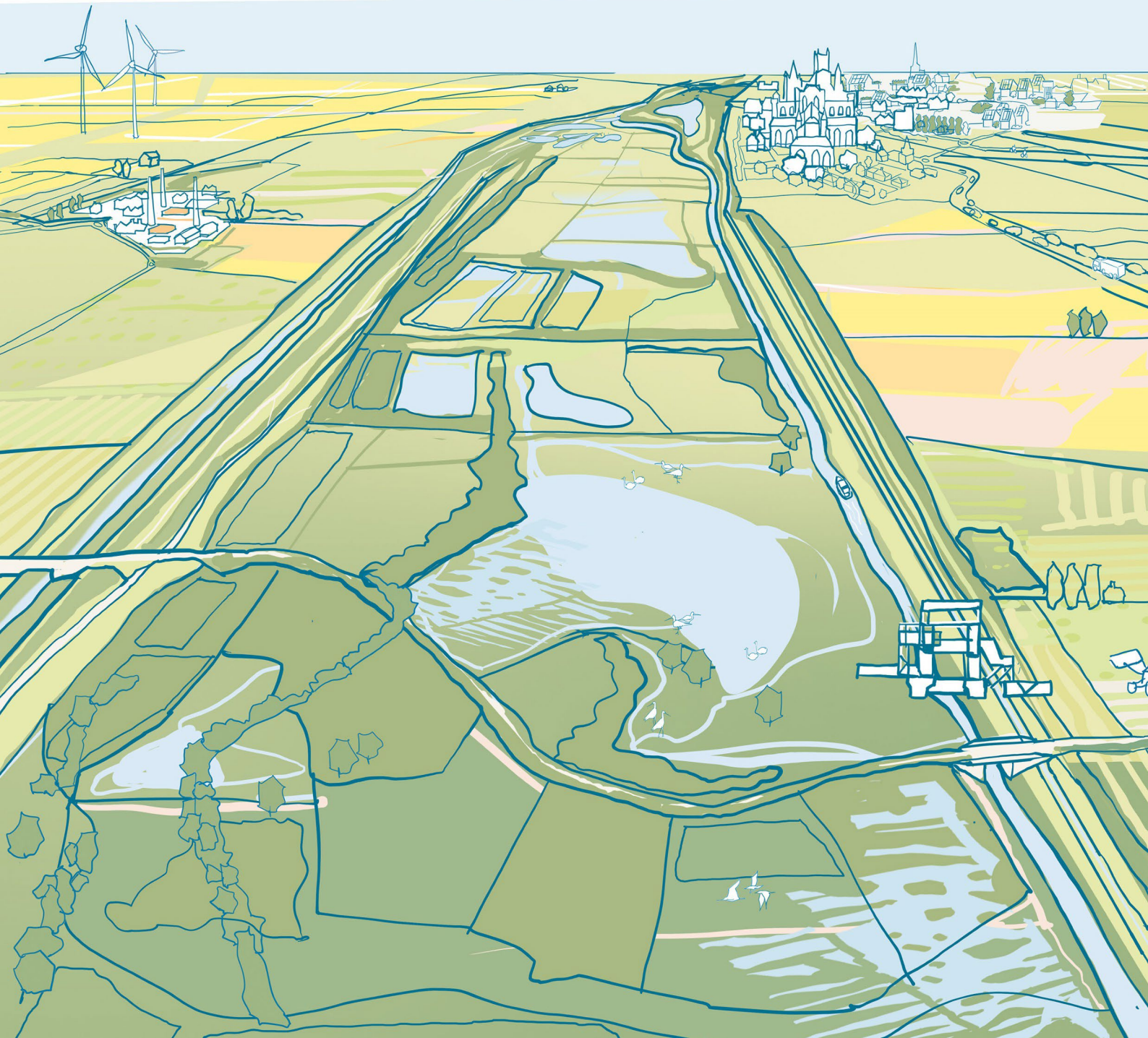
Fens 2100+

Lower Nene

Natural capital register and account

2025



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Executive Summary

Natural capital refers to the elements of the natural environment that provide valuable goods and services to people [1]. *These include food, water, flood alleviation, thriving wildlife and places to enjoy. Natural capital underpins our wellbeing and economic prosperity, providing multiple benefits to society.*

This Natural Capital Baseline Report provides an assessment of the natural capital assets within the Lower Nene catchment[1]. The report highlights the importance of natural capital in supporting economic activity and human wellbeing through the provision of ecosystem services. The assessment was conducted using the Environment Agency's Natural Capital Register and Account Tool (NCRAT) and includes both quantitative and qualitative analysis undertaken through desk-based research, spatial analysis using Geographical Information Systems (GIS) and engagement with key stakeholders.

The catchment comprises 55,255 hectares (ha) (553km^2) of terrestrial and coastal habitats, including urban land; agricultural land; coastal margins; freshwater habitats; and woodlands. The catchment also contains local, national and international designated sites such as The Wash, Nene Washes and the North Norfolk Coast.

The key ecosystem services from natural assets in the catchment can be categorised into provisioning, regulating, cultural and supporting / bundled services. The estimated natural capital values of these are summarised below:

- Agriculture, water supply, timber, and renewable energy generation are key **provisioning services.** Agriculture alone contributes an estimated £47.7 million annually, while water supply is valued at nearly £12 million per year.
- Climate regulation, air quality improvement, hazard regulation, and pollination are critical **regulating services**. Enclosed farmland, woodland and coastal habitats sequester an estimated 7,930tCO_2e/yr[2] in the catchment, thereby providing climate regulation. Conversely, the peatland in the catchment is in a degraded condition and consequently emits approximately 54,960tCO_2e/yr.
- Recreation, physical health, and aesthetic value are important **cultural services**. Despite being predominantly agricultural in land-use, it is estimated that the catchment attracts approximately one million visitors annually to open spaces[3], with an estimated value of £3.9 million annually. This contributes to natural capital value through improvements to physical and mental health (welfare) and can boost the local economy.
- **Supporting / bundled ecosystem services** in the catchment include water quality and biodiversity, which allow other ecosystem services to function and often involve multiple services or non-use values. The catchment hosts a large number of designated sites

[1] The Lower Nene 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 described the study area.

[2] Tonnes of carbon dioxide equivalent per year. This is a measure of how much carbon dioxide would have to be released to have an equivalent warming impact to the amounts of other greenhouse gases.

[3] Open spaces considered within ORVal include publicly accessible green spaces within the catchment, for example, public parks, doorstep greens and nature reserves.

that support biodiversity conservation, for example, approximately 1.3% (462ha) of the catchment is internationally designated as a Special Protection Area, Special Area of Conservation or Ramsar Site. Other statutory sites for nature conservation in the catchment include Sites of Special Scientific Interest and National Nature Reserves.

Ecosystem services that have not been valued but are important for the catchment include pollination and seed dispersal; control of pests and diseases; regulation of soil quality and erosion; biodiversity; and cultural services through the contribution of ecosystems to aesthetics, the historic environment, and a sense of place. Other ecosystem services that have not been valued include volunteering and education. These ecosystem services have not been included due to a lack of data or because they are too complex to accurately determine with the information available. Since there is no marine habitat within the catchment, the provision of food from fish and shellfish landings has not been included as it is not appropriate to attribute these benefits to the study area. It should also be noted that the estimated value for agricultural activities does not include the negative impacts it can have on the other ecosystem service (for example water quality, carbon sequestration, hazard regulation and biodiversity) through pollution, biodiversity loss, erosion and peat degradation. Figure 1 provides an overview of the natural capital value within the catchment.

The natural capital assets in the catchment are at risk, which in turn creates risks for the delivery of ecosystem services. Broadly, the risks identified include climate change; intensive agricultural practices; urban development; poor water resource management; pollution; and invasive species. If not managed, these risks will degrade the quantity and quality of natural capital assets in the catchment and prevent the provision of ecosystem services that our societies economy and wellbeing rely on.

Conversely, there are many opportunities to enhance natural capital assets in the catchment, thereby increasing the provision of ecosystem services, and boosting local and global natural capital value. These opportunities include restoration of natural habitats including peatland, woodland and wetland; habitat creation and growth; implementing Nature-based Solutions (NbS); adopting sustainable practices in agriculture and water management; regenerative farming; and strengthening policy and governance that enables the conservation of natural capital assets and supports sustainable development. These interventions would deliver multiple benefits across a range of ecosystem service types.

The report highlights the critical role of natural capital in supporting the local community's resilience and wellbeing in the catchment, and the value of considering natural capital in strategic decision-making. Through addressing the identified risks and leveraging the opportunities, the Fens2100+ programme, and future investment projects should look to sustainably manage existing natural capital assets and look for opportunities to enhance ecosystem service delivery for future generations.

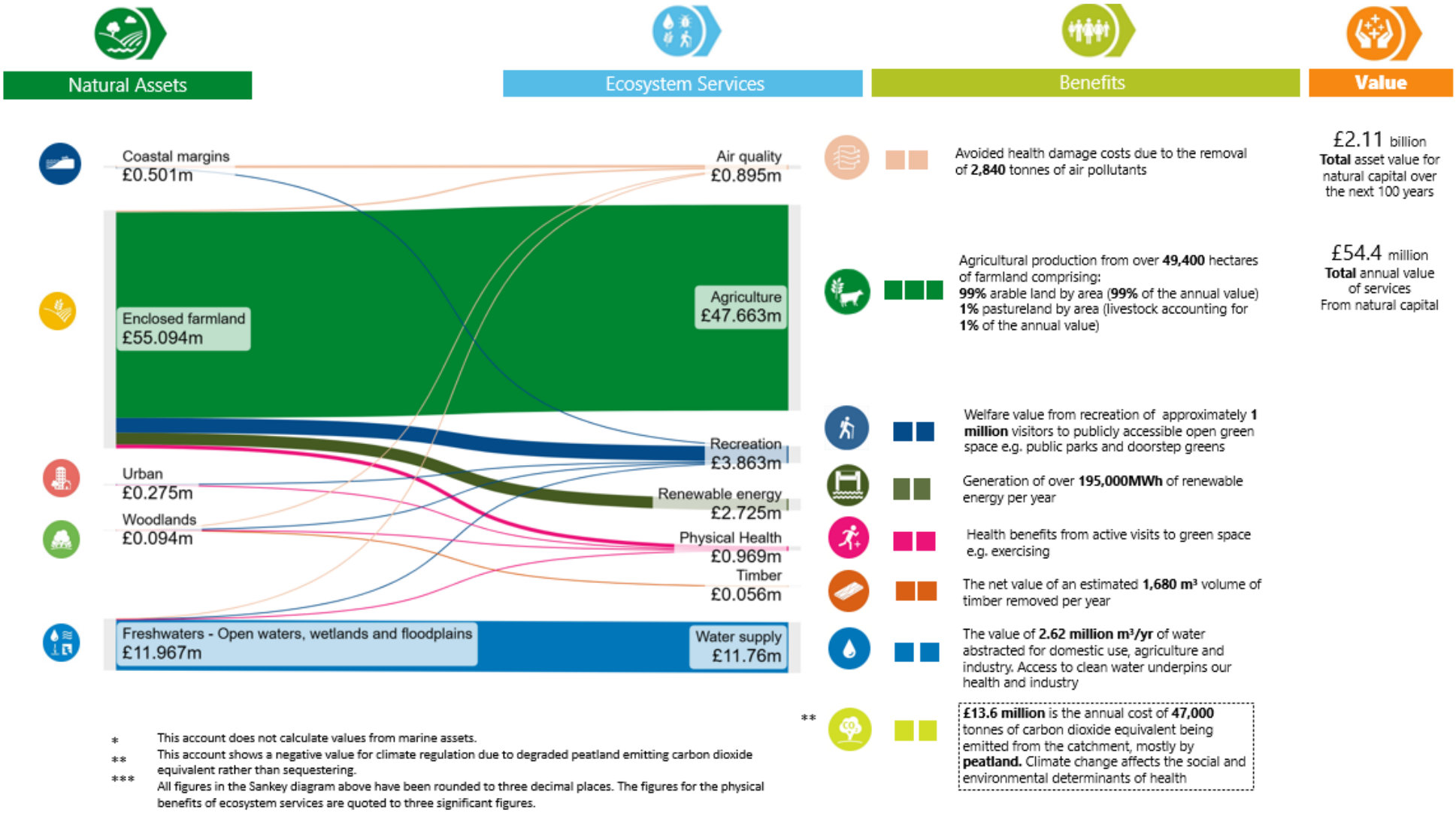

Figure 1: Summary of the NCRAT results for the catchment, showing the flow of ecosystem services and their benefits from natural assets.

1. Introduction

1.1 Aim and purpose of this document

This report presents a catchment-scale natural capital baseline for the Fens2100+ Lower Nene River catchment (hereafter referred to as the 'catchment') It provides an insight into the provision of ecosystem services by natural capital assets across the catchment, highlighting the wider benefits this has on society, such as the importance of natural capital in supporting economic activity and human wellbeing, as well as the risks and opportunities. This report aims to provide decision makers with evidence to support future choices, investments and actions for the Fens2100+ programme.

The assessment was conducted using the Environment Agency's Natural Capital Register and Account Tool (NCRAT) suite of tools[4] and includes an estimated total quantifiable natural capital value (£m) in the catchment, supported by qualitative evidence and analysis. More information on the importance of using a natural capital approach is provided in Section 2.2.

1.2 Usage statement

This report should be read alongside the Lower Nene River baseline evidence report and the Lower Nene environmental and agricultural baseline appendix. 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 catchment is centrally situated within the Fens2100+study area, bordered by the Lower Welland and Great Ouse catchments. The catchment spans across 55,255ha (553km^2), intersecting the Local Authorities of Peterborough, South Holland and Fenland. The catchment includes the reach of the Nene from approximately 8km upstream of Peterborough until its outfall into the Wash. Figure 2 shows the catchment boundary.

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

Internal Drainage Boards (IDBs) play a vital role in managing water levels and drainage across the catchment for agricultural and environmental purposes. The IDB drains discharge to the Main Rivers via various pumping stations and sluice gates. These also regulate water levels on non Main Rivers (ordinary watercourses).

An extensive network of drains are drained by three IDBs (The South Holland, North Level District and Fenland IDBs), with an extensive network of drains including the North Level Main Drain, South Holland Main Drain, New South Eau and the Little Holland Drain.Water management in the catchment is supported by a system of pumping stations, sluices and locks, most notably the Stanground Lock and Sluice, Dog-in-a-Doublet Sluice, Tydd

[4] Environment Agency NCRAT includes: Environment Agency Natural Capital Register and Account Tool version 1.2, Workbook; and Environment Agency natural capital scorecard version 1.2

Pumping Station, Sutton Bridge Sluice and Lutton Leam Sluice. The tidal limit of the river is controlled by the lock and sluice at Dog-in-a-Doublet. Downstream of this point, the River Nene is a highly engineered channel which includes tidal embankments along its 55km length. Critical flood management assets in the catchment include the Whittlesey (Nene) Washes, a flood storage area spanning 15km^2 and extending 20km along the southern side of the River Nene.

Apart from a gentle coastal ridge near the Nene's outfall at the Wash, the catchment is very low-lying. Over a third of the catchment lies below sea-level, with the lowest land located south-west of Tydd Saint Giles. The catchment thus relies heavily on its pumped drainage system to maintain its highly productive agricultural land (91.4% of land in the catchment is classified as Grade 1 or 2 according to the Agricultural Land Classification). The underlying geology of the catchment comprises Oxford Clay Formation, West Walton Formation (Mudstone and Siltstone) and Ampthill Clay Formation. Superficial Tidal Flat Deposits also occupy much of the catchment. In the Catchment, there is also the predominance of peat soils in the south-west of the catchment.

The catchment is located within National Character Area (NCA) 46 The Fens. The Fens is a distinctive, historic and human influenced wetland landscape lying to the west of The Wash, the largest estuarine system in the UK. The NCA is notable for its large-scale, flat, open topography with extensive vistas to level horizons. Land use is predominantly arable agriculture.

The catchment is home to a population of approximately 87,600[5]. Although the catchment is largely rural, it includes several key urban areas, such as Peterborough, Wisbech, Holbeach, Long Sutton, and Sutton Bridge. The railway network connects Peterborough with March and Spalding, although the Wisbech station has remained closed since 1968. However, the Wisbech Rail Project is aiming to restore the line between Wisbech and March. Major roads extend across the catchment, including the A47, A1101, A16, A151, and A17, which support both local and regional connectivity.

There are three Local Planning Authority (LPA) areas within the catchment: Peterborough, South Holland and Fenland. South Holland District Council covers the majority of the catchment, with Fenland to the south east and Peterborough to the south west.

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

Figure 2: Lower Nene River catchment outline

2. Understanding natural capital

2.1 An introduction to natural capital

Natural capital refers to the renewable and non-renewable natural resources that combine to provide valuable goods and services to people [1]. All aspects of the natural environment - including soils; geological formations; habitats; and ecosystems - are natural capital assets which provide ecosystem services, from which flow benefits to society.

There is a growing awareness of the role of natural capital in delivering quality of place, and in enhancing health and wellbeing. Some benefits of natural capital can be measured and valued, but many are difficult to define and quantify. Taking a natural capital approach facilitates comparability between environmental and economic costs and benefits and can help organisations, planners and policy makers assess needs, identify dependencies on natural assets, and translate this into relevant information for decision-making, which can in turn facilitate better design and achievement of policy, strategies, programmes and projects.

A natural capital framework

A natural capital framework, such as that shown in Figure 3, provides a coherent, comprehensive and consistent mechanism to analyse key ecosystem services and benefits provided by nature and is recognised by the HM Government's Green Book as a way to improve appraisal of a range of environmental benefits and effects [2].

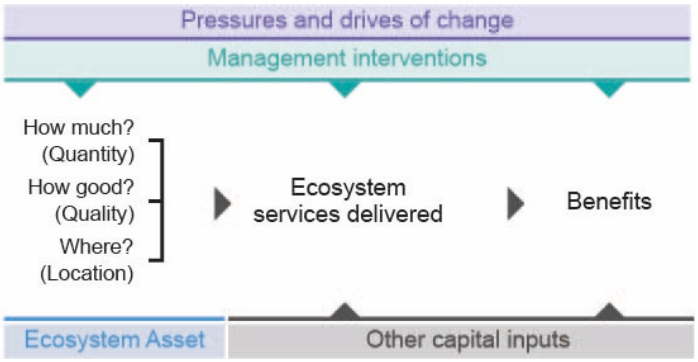

Figure 3: A Natural Capital Framework, adapted from Enabling a Natural Capital Approach Guidance [3]

Natural capital / ecosystem assets

Natural capital assets are aspects of the natural environment. This includes but is not limited to:

- Habitats that serve as natural environments for living organisms such as woodland, heathland, marine and intertidal habitat, scrub, agricultural land, hedgerows, semi-natural grassland and urban trees;
- All living organisms including animals, plants, fungi, and bacteria;
- Green infrastructure, which comprises multifunctional green spaces such as parks and green walls;
- Geological features and processes including rocks, soils and minerals; and
- The water environment, including rivers, lakes, aquifers, and oceans.

The quality, quantity, location and connectivity of these natural capital assets impacts the ecosystems services and benefits they provide. These in turn can be affected by background pressures, management practices and drivers of demand, therefore impacting their natural capital value.

Ecosystem Services

The benefit and contribution of nature to our society is a product of the various ecosystem services it provides, which can be grouped into four categories [4]:

- **Provisioning:** Material outputs from nature (e.g., seafood, water, fibre, genetic material);
- **Regulating:** Indirect benefits from nature generated through regulation of ecosystem processes (e.g., mitigation of climate change through carbon sequestration, water filtration by wetlands, erosion control and protection from storm surges by vegetation, crop pollination by insects);
- **Cultural:** Non-material benefits from nature (e.g., spiritual, aesthetic, recreational, and others); wellbeing gains from sites and areas are often derived from a combination of the heritage, biodiversity and geodiversity aspects; and
- **Supporting/bundled services** [4]**:** Fundamental ecological processes that support the delivery of other ecosystem services (e.g., nutrient cycling, primary production, soil formation). Bundled services may include: Amenity, Biodiversity, Soil Quality, Water Quality, Landscape and non-use benefits.

Benefits

Ecosystem services provide a wealth of benefits to society and the economy, for example:

- Improved physical health through the supply of clean air, water and food; as well as regulation of temperature and flood protection.
- Improved mental health through provision of green and blue space for recreation;
- Improved economy through the availability and quality of commercial activities such as arable farming, aquaculture, timber production, and pastoral farming.

Each ecosystem service will have numerous benefits to society and the economy. For example, erosion control benefits human physical health by reducing the risk of dangerous landslides; mental health by improving access to nature; and benefits the economy by improving soil health for agriculture and reducing the cost of repairing infrastructure after a landslide. Sometimes, other economic inputs are required to enable ecosystem services to provide a benefit to society. For example, the health and wellbeing benefits of recreation requires providing accessibility, including functional gateways and path maintenance.

Value

The value of the benefits provided from ecosystem services in an area can be estimated using quantitative and qualitative information about the quantity, quality and location of natural capital assets, as well as information on how local natural assets are used by society – both locally and globally, and for private and public sectors.

- Quantitative valuation is best used to provide information on the marginal value of incremental changes in impacts or dependencies, either at a point in time or over a given period and is usually monetised in units (£). It can also be used to estimate the economic value of a range of ecosystem services that affect economic performance and human wellbeing - some of which are commonly unpriced and not considered in economic metrics such as Gross Domestic Product (GDP).

- Qualitative valuation, describing the natural capital impacts, is therefore also important as it can be used to take into account the importance, worth, or usefulness of the impact and/or dependency by taking into account the context, to give equal values to any monetary figures presented.

Where products are directly or indirectly linked to ecosystem services and are traded in markets, valuation can be carried out using market prices - this is often the case for provisioning services such as timber production [3]. For other services that are not typically traded in markets, such as improved water quality or climate regulation, non-market based approaches are used. These typically involve measuring the price individuals are willing to pay to secure positive impacts or avoid negative impacts, through stated preference, revealed preference or cost-based approaches [3].

It should be noted that the representation of natural capital in monetary accounts will only ever be partial as a number of ecosystem services remain difficult to quantify and value. Some are highly location specific, for example water flow and impact on flood risk, and some are intangible or difficult to even place a monetary value on, for example cultural services, such as aesthetic experiences and sense of place.

Through valuing natural capital benefits, their importance to society and the economy can be better represented and accounted for in decision making about future place-based planning and investment.

2.2 The importance of considering natural capital within flood risk and water management infrastructure investment

The concepts of natural capital and ecosystem services are widely supported; the challenge, however, is in implementing the approach and embedding it in working practices, so that the value from the natural environment becomes an integral component of investment decision making. This is recognised in the State of Natural Capital Report for England 2024 [5], which explores the relationship between natural capital and infrastructure. Two key outcomes of the report that highlight the importance of natural capital include:

- Infrastructure, such as flood risk and water management infrastructure can deliver benefits for natural capital, such as through the provision of protected natural habitats and connecting corridors for species along linear infrastructure. In addition, the environment affects infrastructure as changes in the environment such as the climate emergency can increase the costs of infrastructure (e.g. cost of damages caused by flooding). In some cases, natural capital approaches may reduce the demand for hard engineered infrastructure, such as coastal defences, by supporting the use of green engineering or NbS.
- There are significant risks to natural capital that must be considered. The degradation of natural capital can lead to the loss of ecosystem services that are vital for human well-being and economic stability. For instance, the destruction of wetlands can increase the risk of flooding, while deforestation can exacerbate climate change by reducing carbon sequestration. Ignoring these risks can result in increased costs for disaster management and recovery, loss of biodiversity, and diminished quality of life.

The consideration and implementation of natural capital approaches in planning future flood risk and water management infrastructure investment can provide a wide range of benefits [6]:

- Reducing risk of not fully considering the value of the natural environment (whether monetised or not) in decision making.
- Enabling a holistic cost to benefit analysis and risk assessment.
- Identifying how economic and social activity is dependent on the natural environment.
- Facilitating an innovative approach to identifying policy solutions and managing risk.
- Helping to identify priorities for investment.
- Providing a basis for systematic accounting of changes to natural capital assets over time.

2.3 Key accounting methods

2.3.1 Natural capital accounting

Natural capital accounting is an approach that can be used to provide a systematic and repeatable exercise to collate information on natural capital, the ecosystem services that they provide and the associated market value (if appropriate) [3]. These accounts can be used to measure, value, monitor and communicate the stock and condition of natural assets and the flows of services that they provide. By understanding the state of natural capital this can help ensure that the value of natural assets is considered as part of the decision-making process.

There are a variety of approaches that can be used in natural capital accounting depending on the scale and purpose of the exercise, however the key considerations in each are the extent, condition, physical flow, monetary flow and asset accounts.

2.3.2 Environment Agency Natural Capital Register and Account Tool

The Environment Agency NCRAT Tool was developed to help estimate the flow of services from natural assets and understand the value and benefits that the natural environment provides.

NCRAT requires information on the habitat extent and condition to be provided alongside other local data and uses this information to calculate flows of services and associated monetary values. This information is then summarised in a benefits statement showing the flows of ecosystem services from assets and the calculated monetary values of selected services including present value over time. Figure 4 outlines the types of input data that is required, process that are undertaken and outputs that are provided by the NCRAT [7].

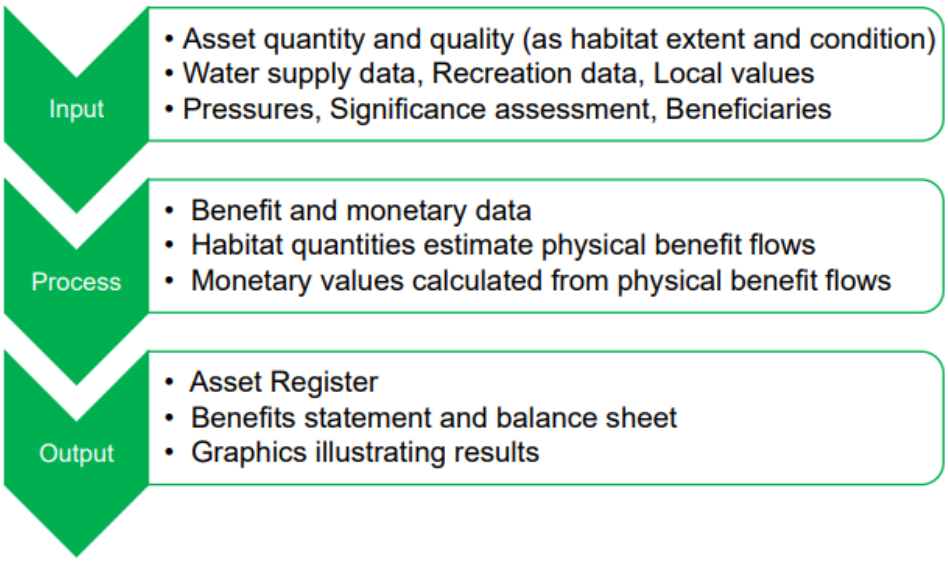

Figure 4: NCRAT Flow Chart

The NCRAT does not include valuation of supporting services (such as nutrient cycling) as this has the potential to lead to double counting as they underpin cultural, provisioning and regulating services. There are also ecosystem services that are not captured by the current version of the NCRAT due to a lack of robust data. This includes pollination, noise mitigation and soil quality and erosion. Where ecosystem services have been identified as being important, but are not captured by NCRAT, qualitative commentary has been provided to ensure that key benefits are captured.

3. Our approach to understanding the benefit and value of natural capital

3.1 Developing our evidence base

This section outlines the methodology used to assess the baseline natural capital value within the catchment.

3.1.1 Methodology

The natural capital assessment was conducted in six distinct stages, broadly aligned with the Natural Capital Protocol [8]and guidance set out within the Enabling a Natural Capital Approach guidance [3]:

1. Desk-based research on natural capital assets, ecosystem services, benefits and plans.
2. An initial materiality assessment to scope in/out relevant ecosystem services based on the wider context of the catchment, use of resources and how people interact with habitats (see section 3.1.3 for more information).
3. Baseline analysis using the Environment Agency's Natural Capital Register and Account Tool (NCRAT), qualitative analysis of additional ecosystem services not quantified within the NCRAT assessment, and spatial GIS analysis.
4. Natural Capital Scorecard and associated narrative (including ecosystem services and benefits that were not assessed in the NCRAT but were scoped in during the materiality assessment).
5. Presenting outcomes of spatial analysis, and natural capital assessment. Contextualisation of results by incorporating outcomes of stakeholder engagement and spatial analysis. Qualitative narrative on wider ecosystem services not assessed in monetary or biophysical terms to provide a holistic perspective on natural capital value generated.
6. Interpret results and identify limitations in the assessment.

3.1.2 Desk-based research: Data Sources

The data sources used for the desk-based assessment of natural capital assets and ecosystem services are listed below.

- Corine Land Cover 2018 [9]
- Provisional Agricultural Land Classification (England) [10]
- Statutory Main Rivers [11]
- OS Open Rivers [12]
- OpenStreetMap waterways [13]
- National Forest Inventory woodland [14]
- England Peat Status GHG and C Storage [15]
- Ancient Woodland Inventory [16]
- Priority Habitat Inventory [17]

- Water Framework Directive (WFD) catchment data – water body classifications and extent (rivers, surface waters and groundwaters) [18]
- WFD water body extent (rivers, surface waters, transitional and coastal waterbodies, lakes and groundwater bodies) [19] [20] [21]
- Felling Licence Applications [22]
- Surface Water Availability for Water Resource Charging [23]
- Groundwater Management Units coloured according to water resource availability [24]
- Bathing waters data [25]
- Sites of Special Scientific Interest [26]
- Special Protected Areas [27]
- Special Area of Conservation [28]
- Ramsar Sites [29]
- National Nature Reserves [30]
- Local Nature Reserves [31]
- Natural England Green Infrastructure Map [32]
- Outdoor Recreation Valuation (ORVal) Tool [33]
- NCRAT Data Support Package[6]

3.1.3 Materiality assessment

The NCRAT requires a range of local information to be entered into the tool to support the assessment. There are instances where the level of effort required to gather the data for a specific input is disproportionate to the scale of the study and relevance of the data to the scheme. In these instances, the information is excluded from the tool. There are also ecosystem services that are not quantified or given a monetary value by the NCRAT but that may be of importance in the catchment (e.g. pollination or soil erosion/ retention) and therefore require additional analysis to capture the potential benefits and provide a more well-rounded account.

An initial materiality assessment was undertaken to determine which ecosystem services are of direct relevance to the catchment and should be considered as part of the baseline natural capital account (e.g. the ecosystem services that are provided currently). The list of ecosystem services outlined in the Natural England Accounting for National Nature Reserves report [34] was used as the basis to scope services in/out of the assessment.

The results of the materiality assessment, including an overview of the ecosystem services that have been scoped in/out is provided in section 4.1.1.

3.1.4 NCRAT

The Environment Agency's NCRAT has been used to develop a baseline of the condition and extent of natural capital assets and help understand and quantify the value and benefits that they provide to society. The NCRAT has been selected as it provides a consistent methodology to develop natural capital registers and accounts for each of the catchments within the Fens2100+ project. The NCRAT is also best suited for use at the strategic scale (above 10,000 ha) and therefore is most suitable for the size of catchments that are considered as part of Fens2100+. An overview of the NCRAT is provided in 2.3.2 and further guidance on the tool can be found in The Natural Capital Register and Account Tool, Version 1.2 – Technical Report [7].

[6] This package was provided by the Environment Agency and is not publicly available.

3.1.5 Confidence Ratings

The NCRAT considers thirteen key ecosystem services as shown below in Figure 5.

Figure 5: Ecosystem services quantified and valued in the NCRAT. Environment Agency © [6]

A natural capital register and account will only ever reveal a partial value of nature, however the benefits statement provides an overview of the flows of ecosystem services from assets and the calculated monetary values of selected services including present value over time. Monetary values have been provided for annual flows and for asset value over a 100-year period (minimum and maximum values also provided where data is available).

Confidence ratings have then been assigned to the monetary values presented for each of the ecosystem services to highlight where the data used to calculate a monetary value is considered to be of greater quality or more appropriate. These confidence intervals are assigned based on a Red-Amber-Green (RAG) rating in line with the NCRAT methodology and are illustrated in Table 1 [7].

As highlighted in Section 3.1.1, the number of ecosystem services and benefits provided by a place vary, and not all of them can be quantified. This means that not all services are currently represented within NCRAT.

Table 1: Confidence rating definitions

Confidence rating	Definition
Green	High confidence in results. Input data and assumptions are based on statistical reports, peer reviewed values or industry standard methodologies
Amber	Moderate confidence in results. Input data and/or assumptions from single source/not peer reviewed or based on sources that are not specifically tailored to this context. Some assumptions or estimations may be open to question. Accuracy is expected to better than plus or minus 50%.
Red	Low confidence in results. Input data and/or parameters from a single source and low level of transferability from original context. It is expected that estimate is in the right order of magnitude. Order of magnitude implies that, for example, for an estimate of 5 the 'real' figure is within the range 0.5 to 50.

Confidence rating	Definition
White	It is not possible to provide a result that can be judged to be in the right order of magnitude. This is due to unquantifiable uncertainty in the science, valuation or the relationship between them. Currently limited to qualitative assessment only.
Grey	These ecosystem services are not valued by the NCRAT, either due to a lack of data or because they are too complex for the scope of this assessment.

3.1.6 Stakeholder Engagement

Stakeholder engagement is valuable to help determining the input data and interpreting the results from the register and account. Other organisations and local stakeholder groups such as The Wildlife Trusts may be able to provide (or have access to) locally specific data, as well as providing different perspectives to qualitative assessments such as risks, pressures, and the significance of benefits in a place.

The qualitative aspects of the assessment, such as the significance assessment, have been based on professional judgement and understanding of the catchment. It is recommended that this be refined through engagement with stakeholders as part of any future update and project progression.

3.1.7 Limitations and assumptions

The following assumptions should be noted, in addition to those provided in the NCRAT [6].

- All values within the analysis were expressed in 2025 prices and British Pound (GBP).
- The 'Risk Register,' 'Significance Assessment,' and 'Beneficiaries Assessment' tabs in the NCRAT spreadsheet tool have been completed without detailed stakeholder engagement having been undertaken. It is recommended that this be refined through engagement with stakeholders as part of any future update and project progression. However, the inputs for these assessments do not impact the overall natural capital value calculated for the study area.
- Statutory main river widths are assumed to be 23m and ordinary watercourses, which are mapped using both the OS Open Rivers and OpenStreetMap datasets, are assumed to be 14m and 5m wide respectively. This has been estimated using aerial imagery of the catchment.
- Woodland areas under management are assumed to be areas with a felling licence expiry dated after 31st March 2015, this is based on the Forest Commission's definition of 'Woodland area under management' having had a felling licence in the past ten years, being owned by government organisations, or having a management plan [35].
- Peatland condition classifications are assigned based on the estimated rate of GHG flux (named 'newghgr' in the 'England Peat Status GHG and C storage dataset') and the closest emission factor provided in the Peatland Code Field Protocol [36].
- To calculate input values for water supply and renewable energy, local authority data was used and adjusted in proportion to size of the catchment. This assumes that the distribution of renewable energy and water supply is even across the local authority.

- To estimate the number of recreational visits in the catchment and the associated value of this, ORVal data was used for each of the Middle layer Super Output Areas (MSOAs) in the catchment. Where an MSOA is only partially within the catchment, the number of visits and associated value was scaled down relative to the area within the catchment – this assumes that the distribution of recreational visits for each welfare group is even across the MSOA.
- Surface water operational catchments with less than 1% of their total area intersecting with the catchment area have been excluded from NCRAT calculations.

The following limitations should also be considered:

- Data resolution is generally low; with the majority of habitat data being derived from remote sensing datasets such as CORINE Land Cover or the Centre for Ecology and Hydrology Land Cover Maps being the main data sources for the assessment. Datasets such as the National Forest Inventory, EA Statutory Main Rivers and OS Open Rivers were used to supplement habitat type data and reduce this limitation.
- The provision of biodiversity benefits is currently not quantifiable within the tool (for example when comparing arable land to more biodiverse semi-natural habitats).
- Since there is no marine habitat in the catchment, the provision of food from fish and shellfish landings has not been included. This is because there is no port recording any fish or shellfish landings, and it is not possible to attribute these benefits to the study area.
- The net carbon sequestration rate for arable land is based on Christie et al. 2011 at 0.107tCO_2e/ha/yr, resulting in a sequestration of carbon [37]. More recent data collated in the Natural England report 'Carbon Storage and Sequestration by Habitat 2021 (NERR094)' uses figures from a study by Muhammed et al. 2018 which showed a net emission rate of 0.290tCO_2e/ha/yr for arable land and a net sequestration rate of 0.360tCO_2e/ha/yr for improved grasslands [38]. There is variation in carbon fluxes on arable land based on a variety of factors, including production and application of fertilisers, vegetation type, catchment topography, weather, and land use. However, it is likely that the 0.107tCO_2e/ha/yr figure does not provide an accurate picture of carbon fluxes within the catchment.
- The area of freshwater habitats is likely to be underrepresented in this study due to the large number of drainage channels in the catchment that are not captured in the EA Main River, OS Open Rivers or OpenStreetMap datasets.
- The 'England Peat Status GHG and C storage dataset' is expected to be an overestimate of peatland extent in the Fens2100+ study area, based on a comparison with more recent data published by Natural England [39]. This indicates the amount of carbon dioxide emitted as a result of actively eroding or degraded peatland has also been overestimated, so the monetary value of climate regulation in the catchment is expected to be greater than calculated for this baseline.
- It is likely that these limitations lead to an underestimate of the benefits provided by semi-natural habitats, and furthermore underestimate the negative impacts of arable land while overemphasising the wider benefits of arable land, beyond food production.
- The NCRAT uses values from the Outdoor Recreation Valuation (ORVal) Tool [33] to estimate welfare values. Welfare values for an existing site are estimated by calculating how much each individual's welfare would fall if they were no longer able to access that

site and then converting that welfare quantity into an equivalent monetary amount. These values may represent an undervaluation as it is based on a travel cost method.

- The NCRAT uses national data to calculate the natural capital value for agriculture. This is based on the average of the John Nix Farm management units Editions 49-52, years 2019-2022 [40]. The natural capital value is updated for the 2024 accounting price year which takes account of inflation to the price base. Local deviations from the national average may lead to the value of local agriculture being misrepresented. In the catchment, there is a higher proportion of arable agriculture and fruit / vegetable crops than the national average, meaning that the NCRAT is likely to underestimate the value of food production.

- The NCRAT values water quality based on all the WFD surface water bodies in the operational catchments that the catchment intersects, including Nene Lower, Welland Lower and Nene Middle. There are 36 surface water bodies across these operational catchments, however only seven of these are within the catchment boundary. All of these waterbodies score ‘moderate’ for ecological status for the River Basin Management Plan Cycle 2 and Cycle 3, except for Morton’s Leam which has a ‘poor’ ecological status.
- This baseline assessment has not been informed or verified by any field surveys or site visits conducted by Arup.
- This baseline assessment is currently limited to the catchment boundary that has been defined for the Fens2100+ project by the Environment Agency. There is no official data boundary that matches the catchment study area.
- The baseline information 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.

4. The natural capital register and account for the catchment

4.1 Materiality Assessment

A summary of ecosystem services to be scoped in/out of the assessment is provided in Table 2 and the full materiality assessment is provided in Appendix A. The initial materiality assessment highlighted that the majority of ecosystem services are of significance and should therefore be scoped into the assessment. Of those services that have been scoped out, this is predominantly due to lack of ports and fish/ shellfish landings within the catchment, predominance of cultivated farmland and lack of woodland. Of those that have been scoped into the assessment, six are not quantified by NCRAT and require additional qualitative analysis. These are indicated using '*' in Table 2.

Please note:

- Ecosystem services related to wild plants, algae & their outputs, wild animals & their outputs, and aquaculture have been scoped out due to lack of reliable data on gathering rates and/or lack of suitable habitat for these benefits to materialise (e.g. availability of coastal waters for fishing and/or aquaculture, presence of ports that record fish landings, availability of land used for commercial hunting, datasets on foraging rates).
- Noise regulation benefits were scoped out of the assessment, as most approaches to quantifying benefits are based on complex modelling that requires significant collection of location-specific data.

Table 2: Materiality Assessment summary

Scoped in	Scoped out
• Materials from plants, animals & algae • Cultivated crops • Water supply • Reared animals & their outputs • Water quality • Air quality • Mass stabilisation and control of erosion rates* • Flood protection • Global, regional & local climate regulation • Pollination & seed dispersal* • Maintenance of nursery populations and habitats* • Pest & disease control* • Global, regional & local climate regulation • Experiential and physical use • Scientific and educational use • Aesthetic* • Spiritual*	• Wild animals & their outputs • Wild plants, algae and their outputs • Aquaculture • Noise regulation

4.2 Natural Assets

4.2.1 Land cover types in the catchment

This section focuses on providing an overview of the quantity, quality and location of natural capital assets within the catchment, which contains approximately 55,255ha of terrestrial and coastal habitats. Figure 6 shows land cover in the catchment according to Corine Land Cover 2018.

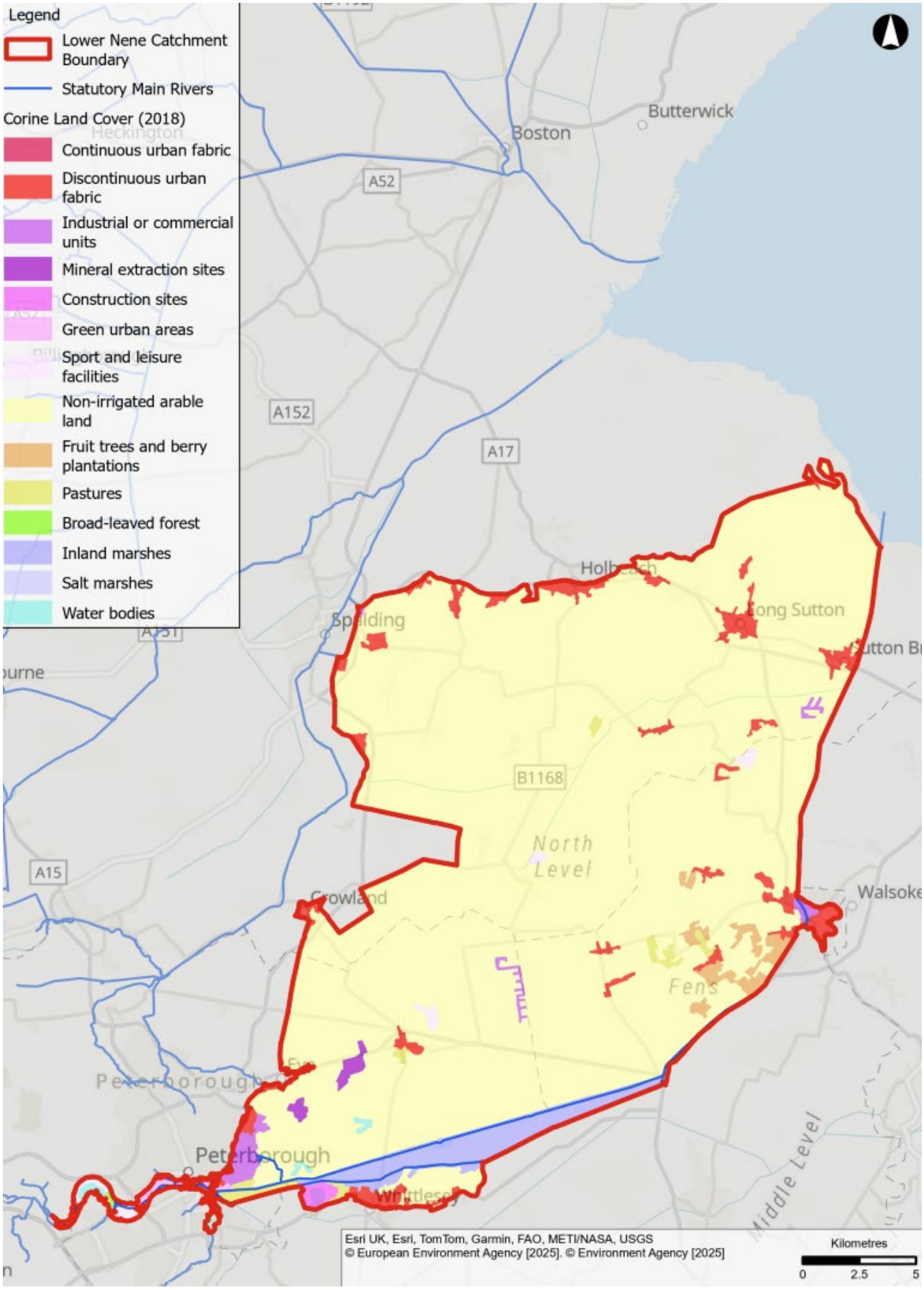

Figure 6: Overview of Corine Land Cover for the catchment.

For the purpose of this report, the natural capital assets in the catchment have been grouped according to UK National Ecosystem Assessment (UKNEA) broad habitat types. The quantity of each habitat type in the catchment is shown in Figure 7. The Office for National Statistics UK Natural Capital Accounts methodology guide provides further detail on habitat types and the methods used to estimate habitat extent, ecosystem services and asset value in the UK.

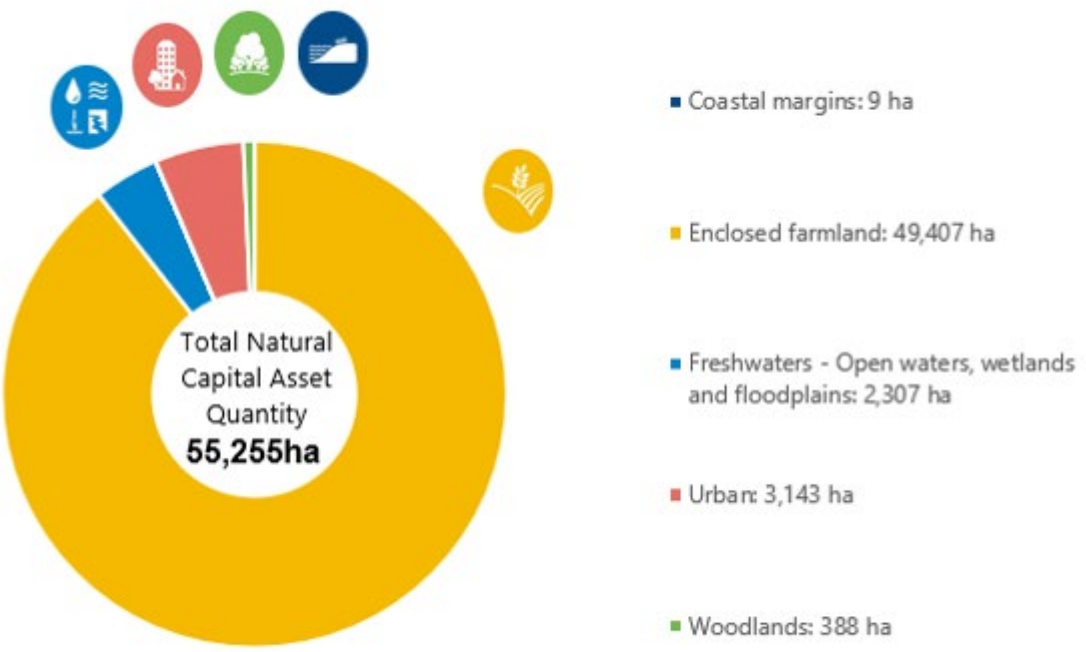

Figure 7: Natural capital asset quantity within the catchment. Based on the UK Natural Capital Ecosystem Assessment broad habitat types / land cover data [41].

4.2.1.1 Coastal margins

The catchment has approximately 5km of coastline along the North Sea and 9ha of coastal saltmarsh. The catchment intersects with the western coastline of The Wash, an intertidal embayment designated as a Ramsar site, Special Protection Area, Special Area of Conservation, and Site of Special Scientific Interest. The site is of significant importance due to habitats such as sublittoral sandbanks, sandflats, mudflats, shallow inlets and reefs which attract a range of wildlife including wintering waterbirds; passage birds; waders; breeding birds; harbour seal; and shellfish [42] [43] [44].

These coastal margins in the catchment include priority habitat such as coastal saltmarsh, coastal floodplain and grazing marsh, saline lagoons and mudflats [45]. Coastal habitats protect against erosion and flooding by dissipating waves, trapping sediment, and creating buffer zones that store water during storms. Additionally, they provide various other ecosystem services, including water quality improvement, carbon sequestration, biodiversity, recreation and tourism, cultural and historic value, and serve as nurseries for many commercial fish species.

4.2.1.2 Enclosed farmland

Enclosed farmland or agricultural land is essential for food production and provides local employment. Additionally, it can support a variety of wintering and breeding birds, as well

as provide habitat connectivity through hedgerow and ditch networks for a variety of other species.

The most abundant land cover type in the catchment is enclosed farmland according to 2018 Corine Land Cover, covering an area of 49,410ha - 89% of the catchment. Around 50,500ha (91.4%) of the total catchment area is classified as Grade 1 and 2 land using the Agricultural Land Classification[7], with the majority of the Grade 1 land located in the north and east of the catchment (see Figure 8) [36].

According to 2018 Corine Land Cover, 99% (48,970 ha) of farmland is used for arable agriculture or horticulture (includes cereal crops, fruit and vegetables and other arable crops), including the limited production of some higher value crops in rotation such as potatoes and sugar beet. In 2022, this was estimated to be approximately 86% based on estimated land use, crop areas and livestock populations on commercial agricultural holdings undertaken by Collinson & Associates.

Approximately 1% (436ha) of farmland is modified grassland according to 2018 Corine Land Cover, used for the keeping of livestock, with a number of farms producing beef cattle and/or sheep. In 2022, this was estimated to be approximately 7% based on estimated land use, crop areas and livestock populations on commercial agricultural holdings undertaken by Collinson & Associates.

It should be noted that since 2019 there has been significant change and market disruptions in agriculture and the food supply, notably the Agricultural Transition following UK exit from the EU. The Agricultural Transition includes the phase out of subsidies such as the Basic Payment Scheme, and the introduction of the Environmental Land Management Scheme and associated pilots which is influencing the type and extent of cropping across the catchment and beyond. Additionally, cropping regimes and agricultural output per hectare on an annual basis are also extremely variable from crop to crop and farm to farm, with impacts such as climate change and extreme weather also influencing agriculture in the catchment.

[7] Grade 1 agricultural land is excellent quality agricultural land with no or very minor limitations for growing agricultural and horticultural crops.
Grade 2 agricultural land is very good quality land with minor limitations that affect crop yield, cultivations or harvesting.
Grade 3 agricultural land is good quality land capable of consistently producing moderate to high yields of a narrow range of arable crops, especially cereals, or moderate yields of other crops including oilseed rape, potatoes and sugar beet.

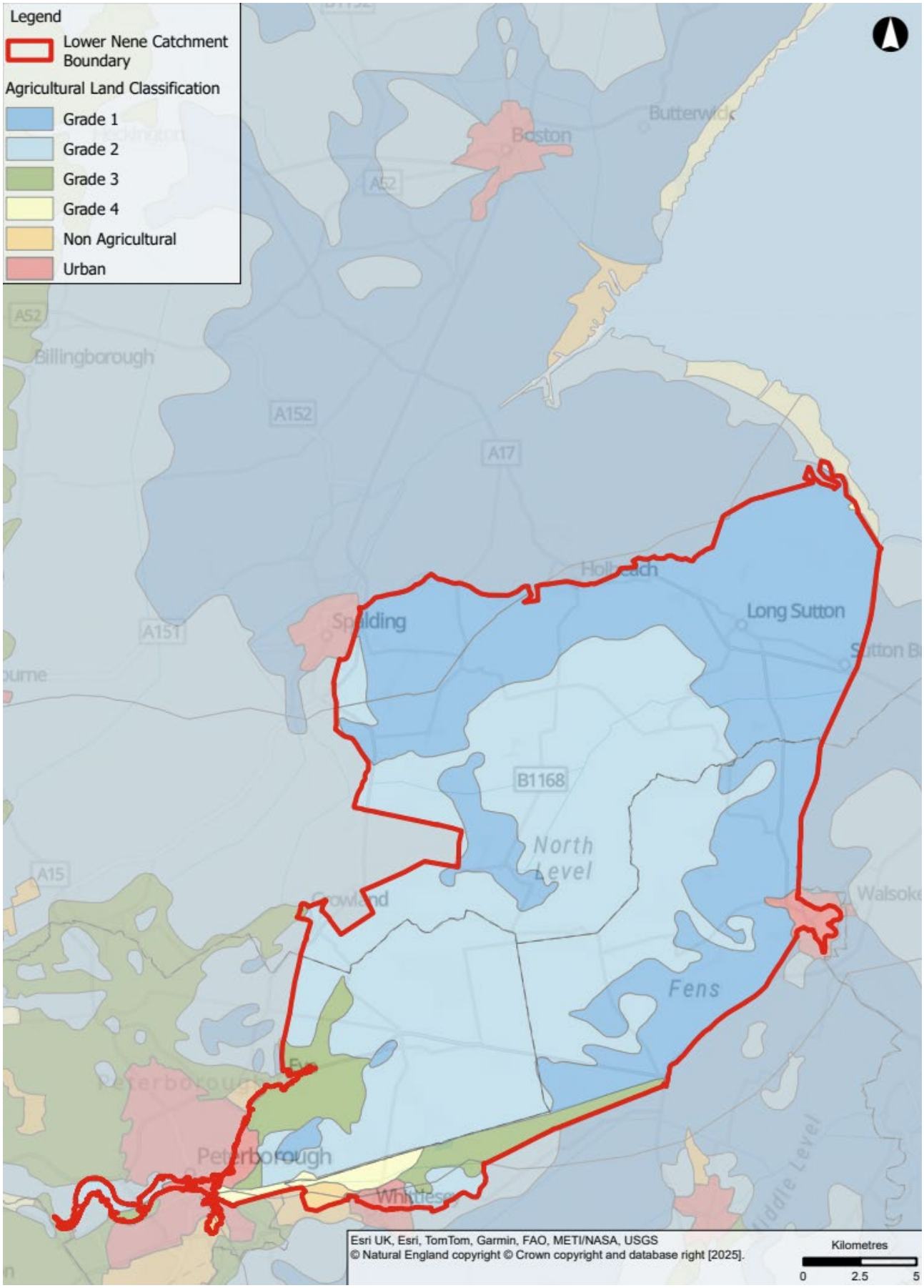

Figure 8: Overview of Agricultural Land Classification in the catchment

4.2.1.3 Urban areas

Urban land is generally characterised by significant alteration from semi-natural habitats caused by humans. Nonetheless, urban land can contain a variety of natural and/or semi-natural natural capital assets in the form of blue or green urban infrastructure. Most commonly, these consist of parks, urban trees, gardens, and allotments. Certain types of green infrastructure such as parks are generally open to the general public and can be crucial in providing a variety of cultural ecosystem services, such as benefits for health and wellbeing, providing aesthetic value and cultural heritage.

The key urban centres in the catchment consisting of built-up areas and gardens is the eastern side of Peterborough town and the villages of Wisbech, Holbeach, Long Sutton, and Sutton Bridge.

There are a number of designated heritage assets located within the vicinity of urban areas, and 17 conservation areas within the catchment. For the historic environment, natural capital benefits can be attributed to 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. Key benefits associated with historic environment assets include amenity, landscape and non-use values, with beneficiaries likely to include local communities and wider society that visit.

Additionally, a large number of non-designated heritage assets are present throughout the catchment including as yet undiscovered archaeological remains, which are likely to be particularly well preserved within peat soils.

4.2.1.4 Woodlands

Woodlands are essential for carbon sequestration, biodiversity, recreation, and economic value, significantly contributing to the country's natural capital. They also provide other vital ecosystem services such as soil formation, water regulation, and air purification. These services not only support environmental health but also enhance human well-being by improving air quality and reducing the impacts of climate change. Additionally, woodlands offer recreational opportunities that promote physical and mental health, and they support various economic activities, including timber production and tourism.

The catchment consists of approximately 390ha of woodland, predominantly made up of mixed deciduous woodland (340ha). There is some coniferous woodland (17ha), young trees (18ha) and felled areas (6ha). The catchment includes commercial woodland that is actively managed (57ha) with a felling licence valid within the last 10 years [14]. No ancient woodland is present according to Natural England's Ancient Woodland Inventory [16].

4.2.1.5 Freshwaters and groundwaters

Freshwater habitats are crucial for supplying drinking water; managing flood risk; supporting a wide variety of activities that benefit health, wellbeing, and economic activity; and can be a significant carbon sink. The east of England is also particularly reliant on water for the irrigation of crops, particularly in the months between June and August; agriculture in this region accounts for approximately 10% of the total water demand [46] .

Freshwater habitats, including rivers and streams, comprise approximately 2,310ha within the catchment, this is likely to be under-representative due to the large number of drainage channels managed by land owners and IDBs that are not captured in the EA Main River, OS Open Rivers datasets or OpenStreetMap datasets.

The catchment is characterised by significant watercourses, most notably the River Nene and the Back River. The River Nene begins in Daventry and enters the catchment 8km upstream of Peterborough. It flows north-east through the catchment, eventually discharging into the North Sea via the Wash. The tidal limit of the river is controlled by the lock and sluice at Dog-in-a-Doublet. Downstream of this point, the Nene is a highly engineered channel that drains approximately 700ha of surrounding land and has a total length of 161km. The catchment also contains an extensive network of drains. These include the North Level Main Drain, South Holland Main Drain, New South Eau and the Little Holland Drain.

A critical flood management feature within the catchment is the Whittlesey (Nene) Washes, a flood storage area spanning 1,450ha and extending 20km along the southern side of the River Nene. The Dog-in-a-Doublet Sluice, located to the north of the Washes, enables the controlled release of water into the tidal River Nene, and controls the level of the river upstream. During periods of high flow, the Washes act as a vital flood storage area; during periods of low flow, the washes serve as a resource for irrigation.

The majority of the catchment falls within the Nene Lower operational catchment, which in turn forms part of the Nene management catchment and Anglian River Basin District (RBD).

Some areas along the northern extent of the catchment fall into the southern edge of the neighbouring Whaplode River water body catchment area, which is located within the Lower Wellend operational catchment. The south-western tip of the catchment, that follows the River Nene falls within Nene Middle operational catchment. The southern boundary of the study area partially ingresses into the ‘Middle Level’ water body catchment, which is part of the Middle Level operational catchment (and Great Ouse study area catchment). Section 4.4 of the Fens2100+ Lower Nene: Environment and Agriculture Appendix provides an overview of the Cycle 3 (2022) status classifications for surface water bodies within the catchment. The location and extent of these surface water bodies and catchments are shown in Figure 9.

The catchment is underlain by 4,780ha of groundwater bodies, namely Northampton Sands and the Nene Mid Lower Jurassic Unit. As stated in the Nene Catchment Abstraction Licensing Strategy (ALS), there are no significant groundwater resources in the catchment [47].

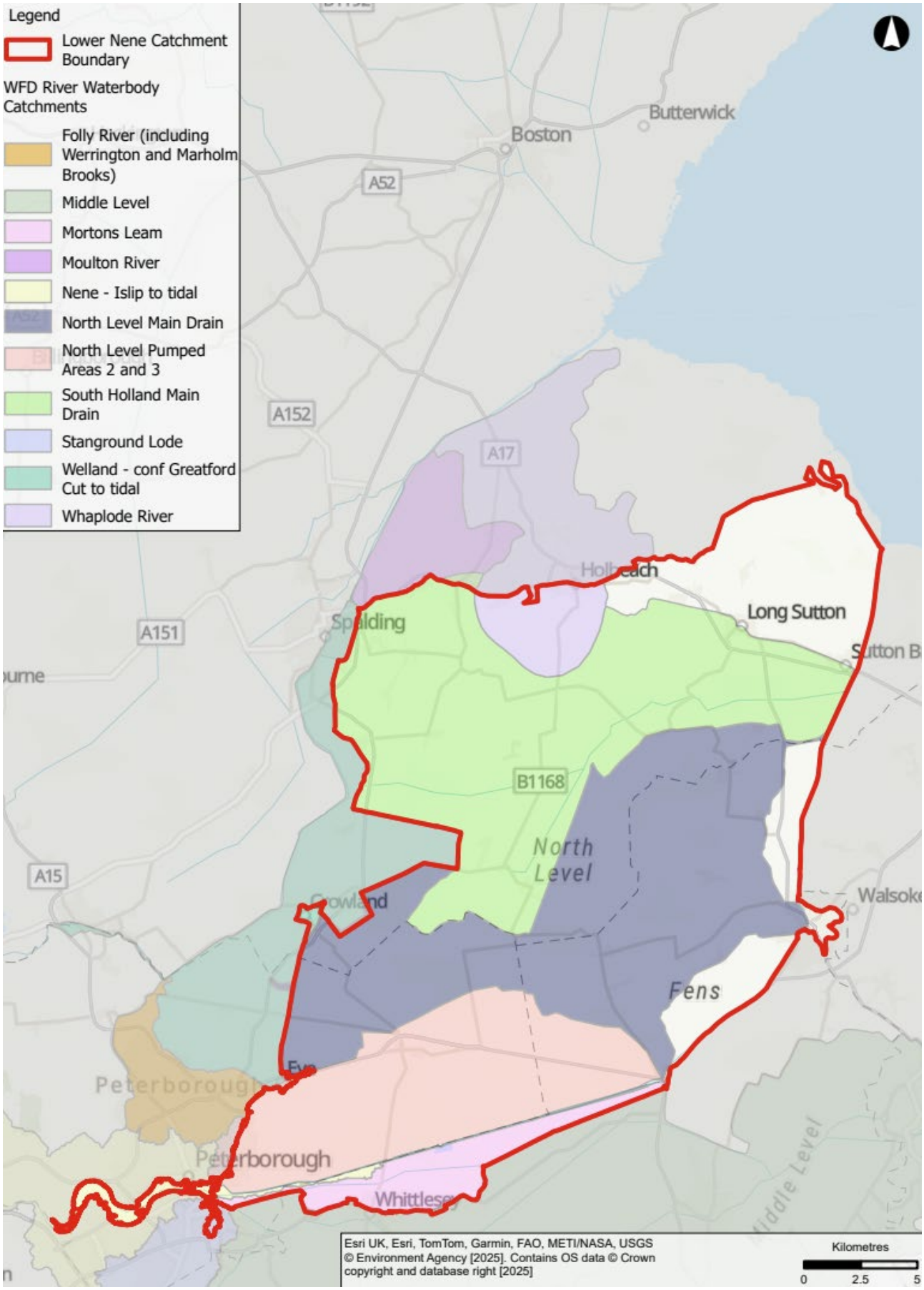

Figure 9: WER/WFD surface waterbodies in the catchment

4.2.2 Peatland in the catchment

Peatlands are wetland areas with a natural layer of peat soils, formed from carbon rich dead and decaying plants under waterlogged conditions, they provide a variety of crucial services to society [48]. Firstly, peatlands represent an important carbon sink globally and have the potential to regulate atmospheric carbon when in a healthy waterlogged condition. However, once peats are in a degraded condition they become carbon sources – this is the case for the majority of peatlands in the UK [49]. Peatlands also provide habitat for a diverse range of species, from *Sphagnum* mosses to butterworts *Pinguicula* to common crane *Grus grus* [48]. Healthy peatlands provide flood management by retaining water and slowing the flow, and provide important sources of high-quality water that can be easily treated for drinking water [48].

According to Natural England's dataset 'England Peat Status GHG and C storage', the catchment contains approximately 16,410ha of peatland. In contrast to Natural England's peatland data, Corine Land Cover data classifies areas with indicative peat presence as 'non-irrigated arable land' and 'mineral extraction sites' which is indicative of peat degradation. This is in exception to the Nene Washes area, which is classified as 'Inland marshes' according to Corine Land Cover.

Furthermore, there is uncertainty and inconsistencies in the data available on extent and condition across the wider Fens. Holman and Kechavarzi, estimate that less than 32,000ha of peatland (thick peat, peat at depth, or thin peat), was still extant in the Fens as a whole, compared to c.150,000 hectares identified as such by the peaty soils locations layer [50].

The Fens for the Future report [51] explains how peatland in the Fens has been degraded through drainage for arable cultivation. Once degraded, peatland emits CO_2 and methane; the report 'UK natural capital: peatlands' by the Office for National Statistics estimates that 7,600 kilotons of carbon dioxide equivalents per year ($ktCO_2e/yr$) are emitted as a result of arable practices on peatland [52].

The baseline condition of this peatland is categorised as 'actively eroding' (approximately 918ha) or 'drained' (approximately 7,290ha) using the peatland's emission factor ($tCO_2e/ha/yr$), in accordance with the Peatland Code Field Protocol [36]. For peatland, in an 'actively eroding' condition, the assumed emission factor is $23.8tCO_2e/ha/yr$; for peatland in 'drained' condition, the assumed emission factor is $4.54tCO_2e/ha/yr$.

Natural England recently released the 2025 England Peat Map [39]. This provides a more accurate and detailed picture of the current state of peatland when compared to the 'England Peat Status GHG and C storage' dataset [15] that has been used for this Natural Capital Baseline. The new peat map has been developed using machine learning, satellite imagery, LiDAR, and updated field surveys to detect peat soils that were previously unmapped or misclassified. The new 2025 peat map shows both gains in mapped extent (due to better detection) and losses or degradation (due to environmental change).

The 2025 England Peat Map suggests that the peatland extents used in this baseline (based on the 2008 England Peat Status dataset) are an overestimation. The new peat map shows approximately 78,000ha of deep peaty soils across all catchments in the Fens2100+ study area, whereas the 2008 dataset shows approximately 155,000ha. There is approximately 70,000ha of intersecting peatland extents between the two datasets, highlighting that the new peat map has identified roughly 8,000ha of previously unmapped peatland across the Fens2100 study area. For climate regulation, this indicates the

amount of carbon dioxide emitted as a result of actively eroding peatland has also been overestimated, so the value of climate regulation is expected to be greater than calculated for this baseline.

As the Natural Capital baseline assessment uses the 2008 ‘England Peat Status GHG and C storage’ dataset, percentage coverages of peat are not directly comparable with the catchment summary report (which uses the 2025 England Peat Map).

4.2.3 Protected areas for biodiversity

There are 16 statutory internationally or nationally designated nature conservation sites within or partially within the catchment, some of which overlap with other designations. These comprise:

- **Nene Washes**– Special Protection Area (SPA), Ramsar site, Special Area of Conservation (SAC) and Site of Special Scientific Interest (SSSI);
- **The Wash** – SPA, Ramsar site and SSSI;
- **The Wash & North Norfolk Coast** – SAC;
- **Adventurers' Land** – SSSI;
- **Bassenhally Pit** – SSSI;
- **Eye Gravel Pit** – SSSI;
- **Eye Green** – Local Nature Reserve (LNR);
- **Woodston Ponds** – LNR;
- **The Boardwalks** – LNR; and
- **The Shrubberies** – LNR.

The location of each designated site is shown in Figure 10, and a summary of each site provided in sections 4.2.3.1 – 4.2.3.10.

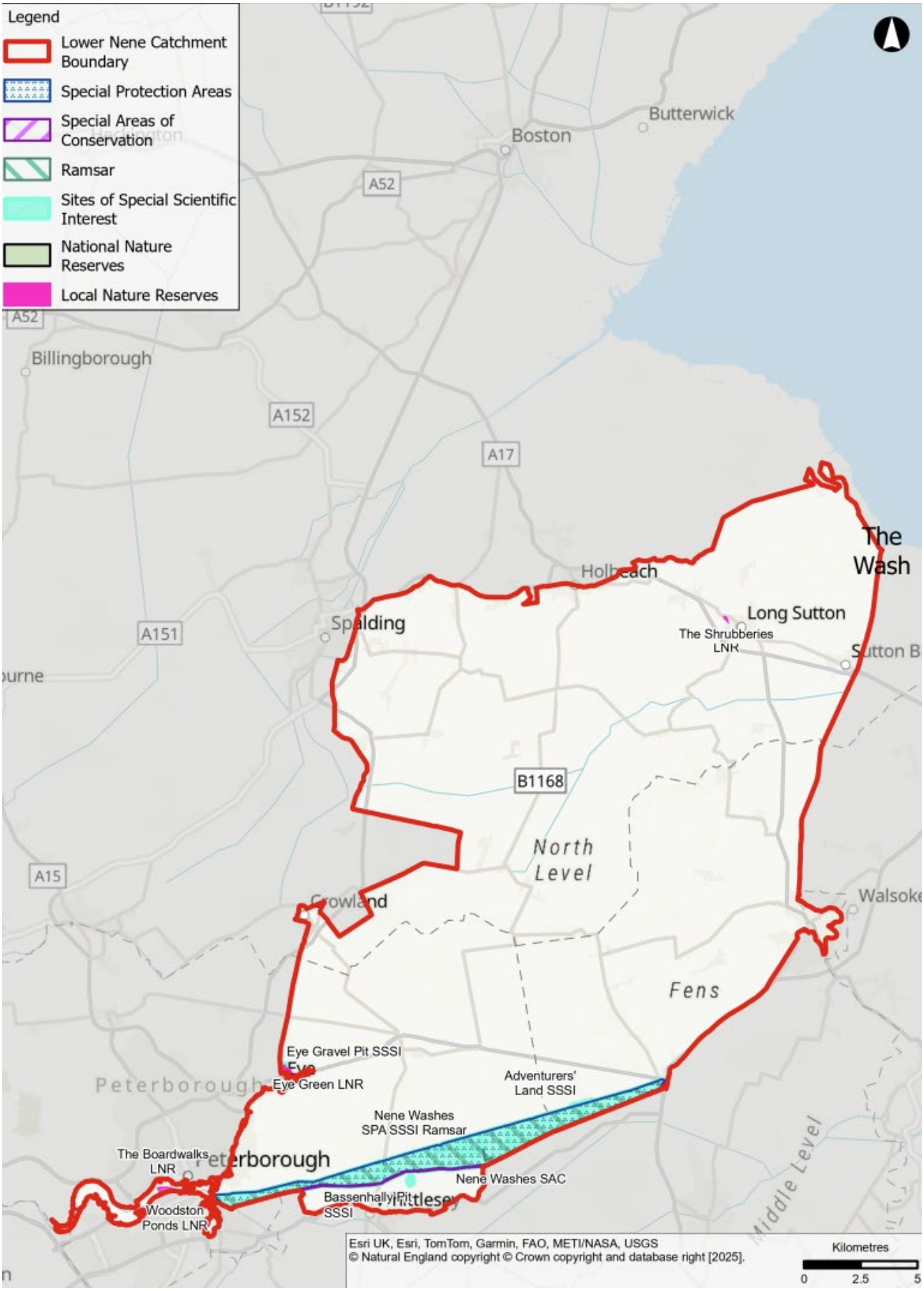

Figure 10: Overview of Designated sites for nature conservation within the catchment

4.2.3.1 Nene Washes (SPA, Ramsar, SAC and SSSI)

The Nene Washes covers approximately 1,515ha of the catchment, including seasonally flooded wet grassland and grazing marsh. This area is vital for its diverse habitats, which include a significant network of drainage ditches supporting rare plants like fringed water-lily and marsh dock. The site hosts internationally important wintering populations of Bewick's swan and supports breeding species such as gadwall, garganey, and black-tailed godwit. It is also home to spined loach in Moreton's Leam, the highest density recorded in the UK. The Nene Washes protect an array of breeding and wintering birds, including redshank, snipe, and Eurasian teal [53].

4.2.3.2 The Wash (SPA, Ramsar and SSSI)

Whilst the Wash covers just under half a hectare (around 0.2ha) of the catchment, the designated site is a key part of the catchment's landscape and it's ecological benefits extend beyond its boundaries into the catchment.

The Wash SPA forms part of the larger Wash and North Norfolk Coast SAC which, as described below, 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 a large number of non-breeding bird species such as: bar-tailed godwit; Bewick's swan; black-tailed godwit; common scoter; curlew; and dark-bellied brent goose [42] [43].

The Wash Ramsar site is Britain's largest estuarine system, fed by four rivers and has extensive saltmarshes, intertidal banks, and deep channels. This aspect of the site is crucial for wildfowl and wading birds, supports a shellfish fishery, and hosts large populations of common and grey seal [44] [54].

4.2.3.3 The Wash & North Norfolk Coast (SAC)

As mentioned above, The Wash & North Norfolk Coast (SAC) covers just a small fraction of the catchment (0.2ha) however it is a key feature of the Fens and provides important ecological context to the catchment.

The site features extensive subtidal sandbanks, mudflats, and large shallow inlets and bays; and supports significant biogenic reefs formed by ross worm. The site is also home to diverse benthic communities, including brittle stars and commercially important fish species. The area includes the largest single expanse of Salicornia vegetation in the UK and extensive Atlantic salt meadows, providing vital habitats for a variety of flora and fauna.

A crucial conservation focus of the site is its role in supporting common seals and otters, both of which benefit from the site's high ecological value. The unique Mediterranean and thermo-Atlantic halophilous scrubs further enhance the site's biodiversity.

4.2.3.4 Adventurers' Land (SSSI)

Adventurers' Land covers 10ha of the catchment. The site spans approximately 10ha and holds geological significance, particularly for studying Flandrian sea-level fluctuations. The site encompasses a variety of habitats, including peats and silty clays, which provide essential data through radiocarbon and micropaleontological analyses. These habitats date back from approximately 6400 BP to 1850 BP, making it invaluable for understanding historical sea-level changes in the Fenland area. The site's protection is driven by its unique geological features and the critical role it plays in advancing knowledge about past environmental conditions.

4.2.3.5 Bassenhally Pit (SSSI)

Bassenhally Pit covers approximately 9ha of the catchment. The site includes habitats such as grassland, aquatic areas, scrub, and woodland. The primary interest lies in the small marsh, which hosts many locally uncommon vascular plants. This rare marsh is dominated by grasses, sedges, and rushes such as creeping bent, jointed rush, common spike-rush, and local spike-rush. It also supports various herbs including lesser water-plantain, early marsh-orchid, and water violet. Sea club-rush stands are particularly notable. The site's diverse habitats make it a valuable resource for wildlife, contributing to its ecological and educational significance. The protection of Bassenhally Pit is driven by its unique marsh and the presence of a variety of plant species that enhance its biodiversity value.

4.2.3.6 Eye Gravel Pit (SSSI)

The total area of the site is less than half a hectare and is a geological designation significant for showcasing Fen Gravel (March Gravel) with marine and occasional non-marine shells. This site is crucial as it lies at the interface between the Pleistocene fluvial and glacial sequences of the East Midlands and the marine succession of Fenland. Eye Gravel Pit provides valuable exposure to sedimentary layers, offering insights into historical geological processes and sea-level changes. Its protection is primarily driven by its unique geological features, which contribute essential data for understanding past environmental conditions in the region.

4.2.3.7 Eye Green (LNR)

Eye Green covers 12ha of the catchment and features a lake, woodland and reed beds. The lake is formed by natural springs filling a disused pit, and is vital for a wide range of wildlife, including resident swans and migratory geese. The grassland areas support wildflowers like violets and pyramidal orchids, while the reed beds and scrub provide cover for water birds such as coots and moorhens, and nesting sites for dunnocks and great tits. The site also includes part of the Eye Gravel Pit geological SSSI. The reserve's key conservation focus is its provision of varied habitats that support a diverse array of species, enhancing its ecological and educational value.

4.2.3.8 Woodston Ponds (LNR)

Woodston Ponds covers 8ha of the catchment and includes habitats such as reedbeds with pools and channels, grassland, scrub, and a small lake with a viewing platform. The reedbeds and pools support various species, such as water stick insects and uncommon water beetles. Dragonflies and damselflies, including the banded demoiselle, thrive along the water’s edge whilst great crested newts hibernate in the vegetation and breed in the pools. Birds such as reed buntings, sedge warblers, grey herons, and several duck species like shoveler inhabit the area. The site's protection focuses on preserving its varied habitats and the wide array of species it supports.

4.2.3.9 The Boardwalks (LNR)

Covering an area of approximately 8ha, the Boardwalks features a range of habitats including ponds, meadows, marshes, trees, scrub, and a river. Its ponds are among the richest sites in Peterborough for water beetles. The reserve supports various species such as toads, frogs, common newts, as well as grass snakes. The western end of the site features a large pool attracting wildfowl and waders, while herons and woodpeckers are also present. Dragonflies and damselflies, including the banded demoiselle, thrive here. The reserve's protection focuses on preserving these varied habitats and the wide array of species it supports, enhancing its ecological value.

4.2.3.10 The Shrubberies (LNR)

The Shrubberies covers 4ha of the catchment and includes old parkland and pasture, a rare habitat in the Fens. The area includes oak and other large trees, supporting 49 species of birds and 12 species of butterflies. The site also features a pond with a wooded island and adjoining marshy areas with fringing alders. Grazed by cattle and sometimes cut for hay, the grassland supports various species. In 1989, an acre of land was planted with native trees. The reserve is important for its unique habitats and the biodiversity it supports, providing a critical refuge for numerous species.

4.2.4 Risk register

The NCRAT includes a Risk Register that highlights how drivers of environmental change may present risks to the quality and quantity of natural assets in the study area. This can be used to highlight which ecosystem services are under pressure and limited in their capacity to continue to provide future benefits.

The assessment of risk is qualitative and informed by the prevalence of the driver of environmental change, as well as the extent and condition of the natural asset in the study area. The drivers of change assessed in the NCRAT are described in Table 3.

Table 3: Drivers of environmental change considered in the Risk Register

Driver of change	Definition
Land-use change (incl. habitat loss)	This can be the result of a number of drivers including development and coastal erosion as well as hazards (e.g. forest fires). Land-use change is usually permanent but it could also be temporary. It is likely to affect the extent of natural capital asset rather than condition.
Climate change	This includes drivers on habitats from changing climatic conditions including temperature, precipitation, soil aridity and storminess. Assessments of the likely impact of climate change over this century are provided in UK Climate Projections[8]
Resource extraction (incl. over-exploitation)	Over-exploitation of resources can impact natural assets through both direct physical damage and additional stress on the resources on which they rely (e.g. water availability).
Population growth	Driver which comes from the demands of a higher population on natural resources and the environment. Note that the impact of population growth may be through future land-use change, resource extraction, and pollution.

[8] UK Climate Projections are available at: https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/index

Pollution	Includes both diffuse sources (e.g. agriculture, urban run-off, atmospheric deposition) and point sources (e.g. sewer overflows, wastewater treatment, abandoned mines).
Invasive species/diseases/pathogens	Invasive species/diseases/pathogens can have significant impacts on ecosystems, threatening the abundance and health of native species.

For this catchment, the natural assets under most pressure are coastal margins; enclosed farmland; and freshwaters. The primary drivers of this are land-use change (including habitat loss), climate change, and resource extraction. Figure 11 shows which ecosystem services are most at risk due to strain on a natural asset.

Level of pressure categories	Description
High	High likelihood the pressure will affect natural asset(s) and high risk of loss of ecosystem service.
Medium	Medium likelihood the pressure will affect natural asset(s) and medium risk of loss of ecosystem service.
Low	Low likelihood the pressure will affect natural asset(s) and low risk of loss of ecosystem service.
None	The pressure is not expected to affect the natural asset(s) nor ecosystem service.
No data	No data available to assess likelihood of pressure and affect on natural asset(s) nor ecosystem service.
Not assessed	Risk rating not completed
	No viable benefit-asset attribution

	Natural capital assets (NEA Broad habitat type)							
Ecosystem Services Group	Coastal margins	Enclosed farmland	Freshwaters - Open waters, wetlands and floodplains	Marine	Mountains, moorlands and heaths	Semi-natural grasslands	Urban	Woodlands
Agriculture		High			None	None		
Fish and shellfish landings	High			None				
Water supply			High					
Timber								Medium
Renewable energy		High	High		None			
Climate regulation	High	High			None	None		Medium
Air quality	High	High	High		None	None		Medium
Hazard regulation								
Recreation	High	High	High		None	None	Medium	Medium
Physical Health	High	High	High		None	None	Medium	Medium
Education		High	High		None	None	Medium	Medium
Volunteering		High	High		None	None	Medium	Medium
Water quality		High	High		None	None	Medium	Medium

Figure 11: Natural Capital Risk Register

4.3 Ecosystem Services

The type and significance of ecosystem services in the catchment are shown in Figure 12. More information about each of these services is provided in the sections below.

Figure 12, the most significant ecosystem services in the catchment are water supply, arable agriculture, climate regulation and hazard regulation. The significance is based on a desk-top assessment of the relative provision of ecosystem service and the amount of people it will impact. The definition of each significance rating is shown in Table 4.

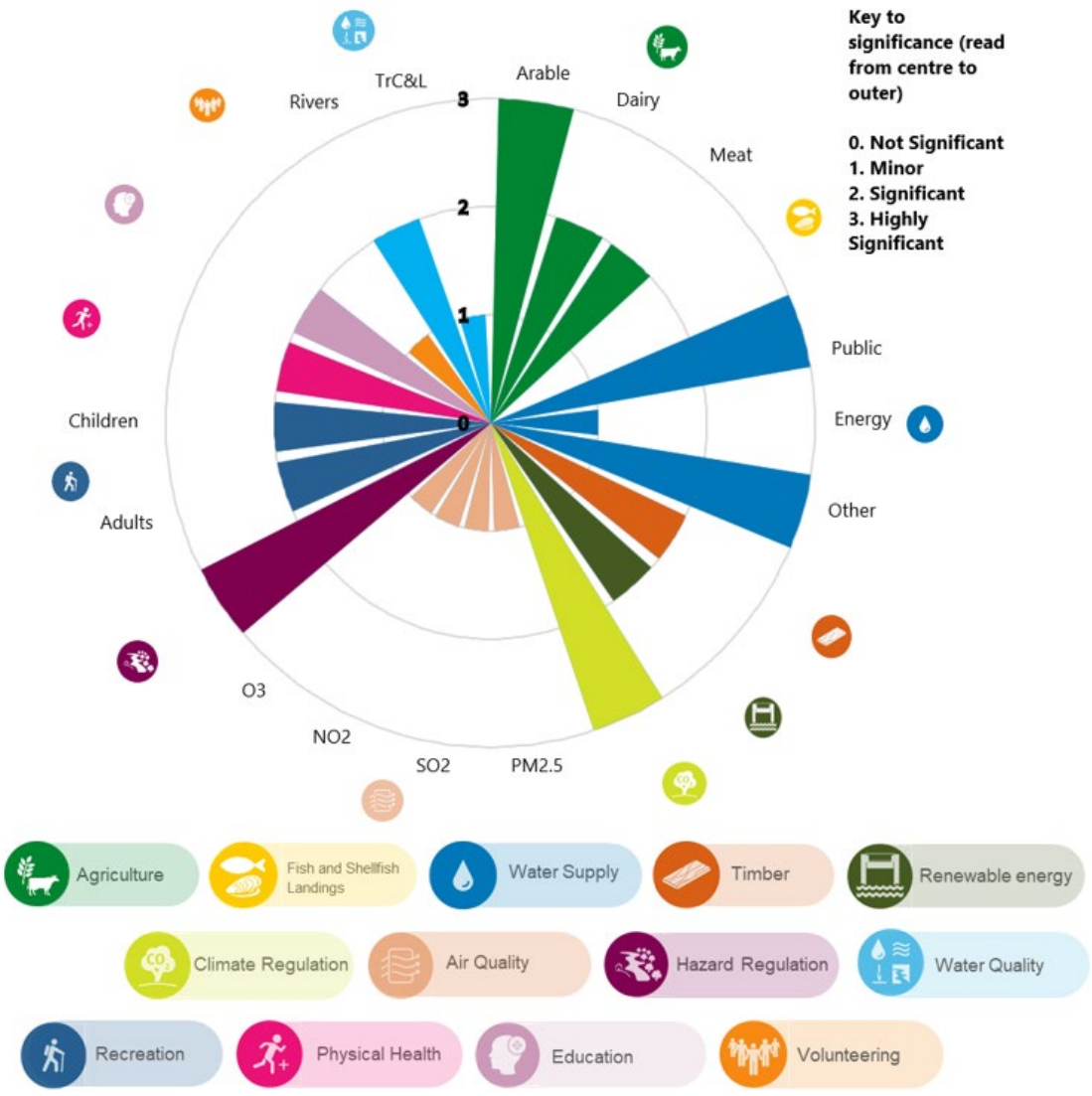

Figure 12: Rose diagram showing the significance of ecosystem services in the catchment.

Table 4: The definition of the ecosystem service significance ratings used in the NCRAT.

Significance rating	Definition
Highly significant	The benefit flow is (very) important to the place in relative terms* because it impacts the wellbeing of a significant proportion (and possibly a wide variety) of people and businesses and/or due to wider social and cultural aspects.
Significant	The benefit flow is of material importance in relative terms* because it impacts the wellbeing of a sizeable proportion of people and businesses.
Minor	The benefit flow is of minor importance in relative terms* because it does not impact most people and business. Note: it may, though, still be highly important to a small number of specific individuals or groups.
Not significant	There is very little or no provision of this benefit and it impacts only a very small number of people and businesses.

*Relative to the provision of other services/benefits within the catchment.

4.3.1 Provisioning Services

Food production

Agriculture plays an important role as an ecosystem service and land-use in the catchment. The majority of terrestrial habitat is comprised of arable fields and agricultural grasslands. Agricultural practices, such as arable farming and livestock rearing, contribute to national food security and support the local economy.

Water supply

The catchment spans across South Holland IDB, Kings Lynn IDB, North Level District IDB and Feldale IDB. The Nene Catchment Abstraction Licensing Strategy (ALS) [55] governs abstraction throughout the Nene catchment. The ALS indicates that there may, on average, only be 76 days annually when abstraction may be available. In addition, the ALS states that water is available across the whole of the catchment at Q30 flows[9] (except for the Feldale IDB area). There is restricted water available at Q50 flows, and no water available for abstraction at Q70 flows. Given the variability of water abstraction throughout the catchment, and the salinity constraints in the north of the catchment, a number of farmers have invested in recent decades in on-farm water storage reservoirs.

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

[9] 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 water body 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.

- 2013: Heavy rainfall leads to flooding throughout the catchment, almost exceeding flood embankments and flooding major roads in the area of Wisbech;
- 2023: Heavy rain in Storm Babet leads to flooding along the River Nene in the vicinity of Peterborough and throughout the catchment; and
- 2024: Heavy rainfall leads to flooding of the Whittlesey (Nene) Washes and other areas within the 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.

Renewable energy

Many natural processes provide a renewable energy source that can be harnessed to produce electricity. Solar power (photovoltaics) and onshore wind generation are the main sources of onshore renewable energy generation in the catchment.

Timber

Woodlands play a fundamental role in providing timber and wood fuel in the UK. There is a small proportion of woodland cover in the catchment, with approximately 388ha of woodland. There are approximately 57ha of commercial woodland that is actively managed with a felling licence valid within the last 10 years [14].

4.3.2 Regulating Services

Climate regulation

Ecosystems regulate a wide range of atmospheric processes that control our climate, including the greenhouse effect, precipitation, the ozone layer, the albedo effect, and atmospheric chemical composition [56]. Locally, this can help reduce urban temperatures and remove air pollutants. Globally, the most significant example of climate regulation by ecosystems is the absorption of greenhouse gases [56].

Some of most significant habitats for carbon sequestration in the catchment are enclosed farmland and woodland. A major source of carbon emissions identified in the NCRAT are habitats located on degraded peatland, such as agricultural fields on deep peat soils. These habitats emit more carbon dioxide equivalent than habitats elsewhere in the catchment can sequester and ongoing soil and water management will likely impact on the future carbon sequestration potential.

Air quality

Most urban areas in England experience significant levels of air pollution which can contribute to adverse health impacts including premature mortality from cardiovascular and respiratory causes. Studies have shown that vegetation can play an important role in removing air pollutants and improving air quality.

The catchment contains two AQMAs in Wisbech which are declared for PM_{10} and SO_2 pollution from a coal-burning industrial activity in the area. However, both AQMAs are in the process of being revoked as the industrial activity is no longer in operation and there have been no exceedances to acceptable air quality pollution levels [57].

Air pollution removal occurs through dry deposition, a mechanism by which pollutants are accumulated on leaf surfaces. Gaseous pollutants can also be removed through leaf stomata uptake.

Hazard regulation

Many habitats can act as buffers to reduce the effect of natural hazards, such as flooding. Relative to bare soil or paved surfaces, natural habitats reduce flooding risk to downstream populations by buffering peak rainfall flows entering rivers. Likewise, coastlines with intact seagrass and kelp beds, coastal wetlands or mudflats are better protected from flooding and coastal erosion.

The coastal habitats present in the catchment dissipate wave energy and provide barriers reducing risk of damage to coastal defences, low lying land, and infrastructure [58]. If unimpeded by coastal development, natural intertidal habitats such as saltmarsh are likely to migrate with rising sea levels predicted under future climate scenarios, thereby providing resilience to future sea level rise.

Disease and pests

Pests can be responsible for agricultural losses and encourage the use of pesticides. Natural pest control, such as by bats and birds, can enhance crop production by reducing herbivorous insects that damage or use parts of crops. Provision of habitats such as semi-natural grasslands and woodlands can support species which prey on pests. Given the high cover of agricultural land in the catchment, natural pest control of infestations is an important regulating service.

Pollination and seed dispersal

Semi-natural habitats such as grasslands, woodlands, hedgerows, and scrub support insect populations that pollinate crops growing on agricultural land. Seed dispersal allows plants to colonise new areas where the species may not already be present, ensuring genetic diversity and supporting other species by providing food, shelter, and habitat.

Soil retention and erosion

Soil retention is required for the maintenance of healthy ecosystems and delivery of other ecosystem services such as food and timber production. Soil resources in the catchment are degraded and eroded due to drainage and tillage of land for agriculture. Tree planting and increased diversity of vegetation structure and cover can help increase soil retention.

4.3.3 Cultural Services

Our cultures, knowledge systems, religious beliefs, social interactions and amenity have been shaped by our interaction with natural ecosystems. Cultural ecosystem services represent a suite of benefits related to amenity and culture, that can have a significant impact on society as a whole and are therefore often difficult to quantify or value.

Recreation

The catchment contains 5km of coastline, includes a section of one National Cycle Route (National Cycle Route 1), the King Charles III England Coast Path National Trail (under construction), and a number of protected and designated sites in the near vicinity of urban areas such as Peterborough. There are also other tourism enterprises such as the 20-hectare East of England Shooting Ground, and the Fenland Airfield at Holbeach St Johns. The Flag Fen archaeology park, which was discovered in 1971, is also within the Lower Nene on the outskirts of Peterborough.

Based on datasets used for ORVal, the catchment contains a total of 83 recreational sites. The most common type of recreational site is graveyard (21 sites). Other sites include three allotments, six amenity parks, 11 cemeteries, one club, one country park, one doorstep green, three golf courses, three nature parks, 17 parks, 15 recreation grounds, and one wood. ORVal data also shows the catchment contains 90 paths.

These sites, along with the protected areas for biodiversity, attract a range of visitors to the local area which contributes to the local economy.

Physical health

Approximately half of the visits made to the local area are likely to partake in activities that are beneficial for their physical health. Improvements to health improve the quality of life for individuals and reduce the pressure on healthcare systems

Education and volunteering

Visits to the catchment for scientific and educational purposes are difficult to quantify, but can create benefits for human society as a whole. The protected areas and heritage sites within the catchment have the potential to enable insights about past and future landscape changes in the area.

Designated sites provide an opportunity for public volunteering, which provides benefits to recipient organisations and their stakeholders, to wider society, and to the volunteers themselves [34].

Aesthetic / sense of place

The concept of sense of place in the context of natural capital refers to the emotional and symbolic meaning that the environment holds for individuals or communities. Intrinsically, it is difficult to measure, as it describes how people perceive, feel about, and interact with their environment.

In the context of this study, aesthetic / sense of place benefits of natural capital assets is based on the character of the landscape which is dominated by its large-scale, flat, open topography with extensive vistas to level horizons, extensive drainage networks and predominantly agricultural land use.

4.3.4 Bundled services

Bundled services are benefits provided by nature that are not easily attributable to specific ecosystem services as they provide multiple types of benefits. Some of the bundled services can also be classified as supporting services, they are crucial to the functioning of ecosystem processes and therefore support the provision of other ecosystem services. Bundled services are typically difficult to quantify as their primary benefit is the underpinning of all other ecosystem services, and therefore do not provide a direct measurable benefit.

Water quality

Ecosystems and vegetation can improve water quality in variety of ways, including through the absorption of excess nutrients; slowing the flow of water which increases water (and pollutant) retention in the soil, helping to prevent sewer overload; providing shade and reducing algae growth; and helping to stabilise river banks and beds with root systems, which reduces sediment runoff [59].

The bundled ecosystem service for water quality entails a range of benefits related to ecosystems functioning to remediate polluted water, the value of good-quality water for economic activities, recreation, education, and for healthy plant and animal populations.

As outlined in Section 4.2.1.5, of the seven surface waterbodies in the catchment, six score 'Moderate' for ecological and one water body scores 'Poor' for ecological status for the River Basin Management Plan Cycle 2 and Cycle 3.

Biodiversity

Biodiversity is defined by the Convention of Biological Diversity as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems" [60]. Biodiversity is an integral characteristic of stable and resilient ecosystems, and is vital for the continuous delivery of all other ecosystem services.

As described in Section 4.2.3, there are designated sites in the catchment that are internationally and nationally important for biodiversity. These areas include a variety of designated and rare habitats including salt marshes, meadows and deciduous woodland; and species such as dunnocks, early marsh orchid and banded demoiselle.

4.4 Benefits

4.4.1 Natural capital benefits

Figure 13 shows the flow of ecosystem services from natural assets in the catchment. For each of the ecosystem services shown, data on the physical flow of benefits is used to estimate a monetary value. Sections 4.4.2 - 4.4.5 below describe the physical benefits from the ecosystem services in the catchment. It should be noted that the benefits of ecosystem services impact different groups of people differently, depending on the service and location. Often, ecosystem services will deliver direct benefits to local people, for example through improved health, and indirect benefits to the wider population, for example by reducing cost to health services.

The monetary values shown have been calculated from the NCRAT.

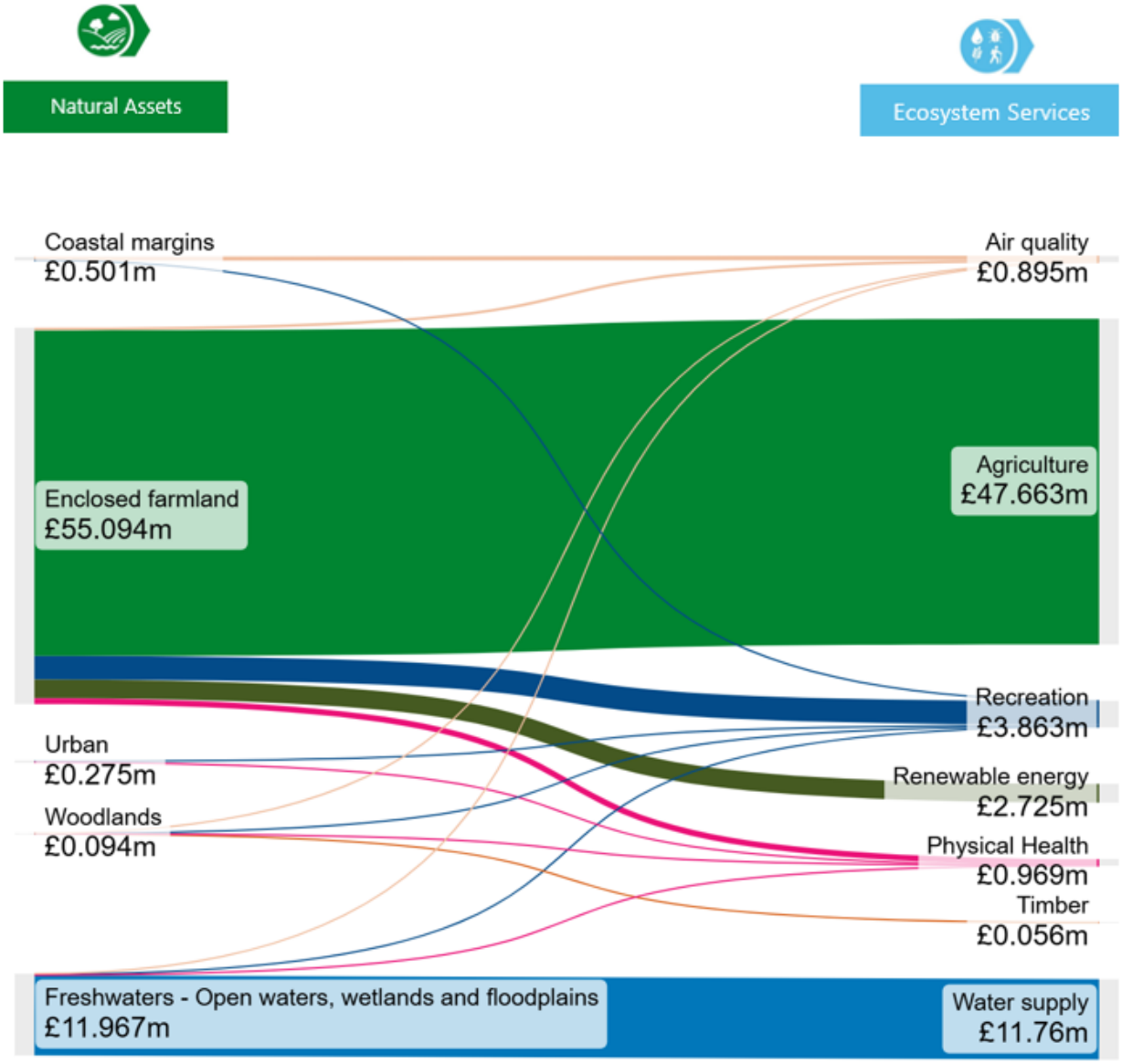

Figure 13: Sankey diagram showing the flow of ecosystem services from natural assets in the catchment.

Some of the benefits that are not included in Figure 13 but are significant to the catchment include:

- Increased pollination and the control of pests and diseases, which promote healthy ecosystems and improve agricultural productivity;
- the cultural, historical and aesthetic value ecosystems provide to places; and
- the provision of all other ecosystem services through biodiversity and biosphere integrity.

These benefits are not assessed with the NCRAT; however, a qualitative assessment of their benefit is provided below.

4.4.2 Provisioning Services

Food production

Agricultural practices, such as arable farming and livestock rearing, contribute significantly to national food security and support the local economy. The estimated annual yields for

arable and livestock (meat and dairy) are approximately 422,000 tonnes and 3,800 tonnes respectively.

Water supply

In 2018, it is estimated that over 10 billion m^3 of water was abstracted from non-tidal surface waters and groundwater in England for public supply, agriculture, industry and energy generation [61]. Overall, the volume of water abstracted from the catchment is approximated to be 2.5 million m^3 per year.

Renewable energy

According to the Department for Energy Security and Net Zero, roughly 309 megawatts (MW) electricity was generated from onshore wind and 440MW from solar power in the five local authorities that intersect with the catchment in 2023 [62]. In comparison, in 2023 across England it was estimated that 3,094MW of electricity was generated from onshore wind, 43MW from hydro generation and 13,976MW from photovoltaics. Approximate figures for each local authority within the catchment are shown in Table 5.

Table 5: The installed generation capacity of onshore wind and solar power for the Local Authority Districts within the catchment

Local Authority District (LAD)	Proportion of the Local Authority District within the catchment	Installed onshore wind generation capacity (MW)		Installed solar generation capacity (MW)	
		Total capacity in LAD	Estimated capacity within catchment	Total capacity in LAD	Estimated capacity within catchment
Fenland	27%	116.7	31.1	40.9	10.9
Peterborough	34%	46.1	15.7	38.6	13.1
South Holland	35%	44.0	15.6	90.2	31.9
Huntingdonshire	<0.01%	69.9	0	151.4	0
King's Lynn and West Norfolk	<0.01%	32.4	0	115.9	0

Since catchment-specific data is not available, the renewable energy generation values for each of the Local Authority Districts in the catchment have been scaled down according to the relative size difference (see Table 4). Using this method, it is estimated that 195,270 MWh/year is generated in the catchment from renewable sources, which is equivalent to an installed generation capacity of approximately 118MW.

From desk-based research, notable renewable energy projects in the catchment include the following:

- Rose and Crown Solar Farm (30MW);
- Long Sutton Butterfly and Wildlife Park Solar (2.7MW);
- Grange Farm (Lincolnshire) Solar (12.7MW);
- The Grange Wind Farm (17MW);
- Holbeach Marsh Wind Farm (16MW);
- McCain Foods AD Plant anaerobic digestion (AD) (MW); and
- Spalding Biomass plant (14.5MW)

It is therefore considered that the 195,270MWh/year could be an underestimate of the overall contribution that renewable energy projects the catchment provides to the wider renewable energy provision of these four local authority areas.

Timber

Woodlands play a fundamental role in providing timber and wood fuel in the UK. There is 388ha of woodland in the catchment, approximately 15% (57ha) has had a management plan or a felling license in the last 10 years or are owned by government organisations. While there are data limitations in relation to actual rates of timber extraction in woodlands within the catchment, national data can be applied to estimate a yearly volume of 1,675m^3.

4.4.3 Regulating Services

Climate regulation

Data presented in the Climate Change Strategy for South Holland, Boston and East Lindsey District Councils suggests that land use, land use change and forestry (LULUCF) is the third largest source of greenhouse gas emissions in South Holland District Council at approximately 109,200tCO_2e/yr. For the catchment (which is 35% of South Holland District Council), the NCRAT presents net greenhouse gas fluxes as emitting roughly 47,030tCO_2e/yr. This is calculated using the extent of different habitat types in the catchment and their average carbon sequestration rates.

The catchment is underlain by approximately 8,205ha of peatland, or 15% of the catchment area. This peat is predominantly in a 'drained' condition (89% of the total peatland area) or 'actively eroding' condition (11% of the total peatland area). The total volume of carbon emitted by peatland in the catchment is estimated to be approximately 54,690tCO_2e/yr. Enclosed farmland, saltmarsh and woodland in the catchment is calculated to sequester approximately 5,290tCO_2e/yr, 2,600tCO_2e/yr and 48tCO_2e/yr, respectively.

It is important to note that the NCRAT assumes all agricultural land (i.e. arable and pastoral) is delivering net sequestration, which is likely incorrect (see limitations in section 3.1.7). At a national scale agriculture is a net emitter of greenhouse gases and it is likely this pattern is similar in the catchment; in 2021 approximately 48MtCO_2e were emitted from as a result of agricultural land management across Great Britain.

Air quality

The NCRAT considers the removal of four air pollutants, Particulate matter ($PM_{2.5}$), Sulphur Dioxide (SO_2), Nitrogen Dioxide (NO_2), and Ozone (O_3). Overall, approximately 2,840 tonnes of air pollutants are removed by vegetation each year. The removal of these air pollutants provides health benefits to the local population in the catchment. Given that the catchment is predominantly rural with a low population density, the health benefits of improved air quality are likely to be less significant than in more urban and densely populated areas.

It is important to note that air pollution is likely to be distributed unevenly across the catchment, however the NCRAT tool assumes an even distribution of air pollutant abatement across the whole catchment rather than modelling variable impact or value across the catchment. Therefore, both the impacts of poor air quality and the benefits of air pollutant removal may vary when measured on the ground.

Hazard regulation

The NCRAT only quantifies and values the cumulative yearly water storage capacity of woodlands in their canopy and soils. In the context of this project, approximately 64,100m^3 of floodwater are temporarily stored in areas of woodland.

Disease and pests

The NCRAT does not quantify benefits relating to disease and pest control. It is estimated that globally 35–40% of potential crop yields are destroyed by pests [63]. Natural pest control, such as by bats and birds, can enhance crop production by reducing herbivorous insects that damage or use parts of crops.

Pollination

The NCRAT does not quantify benefits relating to pollination. Pollination plays a crucial role in promoting healthy ecosystems and supporting the provision of other ecosystem services. Approximately 80% of British wildflower species and 37% of crops grown in the UK benefit from insect pollination, including beans and oilseed rape; additionally, a further 37% of crops grown in the UK, such as carrots and onions, require insect pollination to create viable seeds.

Within the catchment, the crop areas have been estimated based upon commercial agricultural holdings[10] [64] as follows:

- Cereals – 21,296ha (approximately 39% of the catchment land use)
- Arable crops (excluding cereals) – 11,892ha
- Fruit and vegetables – 3,325ha

Many cereal and arable crops are wind-pollinated [65], whereas many fruit and vegetable crops (particularly oilseed rape, orchard fruit, soft fruit and field beans) make use of insects to transfer pollen. Without the pollinating insects these plants would likely have overall reduced quality and yields, resulting in a direct economic value impact. They also contribute to the diversity of wild plant species, habitats and wildlife in England, as well as its resilience and natural beauty. Pollination is therefore an essential ecosystem service which maintains biodiversity and supports other vital ecosystem functions, including soil protection, flood control and carbon sequestration.

The quantification of pollination benefits heavily relies on complex modelling, which is outside the scope of this assessment. Currently the direction and magnitude of changes in pollinator biodiversity, the value and functional relationship of pollinators to agriculture from farm to national scales and how this biodiversity and linked ecosystem service is only partly understood [66].

Soil erosion and retention

The NCRAT does not quantify benefits relating to soil erosion and retention. Soils provide many essential services including an environment for food production, filtering and absorbing water, reducing pollutants, regulating climate and providing habitat for organisms. It is estimated that over 2 million hectares of soil are at risk of erosion in England and Wales and almost 4 million hectares are at risk of soil compaction. This has implications for water resources, flooding and soil quality and food production [67].

[10] Data based upon the most recent Local Authority data for East Lindsey District Council (2021) and apportioned to land within the catchment.

4.4.4 Cultural Services

The NCRAT quantifies and values only four cultural ecosystem services: recreation, physical health, education, and volunteering. For this assessment, education and volunteering benefits have not been included due to lack of data availability.

Recreation

Access to open green spaces can provide a range of benefits to local economies. Based on data from the University of Exeter's ORVal [33], approximately 1.0 million adults (aged 16 or older) visit open green spaces in the catchment every year which supports the growth of local economies. A further 255,000 visits made by children each year but the welfare value of these visits is not quantified in the assessment.

Physical health

Out of the one million yearly visits to open green spaces within the catchment, roughly half (517,000) are likely to partake in activities that are beneficial for their physical health.

Education and volunteering

For this assessment, education and volunteering benefits were not possible to quantify due to lack of data availability. Although visits to the catchment for scientific and educational purposes are difficult to quantify, they do create benefits for human society as a whole. The protected areas and heritage sites within the catchment have the potential to enable insights about past and future landscape changes in the area.

Volunteering visits are similarly difficult to quantify, but can provide benefits to recipient organisations and their stakeholders, to wider society and to the volunteers themselves. Volunteering in nature and outdoor activities can have many positive benefits for the participants such as improving physical health, mental health and social connectedness. This not only provides a direct benefit to those participating in the activity but can have follow-on benefits by reducing national health care costs. Mental health improvements include reduced stress and anxiety and increased positive mood, self-esteem and resilience [68].

Aesthetic / sense of place

The aesthetic and sense of place benefits from nature are intrinsically difficult to measure, as it describes how people perceive, feel about, and interact with their environment. One means of measuring this benefit is through house prices, which tend to increase in areas where there is greater access to green and blue space due to improved local aesthetics.

4.4.5 Bundled services

Bundled services may not produce measurable benefits but are essential for ecological processes to function and facilitate the provision of all ecosystem services. Supporting services are typically not assessed on their own, as their importance underpins all individual ecosystem services discussed as part of this assessment.

Water quality

The bundled ecosystem service for water quality entails a range of benefits related to ecosystems functioning to remediate polluted water, the value of good-quality water for economic activities, recreation, education, and for healthy plant and animal populations.

The NCRAT applies non-market valuation approaches to quantify the value of good water quality within the catchment, mainly by applying data on people's willingness to pay for good water quality in combination with the ecological status of inland and coastal

waterbodies and 2019 bathing water status. The catchment contains seven WFD waterbodies – six rivers and one transitional water body. All waterbodies have a 'moderate' ecological classification status except Morton's Leam in the south of the catchment, which has a 'Poor' ecological status.

Biodiversity

The variety of living organisms in the catchment is important at a local level for increasing resilience to pests and diseases and supporting healthy ecosystems. At a global level, it is important for maintaining genetic diversity, which in turn is required for biosphere integrity, one of the nine planetary boundaries [69]. At both a local and a global level, Biodiversity enables the functioning of ecosystem services that are critical to all life of Earth.

While there are some ways to measure aspects or indicators of biodiversity (e.g. through Biodiversity Metrics, indices or indicator species), the NCRAT does not currently include this.

4.4.6 Beneficiaries Assessment

A qualitative Beneficiaries Assessment has been undertaken that explores who benefits from each ecosystem service, either directly or indirectly. The assessment considers who the beneficiaries of each ecosystem service are (i.e. the local population, wider society, public sector or private sector) and whether they are primary, secondary or indirect beneficiaries. The outputs of this are presented in Appendix A: Output - Benefits Statement.

The local population – including local communities and households (residents) – were identified as the primary beneficiary for most ecosystem services except provisioning services such as agriculture, water supply, timber and renewable energy. For these, as well as pollination, they have been identified as the secondary beneficiary.

The wider society – meaning those who live outside of the study area and include non-governmental organisations – has been identified as an indirect beneficiary for the majority of ecosystem services, specifically regulating and cultural services. For provisioning services and bundled services, the wider society is considered a secondary beneficiary. For climate regulation, the wider society is considered a primary beneficiary.

The public sector – referring to national and local government bodies – has been identified as an indirect beneficiary for the majority of ecosystem services, particularly provisioning services. The public sector is considered a secondary beneficiary of climate regulation, hazard regulation, disease and pest regulation, all bundled services and cultural services including recreation, health, volunteering and education. The public sector is considered the primary beneficiary of the mediation of wastes.

The private sector – including commercial enterprises, farming and industry – is considered a primary beneficiary for provisioning services such as agriculture, water supply, timber, and renewable energy as well as the regulation of disease and pests, pollination, soil condition and erosion, and mediation of wastes. The private sector is considered a secondary beneficiary of all bundled services, climate regulation and hazard regulation. For the remaining services, including cultural services and air quality regulation, the private sector is considered an indirect beneficiary.

4.5 Value

4.5.1 Natural capital value

The total natural capital value that has been estimated for the ecosystem services in the catchment is estimated to be £54.4 million per year, with a 100-year asset value of £2.114 billion. Figure 14 shows how this figure can be broken down into the different benefits from ecosystem services. This value will be an underestimate of the real value of natural capital assets as some benefits have not been valued, including biodiversity which underpins the functioning of all other ecosystem services. More information about the estimated values of each of the ecosystem services is provided below.

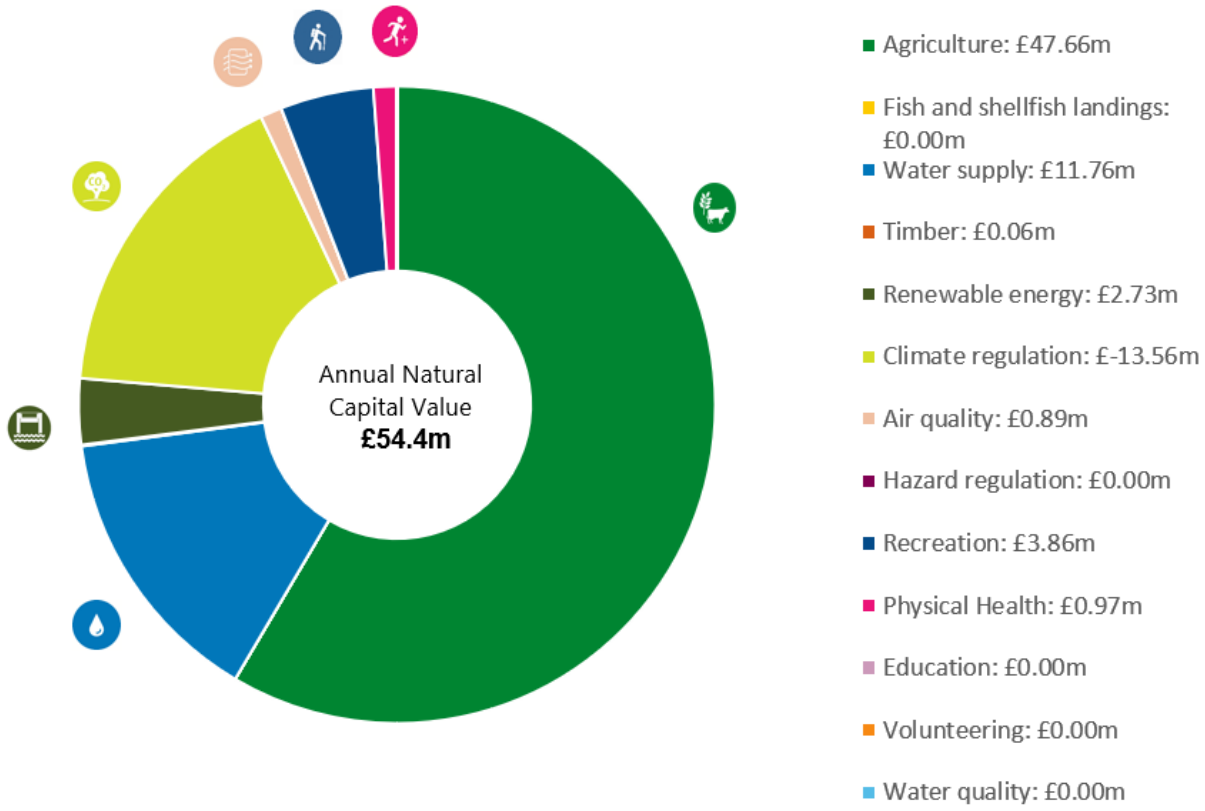

Figure 14: Pie chart showing the natural capital value of different ecosystem services in the catchment (£ million).

Not all ecosystem services have been quantified into a monetary value and so show a value of £0 on Figure 14. Volunteering and education have not been included in the assessment because there is not enough data available to calculate a value. Since there is no marine habitat within the catchment, the provision of food from fish and shellfish landings has not been included as it is not appropriate to attribute these benefits to the study area. The NCRAT does not provide a monetary value for hazard regulation as the valuation methodology is not sufficiently robust. Other ecosystem services not included are those that are particularly hard to quantify, including biodiversity, pollination, regulation of disease and pests, regulation of soil quality and erosion, and cultural benefits relating to amenity, aesthetics and spirituality. Consequently, the total values of assets and services in a natural capital account will always be an underestimate.

4.5.2 Provisioning services

Food production

The estimated annual arable and livestock (dairy and meat) yields are over 422,380 tonnes and 3,830 tonnes respectively, which have a combined worth of over £47.7 million each year. The asset value over the next 100 years for agriculture is £1,421 million. As noted in section 3.1.7, the natural capital values do not include the potential costs from carbon emissions associated with agricultural activities (e.g. cost of carbon emissions from land management, fertiliser production, machinery etc.).

Water supply

Overall, the volume of water abstracted from the catchment is approximated to be 2.6 million m^3 per year, equating to £11.8 million each year and £350 million over the next 100 years – these are the central values. The minimum and maximum annual values for water supply are £1.4 million and £18.6 million respectively.

Renewable energy

The renewable energy generated for the catchment is estimated to be 195,270MWh per year, which has been valued at £2.7 million annually and £81.2 million over the next 100 years.

Timber

The national value of timber and fuel extracted from woodlands is estimated at almost £15 billion. National data can be applied to the catchment to estimate a yearly timber production volume of 1,680m^3, which is valued at approximately £56,500 per year. The 100-year asset value of this is £1.7 million.

A key consideration for this figure is that, in order to provide a constant benefit, woodlands need to be managed sustainably. As such, timber harvest rates should not negatively impact the health and therefore the wider ecosystem service provision within a woodland.

4.5.3 Regulating Services

Climate regulation

Based on the extent of habitat types in the catchment, the NCRAT presents the net greenhouse gas fluxes as emitting roughly 47,000tCO_2e/yr for a central value, providing an annual value of -£13.6 million; this has a 100-year asset value of approximately -£110 million.

The NCRAT provides maximum and minimum values for climate regulation which should also be considered given the amber confidence interval for climate regulation (see Table 1 for confidence interval definitions) and uncertainty in the results. The maximum annual volume of carbon emitted is 47,060tCO_2e/yr (-£13.6 million per year) and the minimum is 47,000tCO_2e/yr (-£13.5 million per year).

The estimated value for climate regulation is based on the extent of different habitat types in the catchment. The majority of the catchment is agricultural land, which has a relatively low carbon sequestration rate. The value for climate regulation would be higher if the area of woodland, wetlands or saltmarsh was increased, as these have a higher carbon sequestration rate. As explained in section 4.2.2, the peatland in the catchment is in a ‘drained’ or ‘actively eroding’ condition and is a net emitter of carbon, which significantly reduces the value for climate regulation.

Air quality
The removal of 2,840 tonnes of air pollutants by vegetation each year leads to an estimated avoided cost of treatment and productivity loss of £895,000 per year and £27.7 million over the next 100 years.

Hazard regulation
In the catchment, an estimated 64,100m^3 of floodwater is temporarily stored in areas of woodland in Lower Nene. The NCRAT does not provide a monetary value for this benefit, however the cost of creating a flood storage reservoir to store a similar amount of water is estimated at £32,370 per year.

Disease and pests
The NCRAT does not provide a monetary value for the benefits associated with disease and pest control in the catchment. There is not sufficient information to calculate the precise economic impact of pests and disease. The spread of invasive and non-native species more broadly is estimated to cost the UK economy £1.8 billion each year [5].

Pollination
The NCRAT does not provide a monetary value for the benefits associated with pollination in the catchment. Pollination by insects and other animals has been estimated to be worth £500 million annually in the UK [5].

Soil erosion and retention.
The NCRAT does not provide a monetary value for the benefits associated with soil erosion and retention in the catchment. As peat is drained it shrinks; becoming lighter, friable and vulnerable to erosion. Production losses due to soil erosion are estimated to cost £40 million per year in England and Wales [5].

4.5.4 Cultural Services

Recreation
The value of approximately 1.0 million visits by adults to open green spaces in the catchment every year is worth approximately £3.9 million each year and has a 100-year asset value of approximately £93 million. The welfare value of a further 255,000 visits made by children each year cannot be quantified but is likely to be significant.

Physical health
By applying a valuation approach to measuring the improvements in ‘quality adjusted life years’ (QUALYs), the NCRAT estimates that £969,500 in healthcare treatment costs can be avoided every year due to improved physical health as a result of 517,00 active visits to green spaces, involving more than 30 minutes of physical activity. The 100-year asset value of this is approximately £29 million.

Education and volunteering
Although education and volunteering have been scoped out of this assessment due to lack of data availability, they are valuable ecosystem services. The number of volunteer hours and educational visits can be used to calculate the value of education and volunteering in a catchment. It is likely that the protected areas and heritage sites within the catchment enable valuable volunteering and educational opportunities. All 141 National Nature Reserves managed by Natural England have a total volunteering value of £1.8 million (for 150,000 hours of work) and a total educational value of £123,000 [68].

Aesthetic / sense of place

The NCRAT does not provide a monetary value for the benefits associated with aesthetics and sense of place. Recreation and aesthetic values are in part captured by house prices as there is value associated with proximity to green and blue spaces for recreation (free trips to nature) and the visual amenity (aesthetic) value provided by being able to view green and blue spaces. In 2021, the combined aesthetic and recreation value of these services in the UK was estimated to be worth £4 billion [70].

4.5.5 Bundled services

Water quality

Based on a willingness to pay approach, the river water quality is worth an estimated £0 per year as an alternative to having poorer water quality. This is because none of the five surface waterbodies within the catchment meet 'Good' or 'High' ecological status and the NCRAT only provides an annual value of good or high water quality per km.

The catchment contains seven WER/WFD waterbodies - six rivers and one transition waterbody. All waterbodies have a 'moderate' ecological classification status except Morton's Leam in the south of the catchment, which has a 'Poor' ecological status.

Biodiversity

The NCRAT does not assess the value of biodiversity. However, the value of biodiversity to our economy and society should not be overlooked as it underpins the value of all other ecosystem services.

The Dasgupta Review provides a thorough assessment into the value of biodiversity to our economy and society [71]. The Report distinguishes six sources of biodiversity's value including human existence, human health, amenity, the provision of ecosystem services from Nature's goods and services, species existence, and the intrinsic value of nature itself [71].

4.5.6 Monetary value confidence intervals

Table 6 shows a RAG rating of confidence in the monetary values assigned to the annual and 100-year flow of benefits [34]. Definitions for confidence intervals are provided in section 3.1.4.

Table 6: The natural capital values calculated using the NCRAT colour coded according to the confidence interval. All figures have been rounded to three significant figures.

Ecosystem Service	Annual value (central) £m	Asset value (PV; 100 yr) (low) £m	Asset value (PV; 100 yr) (high) £m	Asset value (PV; 100 yr) (central) £m
Agriculture - Arable	47.10	-	-	1,404.28
Agriculture - Livestock (dairy)	0.53	-	-	15.66

Agriculture - Livestock (meat)	0.03	-	-	1.02
Fish and shellfish landings	0.00	-	-	0.00
Water supply (public)	1.79	-	-	53.29
Water supply (energy generation)	-	-	-	-
Water supply (all other)	9.97	-	-	297.30
Timber	0.06	-	-	1.68
Renewable energy	2.73	-	-	81.25
Climate regulation	-13.56	109.80	110.52	110.16
Air quality - PM2.5	0.50	-	-	15.24
Air quality - SO2	0.00	-	-	0.14
Air quality - NO2	0.24	-	-	1.99
Air quality - O3	0.15	-	-	10.29
Hazard regulation	-	-	-	-
Disease and pests				
Pollination				
Soil quality / erosion				
Noise mitigation				
Waste remediation				
Recreation (adults)	3.86	-	-	93.25
Recreation (children)	-	-	-	-
Physical Health	0.97	-	-	28.90
Education	0.00	0.00	0.00	0.00
Volunteering	0.00	-	-	0.00

Amenity				
Aesthetic / sense of place				
Spiritual				
Water quality – rivers	0.00	0.00	0.00	0.00
Water quality - transitional, coastal waters and lakes	0.00	0.00	0.00	0.00
Biodiversity				

5. Summary and next steps

5.1 Summary of the NCRAT results for the catchment

The flow of ecosystem services that are derived from natural assets within the catchment were estimated, which was used to calculate the value of the benefits those services provide. This process is summarised in Figure 15. The analysis is not exhaustive and does not include all assets, services and benefits, therefore the natural capital values shown are an underestimate. Figure 15 indicates the confidence in the valuation provided as High (3 coloured squares), Medium (2 coloured squares), or Low (1 coloured square)

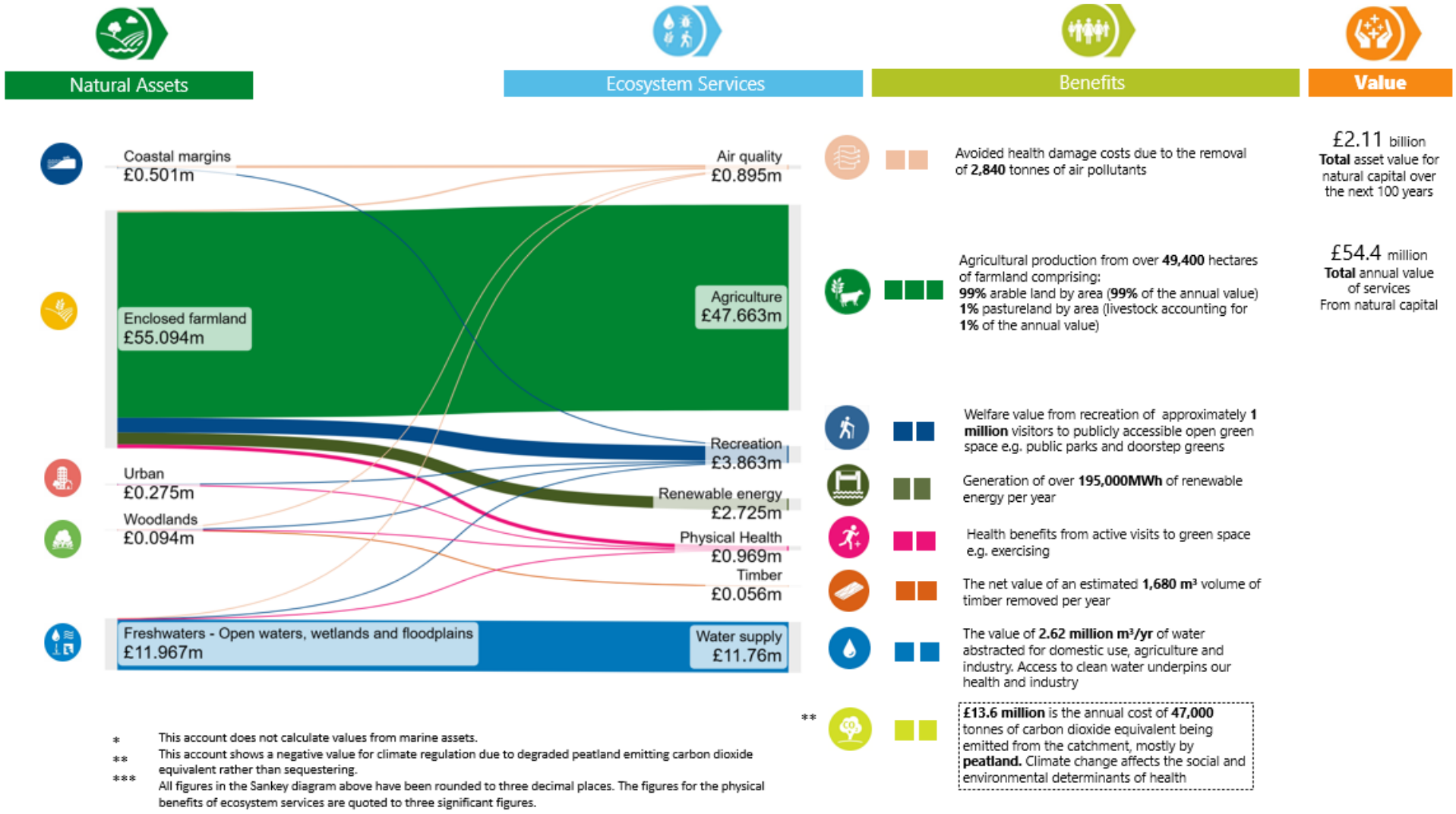

Figure 15: Summary of the NCRAT results for the catchment

5.2 Strengths, weaknesses, opportunities and threats

5.2.1 Strengths

The key natural capital strengths in the catchment include:

- **Statutory designations:** The catchment contains numerous statutory designated sites including Nene Washes (SPA, Ramsar site, SAC, and SSSI); The Wash (SPA, Ramsar site, and SSSI); The Wash & North Norfolk Coast (SAC); Adventurers' Land (SSSI); Bassenhally Pit (SSSI); Eye Gravel Pit (SSSI); Eye Green (LNR); Woodston Ponds (LNR); The Boardwalks (LNR); and The Shrubberies (LNR). These designations provide legal protection to critical habitats, ensuring the conservation of valuable natural resources, supporting biodiversity, and protecting the continuous provision of ecosystem services.

- **Fertile soil:** The large majority (89%) of the catchment is enclosed farmland; the natural capital value of this land is estimated at £48 million annually through food production. Approximately 49,407ha of arable fields and agricultural grasslands support both arable farming and livestock rearing, producing over 422,000 tonnes of arable yields and 3,800 tonnes of livestock yields each year. These activities support food production, provide employment, and help maintain the landscape character of NCA 46 ‘The Fens’.

- **Coastal priority habitat:** The catchment includes approximately 9ha of coastal saltmarsh. Whilst this is a relatively small area in the catchment, it plays a vital role in providing important habitats sublittoral sandbanks, sandflats, mudflats, shallow inlets and reefs which attract a range of wildlife including wintering waterbirds; passage birds; waders; breeding birds; harbour seal; and shellfish [42] [43] [44]. These habitats provide crucial ecosystem services, including water quality improvement, carbon sequestration, biodiversity, recreation, tourism, and protection against erosion and flooding. Additionally, they serve as nurseries for commercial fish species.

- **Water environment:** The catchment contains important surface water and groundwater bodies that are crucial for human water supply and local ecosystem functioning. The main surface waterbodies are the River Nene, Back River, North Level Main Drain, South Holland Main Drain, New South Eau and the Little Holland Drain; the groundwater bodies underlying the catchment include the Northampton Sands and the Nene Mid Lower Jurassic Unit. The natural capital value of water supply in the catchment is estimated at £4.3m annually. The catchment also includes the Whittlesey (Nene) Washes, a flood storage area spanning 1,450ha and extending 20km – this acts as a vital flood storage area in periods of high river flow; and serves as a resource for irrigation during periods of low flow. The Nene Washes is internationally and nationally designated (SPA, Ramsar, SAC and SSSI) for its importance to a wide range of wildlife (see Section 4.2.3.1.).

- **Renewable energy:** The catchment contains three operational solar farms and numerous wind turbines. The renewable energy generated for the catchment is estimated to be 195,270MWh/year per year, which has been valued at £2.7 million annually and £81.2 million over the next 100 years.

5.2.2 Weaknesses

The weaknesses of natural capital in the catchment are as follows:

- **Climate regulation:** A significant portion (30%) of the catchment is comprised of peatland. This peat is in a poor condition, and consequently net emits approximately 110,000tCO_2e/yr. When sequestration from other habitat types are also considered, the annual volume of carbon emitted is 101,995tCO_2e/yr. This is valued at approximately -£29.40 million a year and £110 million over the next 100 years.

- **Environmental degradation:** The vast majority of the catchment is made up of agricultural land, covering 89% of land area. Whilst this is important for food production, intensive agricultural practices can contribute to soil degradation, habitat fragmentation, and pollution. These activities can also lead to the loss of biodiversity, reduced soil fertility, and increased greenhouse gas emissions, impacting ecosystem health and resilience. Additionally, the use of chemical fertilizers and pesticides can contaminate water bodies and groundwater resources, further degrading the quality of natural habitats and affecting aquatic life. The catchment has a relatively low proportion of semi-natural and ancient woodlands, and the condition of peatland has been degraded through drainage. This is likely as a result of historic land use change driven by agricultural intensification.

- **Vulnerability to climate change:** The natural assets in the catchment are at risk from rising sea levels, increased frequency of extreme weather events, and changing precipitation patterns. These changes can lead to habitat loss, reduced biodiversity, and increased vulnerability to coastal erosion and flooding. In addition, it can impact food production through damage to crops and increased soil erosion during extreme weather events, and through unpredictable seasons. The impacts of climate change can also disrupt the balance of marine ecosystems, affecting fish populations and other marine life that are crucial for local fisheries and biodiversity.

  In the catchment, agricultural land and ecologically valuable habitats - including designated sites - are at risk from retreating coastlines, saline intrusion, and coastal flooding. These threats can lead to the loss of valuable farmland, reduced agricultural productivity, and degradation of critical biodiversity areas, directly impacting both economy and ecology of the region, as well as indirectly through the erosion of ecosystem service provision due to habitat degradation.

5.2.3 Threats

Threats to the condition or quality of natural capital assets in the catchment have been identified, including:

Climate change: Rising sea levels, increased frequency of extreme weather events, and changing precipitation patterns pose significant risks to food production, and coastal and marine habitats. The catchment has suffered from floods on multiple occasions e.g. On 27th November 2012 a heavy rains caused flooding from the River Nene at a number of locations. Again in 2023, Storm Babet caused widespread flooding in Lincolnshire, impacting Peterborough and the surrounding area.

The catchment is at risk of further flooding, both from the sea given its low-lying coastal topography as well as from the Lower Nene River which crosses the area. The majority of the catchment area is considered to be at high risk of flooding from rivers or sea (Flood Zone 3) [72]. These changes can lead to habitat loss and reduced biodiversity

(e.g. as a result of salination impacts), and increased vulnerability to coastal erosion and flooding.

Rising sea levels and an increased demand for groundwater abstraction increases the risk of saline intrusion to groundwater and soils. This can lead to a variety of issues such habitat loss, reduced agricultural productivity and loss of aquifer water quality [73].

- **Agricultural practices:** Intensive farming practices, particularly on arable land, can lead to degradation of soil and peat; reduced soil fertility; and increased greenhouse gas emissions. The condition of any remaining peatland in the catchment is already poor due to decades of drainage and intensive agriculture.

  The use of nitrogen and phosphorus-based fertilisers can also contribute to waterway pollution. The Environment Agency's reasons for not achieving Good (RNAG) dataset identifies diffuse pollution from agricultural and rural land management, physical modifications associated with flood defence structures, land drainage operations, sewage discharge, and invasive non-native species (INNS) use as the current RNAG's for the waterbodies within the catchment.

- **Water resource management:** Over-extraction of water from aquifers and rivers can lead to reduced water availability for ecosystems and human use, including irrigation for arable crops. This can exacerbate the impacts of droughts and reduce the resilience of freshwater habitats. The Lower Nene has water available for abstraction 76 days of the year, with 298.8Ml/d available on those days. As such, the annual water availability at this point is 22.7 million m^3 of water. Throughout the catchment, there is considerable seasonal variation in surface water availability and the groundwater in the north is saline [74]. Consequently, irrigated crops can only be produced in this catchment reliably using water from the on-farm reservoirs and roof water capture systems.

  According to the Water Resources East, Lincolnshire is projected to have to water supply-demand deficit in the region of 15-40Ml/d by 2050 – demonstrating the importance of sustainable water management in the local area and the threat of severe water shortage in the future [46].

  There are trade-offs between the benefits that are obtained from different ecosystem services, especially if natural assets are not managed sustainably. For example, abstraction of water for water supply to provide drinking water, grow crops and livestock may deplete water resource and have knock on negative implications for other ecosystems that rely on sufficient flows and volumes of water being available. This includes other provisioning services (such as timber) regulating services (such as climate regulation and soil quality), cultural services (such as recreation and amenity) and bundled services (such as water quality and biodiversity).

- **Pollution:** Air and water pollution from agriculture and urban areas can degrade natural habitats and reduce their ability to provide ecosystem services. This includes the accumulation of pollutants in vegetation and water bodies, impacting human health and biodiversity.

- **Invasive species:** The introduction and spread of invasive species can disrupt local ecosystems by outcompeting native species for resources, altering habitat structures, and introducing diseases. This can lead to a decline in native biodiversity and negatively affect ecosystem functions and services.

- **Urban development:** Expansion of urban areas and infrastructure can lead to habitat fragmentation, loss of green spaces, and increased pollution. This can negatively impact biodiversity and the provision of ecosystem services such as air quality regulation and recreational spaces.

5.2.4 Opportunities

There is opportunity to improve natural capital in the catchment through:

- **Enhancement of asset quality**: Investing in the restoration and enhancement of natural habitats can improve their condition and resilience. This includes reforestation, wetland restoration, peatland restoration (primarily in the south of the catchment, just north of the Nene Washes), and the creation of green infrastructure in urban areas such as Peterborough, Wisbech, Holbeach, Long Sutton, and Sutton Bridge.

  Reducing pollution can also enhance asset quality, addressing sources of excess nutrients, plastics and other pollutants. For example, the Fenland Local Plan Habitat Regulations Assessment indicates that the Nene Washes would benefit from improved water quality, helping to increase the number of successfully breeding target species [75]. The Northampton and Peterborough Natural Capital Investment Plan indicates that the land in the south of the catchment near the Nene Washes has a particularly good opportunity to improve water quality and reduce soil erosion through habitat change [76].

  Enhancement of in-channel habitats would benefit the quality of freshwater natural assets. Possible options could include enhancement of retained riparian and watercourse margins to provide sheltering and spawning opportunities for fish. This could be incorporated as part of bank reprofiling works for improving bank stability.

- **Habitat creation:** Creating new habitats and extension of existing habitats, such as saltmarsh, grazing marsh, lowland meadows and grassland, wetlands, urban green spaces, and wildlife corridors, can enhance biodiversity and ecosystem service provision. This can also provide new opportunities for recreation and tourism.

  Habitat creation should be prioritised in areas adjacent to existing designated sites and done in a way that supports the local ecosystems. Habitat creation should also be prioritised in ‘stepping stone’ areas that can improve ecological connectivity between other habitats. These sites will have the greatest ecological benefit and can be identified using habitat opportunity mapping, as demonstrated in the Northampton and Peterborough Natural Capital Investment Plan [76].

  Given the low topography and high flood risk of the catchment, creating wetland habitat and restoring lowland peatland will be especially important for the future of the catchment to manage flood risk and promote carbon sequestration. It will also be important to manage coastal realignment in order to allow coastal habitats and the benefits they bring, to migrate landward as sea levels rise.

  As stated in the Northampton LNRS Statement of Biodiversity, there are opportunities to increase the network of wildflower verges and expand areas of calcareous grassland in the south of the catchment [77]. The Northampton and Peterborough Natural Capital Investment Plan highlights the opportunity to increase woodland in the catchment [76]. This would benefit a wide range of ecosystem services such as carbon sequestration, noise regulation, air quality improvements, and flood management.

- **Recreation and tourism:** Improving the recreational value of new or existing green space can significantly enhance community well-being, encourage outdoor activity, and promote environmental awareness. This has benefits for natural capital, such as improved human health and education. This can be achieved by improving accessibility to green space through well-maintained and wheelchair-accessible paths, good public transport links and clear signage. Other opportunities to improve the recreational value of natural assets include improving amenities (e.g. benches, bins, lighting and toilet facilities); adding recreational facilities (e.g. playgrounds and sports areas); and by promoting nature engagement through educational signage and community gardens.

- **Use of Nature based Solutions:** Implementing Nature based Solutions (NbS), such as sustainable agriculture, green engineering, and ecosystem-based adaptation, can deliver multiple benefits. Natural flood management is a type of NbS encompassing a suite of measures which work with natural processes to reduce the risk of flooding. These processes protect, restore, and mimic the natural functions of catchments, floodplains and the coast to slow, spread and store water, and each intervention comes with its own set of multiple benefits. NbS solutions can enhance resilience to climate change, improve water quality, and support biodiversity while providing economic and social benefits.

  Increasing the extent and quality of green infrastructure in Peterborough through the Peterborough Nature Partnership would increase local natural capital value in a variety of ways. For example, improving social health and wellbeing; increasing biodiversity; and building resilience to climate change (through shading and flood risk management). The Northampton and Peterborough Natural Capital Investment Plan provides a case study demonstrating how improving the condition of grassland verges in the Peterborough district can increase the biodiversity value, particularly where there are local orchards or arable fields such as oil seed rape [76].

- **Sustainable land and water management:** Adopting sustainable practices in agriculture and water management can reduce environmental impacts and enhance ecosystem services. This includes practices such as conservation agriculture, agroforestry and integrated water resource management.

  Planting hedgerows and grassland along the agricultural field margins provides an opportunity to improve biodiversity and connectivity, and will support other ecosystem services such as pollination, water quality, flood management and climate regulation.

  As indicated in the North Northamptonshire LNRS, catchment-sensitive farming practices are important to improve management of riparian vegetation [77]. This is especially important along key watercourses such as Morton's Leam, which is the only water body in the catchment with a 'Poor' ecological status (according to Cycle 3 2022 WFD classifications).

- **Regenerative farming practices:** The catchment contains the first fully regenerative arable farm in the UK. Regenerative practices focus on restoring soil health, increasing biodiversity, and improving water cycles. Supporting and increasing the use of these practices can lead to more resilient and productive agricultural systems, enhancing ecosystem services and reducing environmental impacts.

There is also opportunity to support appropriate management of salt marshes and grazing marsh, such as the restoration of sustainable grazing marshes.

- **Climate change mitigation and adaptation:** Working collaboratively with catchment stakeholders to deliver integrated solutions in order to mitigate the impact of climate change.

  Tree planting could be considered in locations where it can deliver biodiversity, flood, water quality, water resources and climate adaptation benefits. Consideration should be given to the fact that poor placement of trees on peatland can actually lead to further degradation and drying of the peat through water uptake, inadvertently increasing greenhouse gas emissions [78].

  The Landscape Recovery Fund is a long-term, large-scale government project fund with a focus on addressing climate change and habitat creation. The Ouse Washes is a Landscape Recovery Project within the Great Ouse catchment that provides an opportunity to improve climate change mitigation and adaption whilst simultaneously creating and restoring wetland habitat. The project aims to create 1,000ha of target habitat creation and to form a continuous wetland habitat from the Ouse Washes, Fen Drayton, and Ouse Fen to form 1900ha of continuous wildlife rich habitat. This habitat will provide a refuge for an abundance of priority species, improve biodiversity, and contribute to net zero, while mitigating ecological and hydrological threats currently facing the area. By creating a healthier landscape, the project will support local economies, safeguard communities, and deepen the connection between local people and nature [79].

- **Peat restoration and climate regulation**: Currently, the peatland in the catchment is in a poor condition (see Section 5.2.2). Restoring the lowland peatland sites in the Fens is an opportunity to reduce carbon emissions from degrading peatland, benefiting the environment and society. The Fens East Peat Partnership (FEPP) - part of the Fens for the Future Partnership - has recently been awarded a Nature for Climate Restoration Grant to undertake peat restoration at 15 sites in the Fen [80].

- **Policy and governance:** Strengthening policies and governance frameworks to support natural capital conservation and sustainable development can create an enabling environment for positive change. This includes integrating natural capital into planning and decision-making processes and promoting stakeholder engagement and collaboration. One way of implementing this is through Local Nature Recovery Strategies (LNRS) or assessment and enhancement of natural capital through the local plan making process.

  LNRS were introduced through the Environment Act 2021, as new systems of spatial strategies for nature in England. Each LNRS includes a local habitat map and a written statement of biodiversity priorities, outlining practical actions such as creating wetlands, restoring peatlands, planting trees, and managing existing woodlands more sustainably. Farmers and land managers will be able to use the LNRS to understand the potential of their land for strategic nature recovery actions, which in turn could be applicable for funding through Environmental Land Management Schemes and other funding mechanisms. LNRS should be used by plan-makers to inform the way they address the National Planning Policy Framework requirement for plans to protect and enhance biodiversity, which in turn will have positive outcomes for natural capital.

The Greater Lincolnshire LNRS, which includes part of the catchment, is in the early stages of project planning and organization, focusing on mapping existing habitats and identifying local priorities for nature recovery. It is due to be published in March 2026 following public consultation in Autumn 2025. Managed by Lincolnshire County Council in partnership with North Lincolnshire Council, North East Lincolnshire Council, and the Greater Lincolnshire Nature Partnership, the strategy includes projects like floodplain meadow restoration and aims for no net loss of priority habitats by 2025.

The Cambridgeshire and Peterborough LNRS, which also includes the catchment, is under development and is expected to be published by December 2025. It includes the Doubling Nature Vision which aims to enhance biodiversity and create resilient ecosystems across six priority landscapes, including the Nene Valley, the Great Ouse Valley and the Connected Fens.

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Appendix A
Output - Benefits Statement

Natural Capital Benefits Statement

Data sensitivity: OFFICIAL
Place name: Lower Nene

Summary of physical and monetary flows

The **Natural Capital Benefit Statement** reports the provision ('flow') of a range of benefits. It draws on the currently available evidence to quantify the flow of benefits in physical and monetary terms. The quantitative results are accompanied by the **Significance Assessment** that provides a broader qualitative account of benefits, including those not currently assessed in quantitative terms. Each row represents a discreet combination of physical measurement and monetary valuation methods, and therefore this sheet shows the minimum number of unique rows required to cover all the benefits analysed.

Benefits are categorised according to a modified **ecosystem service classification** that incorporates some **abiotic** elements: (i) **provisioning services** (the production of physical goods we consume such as food and water); (ii) **regulating services** (ecosystems processes related to climate, air quality, hazard regulation, etc.); (iii) **cultural services** (aspects of the natural environment that enrich our lives, such as recreational benefits); and (iv) **'bundled' services** (that combine multiple benefits). The contribution of **supporting services** - the ecological processes and functions such as nutrient cycling that maintain the conditions for life on earth and underpin ecosystem service provision - to current benefits flows is embedded within the monetary benefits for provisioning, regulating, cultural and bundled services.

Instruction: The Benefits Statement is automatically populated from the input and process tabs.

	Ecosystem service	Significance	Benefit valued	Benefit type	Beneficiaries: Local population	Wider Society	Public Sector	Private Sector	Physical flows: Measure (unit)	Avg unit / year	Monetary values: Valuation basis	Annual value (central) £m	Asset value (PV; 100 yr) (low) £m	Asset value (PV; 100 yr) (high) £m	Asset value (PV; 100 yr) (central) £m	Representation
Provisioning	Agriculture - Arable	+ + +	Food	Market	●	●	◑	●	Yield of arable production (tonnes/yr)	422,376	Gross margin	47.10	-	-	1,404.28	
	Agriculture - Livestock (dairy)	+ +	Food	Market	●	●	◑	●	Yield of livestock (dairy) production (kL/yr)	3,708	Gross margin	0.53	-	-	15.66	
	Agriculture - Livestock (meat)	+ +	Food	Market	●	●	◑	●	Yield of livestock (meat) production (tonnes/yr)	118	Gross margin	0.03	-	-	1.02	
	Fish and shellfish landings	- -	Food	Market	○	○	○	○	Volume of fish and shellfish landings (tonnes/yr)	0	Net profit	0.00	-	-	0.00	
	Water supply (public)	+ + +	Water supply	Market	●	●	◑	●	Abstracted raw water quantity (m3/yr)	1,482,096	Resource rent	1.79	-	-	53.29	
	Water supply (energy generation)	+	Water supply	Market	○	○	○	○	Abstracted raw water quantity (m3/yr)	85	Not valued	-	-	-	-	
	Water supply (all other)	+ + +	Water supply	Market	●	●	◑	●	Abstracted raw water quantity (m3/yr)	1,138,130	Marginal value	9.97	-	-	297.30	
	Timber	+	Timber	Market	◑	◑	●	●	Volume of timber removals (m3/yr)	1,675	Stumpage price	0.06	-	-	1.68	
	Renewable energy	+ +	Renewable energy	Market	●	●	◑	●	Renewable energy generation (MWh/yr)	195,273	Resource rent	2.73	-	-	81.25	
Regulating	Climate regulation	+ + +	Climate	Non-market	●	●	●	●	Net CO2eq sequestered (tonnes/yr)*	-47,030	Abatement cost	-13.56	109.80	110.52	110.16	
	Air quality - PM2.5	+	Health	Non-market	●	◑	◑	◑	PM2.5 removed (tonnes/yr)	3	Avoided cost (treatment and productivity) plus welfare value	0.50	-	-	15.24	
	Air quality - SO2	+	Health	Non-market	●	◑	◑	◑	SO2 removed (tonnes/yr)	83	Avoided cost (treatment and productivity) plus welfare value	0.00	-	-	0.14	
	Air quality - NO2	+	Health	Non-market	●	◑	◑	◑	NO2 removed (tonnes/yr)	65	Avoided cost (treatment and productivity) plus welfare value	0.24	-	-	1.99	
	Air quality - O3	+	Health	Non-market	●	◑	◑	◑	O3 removed (tonnes/yr)	2,693	Avoided cost (treatment and productivity) plus welfare value	0.15	-	-	10.29	
	Hazard regulation	+ + +	Flood risk reduction	Non-market	●	◑	●	●	Annual volume of potential flood storage by woodlands (m3/yr)	64,095	Not valued	-	-	-	-	
	Disease and pests	+ +			●	◑	●	●								
	Pollination	+ +			●	◑	◑	●								
	Soil quality / erosion	+ +			●	◑	◑	●								
	Noise mitigation	+			●	◑	◑	○								
	Waste remediation	+			●	◑	●	●								
Cultural	Recreation (adults)	+ + +	Recreation	Non-market	●	◑	●	◑	No. visits to open spaces (visits/yr)	1,003,965	Welfare value	3.86	-	-	93.25	
	Recreation (children)	+ + +	Recreation	Non-market	●	◑	●	◑	No. visits to open spaces (visits/yr)	254,652	Not valued	-	-	-	-	
	Physical Health	+ +	Health	Non-market	●	◑	●	◑	No. active visits to open spaces (visits/yr)	517,042	Avoided treatment cost	0.97	-	-	28.90	
	Education	+ +	Educational benefits	Non-market	●	◑	●	◑	No. educational visits (visits/yr)	0	Exchange value	0.00	0.00	0.00	0.00	
	Volunteering	+	Volunteering	Non-market	●	◑	●	◑	No. volunteering days (days/yr)	0	Opportunity cost	0.00	-	-	0.00	
	Amenity	+ +			●	◑	◑	◑								
	Aesthetic / sense of place	+ +			●	◑	◑	◑								
	Spiritual	+ +			●	◑	◑	◑								
Bundled	Water quality - rivers	+ +	Various	Non-market	●	●	●	●			Welfare value of good water quality	0.00	0.00	0.00	0.00	
	Water quality - transitional, coastal waters and lakes	+	Various	Non-market	●	●	●	●			Welfare value of good water quality	0.00	0.00	0.00	0.00	
	Biodiversity	+ + +			●	●	●	●								
	Total market benefit value (£m)											62.20			1,854.48	
	Total non-market benefit value (£m)											-7.83			259.96	
	Total quantifiable value (£m)											**54.38**			**2,114.45**	

Notes:

* Net carbon dioxide equivalent sequestration is estimated taking into account both carbon sequestration by habitats and green house gas sequestration and emissions from peatland
- Annual value is estimated flow at base year (Year 0)
- Asset value calculated as discounted flow of benefits (present value terms; 100 years). Future flows are discounted in accordance with HM Treasury Green Book guidance. This is an estimate of the gross asset value since it does include (net) costs of maintaining asset condition.
- Where available low - high ranges are reported for (gross) asset value; otherwise the cell has been left blank (-)

Significance key

Highly significant (+ + +)	The benefit flow is (very) important to the place in relative terms* because it impacts the wellbeing of a significant proportion (and possibly a wide variety) of people and businesses and/or due to wider social and cultural aspects.
Significant (+ +)	The benefit flow is of material importance in relative terms* because it impacts the wellbeing of a sizeable proportion of people and businesses.
Minor (+)	The benefit flow is of minor importance in relative terms* because it does not impact most people and business. Note: it may, though, still be highly important to a small number of specific individuals or groups.
Not significant (- -)	There is very little or no provision of this benefit and it impacts only a very small number of people and businesses.
Not assessed (-)	Significance rating not completed.

See "Input - Significance Assessment" tab for more details

Beneficiaries key

●	Direct (primary and secondary) beneficiary from the ecosystem service provision.
◑	Indirect beneficiary from the ecosystem service provision.
○	Beneficiary does not benefit from the ecosystem service provision.
Not assessed (-)	Beneficiaries rating not completed.

See "Input - Beneficiaries" tab for more details

Monetary valuation confidence key

Green	High confidence in results. Input data and assumptions are based on statistical reports, peer reviewed values or industry standard methodologies
Amber	Moderate confidence in results. Input data and/or assumptions from single source/not peer reviewed, or based on sources that are not specifically tailored to this context. We have used some assumptions or estimation and some of these may be open to question. Accuracy is better than +/- 50%
Red	Low confidence in results. Input data and/or parameters from single source and low level of transferability from original context. We are confident that the number is in the right order of magnitude. Order of magnitude implies that for an estimate of 5 that we are confident that the real figure is within the range 0.5 to 50
No value (-)	Not valued or it is not possible to provide a result that can be judged to be in the right order of magnitude. This is due to unquantifiable uncertainty in the science, valuation or the relationship between them. Currently limited to qualitative assessment only.

Representation key

▰	The benefit flow is substantially represented in the monetary valuation process, with only minor elements not included.
▰	The benefit flow is partially represented in the monetary valuation process.
▰	The benefit flow is not represented in the monetary valuation process.
Not assessed (-)	Representation rating not completed.

See "Input - Significance Assessment" tab for more details