshold to be listed in the table above. PV heritage losses in the Maintain amount to £384 over the 100-year appraisal period. Same is true for environment and recreational losses, which amount to £470 over the 100-year appraisal period.

** As described in Section 5.11, the nature of this catchment leads to extreme velocities during flood events which impacts the hazard rating and results in large values of risk to life.

6.3 Summary of Maintain Benefits

Table 6-3: Summary of PV benefits (£k)

Type	Benefits (£k)			
	A	B	C	Total
Residential properties	261,131	8,333	5,038	274,501
Non-residential properties	8,523	142	43	8,708
Indirect commercial losses* avoided	-2	-	-	-2
Agricultural losses avoided	51,717	65,153	1,920	118,790
Environment and recreational losses avoided	12,002	394	553	12,949
Heritage losses avoided	3,818	1	-	3,819
Transport damages avoided	41,417	5,754	5,309	52,480
Utilities damages avoided	13,944	160	90	14,193
Isolated land and properties	35,234	-	27,093	62,328
Mental health costs* avoided	-19	-2	-	-21
Emergency service costs* avoided	-50	-2	-	-52
Risk to life*	-924	-4	-	-928
Evacuation and temporary accommodation*	-5	-1	-	-6
Vehicle damages avoided	-	-	-	-
Intangible impacts*	-122	-	-	-122
Utilities disruption* avoided	-13	-	-	-13
Total (excludes benefits to the local economy)	**426,652**	**79,928**	**40,046**	**546,627**
Benefits to the local economy (GVA)	104,378	-	2,091	106,469

*These damage streams show negative benefits because they have only been assessed in the Maintain scenario and not in the Do Nothing scenario. The reason for exclusion from the Do Nothing assessment is that these damages are unlikely to be accrued as there is enough time for people to retreat from the area that is going to be permanently inundated.

6.4 Sensitivity Testing

The impact of changes to assumptions have largely been reported under the individual damage sections in Section 5. The impact of three of the more uncertain elements with larger impacts on the overall damage figures are summarised below for context and comparison with the baseline values reported Section 5.

6.4.1 Variance of fill rate in the Do Nothing scenario

Two sensitivity tests have been undertaken across all damage streams to determine the impact of variance in the rate at which the catchment fills with water. The baseline assessment assumes a rate of 0.5m per year. For the sensitivity analyses, the rate has been varied to a slower rate of 0.25m a year, and a faster rate of 0.75m per year. The impact on benefits for the Maintain scenario as a result of this change in the Do Nothing baseline is shown in Table 6-4 and Table 6-5 for the decrease and increase in fill rates respectively.

Table 6-4: Summary of PV Do Nothing damages (£k) with a fill rate of 0.25m per year across all subcompartments

Type	Do Nothing Damages (£k)			
	A	B	C	Total
Residential properties	252,034	8,341	5,038	265,413
Non-residential properties	11,150	425	94	11,668
Agricultural losses	56,372	66,751	1,920	125,043
Environment and recreational losses	11,779	394	553	12,726
Heritage losses	3,495	1	-	3,496
Transport damages	39,582	5,754	5,309	50,645
Utilities damages	13,763	160	90	14,012
Isolated land and properties	30,705	-	27,093	57,793
Total (excludes losses to the local economy)	**418,880**	**81,826**	**40,097**	**540,796**
Losses to the local economy (GVA)	92,180	-	2,091	94,271

Table 6-5: Summary of PV Do Nothing damages (£k) with a fill rate of 0.75m per year across all subcompartments

Type	Do Nothing Damages (£k)			
	A	B	C	Total
Residential properties	263,999	8,341	5,038	277,378
Non-residential properties	11,532	425	94	12,050
Agricultural losses	57,332	66,751	1,920	126,003
Environment and recreational losses	12,074	394	553	13,021
Heritage losses	3,895	1	-	3,896
Transport damages	42,008	5,754	5,309	53,071
Utilities damages	13,999	160	90	14,248
Isolated land and properties	36,468	-	27,093	63,561
Total (excludes losses to the local economy)	**441,307**	**81,826**	**40,097**	**563,228**
Losses to the local economy (GVA)	110,253	-	2,091	112,344

6.4.2 Extreme catchment fill scenario – 6m AOD

A further sensitivity test has been undertaken across all damage streams to determine the impact of an extreme event or scenario in which assets up to 6m AOD are written off. This test demonstrates the potential additional losses above the assumed limiting levels in the Do Nothing scenario, and how sensitive the assessment may be to changes in this level.

The impact on benefits for the Maintain scenario as a result of this extreme Do Nothing catchment fill scenario is shown in Table 6-6.

Table 6-6: Summary of PV Do Nothing damages (£k) with a limiting level of 6m across all subcompartments

Type	Do Nothing Damages (£k)			
	A	B	C	Total
Residential properties	338,432	9,769	7,099	355,301
Non-residential properties	13,818	649	110	14,577
Agricultural losses	59,693	66,751	2,580	129,024
Environment and recreational losses	16,773	429	1,167	18,369
Heritage losses	5,679	17	-	5,696
Transport damages	60,468	8,631	5,309	74,409
Utilities damages	15,852	222	295	16,369
Isolated land and properties	6,257	-	-	6,257
Total (excludes losses to the local economy)	**516,972**	**86,468**	**16,560**	**620,002**
Losses to the local economy (GVA)	109,382	-	2,205	111,587

7. Costing

This section sets out the approach to defining the estimated capital cost interventions required for all FRM assets in the Steeping and the estimated point in time at which interventions are required, along with maintenance and operational expenditures.

This exercise has not considered any limitations on funding or the affordability of the investments needed, rather just examining the total investment requirements to sustain the existing asset base to continue to provide the existing Standard of Service, and to inform the cost benefit analysis for the Maintain scenario. An assessment of eligibility for funding at a catchment scale gives a better indication of the limitations on funding based on current Partnership Funding rules and is included in Section 9.

The exercise has been completed to gain a high-level understanding of the broad investment requirements for sustaining the existing asset base, and to understand the cost benefit ratio and available funding to do so. The results should be treated as indicative and used solely for planning of intervention works. For specific interventions, the costs should be reviewed considering existing knowledge, engineering assessment and site constraints in order to most effectively plan future intervention works, and ensure a robust cost is developed at business case development stage for individual investments.

There are no FRM assets located within subcompartment C and so no estimation of whole life cost is included for this subcompartment.

A single “best estimate” cost has been produced based on best available data and standard approaches to estimation of uplifts for elements such as appraisal, design and risk. This has been used to determine the cost benefit analysis and eligibility for funding. However, noting the high-level nature of the data available at this stage, an additional range of costs has been estimated to demonstrate the uncertainty in the cost estimation at this stage.

Risk has been represented with the application of optimism bias; for the best estimate this has been included at 60% for all costs given the uncertainty in cost information at this stage. For the range estimation, optimism bias was included at 30% for the lower bound and 100% for the upper bound.

7.1 Capital costs

Cost information for assets requiring works have been collated based on comparable asset types from the Great Ouse and Witham Tactical Plans, along with data provided by the Middle Level Commissioners on their planned capital interventions. Where there is a lack of data, or the data is not representative, the cost estimation guidance has been used[33] to calculate an estimate of capital costs. Table 7-1 details these assumed costs.

Capital costs are assumed to be the cost of replacement of the asset at the end of its design life. The point in time at which these investments are required has been based on asset deterioration rates as defined in ‘Practical guidance on determining asset deterioration and the use of condition grade deterioration curves: Revision 1 (Report – SC060078/R1, Environment Agency, 2013). It has been assumed that all assets will

[33]https://www.gov.uk/flood-and-coastal-erosion-risk-management-research-reports/long-term-costing-tool-for-flood-and-coastal-risk-management

deteriorate in line with maintenance regime standard 2 as defined this guidance, and that following investment assets will be returned to condition grade 3.

Conservatively, future investments are assumed required when the asset reaches condition grade 5, though it is noted that target condition grade is 3. Information on future investment needs is available from discussions with the North Level and South Holland Internal Drainage Boards, and so for those assets this information has been used instead of the average capital costs derived.

No adjustment is made to this approach for the lower and upper bound costs.

Table 7-1: Estimate of capital costs per asset type

Asset type	Asset Information	Assumed capital cost (£k)
Pumping station	0-1 m^3/s capacity	1,097
	1-2 m^3/s capacity	2,275
	2-5 m3/s capacity	3,708
	5-10 m^3/s capacity	3,708
	10+ m^3/s capacity	87,156
Embankments	Per m	2
Walls	Per m	4
Outfalls	Per unit	39
Sluices	Per unit	2,314
Control gates	Per unit	38
Open channels	Per m	-
Simple culvert	Per m	249
Weirs	Per unit	246
Debris screen	Per unit	19

7.2 Appraisal costs

Consultancy fees and Environment Agency staff costs have been estimated using Project Cost Tool (PCT) curves. At this stage, indicative costs have been included for environmental enhancement and survey exercises (including Ground Investigation (GI) and non-intrusive survey including topographic survey). It has been assumed that Environmental enhancement will equate to 3% of capital costs, that GI will be 5% and non-intrusive survey will be 3% of capital costs. These uplifts were derived based on outturn costs from similar packages of work.

For the lower bound cost estimate, the minimum percentage uplifts from the PCT curves for consultancy and Environment Agency staff costs have been used, regardless of estimated construction value. Conversely, for the upper bound estimate the maximum percentage uplift has been used.

7.3 Future costs

Where costs have been provided for short term investments or capital interventions which are not a full asset replacement, these have been assumed as separate to the capital costs of asset replacement as described in Section 7.1. These costs are referred to as future costs, as they are planned interventions on a programme. However, it should be noted that in some cases these are expected to occur before asset replacement and capital costs.

No adjustment is made to this approach for the lower and upper bound costs.

7.4 Maintenance and operational costs

Anticipated maintenance and operational costs have also been based on expenditure for similar assets in the Great Ouse and Lower Witham catchments. Where this information is not available the relevant cost estimation guidance has been used[34]. These costs were projected out over the whole appraisal period and a 60% risk applied to represent uncertainty in future maintenance and operational activities.

Maintenance and operational cost estimates were adjusted for the cost range estimation by reducing the 60% risk value to 30% for the lower bound estimate and increasing it to 100% for the upper bound estimate.

7.5 Whole life costs

The cost information was forecast over the appraisal period to understand the profile of investment required over a 20 year and a 100-year period. These costs were discounted using HM Treasury discount rates to provide Present Value estimates of Whole Life Costs per asset, summed per subcompartment and totalled for the entire Steeping catchment.

The best estimate of cost to be used in cost benefit analysis, alongside the lower and upper bound costs accounting for uncertainty in investment needs at this stage, are presented in Table 7-3.

[34]https://www.gov.uk/flood-and-coastal-erosion-risk-management-research-reports/long-term-costing-tool-for-flood-and-coastal-risk-management

Table 7-2: Estimate of whole life costs for the Steeping catchment and each subcompartment (£k)

	Steeping (£k)	A (£k)	B (£k)	C (£k)
Capital costs	57,031	25,517	31,514	-
Appraisal costs	30,004	13,697	16,307	-
Risk contingency	52,221	23,528	28,693	-
Future costs	1,342	572	771	-
Maintenance and operational costs	60,925	29,555	31,370	-
Whole life cost	**201,522**	**92,868**	**108,654**	**-**

Table 7-3: Range of whole life costs for the Steeping catchment and each subcompartment (£k)

	Steeping (£k)	A (£k)	B (£k)	C (£k)
Lower bound cost	164,571	75,906	88,665	-
Best estimate cost	201,522	92,868	108,654	-
Upper bound cost	253,642	115,739	137,903	-

8. Cost Benefit Analysis

Capped PV damages, the net PV benefits of implementing the Maintain scenario, and the project costs are used to calculate the benefit cost ratios, shown in Table 8-1.

Table 8-1: Cost Benefit Analysis

Option	Damages (£k)	Benefits (£k)	Whole life costs (£k)	Benefit Cost Ratio
Total - Steeping				
Do Nothing	555,016	-	-	-
Maintain	8,389	546,627	201,522	2.71
Subcompartment A				
Do Nothing	433,427	-	-	-
Maintain	6,775	426,652	92,868	4.59
Subcompartment B				
Do Nothing	81,543	-	-	-
Maintain	1,615	79,928	108,654	0.74
Subcompartment C				
Do Nothing	40,046	-	-	-
Maintain	0	40,046	N/A	N/A

As there are no FRM assets located within subcompartment C, and therefore no whole life costs for this subcompartment, no BCR has been calculated.

9. Partnership Funding

The maximum level of Grant in Aid (GiA) available at a catchment (and sub compartment) level has been calculated using the benefits derived as damages avoided following the methodologies set out in Section 5, and compared with whole life costs for all assets within the catchment (or sub compartment) as derived under Section 7.

Outcome Measure 2 counts follow a simplified approach detailed in Section 9.3 of the Calculate GiA funding for FCERM projects guidance[35]. Outcome Measure 2 properties better protected from flood risk have been defined based on the number of properties at risk in the Maintain scenario, together with those written off in the Do Nothing scenario which are assumed to be at Low Risk in the "after" counts; for the "before" count of properties, these properties are shifted one risk band higher.

No Outcome Measure 4 have been included in the Partnership Funding calculators at this stage of assessment. Table 9-1 and Table 9-2 detail the number of Outcome Measure 2a properties that are better protected against flood risk by sustaining the existing defences over the 100 years benefits period.

Table 9-1: Outcome Measure 2 – Steeping catchment - at risk today

	Low risk	Moderate risk	Intermediate risk	Significant risk	Very significant risk
20% most deprived	-	1,052	-	-	-
21% to 40% most deprived	-	232	-	-	-
60% least deprived	-	1	-	-	-
All deprivation bands	-	1,285	-	-	-

Table 9-2: Outcome Measure 2 – Steeping catchment - at risk after duration of benefits

	Low risk	Moderate risk	Intermediate risk	Significant risk	Very significant risk
20% most deprived	1,052	-	-	-	-
21% to 40% most deprived	232	-	-	-	-
60% least deprived	1	-	-	-	-
All deprivation bands	1,285	-	-	-	-

[35] https://assets.publishing.service.gov.uk/media/66e15a1c44b517b5cc5e2688/LIT_58360__Calculate_GIA_funding.pdf

Table 9-3: Outcome Measure 2 – Subcompartment A - at risk today

	Low risk	Moderate risk	Intermediate risk	Significant risk	Very significant risk
20% most deprived	-	618	-	-	-
21% to 40% most deprived	-	232	-	-	-
60% least deprived	-	1	-	-	-
All deprivation bands	-	851	-	-	-

Table 9-4: Outcome Measure 2 – Subcompartment A - at risk after duration of benefits

	Low risk	Moderate risk	Intermediate risk	Significant risk	Very significant risk
20% most deprived	618	-	-	-	-
21% to 40% most deprived	232	-	-	-	-
60% least deprived	1	-	-	-	-
All deprivation bands	851	-	-	-	-

Table 9-5: Outcome Measure 2 – Subcompartment B - at risk today

	Low risk	Moderate risk	Intermediate risk	Significant risk	Very significant risk
20% most deprived	-	419	-	-	-
21% to 40% most deprived	-	-	-	-	-
60% least deprived	-	-	-	-	-
All deprivation bands	-	419	-	-	-

Table 9-6: Outcome Measure 2 – Subcompartment B - at risk after duration of benefits

	Low risk	Moderate risk	Intermediate risk	Significant risk	Very significant risk
20% most deprived	419	-	-	-	-
21% to 40% most deprived	-	-	-	-	-
60% least deprived	-	-	-	-	-
All deprivation bands	419	-	-	-	-

Table 9-7: Outcome Measure 2 – Subcompartment C - at risk today

	Low risk	Moderate risk	Intermediate risk	Significant risk	Very significant risk
20% most deprived	-	15	-	-	-
21% to 40% most deprived	-	-	-	-	-
60% least deprived	-	-	-	-	-
All deprivation bands	-	-	-	-	-

Table 9-8: Outcome Measure 2 – Subcompartment C - at risk after duration of benefits

	Low risk	Moderate risk	Intermediate risk	Significant risk	Very significant risk
20% most deprived	15	-	-	-	-
21% to 40% most deprived	-	-	-	-	-
60% least deprived	-	-	-	-	-
All deprivation bands	-	-	-	-	-

Table 9-9 details the maximum eligible GiA and the raw PF score for the whole of the Steeping catchment and each subcompartment.

Table 9-9: Partnership funding calculator results

	PV maximum eligible FCERM GiA (£k)	raw PF score (%)
Steeping	33,617	17
A	26,121	28
B	N/A	N/A
C	N/A	N/A

Subcompartment B has a benefit cost ratio below 1 as shown in Table 8-1 and so is not eligible for FCERM GiA. Additionally, there are no FCERM assets located in subcompartment C, thus, no costs and potential GiA eligibility can be calculated.

10. Limitations

There are a number of limitations for the work undertaken at this stage of assessment:

- The model data used for the Steeping catchment economic assessment is representative of fluvial flood risk only. As such there is potential under estimation of flood risk relative to other catchments which use Risk of Flooding from Multiple Sources data for the Maintain scenario. It is considered that this under estimation will be relatively marginal given the standard of protection offered by existing coastal defences, and therefore a low probability of exceedance events occurring.
- The benefits assessment undertaken is broad given the strategic nature of the project, and the damages assumed to accrue under Do Nothing and Maintain scenarios are based on a standardised set of assumptions. This does not allow for more discrete impacts of a Do Nothing scenario such as blockage or failure of structures which may exacerbate risk in discrete areas in the short term.
- The costs developed at this stage are considered indicative only and should be reviewed at more detailed stages of appraisal for individual investments.
- Costs and estimated years for interventions have not been provided by all RMAs for all assets and as such there may be assets for which no cost information is included. Further to this, standardised costing assumptions have been made for a number of assets which may not be appropriate across all assets. The overall impact of this is not considered likely to change the general outcome of the analysis, and the indication of affordability and value for money.
- There are no FRM assets within the extents of subcompartment C so estimation of whole life costs cannot be undertaken to derive a cost benefit ratio and eligible GiA.

11. Conclusions

Over the next 100 years, the Do Nothing scenario is projected to result in PV damages exceeding £555 million, compared to over £8 million under the Maintain scenario. By continuing the current FRM approach, the Maintain scenario delivers estimated benefits of £547 million. The primary driver of these benefits is the decrease in damages to residential properties, particularly in Wainfleet All Saints. In total, 1,284 residential properties as OM2a are protected by the FRM assets maintained under this scenario. Benefits include:

- £282m of property damages avoided[36], including 1,284 residential and 133 non-residential properties avoided write off
- £118.8m of agricultural losses avoided, and 4780ha of land protected
- £13m of environmental and recreational losses avoided
- £3.8m of heritage losses avoided
- £52.5m of transport damages avoided
- £14.2m of utilities damages avoided
- £62.3m of land lost to isolation being avoided.

In addition to these economic benefits, there is an estimated £106.5m of financial losses to the local economy avoided in the first ten years.

To provide this level of protection, a total of 6 pumping stations, 27 outfalls, and significant reaches of open channel and linear flood defences will need to be sustained over the next 100 years, with total whole life costs estimated at £202 million to do so.

Based on the analysis, it is clear that the current FRM measures and activities provide substantial benefits across the Steeping catchment. However, these benefits are not evenly distributed. Subcompartment A demonstrates the highest level of benefit, with a strong return on investment for the FRM interventions implemented. In contrast, Subcompartment B shows a poor return on investment, with a cost benefit ratio below 1. This is likely due to the extensive coastal defences, open channels, and numerous tidal pumps in the area which accrue costs; in contrast, the area is primarily environmental sites and agricultural land rather than residential or commercial receptors, and as such accrues lower benefits. Subcompartment C has no FRM assets within its extents and so this analysis is limited in its scope for this area and only benefits have been quantified. In reality, the nature of this catchment is such that the benefits afforded by coastal assets should be split across all assets and therefore the overall Steeping catchment level BCR and PF score is considered more representative of value for money for sustaining the assets, and a better indication of eligibility for FCERM GiA funding, than the individual compartment values.

The catchment is eligible for £34 million of GiA funding. However, with a PF score of 17%, there is a significant funding gap when compared to the total whole life cost of sustaining the existing FRM assets. To meet this shortfall, approximately £168 million will need to be secured through savings or external funding contributions.

[36] Includes direct residential and non-residential damage as well as indirect commercial losses, mental health costs, emergency services costs, risk to life, evacuation and temporary accommodation costs and intangible impacts to human health

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