

Lower Welland

Environmental and agricultural baseline

2025



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1. Introduction

1.1 Aim and purpose of this document

This document presents a catchment-scale environmental and agricultural baseline for the Lower Welland catchment. It is intended to support future choices, investments and actions for the Fens2100+ programme (hereafter referred to as the “Fens 2100+”). The environmental and agricultural baseline covers the following disciplines:

- Landscape
- Agriculture
- Ground conditions (soils and resources)
- Water Environment
- Biodiversity
- Cultural Heritage
- Population and Health
- Air Quality

1.2 Usage statement

This document should be read alongside the Lower Welland catchment baseline evidence report and associated appendices (including the Lower Welland Assets Baseline Appendix and the Lower Welland Flood Risk Appendix) and is intended to provide a strategic environmental and agricultural baseline which will inform the development of a future Sustainability Appraisal for the Fens 2100+. This document provides a proportionate level of detail required for a strategic catchment-scale baseline. A detailed baseline analysis may be required at project level to align with the Environment Agency’s Minimum Technical Requirements or Environmental Impact Assessment.

1.3 Catchment context

The Lower Welland catchment (hereafter referred to as “the catchment”¹) covers approximately 473km² (47,299ha) of East Lincolnshire, located at the centre of the Fens 2100+ study area (see Figure 1). It covers an area of primarily rural, highly productive agricultural land spanning from the Deeping Fens in the south-west of the catchment to Fosdyke Wash in the east where the River Welland meets the North Sea. The reach of the River Welland encompassed by the catchment is approximately 54km long.

The Environment Agency have permissive powers to carry out flood and coastal risk management activities on Main Rivers as well as certain non-



Figure 1: Lower Welland catchment (Coronation Channel) © Sam Hazell, Arup

¹ The Lower Welland catchment is not strictly a hydrological catchment as there are movements of water both into and out of the area defined, that are not being considered in this report. However, the term ‘catchment’ has been used throughout the dialogue with the Environment Agency during establishment of the study areas and these areas are being defined for water management purposes. Therefore, the term catchment is used to describe the study area.

Main Rivers known as critical ordinary watercourses. In addition, the Environment Agency are responsible for producing a national strategy for Flood and Coastal Erosion Risk Management (FCERM). The latest strategy published in 2020 contains 'Measure 1.5.4'. This requires development of a long-term plan for managing future flood risk in the Fens. Ordinary watercourses are regulated by Internal Drainage Boards (IDBs) and the Lead Local Flood Authority (LLFA), comprising Lincolnshire County Council and Peterborough City Council in the catchment.



Figure 2: River Welland, Spalding © Colin Smith and licensed for reuse under this Creative Commons Licence

The Welland and Deepings, North Level District and South Holland Internal Drainage Boards (IDBs) operate in the catchment. They play a vital role in managing water levels and drainage across the catchment for agricultural and environmental purposes. They seek to maintain and if possible, enhance biodiversity through implementation of their Biodiversity Action Plans (BAP) (Welland and Deepings IDB BAP, 2020; North Level IDB BAP, 2020-2030; and South Holland IDB BAP, 2015). The IDB's are responsible for managing the complex network of drains that feed into Main Rivers by pumps.

The 'Main Rivers' within the catchment include the River Welland and its tributaries such as the River Glen, Folly River and the Bourne Eau.

The Welland and Deepings, North Level District and South Holland IDBs own and are responsible for managing water levels within the network of subsidiary drains that discharge into the catchment by pumps. Most of the pumped drainage system is managed by Welland and Deepings IDB. The IDBs have a complicated task of managing flood risk whilst balancing agricultural water demands for irrigation and maintaining water supply rights to nature reserves.

The catchment's low-lying terrain is typical of the wider Fens with most of the land lying just above sea level at approximately 3m Above Ordnance Datum (AOD).

The land use within the catchment is primarily agricultural, predominantly arable agriculture and higher value horticulture. Spalding is the largest settlement in the catchment, but the majority of the area is sparsely populated, with widely scattered farmsteads and sparse tree cover. Field patterns tend to be larger in the south, with more intact hedgerows and occasional woodland. It is a highly productive agricultural area with approximately 51% of the land classified as Grade 1 agricultural land. Other key land uses are summarised below.

1.3.1 Settlements

The largest settlement in the catchment is the market town of Spalding which sits centrally in the catchment. There are several small settlements elsewhere in the catchment including Holbeach, Pinchbeck, Surfleet, Deeping Saint Nicholas, Gosberton and Fosdyke.

1.3.2 Access and connectivity

The main arterial roads include the A16, A1175, A17 and A16. Figure 4 illustrates the spatial distribution of transport and access routes in the catchment.

- The A16 runs through the centre of the catchment, linking Spalding with Boston;
- The A1175 links Spalding with Market Deeping in the south-west of the catchment;
- The A151 acts as a connecting road through a number of smaller settlements within the catchment between the A16 at Spalding and the A17 at Holbeach.

Other key access and connections across the catchment include:

- The railway station at Spalding provides links to Peterborough and Sleaford via the East Midland Railway network;
- The National Cycle Route 12 runs through the catchment area, located south of Spalding, and parallels the western side of the A16. The National Cycle Route 1 also runs through the catchment following the A17;
- The King Charles III England Coast Path National Trail intersects the north-eastern part of the catchment;
- The River Welland is navigable 36km inland of the wash and that the River Glen is navigable up to Tongue End. This navigation is however dependant on appropriate tide levels for the operation of the locks within the catchment.

1.3.3 Renewable energy infrastructure

There are a number of large infrastructure projects located within the catchment, including the National Grid Bicker Fen-Walpole transmission line; and the 860MW Spalding power station. There are a number of projects either in proposal or construction phase across the catchment, for example, Spalding energy park, one of Europe's largest battery storage parks.



Figure 3: The River Welland at Fosdyke Bridge © Mat Fascione and licensed for reuse under Creative Commons Licence

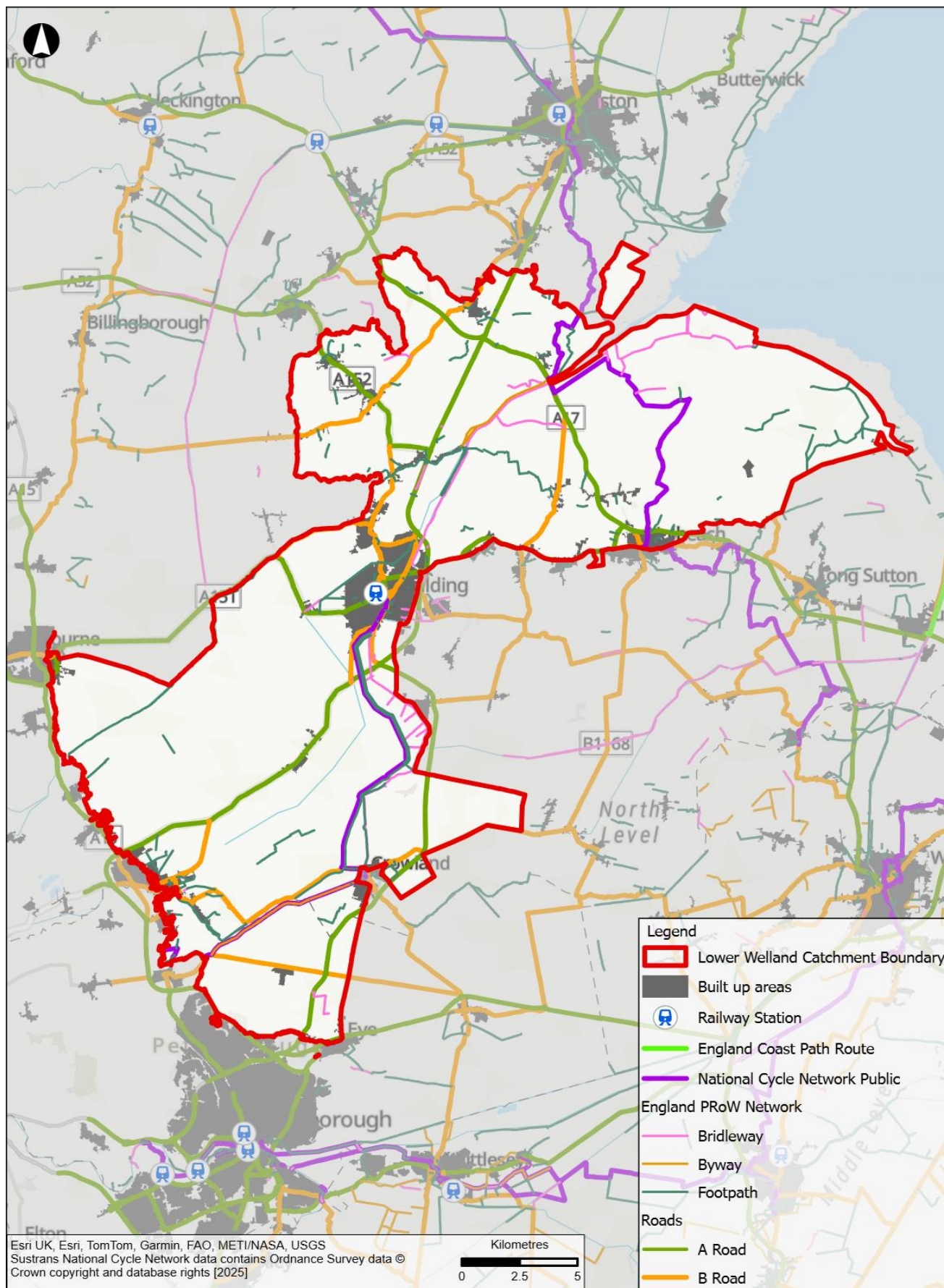


Figure 4: Local transport and access routes

2. Overview of legislation and policy context

This section presents an overview of the legislative and planning policy that may be applicable to any future Flood and Coastal Erosion Risk Management (FCERM) intervention or project within the catchment. This includes national, regional and local policy which has been considered across the disciplines included within this document. A detailed baseline analysis may be required at project level to align with the Environment Agency's Minimum Technical Requirements or Environmental Impact Assessment.

2.1 Environment Act (2021)

The Environment Bill became an Act [1] (law) in November 2021, amending the Environment Act 1995 [2]. The Act provides targets and policy for improving the natural environment in relation to air quality, restoring natural habitats, increasing biodiversity, reducing waste and making better use of resources. Key aspects of the Environment Act 2021 which are relevant to the Fens 2100+ include but are not limited to:

- Provisions that require that at least a 10% net gain for biodiversity be demonstrated through a Biodiversity Net Gain assessment (using Defra's Statutory Biodiversity Metric);
- A new mandatory system of spatial strategies for nature through Local Nature Recovery Strategies (LNRS); designed as tools to encourage more coordinated practical and focused action and investment in nature;
- Measures to support new and existing internal drainage boards (amending the Land Drainage Act 1991);
- Effective collaboration between water companies through statutory water management plans; and
- Requirement for local authorities to report to Defra on local air quality and local air quality management within their local authority area. This also requires an assessment of compliance against the relevant air quality standards.

2.2 Agriculture Act (2020)

The Agriculture Act for England [3], represents a significant shift in agricultural policy post-Brexit. This legislation aims to reward farmers and land managers for delivering "public goods" such as improved air and water quality, thriving wildlife, and measures to tackle climate change. The Bill includes measures to the phase out of the of Basic Payment Scheme (BPS) by 2028, which is proceeding as planned.

Key features of the bill include:

- Environmental Land Management Scheme: Farmers will be incentivised to provide environmental goods and services alongside food production. There will be three schemes:
 - the Sustainable Farming Incentive (SFI) will pay farmers to adopt and maintain sustainable farming practices that can protect and enhance the natural environment alongside food production, and also support farm productivity²;
 - Countryside Stewardship (CS) will pay for more targeted actions relating to specific locations, features and habitats. There will be an extra incentive through CS Plus for land managers to join up across local areas to deliver bigger and better results; and

² Applications for new SFI agreements have ceased as of March 2025.

- Landscape Recovery will pay for bespoke, longer-term, larger scale projects to enhance the natural environment.
- Transition Period: A seven-year transition period to move away from the EU's Basic Payment Scheme (BPS), which primarily rewarded the amount of land farmed, towards a system that rewards environmental benefits. This includes the phase out of the BPS by 2028, which is proceeding as planned. In 2024, the payments are for the first time delinked from land, meaning that farmers who were farming before 2024 will continue to receive the remainder of BPS through to 2027, even if they stop farming or dispose of land. These changes mean there will be a push towards farming being profitable at global market prices by 2028.
- Support for Innovation: Investments in new technology and research to boost productivity and sustainability in farming.

2.3 Flood and Water Management Act (2010)

The Flood and Water Management Act 2010 [4] is a significant piece of legislation in the UK aimed at improving the management of flood risk and water resources. Key aspects of this legislation include:

- Risk Management Authorities: The Act designates various authorities, including the Environment Agency, Lead Local Flood Authorities (LLFAs), and Internal Drainage Boards (IDBs), with specific responsibilities for managing flood risks.
- Partnership and Cooperation: It emphasises the need for these authorities to work in partnership and share information to effectively manage flood risks.
- Sustainable Drainage Systems (SuDS): The Act promotes the use of sustainable drainage systems to manage surface water and reduce flood risk.
- Flood Risk Management Strategies: Authorities are required to develop and implement strategies for managing flood risks, including mapping and assessing flood risks.
- Reservoir Safety: The Act includes provisions to improve the safety of reservoirs, ensuring they are regularly inspected and maintained.
- Powers and Duties: It grants new powers to authorities to carry out works to manage flood risks and imposes duties on them to maintain a register of structures or features that affect flood risk.

2.4 National Planning Policy Framework (NPPF)

The National Planning Policy Framework (NPPF) [5] sets out the Government's planning policies for England and how these should be applied. It was last updated in December 2024. It aims to achieve sustainable development through a balanced approach that considers economic, social, and environmental objectives. Key aspects of Sustainable Development in the NPPF include:

- Growth and innovation: Ensuring sufficient land is available to support economic growth, innovation, and productivity.
- Infrastructure: Coordinating the provision of infrastructure to support development.
- Housing: Providing a sufficient number and range of homes to meet the needs of present and future generations.
- Community well-being: Fostering well-designed, safe, and accessible places that support health, social, and cultural well-being.

- Natural and built environment: Protecting and enhancing natural, built, and historic environments.
- Resource efficiency: Using natural resources prudently, minimising waste and pollution, and mitigating climate change impacts.
- Meeting the challenge of climate change, flooding and coastal change: Supporting measures that ensure the future health and resilience of communities and infrastructure to climate change impacts, including flooding.

2.5 Environmental Improvement Plan (EIP) (2023)

The Environmental Improvement Plan for England (EIP) [6] details how the Government will work with communities and businesses to improve the environment compared to its current state. It is the first revision of the 25 Year Environment Plan (25YEP), providing interim targets to measure progress for improving the environment. Key aspects of the plan which are relevant to the Fens 2100+ include but are not limited to:

- Supporting the management of 70% of the countryside to adopt nature friendly land management practices by incentivising farmers;
- Updating a Green Finance Strategy setting out steps to leverage private finance to deliver the goals of the 25YEP;
- Deliver investment plan to improve coastal and flood defences, including £100 million on the most frequently flooded areas; and
- Reward farmers for actions to reduce risks and impacts from floods, droughts, and wildfires through our new future farming schemes.

2.6 Summary of key legislation, policy and guidance

A wide range of legislation is relevant to the different aspects of the environment and agriculture for Fens 2100+. Table 1 present a summary of the relevant key legislation, policy and guidance. This summary is not intended to be exhaustive and should be reviewed as part of any future interventions or projects.

Table 1: Summary of key environmental legislation and policy

Topic	Relevant Legislation, Policy and Guidance	Summary
Landscape	Guidelines for Landscape and Visual Impact Assessment [7]	Protection of landscape character and quality and the creation of Green Infrastructure.
	The European Landscape Convention (2006) [8]	
Agriculture	Autumn Budget 2024 [9]	The changes to Agricultural Property Relief (APR) and Business Property Relief (BPR) were announced in the Autumn Budget 2024. APR will be extended to include land managed under environmental agreements with the UK government, devolved governments, public bodies, local authorities, or approved responsible bodies. The 100% relief rate for APR and BPR will apply only up to a combined allowance of £1 million. These changes will be legislated in the Finance Bill 2024-25.

Ground Conditions	Safeguarding our Soils - A strategy for England (2009) [10]	Protect best quality soils and agricultural land as well as the protection and restoration of peatland habitat.
	England Peat Action Plan [11]	
	Greater Lincolnshire Nature Partnership – Geodiversity Strategy (GLNP) [12]	
Water Environment	The Environment (Amendment etc.) (EU Exit) Regulations 2020 [13]	The key objectives of these acts/policies are to reduce and manage flood risk, improve water quality (so all water bodies achieve 'Good status' as set out in the Water Environment Regulations), prevent or limit groundwater pollution and promote the efficient use of water.
	Environmental Protection Act 1990 [14]	
	Water Resources Act 1991 [15]	
	The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 (WFD) [16]	
	Land Drainage Act 1991 [17]	
	Water Act 2014 [18]	
	Water Resources (Abstraction and Impounding) Regulations 2006 [19]	
	Flood Risk Regulations 2009 [20]	
	Nitrate Pollution Prevention Regulations 2015 (as amended) [21]	
Biodiversity	The Conservation of Species and Habitat Regulations 2017 [22]	These pieces of legislation state the offences relating to protected species and the requirements for licenses to allow any damaging works to proceed. Specific actions which are prohibited by legislation can be made lawful on the approval and granting of a derogation license from Natural England (NE) and, or assent can be applied for when works are proposed within Special Site of Scientific Interest (SSSI) that could damage the interest features, or specific conditions are stated. In addition, the Habitats Regulations set out the requirement for the consideration of the potential effects of a plan or project upon European Sites through the Habitats Regulations Assessment (HRA) process.
	Wildlife and Countryside Act 1981 (as amended) (WCA) [23]	
	Natural Environment and Rural Communities (NERC) Act 2006 [24]	
	The Countryside and Rights of Way Act 2000 [25]	
	The Hedgerows Regulations 1997 [26]	
	Protection of Badgers Act 1992 [27]	
	The Salmon and Freshwater Fisheries Act 1975 [28]	
	The Eels (England and Wales) Regulations 2009 [29]	
	The Invasive Alien Species (Enforcement and Permitting) Order 2019 [30]	

Cultural Heritage	Ancient Monuments and Archaeological Areas Act (1979) [31]	Protect nationally important archaeological remains, historic buildings, historic landscape features and remains of military aircraft and vessels that have crashed, sunk or been stranded and of associated human remains
	Planning (Listed Buildings and Conservation Areas) Act (1990) [32]	
	Protection of Military Remains Act (1986) [33]	
	Hedgerows Regulations (1997) [34]	
	Treasure Act (1996) [35]	
Population and Health	Countryside and Rights of Way Act (2000) [25]	Promote sustainable and healthy communities and social inclusion and community participation. The policies and guidance encourage a 'whole system' approach to engaging planning and environmental agencies in support of health, well-being and social care provision.
	Health and Social Care Act (2012) [36]	
	Lincolnshire Joint Strategic Needs Assessment [37]	
	Lincolnshire Joint Health and Wellbeing Strategy [38]	
Air Quality	Air Quality Standards Regulations 2010 (amended in 2016) [39]	Defines the policy framework for twelve air pollutants known to have harmful effects on human health or the natural environment. The Secretary of State for the Environment has the duty of ensuring compliance with the air quality limit values. The regulation sets out the national air quality standards for NO ₂ , PM ₁₀ and PM _{2.5} . It also provides guidance on how air quality should be considered to comply with the NPPF.
	Planning Practice Guidance (PPG) 2014 [40]	
	Defra Clean Air Strategy 2019 [41]	

2.7 Local plans

The catchment extents across the Boston Borough Council, South Kesteven District Council and South Holland District Council local authority areas, as well as a small area to the south of the catchment falling within the jurisdiction of Peterborough City Council.

- Boston Borough Council and South Holland District Council have joined to form the South East Lincolnshire Joint Strategic Planning Committee which has produced the South East Lincolnshire Local Plan to cover the combined area of the two councils.
- South Kesteven District Council and Peterborough City Council each have their own Local Plan.

These three Local Plans cover the catchment as shown in Figure 5. The respective Local Plans set out the vision and strategic priorities for each area.

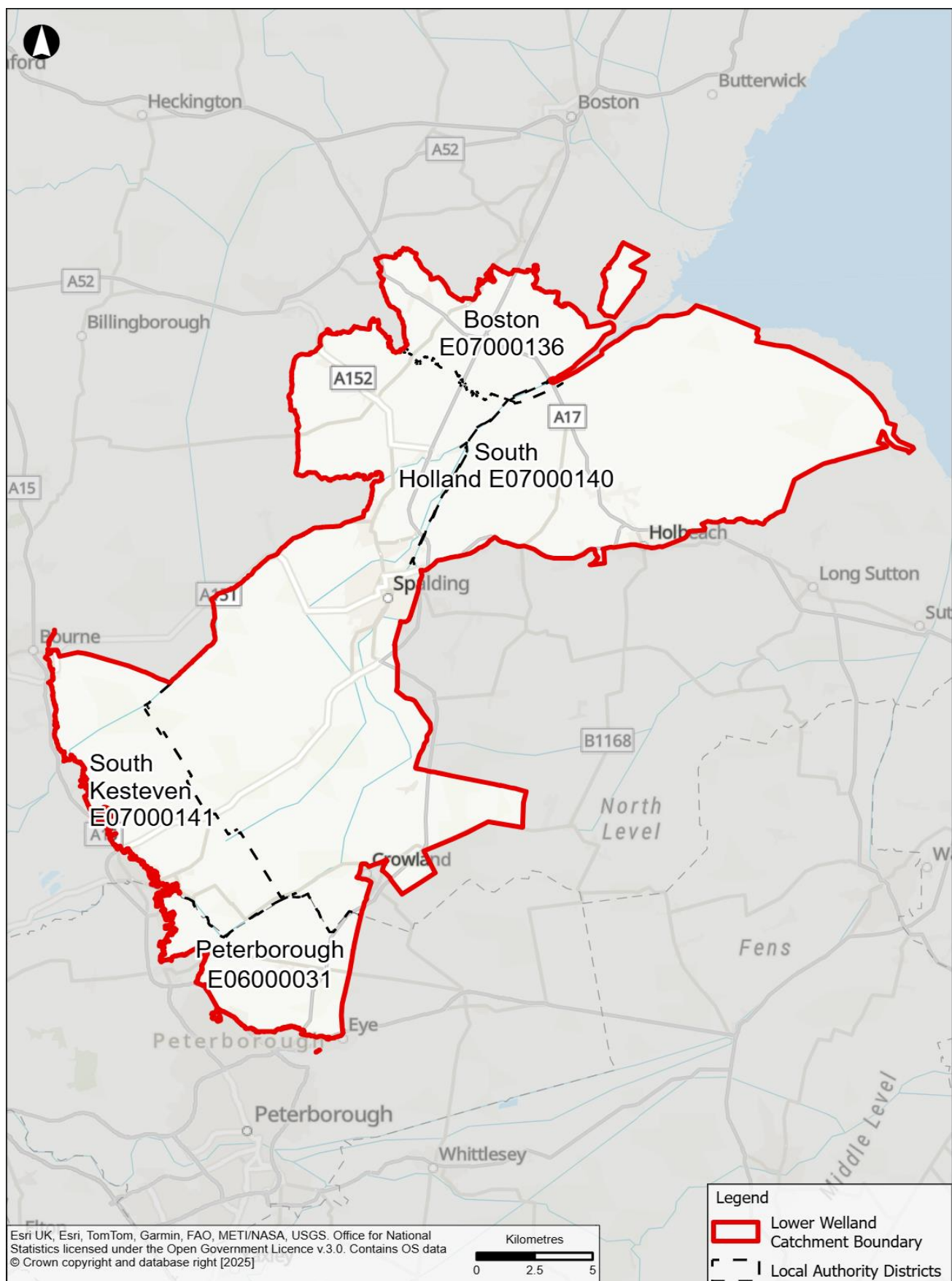


Figure 5: Local authority districts for the catchment

2.7.1 South East Lincolnshire Local Plan

The central and northern portion of the catchment is under the jurisdiction of Boston Borough Council and South Holland District Council. The South East Lincolnshire Local Plan [42] was prepared jointly by Boston Borough Council and South Holland District Council and adopted in March 2019. The following policies are considered key to environment and agriculture:

- Strategic Policy 3 – Design of New Development: outlines the requirement for new developments to respect and enhance the character of the landscape and the quality of an area. The policy also recognises the importance of using high quality and inclusive design and layout to make innovative use of local traditional styles and materials.
- Strategic Policy 4 – Approach to Flood Risk: outlines the requirement for development proposals to take account of flood risk issues and ensures that new development will be resilient to the potential consequences of flooding.
- Strategic Policy 28 – The Natural Environment: recognises the importance of protecting both national and locally-designated habitats and species; and the value of addressing gaps in the ecological network in the Local Plan area.
- Strategic Policy 29 – The Historic Environment: outlines the policy approach with respect to Listed Building and Conservation Areas within the Local Plan area. The policy also recognises the role of enabling development in securing improvements to heritage assets.
- Strategic Policy 30 – Pollution: outlines how new developments must account for environment impacts on surface and groundwater quality, in particular, adverse effects arising from pollution.

2.7.2 South Kesteven Local Plan

The south-west portion of the catchment is under the jurisdiction of South Kesteven District Council. South Kesteven Local Plan [43] 2011-2036 was adopted in 2020. The following policies are considered key to the environment and agriculture:

- Strategic Policy EN1 - Landscape Character: Outlines requirements for development to be appropriate to the character and significant natural, historic and cultural attributes and features of the landscape within which it is situated, and contribute to its conservation, enhancement or restoration.
- Strategic Policy EN2 - Protecting Biodiversity and Geodiversity: Outline requirements for development to conserve and enhance the District's biodiversity and geological interest.
- Strategic Policy EN3: Green Infrastructure: Outlines requirements for development proposals to ensure that existing and new green infrastructure is considered and integrated into design.
- Strategic Policy EN4 – Pollution Control: Outlines the approach to minimise pollution and where possible improve the environment including the requirements of the WER/WFD.
- Strategic Policy EN5 – Water Environment and Flood Risk Management: Outlines the approach of development in relation to flood risk and implementing Sustainable Urban Drainage.
- Strategic Policy EN6 - The Historic Environment: Outlines requirements to protect and enhance heritage assets and their settings.
- Strategic Policy DE1 - Promoting Good Quality Design: Outlines requirements for the application of good design across South Kesteven and to demonstrate compliance with relevant neighbourhood plans.

2.7.3 Peterborough Local Plan

The southern portion of the catchment is under the jurisdiction of Peterborough City Council. The Peterborough Local Plan [44] 2016-2036 was adopted in 2019. The following policies are considered key to the environment and agriculture:

- Strategic Policy LP19 – The Historic Environment: recognizes the importance of the historic environment for the quality of life of local communities and outlines how to protect, conserve and seek opportunities for enhancing heritage assets and their settings.
- Strategic Policy LP20 – Special Character Areas: Outlines the approach to preserve the special character of Wothorpe, Thorpe Road and Ashton.
- Strategic Policy LP23 – Local Green Space, Protected Green Space and Existing Open Spaces: Outlines the requirement to protect spaces from development unless there are no significant detrimental impacts on the character and appearance of the surrounding area, ecology and any heritage assets.
- Strategic Policy LP24 – Nene Valley: Outlines the approach to safeguard and enhance navigation, recreation, biodiversity, ecosystem services and the integrity of the Nene Washes.
- Strategic Policy LP26 – Green Wedges: Outlines the policy approach to granting planning permission within areas identified as Green Wedges. Planning permission will only be granted where it can be demonstrated that the development is not contrary to a list of functions and aims.
- Strategic Policy LP27 - Landscape Character: Outlines the requirement for new development in or adjoining the countryside, to be located and designed in a way that is sensitive to its landscape settings. Both cumulative and individual impacts for each landscape case will be considered.
- Strategic Policy LP28 – Biodiversity and Geological Conservation: Outlines the positive initiatives to manage, protect and enhance priority habitats including wet woodland, rivers and flood meadows.
- Strategic Policy LP32 – Flood and Water Management: Outlines how developments must adhere to the requirements of the NPPF and guidance set out in the Council's Flood and Water Management Supplementary Planning Document.

3. Methodology

This section presents an overview of the methodology used to develop the catchment-scale environmental and agricultural baseline. It has been produced using a desk-based review of publicly available information from a variety of sources.

3.1 Catchment study area

Figure 6 presents an overview of the study area used for the catchment environmental and agricultural baseline.

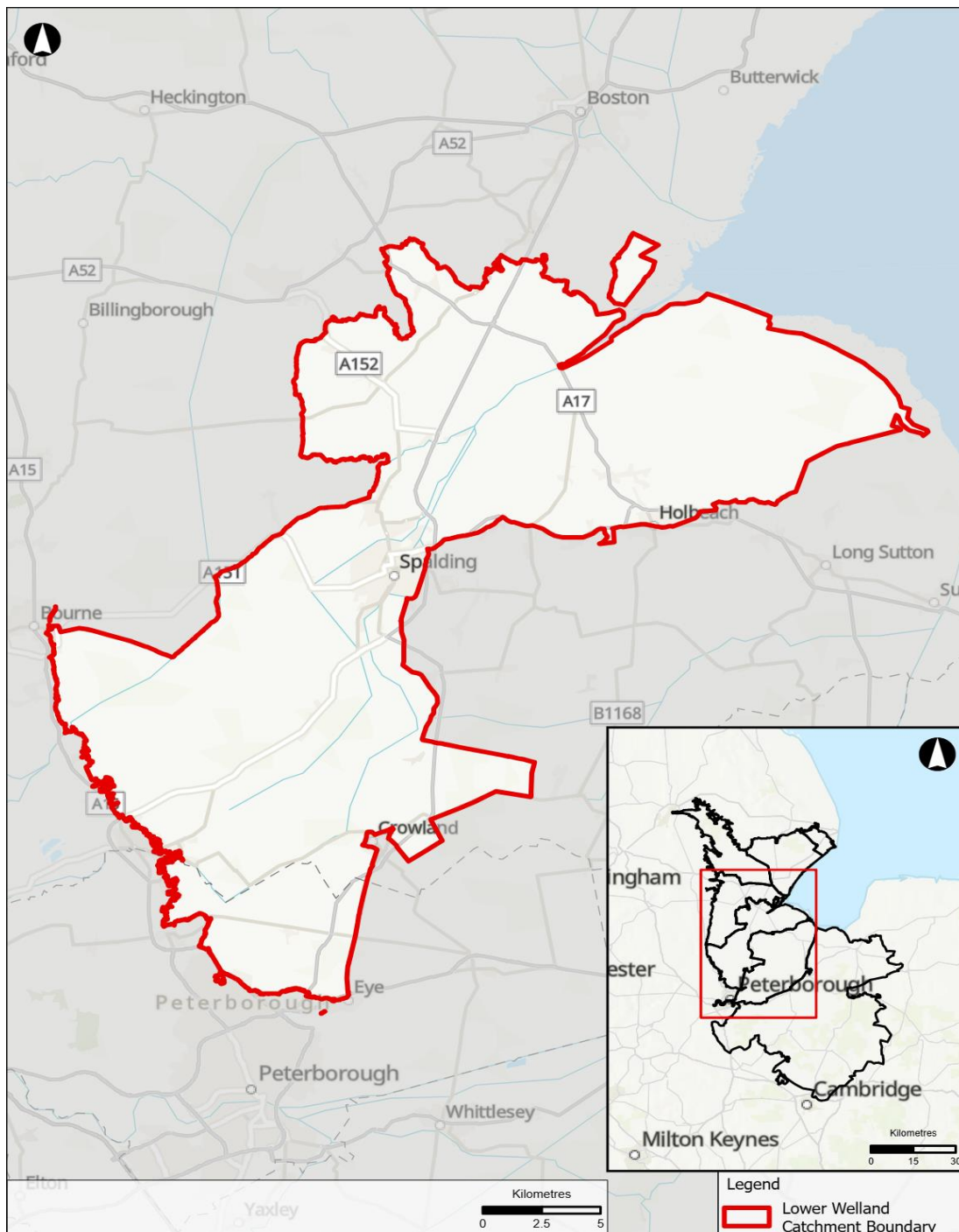


Figure 6: Lower Welland catchment

3.2 Limitations and Assumptions

The following limitations and assumptions have been made in the production of this catchment-scale baseline report:

- The baseline collated comprises a proportionate level of detail from publicly available data sources and it is reported at the geographical basis relevant to the data availability. Therefore, this report reviews and provides commentary of existing reports written by others. Arup accept no responsibility for any error or omission in this report which is due to an error or omission in the original documentation we refer to. Arup have not independently verified the information and have assumed it to be accurate, complete, reliable, and current as of the date of such information.
- This baseline assessment has not been informed or verified by any field surveys or site visits conducted by Arup.
- Due to the strategic nature of this baseline report, engagement and consultation with external stakeholders or statutory consultees has not been undertaken to inform this report.
- This baseline assessment is currently limited to the catchment boundary that has been defined for the Fens 2100+ project by the Environment Agency. It should be noted that the zone of influence for any future interventions or projects as part of Fens 2100+ may extend beyond the study area identified in Figure 6.
- Arup has used publicly available data to undertake a review of baseline conditions throughout the study area.

The following limitations and assumptions apply to the individual environmental and agricultural baseline chapters presented in this document:

- Landscape:
 - The landscape baseline excludes discussion on the significance of landscape and visual considerations.
- Agriculture
 - The agricultural baseline is based on the official data available which is produced at district level. There is no official data boundary that matches the catchment study area. Data reported within this baseline has been sense-checked against other sources such as published satellite data and been informed by local sector knowledge, to ensure that the estimates are as robust as possible.
 - As publicly available satellite derived data on land cover (and crops) improves over the next 5 years, the ability to analyse agricultural data at small spatial levels will improve. However, agricultural cropping is also subject to larger year to year variations, often due to extreme weather events, or longer-term changes in the market. Therefore, even if detailed data was available, e.g. for the 2023-'24 crop year, this would need to be treated with caution and averaged with other years.
 - The greenhouse and controlled environment agriculture data resolution is poor at national as well as regional levels, as Defra withdrew from collecting this data in the early 2010s. This baseline therefore uses the limited Defra data to sense-check local knowledge of the larger greenhouse units. The output per hectare in this sector is also extremely variable from crop to crop and farm to farm. The approach taken was to use conservative averages derived from Defra national data and to check this against feedback from individual growers.
 - The main additional assumption is that farms in the catchments do not, on average, deviate much from regional and national averages of output for the enterprises they run. This is the only practicable way to produce the data, as individual farm level

data is not available or published by any source. Our working assumption is that, given the higher productivity in general of the Fens that this produces a conservative estimate of the true value of farm output in the Fens.

- Ground conditions:
 - This baseline does not provide a review of available ground investigation data (borehole data etc.) beyond those specifically outlined or comprise the development of a catchment level ground model. Further, this baseline excludes discussion on the significance of mineral safeguarding designations, their specific extents or resource volume capability.
- Water environment:
 - The water environment baseline excludes in-depth discussion on Water Framework Directive / Water Environment Regulations. Reporting of all Water Environment Regulations baseline data or delivery of any preliminary compliance assessments has been excluded.
- Biodiversity:
 - The biodiversity baseline excludes discussion on non-statutory designated sites (e.g. Local Wildlife Sites and Roadside Nature Reserves). Records of protected and notable species from Local Environmental Records Centres or flora or fauna records have not been obtained at this stage.
- Cultural heritage:
 - The cultural heritage baseline excludes discussion on the significance of heritage assets, the assessment of impact(s), and a detailed baseline analysis which would identify non-designated heritage assets and specific areas of archaeological potential.
- Population and health:
 - The population and health baseline is based on the official data available which is published at different spatial boundaries. There is no official data boundary that matches the catchment study area. The baseline collated comprises a proportionate level of detail from publicly available data sources and it is reported at the geographical basis relevant to the data availability. Different classes of administrative unit each have their own datasets in terms of the geographical scale at which they operate and these have been used to inform the baseline:
 - Lower Layer Super Output Area (LSOAs)
 - Middle Layer Super Output Areas (MSOAs)
 - Lower Tier Local Authority Areas
 - Upper Tier Local Authority Areas
- Air Quality:
 - The air quality baseline will exclude discussion on consideration of pollutants other than NO₂, NO_x, PM₁₀ and PM_{2.5}. No dispersion modelling has been carried out at this time.

4. Catchment-scale baselines

The following sections provide an overview of the environmental and agricultural baseline.

4.1 Landscape

This section outlines the baseline landscape characteristics for the catchment. Table 2 outlines the key terminology used in this section.

Table 2: Glossary of landscape and land use terminology

Terminology	Summary Definition
National Character Area	A National Character Area (NCA) is a natural subdivision of England based on landscape, biodiversity, geodiversity, and economic activity. Their boundaries follow natural lines in the landscape, not county or district boundaries. This makes them a good framework for decision-making and planning for future change [45].
Landscape Character Assessment	The process of identifying and describing the unique variations in the character of the landscape. It aims to explain the distinct combination of elements and features that make one landscape different from another [46].
Green and Blue Infrastructure	Refers to a strategic network of natural and semi-natural areas designed to deliver a wide range of environmental, social, and economic benefits.

4.1.1 Landscape character

National Character Area

The catchment is largely located within the National Character Area (NCA) 46 The Fens [47] (see Figure 7). The Fens National Character Area is a distinctive, historic and human influenced wetland landscape lying to the west of the Wash estuary. The NCA is notable for its large-scale, flat, open topography with extensive vistas to level horizons. The level, open topography shapes the impression of huge skies which convey a strong sense of place, tranquility and inspiration.

Vegetation cover largely comprises meadows, coastal and flood plain grazing marsh, purple moor-grass and rush pastures and sparse woodland. Given the flat and open landscape, new planting can introduce inappropriate and visually intrusive elements.

The NCA has a distinctive hierarchy of rivers, drains and ditches which strongly influences the dominant rectilinear/geometric landscape pattern which is a consistent feature of the area. The drainage infrastructure (including the network of drainage ditches, embankments and pumping stations) provides an evident reminder of the area's reclaimed past. Statements of Environmental Opportunity (SEO) for the NCA have been identified by Natural England³ based on the unique characteristics and properties of the Fens. These priorities comprise the following which should be considered during future project stages:

- Manage the agricultural landscape and soils which allow the Fens to be a major provider of food and horticultural produce, while seeking to enhance opportunities for biodiversity.

³ Statements of Environmental Opportunity are developed by Natural England and reflect their opinion on how best to secure environmental gains within each NCA.

- Manage the core wetland complexes and increase their connectivity by enhancing the Main Rivers, waterways and their associated riparian habitats and improve recreational access opportunities to the Fens.
- Plan for the creation of new coastal landscapes in the Wash area that are adapted and resilient to the impact of climate change, for the benefit of people and wildlife.
- Conserve, manage and enhance the Fens landscape and increase educational opportunities to access its geodiversity, archaeology and cultural heritage to enhance enjoyment and understanding for those who live work in and visit the Fens.
- Seek partners to aid in the development and future provision of new, distinctive, Fenland economies.

Very small parts of the southwestern edge of the catchment are located within NCA 88 Bedfordshire and Cambridgeshire Claylands and NCA 75 Kesteven Uplands.

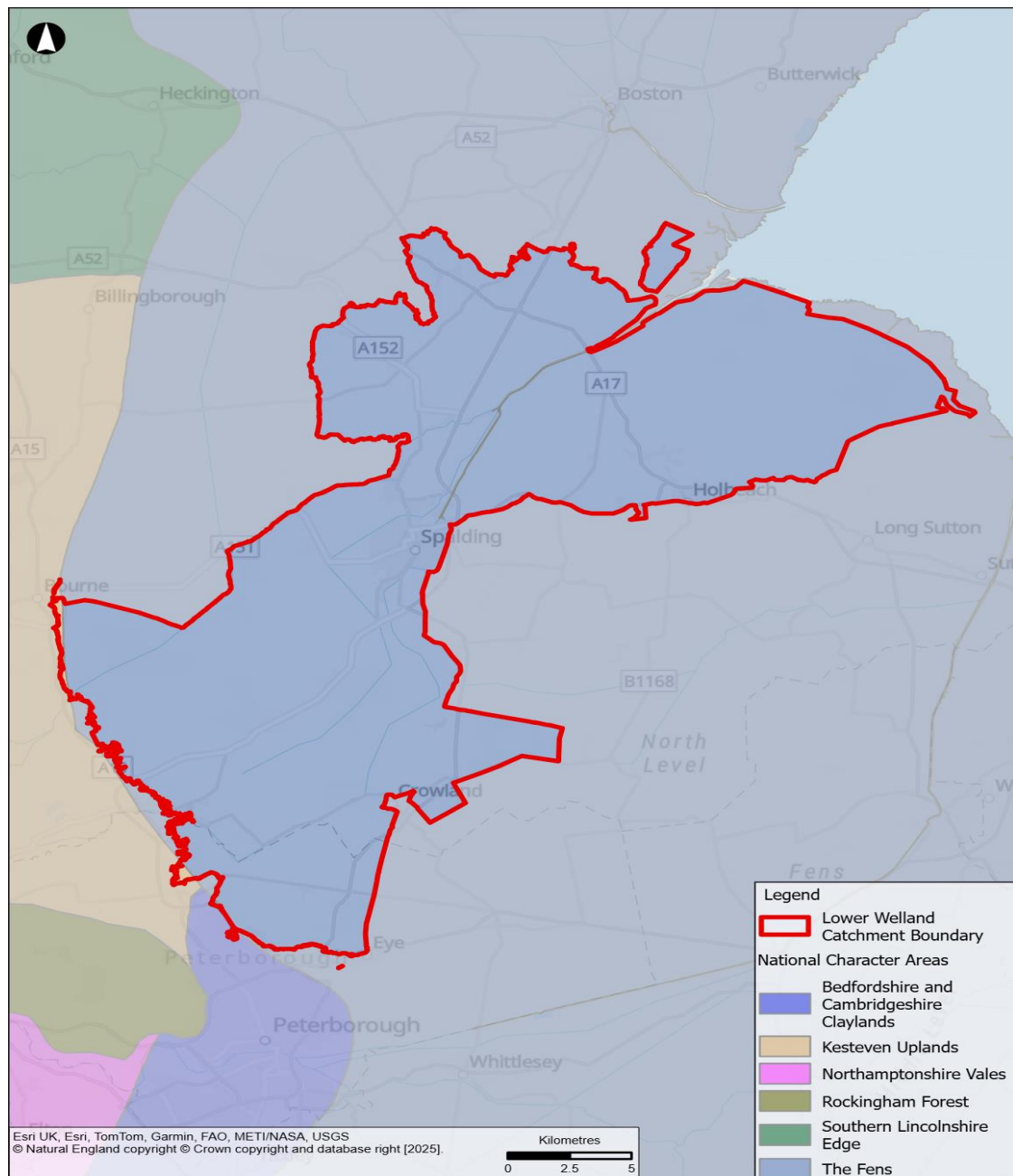


Figure 7: National Character Areas for the catchment

Landscape Character Assessment

The catchment falls within multiple administrative boundaries, as such, the most up to date Landscape Character Assessments (LCA) are detailed below. These are used as a material construction when determining planning applications.

Table 3 Summary of Landscape Character Assessments for local authorities within the catchment

Local Authority	Date Published	Landscape Character Assessment
Boston Borough Council [48]	2009	The north-eastern part of the catchment is covered by the assessment which comprises five character areas: • Frampton to Fosdyke Settled Fen – this covers the majority of the catchment. A largely flat farmed landscape with a patchwork of predominantly arable fields with some pasture. Limited large scale modern influences include rows of pylons and views to working cranes at Boston port and a marina at Fosdyke. • Holland Reclaimed Fen – a flat and low-lying reclaimed fenland with more distant views to Boston Stump and to the Lincolnshire Wolds in East Lindsey District to the north. The large North Forty Foot Drain and South Forty Foot Drain are key dominating features of the area with Bicker windfarm and large-scale pylons on the south-western tip representing modern landmark features. • Bicker to Wyberton Settled Fen - a largely flat landform slightly elevated above the adjacent drained fenland. Views to landmark water towers, and church towers and spires set amongst mature trees in historic villages. Other visible landmarks include the windfarm at Bicker and Boston Stump. A distinctive, cohesive and legibly evolving agricultural landscape, which is peaceful in parts but not particularly remote. • Welland to Haven Reclaimed Saltmarsh – a fairly remote man-made, flat landscape of reclaimed saltmarsh which is surrounded and enclosed by sea banks of varying ages. Views from the tops of the sea banks extend towards The Wash and the Norfolk coast. • Welland to Haven Wash Saltmarsh – an extensive area of open saltmarsh and intertidal winding mud and sand flats, and mud creeks. Open sand and mudflats provide valuable habitats for wildfowl and wading birds protected by many international and national nature conservation designations.
South Kesteven [49]	2007	The south-western part of the catchment is covered by the assessment which comprises two LCAs: • The Fens – comprising low flat terrain, level horizons and large skies with large-scale open rectangular fields, divided by drainage ditches and embanked rivers. There is sparse trees

		and woodland cover with little settlement apart from individual farmsteads, often with large-scale agricultural buildings. • Fen Margin – comprising a transitional area between the wooded Kesteven Uplands and the flat open Fens. There is a broad east-facing slope, with local variations in topography. Medium-scale rectilinear fields with some hedgerow trees and a variety of farming uses. •
Peterborough City Council [50]	2007	The south-eastern part of the catchment is covered by the assessment which comprises three character areas: • The Peterborough Fens – Flat extensive and open landscape with predominantly arable farmland and sparse tree cover. The road pattern is typically rectilinear and raised above the surrounding peat fen. • Welland Valley – Flat open farmland, with ditches forming field boundaries within the largely arable landscape. The meandering River Welland forms the northern boundary. • Peterborough Fen Fringe – Gently undulating landform slightly higher than adjacent fen, promontory of open historically cultivated land extending to the east up to the line of the Catswater Drain.
South Holland District Council [51]	2003	The majority of the catchment is covered by the assessment which comprises two character areas: • The Settled Fens – Predominantly flat terrain with main roads, rivers, and drainage channels on raised banks. Nucleated settlements with mature trees, and prominent church spires. Medium to large fields with intensive market gardening, strong hedgerows and views restricted by shelterbelts and woodlands. • The Peaty Fen – Flat terrain with long, straight roads, rivers and drainage channels on raised banks. Linear settlements with large, uninterrupted views and a sense of openness. Defined by geometric arable fields of cereals and root crops, bounded by drainage channels.

4.1.2 Statutory designated landscapes

There are no statutory landscape designations (i.e. National Parks or National Landscapes⁴) within the catchment. The Lincolnshire Wolds National Landscape is located approximately 34km from the northern boundary of the catchment and the Norfolk Coast National Landscape is located approximately 11km from the north-eastern boundary of the catchment area. There are no local

⁴ Following the government's Landscapes review of 2019, Areas of Outstanding Natural Beauty (AONB) became National Landscapes as of November 2023. A number of documents including legislation still refer to these as AONB. The statutory status of National Landscapes remains.

landscape designations within the catchment. Potential areas for habitat enhancement or creation within the catchment comprises:

- Wooded habitat enhancement or creation – twelve areas located within the catchment, four located within central Spalding.
- Grassland habitat excluding drains enhancement or creation – six areas are located within the catchment, spanning Gosberton and extending along the River Welland in the central northern part of the study area.
- Grassland habitat including drain enhancement or creation – areas located across Gosberton, in the Northwest of the catchment area.
- Mire/Fen/Bog Sites and Water Bodies habitat enhancement or creation – ten areas are located within the catchment, spanning Gosberton and extending along the River Welland in the central northern part of the study area.
- Coastal habitat enhancement or creation – a large area which extends across the northern boundary of South Holland District, from Spalding towards Surfleet.

Heritage and nature conservation designations can contribute to landscape character and landscape value outside of statutory and locally designated landscapes. Please see Section 4.5 and Section 4.6 for further information.

4.1.3 Green and blue infrastructure

The majority of the catchment is covered by The Wash and Fens Green Infrastructure Plan [52], identifying plans to enhance access to green infrastructure, promote biodiversity and proposals for the creation of new habitat networks. The Plan includes habitat network maps that identify potential opportunities to create and enhance habitat networks across the catchment and wider Fens landscape.

Green Infrastructure mapping undertaken by Natural England [53] indicates that the catchment comprises sparse tree cover throughout.

The catchment falls within the boundaries of the Greater Lincolnshire Local Nature Recovery Strategy [54] (LNRS) and the Cambridgeshire and Peterborough LNRS [55] which are currently being developed to identify priorities and opportunities for nature recovery. These strategies will help map areas of existing high-quality habitats or areas of biodiversity, outline opportunities to recover or enhance biodiversity and identify local priorities to provide broader environmental benefits. The Greater Lincolnshire LNRS and the Cambridgeshire and Peterborough LNRS are part of Round 1 of the national rollout.

4.2 Agriculture

This section outlines the baseline agricultural land uses and productivity of the catchment. Table 4 outlines the key terminology used in this section.

Table 4: Glossary of agriculture terminology

Terminology	Summary Definition
Agricultural Land Classification	A system used in England and Wales to assess and compare the quality of agricultural land. It categorises land into five grades based on its versatility and suitability for growing crops.
Countryside Stewardship (CS)	Countryside Stewardship is part of ELMS and recently has undergone changes in what in funds. It provides financial incentives to farmers, foresters, and land managers to

	improve and protect the environment. CS Higher Tier will open in summer 2025.
Entry Level Stewardship (ELS)	An agri-environment scheme in England under the previous Common Agricultural Policy (CAP) that provided funding to farmers and land managers for delivering environmental management on their land. This is now closed to new agreements.
Environmental Land Management Scheme (ELMS)	ELMS are part of the broader agricultural policy reforms in England, transitioning from the EU's Common Agricultural Policy (CAP). It provides financial incentives and support to landowners for making changes to their land that produce environmental benefits. These schemes aim to promote sustainable farming practices, enhance biodiversity, improve water and air quality, and contribute to climate change mitigation. There are currently three ELMS Schemes.
Gross Value Added	An economic productivity metric that measures the contribution of a corporate subsidiary, company, or municipality to an economy, producer, sector, or region.
Soilscape	A soilscape is a classification used to describe the broad regional differences in soil types and their distribution across a landscape. Soilscales are helpful for understanding the general characteristics of soils in a region, including their carbon stock, which can inform land management, agricultural practices, and environmental conservation efforts.

4.2.1 Overview of soilscape within the catchment

Throughout the majority of the catchment towards the Wash and surrounding Spalding, the land is soilscape 21 [56]. This soilscape depending on how light it is, can support different cropping. Given that these soils are mapped as primarily Grade 1, and to a lesser extent Grade 2, it is believed that these areas are more workable than the average of all soilscape 21 soils. These soils have also led to the area being seen as the most important 'double cropping' area of the UK, because the soil enables crops to be planted at any time of year and this enables more than one crop to be grown each year. This is particularly significant for vegetable, salad and ornamental crops.

Adjacent to the Welland outfall, and the Wash around Moulton Marsh Nature Reserve, where the catchment covers a small area of land beyond the seawall, this area is soilscape 1, '*Saltmarsh soils*' suitable for '*Extensive grazing only*'.

In the south of the catchment, there are a range of different soil types, with small areas around Market Deeping having soilscape 5 '*Freely draining lime-rich loamy⁵ soils*'; and soilscape 20 '*Loamy and clayey floodplain soils with naturally high groundwater*'. South of this area at the extreme of the catchment around Baston, the soilscape is soilscape 22 '*Loamy soils with naturally high groundwater*' including the area of the Heidelberg Materials Baston aggregates site.

There are also areas of soilscape 23 '*Loamy and sandy soils with naturally high groundwater and a peaty surface*' and soilscape 27 '*Fen peat soils*' in a seem between Deeping St Nicholas and Bourne.

Natural England's [57] 2008 peaty soils locations layer, identifies 88 km² within this area as peat. Drainage of the lowland peat for agriculture has resulted in peat 'wastage' across the Fens. It is estimated that land levels have lowered by up to 5 metres over the last two centuries due to peat degradation and in some areas of the Fens, such as Holme Fen, shrinkage rates have been recorded at c.18cm annually [59]. As such, most of this area can be assumed to have degraded to wasted peat soils, or to peat remnant mineral soils. The estimated annual volume loss of peat across the North Level and Welland and Deepings IDB districts is 478,103 m³ per year [59]. The

⁵ Loamy soils are composed of a balanced mixture of sand, silt and clay, offering excellent nutrient retention and water-holding capacity. Its structure and fertility make it highly suitable for most plant species and agricultural applications.

estimated carbon stock of peatland within the catchment is discussed further in the Natural Capital Technical Appendix.

4.2.2 Overview of Agricultural Land Classification within the catchment

Across the catchment, around 441km² (93%) of land is classified as ALC Grade 1 and 2 land, with the majority of the Grade 1 located in the northern portion of the catchment (see Figure 8). Table 5 presents an overview of ALC classification.

Table 5: Overview of ALC classification within the catchment

	Grade 1	Grade 2	Grade 3	Grade 4	Non-agricultural
Area (km ²)	242.4	198.4	24.8	0.02	7.09
Percentage of catchment (%)	51.3%	42.0%	5.2%	<0.01%	1.5%

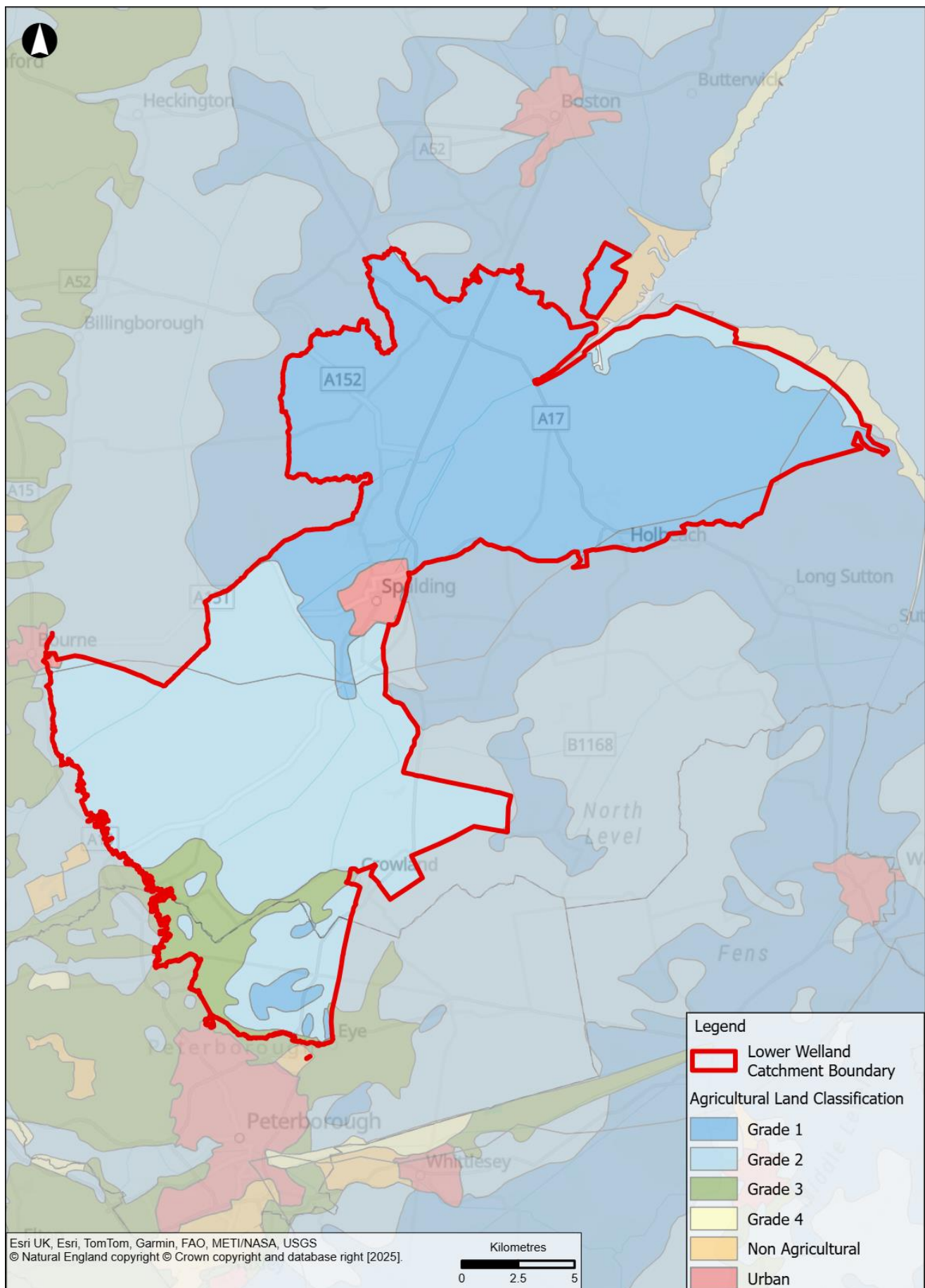


Figure 8: Agricultural Land Classification overview for the catchment

4.2.3 Agriculture and water management

Water abstraction for irrigation throughout the Welland catchment is managed by the Welland catchment abstraction management strategy (CAMS) [58].

The most recent CAMS reports that at Q30 flows the catchment has restricted water available⁶. The CAMS also shows that the southern extreme of the Welland catchment around Market Deeping is underlain by Lincolnshire limestone which has an aquifer, however this has no water remaining available for further abstraction.

There are three assessment points included in the CAMS within the Welland catchment at Surfleet, Kates Bridge, and Marsh Road Sluice, all of which have restricted water available. The catchment has just over 17.5 million tonnes of water available on average for abstraction per annum, with this abstractable volume however only available over a limited period of the year, associated with peak flows primarily across the winter. Therefore, to ensure that high value crops can be irrigated, many farms throughout the catchment have constructed on-farm reservoirs to store winter abstracted water for summer irrigation use.

The catchment has a long history of flooding which impacts both properties and farming. Recent events include:

- Storm Henk - Crowland and Cowbit Washes stored water following a breach in the Cradge Bank. This occurred during high flows after heavy rain on an already saturated catchment.

Flooding has major impacts on crops and to a lesser extent areas of land utilised for livestock grazing. Flood events can restrict the ability to establish new crops, reduce crop yields and quality, or can destroy crops once ready for harvest leading to direct agricultural damages and wider economic consequences for landowners.

4.2.4 Value of agriculture in the catchment

Farms across the catchment are mainly focused on the production of arable crops. The catchment is home to several UK leading agricultural and horticultural businesses, many of which are also engaged in food processing.

Approximately 416km² (88%) of land across the catchment is currently farmed. Land use is not published at catchment level, so the catchment's crop area has been proxied as its relative proportion [59] of the Borough of Boston, South Holland, South Kesteven, and the City of Peterborough districts crop areas, and checked using satellite imagery of crop cover, to estimate the land use allocation as set out in Table 6.

⁶ The Environment Agency's Water Resources Geographical Information System provides a snapshot in time on water availability at four flow snapshots. From high to low, these are: Q30 (i.e. the flow of a river which is exceeded on average for 30% of the time, therefore you would expect the river flow to be lower than Q30 on 256 days in an average year, i.e. a higher flow), Q50, Q70 and Q95. These are calculated for each integrated Water Framework Directive waterbody and looks at the balance between the flow in the river, the quantity needed to support the ecology and the water that can be licensed for abstraction.

Table 6: Key land use within agriculture in the catchment. Data provided by Collinson & Associates (Rounded to nearest decimal place)

	Total farmed area	Cereals	Arable crops excl. cereals	Grassland	Fruit and vegetables
Lower Welland catchment (km ²)	415.9	209.6	107.8	26.9	39.3
Percentage of farmed land in the catchment (%)	n/a	50.4%	25.9%	6.5%	9.4%

Crops produce direct economic output, whereas grassland does not directly create economic value but instead supports the grazing of sheep and cattle, or the production of livestock feed or (AD) energy inputs. It is estimated that the agricultural value of crop areas (based on 2023 data) [60] is as follows:

- Cereal production – c. £30.1 million
- Poultry – c. £31.5 million
- Other arable – c. £25.2 million
- Fruit and vegetables – c. £75.1 million
- Livestock excluding poultry (cattle, calves, sheep, lambs and pigs) – c. £3.3 million

Grassland does not directly create economic value but instead supports the grazing of sheep and cattle, or the production of livestock feed. The estimated overall economic output of crop and livestock is in the region of £183.6 million, highlighting the importance of the agricultural sector.

Within the catchment, there are a number of renewable energy enterprises, farm diversification tourism enterprises, agricultural contracting services and direct farm outlets, such as farm shops, or garden centres. As such, it is anticipated that diversification contributes around 5.4% of total output. The catchment has a concentration of high value cropping, however, without the availability of accurate data on the revenues from the farm diversification enterprises in the catchment, the national average is used to provide a conservative output figure. The gross annual agricultural output (including farm related diversification) in the catchment is therefore believed to be c.£204.5 million (in 2023 values).

4.2.5 Agriculture and the food chain

Farming is critical to the local economy within the catchment. The whole agri-food chain employs people at different stages of food production, from agriculture to food processing and packing and retail.

In the local authority areas that the catchment is located in, a total of 8,000 people were directly employed in crop and animal production, hunting and related service activities sector in 2022.

It is estimated that agriculture supports around 1,889 jobs across the catchment. These 1,889 jobs have a Gross Value Added (GVA) of £42,582 per job, whereas across the UK as a whole, with a total workforce of 462,000 people in 2023, and agricultural GVA of £13.68 million, agricultural GVA was only £29,613 per job [61]. As such, it is estimated that agricultural workers in the catchment contribute a GVA that is almost 44% higher than the national average.

Employment from direct agriculture also supports wider jobs across in the agri-food supply chain. In 2023, farmers purchased £21.086 billion of intermediate consumption (e.g. seeds); and invested £5,140 billion in fixed capital across the UK. Input and capital spending therefore was equivalent to £26.226 billion to generate £34.767 billion of gross output, or 75.4% of gross output. Spending by farmers in the catchment on inputs and capital can therefore be estimated as being £0.157 billion (2023). Given that approximately £300,000 of input spending is believed to support one FTE job in the agricultural input supply chain, this spending is equivalent to a further 525 jobs supported by farms.

Employment is also supported by the further processing, storage and distribution of food produced by agriculture. In 2022 Great Britain had employment in the wider food chain [62] of:

- agriculture (and fishing): 469,000;
- food and drink manufacturing: 445,000; and
- food and drink and agricultural raw materials wholesaling: 250,000; and
- freight logistics sector: 703,300 staff (road, rail and water freight), of which c.30% can be attributed to the food and drink supply chain.

As such 210,990 jobs were associated with logistics in the end-to-end food chain, of which 40% is believed to be focused on the manufacturing and farm to factory gate end of the food chain or c.84,400.

The UK produces around 60% of its food consumption [63] with imports c.40% of its food. Given, that a proportion of domestic food and drink manufacturing, wholesale and logistics is reliant on imported ingredients, it can be estimated that 75% of food chain employment depends on domestic production. Therefore, it is estimated that agriculture and fishing supported a total of $(75\% * (445,000 + 250,000 + 84,400))$ 584,550 jobs in the food and drink chain. As such every job on farm, supported a further 1.25 jobs in the further supply chain.

This national figure however ignores differences between food types, with vegetables and fruit supporting higher supply chain multiples. Similarly, some 'other arable crops' such as potatoes or sugar beet, also disproportionately support more supply chain jobs.

Therefore, in the catchment, as across the Fens as a whole, given the over-representation of vegetable production, and that of higher value crops such as sugar beet or potatoes, this supply chain job multiplier is believed to be higher, at 2 jobs per job supported on farm. Therefore, agriculture in the catchment can be estimated as supporting 6,181 food processing, distribution, storage and wholesale jobs locally and nationally.

The reliance on local employment in food processing, and related industries is demonstrated across the catchment with a number of small and medium food chain businesses present. Spalding is also home to a leading cluster of fresh produce logistics companies. The catchment is also important for food processing research, with the National Centre of Food Manufacturing at Holbeach.

4.2.6 Agriculture and the environment

Within the catchment there are several active middle-tier countryside stewardship agreements. However, the proportion of land covered by these agreements is relatively low compared to other catchments in the Fens. This is because the land in this area is some of the most productive farmland in the UK and is therefore intensively cropped with higher value horticultural and arable crops.

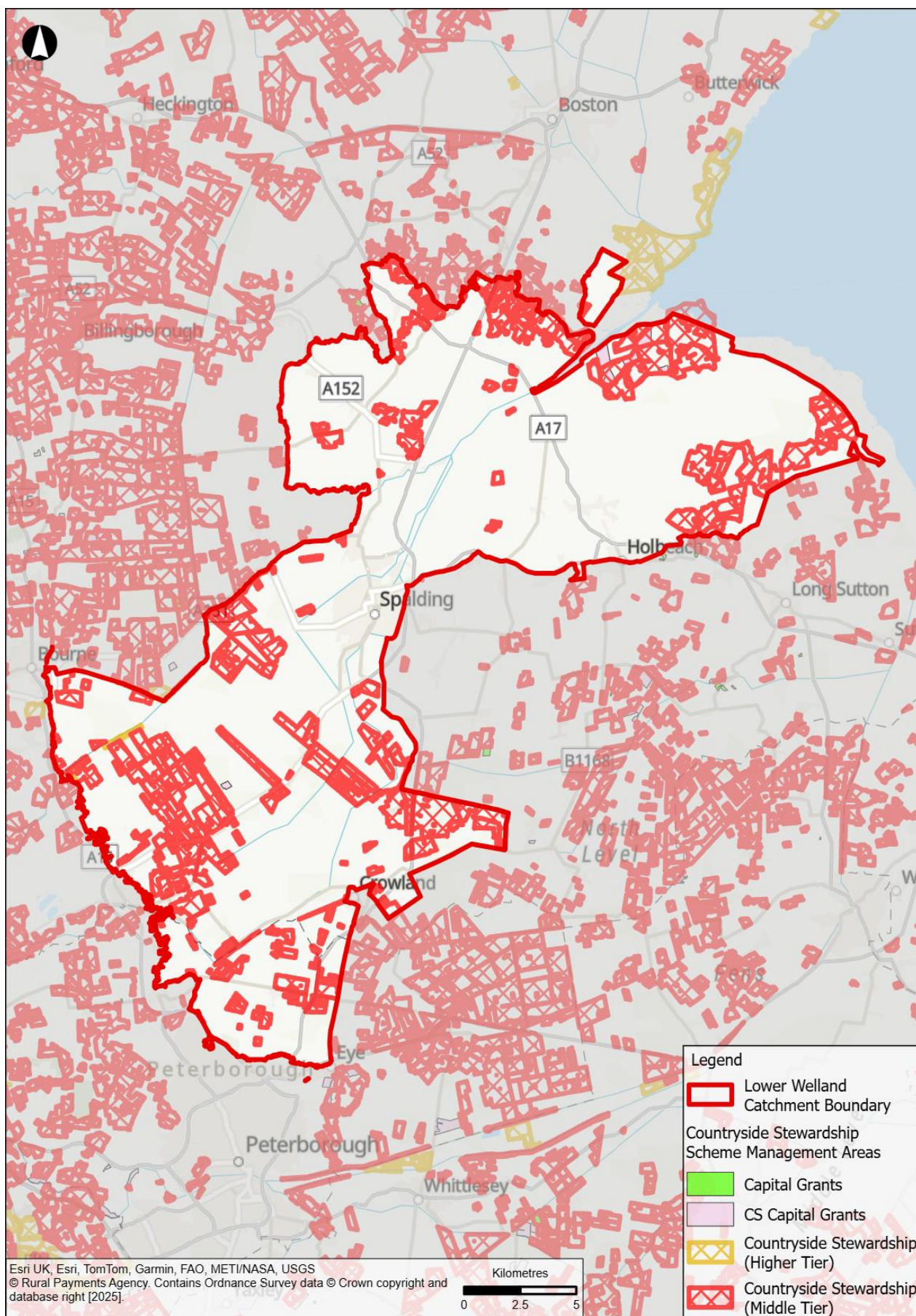


Figure 9: Overview of current environmental stewardship agreements within the catchment



This section outlines the baseline ground conditions in the catchment. Table 7 outlines the key terminology used in this section. It should be noted that superficial deposits of a coastal or marine origin can be highly variable and complex in their composition, deposition and extent. Those presented here are intended to provide an insight into a variety of deposits that may be encountered within the catchment and may not represent the full variety and complexity of such deposits.

Table 7: Glossary of ground conditions terminology

Terminology	Summary Definition
Source Protection Zones (SPZs)	SPZs are defined areas around large and public potable groundwater abstraction sites to protect and safeguard drinking water quality. They constrain the proximity of any activities that may impact upon drinking water abstraction [64].
Nitrate Vulnerable Zone (NVZs)	NVZs are areas designated as being at risk from agricultural nitrate pollution and include just over half of all land in England [65]. Nitrate pollution poses a risk to water quality through eutrophication which is harmful to aquatic life, disrupts biodiversity and damages sensitive habitats and has the potential to affect drinking water.
Engineered materials	Earthworks where the ground has been artificially realigned or adapted. These materials can be poorly sorted, containing an undefined mix of silts, sands, gravels and peats and other organic materials.
Palaeochannels / Roddons	A remnant reach of river bed representing areas of incised channel and tidal creek systems, cut contemporaneously into the underlying clay deposits and filled with “fossilised” silt and sand.
Buried valleys	An ancient, abandoned river or drainage network which has become partially or completely buried by more recent sediment.
Faulting	The process of rock masses breaking and moving along fractures in the Earth’s crust causing displacement.

4.3.1 Catchment-scale designations

Source Protection Zones (SPZ)

Most of the catchment falls outside of any SPZ, with the exception of the area around south-east of Bourne which that is designated as Zone II – Outer Protection and an overlay of Zone I – Inner Protection Zone. The definition of the zones is provided in Table 8.

Table 8: Source Protection Zone definitions as per Groundwater source protection zones (SPZs) - GOV.UK [64]

Designation	Definition
Inner Zone – SPZ1	A groundwater SPZ1 is the area immediately around an abstraction point for domestic supply or for food production purposes. Groundwater in a SPZ1 is most vulnerable to pollution given the close proximity of the abstraction point and the water's intended use for human consumption. It is defined within the Environmental Permitting (England and Wales) Regulations 2016 as one of the following. 1. The area within 50 metres of a point where the groundwater is abstracted for domestic supply or food production purposes. 2. The area where it takes groundwater that is intended to be used to supply water for domestic or food production purposes up to 50 days to travel to the groundwater abstraction point. For any given abstraction point, whichever area is largest applies.
Outer Zone – SPZ2	A groundwater SPZ2 is the area around an abstraction point for domestic supply or for food production purposes that meets one of the following definitions. • The area within 250 metres of the abstraction point if the maximum allowable annual volume, divided by 365, is less than 2,000 cubic metres per day. This is when this is authorised by either an abstraction licence under section 24 of the Water Resources Act 1991 or the right to abstract small quantities under section 27 of the Water Resources Act 1991 • The area within 500 metres of the abstraction point if the maximum allowable annual volume, divided by 365, is equal to or greater than 2,000 cubic metres per day. This is when this is authorised by an abstraction licence under section 24 of the Water Resources Act 1991 • The area where it takes groundwater that is used to supply water for domestic or food production purposes up to 400 days to travel to the groundwater abstraction point .For any given abstraction point, whichever area is largest applies.
Total catchment – SPZ3	This is the area around a supply source within which all the groundwater ends up at the abstraction point. This is the point from where the water is taken. This could extend some distance from the source point.

Nitrate Vulnerable Zone

The majority of the catchment is designated as NVZ apart from some areas on the eastern margin. These areas are designated as being at risk from agricultural nitrate pollution and include just over half of all land in England.

Radon

There is no apparent risk from Radon in the Catchment as the entire Catchment falls within the less than 1% of homes at or above Action Level [66].

4.3.2 Geology

The geology of the catchment is covered by the following geological maps:

- 1:50,000 Boston Sheet 128 Solid and Drift Geology (BGS, 1995)
- 1:63,360 Bourne Sheet 143 Solid Geology [67]
- 1:63,360 Bourne Sheet 143 Drift Geology [68]
- 1:50,000 Spalding Sheet 144 Solid and Drift Geology [69]
- 1:50,000 Peterborough Sheet 158 Solid and Drift Geology [70]

The strata identified within the catchment including those designated as engineered materials, superficial deposits and bedrock geology are described below:

Engineered materials

The catchment is predominately an artificially drained and heavily engineered landscape. It experienced extensive land reclamation activities from the 17th to late 19th Centuries, notably at Deeping Fen, Spalding and Cowbit Washes, Pinchbeck and Surfleet comprising the implementation of embankments, sluices and catchwater drains [71], as well as the reclamation of coastal marshes later in the 19th Century at Holbeach and Moulton Marshes. Land reclamation along The Wash frontage in this region occurred as recently in the 1970s [72]. Much of the inland catchment has also been altered by artificial realignment or adaption of pre-existing watercourses or the formation of new cuts and drains (such as the Coronation Channel) and this has resulted in the creation of many associated earthwork flood embankments but also areas of cuts and adaptations to local infrastructure.

It is commonly observed that many raised flood embankments originate from the 1800s, if not earlier, and are dredging bunds. For some, they have also been adapted and now support roads and access tracks but have not necessarily been strengthened to accommodate for modern traffic loads.

Similarly, the composition of these earthworks is often of poor quality and have been identified as comprising of locally sourced materials, frequently including material from channel “digout” where new cuttings were formed or from deepening and widening existing cuttings. Material from subsequent dredging activities is also locally incorporated to raise the embankments or spread out on the land as natural fertiliser. These materials can be poorly sorted, containing an undefined mix of silts, sands, gravels and peats and other organic materials. These materials also present several engineering risks including settlement and shrinkage, susceptibility to scour and can be susceptible to seepage, all of which can contribute to failure of the embankment and ultimately its ability to retain water. An example of this, is the construction of the Bourne Eau. The Bourne Eau is an embanked high-level carrier, southeast of Bourne and suffered a breach in 2024. On inspection, it appeared that the embankment was formed out of peat and available geological mapping suggests a broad area of peat occurs to the southeast of Bourne.

There are areas such as the Deeping High Bank, along the landward side of the River Welland that both serve as transport links but also as flood defences, to protect farmland and associated properties but appear to suffer much of the same settlement and deformation exhibited throughout the Fens (Figure 10).



Figure 10: Photo of the Deeping High Bank, the Cradge Bank can be seen on the far side of the Welland. The pavement in the high bank is subject to deep rutting and deformation

The majority of the flow on the River Welland was diverted to the south of Market Deeping via 'Maxey Cut' between Tallington and Peakirk which is an artificial channel which is embanked on both sides.

The Crowland and Cowbit Washes, a reservoir under the Reservoirs Act 1975, is located within the catchment. It provides flood water storage at time of high flow in the Welland between Peakirk and Spalding and is fed via a series of concrete siphons. Water is contained between a low-height Cradge Bank adjacent to the Welland and a set-back barrier bank to the east. The area in between is farmed, and although it was designed to periodically flood, it has operated for this purpose very infrequently since its construction.

Tidal influences affect the catchment downstream of Spalding, with areas like Surfleet particularly vulnerable to flooding whenever flows in the River Glen are unable to discharge into the River Welland due to tide-lock at Surfleet Sluice. The IDB drainage network is protected from tidal inundation by Vernatt's Sluice, which sits on the downstream end of Vernatt's Drain where it discharges to the Welland close to Surfleet. Spalding is protected from tidal flooding by Marsh Road Sluice (which prevents the tide moving up the Coronation Channel, and Fulney Lock which fulfils the same purpose on the River Welland channel). Of course, with such tidal influences, the impact of sedimentation and siltation will play a significant role in the operation and effectiveness of such assets.



Figure 11: Photograph (left) of raised earthworks (tidal defences) at Surfleet Sluice (looking downstream) and Photograph (right) of Surfleet Reservoir. Houses built within the online storage area and within the raised defences (not seen, set back).

Superficial deposits

The catchment exhibits a range of superficial deposits with a strong influence from Tidal Flat Deposits which cover the majority of the catchment. The southwestern boundary however is notably more variable and is indicative of the Fen Basin margins and is shown to include outcropping peats, marine gravels such as the Abbey Sand and Gravel Member and the March Gravels Member and extensive River Terrace Deposits.

It should be noted that superficial deposits of a coastal or marine origin can be highly variable and complex in their composition, deposition and extent and may represent frequent episodes of reworking and deposition.

An overview of the superficial materials that may be encountered within the catchment is presented in Figure 12.

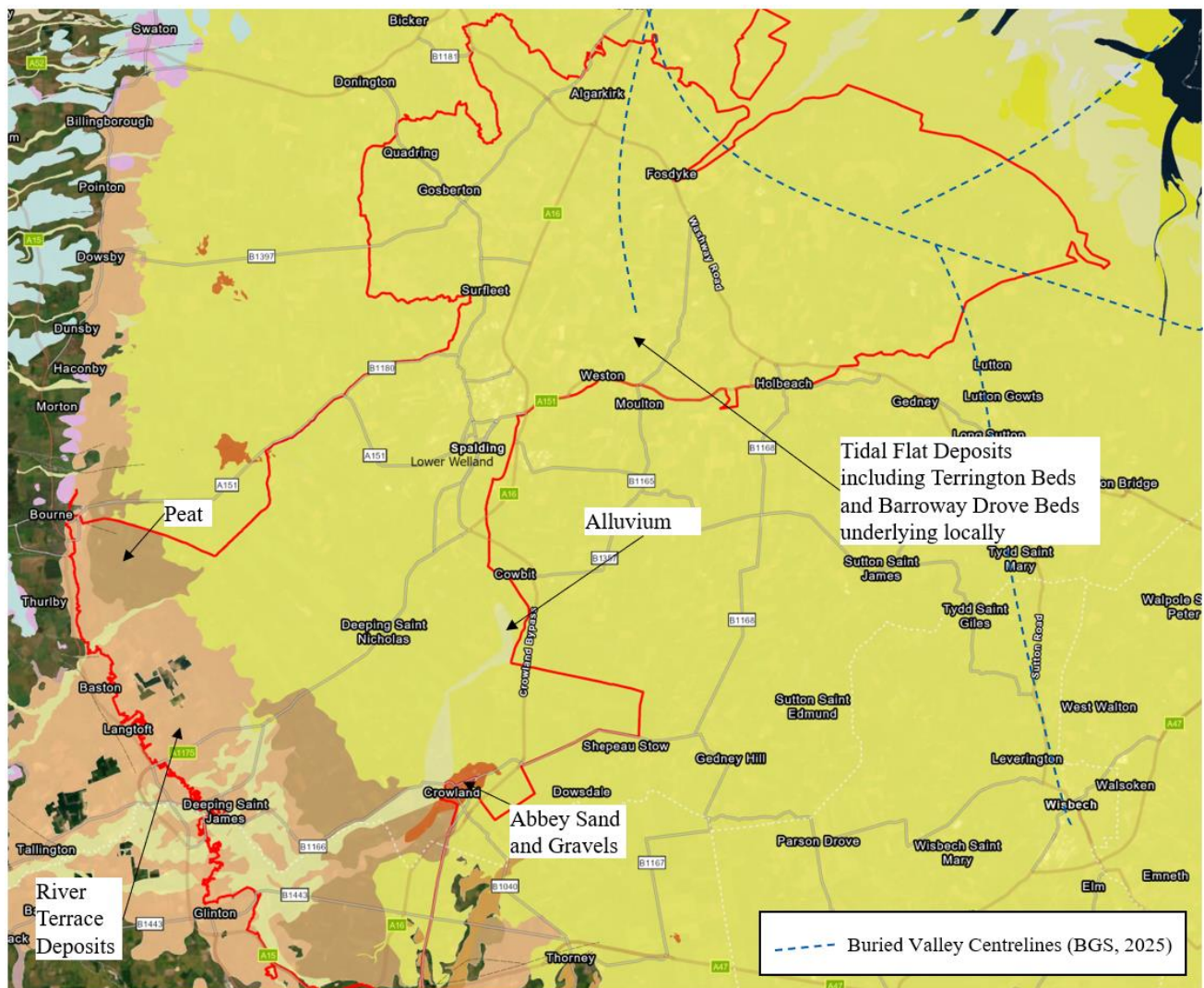


Figure 12: Simplified overview of superficial deposits in the catchment from BGS 1:50K Geological Mapping ©

Alluvium

Alluvium or Alluvial materials, derived from fluvial sources will be present across the catchment and will be subject to frequent periods of deposition and reworking. These are only mapped on the western boundary. Alluvium is often grey or brown in colour but can be locally variable, and is predominantly composed of cohesive materials including significant proportions of clay and silt. Alluvium may also locally contain sands and gravels and varying quantities of organic materials and shell fragments. All materials may be laterally restricted and may only be present as isolated lenses and horizons. The depth and thickness of Alluvium is also likely to be highly variable. Boreholes may sporadically encounter Alluvium such as TF21SW37 [73] (proximal to the River Welland, north of Crowland) where it was described as “brown firm to stiff calcareous silt” and as “yellowish brown with root traces” from 0.40-0.70m below ground level (bgl).

River Terrace deposits

River Terrace Deposits, a deposits of fluvial origin, are frequently described in the available borehole records such as in boreholes TF21SE1 and TF21SW38 (located adjacent to the Deeping High Bank). They are commonly described as “orangish brown sands and gravels” and of some varying thickness. They are also sometimes difficult to distinguish from other gravels in the region such as the Abbey Sand and Gravel Member.

Tidal Flat deposits

The Tidal Flat Deposits can include the following: Terrington Beds, Barroway Drove Beds and Nordelph Peat.

- **Terrington Beds**

The Terrington Beds cover a broad extent of the Catchment and are notably present towards the eastern boundary. They typically comprise of pale brown silts, fine grained sands and interlaminated reddish-brown clays. The deposits can facilitate the creation of marshy land and areas of unconsolidated sediment, mainly of mud and/or sand [74].

- **Barroway Drove Beds**

The Barroway Drove Beds may underlie the Tidal Flat Deposits or crop locally in the Catchment and are widespread between Peterborough and The Wash. They frequently comprise primarily of clay and silt but can locally contain peats and organic materials such as roots and rootlets such as that shown in TF21SW8 (north of Crowland), where they occur as 0.5-1.5m thick beds, and are described as a “grey soft clay with black peaty roots and shells”. Whilst the Barroway Drove Beds may contain Peat, they can also be sandwiched by Peat above (Upper Peat) and Peat below (Lower Peat) which can also be displaying repeating smaller layers or lenses of Peat [75].

- **Peat and Nordelph Peat**

Peat is mapped near Bourne and as broad areas between Crowland and Deeping but is likely to be present across much of the Catchment and may occur as small isolated layers within other deposits. Organic materials and peats are commonly mentioned in borehole records, including an Upper and Lower Peat as mentioned in borehole TF21SW8 (north of Crowland). The borehole describes the Upper and Lower Peat as “black compact with rootlets” and “blue-grey soft silty clay and gravel with peaty wood fragments.”

Marine Gravels

Marine Gravels reported within the catchment. These include the youngest, the Abbey Sand Gravel Member and the older, March Gravels (often concealed below other superficial deposits) but identified at surface near Eye.

The Abbey Sand and Gravel Member (sometimes known as Fen Gravel or Basal Gravel) are mapped locally throughout the catchment including in the vicinity of Deeping. The member can be present locally as isolated or sporadic layers but is identified in borehole TF21SE7 (due west of the A16, near Bank House Farm) as a thin (0.91m thick) layer but could be up 1.50-4.00m thick. It also crops in some areas such as that at Crowland which creates a localised “island” of gravel.

Glacial Deposits

Glacial Till and Glaciofluvial Deposits are indicated to be present on the western edge of the Fen Basin where they form higher ground. They are also frequently reported to be present at depth concealed beneath younger superficial deposits such as the Tidal Flat Deposits and the Marine Gravels. Glacial Till, such as that encountered in TF13NE15 (adjacent to the Lower Welland Drain, west of Swineshead) is described as a “hard dark grey boulder clay” and is identified at a depth of approximately 6.5mbgl. Similarly in TF13NE15, describes the material as a “firm to hard grey and

brown gravelly clay with gravels composed of chalk” and is reported to a depth of approximately 10mbgl below an approximate thickness of sands and gravels to a depth of 4.70mbgl. Glaciofluvial Deposits, such as that in TF14SW10 (near Helpringham) are also present at crop and likely at depth too. In TF14SW10 they are noted at crop and described as sands and gravels to approximately 4.50mbgl.

4.3.3 Bedrock Geology

The catchment is predominantly underlain by mudstone of the Oxford Clay Formation with the West Walton Formation and the Ampthill Clay Formation present in the northeast of the Catchment. On the southwestern boundary of the catchment, the Kellaways Formation (both the Sand and Clay Members) are encountered as is the Cornbrash Formation.

The anticipated bedrock geology of the catchment is presented in Table 9 and a simplified geological map is presented in Figure 13.

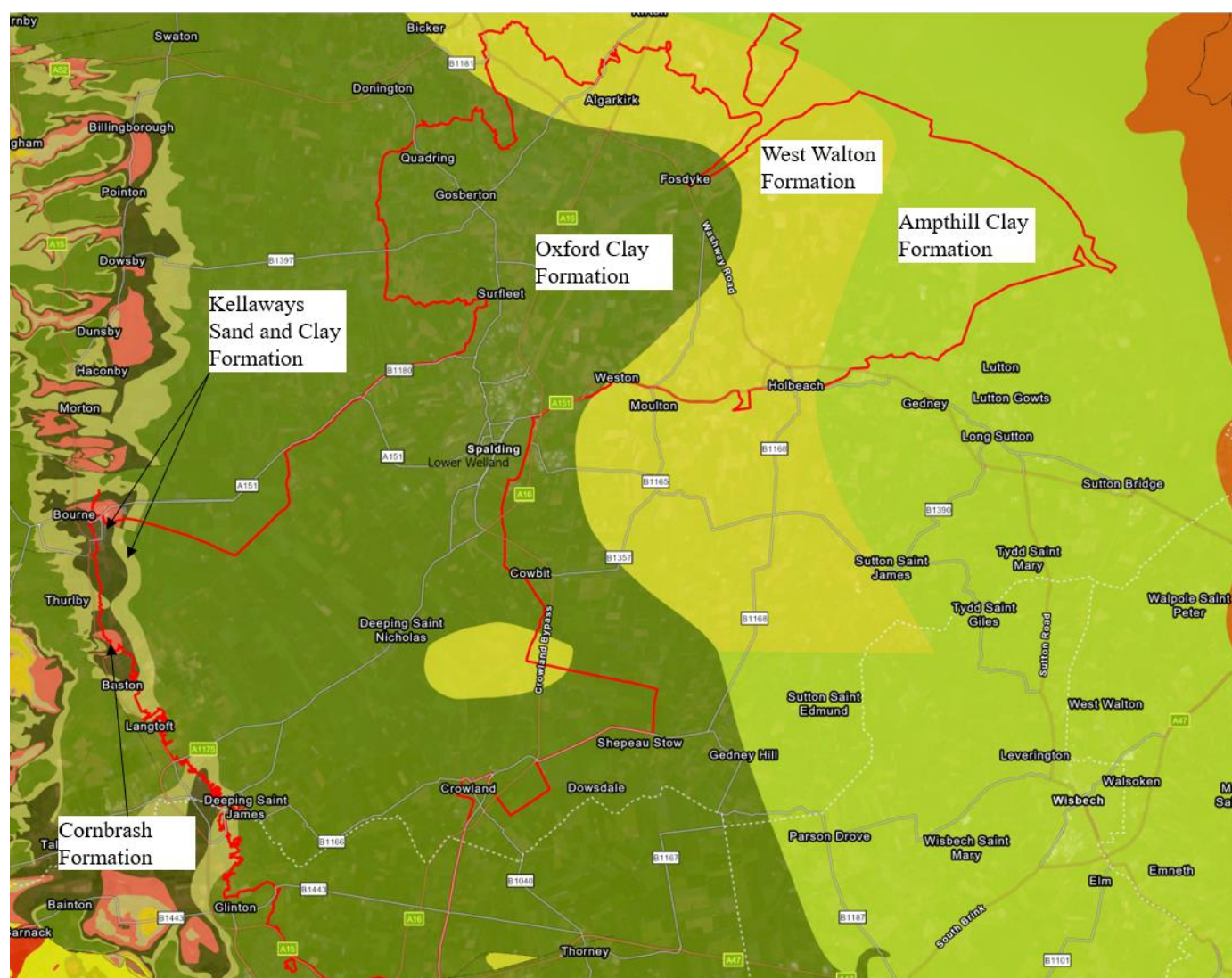


Figure 13: Simplified overview of the bedrock geology underlying the catchment from BGS 1:50K geological mapping

Table 9: Summary of Bedrock Geology within the catchment

Formation	Members (if applicable)	Description [73]
Ampthill Clay Formation		Mudstone, often argillaceous limestones and marls (Woods, M A, 2018). Fossiliferous material can also be expected. Overconsolidated, high plasticity, frequently fissured and susceptible to shallow slope angle failure.
West Walton Formation		Mudstone, often calcareous or silty with argillaceous limestones and marls (Woods, M A, 2018). Fossiliferous material can also be expected. Fissured clays are also expected with selenite (gypsum) crystals reported.
Oxford Clay Formation	Weymouth Member	High to very high plasticity brown, grey, green and blue-grey shelly over-consolidated clay and organic-rich (bituminous) weak mudstones, prone to seasonal shrink-swell movement. Laterally persistent limestone bands and cementstone concretions may be present resulting in locally stronger horizons. (Price, 2018).
	Stewartby Member	
	Peterborough Member	
Kellaways Formation	Kellaways Sand Member	Grey sands, and calcareous siltstones and sandstones, the latter may be relatively hard.
	Kellaways Clay Member	High to very high plasticity over-consolidated clay, it can also contain discreet or frequent sand/sandstone beds and partings.
Cornbrash Formation		Often thin (less than 1m locally), very hard fine grained limestone.

4.3.4 Regional structure

Palaeochannels / “Roddons”

An influential feature of significance in the Fens is the presence of palaeochannels which are locally referred to as “roddons” or “silt-filled creeks” such as those well documented in the Peterborough district – these are however not well recorded on neighbouring district sheets.

The influence of anthropogenic changes and involvement such as agriculture and engineered drainage, has caused these former channels to become positive topographical features [75]. As the land surrounding, which is notably cohesive and susceptible to shrink, the more granular material infilling the former channel remains proud. These features, whilst subtle, can form ridges up to 1m high and can also intersect notable features and locations in the catchment such as Deeping and the River Welland.

It is also noted that the roddons would not be able to facilitate or be re-used as channels in the

event of future marine transgression events, and due to compaction, settlement and peat wastage that has occurred between them, they may be capable of funnelling or concentrating water flow between them [75]. A summary of the encountered roddon structures scale across the Fens is provided in Figure 14.

Table 10: Summary of the identified roddon hierarchy

Roddon Hierarchy	Dimensions	Description
Major “Trunk” Roddon	2m to >1km	Predominantly fine sand, consistent of grain size from mouth to upper extents, likely representative of being deposited under uniform depositional conditions
Tributaries	1m to >10m	Predominantly silt
Minor Tributaries		Predominantly clay

LiDAR imagery for the catchment shows a prominent occurrence of roddons which are of varying scale. Figure 14 shows a range of roddon sizes in the area of Deeping.

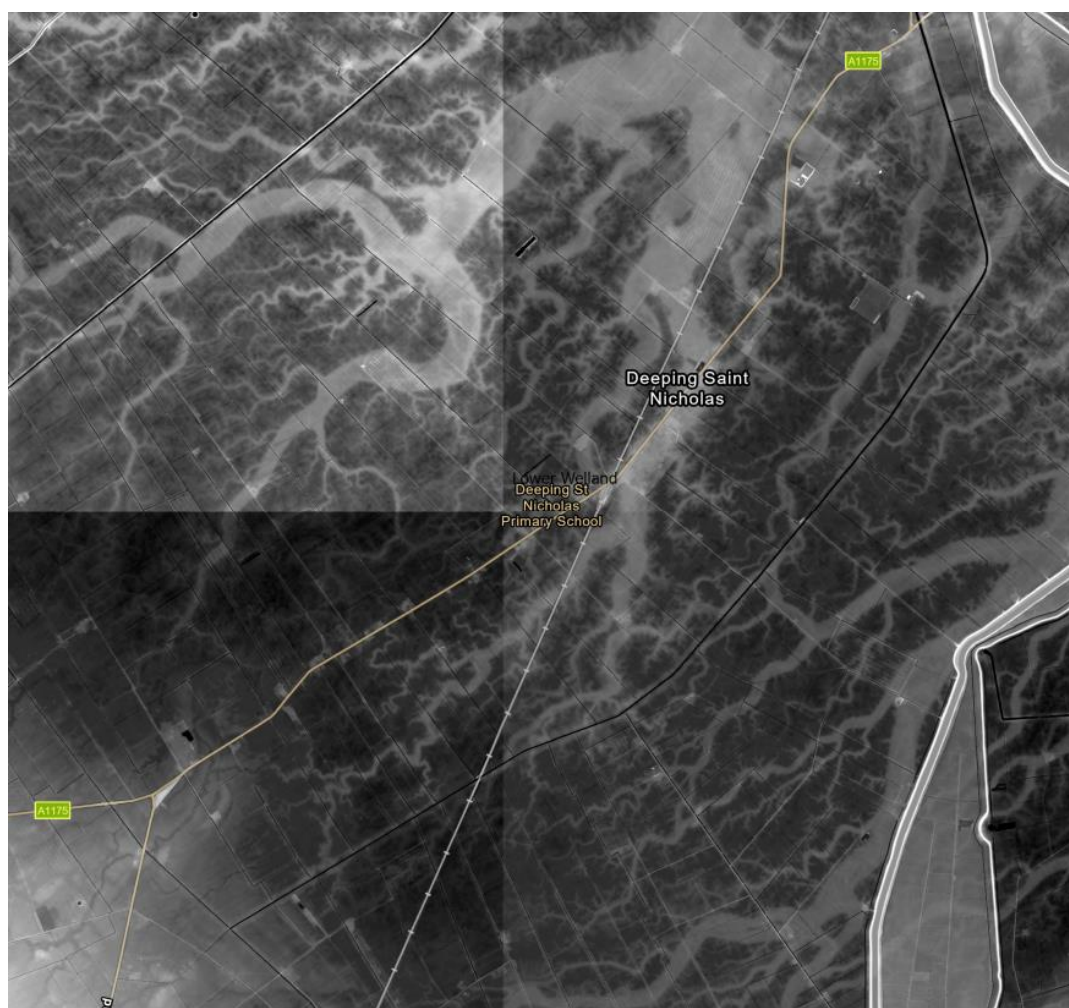


Figure 14: LIDAR composite imaging showing network of roddons of varying sizes crossing the catchment in the area of Deeping. The River Welland can be seen to the southeast.

Buried Valleys

Buried valley features (see Figure 12) are indicated to be present to the southeast Boston, orientated northeast to southwest and from northwest to southeast in the northeast portion of the catchment [76]. Buried valleys would likely be infilled with a mix of sands and gravels and possibly Glacial Till. Buried valleys present the risk of encountering much deeper than anticipated superficial deposits.

Faulting

Faulting is not common throughout most of the catchment apart from a few striking due east to west on the southwestern margin.

4.3.5 Hydrogeology

A summary of aquifer designations for geologies at outcrop and underlying the site has been prepared using information from the GeoIndex [73]. Magic Maps and hydrogeological Mapping [77].

Superficial Geology Aquifers

A summary of the superficial aquifers is presented in Table 11.

Table 11: Summary of encountered superficial deposit aquifer designations within the catchment

Formation	Bedrock Aquifer Designation
Alluvium	Secondary A. Very small yields and often poor water quality.
Glaciofluvial Deposits	
Marine Gravels including the Abbey Sands and Gravel Member	
Glacial Till	Secondary (Undifferentiated) Very small yields and often poor water quality.
Tidal Flats Deposits including Terrington Beds and Barroway Drove Beds	Unproductive. Low permeability that can however confine underlying.
Peat	

Bedrock Geology Aquifers

A summary of the bedrock aquifers is presented in Table 12.

Table 12: Summary of encountered bedrock geology aquifer designations within the catchment

Formation	Bedrock Aquifer Designation
Kellaways Sand Member	Secondary A
Cornbrash Formation	
Kellaways Clay Member	Unproductive. Low permeability that can however confine underlying aquifers
Ampthill Clay Formation	

West Walton Formation	
Oxford Clay Formation	

4.3.6 Geotechnical Appraisal – engineered structures

Earthworks

Earthworks constructed within the catchment to facilitate the transportation and containment of surface waters may be locally subject to failures and degradation. Recent experience on the Welland and Bourne Eau support this. Many earthworks are likely to have not been built to modern engineering standards and are commonly composed of dredgings and localised digout however in many cases they perform as required despite this. The composition and distribution of the materials can be highly variable and as a result can present the risk of localised failures. These failures can be divided into the following key risks:

Earthwork slope instability

Slope instability of the embankments side slopes could take the form of shallow surface slips where the embankment is not particularly high and the slopes are steep, or deeper, rotational failures where the embankments are taller with slopes that are less steep and poor foundation soils (i.e. peat). Near Bourne, it is understood that embankments were built with materials containing notable amount of peat and were founded on peat, the combination of which ultimately lead to a failure of the asset. The cause of slope instability is due to high groundwater conditions within the embankment and the foundation soil during flood conditions coupled with the embankments being built out of low strength soils with overly steep side slope angles over poor foundation soils also with low strength.

Poor vegetation cover can also present a risk to shallow slope instability. If vegetation was well-maintained vegetation, it can help to stabilise the shallow soils through root cohesion and control of moisture content. For example, a ranker sward comprising of shallow or predominantly tap-rooted vegetation offers poor resistance compared to a species-rich grass sward.

Slope instability is often a very localised feature and where it does occur it might only impact of a few metres to a few 10s of metres of linear embankment. It can result in potential loss of containment by increasing the risk of seepage due to the reduced seepage pathways through the embankment. Also, further scour or erosion of the embankment can occur where bare soil is exposed either on the riverward face or the landward face.

Settlement and deformation

Settlement can occur from a range of causes. The embankment can settle due to consolidation of the foundation soil due to ongoing drainage activities and long-term creep settlement of organic rich soils. Settlement can over time lower the crest and where the foundation soil comprises contrasting soils which consolidate by different amounts, differential settlement can occur across the embankment.

Settlement may occur due to internal consolidation of the embankment where this was inadequately compacted. At a shallow depth with embankments where clay soils are present, these can be susceptible to changes in moisture and can readily change in volume leading to shrinkage and swelling. Overtime this can lead to differential settlement at the surface and becomes particularly obvious where embankments support roads in the form of cracking and undulation of the pavement, such as those along the Deeping High Bank and Barrier Bank within the Crowland and Cowbit Washes.

Settlement and deformation can also be increased by traffic loading of the crest where roads or access tracks are present on top of embankments, or due to heavy loading by maintenance plant.

Overtopping

Overtopping of embankments is identified as a risk, particularly if low spots are present due to settlement. Where embankments are poorly vegetated (either a lack of soil binding vegetation or surface cover), there is additional risk from scour during an overtopping event which could lead to a breach and effective loss of containment.

The Cradge Bank within the Welland Washes has an embankment which is designed to overtop, however, defects in the embankment occurred during recent flooding.

Seepage

Seepage can occur in earthworks or structures that are composed of granular or have more permeable layers such as sands and gravels. It can also occur where there are palaeochannels beneath the embankment or where there are burrowing animals. As mentioned, the composition of earthworks in the region can be of variable composition so the risk of seepage can be highly variable.

Seepage essentially undermines the effectiveness of any structure designed to retain water and can result in the removal of material, particularly fines and ultimately leading to reduction in mass soil strength with the potential to induce slope failure or ultimately, breaching.

Some embankments on the Bourne Eau have been noticed to be prone to seepage due to having been formed out of peaty soils.

Animal activity

Animal activity presents several risks to earthworks including the establishment of burrows through and within earthworks but also from the frequent trafficking and trampling of surface soils and vegetation. Burrowing can encourage instability and promote seepage whilst animal movement on the surface, can lead to the removal of protective vegetation.

Burrowing, particularly from badgers was mentioned by the operations team to be particularly challenging to manage and had many additional costs and repairs associated with it.

Asbestos edge protect

The river bank adjacent along some sections of the Crowland and Cowbit Washes is edges with asbestos containing sheeting.

Aggressive groundwater conditions

Acid groundwaters could be encountered in areas that are rich in pyritic minerals such as the fossiliferous strata, such as the Oxford Clay, Ampthill Clay and West Walton Formations. Those that promote mobility of groundwaters or where groundwater levels can fluctuate as to promote oxidation, would be anticipated to have a greater potential to create aggressive (acidic) groundwater conditions and would potentially have a detrimental impact on concrete foundations and sub-structures. Peat also has the potential to increase acidity in groundwaters.

Areas of reclaimed coastal marsh, and other low-lying areas of the Lower Welland catchment, may be susceptible to elevated salinity in the ground and groundwater associated with historic tidal inundation and saltwater intrusion [78]. Salinity levels can be higher during drier months and during increased water abstraction where lower groundwater tables might allow saline water intrusion.

4.4 Water environment

This section outlines the baseline water environment in the catchment, focusing primarily on surface water bodies considered within the Water Environment Regulations (WER)/Water Framework Directive (WFD). Analysis of the groundwater bodies present within the catchment has focused on their overarching statuses at this stage. Further information regarding the hydrogeology baseline condition of the catchment, including details of the various aquifers and source protection zones and drinking water safeguard zones present, is provided in the Ground Conditions (soils and resources) baseline above. An overview of flood risk and key flood risk management infrastructure within the catchment is provided in the Lower Welland catchment baseline report, and the flood risk technical appendix. Table 13 outlines the key terminology used in this section.

Table 13: Glossary of water environment terminology

Terminology	Summary Definition
Main River	Designated 'Main rivers' are usually larger rivers and streams with the highest flood risk. The Environment Agency, using its permissive powers, can carry out maintenance, improvement, or construction work on Main Rivers to manage flood risk and protect the environment. As these powers are permissive only, the Environment Agency is not obliged to carry out either maintenance or new works on Main Rivers.
Flood Zone	Areas classified by the probability of river or sea flooding, excluding the presence of flood defences.
AIMS	Asset Information and Maintenance programme dataset detailing flood risk management assets. The dataset is owned by the Environment Agency but includes assets also owned or operated by third parties.
River Basin District	The area of land (and sea) comprising one or more neighbouring river basins together with their associated groundwaters and coastal waters. There are 10 river basin districts in England.
Management catchment	A sub-category of a river basin district, a management catchment comprises a number of water body catchments in one management unit at which actions are applied.
Operational catchment	A sub-category of a management catchment, an operational catchment groups water body catchments together for economic appraisal.
Water Framework Directive (WFD) or Water Environment Regulations (WER)	Legislation designed to halt the deterioration in status of water bodies in Europe (WFD) and England (WER) and achieve good status for rivers, lakes and groundwaters.
River Basin Management Plan (RBMP)	RBMPs are produced for each river basin district and set the legally binding, locally specific environmental objectives for water regulation and planning activities.

4.4.1 Catchment overview

The Main Rivers within the catchment comprise the River Welland (54km long⁷) and its tributaries the Maxey Cut, South Drain, Folly River, and further north, the River Glen and its tributary Bourne Eau.

- The Bourne Eau is located in the furthest western extent of the catchment study area and flows in a south-easterly direction before forming a confluence with the River Glen. The River Glen then flows in a general north-easterly direction to Surfleet, where it forms a confluence with the River Welland adjacent to the outfall of Vernatt's Drain.
- The River Welland enters the south-western extent of the catchment study area, to the south-east of Market Deeping. Just north of Peakirk it is joined by two Main River tributaries: the South Drain and Folly River. The Maxey Cut is an artificial relief channel which diverts high flows from the River Welland in West Deeping, Market Deeping and Deeping St James. It was constructed as part of a flood relief scheme in 1947, and reconverges with the Welland within the study area downstream of Peakirk. In this location a portion of the West Glen river flow has also been diverted into the Welland as part of the same flood relief scheme via the Greatford Cut located upstream of the catchment study area.
- The Deeping Lakes Site of Special Scientific Interest (SSSI) and Nature Reserve is located adjacent the confluence of the River Welland, Maxey Cut and Folly River. The main lake dates from the 1800s and two smaller lakes and pools comprise the Welland Bank Quarry dating back to the 1990s. From Peakirk, the River Welland then flows in a north-easterly direction through the centre of the catchment study area. Within Spalding, flows from the River Welland are preferentially routed through the Coronation Channel, a flood relief channel constructed in 1953 following the floods of 1947. The River Welland is tidal downstream of Fulney Lock, located in the north of Spalding, and Marsh Road Sluice sets the tidal limit on the Coronation Channel. The tidal Fulney Lock allows navigation by watercraft, which can navigate on the River Welland as far inland as the Folly River. The extent of these Main Rivers are shown in Figure 15.
- The Main Rivers in the catchment largely comprise linear and embanked drainage channels. Drainage water is discharged into the Main River network by a complex network of infrastructure managed by Welland and Deepings, North Level District and South Holland Internal Drainage Boards (IDBs).

⁷ Based on measurements of Main River within the catchment study area boundary undertaken in ArcGIS.

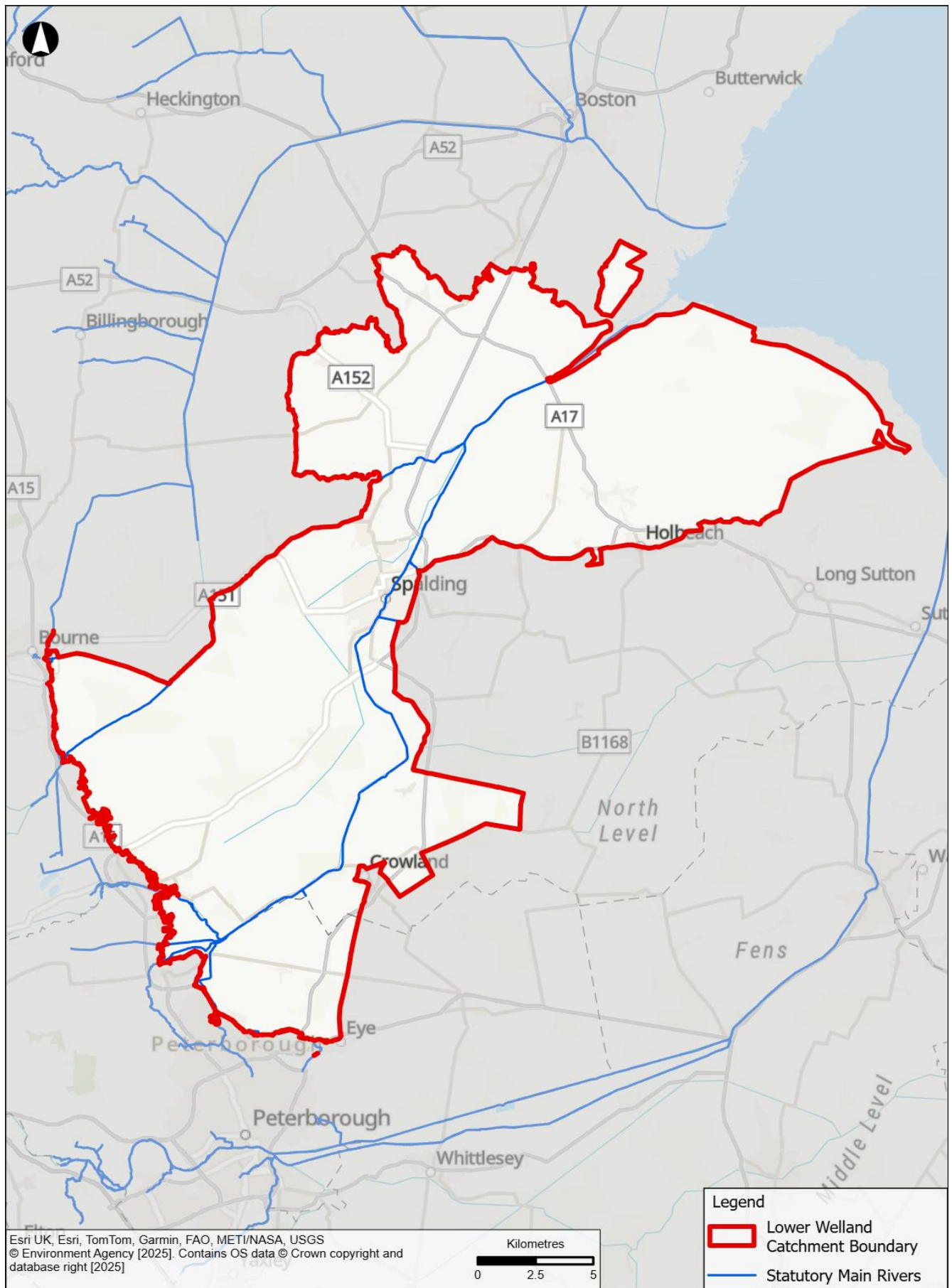


Figure 15: Main Rivers in the catchment

4.4.2 Water Environment Regulations (WER) / Water Framework Directive (WFD)

Surface water bodies

The catchment is located within the Anglian River Basin District (RBD), which extends from Lincolnshire in the north to Essex in the south, and Northamptonshire in the west to the East Anglian coast. The RBD is subdivided into 14 Management Catchments. The catchment study area falls partially within the Welland and Witham management catchments, and within the Welland Lower and Glens and South Forty Foot Drain operational catchments respectively. The lower reaches of the Welland are partially located within the Anglian Transitional and Coastal (TraC) management catchment and The Wash TraC operational catchment.

A significant proportion of the catchment study area falls within the 'Vernatt's Drain' and 'Welland – conf Greatford Cut to Tidal' river water body catchments. The latter is fed by the 'Maxey Cut', 'Brook Drain (including Marholm Brooks)' and 'Folly River (including Werrington and Marholm Brooks)' river water body catchments, which partially extent into the far south-western extent of the study area boundary.

The 'Welland – conf Greatford Cut to Tidal' transitions into the 'Welland' transitional water body at Fulney. The 'Glen', 'Risegate Eau', 'Fosdyke Bridge Outfall' and 'Kirton Marsh Drain' river water bodies comprise the northern portion of the catchment study area and form a confluence with the left bank of the 'Welland' transitional water body downstream of Surfleet. The 'Moulton River' and 'Whaplode River' river water bodies flow in a northerly direction and form a confluence with the right bank of the 'Welland' downstream of Spalding Marsh.

The boundary of the catchment partially ingress into the WER/WFD catchments of the 'Black Sluice IDB draining to the South Forty Foot Drain' to the north, and the 'North Level Main Drain' and 'South Holland Main Drain' to the south-east. The 'Black Sluice IDB draining to the South Forty Foot Drain' is part of the South Forty Foot catchment study area and the 'North Level Main Drain' and 'South Holland Main Drain' are part of the Lower Nene catchment study areas and have therefore been excluded from this baseline.

Parts of the north-eastern extent of the catchment study area comprise areas that are not defined as WER/WFD surface water bodies. These are lowland coastal areas which drain into saltmarsh and mudflat habitats that form the margins of the 'Wash Inner' transitional (TRaC) water body extent located downstream.

The location and extent of these surface water body catchments relative to the catchment boundary is shown in Figure 16. An overview of these surface water bodies and their current statuses is then provided in Table 14. All the WER/WFD surface water bodies in the catchment area are heavily modified or artificial.

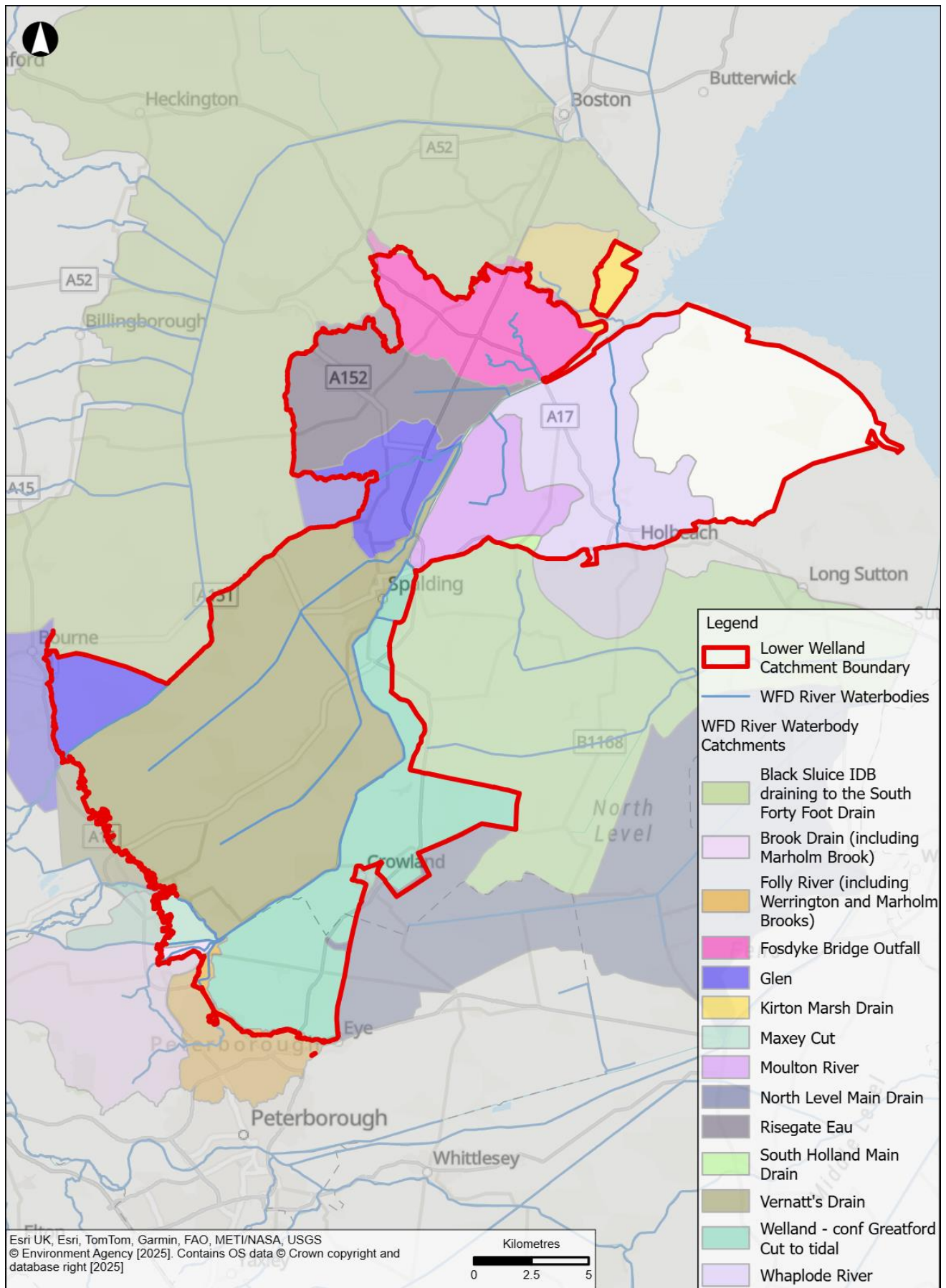


Figure 16: WER/WFD surface water bodies in the catchment

Table 14: Summary of WER/WFD surface water bodies within the catchment and their latest Cycle 3 (2022) status classifications

Waterbody Name	Waterbody ID	Waterbody Type	Hydromorphological Designation	Catchment area (km2)	Overall Status	Ecological Status	Biological quality elements	Physico-chemical quality elements	Hydromorphological Supporting Elements	Supporting Elements	Specific Pollutants	Chemical Status
Maxey Cut	GB205031050595	River	Artificial	10.2	Moderate	Moderate	Good	Moderate	Supports Good	Moderate	High	Fail*
Welland - conf Greatford Cut to tidal	GB205031050685	River	Heavily Modified	71.2	Moderate	Moderate	Good	Moderate	Supports Good	Moderate	High	Fail*
Vernatt's Drain	GB205031050705	River	Artificial	160.7	Moderate	Moderate	Moderate	Moderate	Supports Good	Good	High	Fail*
Folly River (including Werrington and Marholm Brooks)	GB105031050560	River	Heavily Modified	22.1	Poor	Poor	Poor	Moderate	Supports Good	Good	High	Fail*
Brook Drain (including Marholm Brook)	GB105031050595	River	Heavily Modified	49.9	Poor	Poor	Poor	Moderate	Supports Good	Moderate	High	Fail*
Glen	GB105031050720	River	Artificial	57	Moderate	Moderate	Good	Good	-	Moderate	High	Fail*
Whaplode River	GB205031055495	River	Artificial	68.8	Moderate	Moderate	Bad	Moderate	Supports Good	Good	High	Fail*
Risegate Eau	GB205031055525	River	Artificial	38.7	Poor	Poor	Poor	Moderate	Supports Good	Good	-	Fail*
Fosdyke Bridge Outfall	GB205031055535	River	Artificial	35.5	Bad	Bad	Bad	Moderate	Supports Good	Good	High	Fail*

Moulton River	GB205031050755	River	Artificial	24.3	Moderate	Moderate	-	Moderate	Supports Good	Good	-	Fail*
Kirton Marsh Drain	GB205031055545	River	Artificial	15.7	Good	Good	Poor	-	Supports Good	Good	-	Fail*
Welland	GB530503100400	Transitional Water	Heavily modified	1.4	Moderate	Moderate	-	Moderate	Supports Good	Good	-	Fail*

Note: Chemical Status is assessed once per RBMP Cycle (every 6 years) and so was last assessed in 2019 (and is recorded as 'does not require assessment' within the latest interim Cycle 3 2022 status classifications)

Existing pressures on status

The Environment Agency's 'Reasons for Not Achieving Good' (RNAG) dataset identifies the key pressures and activities that are currently considered to be limiting the status of each of the different status elements that are not currently achieving their 'Good' status objective. Each RNAG is linked to a 'Surface Water Management Issue' (SWMI), which have been identified via the catchment management planning process. These comprise the main issues that are deemed to limit the uses and potential benefits of managing the water environment in the river basin district in a sustainable way.

The latest RNAG identified for the river water bodies present within the catchment are summarised in Table 15. The current RNAGs identified for the river water bodies in the study are primarily related to diffuse and point source pollution from agriculture and rural land management and water industry as well as physical modification associated with agriculture and rural land management and local and central government.

Table 15: Summary of RNAG for waterbodies within the catchment

Number of RNAGs per Surface Water Management Issue (SWMI)							
Water body	Physical modifications	Pollution from wastewater	Pollution from towns, cities and transport	Changes to the natural flow and level of water	Invasive non-native species	Pollution from rural areas	Pollution from abandoned mine
Maxey Cut	1	1	0	0	0	2	0
Welland - conf Greatford Cut to tidal	1	1	0	0	0	2	0
Vernatt's Drain	0	0	0	0	0	0	0
Folly River (including Werrington and Marholm Brooks)	0	1	2	0	0	0	0
Brook Drain (including Marholm Brook)	2	0	0	0	0	0	0
Glen	3	0	0	0	0	0	0
Whaplode River	0	4	1	0	0	1	0

Risegate Eau	0	2	0	0	0	1	0
Fosdyke Bridge Outfall	1	3	0	0	0	0	0
Moulton River	0	0	0	0	0	0	0
Kirton Marsh Drain	0	0	0	0	0	0	0
Welland	0	0	0	0	0	1	0
TOTAL	8	12	3	0	0	7	0

Mitigation Measures

The artificial and heavily modified water body Mitigation Measures assessments for the relevant surface water bodies within the catchment have identified various measures derived to mitigate the impacts of flood protection, land drainage, recreation and water regulation 'uses'. These measures are required to be in place in order for the water bodies to achieve their Good Ecological Potential objectives under the WER/WFD. A variety of measures are already in place or not applicable to some of the water bodies. The measures which are not in place are outlined in Table 16.

Table 16: Mitigation Measures which are currently not in place in the relevant Surface Water Bodies

Mitigation Measures Not in Place	Relevant Surface Water Body
Removal or re-location of set-back embankments	Brook Drain (including Marholm Brook); Folly River (including Werrington and Marholm Brooks); Welland - conf Greatford Cut to tidal
Restoration of lateral connectivity with the water bodies surrounding floodplain e.g. flood plain spillways	Brook Drain (including Marholm Brook); Folly River (including Werrington and Marholm Brooks); Welland - conf Greatford Cut to tidal
Preserve and/or restore existing in stream and riparian/shoreline habitats	Brook Drain (including Marholm Brook); Folly River (including Werrington and Marholm Brooks); Maxey Cut; Welland - conf Greatford Cut to tidal
Modification of structure to prevent/reduce fish entrainment e.g. screens	Brook Drain (including Marholm Brook);
Retro-fitting existing structures to accommodate niche habitats, as opposed to more substantial structural modifications that would be likely to deliver greater hydromorphological change but may not be possible given the use	Brook Drain (including Marholm Brook); Folly River (including Werrington and Marholm Brooks); Maxey Cut
Implement an active sediment management strategy (develop and revise) which could include a) substrate reinstatement, b) sediment traps, c) allow natural recovery minimising	Brook Drain (including Marholm Brook); Folly River (including Werrington and Marholm Brooks)

maintenance, d) riffle construction, e) reduce all bar necessary management in flood risk areas	
Implement an active and operational dredging disposal strategy	Glen
Ensure that boats use the central track of navigation to protect marginal habitat e.g. Signage, buoys etc.	Glen
Restore or increase in-channel morphological diversity e.g. riffle and pool creation and bar creation etc.	Maxey Cut
Installation of structures designed to facilitate and improve the passage of migratory (e.g. salmon and sea trout) and non-migratory fish where structures cannot be removed	Maxey Cut
Good practice management of in channel and riparian vegetation works or maintenance practices (e.g. macrophyte cutting), carried out in a manner that considers the impacts of the activity upon ecology and hydromorphology	Maxey Cut
Leaving habitat or parts of natural habitat while undertaking operations or maintenance in a water body	Maxey Cut
Ensure best practice techniques are applied when undertaking maintenance activities to minimise impacts to the habitat	Maxey Cut
Ensure best practice is applied when undertaking maintenance works e.g. coffer dam placement, working during appropriate flow conditions	Maxey Cut
Managed realignment of flood defence assets	Welland - conf Greatford Cut to tidal
Activity to create new habitat where it did not exist before	Welland - conf Greatford Cut to tidal
Rehabilitation of degraded bankside habitats to improve their physical structure and the condition of the riparian zone. Bank rehabilitation includes bank reprofiling, the creation of aquatic ledges and removal of hard bank protection etc.	Welland - conf Greatford Cut to tidal

WER/WFD protected areas

Under the WER/WFD, 'Protected Areas' were defined as areas requiring additional protection because of their sensitivity to pollution or due to their particular economic, social or environmental importance. These include designated water bodies (or parts of water bodies) or catchment areas that are abstracted from for human consumption, support economically significant aquatic species, are recreational waters, are sensitive to nutrient enrichment or support habitats or species of international conservation importance.

The specific environmental designations, measures and actions for these Protected Areas have been established under previous European Directives and their associated domestic legislation / regulations, which set out the requirements to ensure the protection of the area's water environment or protection of wildlife that is directly dependant on that water environment. Where a WER/WFD water body falls within or forms all or part of one of these designated Protected Areas, the water body is subject to additional environmental objectives (and associated monitoring regimes, risk assessments, and regulations) in accordance with the relevant legislation.

The WER/WFD Protected Areas present within the catchment are summarised in Table 17.

Table 17: WER/WFD protected areas present within the catchment

Protected Area Type	Protected Area Name (code)	Relevant waterbody
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Nitrates Directive	River Welland NVZ (S832)	Maxey Cut; Welland - conf Greatford Cut to Tidal; Brook Drain (including Marholm Brook); Folly River (including Warrington and Marholm Brook)
	Lincolnshire Limestone (G69)	Brook Drain (including Marholm Brook)
	Glen NVZ (S378)	Glen
	Fosdyke Bridge Outfall NVZ (S715)	Fosdyke Bridge Outfall
	Risegate Eau NVZ (S381)	Risegate Eau
	Whaplode River NVZ (S824)	Whaplode River
	Vernatt's Drain NVZ (S379)	Vernatt's Drain
Shellfish Water Directive	West Wash (UKSW4)	Glen; Fosdyke Bridge Outfall; Kirton Marsh Drain; Risegate Eau; Vernatt's Drain; Moulton River; Whaplode River; Welland
Special Area of Conservation	The Wash & North Norfolk Coast (UK0017075)	Fosdyke Bridge Outfall; Kirton Marsh Drain; Whaplode Rive; Welland
Special Protection Area	The Wash (UK9008021)	Fosdyke Bridge Outfall; Kirton Marsh Drain; Whaplode River; Welland
Ramsar Site	The Wash (UK11072)	Fosdyke Bridge Outfall; Kirton Marsh Drain; Whaplode Rive; Welland
Urban Waste Water Treatment Directive	River Welland (UKENRI62)	Maxey Cut; Welland - conf Greatford Cut to Tidal

Groundwater bodies

Groundwater bodies are the principal units of groundwater as defined in the WER/WFD, and are hydraulically connected, distinct entities of groundwater.

The catchment is not located within a WER/WFD groundwater body.

4.5 Biodiversity

This section outlines the baseline biodiversity in the catchment. Table 18 outlines the key terminology used in this section.

Table 18: Glossary of biodiversity terminology

Terminology	Summary Definition
Priority Habitat and Species	Priority habitats and Species are those identified as being of principal importance for the conservation of biodiversity. These habitats are listed under Section 41 of the Natural Environment and Rural Communities (NERC) Act 2006.
Critically Endangered	Critically Endangered species are defined by the IUCN as species that face an extremely high risk of extinction in wild habitats.
Endangered	Endangered species are species which have been defined by IUCN as very likely to become extinct in their known native ranges in the near future.
Biodiversity Net Gain (BNG)	Biodiversity net gain (BNG) is a world-leading government strategy to create and improve natural habitats by making sure development has a measurably positive impact.
International Union for Conservation of Nature (IUCN)	International Union for Conservation of Nature is a membership union comprised of government and civil society organisations and is regarded as the global authority on the status of the natural world and the measures needed to safeguard it.
Local Nature Reserves (LNR)	Local Nature Reserve are statutory designated areas under Section 21 of the National Parks and Access to the Countryside act 1949.
National Nature Reserves (NNR)	National Nature Reserves are areas of land declared under the National Parks and Access to the Countryside Act 1949 or Wildlife and Countryside Act (1981).
Special Areas of Conservation (SAC)	Special Areas of Conservation are protected areas in the UK designated under the Conservation of Habitats and Species Regulations 2017 (as amended) in England and Wales (including the adjacent territorial sea).
Special Protection Areas (SPAs)	Special Protection Areas are protected areas for birds in the UK classified under the Conservation of Habitats and Species Regulations 2017 (as amended) in England and Wales (including the adjacent territorial sea).
Sites of Special Scientific Interest (SSSI)	Sites of Special Scientific Interest are protected areas within England. They are designated (legally protected) to maintain and protect a specific aspect of biological or earth heritage interest.

4.5.1 Designated nature conservation sites

There are 12 statutory internationally/nationally designated nature conservation sites within or partially within the catchment, some of which overlap in entirety or partially with other designations. These comprise:

- The Wash - Site of Special Scientific Interest (SSSI), Special Protection Area (SPA), Ramsar site and National Nature Reserve (NNR);
- The Wash & North Norfolk Coast - Special Area of Conservation (SAC);
- Deeping Gravel Pits – SSSI;
- Cowbit Wash – SSSI;
- Cross Drain – SSSI;
- Baston and Thurlby Fens – SSSI;
- Surfleet Lows– SSSI;
- Baston Fen – SAC;
- Vernatt's – Local Nature Reserve (LNR).

The location of each designated site is shown in Figure 17 and a summary provided in Table 19.

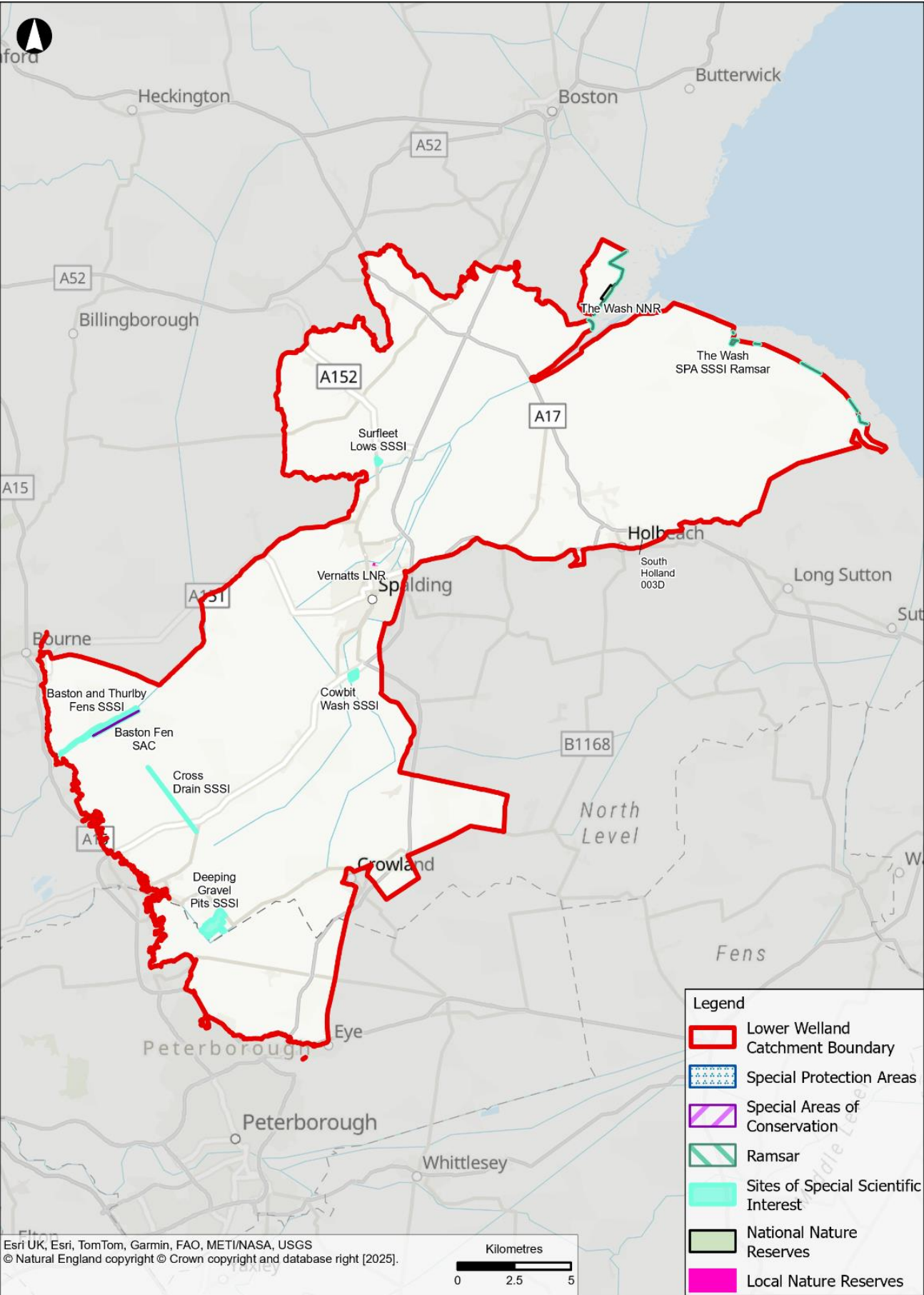


Figure 17: Overview of Designated sites for nature conservation within the catchment

Table 19: Designated sites within the catchment

Site Name	Designation	Citation / Overview and key features
The Wash	SSSI SPA Ramsar NNR	The Wash overlaps with the catchment for less than 1% of the protected areas total as the site is associated coastal intertidal mudflats and saltmarshes SSSI – Covers the same area as the SPA and Ramsar, and is of international biological interest. The intertidal mudflats and saltmarshes are crucial winter-feeding areas for waders and wildfowl, supporting large numbers of migrant birds. The saltmarsh and shingle communities are botanically significant, and the mature saltmarsh is a valuable bird breeding zone. The Wash is also an important breeding ground for common seals (<i>Phoca vitulina</i>). SPA – The Wash Special Protection Area (SPA) covers 622 km² and forms part of the larger Wash and North Norfolk Coast Special Area of Conservation which encompasses the largest embayment in the UK, as well as extensive intertidal sand and mudflats, subtidal sandbanks, biogenic and geogenic reef, saltmarsh and a barrier beach system unique in the UK. The Wash SPA supports non-breeding including a large number of species such as: bar-tailed godwit; bewick's swan (<i>Cygnus columbianus bewickii</i>) and black-tailed godwit (<i>Limosa limosa islandica</i>). Ramsar – The Wash is Britain's largest estuarine system, fed by four rivers. It has extensive saltmarshes, intertidal banks, and deep channels. It is crucial for migrant wildfowl and wading birds, supports a shellfish fishery, and hosts large populations of common and grey seals. The sublittoral area includes diverse marine communities. NNR - The Wash National Nature Reserve, covering over 8,880 hectares, is one of England's last great wildernesses and its largest reserve. This crucial wetland, with extensive mudflats and saltmarshes, supports thousands of birds year-round. In winter, it attracts wildfowl like pink-footed geese (<i>Anser brachyrhynchus</i>) and shelduck (<i>Tadorna tadorna</i>), while summer sees waders and seabirds breeding. The Wash is also a prime breeding area for common seals (<i>Phoca vitulina</i>), hosting one of England's largest populations.
The Wash & North Norfolk Coast	SAC	The Wash & North Norfolk Coast overlaps with the catchment for less than 1% of the protected areas total as the site is associated coastal subtidal sandbanks mudflats and shallow bays SAC - The Wash & North Norfolk Coast Special Area of Conservation (SAC) is one of the UK's premier marine areas, featuring extensive subtidal sandbanks, diverse mudflats, and large shallow inlets and bays. It supports significant biogenic reefs formed by Ross worm (<i>Sabellaria spinulosa</i>) and is home to diverse benthic communities, including brittlestars and commercially important fish species. The site also includes the largest single area of glasswort (<i>Salicornia</i>) vegetation in the UK and extensive Atlantic salt meadows. Additionally, it is a crucial habitat for common seals (<i>Phoca vitulina</i>) and otters (<i>Lutra lutra</i>), contributing to its high ecological value. The unique Mediterranean and thermo-Atlantic halophilous scrubs further enhance the site's biodiversity.
Deeping Gravel Pits	SSSI	Deeping Gravel Pits completely falls within the catchment SSSI - Deeping Gravel Pits, a Site of Special Scientific Interest (SSSI) covering 55.9 hectares, is an important ornithological site due to its variety of habitats and undisturbed nature. It supports the largest heronry in Lincolnshire with over seventy occupied nests and hosts a diverse community of wintering wildfowl and breeding birds. The site features rich aquatic and fen vegetation, including common reed (<i>Phragmites australis</i>), lesser bulrush (<i>Typha angustifolia</i>), common clubrush (<i>Schoenoplectus lacustris</i>), yellow water-lily (<i>Nuphar lutea</i>), yellow iris (<i>Iris pseudacorus</i>), willow scrub (<i>Salix</i> spp.), pedunculate oak (<i>Quercus robur</i>), and ash woodland (<i>Fraxinus excelsior</i>).

Cowbit Wash	SSSI	Cowbit Wash completely overlaps with the catchment SSSI - Cowbit Wash is a Site of Special Scientific Interest (SSSI) designated for its geological significance. It provides valuable data on post-glacial sea level changes through the analysis of marine clastic and freshwater peat layers.
Cross Drain	SSSI	Cross Drain completely overlaps with the catchment SSSI - Cross Drain, a Site of Special Scientific Interest (SSSI), is one of the best remaining areas of open water typical of fenland, supporting an exceptional beetle fauna, including two national rarities, and a diverse aquatic flora with nationally scarce plants. The mesotrophic water flows slowly over a gravelly, sandy bed, hosting species like lesser water plantain (<i>Baldellia ranunculoides</i>) and fen pondweed (<i>Potamogeton coloratus</i>). This habitat holds over 20% of all British water beetles, reflecting its low nutrient status and unpolluted nature, which is exceptional in an arable environment.
Baston and Thurlby Fens	SSSI	The Baston and Thurlby Fens overlaps with the catchment SSSI - Baston and Thurlby Fens, designated as a Site of Special Scientific Interest (SSSI), is a unique Wildlife Trust reserve in Lincolnshire. This washland habitat features flooded borrow pits and marshes, supporting diverse wetland plant communities such as reed sweet-grass (<i>Glyceria maxima</i>), common reed (<i>Phragmites australis</i>), and yellow iris (<i>Iris pseudacorus</i>). The site is a stronghold for the spined loach (<i>Cobitis taenia</i>) and hosts an exceptionally rich dragonfly and damselfly fauna, including species like the hairy dragonfly (<i>Brachytron pratense</i>) and ruddy darter (<i>Sympetrum sanguineum</i>).
Surfleet Lows	SSSI	Surfleet Lows completely falls within the catchment SSSI - Surfleet Lows, designated as a Site of Special Scientific Interest (SSSI), is a rare example of a wet alluvial meadow in Lincolnshire, largely untouched by agricultural improvement. This unique habitat supports a diverse range of meadow and coastal plant species, including marsh foxtail (<i>Alopecurus geniculatus</i>), floating sweet-grass (<i>Glyceria fluitans</i>), and sea milkwort (<i>Glaux maritima</i>). The meadow's high salinity, a remnant of its coastal creek origins, fosters the growth of brackish marsh plants, while winter flooding attracts various waterfowl and other bird species.
Baston Fen	SAC	The Baston Fen completely falls within the catchment SAC – Baston Fen Special Area of Conservation (SAC) is designated for the Annex II species, spined loach (<i>Cobitis taenia</i>). The Counterdrain, a large drainage channel alongside Baston Fen, hosts high densities of this species, showcasing one of the few significant populations in the Welland catchment. The submerged plants provide excellent habitat, making this one of only four outstanding localities for <i>Cobitis taenia</i> in the United Kingdom.
Vernatt's	LNR	The Vernatt's completely overlaps with the catchment LNR – The Vernatt's Local Nature Reserve (LNR) consists of 1.68 ha of a wildflower meadow, attracting damselflies and small copper butterflies as well as a mixture of wetland habitats including reedbeds, marsh and a large pond. This is home for the elusive water vole (<i>Arvicola amphibius</i>), reed warblers (<i>Acrocephalus scirpaceus</i>) and buzzes with insect life.

4.5.2 Priority habitats and other habitats

A habitat map for the catchment was created using Arup's suite of earth observation tools. Initially, habitats within the catchment that are listed on the Priority Habitat Inventory (PHI) were mapped. The PHI describes the spatial extent of 25 priority habitats in England. They were extracted from the existing Lower Welland map tiles to highlight areas specifically designated by Natural England.

In cases, where a single area has multiple priority habitat designations (indicative of coexisting habitats in the PHI) both habitats were kept as a separate category. For example, "Coastal floodplain and grazing marsh" and "Coastal floodplain and grazing marsh; Coastal saltmarsh" were kept as two discrete classes in accordance with the PHI.

Following mapping of the PHI areas, OS open map data was used to identify features such as roads, buildings, trees and intertidal zones. Remaining habitats were then identified using a combination of earth observation imagery and publicly available datasets. The imagery was segmented into polygons and each polygon was assigned to a habitat type based on classification rules using Living England, Corine Land Cover, European Space Agency (ESA) World Cover datasets.

The habitats (including priority habitats) that have been identified within the boundary of the catchment are shown in Figure 18 and presented in Table 20. Arable and horticultural is the key habitat type throughout the catchment.

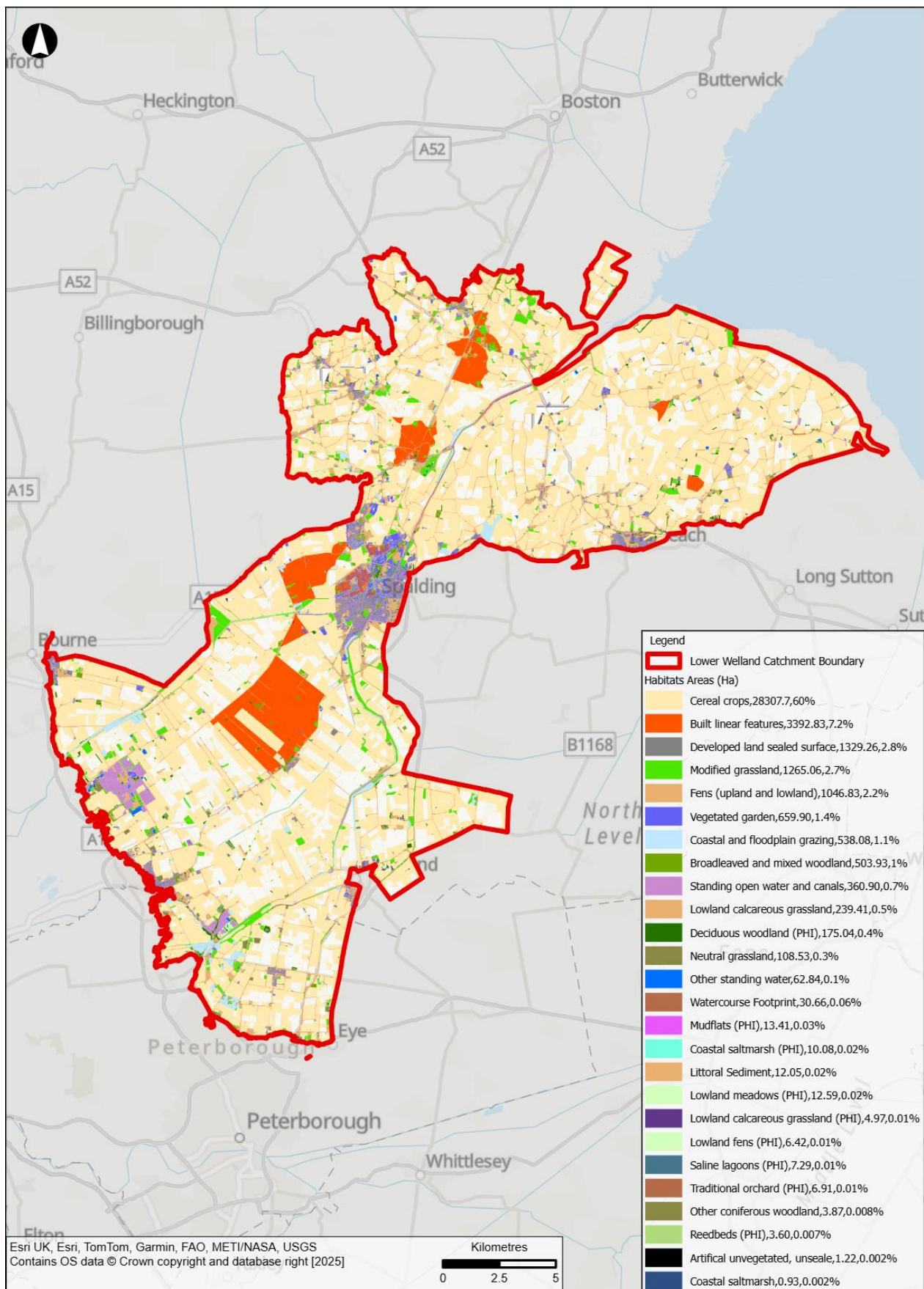


Figure 18: Habitat map for the catchment developed using earth observation.

Table 20: Habitat types identified within the catchment

	Habitat Type	Area within the catchment (ha)	Habitat Description [79]	Context within the catchment
Coastal	Coastal Saltmarsh (PHI)	666.67 ha	Coastal saltmarshes in the UK, are the vegetated upper portions of intertidal mudflats. They lie between mean high water neap tides and mean high water spring tides, with the lower limit defined by pioneer saltmarsh vegetation and the upper limit one metre above the highest astronomical tides. Saltmarshes are found in sheltered locations such as estuaries, saline lagoons, behind barrier islands, at sea loch heads, and on beach plains. Their vegetation consists of halophytic species adapted to regular tidal immersion, showing clear zonation based on inundation frequency. Pioneer species like glassworts can withstand up to 600 tides per year, while upper marsh species endure occasional inundation.	This habitat is limited to northern portion of the catchment along the coast and River Welland. This habitat is associated a couple of the designated nature conservation sites including The Wash National Nature Reserve.
	Mudflats (PHI)	13.42 ha	Mudflats are intertidal habitats formed by sediment deposition in low-energy coastal environments like estuaries. Their sediment is mainly silts and clays with high organic content, and sand content increases near estuary mouths. Mudflats are linked to other coastal habitats such as soft cliffs and saltmarshes, often appearing between subtidal channels and vegetated saltmarshes. They can be several kilometres wide in large estuaries but have been reduced by land reclamation. Mudflats dissipate wave energy, reducing erosion and flooding risks, and play a crucial role in nutrient chemistry and contaminant sequestration. They are highly productive but have low species diversity.	This habitat is limited to northern portion of the catchment along the coast. This habitat is associated a couple of the designated nature conservation sites including The Wash National Nature Reserve.
	Littoral Sediment	12.05 ha	This is an area of littoral sediment identified from publicly available sources.	This habitat is primarily located in the southern portion of the catchment.
	Saline Lagoons (PHI)	7.29 ha	Saline lagoons are partially separated from the sea, retaining seawater at low tide and varying in salinity from brackish to hyper-saline. They support diverse flora and fauna, including rare invertebrates and important bird habitats. These lagoons can be separated by natural barriers like sand or shingle, rocky sills, or artificial constructions, with water exchange influenced by channels, percolation, or overtopping.	This habitat is limited to small, isolated patches within the northern portion of the catchment.
	Coastal saltmarsh	1.47 ha	This is an area of coastal saltmarsh identified from publicly available sources but not identified on the PHI.	This habitat is limited to the northern portion of the catchment.
	Coastal and floodplain grazing	0.08 ha	This habitat is a combination of coastal and floodplain grazing marsh and coastal saltmarsh (descriptions of these habitats is described in detail in the habitat descriptions for the individual habitats).	This habitat is limited to a small, isolated patch

	marsh, Coastal saltmarsh (PHI)			
Aquatic / semi-aquatic	Fens (upland and lowland)	1086.59 ha	This is an area of lowland Fens habitat identified from publicly available sources.	This habitat is located in multiple locations across the catchment. This habitat is associated with the Willow Tree Fen Nature Reserve and the Deeping Lakes Nature Reserve. There are further isolated patches located across the catchment.
	Coastal and Floodplain Grazing Marsh (PHI)	618.06 ha	Grazing marsh is defined as periodically inundated pasture, or meadow with ditches which maintain the water levels, containing standing brackish or fresh water. The ditches are especially rich in plants and invertebrates. Almost all areas are grazed, and some are cut for hay or silage. Sites may contain seasonal water-filled hollows and permanent ponds with emergent swamp communities, but not extensive areas of tall fen species like reeds; although they may abut with fen and reed swamp communities. Grazing marshes are particularly important for the number of breeding waders such as snipe (<i>Gallinago gallinago</i>), lapwing (<i>Vanellus vanellus</i>) and curlew (<i>Numenius Arquata</i>) they support. Internationally important populations of wintering wildfowl also occur including Bewick swans (<i>Cygnus bewickii</i>) and whooper swans (<i>Cygnus cygnus</i>).	This habitat found throughout the catchment. This habitat is associated a couple of the designated nature conservation sites including the Baston and Thurlby Fens SSSI.
	Standing open water and canals	360.90 ha	This is an area of standing open water and canals identified from publicly available sources.	This habitat is primarily located within the southwest region of the catchment, associated with the various drains.
	Ponds	62.96 ha	This is an area of ponds identified from publicly available sources.	This habitat is primarily located within the southwest region of the catchment, north of Market Deeping.
	Watercourse	30.67 ha	This is an area of watercourse identified from publicly available sources.	This habitat is primarily associated with the River Welland in the northern region of the catchment.
	Lowland Fens (PHI)	6.43 ha	Lowland Fens are peatlands that receive water and nutrients from the soil, rock, and groundwater, as well as from rainfall, making them minerotrophic. These Fens can be categorised into topogenous Fens, where water movement is vertical, and soligenous Fens, where water movement is lateral. Rich in biodiversity, lowland Fens support a variety of plant and	This habitat is limited to small, isolated patches within the southern portion of the catchment.

			animal communities, including up to 550 species of higher plants and numerous insect species, making them crucial habitats despite their decline in the past century.	
	Reedbeds (PHI)	3.60 ha	Reedbeds are wetlands dominated by common reed (<i>Phragmites australis</i>), with the water table at or above ground level for most of the year. They often include areas of open water, ditches, wet grassland, and carr woodland. Reedbeds are crucial habitats for birds in the UK, supporting rare species like the bittern and marsh harrier, and providing roosting sites for migratory birds and raptors. Additionally, they are home to several rare invertebrates, including the red leopard moth and a rove beetle.	This habitat is limited to small, isolated patches in western portion of the catchment along the River Glen. This habitat is associated the Baston and Thurlby Fens SSSI.
	Fens (upland and lowland)	1086.59 ha	This is an area of lowland Fens habitat identified from publicly available sources.	This habitat is located in multiple locations across the catchment. This habitat is associated with the Willow Tree Fen Nature Reserve and the Deeping Lakes Nature Reserve. There are further isolated patches located across the catchment.
Grassland	Modified grassland	1336.24 ha	This is an area of modified grassland identified from publicly available sources.	This habitat is located in multiple locations across the catchment.
	Lowland calcareous grassland	240.80 ha	This is an area of lowland calcareous grassland identified from publicly available sources.	This habitat is limited to large, isolated patches with the northwest region of the catchment.
	Neutral grassland	108.79 ha	This is an area of neutral grassland identified from publicly available sources.	This habitat is concentrated in small, isolated patches with the southern region of the catchment.
	Lowland Meadow (PHI)	12.59 ha	Lowland grasslands, treated as lowland meadows, includes most forms of unimproved neutral grassland in the UK. It covers various plant communities and considers both hay-cut and livestock-grazed pastures. These grasslands, though less common in non-agricultural settings, can be found in recreational sites, churchyards, and roadside verges. Excluded are maritime grasslands, upland hay meadows, and <i>Molinia-Juncus</i> pastures. Unimproved neutral grassland has declined significantly due to changing agricultural practices, with a 97% reduction in lowland England and Wales by 1984. Losses continued in the 1980s and 1990s, at rates of 2-10% per annum in some areas.	This habitat is limited to small, isolated patches within the southern portion of the catchment.

	Lowland Calcareous grassland (PHI)	4.97 ha	Lowland calcareous grassland is a unique habitat found on shallow, lime-rich soils over limestone rocks, primarily in southern and eastern UK. These grasslands support a rich variety of flora and fauna, including rare species like the monkey orchid (<i>Orchis simia</i>) and the adonis blue butterfly (<i>Lysandra bellargus</i>). Ecologically, they are vital for maintaining biodiversity, providing essential habitats for specialised plants and invertebrates, and supporting the life cycles of species such as the Duke of Burgundy fritillary (<i>Hamearis lucina</i>) and the wart-biter cricket (<i>Decticus verrucivorus</i>).	This habitat is limited to small linear patch in the northern portion of the catchment along the River Welland.
Woodland	Broadleaved and mixed woodland	519.40 ha	This is an area of broadleaved and mixed woodland identified from publicly available sources.	This habitat is primarily associated with the central northwestern and southern regions of the catchment.
	Deciduous woodland (PHI)	177.91 ha	Lowland mixed deciduous woodland grows on a range of soil conditions, from very acidic to base-rich, and includes most semi-natural woodland in southern and eastern England, and parts of lowland Wales and Scotland. These woodlands, often ancient and small (less than 20ha), complement upland oak and ash types. They show great variety in canopy and ground flora species, with <i>Quercus robur</i> being the common oak. The National Vegetation Classification places most of this type in W8 and W10, with lesser amounts in W16. Locally, they may form mosaics with other types, including beech woodland and wet areas. Canopy variations include field maple, lime, elm, hornbeam, wych elm, ash, and oak, with occasional birch and alder stands.	This habitat is primarily limited to small, isolated patches.
	Other coniferous woodland	3.87 ha	This is an area of other coniferous woodland identified from publicly available sources.	This habitat is limited to small, isolated patches.
Agricultural	Arable and Horticulture	40519.90 ha	This is an area of arable land / horticultural land identified from publicly available sources. Further analysis of agricultural land use is available in the Lower Welland Catchment Agricultural Baseline. It is noted that there are likely to be some variation between landcover datasets used. The agricultural baseline has identified that the agricultural land use in the catchment is dominated by arable crops.	This habitat is widely dispersed across the entirety of the catchment.
	Vegetated Garden	669.95 ha	This is an area of vegetated garden identified from publicly available sources.	This habitat is scattered throughout the entire catchment. Generally, the areas are adjacent to residential areas.
	Traditional Orchard (PHI)	6.92 ha	Habitat structure, rather than vegetation type, topography, or soils, defines traditional orchards. These orchards are similar to wood-pasture and parkland but differ in tree species (mainly Rosaceae), denser tree	This habitat is limited to small, isolated patches across the catchment.

			arrangement, smaller habitat patches, and wider dispersion. They include nut plantings like hazel and walnuts. Management focuses on fruit and nut production through grafting and pruning, unlike wood-pastures where timber is the main product. Grazing or cutting herbaceous vegetation is integral, and scrub, often in hedgerows, plays a similar ecological role. Ponds and wetlands are common for livestock watering.	
Developed Land	Built linear features	1388.92 ha	This is an area of built linear features identified from publicly available sources.	This habitat is primarily associated with agricultural areas adjacent to watercourses.
	Developed land sealed surface	1344.95 ha	This is an area of developed land sealed surface identified from publicly available sources.	This habitat is located across the catchment and is associated residential communities such as Spalding.
	Artificial unvegetated, unsealed	1.23 ha	This is an area of artificial unvegetated, unsealed land identified from publicly available sources.	This habitat is limited to small, isolated patches.

4.5.3 Key species

The key species identified as qualifying species for the protected areas and designated sites within the catchment are presented in Table 21. Only species that are relevant to protected areas are included in the following table. Therefore, this table is intended to highlight some of the key species and not as an exhaustive list.

Table 21: Key species within the catchment

Species Common Name	Scientific Name	Relevant Protected Area or Key Habitats
Common seal	<i>Phoca vitulina</i>	The Wash Ramsar, The Wash & North Norfolk Coast SAC, The Wash SSSI
Wigeon	<i>Mareca penelope</i>	The Wash SPA, Surfleet Lows, Baston and Thurlby Fens SSSI
Spined loach	<i>Cobitis taenia</i>	Baston and Thurlby Fens SSSI, Baston Fens SAC
Little tern	<i>Sterna albifrons albifrons</i>	The Wash Ramsar, The Wash SPA
Eurasian curlew	<i>Numenius arquata arquata</i>	The Wash Ramsar, The Wash SPA
Bar-tailed godwit	<i>Limosa lapponica lapponica</i>	The Wash Ramsar, The Wash SPA
Eurasian oystercatcher	<i>Haematopus ostralegus ostralegus</i>	The Wash Ramsar, The Wash SPA
Grey plover	<i>Pluvialis squatarola</i>	The Wash Ramsar, The Wash SPA
Common tern	<i>Sterna hirundo hirundo</i>	The Wash Ramsar, The Wash SPA
Dark-bellied brent goose	<i>Branta bernicla bernicla</i>	The Wash Ramsar, The Wash SPA

4.5.4 Critical habitat screening

A critical habitat screening exercise has been conducted based on the criteria outlined in International Finance Corporation Performance Standard 6 - Biodiversity Conservation and Sustainable Management of Living Natural Resources (2012) [80].

Critical habitats are defined as areas with high biodiversity value based on criterion 1 to 5 as outlined in the IFC guidance note. This screening has specifically focused only on Criterion 1 in Performance Standard 6 as defined below (see Figure 19).

International Finance Corporation Performance Standard 6 - Biodiversity Conservation and Sustainable Management of Living Natural Resources.

Criterion 1: Critically Endangered and Endangered Species.

Species threatened with global extinction and listed as CR and EN on the IUCN Red List of Threatened Species shall be considered as part of Criterion 1. Critically Endangered species face an extremely high risk of extinction in the wild. Endangered species face a very high risk of extinction in the wild.

As described in footnote 11 of Performance Standard 6, the inclusion in Criterion 1 of species that are listed nationally/regionally as CR or EN in countries that adhere to IUCN guidance shall be determined on a project-by-project basis in consultation with competent professionals.

Thresholds for Criterion 1 are the following:

- a) Areas that support globally important concentrations of an IUCN Red-listed EN or CR species ($\geq 0.5\%$ of the global population AND ≥ 5 reproductive units GN16 of a CR or EN species).
- b) Areas that support globally important concentrations of an IUCN Red-listed Vulnerable (VU) species, the loss of which would result in the change of the IUCN Red List status to EN or CR and meet the thresholds in GN72(a).
- c) As appropriate, areas containing important concentrations of a nationally or regionally listed EN or CR species.

Figure 19: Critical habitat Criterion 1

The results of the critical habitat screening are presented in Table 22.

Table 22: Overview of IUCN Global Red List species identified within the catchment

Common Name and Status (IUCN Global Red List)	Scientific Name	Habitat and ecology	Population Trend	Relevance to the East and West Fens catchment
Interrupted Brome (Extinct in the Wild) Endemic to England	<i>Bromus interruptus</i>	Arable farmland / sown crops	Unspecified	Extinction of species in the wild occurred in 1972, with the last known population in Cambridgeshire. This plant, once found in southern Lincolnshire and Cambridgeshire, was reintroduced to Whittlesford, Cambridgeshire, in 2003. The reintroduction marked a significant conservation milestone as the first known reintroduction of an extinct plant in Britain (Moyse 2019). Reintroductions have focused on Ranscombe Farm Reserve in Kent and therefore it is unlikely to be present in the catchment.
Allis Shad (Critically Endangered)	<i>Alosa alosa</i>	Wetlands (inland), Marine Neritic, Marine Oceanic	Decreasing	The species is native to the northeastern Atlantic ocean and considered rare within most of its range. This species was formally known to spawn in a number of rivers in the UK however the only recent spawning site is the Tamar Estuary (Plymouth Sound Esturies SAC). It is considered possibly extinct within the catchment.
Balearic Shearwater (Critically Endangered)	<i>Puffinus mauretanicus</i>	Marine Neritic, Marine Oceanic, Marine Coastal/Supratidal	Decreasing	The fully migratory species congregates off the Atlantic coasts of southwest Europe during the summer and autumn, after breeding in the Mediterranean (IUCN 2024). Since the 1990s, an apparent increase in Balearic Shearwaters in north-west European waters, including north-west France and south-west Britain, was noted (BirdGuide 2021).
European Eel (Critically Endangered)	<i>Anguilla anguilla</i>	Wetlands (inland), Marine Neritic, Marine Oceanic, Marine Intertidal, Artificial/Aquatic & Marine	Decreasing	European Eel has been recorded at multiple locations on the River Welland, Maxey Cut, Malcolm Brook, Folly River, North Drove Drain, South Drove Drain, Whaplode River Drain, and Holbech River therefore assumed to be present in catchment (EA Ecology and Fish Data Explorer 2025). Barriers to migration may be present in catchment.
Depressed River Mussel (Endangered)	<i>Pseudanodonta complanata</i>	Wetlands (inland)	Decreasing	The species has been lost from at least 50% of its previously known sites over the past 20 years. Threats are likely related to habitat degradation and loss, including poor river management, water pollution (organic and inorganic), siltation, channeling, water abstraction, drought, and poaching for private collections and aquaria (IUCN 2011).
White-clawed Crayfish (Endangered)	<i>Austropotamobius pallipes</i>	Wetlands (inland), Artificial/Aquatic & Marine	Decreasing	This species has declined by 50-80% in England, France, and Italy, primarily due to invasive crayfish species and crayfish plague. Despite international

				and national protections, these measures have limited success in halting the spread of non-native species (IUCN 2010).
Freshwater Pearl Mussel (Endangered)	<i>Margaritifera margaritifera</i>	Wetlands (inland)	Decreasing	It is possible that some scattered individuals are present within the catchment however the only viable populations are in Scotland.
Glistening waxcap (Endangered)	<i>Gloioxanthomyces vitellinus</i>	Grassland	Decreasing	The IUCN red list distribution indicates that this species range falls within the catchment however the presence of this species is unconfirmed at present.



This section outlines the cultural heritage baseline in the catchment. Table 23 outlines the key terminology used in this section.

Table 23: Glossary of cultural heritage terminology

Terminology	Summary Definition
Designated heritage asset	A World Heritage Site, Scheduled Monument, Listed Building, Protected Wreck Site, Registered Park and Garden, Registered Battlefield or Conservation Area designated under the relevant legislation.
Non-designated heritage asset	A building, monument, site, place, area or landscape identified as having a degree of significance meriting consideration in planning decisions, because of its heritage interest. It includes designated heritage assets and assets identified by the local planning authority (including local listing).
Historic environment	All aspects of the environment resulting from the interaction between people and places through time, including all surviving physical remains of past human activity, whether visible, buried or submerged, and landscaped and planted or managed flora.
Historic Landscape Character	The Historic Landscape Character of Lincolnshire is interpreted on two scales: Character Area and Character Zone. There are 10 Character Area's across the county. Character Areas are large, regional parts of the county's landscape and are known as, for example, 'The Fens', 'The Wash', and 'The Southern Cliff'. Each Character Area comprises between two and five Character Zones, for example, 'The East Fen' and 'The West Fen' are the two Character Zones of 'The Fens' Character Area. Character Zones can still cover large parts of the landscape and are assessed in greater detail than Character Areas which communicate the broad trends of the component Character Zones. The major urban centres of exclude the major urban centres of Lincoln, Scunthorpe, and Grimsby are excluded and have their own urban assessments.
Saltern	Salterns are associated with salt making. The process of extracting salt from seawater (or other naturally occurring brine) in the fens and marshlands of Britain during the Iron Age and Roman, Early Medieval, and Medieval periods was principally through evaporation. The excavation of pools in which to hold water for evaporation resulted in the production of large amounts of waste material (e.g. clay or sand) which was deposited in large mounds near the pools. These mounds are the 'salterns'. In Lincolnshire salterns are known to have been sufficiently large and numerous to create areas of elevated and dry ground, effectively pushing the coastline away from nearby settlements. Some surviving salterns (and their associated settlements) are designated scheduled monuments, although most are not. They are, however, an important archaeological and heritage resource.
Setting of a heritage asset	The surroundings in which a heritage asset is experienced. Its extent is not fixed and may change as the asset and its surroundings evolve. Elements of a setting may make a positive or negative contribution to the significance of an asset, may affect the ability to appreciate that significance or may be neutral.
Significance (for heritage policy)	The value of a heritage asset to this and future generations because of its heritage interest. The interest may be archaeological, architectural, artistic or historic. Significance derives not only from a heritage asset's physical presence, but also from its setting. For World Heritage Sites, the cultural value described within each site's Statement of Outstanding Universal Value forms part of its significance.

4.6.1 Archaeological and historical background

The catchment historic environment is best understood through the evidence of the long interaction of people, the land and the sea which can be read in the settlements, fields, place names and the layers of soil in this area.

The coastal zone of Lincolnshire changed dramatically throughout the Prehistoric period. During the Palaeolithic (1,000,000BCE-10,000BCE), the fenlands and intertidal zones of the catchment had not yet formed [81] and did not emerge until after the last Ice Age approximately 10,000 years ago at the start of the Mesolithic (10,000BCE-4,000BCE) period. As the ice sheets retreated and sea levels rose, the vast plains of Doggerland (which once linked Britain with north-western Europe) were submerged and a coastline more akin to that of Lincolnshire and the Wash today emerged [82].

For most of the Later Prehistoric (4,000BCE-43CE) period the catchment would have been an expanse of marshes and creeks influenced by seasonal inundation by the sea, the flooding of the River Welland and its tributaries, and run-off of surface water from the higher limestone cliff edge to the west. These characteristics are reflected in dominance of Tidal Flat (Clays and Silts) Deposits throughout all but the western edge of the catchment – which comprises a mixture of Alluvium (Clay, Silt, Sand and Gravel) Deposits along the course of the River Welland and its tributaries, and the River Terrace Deposits along the edges of the watercourses and river valleys at the hinterland of the limestone cliff edge in the very west of the catchment.

The fenland and coastal landscape of the catchment would have been an excellent resource for Prehistoric people for fishing, fowling, and foraging, and for the provision of materials such as rushes and reeds. The hinterland of the limestone cliff edge would have afforded passage to the higher, drier and woodland and landscapes of the plateau where game and materials such as stone and wood could be obtained. Evidence for Prehistoric activity in the catchment typically comprises cropmark features of possible enclosures and, toward the western edge of the catchment, recorded artefact finds.

The catchment includes multiple Roman (43CE-410CE) and Romano-British settlement and industrial sites. The Romans were also responsible for a major landscape feature, the Carr Dyke, which stretches over approximately 92km from Peterborough to Lincoln and is an artificial channel constructed around 125CE [83]. While much of its length has been incorporated into later Post Medieval (1540CE-1901CE) drainage systems, elements do survive as legible and upstanding earthworks. It is estimated that when first constructed Carr Dyke was approximately 15m wide and 2m-4m deep with sloping sides and a flat bottom [83]. Its primary purpose appears to have been as a drain to control and divert flood water, however, some sections would have been navigable, making Carr Dyke the largest of known Romano-British canals in Britain [83].

Along its route, Carr Dyke was connected to multiple secondary canals or watercourses and interacted with several trackways and Roman roads. An example of this is found near Baston, just south of Bourne at the western edge of the catchment, where the remains of a Roman road have been recorded along the route and continuing alignment of Baston Outgang road. The road runs directly from Baston (in proximity to Carr Dyke) to Spalding.

During the Roman period Spalding was located at the edge of the semi-saltmarsh and saltmarsh landscape of this part of Lincolnshire, with ready links to the coast and north sea via Bicker Haven. Spalding, and the area around the modern town, was heavily settled during the Roman period, with the town and its satellite settlements involved in several rural and commercial industries, chief amongst which was salt production. Evidence for salt production survives in the form of salterns, some of which could have earlier Iron Age (800BCE-43CE) origins.

Following withdrawal of direct control of England from Rome in 410CE, a wave of settlers from mainland Europe arrived. It is from the 6th Century Anglian tribe the *Spaldingas* that the name 'Spalding' is derived. The tribal lands of the *Spaldingas* remained an administratively independent entity as a part of the larger Early Medieval Kingdom of Mercia until the late 9th Century. During this time, the Crowland Abbey Benedictine monastery was initially built in memory of St. Guthlac in the early eighth century which has since been ruined and rebuilt numerous times through history reflecting its cultural significance locally.

Salt production appears to have continued uninterrupted during the Early Medieval period (410CE-1066CE) until the mid-7th Century when climatic changes and flooding resulted in a period of decline [84].

Like Spalding, many of the smaller villages and towns of the catchment were settled and occupied by the *Spaldingas* during the Early Medieval period, although they were likely originally settled as individual or small groups of farmsteads or hamlets before growing into larger villages during the Medieval (1066CE-1542CE) period. Many of these settlements are recorded in the Domesday survey of 1086. In the Medieval period, these settlements were set within open arable fields, with arable farming and grazing on common land. Although sometimes referred to erroneously as 'Roman Bank', the Sea Bank, an earthen embankment which stretches from near Skegness to King's Lynn and loops inland toward Spalding in the catchment area, is likely to be a Medieval construction [85]. Today, the remains of the Medieval Sea Bank are around 16km from the coastline of the Wash. The later Post Medieval (1542CE-1901CE) Gedney Dawsmere and Holbeach sea bank runs along the edge of the catchment.

Although a natural reduction in the water table of the Fens and neighbouring marshlands had begun around the end of the Roman period, the effects of this change were largely unnoticeable to local communities until the late 16th Century to early 17th Century when sea levels fell. This resulted in the de-watering of Bicker Haven and spurred the formal, planned draining and enclosure of the area during the mid-17th Century. The draining of Bicker Haven was one of multiple coordinated schemes for drainage and coastal land reclamation of the time [85], the purpose of which was to allow the rich and fertile soils of the catchment to be used year-round for intensive agriculture.

During the 18th Century numerous drainage channels were cut and pumping stations constructed to overcome the challenge of draining land that, because of historic natural drying and shrinkage (which started as early as the end of the Roman period), was now below sea level [86]. While initially wind powered, the pumping engines of the catchment were replaced by steam engines during the 19th Century. It is likely that the greater efficiency and capacity of these engines actually contributed to the ever-increasing need for pumping [85] as the drained agricultural land continued to dry and shrink, settling lower, and lower beneath sea level, defences, and the canalised and partially surviving natural course of the River Welland and its tributaries. Shrinkage associated with 19th Century, and ongoing 20th Century and early 21st Century drainage and water management, is a particular issue for the surviving areas of peatland at the western edge of the catchment near Bourne, Market Deeping, and Crowland.

Along the coastline in particular there are a large number of Second World War defences, including pillboxes, tank cubes and gun emplacements which were created as a first line of defence against an invasion from the sea. There are also further defences inland along key infrastructure corridors and at settlements [87].

4.6.2 Historic Landscape Character

As discussed in the Landscape baseline, the catchment is situated almost wholly within The Fens NCA and partially within the Bedfordshire and Cambridgeshire Claylands NCA and Kesteven Uplands NCA. Figure 20 shows the Historic Landscape Character areas within the catchment. Three of Lincolnshire's HLC areas are present in the landscape of the catchment. These are: The Fens, The Wash, and a narrow strip of The Southern Cliff. The south-western corner of the catchment lies within the Peterborough HLC area.

- **The Southern Cliff HLC**

Only the very western fringe of the catchment is part of this HLC area which, as it interacts with the catchment, marks the downward slope from the uplands to the fen edge. The catchment extends within a single character zone of The Southern Cliff HLC, The Fen Edge Settlements.

The Fen Edge Settlements character zone is defined along its eastern edge, where it interacts with the catchment, by the route of Carr Dyke and a line of nucleated settlements which run from Bourne to Market Deeping along its south-western edge. These settlements are typically located along the route of the A15.

- **The Fens HLC**

The centre of the catchment comprises The Witham Fens and The Eastern Fens character zones of The Fens HLC. The Eastern Fens character zone of the catchment comprises small, scattered nucleated settlements which are typically located on ridges of slightly higher, drier ground and isolated farmsteads. The farmsteads are often associated with the reclamation of the Fens and planned enclosure of the 18th and 19th Century, and the surrounding landscape is typically divided into a pattern of rectilinear fields separated by drains rather than hedges that are used for intensive arable farming. There are no nucleated settlements present within The Witham Fens character zone of the catchment; these are predominantly located further north in the Lower Witham catchment (which is located north of the neighbouring Witham South Forty Foot catchment (see Figure 1)). Like The Eastern Fens character zone, The Witham Fens character zone typically comprises dispersed isolated farmsteads with little intervisibility, and some irregular linear settlements along larger routeways.

- **The Wash HLC**

The north-eastern landscape of the catchment is part of The Wash HLC area, particularly the Townlands and Reclaimed Wash Farmlands character zones. Part of the Bicker Haven and Reclaimed Coastal Fringe character zones also extend into the catchment. Within the catchment the Townlands character zone comprises a string of nucleated market towns and villages located around the western circumference of The Wash. The principal settlements in this part of the catchment are Quadring, Gosberton, Surfleet and Surfleet Seas End, Pinchbeck and Crossgate, and the large town of Spalding. Several of the settlements date from the Early Medieval period, and Spalding has had almost continuous occupation since the Roman period. Historically, the Bicker Haven character zone was a tidal estuary. The zone is predominantly made up of isolated farm complexes, irregular geometric fields and small sinuous relict natural drainage channels [88]. In the southernmost portion of the character zone, the field patterns have a strict rectilinear form, indicative of later parliamentary enclosure. There are multiple large, industrial scale farmsteads throughout the Reclaimed Wash Farmlands character zone and there are a small number of orchards to the south-west. The settlement density in the Reclaimed Coastal Fringe is very low and typically comprises individual 19th and 20th Century farmsteads and isolated barns and other agricultural buildings. Although predominantly agricultural in land use, which includes the grazing of outlying saltmarsh areas, it is most keenly characterised by the network of active and relict earth sea-banks and its small minor roads and trackways.

- **Peterborough HLC**

The landscape of the south-western corner of the catchment, in the vicinity of Peterborough, comprises interspersed areas of Pre-18th Century Enclosure, Post-18th Century Enclosure, Park and Leisure Landscapes, Built-up Areas, Major Transportation and Communication routes, and areas of the 'Other Types' [89] of the Peterborough HLC typology.

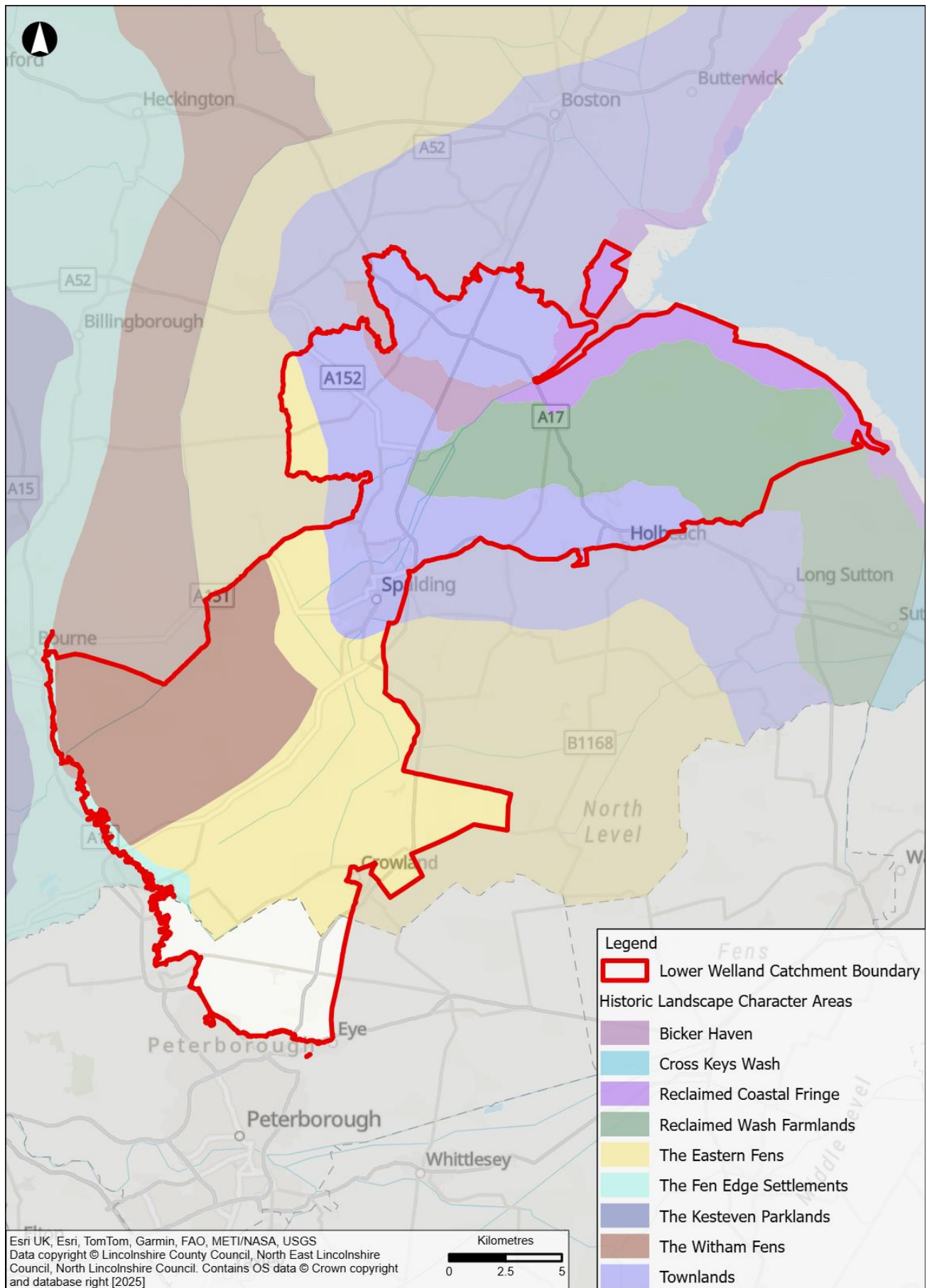


Figure 20: Historic Landscape Character areas within the catchment

4.6.3 Designated heritage assets

In total, 389 designated heritage assets are located throughout the catchment including:

- 26 scheduled monuments - The scheduled monuments include prehistoric burial mounds, areas of prehistoric and Romano-British settlement, sections of the Car Dyke, shrunken medieval settlements and churchyard crosses, medieval religious and high-status sites, and a former pumping station.
- 14 Grade I listed buildings - The majority of these listings are churches as well as a memorial village cross and hall; and

There are 138 Grade II listed buildings, one Grade II registered park and gardens, Ayscoughfee Hall, and the following nine conservation areas:

- Wigtoft Conservation Area
- Spalding Conservation Area
- Gosberton Conservation Area
- Gedney Dawsmere Conservation Area
- Northborough Conservation Area
- Peakirk Conservation Area
- Holbeach Conservation Area
- Pinchbeck Conservation Area
- Langtoft Conservation Area

There are no World Heritage Sites, Grade I or Grade II* registered park and gardens, registered battlefields, or protected wreck sites within the catchment. Figure 21 sets out the designated heritage assets within the catchment.

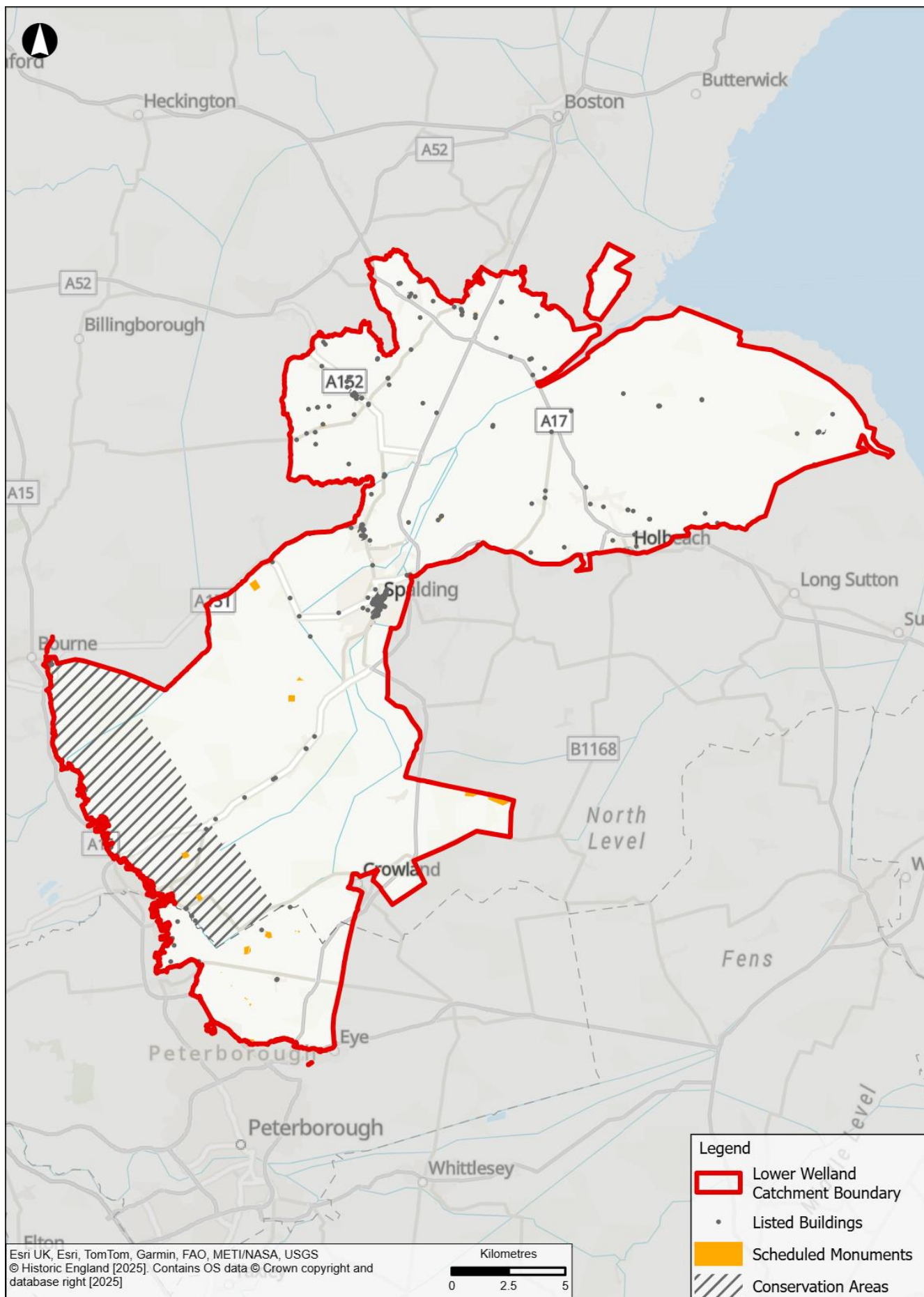


Figure 21: Designated sites for heritage within the catchment

4.6.4 Non-designated heritage assets

While specific non-designated heritage assets have not been identified as part of this study, the following are known or likely to be present:

- Unrecorded archaeological features and remains and palaeoenvironmental deposits are likely to be present throughout the catchment. Because of the waterlogged and anaerobic environments of the catchment, it is likely that ecofacts and composite, organic, and inorganic artefacts will survive.
- There is the potential for areas of Peat to survive in sealed environments beneath the fertile topsoil and Tidal Flat (Clays and Silts) Deposits of the catchment. Peat has a high potential for paleoenvironmental deposits and other organic materials.
- Unrecorded Prehistoric and Roman archaeology is likely to be present along the hinterland of the fen edge and, with regard to unrecorded Roman archaeology, in proximity to other recorded sites throughout the catchment, particularly at or in the vicinity of Spalding. It is likely the unrecorded Prehistoric archaeology will also survive beneath the fertile and rich topsoil and Tidal Flat Deposits of the former fenlands of the catchment.
- Many of the catchment's settlements are likely to have Early Medieval origins and may represent a continuation of occupation within a localised area since the Roman period, particularly in the vicinity of Spalding. Recorded and unrecorded archaeology associated with potentially Roman, but more likely Early Medieval and Medieval occupation are likely to survive within and in proximity to the towns and villages of the catchment and, potentially, around their edges – although later Post Medieval and 20th Century expansion may have resulted in the truncation or loss of some remains and landscape features.
- The remains of salterns, many of which were in use during the Medieval period, are scattered throughout the catchment. Some may have Roman (and in some cases potentially earlier) origins.
- Many of the isolated farms, farmsteads, and farm buildings of the catchment, if not listed buildings, are typically recorded as non-designated built heritage assets and are Post Medieval in date.

Prehistoric remains are likely to date from the Mesolithic period onward. These are likely to comprise scatters of stone tools or the detritus from tool manufacture and are most commonly recovered from higher drier parts of the landscape, beyond the fen-edge. Overall, Mesolithic remains are rare across the county and there is little known evidence of seasonal occupation sites; although these would have existed.

It is possible that the known Neolithic settlement sites of the county have Mesolithic origin or connections. Remains likely to be encountered from the Neolithic period include examples of tools (including weapons), and pottery - although fewer examples of this have been recovered north of the River Welland. Burial monuments for inhumed remains are also built during this period. Often, evidence for the Bronze Age transition is found near these monuments and at the same settlement sites.

The Bronze Age is notable not only the wider adoption of metal (resulting in the presence of metalworking sites and metal artefacts), but also changes in burial practice with community burial monuments falling out of use in favour of individual burial mounds. There are also observable changes in pottery typologies. These trends continue into and throughout the Iron Age, although burial in monuments disappears from practice.

The Iron Age also brings with it evidence for possible landscape division through the marking of territorial boundaries and salt production. Important archaeological remains, such as trackways or walkways, boats, and metal and wooden objects such as swords and shields and jewellery, survive well in waterlogged environments and, when found, are often of national importance.

Roman influence in rural Lincolnshire is most observable through the presence of large-scale engineering works such as Carr Dyke, and other navigable canals and waterways, and the roads network. There are shifts in religious and burial practice during the Roman period with inhumation and cremation cemeteries replacing the Iron Age preference for excarnation. It is likely that the 'Romanisation' of the Iron Age settlements occurred steadily during the period with existing settlements and societal structures being absorbed into the more structured rural Roman economy and practices of land and people management. Industry expands during this period with remains of metal working sites, evidence of large-scale quarrying, and the production of pottery and presence of kilns becoming common. Salt production also continues.

4.7 Population and health

This section outlines the population and health baseline for the catchment. Table 24 outlines the key terminology used in this section.

Table 24: Glossary of population and health terminology

Terminology	Summary Definition
Indices of Multiple Deprivation (IMD) [90]	These datasets are small area measures of relative deprivation across each of the constituent nations of the United Kingdom and is part of a suite of outputs that form the Indices of Deprivation (IoD). The IoD2019 is based on 39 separate indicators, organised across seven distinct domains of deprivation which are combined and weighted to calculate the Index of Multiple Deprivation 2019. Areas are ranked from the most deprived area (rank 1) to the least deprived area. Some of these separate indicators include Employment Deprivation, Income Deprivation, Health Deprivation and Disability, Education Skills and Training Deprivation, Crime, Living Environment Deprivation and Barriers to Housing and Services.
Lower Layer Super Output Area (LSOAs) [91]	These are defined geographical areas which comprise between 400 and 1,200 households and have a usually resident population of between 1,000 and 3,000 persons. These LSOAs are a neat aggregation or split of wards, or may be exactly the same as wards in some areas. Unlike wards whose population sizes vary widely, the LSOAs provide a consistently sized statistical unit. There are 32,844 LSOAs in England.
Middle Layer Super Output Areas (MSOAs)	Middle layer Super Output Areas (MSOAs) are made up of groups of LSOAs, usually four or five. They comprise between 2,000 and 6,000 households and have a usually resident population between 5,000 and 15,000 persons. MSOAs fit within local authorities. There are 6,856 MSOAs in England.

Different classes of administrative unit each have their own datasets and are ordered from smallest to largest in terms of the geographical scale at which they operate. Data for the population and health baseline is collected at the level of Wards, Lower Layer Super Output Areas (LSOAs), and Middle Layer Super Output Areas (MSOAs). All of these administrative areas which intersect with the catchment have been included in the analysis and are listed in

Table 25.

In most of England, including the Fens, there is a two-tier system of local government sitting at larger scales than the MSOAs: county and district. In two-tier areas, each county council area is subdivided into districts, for which there is an independent district council. The catchment is entirely contained within the county of Lincolnshire (governed by the Lincolnshire County Council). Below this level, the catchment is sub-divided into four district areas as seen in Figure 5:

- Boston Borough Council;
- South Holland District Council;
- South Kesteven District Council; and
- Peterborough City Council.

Boston Borough, South Holland and South Kesteven are located within the county of Lincolnshire (and are thus governed by the Lincolnshire County Council). Peterborough City Council is a unitary authority and thus possesses powers of a county and district council combined.

4.7.1 Overview

The catchment is located in the county of Lincolnshire. Figure 22 and Figure 23 show a map of the MSOA and LSOA areas within the catchment.

Table 25 shows the MSOA and LSOA areas that intersect the catchment and will henceforth be used to analyse and report the demographic and health profile. Where summary values were not available at the LSOA or MSOA level, data for the relevant district and county council areas have also been provided.

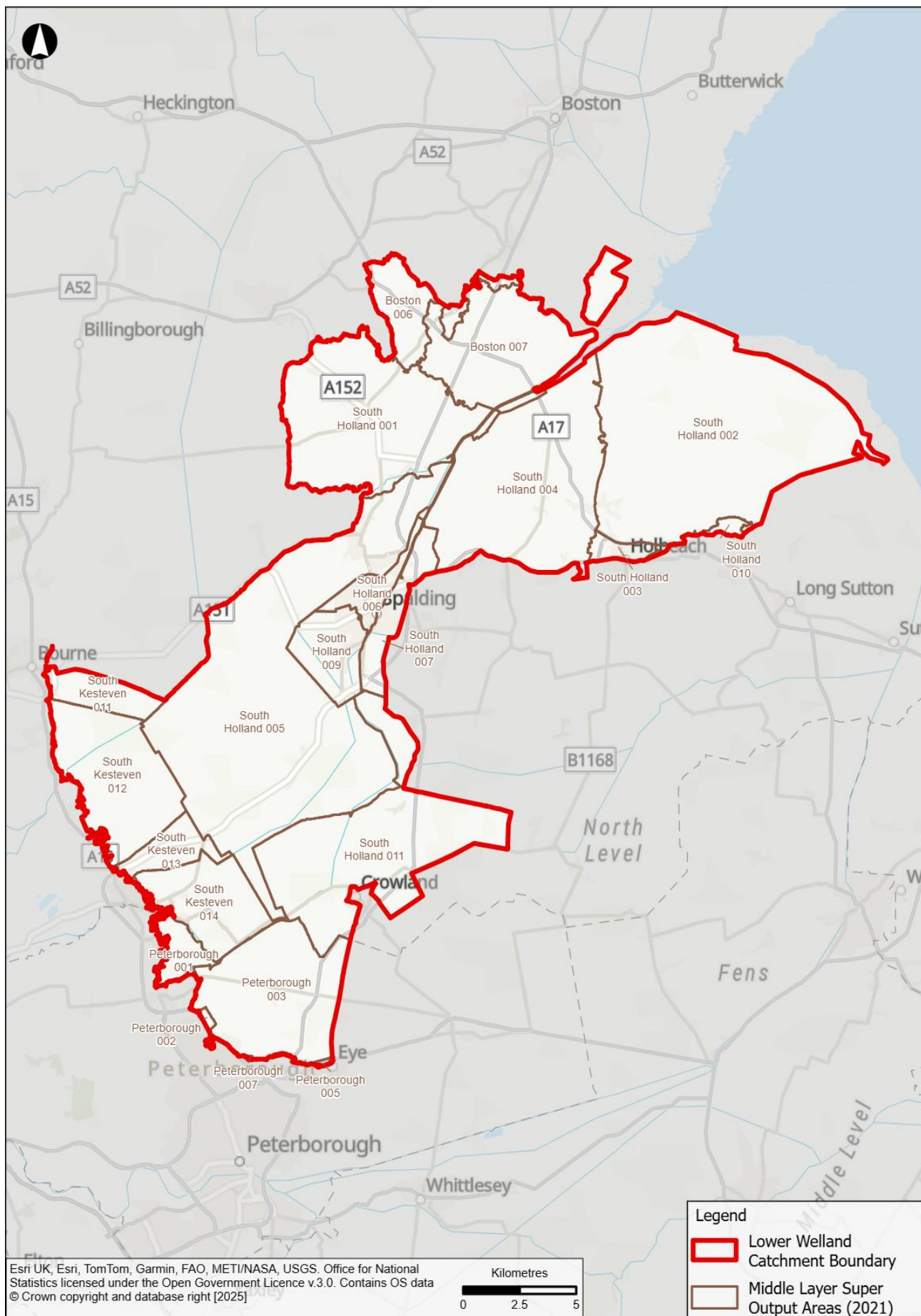


Figure 22: MSOAs which intersect with the catchment boundary

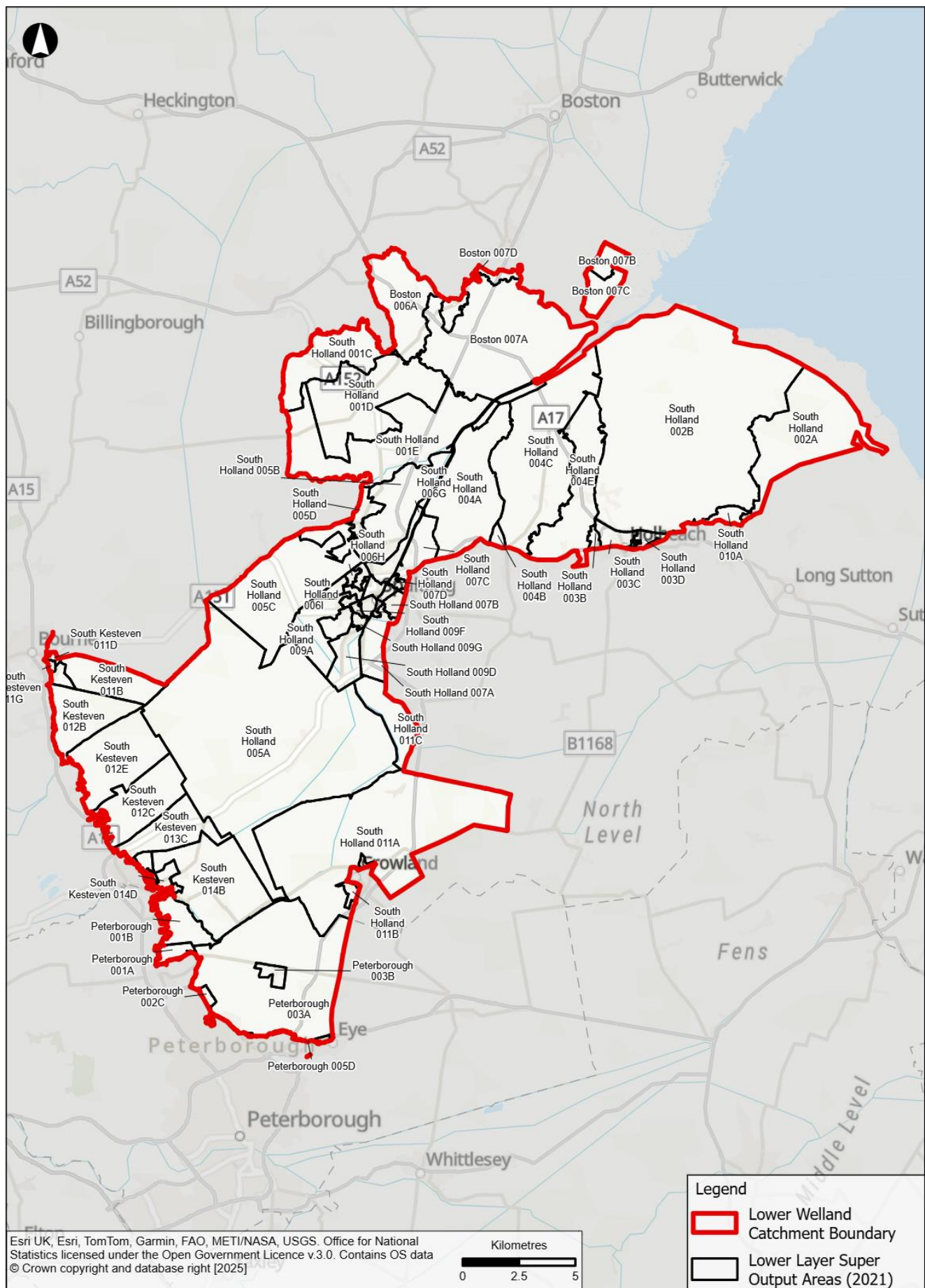


Figure 23: LSOAs which intersect with the catchment boundary

Table 25: LSOAs and MSOAs which intersect with the catchment boundary

LSOAs		MSOAs	
Peterborough 005C	E01015619	Peterborough 001	E02003237
Peterborough 005D	E01015620	Peterborough 002	E02003238
Peterborough 001A	E01015629	Peterborough 003	E02003239
Peterborough 003A	E01015630	Peterborough 005	E02003241
Peterborough 003B	E01015631	Peterborough 007	E02003243
Peterborough 001B	E01015635	Boston 006	E02005422
Peterborough 002B	E01015680	Boston 007	E02005423
Peterborough 002C	E01015681	South Holland 001	E02005465
Peterborough 003D	E01015684	South Holland 002	E02005466
Peterborough 003E	E01015685	South Holland 003	E02005467
Boston 006A	E01026016	South Holland 004	E02005468
Boston 007A	E01026017	South Holland 005	E02005469
Boston 007B	E01026018	South Holland 006	E02005470
Boston 007C	E01026019	South Holland 007	E02005471
Boston 007D	E01026020	South Holland 009	E02005473
Boston 006C	E01026034	South Holland 010	E02005474
South Holland 011A	E01026239	South Holland 011	E02005475
South Holland 011B	E01026240	South Kesteven 011	E02005486
South Holland 005A	E01026241	South Kesteven 012	E02005487
South Holland 001A	E01026242	South Kesteven 013	E02005488
South Holland 001C	E01026244	South Kesteven 014	E02005489
South Holland 010A	E01026245		
South Holland 002A	E01026246		
South Holland 001D	E01026247		
South Holland 002B	E01026248		
South Holland 010B	E01026249		
South Holland 003A	E01026250		
South Holland 003B	E01026251		
South Holland 003C	E01026252		
South Holland 003D	E01026253		
South Holland 005B	E01026258		
South Holland 005C	E01026259		
South Holland 005D	E01026260		
South Holland 009A	E01026262		
South Holland 009B	E01026263		
South Holland 009C	E01026264		
South Holland 009D	E01026265		
South Holland 006B	E01026266		
South Holland 007A	E01026268		
South Holland 007B	E01026269		
South Holland 007C	E01026270		
South Holland 007D	E01026271		
South Holland 007E	E01026272		
South Holland 006C	E01026273		
South Holland 006E	E01026275		
South Holland 001E	E01026276		

South Holland 004A	E01026281
South Holland 004B	E01026282
South Holland 004C	E01026283
South Holland 011C	E01026284
South Holland 004D	E01026285
South Holland 004E	E01026286
South Kesteven 011B	E01026296
South Kesteven 011C	E01026297
South Kesteven 011D	E01026298
South Kesteven 014A	E01026303
South Kesteven 014B	E01026304
South Kesteven 014C	E01026305
South Kesteven 014D	E01026306
South Kesteven 014E	E01026307
South Kesteven 013C	E01026336
South Kesteven 013D	E01026337
South Kesteven 012B	E01026360
South Kesteven 012C	E01026362
South Kesteven 012E	E01026364
South Holland 006F	E01032995
South Holland 006G	E01032996
South Kesteven 011E	E01032997
South Kesteven 011G	E01032999
South Holland 006H	E01034697
South Holland 006I	E01034698
South Holland 009F	E01034699
South Holland 009G	E01034700
Peterborough 007G	E01035538

4.7.2 Demographic Profile

Population

In 2022, the total population of the catchment was approximately 75,443^{*8} compared to the population of Lincolnshire which totals 766,333 [92]. Between 2011 and 2021, all four of the local authority districts which intersect with the catchment have seen rates of population growth above the overall rate for England (6.6%). Of these districts, Peterborough City Council saw the largest percentage growth between 2011 and 2021, at 17.5% [93].

However, when considering solely the MSOA areas intersecting with the catchment, it was those within the Boston Borough Council area (corresponding to the northern portion of the catchment) which had the highest average growth over this same period, growing by approximately 10.5% [93]. Across all MSOAs intersecting with the catchment, the average growth over the decade was 9.0%. Peterborough 007 (north-eastern edge of Peterborough) and South Holland 006 (central and western Spalding) saw a boom in growth, increasing by more than 24% over the decade.

Future population growth is only projected for local authority areas or larger national units, so it is difficult to predict whether the rapid growth observed across the catchment since 2011 will

⁸ This population figure has been calculated using the total population of every LSOA that fully or partially overlaps with the Lower Welland catchment area. It considers the proportion of the LSOA which intersects with the catchment, such that the same percentage of the population of an LSOA will be counted as the percentage area which overlaps with the catchment. It is assumed that the population density across each LSOA is uniform.

continue. At the district level, all four districts (Peterborough, Boston, South Holland and South Kesteven) are anticipated to continue to grow above the predicted population growth rate for England (6%) between 2025 and 2043, at 9%, 9.5%, 10.2% and 8.3% respectively [94]. Section 4.7.6 outlines the provisions that have been made in the relevant Local Plans for the additional housing which will accommodate this future population growth in settlements across the catchment.

Population density

The population density within LSOAs intersecting with the catchment are displayed in Table 26. The highest density area in the catchment is the South Holland 009F LSOA (which spans the railway south of the town centre) where there are 6,664 residents per km². The lowest density area in the catchment is the South Holland 005A LSOA, which encompasses the area in the south-west of the catchment around Deeping St Nicholas. In this LSOA there are just 30 residents per km² [95].

Table 26: Population Density by LSOA Area (2021)

LSOA	Area (km ²)	Mid-2022 population	Population Density (residents per km ²)
Peterborough 005C	0.91	2,192	2,420
Peterborough 005D	6.30	2,203	350
Peterborough 001A	5.54	1,725	311
Peterborough 003A	39.23	2,027	52
Peterborough 003B	0.88	1,489	1,696
Peterborough 001B	6.22	1,615	260
Peterborough 007G	1.66	1,847	1,112
Peterborough 002B	0.44	1,496	3,387
Peterborough 002C	0.83	1,425	1,712
Peterborough 003D	0.50	1,410	2,802
Peterborough 003E	0.57	1,530	2,705
Boston 006A	32.57	2,407	74
Boston 007A	27.54	1,641	60
Boston 007B	29.97	1,704	57
Boston 007C	15.71	2,756	175
Boston 007D	7.79	2,947	378
Boston 006C	10.22	1,812	177
South Holland 011A	52.89	2,140	40

South Holland 011B	1.50	3,029	2,023
South Holland 005A	66.85	2,021	30
South Holland 001A	20.86	1,890	91
South Holland 001C	16.77	1,359	81
South Holland 010A	27.75	2,469	89
South Holland 002A	51.58	2,329	45
South Holland 001D	15.49	1,924	124
South Holland 002B	75.25	2,346	31
South Holland 010B	30.82	2,083	68
South Holland 003A	0.50	2,164	4,341
South Holland 003B	1.27	1,840	1,444
South Holland 003C	1.39	1,780	1,284
South Holland 003D	0.88	2,040	2,322
South Holland 005B	11.52	2,456	213
South Holland 005C	40.24	1,766	44
South Holland 005D	3.94	2,006	509
South Holland 009A	4.69	1,480	316
South Holland 009B	1.32	2,508	1,897
South Holland 009C	0.28	1,649	5,881
South Holland 009D	3.05	1,442	473
South Holland 006B	0.53	2,321	4,415
South Holland 007A	8.50	2,025	238
South Holland 007B	1.32	2,207	1,669
South Holland 007C	6.52	1,964	301
South Holland 007D	0.32	1,756	5,527
South Holland 007E	0.34	1,424	4,198
South Holland 006C	0.49	1,765	3,576
South Holland 006E	0.44	2,700	6,106
South Holland 006I	0.64	1,805	2,839

South Holland 006H	0.30	1,510	5,079
South Holland 009F	0.23	1,504	6,664
South Holland 009G	0.36	1,367	3,847
South Holland 001E	35.32	2,359	67
South Holland 004A	22.10	1,438	65
South Holland 004B	20.44	1,929	94
South Holland 004C	26.30	1,790	68
South Holland 011C	18.10	2,393	132
South Holland 004D	23.06	1,418	61
South Holland 004E	11.87	1,227	103
South Holland 006F	0.63	1,480	2,351
South Holland 006G	1.80	1,388	772
South Kesteven 011B	27.57	1,495	54
South Kesteven 011C	0.42	1,459	3,505
South Kesteven 011D	2.83	2,166	766
South Kesteven 014A	0.24	1,287	5,460
South Kesteven 014B	13.83	1,506	109
South Kesteven 014C	0.61	1,386	2,278
South Kesteven 014D	1.01	1,917	1,905
South Kesteven 014E	0.38	1,243	3,312
South Kesteven 013C	6.38	1,799	282
South Kesteven 013D	0.53	2,284	4,327
South Kesteven 012B	15.92	2,148	135
South Kesteven 012C	11.18	1,673	150
South Kesteven 012E	14.39	1,836	128
South Kesteven 011E	0.97	1,381	1,430
South Kesteven 011G	0.49	1,259	2,574

Age distribution

The catchment has a distinctively elderly population (residents aged 65 or over) relative to Lincolnshire (23.8%) and England (18.5%). Table 27 shows that the Peterborough 007MSOA, covering the area just west of Eye, has an unusually young population in the catchment, with only 12.1% of residents aged 65+ and more than 27.9% of its population aged 0-15. In contrast, South Holland 010 which covers the rural central portion of the catchment between Holbeach and Throckenholt has a much lower percentage of under-16s, at just 14.6%.

Although currently high, the proportion of elderly residents in the catchment is expected to rise significantly by 2043 [108]. The projected increases for the four local authorities indicate a notable aging trend across all districts and are summarised as follows:

- Boston Borough: From 20.8% in 2018 to 24.7% in 2043;
- South Holland: From 24.2% to 29.0%;
- City of Peterborough: From 14.7% to 19.9%;
- South Kesteven: from 22.8% in 2018 to 31.4% in 2043, the most significant increase among the four districts.

Table 27: Age structure by MSOA area

MSOA Area	Age Band		
	0-15	16-64	65+
Peterborough 001	16.0%	56.8%	27.2%
Peterborough 002	20.6%	64.1%	15.3%
Peterborough 003	17.6%	57.1%	25.3%
Peterborough 05	21.7%	58.6%	19.7%
Peterborough 007	27.9%	60.0%	12.1%
Boston 006	17.1%	56.1%	26.8%
Boston 007	20.2%	56.0%	23.8%
South Holland 001	15.9%	56.2%	27.9%
South Holland 002	16.0%	54.4%	29.6%
South Holland 003	17.6%	55.9%	26.5%
South Holland 004	16.4%	56.3%	27.3%
South Holland 005	19.0%	58.2%	22.8%

South Holland 006	18.5%	63.8%	17.7%
South Holland 007	19.0%	60.1%	20.5%
South Holland 009	19.0%	60.5%	29.1%
South Holland 010	14.6%	56.3%	29.1%
South Holland 011	19.3%	58.0%	22.7%
South Kesteven 011	19.6%	57.7%	22.7%
South Kesteven 012	16.2%	56.7%	27.1%
South Kesteven 013	18.1%	56.2%	25.7%
South Kesteven 014	18.2%	58.7%	23.1%
Lincolnshire	17.2%	59.0%	23.8%
Peterborough	23.7%	61.3%	15.0%
England	19.2%	62.3%	18.5%

Ethnicity

The catchment has a much higher proportion of ethnically white residents than England. Across the seventy-four LSOA areas which wholly or partially overlap with the catchment, an average of 95.6% of the residents are white, compared to a national average of approximately 82% [96]. Of those white residents, the vast majority (89.4%) identified as 'English, Welsh, Scottish, Northern Irish or British', with 9.9% identified as 'other white' and less than 0.33% as 'Gypsy or Irish Traveller' and 'Roma'.

The second largest ethnic group in the catchment is Asian (including Bangladeshi, Chinese, Indian, Pakistani, or other), making up approximately 1.6% of the population.

4.7.3 Employment Status

Employment

The largest employment sector in the catchment is 'Wholesale and retail trade; repair of motor vehicles and motorcycles', which constitutes an average of 18.9% across the twenty-one MSOAs which intersect with the catchment. Another large sector is 'human health and social work activities', employing 12.0% of working adults in the catchment. Approximately 11.9% of economically active adults in the catchment are employed in the manufacturing sector, which is greater than the England average of 7.3%. 'Agriculture, forestry and fishing' employs an average of 3.6% of adults in the catchment, but the percentage is much higher than average in South Holland 002, north and east of Holbeach where 7.7% of working adults are employed in the sector.

For information on employment within the agricultural sector, please see Section 4.2.

Travel

Across the catchment, there is a high reliance on private vehicles for getting to and from places of

work, however there is some variation between rural and urban areas.

The most common commute mode is in a car or van (either as a driver or passenger) with an average of approximately 65.1% travelling to work in this way across the twenty-one MSOAs. In Boston 007, which covers the area between Fosdyke, Algakirk and the coast in the north of the catchment, as many as 74.9% of workers travel to their place of work in a car or van, either as a passenger or driver. In South Holland 003 (Holbeach) this figure is the highest of any in the catchment, at 75.4%. Even the lowest rates of private vehicle use (55.0% in Peterborough 001 and South Holland 007)) are significantly higher than the England figure of 44.5%.

In terms of active travel modes, an average of 2.5% of commuters in the catchment travel to work by bicycle (which is higher than the England average of 2.1%). Rates of cycling to work are highest in Spalding, where an average of 6.2% of workers cycling to work across the three MSOAs which cover the town. Cycling is least common in the south-west of the catchment, between market Deeping and Bourne, where only 0.9% of commuters use a bicycle as their primary transport mode. Across the catchment, 5.6% of workers commute on foot, but again there are pockets where walking is a much more popular mode. For example, 14.1% of workers walk to work in South Holland 007 (eastern Spalding).

Unemployment

There is significant variation in unemployment (measured as a percentage of the working age population claiming out of work benefits) across the catchment [97]. Only in two of the twenty-one MSOAs are unemployment rates higher than the averages for England, and generally rates of unemployment are low. However, in Peterborough 007, in the south-west of the catchment levels of unemployment are acute. In this area, which covers Paston in north-east Peterborough, unemployment rates for 2021-2022 were 9.1%. This is far higher than any other area in the catchment, and almost twice the England average of 5.0%.

Long-term unemployment rates do not correlate with unemployment across the catchment. For example, Peterborough 007 had relatively low rates of long-term unemployment in the same period, at a rate of only 7 people per 10,000. Long-term unemployment rates are lower than the England average in eighteen of the twenty-one MSOAs.

4.7.4 Health profiles

Life expectancy

Average life expectancy at birth for both males and females within the catchment are below the England average. For females in the catchment, Boston 006 (which covers Swineshead, Bicker and Holland Fen) had the highest life expectancy of any MSOA in the catchment, at 88.2 years. For males, the longest life expectancy was recorded in Peterborough 002 (82.8 years) and the lowest in Peterborough 007 (77.7 years).

Mortality and cause of death

Health indicators relating to mortality are assessed using the Standardised Mortality Ratio (SMR) which is calculated by dividing the number of observed deaths by the number of expected deaths. This ratio illustrates whether a study population is more or less likely to die than a reference population (in this case the reference population is England, which has a SMR of 100). Wherever the SMR is greater than 100, there are a higher number of deaths than expected.

Deaths from causes considered preventable in those residents aged 75 or younger have an average SMR of 86.6 across all MSOAs meaning that preventable deaths are less likely in the catchment than in England as a whole. However, Peterborough 007 (Paston) the SMR of deaths from preventable causes is extremely high, at 161.

Long-term illness or disability

As an average across the MSOAs which overlap with the catchment, 5.3% of the population are classed as being in either bad or very bad health [98]. This compares to an average of 5.2% across England as a whole.

South Kesteven 014 (covering the eastern part of Market Deeping) has the lowest percentage of residents with a limiting long-term illness or disability, at 13.2%. The highest percentage was recorded in South Holland 010 covering Crowland and Cowbit in the south-west of the catchment. In this MSA, 23.4% of residents have a limiting long-term illness or disability.

Obesity

Obesity is prevalent across the wider Fens study area, and the catchment is no exception. The majority of the MSOAs intersecting the catchment have a prevalence of obesity (including overweight) in adults which is within the highest 20% nationally [99]. The prevalence of obesity (including severe obesity) among year six students in the catchment is also high, particularly in northern Peterborough and in the areas of the catchment nearest the coast in the north and east. In Peterborough 007 (Paston) 32.5% of year six students are obese or severely obese. In South Holland 002, covering the coastal area north and east of Holbeach 33.3% of year six students are obese or severely obese, which is far higher than the average for England of 21.6% [99].

Mental wellbeing

The estimated prevalence of common mental disorders (aged 16 and over) is 15.8% for Lincolnshire, which is marginally lower than the prevalence of 16.9% reported for England [100]. However, in Peterborough, the estimated prevalence is much higher, at 18.8%.

Self-reported wellbeing

Self-reported wellbeing status of people within the UK is now measured by the Office for National Statistics. This data is only available at county and unitary authority level.

Reports for Lincolnshire reflected fewer people with a low satisfaction score than the England average, at 4.5% compared to 6.1%. Comparatively, the proportion of people with a low happiness score was significantly lower in Lincolnshire than the England average. The percentage of people with a high anxiety score was only marginally higher than the England average of 24.2%, with the Lincolnshire score being 25.5% [101].

In Peterborough, a greater proportion of residents reported low satisfaction, low happiness, and high levels of anxiety than the England averages. For example, 8.7% of residents in Peterborough reported low life satisfaction, compared to 5.6% across England as a whole.

4.7.5 Deprivation

Overall deprivation

Apart from the coastal north-east of the catchment, and South Holland 007C just north-east of Spalding, which are all within the top 30% of deprivation, all other LSOAs covering the catchment have levels of overall deprivation which are generally in line with, or below the national average (see Figure 24) [90]. The LSOAs covering Baston and Langtoft in the south-west of the catchment have some of the lowest levels of deprivation anywhere in England: in 2019, South Kesteven 012E was ranked 32,297 out of 32,844 (where 1 is the most deprived). This places it in the 2% least deprived neighbourhoods. The most deprived LSOAs which intersects with the catchment is Boston 007A covering Sutterton and Algarkirk, which is within the top 30% of most deprived neighbourhoods in England, based on the most recent 2019 data.

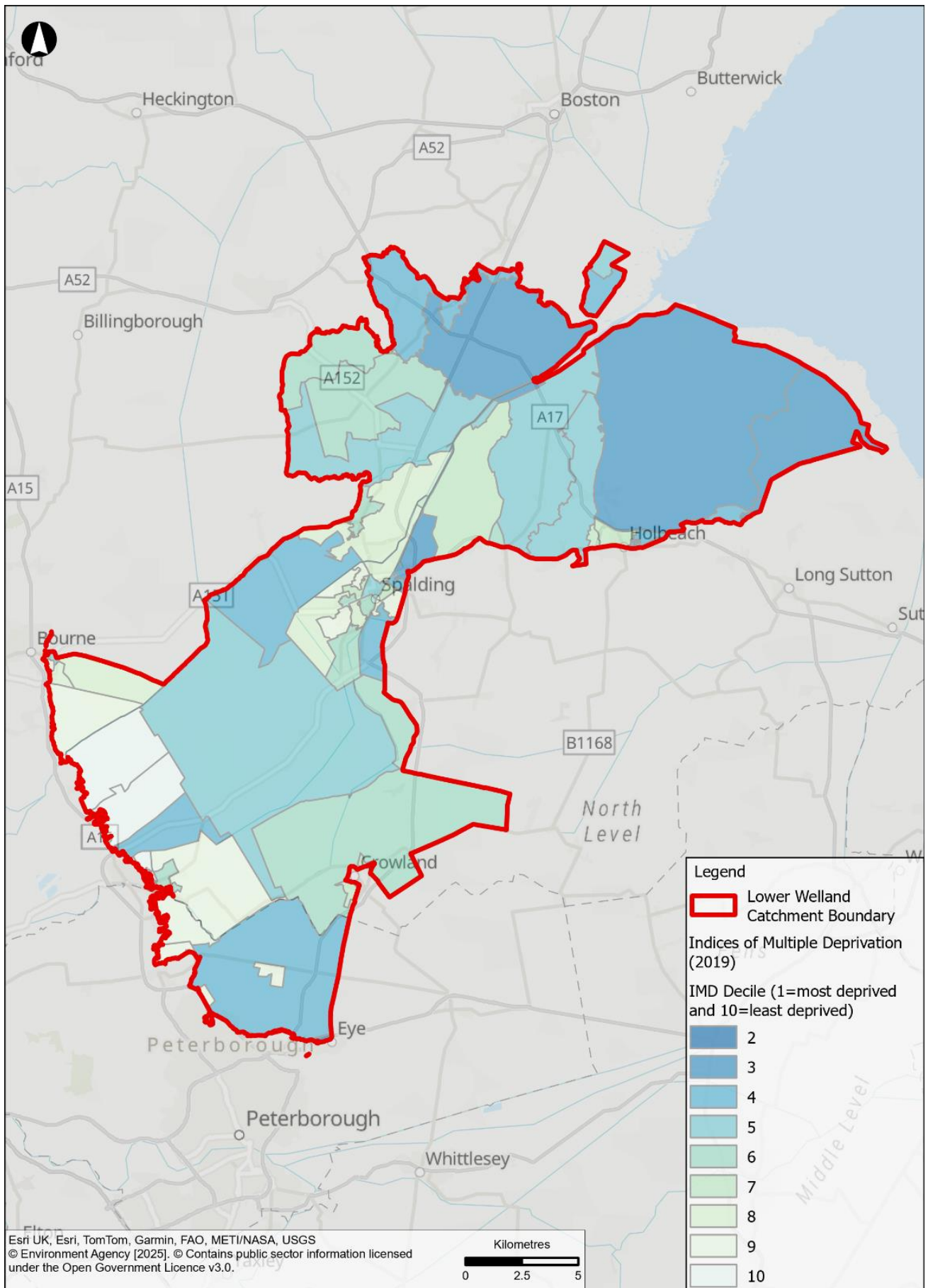


Figure 24: Map of deprivation across the catchment

Education, skills and training deprivation

In terms of education, skills and training, the majority of LSOAs intersecting with catchment are within the top 50% most deprived. Three of the LSOAs which partially overlap with the catchment to the eastern side of Spalding are within the top 10% most deprived. South Holland 007C, covering the area around Holbeach Road to the north-east of the town was the most deprived, ranking 1,090th out of 32,844 LSOAs in England in 2019. As with other deprivation measures, there is a stark contrast between the majority of the catchment and the South Kesteven district in the most westerly region, near Bourne. In this area, three of the neighbourhoods are within the 20% least deprived in the country for education, skills and training.

Taken as an average across all MSOAs in the catchment, 20.8% of residents in the catchment have no qualifications [102]. South Holland 007 just to the east of Spalding has the highest percentage of residents with no qualifications, at 28.3%, matching with the broader pattern of deprivation described above.

Income deprivation

The income deprivation domain measures the proportion of the population experiencing deprivation relating to low income. This included those people who are out of work as well as those who are in work but who have low earnings. The IMD 2019 identified that the Boston 007A and 007C LSOAs located north of the River Welland near the coast are the 20% most deprived neighbourhoods in the country [90]. The majority of the other LSOAs in the catchment are ranked between the 4th and 7th decile, showing comparatively similar levels of income deprivation to the rest of England.

4.7.6 Housing and private property

Housing allocations in the Boston Borough and South Holland Districts, for settlements within, or partially located within the catchment are outlined in the South East Lincolnshire Local Plan as follows [42]:

- Spalding has a housing allocation of 5510;
- Holbeach has a housing allocation of 2202;
- Pinchbeck has a housing allocation of 252;
- Sutterton has a housing allocation of 308;
- Cowbit has a housing allocation of 120;
- Quadring has a housing allocation of 130;
- Deeping St Nicholas has a housing allocation of 80;
- Gosberton has a housing allocation of 270;
- Moulton has a housing allocation of 190;
- Surfleet has a housing allocation of 180;
- Weston has a housing allocation of 310; and
- Wigtoft has a housing allocation of 30.

The Local Plan for South Kesteven in the south-west of the catchment outlines the following in relation to housing need in their district [43]:

- 650 new homes are needed annually over the period 2011-2036

The Local Plan for Peterborough City Council [103] in the far south of the catchment has outlined two sites allocated for Urban Extensions, adjacent to the catchment boundary. LP35.2 and LP35.6 have a combined indicative number of dwellings in the Plan Period (2018-2036) of 2,945. There

are further sites allocated for residential development in Glinton, Peakirk, Newborough and Eye, as well as several sites within Peterborough's suburbs.

4.7.7 Social infrastructure

There are a range of community resources located within the catchment:

- There are 33 educational establishments within the catchment [119]. Half of these are concentrated in Spalding in the centre of the catchment. The only schools in the north of the catchment area are in Sutterton and Holbeach, reflecting the lower population density in areas towards the coast.
- There are two special schools in the catchment providing support to primary and secondary aged pupils with a range of learning difficulties and disabilities [104].
- Gosberton Youth Centre is the only designated youth centre in the catchment [104].
- The only hospital within the catchment is the Johnson Community Hospital in Pinchbeck, just north of Spalding, which has an urgent treatment centre for non-critical illnesses and injuries. The nearest hospital providing all major specialties and 24-hour major accident and emergency services are the Pilgrim Hospital in Boston and the Peterborough City Hospital to the south [104].
- In terms of dentistry and GP surgeries, the central and northern catchment is served by practices in Spalding, Pinchbeck and Gosberton. There are no dental services or GP practices within the southern catchment but communities in this area are served by those in Spalding, or further west and south in Bourne, Market Deeping, Eye and Peterborough [104].
- The nine residential care/nursing homes in the catchment are located in the north and east of the catchment. The west and south of the catchment is served by nursing homes located in Heckington, Dowsby, and Bourne [104].
- Public libraries within the catchment include Spalding, Long Sutton and Crowland. There is also a Community Library in Market Deeping just outside the south-western catchment boundary [104].
- Ayscoughfee Hall in central Spalding is the only registered park or garden within the catchment [105].
- Within the catchment, there are seventeen sports facilities, fourteen of which are located in Spalding or villages further north. Although there are only three sports facilities in the southern catchment, there are twelve further facilities within 1km of the catchment boundary, located in the settlements between Bourne and Peterborough [106].

The key challenges identified in the local plans which have prevented better provision of leisure facilities are the ageing population, low population density and small settlement sizes, heavy reliance on private transport, and significant levels of deprivation and poor health.

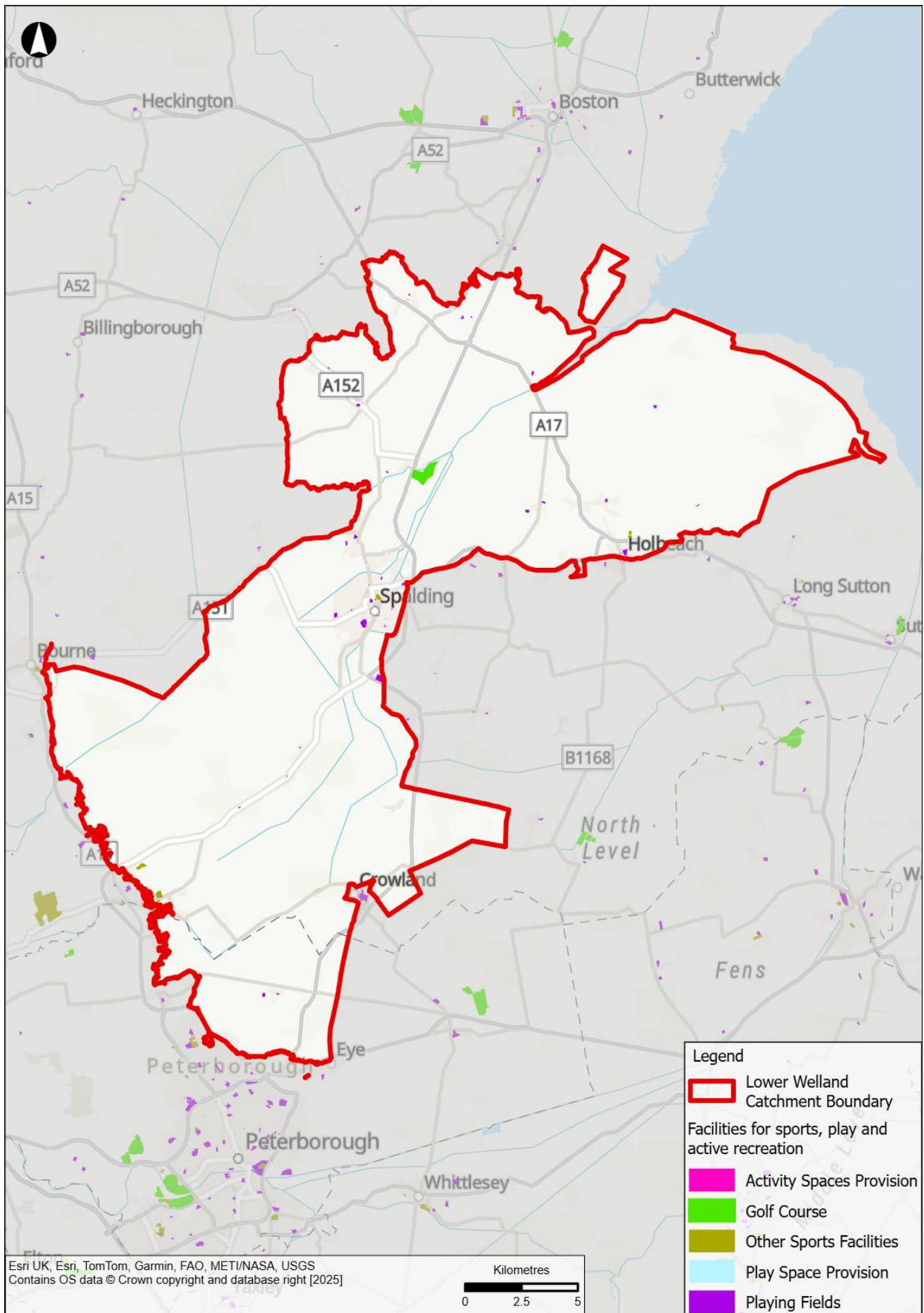


Figure 25: Facilities for sports, play and active recreation within the catchment

4.7.8 Transport Infrastructure

The catchment is poorly served for active travel routes (refer to Figure 4):

- There are approximately 215.8 km of Public Rights of Way within the catchment boundary, comprising 144.4 km of footpaths, 58.0 km of bridleways and 13.4 km of byways open to all traffic. Generally, routes are well provided along the banks of the River Welland itself, as well as along the River Glen approaching Surfleet. Nevertheless, many of the rural communities within the catchment such as Deeping St Nicholas, Holbeach and Gosberton have no access to any meaningfully joined-up network of routes for walking, wheeling or horse-riding [107].
- The Sustrans National Cycle Network Route 1 and 12 pass through the catchment, connecting Holbeach with Fosdyke Bridge to the north-east of the catchment and Spalding with Peterborough to the south [108].
- The King Charles III England Coast Path National Trail follows the entire coastline of the catchment [109].

4.8 Air quality

This section outlines the air quality baseline in the catchment. Table 28 outlines the key terminology used in this section.

Table 28: Glossary of air quality terminology

Terminology	Summary Definition
Air quality management area (AQMA)	A geographically defined area designated by a local authority where national air quality objectives are not likely to be met. This may cover an area from one street or much larger where the Local Authority is required to develop an Air Quality Action Plan to improve air quality in the that area.
Air Quality Action Plan	The action plan developed by a local authority setting out measures to address achieving air quality objectives in a designated AQMA.
Background concentrations	The levels of air pollutants for a reference year including nitrogen, nitrogen dioxide and particulate matter, published by Defra for support the review and assessment of local air quality under the Environment Act (2021) [1]
Sensitive receptors	A receptor that is potentially sensitive to changes in air quality such as residential property, schools, hospitals, and statutory designated ecological sites.
NO _x , NO ₂	Nitrogen oxides (NO _x) refers to nitric oxide (NO) and nitrogen dioxide (NO ₂), both of which are mainly formed during the combustion of fossil fuels.
PM ₁₀ and PM _{2.5}	Particulate matter (PM) is everything in the air that is not a gas. It consists of a huge variety of chemical compounds and materials, some of which can be toxic. Particulates are classified according to size. The UK is currently focused on measuring the fractions of PM where particles are less than 10 micrometres in diameter (PM ₁₀) and less than 2.5 micrometres in diameter (PM _{2.5}).
Units - µg/m ³	The units are in microgrammes of pollutant per cubic metre of air.

4.8.1 AQMAs

There are no AQMAs within the Catchment. The closest AQMA is AQMA No.1, located approximately 4km south of the Catchment. It was declared in 2007 by Peterborough Council due to exceedances of 15-minute mean sulphur dioxide SO₂. Given the distance from the Catchment, this AQMA is not considered further considered in this assessment.

4.8.2 Air quality monitoring

A review of the existing air quality conditions in the Catchment area has been undertaken using the Boston Borough Council 2023 Air Quality Status Report [110] South Holland District Council 2024 Air Quality Status Report [111], South Kesteven District Council 2024 Air Quality Status Report [112] and Peterborough City Council 2024 Air Quality Status Report [113]. Within the Catchment area, there are no monitoring sites from Boston Borough Council, South Kesteven District Councils and Peterborough City Council. However, South Holland District Council has several monitoring sites, including diffusion tubes and automatic monitors from South Holland District Council.

The urban automatic monitor is located at Spalding Monkshouse School and measures NO₂ and PM₁₀ concentrations, which are shown to be below than the annual mean objective (40µg/m³) from 2019 to 2023. The 2023 Defra background concentrations for the OS grid square for the automatic

urban background monitoring site (CM1) were compared with the actual measured values. At site CM1, Defra's predicted concentrations ($6.9 \mu\text{g}/\text{m}^3$) is generally lower than the actual measured concentrations ($8.2 \mu\text{g}/\text{m}^3$). However, due to the area being largely rural Defra's predicted concentrations were used for this assessment.

4.8.3 Background concentrations

Background concentrations refer to the existing levels of pollution in the atmosphere, produced by a variety of stationary and non-stationary sources, such as roads and industrial processes. Defra publishes background pollutant mapping [114] for every $1\text{km} \times 1\text{km}$ OS grid square across the UK for NO_x , NO_2 and PM_{10} and $\text{PM}_{2.5}$, as well as national air quality objectives for each pollutant. As there are no background monitoring sites within the catchment, Defra background data have been used as the representative for the area.

The Catchment spans across 375 grid squares. The background pollutant mapping has been reviewed for those grid squares and an average of the 2024 Defra background concentration has been used as the representative for the area. The average Defra background concentrations for NO_2 is $5.8 \mu\text{g}/\text{m}^3$, NO_x (relevant to ecological receptors) is $7.3 \mu\text{g}/\text{m}^3$, PM_{10} is $13.3 \mu\text{g}/\text{m}^3$ and $\text{PM}_{2.5}$ is $6.0 \mu\text{g}/\text{m}^3$. All concentrations are well below the annual air quality standards for NO_2 ($40 \mu\text{g}/\text{m}^3$), NO_x ($30 \mu\text{g}/\text{m}^3$), PM_{10} ($40 \mu\text{g}/\text{m}^3$) and $\text{PM}_{2.5}$ ($20 \mu\text{g}/\text{m}^3$). The $\text{PM}_{2.5}$ Defra background concentration is also below the Environmental Improvement Plan target ($12 \mu\text{g}/\text{m}^3$) and the Environmental Target ($10 \mu\text{g}/\text{m}^3$) for $\text{PM}_{2.5}$.

4.8.4 Sources of Air Pollution

Industrial air pollution sources are regulated through a system of operating permits or authorisations, requiring stringent emission limits to be met, and ensuring that any releases to the environment are minimised or rendered harmless. Regulated (or prescribed) industrial processes are classified as Part A(1), A(2), Part B of Medium Combustion Plant (MCP) processes and are regulated through the Pollution Prevention and Control (PPC) system [115] [116]. The larger more polluting processes are regulated by the Environment Agency (EA), and the smaller, less polluting ones by the local authorities. Local authorities focus on regulation for emissions to air, whereas the EA regulates emissions to air, water, and land.

There are several Part A(1) and MCP processes within the Catchment listed on the EA website [117], however only three of these have releases to air and relevant combustion activities. These sites are Spalding Energy Expansion Limited (activity: Combustion 50MW) and two MCP Johnsons Textile Services Limited and Greenyard Fresh UK Ltd. It is assumed that these processes are included in the Defra background concentrations. The impact of other smaller industrial processes further from the Catchment are also assumed to be represented in the background concentrations used in this assessment.

Traffic is a significant contributor to air pollution. Pollution from traffic includes vehicle exhaust emissions, secondary pollutants formed in the atmosphere, evaporative emissions from vehicles and non-combustion emissions such as tyre wear and road dust. There are very few A-roads within the Catchment: the A1175, A16 and A17 spanning approximately 13.8km, 20km, and 17.5km and 7km, respectively.

4.8.5 Sensitive Receptors

Sensitive human receptors are defined as those residential properties, schools and hospitals that are likely to experience a change in pollutant concentrations with potential exposure relevant to the averaging periods set out in the air quality standards.

In the catchment, these include:

- Individual properties and residential areas within the catchment e.g. Spalding; Gosberton; Pinchbeck, and Deeping St Nicholas, etc;
- Gosberton House Academy;
- Surfleet Primary School;
- Pinchbeck East C of E Primary School;
- Monkshouse Primary Academy;
- Spalding Primary School;
- Puddleducks Day Nursery;
- Busy Bee Preschool and Day Nursery;
- Wygate Park Academy;
- Johnson Community Hospital; and
- Beechfield Medical Centre.

Sensitive ecological receptors are defined as those sites whose qualifying features have been designated as sensitive to air pollutants. Within the catchment, there are several sensitive ecological receptors with national and international designations, including Cowbit Wash, Cross Drain, Deeping Gravel Pits, Surfleet Lows, and the Baston and Thurlby Fens SSSI, as well as the Baston Fen SAC. Please see Section 4.5 for further information.

5. References

- [1 HM Government, "Environment Act 2021," n.d.. [Online]. Available:
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