Anglian River Basin District

Flood Risk Management Plan 2015 - 2021

PART B – Sub Areas in the Anglian River Basin District

March 2016
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## Glossary and abbreviations

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<th>Abbreviation</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>AONB</td>
<td>Area of Outstanding Natural Beauty</td>
</tr>
<tr>
<td>BAP</td>
<td>Biodiversity Action Plan</td>
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<tr>
<td>Catchment</td>
<td>The watershed of a surface water river system</td>
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<tr>
<td>Catchment Sensitive Farming</td>
<td>Managing the land to reduce surface water runoff, and the resulting pollution and siltation of watercourses.</td>
</tr>
<tr>
<td>CFMP</td>
<td>Catchment Flood Management Plan</td>
</tr>
<tr>
<td>Defra</td>
<td>Department for Environment, Food and Rural Affairs</td>
</tr>
<tr>
<td>EA</td>
<td>Environment Agency</td>
</tr>
<tr>
<td>EPR</td>
<td>Environmental Protection Regulations</td>
</tr>
<tr>
<td>EU</td>
<td>European Union</td>
</tr>
<tr>
<td>FCERI</td>
<td>Flood and coastal erosion risk management</td>
</tr>
<tr>
<td>Flood Risk Area (FRA)</td>
<td>Areas where the risk of flooding from local flood risks is significant as designated under the Flood Risk Regulations.</td>
</tr>
<tr>
<td>Fluvial</td>
<td>From/of rivers.</td>
</tr>
<tr>
<td>FRMP</td>
<td>Flood Risk Management Plan</td>
</tr>
<tr>
<td>FRMP</td>
<td>Flood Risk Management Plan – plan produced to deliver the requirements of the Flood Risk Regulations.</td>
</tr>
<tr>
<td>Government</td>
<td>The term government is used within this report to refer to Defra (the Department for Environment, Food and Rural Affairs) and Welsh Government.</td>
</tr>
<tr>
<td>Groundwater flooding</td>
<td>Occurs when water levels in the ground rise above the natural surface. Low-lying areas underlain by permeable strata are particularly susceptible.</td>
</tr>
<tr>
<td>Ha</td>
<td>Hectares</td>
</tr>
<tr>
<td>IDB</td>
<td>Internal Drainage Board</td>
</tr>
<tr>
<td>Km</td>
<td>Kilometres</td>
</tr>
<tr>
<td>Liaison Panel (LP)</td>
<td>Each RBD has a Liaison Panel made up of representatives for the key sectors to steer the River Basin Management Plan. Members bring their experience, knowledge and their sector views acting as a two-way channel between the panel and their sector.</td>
</tr>
<tr>
<td>LLFA</td>
<td>Lead Local Flood Authority</td>
</tr>
<tr>
<td>LFRMS</td>
<td>Local flood risk management strategy produced by LLFAs under the Flood and Water Management Act 2010.</td>
</tr>
<tr>
<td>LRF</td>
<td>Local Resilience Forum partners</td>
</tr>
<tr>
<td>Main river</td>
<td>A watercourse shown as such on the main river map, and for which the Environment Agency and Natural Resources Wales has responsibilities and powers</td>
</tr>
<tr>
<td>MAFP</td>
<td>Multi Agency Flood Plan</td>
</tr>
<tr>
<td>NE</td>
<td>Natural England</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Definition</td>
</tr>
<tr>
<td>--------------</td>
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</tr>
<tr>
<td>NNR</td>
<td>National Nature Reserve</td>
</tr>
<tr>
<td>PCC</td>
<td>Peterborough City Council</td>
</tr>
<tr>
<td>PLP</td>
<td>Property Level Protection</td>
</tr>
<tr>
<td>PMF</td>
<td>Probable Maximum Flow</td>
</tr>
<tr>
<td>Ramsar</td>
<td>Wetlands of international importance designated under the Ramsar Convention</td>
</tr>
<tr>
<td>RBD</td>
<td>River Basin District - these are the reporting units to the European Commission for the Water Framework Directive and the Floods Directive.</td>
</tr>
<tr>
<td>RCC</td>
<td>Rutland County Council</td>
</tr>
<tr>
<td>Reservoir</td>
<td>A natural or artificial lake where water is collected and stored until needed. Reservoirs can be used for irrigation, recreation, providing water supply for municipal needs, hydroelectric power or controlling water flow.</td>
</tr>
<tr>
<td>RMAs</td>
<td>Risk Management Authorities - Organisations that have a key role in flood and coastal erosion risk management as defined by the Act. These are the Environment Agency, Natural Resources Wales, LLFAs, district councils where there is no unitary authority, internal drainage boards, water companies, and highways authorities.</td>
</tr>
<tr>
<td>RFCC</td>
<td>Regional Flood and Coastal Committee</td>
</tr>
<tr>
<td>River flooding</td>
<td>Occurs when water levels in a channel overwhelms the capacity of the channel.</td>
</tr>
<tr>
<td>SAC</td>
<td>Special Area of Conservation</td>
</tr>
<tr>
<td>SCC</td>
<td>Suffolk County Council</td>
</tr>
<tr>
<td>Services</td>
<td>Services include schools, hospitals, nursing/care/retirement homes, police stations, fire and ambulance stations, prisons, sewerage treatment works and electricity installations. Only those in areas at risk of flooding are shown on these maps.</td>
</tr>
<tr>
<td>SMP</td>
<td>Shoreline Management Plan</td>
</tr>
<tr>
<td>SPA</td>
<td>Special Protection Area</td>
</tr>
<tr>
<td>SSSI</td>
<td>Site of Special Scientific Interest</td>
</tr>
<tr>
<td>Standard of Protection</td>
<td>The annual probability of the design flood level being reached or exceeded</td>
</tr>
<tr>
<td>SuDS</td>
<td>Sustainable Drainage Systems</td>
</tr>
<tr>
<td>SSSI</td>
<td>Sites of Special Scientific Interest</td>
</tr>
<tr>
<td>Sewer Flooding</td>
<td>Flooding as a result of overloading of the sewerage system due to limited system capacity or failure of sewer asset.</td>
</tr>
<tr>
<td>Surface water flooding</td>
<td>Flooding from rainwater (including snow and other precipitation) which has not entered a watercourse, drainage system or public sewer.</td>
</tr>
<tr>
<td>SWMP</td>
<td>Surface Water Management Plan</td>
</tr>
<tr>
<td>Tills</td>
<td>Boulder clay or other sediment deposited by melting glaciers or ice sheets.</td>
</tr>
<tr>
<td>Tributaries</td>
<td>A river or stream flowing into a larger river or lake.</td>
</tr>
<tr>
<td>WFD</td>
<td>Water Framework Directive</td>
</tr>
</tbody>
</table>
The layout of this document

Flood Risk Management Plans have been divided into four sections to help readers identify and access information relevant to them. This is Part B. We have divided the plan into four parts:

<table>
<thead>
<tr>
<th>Name</th>
<th>Audience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summary Document</td>
<td>For those who would like an overview of the plan.</td>
</tr>
<tr>
<td>Part A: Background and RBD wide information</td>
<td>For those who would like the legislative background and RBD wide, high level information.</td>
</tr>
<tr>
<td>Part B: Catchment Summaries</td>
<td>For those who require the detail of the sub-areas and flooding statistics. This section includes the catchments based on Water Framework Directive (WFD) management catchments, Flood Risk Areas (identified through the Preliminary Flood Risk Assessment) and other strategic areas across the RBD.</td>
</tr>
<tr>
<td>Part C: Appendices</td>
<td>For those who would like to see the detailed of the measures for the river basin district and individual communities.</td>
</tr>
</tbody>
</table>

This is Part B which introduces each of the sub-areas in turn. This section outlines the catchments based on Water Framework Directive (WFD) management catchments, which make up the RBD, then the Flood Risk Areas (identified through the Preliminary Flood Risk Assessment) and other strategic areas across the RBD.

The other parts of the flood risk management plan are located on [gov.uk](https://www.gov.uk/government/publications/anglian-river-basin-district-flood-risk-management-plan)
During December 2015, Storms Desmond, Eva and Frank brought record breaking levels of rainfall and significant flooding to some parts of the country. On 5 and 6 December the highest ever river flows were registered in several large catchments including the Eden, Lune and Tyne. On 25 and 26 December further record river levels were registered for many large rivers draining the Pennines. The Met Office confirmed that December 2015 was the wettest on record in parts of the UK, including Cumbria which experienced more than two and a half times expected monthly rainfall.

Across the country over 19,000 homes were flooded, with thousands more affected by loss of power supply and travel disruption. Existing flood defences played an essential part in protecting thousands of homes during December with 12,500 benefitting during Storm Desmond and 10,900 during Storm Eva. Support to affected communities, business and the agricultural sector is in place, along with a programme of inspections and repairs to damaged defences.

It is essential to ensure that we have the very best possible plans in place for flood management across the whole country. Following the December 2015 floods, Defra announced a National Flood Resilience Review, to assess how the country can be better protected from future flooding and increasingly extreme weather events. The review is looking at climate modelling, infrastructure, resilience and future investment strategy. Government is also working to strengthen or establish partnerships in the areas most flood affected to encourage a more integrated approach to managing risk across the whole catchment. These Partnerships are considering improvements to flood defences, upstream options to help slow the flow and surface water runoff, and how planning and design of urban areas can help reduce flood risk. They are also aiming to build stronger links between local residents, community groups and flood management planning and decision making. The resulting actions from the Local Flood Partnerships in Cumbria and Yorkshire will complement the measures in the relevant FRMPs and the learning from this approach will be shared across the country. In England, the Government is investing £2.3bn on 1,500 flood defence schemes between 2015-2021. Investment in flood risk management infrastructure not only reduces the risks of flooding but also supports growth by helping to create new jobs, bringing confidence to areas previously affected by floods and creating and restoring habitats.
1. Sub-areas in the Anglian River Basin District

Introduction
There are a number of sub-areas within the Anglian RBD. These sub-areas and issues in them are described in Catchment Summaries in Part B of the FRMP. These are:

- Catchments (which are set out according to WFD Management Catchments)
- Flood Risk Areas (identified in the Preliminary Flood Risk Assessment): areas that require flood risk management plans for local sources of flooding.
- Strategic areas are where flood risk management needs to be considered across more than 1 sub-area.

Figure 1: Anglian RBD showing Catchments, South Essex Flood Risk Area and the Fens Strategic Area
Flood Risk Areas
These are identified through the Preliminary Flood Risk Assessment as areas of potentially significant local flood risk (for instance surface runoff, groundwater and ordinary watercourses), for which FRMPs need to be prepared. Within the Anglian FRMP there is only one FRA:

- **South Essex Flood Risk Area** – covers the southern section of the Combined Essex Catchment. A small section of this FRA falls within the Thames RBD, but for simplicity, all the information is included in this FRMP. The Environment Agency has worked with Essex County Council and Southend-On-Sea Borough council to include information for local sources of flooding for the South Essex FRA risk in Part B.

Management Catchments
These are areas where engagement is focussed to enable a catchment based approach to water management. There are 11 catchments in the Anglian RBD, as listed below:

- Broadland Rivers
- Cam and Ely Ouse (including South Level)
- Combined Essex
- East Suffolk
- Nene
- North Norfolk Rivers
- North West Norfolk
- Old Bedford (including middle Level)
- Upper and Bedford Ouse
- Welland
- Witham

Strategic Area
These are areas where it is important to consider flood risk management across more than 1 sub-area, so that partners can work in a co-ordinated way to set out conclusions, objectives and measures to manage risk. There is one strategic area:

- **The Fens Strategic Area** - The Fens is a vast area of low-lying land below sea level, which extends across Cambridgeshire, Norfolk, Suffolk and Lincolnshire. As the Fens encompass numerous catchments and multiple sources of flooding, the area is considered an important strategic area.
2. Conclusions, objectives and measures to manage risk in the South Essex Flood Risk Area

Essex County Council and Southend Borough Council have worked in partnership with the Environment Agency to produce a joint FRMP that includes the conclusions of flood risk for all sources. The following sections consider the ongoing, agreed and proposed measures for the South Essex Flood Risk Areas in the Anglian River Basin District.

Introduction to the South Essex Flood Risk Area

Using the flood map for surface water and the national flood risk thresholds criteria and guidance provided by the Environment Agency a FRA was identified in South Essex. A FRA is identified when a cluster of 1km2 grid squares leads to an area where flood risk is most concentrated, and over 30,000 people are predicted to be at significant risk of flooding (as described in government guidance). It is estimated that 560,800 people (around 238,700 properties) are considered to be at risk from surface water flooding within the South Essex FRA, in addition to 36,450 non-residential properties.

![Figure 2: Overview map of the South Essex Flood Risk Area](image-url)
The South Essex FRA is 252km$^2$ in extent and covers two Lead Local Flood Authorities (LLFAs); the majority of Southend Borough Council (67.8km$^2$), Unitary Authority, and the southern part of Essex County Council (184.2km$^2$). This includes Basildon, Rochford and northern part of Castle Point. The main urban areas in the north west of the FRA are Billericay and Basildon, Hockley and Hawkwell in the north east; Shoeburyness, Westcliff and Leigh-on-Sea in the south east and Hadleigh, South Benfleet and Laindon to the south West. This area has a total population of 476,286 people. The South Essex FRA is located within the Combined Essex Catchment.

![Map of South Essex FRA]

**Figure 3: Local authorities within the South Essex FRA**

**Land use and management**

The FRA, which is south of the River Crouch is significantly urban in character and includes the towns of Billericay, Wickford, Basildon, Rayleigh, Thundersley and Southend on Sea.

Historically, urban areas were built on plateaus, an area of high ground with a fairly level surface, which is higher than the surrounding ‘Thames Marshes’ such as Basildon. The low-lying marshy areas in the river and tidal plains were not developed until the industrial revolution, or even more recently as the pressure for land grew.

The size and location of urban areas in a catchment can affect flood risk. Urbanisation increases impermeable areas and leads to a more rapid response to rainfall which can potentially increase surface water and higher flood peaks. However, exactly where an urban area is located in a catchment will determine whether flood risk increases or reduces. Basildon
is the largest urban development in the South Essex FRA and is located near the top of the Crouch catchment. Urban areas in the upper reaches of the catchment the rapidly response to rainfall can combine with peak river flows exasperating the risk of flooding. Rainfall levels in Basildon are likely to have a significant effect on flood flows in the River Crouch.

Urban areas may also be at risk from flooding from other sources, including inadequate local drainage systems and groundwater. Inappropriate development in floodplains also increases flood risk to people and property.

South Essex has a wide range of industry and commerce due to its close vicinity to London. There is some heavy industry and power generation along the Thames Estuary, with ports, bulk terminals and associated bulk storage facilities. Other commercial uses throughout the FRA area include light industrial/commercial business parks, warehousing and distribution.

The southern part of the area is designated as Thames Gateway South Essex (TGSE), a regional and national priority for regeneration and growth with the potential to make a major contribution to improving the region’s economy. TGSE is part of the Thames Gateway area, which extends into London and the South East. It has been designated a growth area under the government’s Sustainable Communities Plan. Southend-on-Sea and Rochford are cultural and intellectual hubs and a higher education centre of excellence, with focus on Southend town centre and Shoeburyness. Southend airport is also within the FRA, but is not consider at risk of flooding. The airport is used for freight and tourism travelling within the UK to Europe and further. Recent years have seen the regeneration and development of London Southend airport as part of the expanding TGSE.

Geology

The underlying geology is dominated by the London Clay Formation in the south of the area. However, the chalk outcrops in the northwest with a southwest to northeast trending outcrop boundary. The Chalk outcrops are classified by the Environment Agency as a Principal Aquifer and is utilised for public water supply. The significant thickness of the London Clay formation does not allow significant movement of groundwater. Where the underlying bedrock is clay, there are higher rates of rainfall runoff, and this run-off flows directly into the watercourses. There is also a risk from surface water flooding in these areas. In the areas where there is chalk bedrock, run-off may infiltrate the rock delaying the response of rivers to rainfall and reducing peak flood flows. There is also a risk from groundwater flooding in these areas.

River Terrace Deposits form a significant layer across much of Rochford and Shoeburyness. This is capable of holding groundwater above the impermeable London Clay Formation which ground water cannot flow through. Localised areas in western Rochford district and Basildon borough behave as aquifers, storing ground water. Geology affects the suitability of Sustainable Urban Drainage Networks and areas of Basildon, Rochford and Castlepoint are considered more suitable where there are areas of permeable ground. However, the majority of the southern half of Castle Point, much of Basildon and Southend and the central and west parts of Rochford DC are potentially unsuitable for infiltration SUDS where there is the presence of London Clay Formations.

Alluvium, the sediment deposited by rivers, is made up of clay and silty sand that is associated with the small tributary of the River Crouch in the north western part of the study area. Fragmented areas of London Clay Formation are exposed on the surface in the western part of the FRA, on both sides of the Prittle Brook where there are no drift deposits.
The Tidal Flat Deposits comprising of silty clay with sand mounds are located near Southend and Shoeburyness. These deposits are 1 m to 5m thick at Southend and 3m to 5m thick at Shoeburyness. A thin Basal Sand and Gravel layer usually underlies the Tidal Flat Deposits. East of Southend pier, there is a narrow strip of Blown Sand with an approximate thickness of 2m along the coastline on top of the Tidal Flat Deposits.

**National and international designations**

There is an estimated 9898ha of designated habitat in the South Essex FRA. The majority of this is coastal habitat and is highly valued and designated as SSSI, RAMSAR, SAC and SPA for its diverse habitat and species. Further inland Norsey Wood and Hockley Wood are designated as SSSI sites. There is also 96ha of Ancient Scheduled Monuments and over 45 listed buildings.

**Partnership working**

The Essex Partnership for Flood Management (EPFM) has been created to bring together all key stakeholders so they may contribute to a strategic overview of matters surrounding flooding in Essex. This ensures a consistent, coordinated and collaborative approach is taken with regard to flood risk management. The EPFM meets quarterly and continues to contribute to key decisions on projects, strategies funding and communications.

The EPFM has an elected member from each of the 12 district, borough and city councils within Essex. The chair of the partnership is the ECC Cabinet Member for Communities and Planning who also sits on the RFCC for Anglian (East). Members are often supported at the EPFM by lead advisors from their councils.

Representatives from Flood Risk Management Authorities and a range of other stakeholders are invited to take part when appropriate. Due to the substantial crossover between the work done in Essex and in Southend and Thurrock, both councils have also been invited to send members to join the EPFM.

The Flood Risk Partnership for the Southend Unitary area comprises Southend-on-Sea Borough Council, the Environment Agency and Anglian Water Services Ltd, the waste water service provider for the area. These agencies have been involved in the development of a Surface Water Management Plan and the early stages of the development of a Local Flood Risk Management Strategy for the Borough.

**Climate change**

By the 2080s, under Medium emissions, over most of lowland UK estimates are for heavy rain days (rainfall greater than 25 mm)

There is a level of uncertainty about the calculated effects this will have on local sources of flood risk, but we can be more certain that heavy rainfall will intensify in winter compared to summer and the proportion of summertime rainfall falling as heavy downpours may increase.

**Flood risk maps and statistics**

**Flooding from Surface water**

Surface water flooding occurs when heavy rainfall exceeds the capacity of local drainage networks and water flows across the ground.

Surface water flooding, particularly in large urban areas such as Southend-on-Sea, Rochford, and Wickford, is due to the impermeable surfaces of these urban areas. Basildon, Hawkwell,
Hockley and Rayleigh are susceptible to surface water flooding due to the steep slopes and underlying impermeable clay. The low elevations and flat topography of the Shoeburyness area is conducive to surface water ponding.

There are a number of surface water courses within the South Essex FRA and a complex network of drainage systems. This is predominantly made up of minor streams, channels, and ditches, with the exception of the upper reaches of the River Crouch. The upper section of the River Crouch catchment has both rural and urban areas, including a substantial proportion of Basildon, Wickford and Billericay. The flow in the river Crouch is responsive to rainfall, and groundwater. Other water courses include Dunton Brook at Wickford, Rawreth Brook, Prittle Brook, Eastwood Brook and Mucking Hall Brook. Both the Eastwood Brook and Prittle Brook flow through relatively steep urban catchments which have been extensively altered to facilitate drainage and flood alleviation. These watercourses therefore respond rapidly to rainfall and flooding is likely to occur with little warning and fast flows.

The River Shoe in Shoeburyness was originally a small river that flowed from a spring at St Mary’s Church, south through the shallow valley to the sea. The downstream section through Gunners Park is now known as Barge Pier Ditch; it is now a deep modern drainage ditch, the banks of which have been stabilised by the presence of gabions and vegetation. The upper reaches are now largely culverted, but, at present do not present flooding problems. This ponding experienced in the downstream areas may be the result of high groundwater levels in the area.

Southchurch Park is also a low-lying area that is susceptible to surface water ponding. This area includes a surface water storage pond along the Willingale Brook which collects surface water run-off from the residential area to the north. This is working with natural processes to slow down water or allow it to infiltrate into the ground to help manage flood risk. Anglian Water maintain a series of pumping stations which then pump surface water outflows from the water storage ponds south to the Thames estuary. There is also an EDF electrical substation close by which may be considered critical infrastructure at risk from surface water flooding. Surface water flooding affects a number of roads around the borough including Angel Roundabout, Harp House roundabout, Eastern Avenue and Chalkwell Avenue, as well as railway lines. These highways create key pathways for surface water flows during periods of heavy rainfall.

Parts of Southend town centre are considered to be at risk of pluvial flooding including land between Victoria Avenue and Baxter Avenue, and land west of Sutton Road, particularly from Vale Avenue south to Greyhound Way. Any future development proposed for this area should take due consideration for the impact of surface water flow paths to the development as well as the effective management of surface water on the site.

The corridors of Prittle Brook, Eastwood Brook and Mucking Hall Brook and their associated tributaries are susceptible to surface water flooding as these areas lie in the flow paths created by the local topography and are affected by the local built environment (roads, culverts, and bridges).

The catchments of these watercourses are highly urbanised and therefore the surrounding residential properties are at risk from surface water flows directed towards these watercourses.
Figure 4: Updated Flood Map for surface water (uFMfSW) in the South Essex FRA
**Surface water key Statistics**

Table 1: Summary flood risk from surface water to people, economic activity and the natural and historic environment across the South Essex Flood Risk Area

<table>
<thead>
<tr>
<th>Surface Water</th>
<th>Total in FRA</th>
<th>High risk</th>
<th>Moderate risk</th>
<th>Low risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk to people:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of people in area:</td>
<td>476,300</td>
<td>13,950</td>
<td>13,600</td>
<td>56,950</td>
</tr>
<tr>
<td>Number of properties in area:</td>
<td>202,700</td>
<td>5,950</td>
<td>5,800</td>
<td>24,250</td>
</tr>
<tr>
<td>Number of services:</td>
<td>430</td>
<td>30</td>
<td>20</td>
<td>80</td>
</tr>
<tr>
<td>Risk to economic activity:</td>
<td></td>
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**Flooding from groundwater**

Groundwater flooding occurs as a result of water rising up from the underlying aquifer or from water flowing from abnormal springs. This tends to occur after long periods of sustained high rainfall, and the areas at most risk are often low-lying where the water table is more likely to be at shallow depth. Groundwater flooding is known to occur in areas underlain by major
aquifers, although increasingly it is also being associated with more localised floodplain sands and gravels.

**Flooding from sewers**

Sewer flooding is often caused by excess surface water entering the drainage network. Sewer flooding has caused problems in the past in Southend-on-Sea, Castle Point and Basildon. The majority of this flooding is a result of the inadequate capacity of the sewage system and blockages.

Although the area has seen a number of events as a result of sewer flooding there are no records of properties affected by sewer flooding with significant consequences within Essex.

**Sustainable Flood Risk Management**

- Flood risk management measures need to be considered in areas of regeneration and redevelopment within the FRA. This will allow policies to create green corridors, incorporate flood resilience measures and to influence the layout and design of development to manage flood risk.

- Organisations need to work together to manage all sources of flooding and provide an integrated approach to urban drainage issues and surface water flooding as such events could increase in the future due to more frequent and intense storms.

- The risk of flooding cannot be eliminated, only managed; therefore flood awareness plans and emergency response plans must be developed to manage flood risk and the consequences of flooding from the flood defences failing or being overwhelmed.

- Any redevelopment of floodplain areas is an opportunity to increase their flood resilience.

- Improvement of maintenance activities to manage flood risk into the future should be investigated and where possible, flood risk should be managed by storing water on the floodplain upstream of settlements at risk.

- To ensure that new development does not contribute to existing flooding problems, and where possible is able to provide betterment, Essex County Council will promote SuDS through the planning process in line with government policy.

- Essex County Council has produced a local SuDS Design and Adoption Guide which has been to public consultation and subsequently revised and is available in draft form from their website at www.essex.gov.uk/flooding. It provides a steer to developers on the types of SuDS.

**Conclusions and objectives for the South Essex Flood Risk Area**

Within the FRA 18% of the population is at risk of flooding from local sources. Of the population at risk of flooding 17% is considered at high risk. Much of this is concentrated in within the large urban areas such as Southend-on-Sea, Rochford, and Wickford and is due to the impermeable surfaces of these urban areas. Basildon, Hawkwell, Hockley and Rayleigh are susceptible to surface water flooding due to the steep gradients and underlying impermeable clay. The low elevations and flat topography of the Shoeburyness area is conducive to surface water ponding.

An estimated 39% of the service and infrastructure are considered to be at risk of local sources of flood risk. Of the services at risk 16% are considered to be at high risk, but the
majority (46%) of services at risk are located in low risk areas. In the indicative FRA 23% of non – residential property, which includes commercial properties, schools and hospitals, are considered at risk. Again, the majority (62%) of non-residential properties are considered low risk with 23% considered at high risk. Critical transport links within the area include the A127 and A13 links and the M25. The A13 also links Tilbury and London Gateway docks. The A127 is the main route into Southend and also provides links to north Essex. There are 2 main railway lines to London within the FRA, one to Fenchurch Street and one to Liverpool Street. These lines also provide direct rail links to Southend airport and Stansted airport. An estimated 43% of the Stansted passengers use public transport to the airport. An estimated 46% of the roads and 45% of the railways are at risk of flooding, of this 53% of the rail network is considered to be at high risk.

Of the total area of agricultural land 20% is considered to be at risk of flooding from local sources.

Of the 6 EU designated bathing water within the FRA, 1 of these is considered to be at high risk and 2 at low risk which would be affected by heavy rain. The majority of the Environmental Permit Regulated (EPR) sites are considered to be at high risk. This needs careful management as surface water could potentially lead to leachate form the sites. The most predominate environmental designation within the FRA is for sites of Special Sites of Scientific Interest (SSSI). Of the designated site within the FRA, less than 2% is considered at risk from local sources of flooding. Of the Schedule Ancient Monuments 16% are considered to be a flood risk and an estimated total of 45 listed buildings.

The nature of flooding in the South Essex Flood Risk Area can be broadly divided into the following categories:

- **River Valleys** – the areas particularly susceptible to surface water flooding are formed by the river valleys of the River Crouch, Nevendon Brook, North Benfleet Brook, Basildon Brook, Prittle Brook, Eastwood Brook, Rawreth Brook and the River Roach.

- **Low Lying Areas** – areas such as underpasses, subways and lowered roads beneath railway lines are more susceptible to surface water flooding;

- **Railway Embankments and Cuttings** – discrete surface water flooding locations along the up-stream side of the raised network rail embankment;

- **Topographical Low Points** – areas which are at topographical low points which result in small, discrete areas of deep surface water ponding such as Shoeburyness and Southchurch Park; and,

- **Local Drainage Capacity** – areas which flood as a result of poor local drainage network capacity such as Southend-on-Sea, Castle Point and Basildon.

**Objectives for the area of Flood Risk Area within Essex County Councils boundary:**

This is from Essex County Councils Local Flood Risk Management Strategy.

1. To develop a clearer understanding of the risks of flooding from surface runoff, groundwater and ordinary watercourses and to consider how best to communicate and share the information that becomes available
2. To define and explain the criteria by which areas at risk of flooding from surface runoff, groundwater and ordinary watercourses are assessed and resources are prioritised.

3. To set out clear and consistent plans for risk management so that communities and businesses can make informed decisions about the management of the residual risk.

4. To ensure that planning decisions are properly informed by flooding issues and the impact future planning may have.

5. To encourage innovative management of flood and coastal erosion risks, taking account of the needs of communities and the natural and built environment.

6. To ensure that emergency plans and responses to flood incidents are effective and that communities are able to respond properly to flood warnings.

**Objectives for the area of the Flood Risk Area within Southend – on – Sea Borough Councils boundary:**

This is from Southend-On-Sea Borough Councils Local Flood Risk Management Strategy:

1. Improve understanding of flood risk including likely effects of climate change.

2. Encourage future development to provide a betterment to flood risk.

3. Pursue flood risk management measures using a risk based approach that provide multiple social, economic and environmental benefits to the borough.

4. Raise awareness of flood risk and management measures to communities, residents and businesses.

5. Use knowledge of flooding to inform the emergency response.

6. Continue to manage local flood risk and coastal flooding & erosion.

**Measures across the South Essex Flood risk Area**

Across the South Essex FRA there are 53 measures to manage local sources of flood risk. These are summarised below, with the detailed measures set out in Part C: appendices. Measures included, are over and above RMA ‘flood risk management activities’ undertaken routinely, as explained in Part A, Section 4 – How to Manage Risk . Measures cover discrete pieces of work such as projects and campaigns.

**Preventing risk:** 21 measure

- Studies to understand risk in Rochford Watery Lane and Rayleigh West.

- Further development and feasibility assessment of a variety of Surface Water alleviation measures for Maldon and Heybridge have been proposed within the Surface Water Management Plan. These are detailed through the SWMP and associated Action Plan, with specific measures proposed for each CDA.

- Investigate and determine appropriate solutions for managing flood risk from all sources to people and property along the mid-course of Eastwood Brook within Southend-on-Sea, in partnership with key partner risk management authorities. This will also meet the objectives of Southend BC’s SWMP which seeks for collaborative working to consider managing flood risks at a ‘cross-boundary’ level. Possible solutions that should be considered include a combination of property level protection and flow attenuation measures.
• Work with the community in Rawreth look at ways to reduce the risk of flooding to the community this may include Individual Property Protection. Partnership funding will be required.

Preparing for risk: 9 measure

• Identify areas that would benefit from a surface water forecasting system and determine feasibility.

• Undertake SWMPs and detailed investigations in high priority CDAs as identified by SWMP

• Monitor flood risk and take account of the cumulative effects of new development, urban creep and climate change on the risk of flooding throughout the Southend-on-sea Borough. This will be delivered by maintaining configured flood mapping, developing a system for shared data storage and usage between the RMAs, developing a network of rain gauges across the Borough and undertake groundwater monitoring and improve recording and investigation systems.

• Use information on flood risk to identify property / people / groups at risk, in order to inform emergency planning and emergency response priorities within the Southend-on-sea Borough

Protecting from risk: 21 measures

• Surface Water Management Study for Basildon Kingswood, Basildon North West Billericay, New Thundersley, Hockley Sluice, Wagtail Drive Maldon and East Thundersley to determine options.

• Options for maintenance of the flood storage area in Castle point – South Benfleet

• The Nevendon Brook along Borwick Lane in Wickford regularly floods out onto the highway and into properties gardens. The watercourse receives annual vegetation clearance and regular inspections and removals of blockages, yet still floods frequently. It is suggested that the cause of this flooding is due to an under sized culvert on the Nevendon Road highways culvert. Work with ECC and County Highway to investigate further and agree potential solutions and funding sources.

• A total of £19 million capital funding is available from Essex County Council to deliver a 5 year programme (2015-2020) of flood management schemes within the Essex County Council area. The focus is around surface water and local flood risk, but other projects will include property-level protection and partnership funding contributions

Recovery and Review: 2 measures

• Complete Flood Investigation Reports following flooding events where required

• Encourage residents, businesses and stakeholders to report incidents of flooding

The Flood risk Area sits within the Combined Essex Catchment. For a summary of the measures for to manage flooding from reservoirs, rivers and sea see section 6 the combined Essex Catchment.
3. Conclusions, objectives and measures to manage flood risk in Anglian River Basin District Catchments

The following sections consider the measures for each of the following catchments in the Anglian RBD:

- Broadland Rivers
- Cam and Ely Ouse (including South Level)
- Combined Essex
- East Suffolk
- Nene
- North Norfolk Rivers
- North West Norfolk
- Old Bedford and Middle Level
- Upper and Bedford Ouse
- Welland
- Witham

Each section includes a summary of the catchment, key statistics, and conclusions and objectives on flood risk. It provides a summary of the required measures to effectively manage this risk. Within each catchment section there is also a description of wider catchment issues including river basin management plan (RBMP) priorities for the catchments. This will allow all RMAs to consider how to achieve multiple benefits in managing flood risk.

Working with lead local flood authorities (LLFAs)

The Environment Agency has worked in partnership with other RMAs, in particular LLFAs, to pool information to develop an overall plan for managing all sources of flood risk and coastal erosion. Of particular importance are the Local Flood Risk Management Strategies developed by all LLFAs. Below lists the lead local flood authorities (LLFAs) in the Anglian RBD and which of the sub-areas listed above they cover. This FRMP includes actions and objectives from all the LLFA strategies within the Anglian RBD. Please see the link to the LFRMS for further information.

<table>
<thead>
<tr>
<th>LLFA</th>
<th>Relevant management catchment</th>
<th>Link to further information</th>
</tr>
</thead>
</table>
| Lincolnshire County Council | • Witham  
• Welland  
• Nene                       | Lincolnshire County Council LFRMS             |
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| Rutland County Council      | • Welland  
  • Nene  
  • Witham                                                          | Rutland County Council Flooding web page                          |
| Leicestershire County Council| • Welland                                                            | Leicester Local Flood Risk Management Strategy                    |
| Peterborough City Council   | • Welland  
  • Nene  
  • Old Bedford & Middle Level                                      | Peterborough Local Flood Risk Management Strategy                |
| Northamptonshire County Council | • Welland  
  • Nene  
  • Upper & Bedford Ouse                                             | Northamptonshire Local Flood Risk Management Strategy            |
| Milton Keynes COUNCIL       | • Upper & Bedford Ouse                                              | Milton Keynes Flood and Water Management                          |
| Central Bedfordshire        | • Upper & Bedford Ouse                                              | Central Bedfordshire Local Flood Risk Management Strategy        |
| Bedford Borough Council     | • Upper & Bedford Ouse                                              | Bedford Borough Council Flood Risk Management                     |
| Cambridgeshire County Council | • Nene  
  • Old Bedford & Middle Level  
  • Upper & Bedford Ouse  
  • Cam, Ely Ouse and South Level  
  • Combined Essex                                                      | Cambridgeshire Local Flood Risk Management Strategy                |
| Norfolk County Council      | • North West Norfolk  
  • North Norfolk Rivers  
  • Broadland Rivers  
  • Cam, Ely Ouse and South Level  
  • Old Bedford & Middle Level  
  • Nene                                                                  | Norfolk County Council Flood Risk Management                      |
| Suffolk County Council      | • Broadland Rivers  
  • Cam, Ely Ouse and South Level  
  • East Suffolk  
  • Combined Essex                                                        | Suffolk Local Flood Risk Management Strategy                      |
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<th>Relevant management catchment</th>
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</table>
| Essex County Council | • Combined Essex  
• South Essex FRA | Essex County Council Local Flood Risk Management Strategy |
| Southend on Sea Borough Council | • Combined Essex  
• South Essex FRA | Southend - on - Sea Borough Council Local Flood Risk Management Strategy |

**Find out more**

- **Preliminary Flood Risk Assessment and Flood Risk Areas**

- **Preliminary Flood Risk Assessment for Essex**

- **Southend Borough Council Preliminary Flood Risk Assessment**
3.1. The Broadland Rivers Catchment

Introduction to the catchment

The Broadland Rivers catchment is a relatively large catchment covering an area of 3,237km². This includes around two thirds of Norfolk and part of north Suffolk. Much of the area is rural with pockets of urban settlements ranging from cities and towns to rural hamlets. The major settlement in this area is Norwich, the largest city in East Anglia, which sits broadly in the centre of the catchment at the confluence of the Wensum and the Yare. Other large settlements include the seaside towns of Great Yarmouth and Lowestoft, where major regeneration is planned.

The Broadland Rivers catchment area is generally flat in comparison to the upstream areas of Norwich which are relatively hilly. This higher ground comprises of the rivers that drain Norfolk and Suffolk by exiting to the sea at Great Yarmouth.

To the north are the Broadland rivers of the Bure, Ant, and Thurne. These drain the areas around the market towns of Aylsham, North Walsham, Stalham, Hoveton, Wroxham and Acle. A characteristic feature of the upper reaches of the river Wensum, Bure and Ant is they have a stepped river bed profile created by numerous mills, weirs and locks. The drop in riverbed level at the lock gates can be as much as a few metres and flood waters can back up behind these structures. The upper reaches of the rivers, including the river Wensum (an important chalk river) and the river Waveney (a classic lowland river), contrast with the low-lying reaches further down the catchment where the land is mostly at, or below sea level.

In amongst these slow flowing rivers are over 22 interconnected lakes and wetlands known as the Broads after which the catchment takes its name. These are man-made features created by medieval peat digging that have subsequently flooded. The largest are Hickling Broad and Barton Broad. The Broads are connected by navigable rivers and the area’s economy is dominated by the provision of leisure facilities associated with these waters.

Once the rivers reach the Broads, they become wide and flat and tidal in nature. Here different rivers can share the same flood plain (for example the Halvergate Triangle between the river Yare and Waveney). The level of the flood plain varies in the tidal broads due to land use. The main outlet to the sea is the mouth of the Yare at Great Yarmouth, which controls the flow of tidal waters into the Broads.

Land use and management

The population of the catchment is 755,226. The Broadlands has a strong farming heritage, with over 80% used for agriculture. Land drainage in the Broads, Norfolk rivers, and Lower Yare, Waveney and Lothingland areas improves agricultural production for over 28,000 hectares of land. In the Broads area and river valleys 36 pumps and 746km of watercourse are maintained to help manage and drain the land.

The catchment supports important wildlife and landscape, excellent angling, inland navigation, historic towns and the city of Norwich. All of these combine to make it a thriving tourist destination, with water-based recreation such as boating and angling vitally important to the
local economy. In 2011 7.4 million people visited the Broads, resulting in an estimated visitor spend of £469 million which supported over 6,000 jobs.

**Geology**

The underlying geology is chalk to the west and crag (gravel, sand and silt mix) to the east. This is largely covered by an upper layer of sand, silt and clay. Chalk is close to the surface or exposed in some locations in the north-west. Peat soils generally occur around the Broads and in the river valleys; finer sandier soils occur to the north and east; and heavier silt and clay soils are found to the south and west.

This catchment includes the Broadland Rivers Chalk and Crag groundwater body. The Chalk and Crag are classified as principal aquifers which means they provide a high level of water storage which can help absorb surface water. They support water supply and/or river base flow on a strategic scale.

**National and international designations**

The Broadland Rivers catchment incorporates the Norfolk and Suffolk Broads national park, Britain’s largest protected wetland. The Broads is an important wetland for nature conservation, and home to some of the rarest plants and animals in the UK. The Broads holds the majority of the UK fen resource in the Bure, Ant and Thurne.

The catchment has a high density of nationally important protected sites totalling 31051ha, including the Broads and River Wensum SACs and the Broadland SPA and RAMSAR site. Water quality has to be managed carefully in these protected areas and lakes.
Partnership working

Within the Broadland Rivers catchment there are 2 LLFAs, Norfolk County Council (NCC) and Suffolk County Council (SCC). The Environment Agency has worked in close with NCC and SCC who have provided measures from their Local Flood Risk Management Strategies (LFRMS) to be included in the Anglian FRMP. SCC’s LFRM was published in February 2013 and NCC’s LFRMS was published in autumn 2015.

There are also 10 district council with the Broadland River catchment, 5 of these are maritime councils.

The Broadland River catchment also benefits from the existence of the Norfolk Water Management Partnership (NWMP) and the Suffolk Flood Risk Management Partnership (SFRMP). The partnerships bring together the LLFA, district councils, IDBs, highway authorities and water companies, NE and NFU and the Environment Agency to help manage local flood risk.

There are also 3 IDBs within the catchment – Norfolk Rivers, Broads and Waveney Lower Yare and Lothingland. The Environment Agency assist IDBs in the development of their programme of capital upgrade works for flood risk management assets. As part of this, IDBs and the Environment Agency have jointly prepared public sector cooperation agreements (PSCAs) with the Norfolk Rivers, Broads IDB. PSCAs provide a legal mechanism for both parties to maximise their combined resources to deliver a more efficient way of providing services and work for the benefit of local communities.

Wider catchment issues with an impact on flood risk management

- The Environment Agency prioritise funding to protect people and property and in some rural locations it is hard to justify funding for flood risk management. However, we understand these areas are of value to the landowners, communities and local economy. The Environment Agency will work with landowners to ensure they understand their risk and provide advice for them if they wish to carry out their own maintenance, therefore we are working with landowners

- Saline incursion (salt water flowing up the rivers from the sea) threatens the ecology of the rivers and the protected areas in many of the lower reaches of the low-lying Broadland Rivers catchment. The Upper Thurne is particularly sensitive, as it is a freshwater fishery. Saline intrusion (salt water from the sea via groundwater) is also a significant risk in the Upper Thurne given the close proximity to the sea and current land drainage practices.

- Climate change and the increasing pressure of housing development have the potential to put further strain on river flows and water supplies. RMAs will continue to work with water companies and other partners to increase water capture and water efficiency.

- Rural land management practices within the catchment can contribute to high phosphate levels and increased sediment in the rivers. Work is needed to reduce run-off, and soil, nutrient and pesticide loss, along with a reduction of nutrients in watercourses from public and private waste water.

- The rivers are especially vulnerable to invasive non-native species. The only way to prevent the species from spreading is by water users following basic bio-security procedures, as described through the ‘Check, Clean, Dry’ campaign. Invasive species in the catchment include signal crayfish in the middle and lower Wensum and in the Middle Yare and invasive shrimp, *dikerogammarus villosus*, in the Broads. Invasive non-native
species can also have impacts on flood risk e.g. the rapid plant growth of floating pennywort can block channels, pumps and culverts; crayfish and mitten crabs burrowing in river banks can undermine them and cause bank erosion and damage to flood defence assets.

**Coastal erosion**

Coastal erosion can be significant. The area has lost villages to the sea over the past 500 years and the soft dunes and cliffs continue to erode, some at an average of 1 metre per year. At Happisburgh, numerous properties have been lost to the sea over the past 20 years and at Hemsby 6 properties fell into the sea because of the erosive effects of the December 2013 tidal surge.

**Climate change**

The climate is changing and this is likely to have an impact on flooding and coastal erosion. Sea levels are rising and winter rainfall may become more intense. Changes in weather patterns and, in particular, more torrential rainfall is likely to increase flood risk from surface water and ordinary watercourses as well as rivers. Communities within the Broadland Rivers catchment have experienced an increase in both severity and frequency of existing flooding problems and communities that have not flooded previously have been affected in recent years. It is likely that this pattern will continue. Surface water and sewer flooding may increase due to more intense summer rainfall events. The main areas of flood risk remain the three urban areas of Norwich, Great Yarmouth and Lowestoft. Undefended settlements along the fluvial and tidal watercourses will experience more moderate increases in risk.

Rising sea levels mean that waves and storm surges could cause greater coastal erosion. Changes to the currents acting on the coast could also lead to changes in the movement of coastal sediments, affecting both coastal deposition and erosion. This could expose new risks from coastal flooding, lead to a greater risk of coastal defences failing and increase the need for maintenance work on defences and more extensive warning systems.

Due to the low lying nature of the Broads climate change will increase the probability of tidal flooding and increase the length of time watercourses will not be able to flow freely to the sea at high tide, causing tide-locked.

**Flood risk maps and statistics**

**Flooding from rivers and the sea**

There is a risk of river flooding from the River Bure, Wensum, Yare, Tiffey, Tas and Tud and Waveney. Particular areas of risk are: Aylsham, Wroxham and Hoveton, Fakenham to Swanton Morley, Costessey, Barnham Broom to Cringleford, Diss, Bungay, and there are over 1,000 properties at risk within the city of Norwich. On one occasion a combination of river and surface water led to flooding around the Wendling Beck area.

Tidal flooding can have a dramatic effect on the coastline, causing significant coastal erosion and overtopping or breaching of tidal defences causing rapid inundation of areas behind defences presenting a sever risk to life. This could inundate the coastal communities and towns of Walcott, Bacton, Sea Palling, Great Yarmouth, Lowestoft and Oulton Broad. Oulton Broad can potentially flood twice on the same tide – once from overtopping of Mutford Lock and then about 2 hours later from the surge progressing up the tidal river Waveney.
The characteristics of the rivers in Broadland mean they are susceptible to flooding from tidal surges which penetrate up the rivers. The scale is significant. It can take up to 5 hours for the tide to travel from Gorleston to Stalham. Furthermore, the low-lying nature of the land means that once defences are overtopped, water can travel significant distances, putting settlements at flood risk that are some distance from the channel. The following rivers are affected by tidal and river flooding: the river Bure, Thurne, Ant, Yare, Waveney and Trinity Broads (on a very large tidal surge). Areas at risk are Repps, Bastwick, Potter Heigham, Honing, Stalham Staithe St. Olaves, Oulton Broad, Beccles, Wroxham, Hoveton and Horning to Acle, Breydon Water and Norwich, particularly at Brundall and Reedham.

Figure 6: Flood Risk from Rivers and the Sea in the Broadland Catchment – National Flood Risk Assessment (NAFRA)
Table 3: Summary of the Flood Risk from Rivers and the Sea to people, economic activity and the natural environment across the Broadland Catchment

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<td>18,650</td>
<td>1,900</td>
<td>7,700</td>
<td>50</td>
</tr>
<tr>
<td>Risk to the natural and historic environment:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of EU designated bathing waters within 50m:</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Number of EPR installations within 50m:</td>
<td>127</td>
<td>4</td>
<td>0</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Area of SAC within area (ha):</td>
<td>6,800</td>
<td>4,500</td>
<td>450</td>
<td>1,150</td>
<td>0</td>
</tr>
<tr>
<td>Area of SPA within area (ha):</td>
<td>6,350</td>
<td>4,700</td>
<td>400</td>
<td>950</td>
<td>0</td>
</tr>
<tr>
<td>Area of RAMSAR site within area (ha):</td>
<td>6,400</td>
<td>4,700</td>
<td>400</td>
<td>950</td>
<td>0</td>
</tr>
<tr>
<td>Area of World Heritage Site within area (ha):</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Area of SSSI within area (ha):</td>
<td>8,950</td>
<td>5,300</td>
<td>500</td>
<td>1,250</td>
<td>0</td>
</tr>
<tr>
<td>Area of Parks and Gardens within area (ha):</td>
<td>4,850</td>
<td>150</td>
<td>&lt;50</td>
<td>50</td>
<td>0</td>
</tr>
<tr>
<td>Area of Scheduled Ancient Monument within area (ha):</td>
<td>500</td>
<td>&lt;50</td>
<td>&lt;50</td>
<td>&lt;50</td>
<td>0</td>
</tr>
<tr>
<td>Number of Listed Buildings within area:</td>
<td>8,850</td>
<td>130</td>
<td>30</td>
<td>350</td>
<td>0</td>
</tr>
<tr>
<td>Number of Licensed water abstractions within the area:</td>
<td>1,110</td>
<td>220</td>
<td>20</td>
<td>50</td>
<td>0</td>
</tr>
</tbody>
</table>

Flooding from reservoirs

There are numerous reservoirs in the area, predominantly for agricultural purposes. Environment Agency published flood risk maps for reservoirs show around 359 people and 135 non-residential properties are located in areas that would flood as a result of reservoir failure within the Broadland Rivers catchment. In addition, 1,118ha of agricultural land is considered to be located in areas that would flood as a result of reservoir failure as well as 26 licensed abstraction points. An estimated 285ha of designated habitat and 17 listed buildings are also in areas that would flood as a result of reservoir failure.
Figure 7: Summary flood risk from reservoirs to people, economic activity and the natural and historic environment across the Broadland Rivers Catchment
Flooding from surface water

Surface water and sewer flooding affect the catchment. Norwich (inc. Dryton, Taverham and Cringleford) and Great Yarmouth (inc. Gorleston and Bradwell) are known to have experienced surface water flooding, along with many other smaller communities. The LLFA flood maps for surface water flooding identify additional areas at risk from surface water flooding across the catchment.

Flooding from groundwater

There is no consistent local information available which provides evidence of possible future groundwater flood risk in the Broadland catchment. The groundwater flooding problems in Poringland and Framingham Earl are most likely to be the result of water percolation through the overlying glacial sands and gravels followed by surface run-off across the interface with the underlying chalky boulder clay. For more information on local sources of flood risk please

Table 4: Flood Risk from Reservoirs in the Broadland Rivers Catchment

<table>
<thead>
<tr>
<th>Reservoirs</th>
<th>Total in catchment</th>
<th>Maximum extent of flooding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk to people:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of people in area:</td>
<td>755,250</td>
<td>350</td>
</tr>
<tr>
<td>Number of services:</td>
<td>1,780</td>
<td>10</td>
</tr>
<tr>
<td>Risk to economic activity:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of non-residential properties:</td>
<td>125,300</td>
<td>150</td>
</tr>
<tr>
<td>Number of airports:</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Length of roads (primary routes) (km):</td>
<td>450</td>
<td>0</td>
</tr>
<tr>
<td>Length of railway (km):</td>
<td>180</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Agricultural land (ha):</td>
<td>282,950</td>
<td>1,100</td>
</tr>
<tr>
<td>Risk to the natural and historic environment:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of EU designated bathing waters within 50m:</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Number of EPR installations within 50m:</td>
<td>127</td>
<td>0</td>
</tr>
<tr>
<td>Area of SAC within area (ha):</td>
<td>6,800</td>
<td>100</td>
</tr>
<tr>
<td>Area of SPA within area (ha):</td>
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<td>&lt;50</td>
</tr>
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<td>&lt;50</td>
</tr>
<tr>
<td>Area of World Heritage Site within area (ha):</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Area of SSSI within area (ha):</td>
<td>8,950</td>
<td>100</td>
</tr>
<tr>
<td>Area of Parks and Gardens within area (ha):</td>
<td>4,850</td>
<td>50</td>
</tr>
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<td>Area of Scheduled Ancient Monument within area (ha):</td>
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<td>20</td>
</tr>
<tr>
<td>Number of Licensed water abstractions within the area:</td>
<td>1,110</td>
<td>30</td>
</tr>
</tbody>
</table>
see local surface water management plans or the local FRMS or contact Norfolk County Council or Suffolk County Council.

Conclusions and objectives for the Broadland Rivers Catchment

The characteristics of the rivers in Broadland mean that they are susceptible to flooding from tidal surges which travel up the rivers. Furthermore, the low-lying nature of the land means that once defences are overtopped, water can travel significant distances – putting settlements at flood risk that are some distance from the channel.

Coastal areas within the catchment most susceptible to flooding from the sea are:

- Tidal River Bure – 824 properties at risk, stretching from Wroxham, Hoveton and Horning to Acle. The Acle Straight – the route that the main A47 road and the railway line take across Halvergate Marshes. Is susceptible to tidal flooding and was flooded in 1938, 1953, 1978 and 2006.
- Tidal River Thurne – 277 properties are at risk, predominantly close to the river at Repps, Bastwick and Potter Heigham.
- River Ant – 121 properties at risk, mostly at Honing and Stalham Staithe.
- Outlying villages on the Bure, Ant and Thurne – these are the properties that are not adjacent to the rivers but across low-lying marshes. They would need a significant tidal surge to flood and collectively total 1,362 properties.
- Trinity Broads – these Broads are not connected by navigation to the rest of the network. They consist of fresh water and would only be at risk in a very large surge. 130 properties are at risk in such circumstances.
- Tidal River Yare – 562 properties at risk between Breydon Water and Norwich, particularly at Brundall and Reedham.
- Tidal River Waveney – 763 properties at risk, principally in St. Olaves, Oulton Broad and Beccles.

This combination of low-lying land and the network of broads and rivers means that an estimated 7% of the total population of the Broadland Rivers catchment is considered to be at risk of flooding from the rivers and sea, of this 6% (of the total population at risk) is considered to be at high risk.

Again, it is the landscape of the Broads that provides a thriving tourist economy that also leads to the risk of flooding. An estimated 8% of non residential properties (which includes commercial properties) is considered at flood risk, of these 28% are considered to be at high risk from flooding.

The infrastructure of the catchment is also at risk in parts of the catchment and 26% of the primary route road network is at risk and 34% of the rail network at risk from flooding.

Of the 282,953ha of agricultural land 10% is considered to be at flood risk and pumps and land drainage is important to manage the risk. The access to abstraction points is also important to the agricultural economy and an estimated 26% of the licensed water abstraction points are considered at risk from flooding.

The catchment has a high density of nationally important European designated and protected sites. An estimated 76% of the designated area is considered to be at flood risk. However, in some locations the value of the site is as a result of their location to rivers or the coast. Of the
listed buildings within the catchment 6% are considered to be at flood risk in the catchment along with 30% of area designated for scheduled ancient monuments.

For the rivers within the catchment that are susceptible to fluvial flooding alone, the risk is as follows;

- River Bure – 240 properties at risk, mostly in the towns of Aylsham, Wroxham and Hoveton.
- River Wensum – 68 properties at risk from Fakenham to Swanton Morley. On Wendling Beck, 33 properties are at risk of flooding form a combination of river and surface water flooding. Downstream of Swanton Morley the threat of river flooding is significant with 185 properties at risk in and around Costessey and over 1,000 at risk within the city of Norwich. The most significant flood in the history of Norwich was in August 1912. On that occasion over 3,600 properties were flooded.
- River Yare – 49 properties at risk from Barnham Broom to Cringleford
- Rivers Tiffey, Tas and Tud – 34 isolated properties at risk
- River Waveney – there are 158 properties at risk on the upper reaches, principally in and around Diss. On the lower reach 122 properties are at risk, mostly in Bungay.

The risk of flooding from reservoirs is very low in the Broadlands River catchment. This is partly to do with the amount of natural water sources and aquifers in the Broadland Rivers. This means there is little need for manmade reservoirs in the catchment.

Objectives for the Broadland Rivers Catchment
This is a summary of the Environment Agency objectives for this catchment. More detail of these objectives can be found in Part A, section 8 conclusions, objectives and measures. The catchment also includes measures from other RMAs. The objectives for these measures can be found in ‘Part C, Annex 2 - Source of objectives and measures for the FRMP’.

Social
- Understanding Flood Risk and Working in Partnership
- Community preparedness and resilience
- Minimise community disruption
- Time to adapt to coastal erosion
- Avoid inappropriate development in areas of flood and coastal erosion
- Reduce risk to life, people and property
- Maintain existing assets minimise the risk of flooding to residential properties
- Continue river, watercourse and tidal defence maintenance

Economic
- Reduce economic damage to non-residential properties
- Maintain existing assets minimise the economic damage from flooding to non-residential properties
- Economic, regeneration and funding opportunities
• Minimise the risk of flooding to transport services
• Continue river and watercourse maintenance to minimise the risk of flooding to non-residential properties
• Consider flood risk to agricultural land
• Understanding Flood Risk and Working in Partnership with landowners
• Ensure that FRM activities do not adversely affect the tourism industry

Environmental
• Contribute to achieving Water Framework Directive (WFD) objectives
• Minimise the negative impacts of flooding to Designated nature conservation Sites
• Minimise the negative impacts of flooding to designated heritage sites

Reservoirs
• Reduce the risk of flooding from reservoirs to people, property, infrastructure and the environment.

Measures across the Broadland River Catchment
There are 187 measures to manage flood risk across the Catchment. These are summarised below, with the detailed measures set out in the Part C: appendices. Measures included, are over and above RMA ‘flood risk management activities’ undertaken routinely, as explained in Part A, Section 4 – How to Manage Risk.

Preventing risk: 74 Measures
• Carry out Gorleston to Lowestoft Study which includes a review of policies at Corton and Hopton and considers Hold the Line at north Lowestoft and management of derelict defences.
• Develop an implementation plan for 3 key sites - Lowestoft South Beach; Kessingland Levels; Southwold.
• Develop a Flood Risk Study and integrate surface water management plan for Lowestoft and Great Yarmouth to investigate how we can take further action to reduce actual and residual flood risk.
• Structure appraisal of Lothing Hundred System.

Preparing for risk: 29 Measures
• Champion, investigate and seek funds for the deployment of coastal adaptation measures to enable a managed approach to coastal change. Including measures for businesses, households, community resilience, heritage, environment and infrastructure in Corton, Hopton, Lowestoft and Great Yarmouth.
• Review Flood Forecasting and Warning delivery plan to determine the need for new/modified flood warnings following Buxton Flood Risk Study
• Promote partnership working by Leading and supporting the Norfolk Water Management Partnership officer and member groups to communicate and share best practice between Norfolk RMAs.
Protecting from risk: 84 Measures

- Continue with the Broadland Flood Alleviation Project (BFAP) to maintain the flood embankments. Develop a resistance and resilience plan and possibility of property level protection for properties at most risk in areas such as Wroxham, Hoveton and Potter Heigham.

- Continue with the River Wensum Restoration Strategy to restore the river to a more natural geomorphology, vegetation and flow regime. This includes reconnecting the river to surrounding flood plain where possible, and increasing the flood storage potential during extreme events, to reduce flood risk downstream at Norwich.

- Continue with and implement the outcomes of the recently completed Lowestoft Standards of Protection Study to investigate what can be done to reduce the current level of flood risk. The study should investigate the feasibility of the options of building a flood defence scheme or a tidal barrier to reduce the flood risk in Lowestoft

- refurbishment, renewal or removal of beach control structures with beach management to reduce the risk undermining of the sea wall and create and maintain a protective beach and restore public access to the beach at Corton, Gunton and from Lowestoft South Beach to Pakefield,

- Investigate flood risk in Buxton, Norwich and Bungay and identify ways to reduce the risk.
3.2. The Cam and Ely Ouse Catchment summary

Introduction to the catchment

The Cam and Ely Ouse catchment comprises an area of approximately 3,600km² extending from Swaffham in the north, to Royston and Saffron Walden in the south, and from Potton in the west, to Attleborough in the east.

The area is characterised by the East Anglian Chalklands in the south, Brecklands in the north, and the South Level fenland to the west of the area.

This catchment comprises 4 main tributaries: the Cam which receives tributary water from the river Granta, the Lodes (which form a part of the South Level system), the river Rhee and Bourn Brook; the river Lark and its tributaries; the Little Ouse and its tributaries, which include the Thet and the Sapiston/Black Bourn; and the river Wissey and its tributaries.

The South Level fenland area of the catchment is dependent upon a heavily man-made flood risk management system being effectively managed and maintained, which requires significant investment.

Following the floods of 1947 when a number of breaches occurred in this catchment, the Ely Ouse Flood Protection scheme was constructed. The scheme was designed and constructed to prevent overtopping and breaching of the raised embankments on the South Level Rivers (Cam; Old West; Ely Ouse; Ten Mile; Lark; Little Ouse and Wissey)

The scheme had 3 main elements:

- The widening and deepening of the Ely Ouse and Ten Mile River at certain locations
- The construction of a 47km long “Cut-Off Channel” from Suffolk to Denver
- The construction of a 7km long “Relief Channel” from Denver to King’s Lynn

The main flood risk management structure for this catchment is Denver Complex, which incorporates a number of discharge sluices and 2 navigational locks. Normal flows are discharged through Denver Little Eye sluices directly into the Great Ouse Tidal River. Under flood flow conditions it is not possible to discharge through the Little Eyes, so in order to manage upstream levels and reduce the flood risk, water is discharged through the AG Wright (or Head Sluice) into the Relief Channel and eventually into the Great Ouse Tidal River at King’s Lynn.

The sluices at Denver also prevent inundation during periods of high tides or surges.

River flows fall dramatically during summer months, as water is drawn from the system via slackers for agricultural irrigation purposes.

Land use and management

The overall catchment has a population of around 630,000. The catchment is predominantly low-lying and rural in nature, with high-grade agricultural land within the South Level fenlands. This is an area that has been actively drained and consists of a highly managed network of drains and dykes that allow the productive fenland peat soils to be farmed.
The main urban areas within the Cam and Ely Ouse are; Cambridge, Royston, Saffron Walden, Newmarket, Bury St Edmunds, Ely, and Swaffham. The area is rapidly developing due to its strategic position in south-east England, particularly within south Cambridgeshire. Several new developments are proposed around Cambridge, including a new town, Northstowe, and the redevelopment of the former RAF Alconbury.

In addition, the main link road through the catchment, the A14, is being upgraded and this will pave the way for further developments to take place. These developments will bring with them future flood risk challenges, creating opportunities for innovative sustainable drainage improvements which could provide benefits for the wider area.

Figure 8: Overview of the Cam and Ely Ouse Catchment

Geology

There are 2 important aquifers in this catchment. The largest is the chalk which underlies the eastern and central part of the area and is primarily exploited for public water supply and spray irrigation. The groundwater in the chalk generally discharges either at discrete springs or gradually along the length of rivers providing valuable base flow.

The other principal aquifer is lower greensand (known as the Woburn Sands) which outcrops further west and is separated from the chalk by a layer of gault clay. Although the greensand unit underlies the whole area, the dip of the strata means that it is only important for water supply along the outcrop and to a distance of about 15km to the east.

Towards the east the solid geology is overlain by an increasing thickness of boulder clay (Till) and quaternary sands and gravels, the latter acting locally as important secondary aquifers. In the far west the geology is clay.
National and international designations

Within the Cam and Ely Ouse catchment there are a number of sites designated for their environmental importance including: 4 SACs and 120 SSSIs of which 57 are water-dependent. The only SPA in the catchment is Breckland SPA.

There are a number of scheduled monuments and listed buildings, designated for their heritage value, across the catchment.

Partnership working

A good working relationship has developed between the partners within the Cam and Ely Ouse catchment. The lead local flood authority (LLFA) of Cambridgeshire County Council covers the majority of the catchment. They published their Local Flood Risk Management Strategy (LFRMS) in 2013 and are working with partners to prepare an updated version in the light of the new flood hazard mapping and other new data.

There are also a number of LLFAs which are partially within the catchment: Essex County Council; Norfolk County Council; Hertfordshire County Council; Central Bedfordshire County Council; and, Suffolk County Council. Many of these LLFAs have published local flood risk management strategies and are working together with the Environment Agency to prepare updated versions in the light of the new flood hazard mapping and other new data.

All of the LLFAs have formed flood risk management partnership groups that bring together all risk management authorities to effectively manage flood risk from all sources of flooding.

In addition to the LLFAs, there are 14 IDBs: Ely Group of IDBs which is a group of 10 smaller IDBs; East Harling IDB; Haddenham Level Drainage Commissioners; and Downham and Stow Bardolph IDB.

The Environment Agency and IDBs work closely together within this catchment, developing a coordinated programme of capital upgrade and maintenance works for flood risk management. As part of this, IDBs and the Environment Agency are exploring the use of public sector cooperation agreements (PSCAs) which provide a legal mechanism for both parties to maximise their combined resources to deliver a more efficient way of providing services and work for the benefit of local communities.

Wider catchment issues with an impact on flood risk management

The ecology of many watercourses in the catchment is impacted by silt and excess nutrients from both sewage treatment works and diffuse agricultural pollution.

Reducing the amount of silt entering watercourses would have a positive impact on flood risk and avoid the need to undertake costly maintenance work to remove it.

Excess nutrients can disturb the natural balance of a watercourse and cause rapid growth of vegetation and algae which can reduce flow in the river and may require expensive vegetation management. Low flows and high summer temperatures can exacerbate these effects.

The extent of historic river modification, such as heavily embanked or re-sectioned rivers, has decreased habitat diversity. Weirs and flood defence structures have been identified as obstacles to fish and eel passage.

All barriers to fish migration and sediment transfer are being reviewed to open up more rivers for fish and eel migration in response to the Eel Regulations 2009. Opportunities are being sought to re-establish, as far as possible, the natural functioning of river systems. This can be
done by working with natural processes and improving floodplain connectivity to have a positive impact on flood risk management.

Invasive non-native species pose a significant future threat in this catchment, although the impacts are not yet widespread. Signal crayfish are present in the river Lark, increasing the amount of fine sediment and silt build-up in the river. Floating Pennywort is present in the Cam and Ely Ouse and has the potential to impact on recreational use, and affects the aesthetic value of watercourses. The plant can grow up to 20cm per day, forming dense interwoven mats that can extend a significant distance above and below the water surface.

**Climate change**

The climate is changing and this is likely to have an impact on flooding and coastal erosion. Sea levels are rising and winter rainfall may become more intense. Changes in weather patterns and, in particular, more torrential rainfall is likely to increase flood risk from surface water and ordinary watercourses as well as rivers. Communities within the Cam and Ely Ouse catchment could experience an increase in both the severity and frequency of existing flooding problems, and communities that have not flooded previously could be affected in the future. It is likely that this pattern will continue through the effects of climate change.

The city of Cambridge and many smaller communities are likely to be affected by an increase in the risk of surface water flooding caused by higher levels of rainfall. Risk of flooding may also increase during winter as a result.

**Flood risk maps and statistics**

**Flooding from rivers**

Approximately 23,000 people are at risk of flooding from rivers within the Cam and Ely Ouse catchment, representing 3.6% of the total population. Nearly 9,000 non-residential properties and approximately 20% of the agricultural land within the catchment are at risk of flooding from rivers. Approximately 4.8% of SSSI sites and more than 55% of Ramsar sites are at risk of flooding from rivers in the area.

The main places at risk of river flooding are Cambridge and Saffron Walden.
Figure 9: Flood Risk from Rivers in the Cam and Ely Ouse Catchment – National Flood Risk Assessment (NAFRA)
Table 5: Summary flood risk from rivers and sea to people, economic activity and the natural and historic environment across the Cam and Ely Ouse Catchment.

<table>
<thead>
<tr>
<th>Risk to people:</th>
<th>Total in Catchment</th>
<th>High risk</th>
<th>Moderate risk</th>
<th>Low risk</th>
<th>Very low risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of people in area:</td>
<td>630,600</td>
<td>4,550</td>
<td>11,200</td>
<td>7,050</td>
<td>&lt;50</td>
</tr>
<tr>
<td>Number of services:</td>
<td>1,910</td>
<td>40</td>
<td>120</td>
<td>50</td>
<td>0</td>
</tr>
</tbody>
</table>

| Risk to economic activity: | | | | | |
| Number of non-residential properties: | 111,750 | 1,050 | 5,850 | 1,900 | 10 |
| Number of airports: | 1 | 0 | 0 | 0 | 0 |
| Length of roads (primary routes) (km): | 740 | <10 | 30 | 10 | <10 |
| Length of railway (km): | 260 | <10 | 60 | 10 | <10 |
| Agricultural land (ha): | 282,150 | 5,050 | 46,600 | 5,700 | <50 |

| Risk to the natural and historic environment: | | | | | |
| Number of EU designated bathing waters within 50m: | 0 | 0 | 0 | 0 | 0 |
| Number of EPR installations within 50m: | 112 | 5 | 9 | 3 | 0 |
| Area of SAC within area (ha): | 8,450 | 150 | 250 | 150 | <50 |
| Area of SPA within area (ha): | 39,600 | 550 | 400 | 350 | <50 |
| Area of RAMSAR site within area (ha): | 550 | 100 | 150 | <50 | 0 |
| Area of World Heritage Site within area (ha): | 0 | 0 | 0 | 0 | 0 |
| Area of SSSI within area (ha): | 43,300 | 850 | 800 | 500 | <50 |
| Area of Parks and Gardens within area (ha): | 3,800 | 100 | 100 | 100 | 0 |
| Area of Scheduled Ancient Monument within area (ha): | 1,300 | <50 | 100 | 100 | <50 |
| Number of Listed Buildings within area: | 9400 | 170 | 170 | 180 | 1 |
| Number of Licensed water abstractions within the area: | 5,940 | 800 | 3,930 | 90 | 0 |

Flooding from reservoirs

Nearly 4,000 people are at risk of flooding from reservoirs in the Cam and Ely Ouse catchment, representing approximately 6% of the total population within the catchment. The main risk is from the Ouse Washes reservoir, which lies just outside of the catchment, within the Old Bedford and Middle Level catchment. Approximately 3,500 non-residential properties and 9% of agricultural land are at risk of flooding from reservoirs in the Cam and Ely Ouse catchment. Approximately 4% of SSSI sites are also at risk of reservoir flooding in the area.

It is important to note that the likelihood of flooding from reservoirs is extremely low. However, in the unlikely event of a reservoir failure, there is the potential for a large volume of water to escape over a short period of time with little or no warning, which could lead to property damage or even loss of life.
Figure 10: Flood Risk from Reservoirs in the Cam and Ely Ouse Catchment
Table 6: Summary flood risk from reservoirs to people, economic activity and the natural and historic environment across the Cam and Ely Ouse Catchment.

<table>
<thead>
<tr>
<th>Reservoirs</th>
<th>Total in RBD</th>
<th>Maximum extent of flooding</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Risk to people:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of people in area:</td>
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<td>4,000</td>
</tr>
<tr>
<td>Number of services:</td>
<td>1,910</td>
<td>50</td>
</tr>
<tr>
<td><strong>Risk to economic activity:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of non-residential properties:</td>
<td>111,750</td>
<td>3,500</td>
</tr>
<tr>
<td>Number of airports:</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Length of roads (primary routes) (km):</td>
<td>740</td>
<td>10</td>
</tr>
<tr>
<td>Length of railway (km):</td>
<td>260</td>
<td>20</td>
</tr>
<tr>
<td>Agricultural land (ha):</td>
<td>282,150</td>
<td>25,000</td>
</tr>
<tr>
<td><strong>Risk to the natural and historic environment:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of EU designated bathing waters within 50m:</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Number of EPR installations within 50m:</td>
<td>112</td>
<td>13</td>
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<tr>
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<td>8,450</td>
<td>450</td>
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<tr>
<td>Area of SPA within area (ha):</td>
<td>39,600</td>
<td>1,400</td>
</tr>
<tr>
<td>Area of RAMSAR site within area (ha):</td>
<td>550</td>
<td>50</td>
</tr>
<tr>
<td>Area of World Heritage Site within area (ha):</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Area of SSSI within area (ha):</td>
<td>43,300</td>
<td>1,650</td>
</tr>
<tr>
<td>Area of Parks and Gardens within area (ha):</td>
<td>3,800</td>
<td>150</td>
</tr>
<tr>
<td>Area of Scheduled Ancient Monument within area (ha):</td>
<td>1,300</td>
<td>100</td>
</tr>
<tr>
<td>Number of Listed Buildings within area:</td>
<td>9,400</td>
<td>80</td>
</tr>
<tr>
<td>Number of Licensed water abstractions within the area:</td>
<td>5,940</td>
<td>2,840</td>
</tr>
</tbody>
</table>

Flooding from groundwater, surface water and sewers

Surface water flooding is a significant risk in urban areas within this catchment, particularly around Cambridge, the largest growth regions in the country. The updated surface water flood maps (December 2013) show a widespread problem. Lead local flood authorities are addressing surface water flood risk through the development and implementation of their local flood risk management strategies.

There has been some sewer flooding within the catchment, particularly within the Cambridge area, largely due to surface water inundation of sewers following significant rainfall events.

Newmarket and Bury St Edmunds are at risk from groundwater flooding which occurs after long periods of sustained rainfall. Groundwater at these locations is monitored using automated detection probes, and a flood warning advice service has been developed for these locations.
Conclusions and objectives for the Cam and Ely Ouse Catchment

Conclusions
The catchments within the Cam and Ely Ouse receive low rainfall levels in comparison to the national average. Much of the catchment is underlain by permeable bedrock resulting in the rainfall being stored in aquifers underground which feed the rivers slowly. However, the heavily modified nature of large parts of the catchment introduces manmade risks in the form of embanked watercourses and loss of floodplain.

Less than 4% of the population within the catchment is at risk of flooding from rivers. The Cam and Ely Ouse catchment has 4 significant river systems: the River Cam; the Lark; the Wissey; and the Little Ouse and its tributaries. The main risk areas on these rivers are Cambridge, Ely and Saffron Walden. A few smaller settlements in the catchment are also at risk of river flooding.

The Great Ouse Tidal River Action Plan aims to deliver the recommendations of the 2010 Tidal River Strategy (TRS), taking account of recent climate change guidance and the introduction of partnership funding. The purpose of the Tidal River Action Plan is to deliver a shared long-term vision of flood risk management within the Tidal River floodplain. This plan covers an area of the Norfolk and Cambridgeshire Fens with approximately 2,400 properties and 26,000 ha of prime agricultural land at flood risk.

The flood risk to people within the catchment is relatively low due to a combination of slow reacting rivers and an inland position. Flood risk to farmland is also low, since much of the agricultural land is protected by a network of dykes, drains and embankments managed by IDBs. These also help to protect smaller communities and infrastructure.

Surface water, ordinary watercourses, sewers, reservoirs and groundwater also present flood risk at specific locations within the catchment.

Whilst the area has some challenging flooding problems to address, the amount of undeveloped land available in the catchment means that there is potential to adopt new techniques and practices to alleviate these problems. The national significance of the area for food production should be considered when planning new approaches and long term options to managing flood risk.

CFMPs published in 2008 considered possible increases in flood levels, extent and risk if climate change were to increase flood flows by 20%. Climate projections since then suggest flood flows could increase by more than that but acknowledge significant uncertainty. No additional analysis is proposed at this stage; instead the preferred approach is to emphasise the uncertainty in climate change impacts. Planners, Emergency Planners, Asset Managers and others should ask questions such as: “have we considered what might happen if flood risk is worse than previously considered?” and “what can we do to mitigate the increased flood risk?”

Objectives for the Cam and Ely Ouse Catchment
This is a summary of the Environment Agency objectives for this catchment. More detail of these objectives can be found in Part A, section 8 conclusions, objectives and measures. The catchment also includes measures from other RMAs. The objectives for these measures can be found in ‘Part C, Annex 2 - Source of objectives and measures for the FRMP’.

Social
- Understanding Flood Risk and Working in Partnership
- Community preparedness and resilience
- Minimise community disruption
- Avoid inappropriate development in areas of flood risk
- Reduce risk to life, people and property
- Maintain existing assets minimise the risk of flooding to residential properties
- Continue river, watercourse and tidal defence maintenance

**Economic**
- Reduce economic damage to non-residential properties
- Maintain existing assets minimise the economic damage from flooding to non-residential properties
- Economic, regeneration and funding opportunities
- Minimise the risk of flooding to transport services
- Continue river and watercourse maintenance to minimise the risk of flooding to non-residential properties
- Consider flood risk to agricultural Land
- Understanding Flood Risk and Working in Partnership with landowners
- Ensure that FRM activities do not adversely affect the tourism industry

**Environmental**
- Contribute to achieving Water Framework Directive (WFD) objectives
- Minimise the negative impacts of flooding to Designated nature conservation sites
- Minimise the negative impacts of flooding to designated heritage sites

**Reservoirs**
- Reduce the risk of flooding from reservoirs to people, property, infrastructure and the environment.

**Measures across the Cam and Ely Ouse Catchment**

Across the Cam and Ely Ouse Catchment there are 80 measures to manage flood risk. These are summarised below, with the detailed measures set out in the [Part C: appendices](#). Measures included, are over and above RMA ‘flood risk management activities’ undertaken routinely, as explained in Part A, Section 4 – How to Manage Risk. Measures cover discrete pieces of work such as projects and campaigns.

**Preventing risk:** 34 measures
- Develop mitigation measures to reduce flood risk to highways across Norfolk
- Investigate the risk of groundwater flooding across Norfolk
- Develop a SuDS design guide for Essex and Suffolk
- Engage with landowners to apply appropriate land management practices to reduce flood risk in Essex
- Investigate the potential for property level protection along the River Kennett, and in suitable locations across Cambridgeshire, Essex, Norfolk and Suffolk

**Preparing for risk:** 19 measures
- Establish and maintain a flood management partnership between RMAs in Essex
- Develop an education and marketing programme to increase awareness of flood risk within Norfolk
- Develop and promote guidance for riparian owners within Suffolk and Norfolk
• Promote partnership working within Norfolk to communicate and share best practice between RMAs
• Identify areas and determine the feasibility of a surface water flood forecasting system in Essex

Protecting from risk: 26 measures
• Reduce flood risk to residential properties in Cambridge
• Develop detailed Surface Water Management Plans for Histon and Impington
• Review flood risk and identify mitigation options for Girton
• Development and delivery of the Tidal River Partnership Action Plan
• Develop a collaborative and strategic approach to flood risk in the Fens

Recovery and review of risk: 1 measure
• Complete flood investigation works to reduce flood risk in a Suffolk community

The above are catchment-specific flood risk management measures. Please refer back to section 8 of Part A of the FRMP to see the measures that apply to the entire or large parts of the Anglian RBD.
3.3. The Combined Essex Catchment

Introduction to the catchment

The Combined Essex catchment covers 3,414Km2; most of the county of Essex, stretching from the Thames Estuary in the south to the tributaries of the river Stour which flow from the north. It also includes a significant proportion of south Suffolk, including Sudbury, Haverhill, Hadleigh and Lavenham. The topography is generally low-lying and annual rainfall for the area is considered lower that the nationally average.

The catchment is made up of river valleys with undulating hills at the heads of the rivers in the west of the catchment. Significant urban areas include Braintree, Haverhill, Witham, Harwich and Colchester the oldest recorded roman town in Britain. In addition, Halstead, Sudbury, Hadleigh, Manningtree, Coggeshall, Frinton on Sea, Brightlingsea, Maldon and Great Dunmow are significant market towns.

The county town of Chelmsford sits where the rivers Chelmer, Wid and Can join. Eastwards, towards the coast, is the Dengie, this area is sparsely populated marshland that is drained for intensive arable crop production.

South of the river Crouch the catchment is significantly more urban in character and includes the towns of Billericay, Wickford, Basildon, Rayleigh, Thundersley and Southend-on-Sea. It is the urbanisation of the southern part of the catchment that contributes to the flood risk. The predominantly hard surfaces respond rapidly to heavy rainfall preventing water soaking into the ground. North of Southend, a network of creeks separates numerous islands from the mainland of Essex (Foulness, Wallasea and Potton Islands being the principal ones). Much of this land is used by the MOD.

There are also popular seaside resorts dotted along the coast, Clacton on Sea and Southend-on-Sea being the largest.

There are areas of high grounds between Brentwood and Billericay to the north, the Langdon Hills at Basildon and the area of land between South Benfleet and Hockley in the east.

Essex has a long history of flooding from the sea. 38 people lost their lives in Jaywick in 1953; following the tragedy a significant sea wall was built around the coast to prevent a recurrence. This defence has successfully protected Essex during all subsequent tidal surges.

The many rivers have often flooded, with 1947, 1958, 1968 and 2001 being the most notable. Once the rural catchments are saturated the rivers react quickly to rainfall causing floods that are short and sharp in nature.

The risk of surface water flooding in the south of the catchment is recognised as an indicative FRA in the Combined Essex catchment. This covers the southern part of Essex County Councils area and all of Southend Borough Councils area. More information can be found in the chapter on the South Essex Flood Risk Area.
Land Use and Management

The total population of the Combined Essex catchment is 1,367,279 people. The rural agricultural areas to the north of the catchment contrast the southern area, Thameside, where the main land use is industrial.

Over 87% of north Essex is classified as agricultural land, predominantly grade 2 and 3 and only 6% is urban with the remaining used for recreation, woodland and horticulture. The agricultural land is mainly used as pasture and for arable cultivation. In south Essex it’s estimated that 23% of land is urban and only 46% agricultural, used mainly for cereal and root crop production.

Tourism dominates the local economy on the coast, whether it is beach-based at Frinton, Clacton, Jaywick and Southend or linked to the seafood culture of Maldon and West Mersea. Recreational activities like walking and sailing are also popular in the estuaries. The commercial shipping from ports at Ipswich, Felixstowe and Harwich, is also important to the economy of the area.

Figure 11: Overview of the Combined Essex Catchment

Geology

North Essex is made up of 2 different layers of geology which determines how groundwater flows through the catchment. The bottom layer, or bedrock, is the solid geology which consists of compacted rocks. The top layer is the drift geology which is less compacted. Drift deposits overlay the solid geology in much of north Essex but are not always present.
The solid geology is mostly mudstone (London clay) which is impermeable and rapid run-off can be expected in these areas. Sands are present in the north-east of the catchment, whereas chalk is found in the north-west which is better at absorbing rain.

Top layer is sediment of various sizes that were deposited by the movement of ice called glacial tills. Sediment deposited by flowing water such as sands and gravels are found along historic river valleys. The majority of the south Essex does not have any drift geology and areas to the east and south have a combination of either clay silt and sand or sand and gravel. The permeability of the drift geology will affect the amount of rain water that reaches the underlying solid geology. In the areas with no drift deposits clay geology generally underlies the soil and prevents the rainfall from soaking away. This increases the amount of surface runoff, and leads to faster and fuller rivers and a risk of flooding.

Many watercourses, for example Prittle Brook and Eastwood Brook, have been extensively altered to help drainage and manage flooding which contributes the their rapid response to heavy rainfall.

**National and international designations**

Within the catchment there are a number of sites designated for their environmental importance including SPAs, SACs, Ramsar sites, SSSI and NNRs.

The varied inter-tidal and freshwater habitats of the Essex coast make it important for over-wintering and breeding birds, especially for the migration of wildfowl and waders, and almost all the coast is designated.

The sea defences themselves are very important habitats for many insects, amphibians and reptiles. The fresh and brackish (slightly salty) water borrow-dyke areas behind the defences are home to BAP species like water vole and great-crested newts. Another important BAP species is the native oyster which can be found in the Blackwater and Colne estuaries and Hamford Water and the blackwater herring is a local species found only in Essex waters.

Important environmental sites in the catchment include: Abberton Reservoir and the internationally significant estuaries of the Blackwater, Dengie, Hamford Water, Crouch and Roach Estuaries and Stour Orwell. There are 36 SSSIs within the catchment. Over 160 scheduled monuments, designated for their heritage value, are distributed across the catchment. River flooding has a minimal impact on these sites but they would be affected by flooding from the sea.

**Partnership working**

Within the Essex Combined catchment there are 4 LLFAs, Essex County Council (ECC) and Southend – On – Sea Borough Council (SBC), a section of Suffolk County Council and a very small part of Cambridgeshire County Council.

The Environment Agency has worked in close with the LLFAs who have provided measures from their Local Flood Risk Management Strategies (LFRMS) to be included in the Anglian FRMP. ECC and SBC have a duty to produce a FRMP for local sources of flood risk the Environment Agency has included information from ECC and SBC which is included in the FRA section.

SCC LFRMS was published in February 2013, ECC’s LFRMS was published in April 2013, and SBC’s LFRMS was published in December 2015.
There are also 16 district council with the Combined Essex catchment, 6 of these are maritime councils.

The Essex Combined catchment also benefits from the existence of the Essex Flood Partnership Board (EFPB), Southend Flood Partnership and Suffolk Flood Risk Management Partnership (SFRMP). The partnerships bring together the LLFA, district councils, IDBs, highway authorities and water companies, NE and NFU and the Environment Agency to help manage local flood risk.

Wider Catchment Issues with an Impact on Flood Risk Management

- The Environment Agency priorities funding to protect people and property and in some rural locations it is hard to justify funding for defences. However, we understand these areas are of value to the landowners and communities. The Environment Agency will work with landowners to ensure they understand their risk and provide advice for them if they wish to carry out their own maintenance, therefore we are working with landowners.

- The ecology of the catchment is impacted by historic physical modifications to the natural channel and land drainage practices. Changes to river and floodplain management will increase connectivity, reduce barriers to fish migration and enhance the diversity of river habitats. The Ely Ouse to Essex Transfer Scheme augments flows in the river Stour and river Pant and Blackwater to allow public water supply abstractions to take place when natural flows in the rivers are not sufficient. These changes affect the natural flow regime and can reduce habitat diversity. Some structures can form barriers to fish passage, preventing migratory species such as sea trout and eels from reaching spawning or feeding grounds and also inhibiting the movement of coarse fish. There needs to be a balance between managing flood risk and ensuring our rivers are a healthy as they can be.

- The rivers are especially vulnerable to invasive non-native species. The only way to prevent the species from spreading is by water users following basic bio-security procedures, as described through the ‘Check, Clean, Dry’ campaign. Invasive non-native species present within the catchment include American signal crayfish, Chinese mitten crabs, Himalayan balsam, Japanese knotweed, giant hogweed and floating pennywort. Invasive non-native species impact flood risk as rapid plant growth can block channels, pumps and culverts. Crayfish and mitten crabs burrowing into banks can undermine river banks and damage flood defence assets. The erosion of the bank can increase sediment loads in rivers causing other issues. Himalayan balsam grows rapidly along river corridors, but dies off completely in autumn, leaving bare earth and exposed banks which then unstable during heavy winter rainfall and increased river flows.

- Pollution from wastewater and diffuse pollution from rural and urban areas. High levels of nutrients, and in particular phosphorus, can cause changes to the plant communities in rivers and lakes, allowing species to dominate and excessive weed growth. This not only reduces habitat diversity, but can cause a number of other problems in the river, including algal blooms, overshading and a reduction in oxygen. Discharges from sewage treatment works and industrial wastewater treatment plants contribute to high levels of phosphate in the rivers. Surface water run-off from farm yards and fields can also carry high levels of nutrients into our
rivers. Combined sewer overflows and misconnections in urban areas can also contribute a reduction in water quality.

- Low flows and drought. The catchment is very dry, with an average rainfall of less than 600mm each year. There is also heavy abstraction, providing water for public drinking water supply as well as irrigation of crops and industrial use. Many of the rivers are affected by drought and periods of low flows. This can cause low levels of oxygen and concentrated pollutants in the river. This is also exacerbated by the impacts of historic changes to the shape of the rivers.

**Coastal erosion**

Much of the shoreline is made up of embankments that protect low-lying land against flooding. There are also a number of stretches of higher, soft-eroding cliffs on the open coast such as the Naze in Walton, and Measea Island. The cliffs at the Naze are, on average, eroding away at a rate of 1-2m per year, but large cliff ‘slumps’ mean that sometimes many metres can fall onto the beach below in a single day. There are some estuary cliffs in the mid sections of the estuaries, these are generally undefended, with the exception of the cliff frontages of Southend and the Tendring Peninsula at Clacton and Holland-on-Sea which are defended against coastal erosion. Major capital schemes are planned for Clacton on Sea and Southend on Sea.

**Climate change**

The climate is changing and this is likely to have an impact on flooding and coastal erosion. Sea levels are rising and winter rainfall may become more intense. Changes in weather patterns and, in particular, more torrential rainfall is likely to increase flood risk from surface water and ordinary watercourses as well as rivers. Communities within the Combined Essex catchment have experienced an increase in both severity and frequency of existing flooding problems and communities that have not flooded previously have been affected in recent years. It is likely that this pattern will continue.

Rising sea levels mean that waves and storm surges could cause a greater risk of coastal erosion to vulnerable beaches along the Tendring peninsular and the soft cliff frontage in the Stour and Blackwater estuary. Changes to the currents acting on the coast could also lead to changes in the movement of coastal sediments, affecting both coastal deposition and erosion. This could expose new risks from coastal flooding, lead to a greater risk of coastal defences failing and increase the need for maintenance work on defences and more extensive warning systems. Barriers in the Stour and Colne allow us to manage tidal locking heavy rainfall on a high tide following heavy rainfall. Rises in sea level and also prolong intense rainfall will mean the barriers will need to be operated more frequently.

**Flood risk maps and statistics**

**Flooding from rivers and sea**

There is a risk of flooding from the rivers Stour Colne, Blackwater Chelmer, Chelmer, Crouch, Roach and Prittlewell and Eastwood Brook and their tributaries, (the river Brain, Can and Wid). Areas at risk of flooding include Sudbury, Clare and Cavendish, Bures, Nayland and Stratford St Mary, Boxford, Lavenham and Sudbury Halstead Earls Great Yeldham and Sible Hedingham Colne, White Colne and Chappel, Colchester, Bocking and Braintree, Coggeshall, Bradwell, Feering and Kelvedon, Notleys, Great Dunmow and Witham, Little Waltham, Chelmsford, Brentwood and Wickford.
Much of the Essex coast is at risk of flooding from the sea due to a combination of the long estuaries and its low-lying nature. Tidal surges can have a dramatic effect on the open coast and the estuaries, causing significant erosion and flooding that presents a severe risk to life. Running from north to south the estuaries are the Stour, Colne, Blackwater, Crouch and Roach Estuary and the embayment Hamford Water. Coastal flooding could inundate coastal communities and the towns of Manningtree, Mistley, Brantham, Harwich Parkeston, Dovercourt, Walton-on-the-Naze, Jaywick, Brightlingsea, Wivenhoe, Colchester Mersea Island, Virle, Tollesbury, Maldon, Heybridge, Maylandsea, Saint Lawrence, South Woodham Ferrers, Dengie Peninsula, Hullbridge Paglesham, East of Paglesham, Rochford, Barling, Little Wakering, Great Wakering, Southend-on-Sea, Wallasea Island, Potton Island, Foulness islands and Burnham on Crouch. There is also a significant concentration of caravan parks and campsites directly behind defences at Jaywick, Pointclear, Brightlingsea, Maldon and Heybridge at risk of flooding if the defences were overtopped.

Figure 12: Flood risk from rivers and sea in the Combined Essex Catchment – National Flood Risk Assessment (NAFRA)
Table 7: Summary flood risk from rivers and sea to people, economic activity and the natural and historic environment across the Essex Combined Catchment

<table>
<thead>
<tr>
<th>Risk to people:</th>
<th>Total in Catchment</th>
<th>High risk</th>
<th>Moderate risk</th>
<th>Low risk</th>
<th>Very low risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of people in area:</td>
<td>1,367,300</td>
<td>9,500</td>
<td>11,200</td>
<td>34,350</td>
<td>5,250</td>
</tr>
<tr>
<td>Number of services:</td>
<td>2,620</td>
<td>100</td>
<td>50</td>
<td>90</td>
<td>10</td>
</tr>
</tbody>
</table>

| Risk to economic activity: | | |
|---------------------------|---|---|---|---|---|
| Number of non-residential properties: | 160,750 | 2,950 | 2,350 | 6,100 | 900 |
| Number of airports: | 1 | 0 | 0 | 0 | 0 |
| Length of roads (primary routes)(km): | 490 | <10 | <10 | <10 | <10 |
| Length of railway (km): | 240 | <10 | <10 | 10 | 0 |
| Agricultural land (ha): | 300,100 | 13,850 | 5,400 | 9,950 | 250 |

| Risk to the natural and historic environment: | | |
|-----------------------------------------------|---|---|---|---|---|
| Number of EU designated bathing waters within 50m: | 5 | 5 | 0 | 0 | 0 |
| Number of EPR installations within 50m: | 58 | 3 | 2 | 9 | 0 |
| Area of SAC within area (ha): | 3,850 | 2,950 | 100 | 300 | <50 |
| Area of SPA within area (ha): | 8,300 | 4,450 | 750 | 1,550 | 100 |
| Area of RAMSAR site within area (ha): | 8,300 | 4,450 | 750 | 1,550 | 100 |
| Area of World Heritage Site within area (ha): | 0 | 0 | 0 | 0 | 0 |
| Area of SSSI within area (ha): | 11,300 | 4,900 | 1,000 | 1,600 | 100 |
| Area of Parks and Gardens within area (ha): | 1,700 | 50 | <50 | <50 | 0 |
| Area of Scheduled Ancient Monument within area (ha): | 750 | 50 | <50 | <50 | 0 |
| Number of Listed Buildings within area: | 13,670 | 410 | 190 | 420 | 40 |
| Number of Licensed water abstractions within the area: | 1,440 | 370 | 90 | 30 | 0 |

**Reservoirs**

There are numerous reservoirs in the area, predominantly for agricultural purposes. They are currently being risk assessed in line with the requirements of the Flood and Water Management Act 2010. Three major reservoirs, used for public water supply, exist at Ardleigh, Hanningfield and Abberton. An estimated 26,040 people live within the maximum extent of flood from reservoirs in the catchment.
Figure 13: Flood Risk extents from Reservoirs in the Essex Combined Catchment
Table 8: Summary flood risk from reservoirs to people, economic activity and the natural and historic environment across the Essex Combined Catchment

<table>
<thead>
<tr>
<th>Reservoirs</th>
<th>Total in Catchment</th>
<th>Maximum extent of flooding</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Risk to people:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of people in area:</td>
<td>1,367,300</td>
<td>26,050</td>
</tr>
<tr>
<td>Number of services:</td>
<td>2,620</td>
<td>80</td>
</tr>
<tr>
<td><strong>Risk to economic activity:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of non-residential properties:</td>
<td>160,750</td>
<td>3,850</td>
</tr>
<tr>
<td>Number of airports:</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Length of roads (primary roads) (km):</td>
<td>490</td>
<td>30</td>
</tr>
<tr>
<td>Length of railway (km):</td>
<td>240</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Agricultural land (ha):</td>
<td>300,100</td>
<td>5,950</td>
</tr>
<tr>
<td><strong>Risk to the natural and historic environment:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of EU designated bathing waters within 50m:</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Number of EPR installations within 50m:</td>
<td>58</td>
<td>1</td>
</tr>
<tr>
<td>Area of SAC within area (ha):</td>
<td>3,850</td>
<td>750</td>
</tr>
<tr>
<td>Area of SPA within area (ha):</td>
<td>8,300</td>
<td>1,150</td>
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<tr>
<td>Area of RAMSAR site within area (ha):</td>
<td>8,300</td>
<td>1,150</td>
</tr>
<tr>
<td>Area of World Heritage Site within area (ha):</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Area of SSSI within area (ha):</td>
<td>11,300</td>
<td>1,350</td>
</tr>
<tr>
<td>Area of Parks and Gardens within area (ha):</td>
<td>1,700</td>
<td>&lt;50</td>
</tr>
<tr>
<td>Area of Scheduled Ancient Monument within area (ha):</td>
<td>750</td>
<td>&lt;50</td>
</tr>
<tr>
<td>Number of Listed Buildings within area:</td>
<td>13,670</td>
<td>360</td>
</tr>
<tr>
<td>Number of Licensed water abstractions within the area:</td>
<td>1,440</td>
<td>210</td>
</tr>
</tbody>
</table>

**Surface water flooding**

Surface water flooding can be significant in this area, particularly in the urbanised areas of south Essex. The Southend area experienced major surface water flooding in 2013 with over 240 properties flooded. South Essex is flat and built on land that was often marsh. This means surface water drainage is poor and causes regular problems on a limited scale in Basildon, Rayleigh Rawreth and Benfleet. Using the flood map for surface water and the national flood risk thresholds criteria and guidance provided by the Environment Agency a FRA was identified in south Essex. Please see the section on the South Essex Flood Risk Area for more information.

**Ground water**

At Burnham-on-Crouch and Rayleigh, groundwater levels are slowly rising in response to the end of long-term water abstraction during the 1970s. The chalk does not provide a groundwater discharge to any of the rivers, except the lower reaches of the Mardyke. We do
not consider groundwater to be a significant flood-related issue in south Essex as the overlaying impermeable deposits of London clay on the chalk aquifer reduce this.

Conclusions and objectives in the Combined Essex Catchment

Conclusions:

An estimated 4% of the population of the Combined Essex catchment is considered to be at risk of flooding from the rivers and sea. The majority (57%) of people at risk are considered to be at low risk. Of all the services (including hospitals, Schools, substations and Sewerage treatment works) 10% are considered to be a risk of flooding from the river and sea within the Combined Essex catchment. An estimated 8% of non-residential properties are considered at risk with the majority (50%) considered to be at low risk. Less than 8% of the primary road routes and 9% of the rail network is at risk from flooding from rivers and the sea. Less than 10% of agricultural land is considered at risk with the majority (47%) considered at high risk.

Water abstraction is important in the catchment for public water supply, industry and agriculture and an estimated 34% of licensed water abstraction points are considered to be at risk, with 75% of this sites at risk considered to be at high risk.

There are 5 EU designated bathing water area within 50m of the flood zone and this is considered to be at high risk of being affect by flooding. Environmental Permit Regulation (EPR) sites include historic and operating landfills sites. Less than 2% of the sites are considered to be at risk. In addition to less than 8% of listed buildings considered to be at risk 69% of the total hectares of environmental and historic designated sites in the catchment are also at risk. However, in most of the designated areas the value of the site is as a result of their location close to rivers or the coast.

- In total approximately 90 properties are at risk on the river Stour. In the middle reaches of the river Stour there are an estimated 460 properties at risk, particularly in Sudbury, Clare and Cavendish. Further downstream flooding can take place in Bures, Nayland and Stratford St Mary. An estimated 160 properties are at risk on the Stour as it flows down to Constable Country, a further 170 on the Box and Brett, principally in Boxford, Lavenham and Sudbury.
- Almost 400 properties are at risk in the quick reacting upper catchment of the river Colne, flooding can rapidly affect the settlements of Great Yeldham and Sible Hedingham. Further downstream flooding is a significant risk in Earls Colne, White Colne and Chappel and Halstead and an estimated of 600 properties are at risk in these locations. The river Colne becomes tidal at Colchester, where over 1,200 properties are at risk.
- River Blackwater begins life as the river Pant, changing its name at Braintree. Rising at Wimbish, there are 280 properties at risk, mostly in Bocking and Braintree. In total 350 properties are at risk on this stretch including Coggeshall, Bradwell, Feering and Kelvedon. There are 140 properties at risk on the River Brain, principally in the Notleys and Witham.
- In this first reach of the river Chelmer, there are 170 properties at risk, principally in Great Dunmow, Little Waltham and northern Chelmsford. The river then meets 2 major tributaries, the river Can, flowing from the west, and the river Wid flowing north from Brentwood where there are up to 100 properties at risk. The meeting of
these 3 watercourses means there is considerable flood risk to Chelmsford – in total over 1,900 properties.

- River Crouch drains south Essex from Basildon, in the west, to the head of the estuary at Battlesbridge. 250 properties are at risk, principally at Wickford.
- There are 3 main watercourses that drain the Southend suburbs of Eastwood and Prittlewell - with an estimated 240 properties at risk.

The risk of flooding from reservoirs is very low in the Combined Essex River catchment

**Objectives:**

This is a summary of the Environment Agency objectives for this catchment. More detail of these objectives can be found in Part A, section 8 conclusions, objectives and measures. The catchment also includes measures from other RMAs. The objectives for these measures can be found in ‘Part C, Annex 2 - Source of objectives and measures for the FRMP’.

**Social**

- Understanding Flood Risk and Working in Partnership
- Community preparedness and resilience
- Minimise community disruption
- Time to adapt to coastal erosion
- Avoid inappropriate development in areas of flood and coastal erosion
- Reduce risk to life, people and property
- Maintain existing assets minimise the risk of flooding to residential properties
- Continue river, watercourse and tidal defence maintenance

**Economic**

- Reduce economic damage to non-residential properties
- Maintain existing assets minimise the economic damage from flooding to non-residential properties
- Economic, regeneration and funding opportunities
- Minimise the risk of flooding to transport services
- Continue river and watercourse maintenance to minimise the risk of flooding to non-residential properties
- Consider flood risk to agricultural Land
- Understanding Flood Risk and Working in Partnership with landowners
- Ensure that FRM activities do not adversely affect the tourism industry

**Environmental**

- Contribute to achieving Water Framework Directive (WFD) objectives
- Minimise the negative impacts of flooding to Designated nature conservation Sites
Minimise the negative impacts of flooding to designated heritage sites

Reservoirs

Reduce the risk of flooding from reservoirs to people, property, infrastructure and the environment.

Measures across the Combined Essex Catchment

There are a total of 303 measures to manage flood risk across the catchment, 44 of which are within the South Essex FRA. All of the measures are summarised below, with the detailed measures set out in the Part C: appendices. Measures included, are over and above RMA ‘flood risk management activities’ undertaken routinely, as explained in Part A, Section 4 – How to Manage Risk. Measures cover discrete pieces of work such as projects and campaigns.

Preventing risk: 122 measures

- Work with partner risk management authorities to develop a flood risk study for the community along the mid-course of Eastwood Brook Coggeshall and Kelvedon.
- Work with the community at Ford Street in partnership with Essex County Council and Colchester Borough Council to reduce flood risk in the area where possible through defences or property level protection. There is fluvial flood risk from both the River Colne and Wash Brook.
- Heybridge is at significant risk from both surface water and river flooding which is predicted to increase with climate change. We will work with Risk Management Authorities, the community, landowners and developers to look at ways to reduce the risk of flooding through a range of solutions and schemes. The study should identify the current level of fluvial flood risk from the Langford Ditch, Holloway road Ditch, Heybridge Hall Ditch and the Spicketts Brook.
- Develop planning policy locally for caravan parks within a national policy framework e.g. roll-back policy. This needs to include the issue of permanent residency. Potential route for delivery via LA and caravan park owners with EA. And TDC Coastal pathfinder.
- Work with communities to investigate ways to manage flood risk in Bocking, Churchstreet, Braintree, Ashingdon, Bulpham, Gt Bardfield, Clacton, Gt Yeldham, Gt Dunmow, Haverings Gore, Little Waltham, Sible Hedingham, Steeple Bumpstead, Witham Dedham and Ford Street.

Preparing for risk: 42 measures

- Work with NE to agree a shared planned approach for adaptation and resilience of Holland Marshes, Cornard Mere, Cattawade Marsh, Upper Colne Marshes, Mark Tey Brick Pits, Roman River, Arger Fen, Chalky Wood SSSIs, Dedham Vale and Suffolk Coast and heaths AONB.
- Ensure partnership working and a flexible approach to the planning policies for Jaywick - short term planning guidance sought to avoid blight. Potential delivery route - TDC Core Strategy Review, TDC Pathfinder work.
- Develop and disseminate flood risk guidance specifically for caravan owners, occupants and businesses to raise awareness of risk and emergency plans. These are found along the Tendring peninsula, Colne, Blackwater, Roach and Crouch Estuaries.
• Understand resilience and recovery of habitats at risk

Protecting from risk: 128 measures

• Work with Essex County Council and other partners to develop SUDS schemes that deliver multiple benefits for managing pollution and flood risk. As well as improving land management techniques and carrying out habitat improvements with potential project at Potential projects we seek to develop include meander reconnection on Prittle Brook at Belfairs Wood, channel reprofiling on Noblesgreen Ditch at Jubilee Country Park, Great Dunmow and in-channel works in the Upper Chelmer.

• Investigation of flood risk at Cavendish, Bures Way, Claire, Heybridge Jolly Sailor Sluice, Hundon, Stratford St Mary, Lavenham, Nayland and Chelmsford.

• Implement the recommendations from the Chelmer Flood Risk Study and Chelmsford Flood Alleviation Scheme Viability Study. These studies will investigate creating/developing storage on the River Wid policy unit. This will mitigate future flood risk to Chelmsford. The study should determine the possible location of storage and combination of river restoration and engineered flood storage. Where possible the study should enhance the environment by improving the natural state of the river and its habitat.

• Conditioning, refurbishment and maintenance of assets at Borley Mill, Chelmsford automated gates, Cockett wick sluice trash screen, Colne Barrier, Long Melford channel clearance, Prittle Brook as well as others.

Recovery and review of risk: 11 measures

• Flood investigation at Boxford

• Understand contaminated land at flood risk and waste filled flood defences along the Dengie peninsular and the Roach and Crouch Estuary and specific sites of Barling Marsh

• Consider opportunities for use of dredged materials from the port and local marinas in improving/enhancing eroding intertidal areas. Linked to wider strategic review of potential sediment sources and receptor sites for dredged material. Potential route for delivery - beneficial use study. Sites include off Levington, Maldon, Mersea Island and Horsea Island.

The above are catchment-specific flood risk management measures. Please refer back to section 8 of Part A of the FRMP to see the measures that apply to the entire or large parts of the Anglian RBD.
3.4. The East Suffolk Catchment

Introduction to the catchment
The East Suffolk Catchment comprises of the Suffolk coast and estuaries from Kessingland to Landguard Point and the rivers that drain into the North Sea between those two points. It is a predominantly rural catchment. The county town of Ipswich is the largest settlement and the nearby port of Felixstowe, handling over 40% of national container traffic, has significant economic importance. Elsewhere, villages predominate with significant coastal resorts and market towns. The largest market town is Woodbridge, followed by Stowmarket, Needham Market, Wickham Market, Framlingham, Saxmundham and Halesworth. The major coastal resorts are Aldeburgh, Southwold and Felixstowe.

The vast majority of the coastline is designated an Area of Outstanding Natural Beauty (AONB). Most of the coastal settlements are at tidal flood risk. In Felixstowe, 41 people were killed by the 1953 tidal surge. Significant defences prevented a repeat in 2013.

The rivers are mostly small with few properties at risk from river flooding but rather more from risk of tidal flooding in the estuaries. In the south of the county, the River Gipping is the most significant river in the catchment. At Ipswich the River Gipping becomes the River Orwell. Suffolk County Council is the only Lead Local Flood Authority within this catchment.

Figure 14: Overview of the East Suffolk Catchment
Land use and management

The East Suffolk Catchment is mainly rural with 90% of the total land area used for agricultural land. This supports a regionally and nationally valuable agricultural industry as the sandy soil makes it particularly good for root crops.

The economic structure was historically agriculture and maritime industries and farming continues to be a core primary industry. Market towns are important to East Suffolk’s social and economic infrastructure. They encourage new services, provide housing and act as centres for employment in rural areas. Maintaining these is vital to the sustainability of the region’s rural economy. A range of information technology industries have established due to the A14 corridor, particularly in and around Ipswich. These industries are likely to continue to expand in the future. Maritime industries continue to be important. Felixstowe is the fourth largest container port in Europe, with direct road (A14) and rail links to London and the Midlands. Links to Europe through Felixstowe provide both opportunities and markets and competition for the regional economy. It is important that East Anglia continues to benefit of the region’s international and national transport gateways. Future economic growth in the port areas of the Gipping Valley will encourage future urban development in these areas.

The landscape and natural features of the catchment dictates the gradient of the rivers which influences the velocity of flow and risk of flooding. Where channel gradients are steeper, the river will respond quicker to rainfall and flow velocities can be high. In contrast where river gradients are flatter, the river responds less quickly to rainfall and flow velocities tend to be slower.

This varies across the catchment but the majority of the catchment is flat, especially towards the east where the land gently falls into coastal wetlands. The headwaters of the rivers are located on high ground towards the west of the catchment around Stowmarket, Debenham, Framlingham and Halesworth. Slopes in this area are commonly gradual, however, there are steeper sections within the headwaters of the catchments where rainwater can run off the land quickly and influence how rivers respond. The headwaters of the Gipping Valley are on higher ground, approaching 100 metres AOD in some places.

Some coastal land is below current sea level, including areas surrounding the Blyth and Alde-Ore estuaries. This land is particularly vulnerable to sea level change and coastal flooding. Where the catchment is flatter and channel slopes are less steep, the lag-time between the rainfall and the on-set of flooding is longer. Further downstream, where tributaries join the main channel, there is a delay after the rainfall but the flooding lasts longer.

Geology

Marine derived sands and gravels are the common underlying geology in the north and east of the catchment, whilst chalk dominates in the west. These underlying rocks are mainly overlapped by less permeable glacial till (sediment of various particle sizes deposited by the movement of ice), which reduces the infiltration of rainfall in to the soil. This leads to higher rates of rainfall run-off meaning there is a greater risk from surface water flooding in these areas. However flooding from groundwater is a small component of the source of flooding in East Suffolk. Marine derived crags (sands and gravels) are the common underlying geology in the north and east of the catchment, whilst chalk dominates in the north and west. These are overlapped by glacial till meaning that groundwater flooding is a contributing factor to flood risk in East Suffolk catchment. Soils across large areas of the northern and western part of the
catchment are clayey and naturally slow draining. These become deep, free-draining acidic soils towards the coast.

**National and international designations**

The coastal and estuarial environments in East Suffolk are important for a range of wildlife, especially birdlife. Ecological diversity and importance is recognised as the area includes many internationally designated sites, including 6 SACs, 6 SPAs and 4 Ramsar sites. At a national designation level there are 70 Sites of Special Scientific Interest (SSSIs) and 5 NNRs in the catchment. The Suffolk Coast and Heaths ANOB protects a large area of the coast for its exceptional landscape character, value for biodiversity and as a public amenity. There are over 150 scheduled ancient monuments distributed across the catchment, as well as many listed buildings and registered parks and gardens. The environmental assets within the catchment area support an important tourism and recreation industry.

**Partnership working**

Within the catchment there is 1 LLFAs, Suffolk County Council (SCC). The Environment Agency has worked with SCC who has provided measures from their Local Flood Risk Management Strategies (LFRMS) to be included in the Anglian FRMP. SCC’s LFRM was published in February 2013.

There are also 6 district council with the catchment, 3 of these are maritime councils.

The catchment also benefits from the existence of the Suffolk Flood Risk Management Partnership (SFRMP). The partnerships bring together the LLFA, district councils, IDBs, highway authorities and water companies, NE and NFU and the Environment Agency to help manage local flood risk.

There are also 2 IDBs within the catchment – East Suffolk and Waveney Lower Yare and Lothingland. The Environment Agency assist IDBs in the development of their programme of capital upgrade works for flood risk management assets. As part of this, IDBs and the Environment Agency are exploring the use of public sector cooperation agreements (PSCAs) which provide a legal mechanism for both parties to maximise their combined resources to deliver a more efficient way of providing services and work for the benefit of local communities.

**Wider catchment issues with an impact on flood risk management**

- The Environment Agency priorities funding to protect people and property and in some rural locations it is hard to justify funding for defences. However, we understand these areas are of value to the landowners and communities. The Environment Agency will work with landowners to ensure they understand their risk and provide advice for them if they wish to carry out their own maintenance. Therefore we are working with landowners.

- The ecology of the catchment is impacted by historic physical modifications to the natural channel and land drainage practices. Changes to river and floodplain management will increase connectivity, reduce barriers of fish migration and to enhance the diversity of in-channel and riparian habitats. Some structures can form barriers to fish passage, preventing migratory species such as Sea Trout and Eels from reaching spawning or feeding grounds and also inhibiting the movement of coarse fish. There need to be a balance of managing flood risk but also ensuring our rivers are a healthy as they can be.
• Pollution from wastewater and diffuse pollution from rural and urban areas. High levels of nutrients, and in particular phosphorus, can cause changes to the plant communities in rivers and lakes, allowing species to dominate and excessive weed growth. This not only reduces habitat diversity, but can cause a number of other problems in the river, including algal blooms, overshading and a reduction in oxygen. Discharges from sewage treatment works and industrial waste water treatment plants contribute to high levels of phosphate in the rivers. Surface water run-off from farm yards and fields can also carry high levels of nutrients into our rivers. Combined Sewer Overflows and misconnections in urban areas can also contribute a reduction in water quality.

• Low flows and drought. The catchment is very dry, with an average rainfall of less than 600mm each year. There is also heavy abstraction, providing water for public drinking water supply as well as irrigation of crops and industrial use. Many of the rivers are affected by drought and periods of low flows. This can cause low levels of oxygen and concentrated pollutants in the river. This is also exacerbated by the impacts of historic changes to the shape of the rivers.

Coastal erosion

Coastal erosion can be significant. The area has lost villages to the sea over the past 500 years (most famously at Dunwich where a whole town of 7 parishes has been taken by the sea) and the soft dunes and cliffs continue to erode. Significant erosion is an issue at Easton Bavents and Covehithe north of Southwold, and at Dunwich, Thorpeness, Slaughden, Shingle Street and Bawdsey further south.

Climate change

The climate is changing and this is likely to have an impact on flooding and coastal erosion. Sea levels are rising and winter rainfall may become more intense. Changes in weather patterns and, in particular, more torrential rainfall is likely to increase flood risk from surface water and ordinary watercourses as well as rivers. Communities within the Essex Combined Catchment have experienced an increase in both severity and frequency of existing flooding problems and communities that have not flooded previously have been affected in recent years. It is likely that this pattern will continue.

Rising sea levels mean that waves and storm surges could cause greater coastal erosion. Changes to the currents acting on the coast could also lead to changes in the movement of coastal sediments, affecting both coastal deposition and erosion. This could expose new risks from coastal flooding, lead to a greater risk of coastal defences failing and increase the need for maintenance work on defences and more extensive warning systems.

Flood risk maps and statistics

Flooding from rivers and the sea

The rivers of East Suffolk have change over time in response to urban expansion and changes in agricultural practices. Flood risk to people and property has increased because urban expansion has meant more people are living near rivers and on natural flood plains. Urban growth has also increased pressure on drainage systems for run-off and surface water. A change in agricultural practices has also increased rainfall run-off causing river levels to rises quickly in heavy rainfall. The use of land drains and agricultural intensification, as well as
Deforestation and soil degradation can reduce the amount of water soaking into the ground and increasing surface water run-off, raising river levels.

Tidal flooding occurs when sea levels along the East coast of England increase during high tides or when there is a storm surge. Tidal surges can have a dramatic effect on the coastline, causing significant coastal erosion and tidal flooding that presents a severe risk to life. In this catchment the effect of tidal flooding on the open coast in the estuaries can be significant. In the south of the catchment, the Felixstowe peninsula is bounded by the Deben and Orwell Estuaries.

**Figure 15: Flood Risk from Rivers and the Sea in the East Suffolk – National Flood Risk Assessment (NAFRA)**
Table 9: Summary of flood risk from rivers and sea to people, economic activity and the natural and historic environment across the East Suffolk Catchment.

<table>
<thead>
<tr>
<th>River and Sea Risk to people:</th>
<th>Total in Catchment</th>
<th>High risk</th>
<th>Moderate risk</th>
<th>Low risk</th>
<th>Very low risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of people in area:</td>
<td>372,450</td>
<td>2,250</td>
<td>1,450</td>
<td>8,800</td>
<td>2,900</td>
</tr>
<tr>
<td>Number of services:</td>
<td>780</td>
<td>70</td>
<td>10</td>
<td>50</td>
<td>&lt;10</td>
</tr>
</tbody>
</table>

| Risk to economic activity:    |                    |           |               |          |               |
| Number of non-residential properties: |    |           |               |          |               |
| Number of airports:           | 0                  | 0         | 0             | 0        | 0             |
| Length of roads (primary routes)(km): | 220     | <10       | <10           | <10      | 0             |
| Length of railway (km):       | 130                | <10       | <10           | <10      | <10           |
| Agricultural land (ha):       | 119,700            | 6,300     | 1,000         | 1,450    | 50            |

| Risk to the natural and historic environment: | | | | | |
| Number of EU designated bathing waters within 50m: | 0 | 0 | 0 | 0 | 0 |
| Number of EPR installations within 50m: | 58 | 3 | 0 | 6 | 0 |
| Area of SAC within area (ha): | 2,950 | 1,150 | <50 | 500 | <50 |
| Area of SPA within area (ha): | 7,350 | 2,050 | 100 | 600 | 50 |
| Area of RAMSAR site within area (ha): | 3,650 | 1,800 | 50 | 600 | <50 |
| Area of World Heritage Site within area (ha): | 0 | 0 | 0 | 0 | 0 |
| Area of SSSI within area (ha): | 9,150 | 2,450 | 200 | 850 | 100 |
| Area of Parks and Gardens within area (ha): | 1,300 | 50 | <50 | <50 | 0 |
| Area of Scheduled Ancient Monument within area (ha): | 250 | <50 | <50 | <50 | <50 |
| Number of Listed Buildings within area: | 4,970 | 70 | 40 | 110 | 30 |
| Number of Licensed water abstractions within the area: | 630 | 200 | 10 | 30 | <10 |

Flooding from reservoirs

There are numerous reservoirs in the area, predominantly for agricultural purposes. They are currently being risk assessed in line with the requirements of the Flood and Water management Act 2010. An estimated 371 people live within the maximum extent of flood from reservoirs in the catchment.
Figure 16: Flood Risk from Reservoirs in the East Suffolk Catchment
Table 10: A Summary of risk of flooding to people, economic activity and the natural and historic environment from reservoirs across the East Suffolk Catchment.

<table>
<thead>
<tr>
<th>Reservoirs</th>
<th>Total in Catchment</th>
<th>Maximum extent of flooding</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Risk to people:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of people in area:</td>
<td>372,450</td>
<td>350</td>
</tr>
<tr>
<td>Number of services:</td>
<td>780</td>
<td>20</td>
</tr>
<tr>
<td><strong>Risk to economic activity:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of non-residential properties:</td>
<td>57,750</td>
<td>200</td>
</tr>
<tr>
<td>Number of airports:</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Length of roads (primary roads) (km):</td>
<td>220</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Length of railway (km):</td>
<td>130</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Agricultural land (ha):</td>
<td>119,700</td>
<td>1,200</td>
</tr>
<tr>
<td><strong>Risk to the natural and historic environment:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of EU designated bathing waters within 50m:</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Number of EPR installations within 50m:</td>
<td>58</td>
<td>1</td>
</tr>
<tr>
<td>Area of SAC within area (ha):</td>
<td>2,950</td>
<td>50</td>
</tr>
<tr>
<td>Area of SPA within area (ha):</td>
<td>7,350</td>
<td>200</td>
</tr>
<tr>
<td>Area of RAMSAR site within area (ha):</td>
<td>3,650</td>
<td>100</td>
</tr>
<tr>
<td>Area of World Heritage Site within area (ha):</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Area of SSSI within area (ha):</td>
<td>9,150</td>
<td>200</td>
</tr>
<tr>
<td>Area of Parks and Gardens within area (ha):</td>
<td>1,300</td>
<td>&lt;50</td>
</tr>
<tr>
<td>Area of Scheduled Ancient Monument within area (ha):</td>
<td>250</td>
<td>&lt;50</td>
</tr>
<tr>
<td>Number of Listed Buildings within area:</td>
<td>4,970</td>
<td>10</td>
</tr>
<tr>
<td>Number of Licensed water abstractions within the area:</td>
<td>630</td>
<td>60</td>
</tr>
</tbody>
</table>

Conclusions and objectives for the East Suffolk Catchment

**Conclusions:**

The main sources of flood risk for people, property, infrastructure and the land are:

- River flooding from all the main rivers and their tributaries. Particular areas at risk are the towns of Ipswich, Debenham, Great Blakenham and Claydon, Needham Market, Stowmarket, Framlingham and Halesworth;

- Tidal flooding from the River Orwell in the ports, docklands and some urban areas of Ipswich.

- the impacts of rivers not being able to flow freely to the sea at high tide (called tide locking), such as at Ipswich (River Gipping), along the Lothingland Hundred River, Cove Run (Wrentham watercourse) and the River Minsmere;
- Surface water flooding in parts of the upper/mid catchments due to the underlying geology combined with seasonally waterlogged soils and steep slopes. Halesworth, Leiston, Knodishall, Wrentham, Needham Market, Saxmundham and Pettaugh (near Stowmarket) have experienced this type of flooding. Ipswich has also experienced surface water flooding due to impermeable surfaces and blocked drains;

- Sewer flooding due to heavy rainfall overwhelming the sewer network and discharge points becoming blocked by high river levels, or due to blockages within the sewer network. Sewer flooding has occurred in parts of Ipswich, Woodbridge and Melton.

Of the total population within the East Suffolk Catchment 16% is considered to be at flood risk of flooding from rivers and sea. Of the total population at risk the majority (57%) is considered to be a low risk, with 15% considered to be a high risk of flooding from rivers and sea. An estimated 18% of services, 3% of primary roads and 6% of rails are at risk of flooding from rivers and sea. Around 7% of non-residential properties within the catchment are considered to be at risk of flooding, the majority (57%) are considered low risk. Much of the agricultural land is in low lying areas and 7% of the total of agricultural land with the catchment is considered to be at risk the majority (71%) of the area of agricultural land at flood risk is considered to be a high flood risk.

Much of the water abstraction licenses are for agricultural irrigation for arable crops and just fewer than 40% of the licensed abstraction points are at flood risk from rivers and sea. This could result in the permanent loss of abstraction points through saline incursion. An estimated 16% of Environmental Permit Regulation Sites such as landfill sites are considered to be at risk from rivers and sea the majority are considered low risk. In addition to 5% of the listed buildings at risk in the catchment 40% of the area environmental and historic designated sites are considered to be at risk.

There are relatively few reservoirs in the catchment and they are located mostly around the estuaries and used for irrigation of arable crops. Less than 0.1% of the population of the catchment are within the maximum extent of flooding from reservoirs. Less than 2% of services, 0.5% of primary roads 0.8% of rail are within the maximum extent of flooding from reservoirs. Of the non-residential properties within the catchment only 0.3% are considered to be within the maximum extent of flooding from reservoirs. Just over 1% of agricultural land and 10% of licensed abstraction points are considered to be within the maximum extent of flooding from reservoirs. Less than 2% of EPR sites are considered to be at risk of reservoir flooding. Just over 11% of the areas of historic and environmental designated sites are within the extent of reservoir flooding.

**Objectives:**

This is a summary of the Environment Agency objectives for this catchment. More detail of these objectives can be found in Part A, section 8 conclusions, objectives and measures. The catchment also includes measures from other RMAs. The objectives for these measures can be found in ‘Part C, Annex 2 - Source of objectives and measures for the FRMP’.

**Social**

- Understanding Flood Risk and Working in Partnership
- Community preparedness and resilience
- Minimise community disruption
- Time to adapt to coastal erosion
• Avoid inappropriate development in areas of flood and coastal erosion
• Reduce risk to life, people and property
• Maintain existing assets minimise the risk of flooding to residential properties
• Continue river, watercourse and tidal defence maintenance

Economic
• Reduce economic damage to non-residential properties
• Maintain existing assets minimise the economic damage from flooding to non-residential properties
• Economic, regeneration and funding opportunities
• Minimise the risk of flooding to transport services
• Continue river and watercourse maintenance to minimise the risk of flooding to non-residential properties
• Consider flood risk to agricultural Land
• Understanding Flood Risk and Working in Partnership with landowners
• Ensure that FRM activities do not adversely affect the tourism industry

Environmental
• Contribute to achieving Water Framework Directive (WFD) objectives
• Minimise the negative impacts of flooding to Designated nature conservation Sites
• Minimise the negative impacts of flooding to designated heritage sites

Reservoirs
• Reduce the risk of flooding from reservoirs to people, property, infrastructure and the environment.

Measures across the East Suffolk Catchment

There are 228 measures to manage flood risk across the Catchment. These are summarised below, with the detailed measures set out in the Part C: appendices Measures included, are over and above RMA ‘flood risk management activities’ undertaken routinely, as explained in Part A, Section 4 – How to Manage Risk. Measures cover discrete pieces of work such as projects and campaigns.

Preventing risk: 107 measures
• Completion and implementation of estuary plans (Deben and Alde Ore)
• Working with communities to develop flood risk management projects to reduce risk to communities at Debenham, Needham Market, Woodbridge, Tunstall
• Working with natural processes to manage flood risk such as beneficial use of dredging and managed realignment in the Deben and Alde Ore.
• Beach profiling and monitoring at Benacre, Easton Broad, Southwold, East Lane, Felixstowe and along Thorpeness to Aldeburgh. Also monitor Defences conditions along Hollesley Bay.
Preparing for risk: 26 measures

- Continue to develop community adaptation in area of changing coast such as Easton Bavents, Covehithe, Bawdsey and Slaughden.
- Set up Kessingland Management Group.

Protecting from risk: 90 measures

- Planning for future loss of abstraction points through saline incursion along the Alde Ore, Deben and the Blyth Estuary.
- Suffolk Recondition Package of Assets including Barnby Pump replacement; North Cove Pumping Station; Hollesley Pumping Station replacement pump; Butley Mills seawalls; Waveney Control Structure repairs
- Beach management at North, Central and Southern Felixstowe as required.
- Continue with the Ipswich Strategy to construct a tidal barrier to offer protection and reduce flood risk to people, property, critical infrastructure and able growth and regeneration of the docks.

Recovery and review of risk: 5 measures

- Desk based assessment to identify locations and cultural/ecological significance of coastal historic grazing marshes in South Suffolk.

The above are catchment-specific flood risk management measures. Please refer back to section 8 of Part A of the FRMP to see the measures that apply to the entire or large parts of the Anglian RBD.
3.5. The Nene Catchment

Introduction to the catchment

The catchment of the Nene is located in the east of England. It extends eastwards from Daventry through Northampton, Wellingborough and Peterborough to its outfall into The Wash. The Nene Catchment includes the major tributaries of the Kislingbury Branch, Brampton Branch, Wootton Brook, river Ise, Willow Brook and Harpers Brook. The river Nene passes through the low-lying fens area (downstream of Peterborough) where the river is embanked and heavily modified.

The river Nene and its upland tributaries rise in the west of the catchment, upstream of Northampton. After these headwaters meet in Northampton, the river Nene flows across gently undulating rural country to the flat plains around Peterborough, before entering the embanked tidal section through the fens. Much of the fens lies below sea level, relying on pumping stations for drainage, and is influenced by the tidal cycle. IDBs undertake a critical role in managing land drainage within these low-lying fenland areas and maintaining high-quality arable land.

Land use and management

The overall catchment area is about 2,270 km$^2$ and has a population of approximately 800,000. Although there are large centres of population such as Northampton, Wellingborough, Kettering, Corby and Peterborough, the catchment is largely rural.

Figure 17: Overview of the Nene Catchment
Almost 60% of the agricultural land in the catchment is Grade 3, with Grades 1 and 2 making up a further 32%. The highest quality Grade 1 agricultural land is found mainly in The Fens, where the area is intensively farmed to produce arable crops. High quality Grade 2 agricultural land is found to the east of Peterborough and is similarly extensively farmed. The land to the west of Peterborough is mainly Grade 3.

**Geology**

The underlying geology of the catchment can be split into mudstones to the west of Northampton, limestone between Northampton and Peterborough and clays to the east of Peterborough.

There are higher rates of rainfall run-off where the underlying rock is non-porous mudstones. This run-off flows directly into watercourses.

In the areas of limestone or sandstone bedrock the response of rivers to rainfall is delayed because rainwater is able to permeate the rock. This reduces peak flood flows. There is a risk from groundwater flooding in these areas. In the lower fenland areas downstream of Peterborough, the predominance of peat soils and the low gradients means water moves slowly to the river channels.

**National and international designations**

There are a number of sites designated for their environmental importance within the River Nene catchment. These include Ramsar sites, SPAs, SACs and SSSIs.

Important environmental sites in the catchment include: The Nene Washes (SPA, SAC, Ramsar); the Upper Nene Valley Gravel Pits (SPA); and Orton Pit (SAC). The Wash (Ramsar, SPA, SAC) is located downstream of the catchment, however, the River Nene and flood risk management activities can have an effect on this area. Throughout the catchment there are 60 SSSIs. The historic and cultural value of the catchment is recognised with a number of scheduled ancient monuments and listed buildings.

**Partnership working**

Within the Nene catchment, there is an excellent working relationship with between partners. There are 2 LLFAs, Northamptonshire County Council (NCC) and Peterborough City Council (PCC) that cover the majority of the catchment. The river Nene catchment also includes small areas covered by Cambridgeshire County Council, Lincolnshire County Council, Bedfordshire Borough Council and Norfolk County Council.

NCC and PCC have worked in close partnership with the Environment Agency and have contributed to the Anglian FRMP. The Environment Agency have supported NCC in producing their Local Flood Risk Management Strategy (LFRMS), published October 2013, and are committed to working closely with PCC to help them prepare and produce their LFRMS.

The Nene catchment also benefits from the existence of the Lincolnshire, Northamptonshire and the Peterborough Flood Risk Management Partnerships. RMA partners co-ordinate our approach to flood risk management through these partnerships. The partnerships include those partners mentioned above plus representatives from district councils, Regional Flood and Coastal Committee representatives, Anglian Water Services Ltd and other partners such as the IDBs.

There are 6 IDBs within the catchment – North Level District IDB, Fieldale IDB, South Holland IDB, King’s Lynn IDB, Waldersley IDB and Hundred of Wisbech IDB. The Environment Agency assist IDBs in the development of their programme of capital upgrade works for flood risk management assets. As part of this, IDBs and the Environment Agency have jointly prepared
public sector cooperation agreements (PSCAs) which provide a legal mechanism for both parties to maximise their combined resources to deliver a more efficient way of providing services and work for the benefit of local communities.

**Wider catchment issues with an impact on flood risk management**

Silt and excess nutrients are exacerbated by inputs from sewage treatment works and private sewerage systems. Silt can cause a particular problem for effective flood risk management in this highly-modified lowland watercourse. This can sometimes mean silt needs to be removed which is expensive and needs to be carefully considered to reduce its impact on the environment.

Low flows and high summer temperatures can make this issue worse. Nutrients can disturb the natural balance of a watercourse and cause excess growth of vegetation and algae. This reduces the ability of the lowland water courses to pass flows and requires expensive vegetation management.

The legacy of drainage works on large stretches of rivers and dykes has created poor habitat in some areas. Obstructions from weirs and flood defence works prevent some species of fish and eels from migrating and spawning.

While the impacts are not yet widespread, invasive non-native species do pose a significant future threat in the catchments. For example, signal crayfish present in the river Nene, increase the amount of fine sediment and silt build-up in the river through their burrowing activities.

**Coastal erosion**

Tides rather than wave action are the main factor controlling sedimentary processes in The Wash. Most of the shoreline is fronted by salt marsh, inter-tidal mud flats and sand flats. These dissipate wave energy long before the waves reach the grassed earth flood banks. Coastal erosion is therefore not a major consideration in this catchment.

**Climate change**

The climate is changing and this is likely to have an impact on flooding and coastal erosion. Sea levels are rising and rainfall is becoming more intense. Changes in weather patterns, especially more torrential rainfall, are likely to increase flood risk from surface water and ordinary watercourses as well as rivers. Communities within the Nene catchment have experienced an increase in both severity and frequency of existing flooding problems, and communities that have not flooded previously have been affected in recent years. It is likely that this pattern will continue through the effects of climate change.

Changes to currents and sea levels may also lead to changes in the movement of sediment. In the Nene catchment this could increase build-up and could expose the catchment to new coastal flood risk. This may lead to a greater risk of coastal defences failing, increase the need for maintenance work on defences and require more extensive warning systems. With the coastal area of the Nene Catchment already at risk from tidal flooding up to 27km inland, climate change will present increased challenges to those trying to reduce tidal flood risk in this area.

Urban areas within the Nene catchment such as Northampton, Wellingborough, Kettering, Corby and Peterborough are likely to suffer an increase in the risk of surface water flooding caused by higher levels of rainfall. Risk of flooding may also increase during winter as a result.
Flood risk maps and statistics

Flooding from rivers and the sea

The catchment is at risk of river - or fluvial, flooding from the river Nene, river Ise, Harpers Brook, Willow Brook and their tributaries.

More than 58,500 people are at risk of flooding from rivers and the sea in the Nene catchment. This represents 7.5% of the total population. Approximately, 15,800 non-residential properties are also at risk. Approximately 31% of the agricultural land, 56% of SSSI sites and 78% of Ramsar sites within the catchment are at risk of this type of flooding.

There are raised defences in a number of locations along the river Nene, for example in the centre of Northampton and Thrapston.

Watercourses downstream of Peterborough typically have raised banks and flow at a higher level than the surrounding land. They can be affected by the tide, which can impact the flow of water out to sea.

Flooding can occur when river flows or tides rise over the top of raised flood banks or from breaching. While the likelihood of this is very low, the consequences could be significant and may cause rapid flooding of areas immediately behind the flood banks. This would lead to risk to people damage to property and economic consequences.

The shoreline where the river Nene flows into The Wash is characterised by a sea bank which divides extensive salt marsh and mud flats from a wide expanse of low-lying agricultural land. Most of the agricultural land has been reclaimed from the sea over the past centuries. It supports a regionally and nationally valuable agricultural industry. The salt marsh and mud flats provide important habitats for wildlife and act as a natural sea defence. They also contribute to the economy of the area by supporting the shellfish industry and tourism.

The sea banks reduce flood risk to a very wide area that is typically at or below sea level. Salt marshes and mud flats are the main natural features. While salt marshes are currently growing, the future development of the salt marsh and mud flats is extremely uncertain and is dependent on the future rate of sea-level rise, the availability of sediment and a range of other factors. These uncertainties may impact on the flood defences and on the environment around the shoreline as well as on the value of the salt marshes.
Figure 18: Flood risk from rivers and the sea in the Nene Catchment – National Flood Risk Assessment (NAFRA)
Table 11: Summary of flood risk from rivers and sea to people, economic activity and the natural and historic environment.

<table>
<thead>
<tr>
<th>Risk to people:</th>
<th>Total in catchment</th>
<th>High risk</th>
<th>Medium risk</th>
<th>Low risk</th>
<th>Very low risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of people in area:</td>
<td>793,400</td>
<td>1,550</td>
<td>22,800</td>
<td>34,600</td>
<td>&lt;50</td>
</tr>
<tr>
<td>Number of services:</td>
<td>1,610</td>
<td>40</td>
<td>90</td>
<td>100</td>
<td>0</td>
</tr>
</tbody>
</table>

| Risk to economic activity: | | | | | |
| Number of non-residential properties: | 92,550 | 1,050 | 7,200 | 7,550 | <50 |
| Number of airports: | 0 | 0 | 0 | 0 | 0 |
| Length of roads (km): | 730 | 10 | 40 | 60 | 0 |
| Length of railway (km): | 120 | <10 | <10 | <10 | <10 |
| Agricultural land (ha): | 206,600 | 8,900 | 37,100 | 17,500 | <50 |

| Risk to the natural and historic environment: | | | | | |
| Number of EU designated bathing waters within 50m: | 0 | 0 | 0 | 0 | 0 |
| Number of EPR installations within 50m: | 60 | 7 | 14 | 5 | 0 |
| Area of SAC within area (ha): | 600 | 100 | <50 | <50 | 0 |
| Area of SPA within area (ha): | 1,850 | 1,500 | <50 | <50 | 0 |
| Area of RAMSAR site within area (ha): | 1,850 | 1,450 | <50 | <50 | <50 |
| Area of World Heritage Site within area (ha): | 0 | 0 | 0 | 0 | 0 |
| Area of SSSI within area (ha): | 5,400 | 2,750 | 150 | 150 | 0 |
| Area of Parks and Gardens within area (ha): | 4,050 | 100 | 50 | 50 | <50 |
| Area of Scheduled Ancient Monument within area (ha): | 950 | 100 | 50 | 50 | 0 |
| Number of Listed Buildings within area: | 5,500 | 70 | 170 | 260 | 0 |
| Number of Licensed water abstractions within the area: | 260 | 90 | 100 | <10 | 0 |

Flooding from reservoirs

There are a number of large raised reservoirs within the catchment. These are used for water supply, irrigation, boating and flood storage.

The Nene supplies Pitsford Reservoir and Rutland Water. These reservoirs provide drinking water to Kettering, Northampton, Peterborough, Oakham and surrounding areas. Rutland Water is also an internationally-important site for wildlife.

Our recently-published Flood Risk Maps for reservoirs show around 23,000 people at risk from flooding from failure of a reservoir within the Nene Catchment. This represents approximately 3% of the total population. Almost 5,500 non-residential properties are also at risk along with approximately 11% of the agricultural land, 28% of SSSI sites and 1% of Ramsar sites.
The likelihood of flooding from reservoirs is extremely low. However, in the unlikely event that a reservoir dam failed, a large volume of water may be released at once and flooding could happen with little or no warning. This may put lives at risk.

Figure 19: Flood risk from reservoirs in the Nene Catchment
Table 12: Summary flood risk from reservoirs to people, economic activity and the natural and historic environment.

<table>
<thead>
<tr>
<th>Reservoirs</th>
<th>Total in catchment</th>
<th>At risk of flooding from reservoirs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Risk to people:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of people in area:</td>
<td>793,400</td>
<td>22,950</td>
</tr>
<tr>
<td>Number of services:</td>
<td>1,610</td>
<td>100</td>
</tr>
<tr>
<td><strong>Risk to economic activity:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of non-residential properties:</td>
<td>92,550</td>
<td>5,450</td>
</tr>
<tr>
<td>Number of airports:</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Length of roads (km):</td>
<td>730</td>
<td>70</td>
</tr>
<tr>
<td>Length of railway (km):</td>
<td>120</td>
<td>10</td>
</tr>
<tr>
<td>Agricultural land (ha):</td>
<td>206,600</td>
<td>22,600</td>
</tr>
<tr>
<td><strong>Risk to the natural and historic environment:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of EU designated bathing waters within 50m:</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Number of EPR installations within 50m:</td>
<td>60</td>
<td>5</td>
</tr>
<tr>
<td>Area of SAC within area (ha):</td>
<td>600</td>
<td>&lt;50</td>
</tr>
<tr>
<td>Area of SPA within area (ha):</td>
<td>1,850</td>
<td>&lt;50</td>
</tr>
<tr>
<td>Area of RAMSAR site within area (ha):</td>
<td>1,850</td>
<td>&lt;50</td>
</tr>
<tr>
<td>Area of World Heritage Site within area (ha):</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Area of SSSI within area (ha):</td>
<td>5,400</td>
<td>1,500</td>
</tr>
<tr>
<td>Area of Parks and Gardens within area (ha):</td>
<td>4,050</td>
<td>100</td>
</tr>
<tr>
<td>Area of Scheduled Ancient Monument within area (ha):</td>
<td>950</td>
<td>150</td>
</tr>
<tr>
<td>Number of Listed Buildings within area:</td>
<td>5,500</td>
<td>180</td>
</tr>
<tr>
<td>Number of Licensed water abstractions within the area:</td>
<td>260</td>
<td>150</td>
</tr>
</tbody>
</table>

**Other sources of flooding**

Flooding can also occur from lowland drains and watercourses. Responsibility for these rests with those people who own the land adjacent to them – or riparian owners.

The catchment has previously been affected by surface water and sewer flooding. Flood maps for surface water flooding, published in December 2013, show many areas across the catchment at risk from these types of flooding. Corby, Wellingborough, Kettering and Oundle are known to have experienced these types of flooding, along with many other smaller communities.

There are few incidents of flooding from groundwater recorded within the Nene Catchment. However, Glapthorn, Oundle and parts of Kettering and Northampton are vulnerable because of high groundwater levels in the underlying limestone or sandstone rock. Groundwater levels within the lowland area are normally kept artificially low through drainage work undertaken by the IDBs. This management activity maintains a low risk of groundwater flooding in the lowlands.
Conclusions and objectives for the Nene Catchment

Conclusions

The rural nature of the catchment means that only 7.5% of the population and 17% of commercial properties are at risk of flooding from rivers or the sea. Of the population at risk of flooding from rivers and the seas, the majority are considered to be medium risk (39%) and low risk (59%). Large areas of high-grade agricultural land are also at risk downstream of Peterborough.

Approximately 3% of the total population and less than 5,500 non-residential properties are at risk of flooding from reservoirs.

Other sources of flooding including surface water, ordinary watercourses, ground water and sewers are also significant in this catchment. There have been many reported incidents of this type of flooding in recent years affecting householders and businesses. The updated surface water flood maps (December 2013) shows a widespread problem.

A major flood alleviation scheme including raised flood banks, walls and flood gates was built at Northampton following the floods of 1998. Flood risk management structures built as part of this scheme are regularly inspected and maintained. Other sources of flooding within the catchment include reservoirs, ordinary watercourses, groundwater, surface water and sewers. The surface water flood maps, published in December 2013, show the significance of surface water flooding in the catchment. There have been a number of incidents of flooding of this type affecting householders and businesses in recent times.

The SMP for the coast, which was completed in 2010, sets out how coastal erosion can be managed sustainably and also sets out the direction for managing coastal flood risk. This Flood Risk Management Plan summarises some of that information but does not change the approach of the SMP, which was arrived at through significant consultation and negotiation between members of the coastal groups who prepared the plans. Therefore the SMP actions can only be changed by the coastal groups.

CFMPs, which were published in 2008, considered possible increases in the level of flooding, its extent and risk if climate change were to increase flood flows by 20%. Climate projections since then suggest flood flows could increase by more than this but acknowledge significant uncertainty. No additional analysis is proposed at this stage. Instead the preferred approach is to emphasise the uncertainty in climate change impacts. Planners, emergency planners, asset managers and others should ask questions such as: “have we considered what might happen if flood risk is worse than previously considered?” and “what can we do to mitigate the increased flood risk?”

While the catchment has some challenging flooding problems to address, particularly given the development pressure, there is a large amount of undeveloped land which may mean there is space to alleviate these problems. However, the national significance of the lower end of the catchment for food production needs to be considered when planning new approaches to flood risk management.

Objectives

This is a summary of the Environment Agency objectives for this catchment. More detail of these objectives can be found in Part A, section 8 conclusions, objectives and measures. The catchment also includes measures from other RMAs. The objectives for these measures can be found in ‘Part C, Annex 2 - Source of objectives and measures for the FRMP’.
Social
- Understanding Flood Risk and Working in Partnership
- Community preparedness and resilience
- Minimise community disruption
- Time to adapt to coastal erosion
- Avoid inappropriate development in areas of flood and coastal erosion
- Reduce risk to life, people and property
- Maintain existing assets minimise the risk of flooding to residential properties
- Continue river, watercourse and tidal defence maintenance

Economic
- Reduce economic damage to non-residential properties
- Maintain existing assets minimise the economic damage from flooding to non-residential properties
- Economic, regeneration and funding opportunities
- Minimise the risk of flooding to transport services
- Continue river and watercourse maintenance to minimise the risk of flooding to non-residential properties
- Consider flood risk to agricultural Land
- Understanding Flood Risk and Working in Partnership with landowners
- Ensure that FRM activities do not adversely affect the tourism industry

Environmental
- Contribute to achieving Water Framework Directive (WFD) objectives
- Minimise the negative impacts of flooding to designated nature conservation Sites
- Minimise the negative impacts of flooding to designated heritage sites

Reservoirs
- Reduce the risk of flooding from reservoirs to people, property, infrastructure and the environment.

Measures across the Nene Catchment

There are 116 measures to manage flood risk across the Nene Catchment. These are summarised below, with the detailed measures set out in the Part C: appendices. Measures included, are over and above RMA ‘flood risk management activities’ undertaken routinely, as explained in Part A, Section 4 – How to Manage Risk. Measures cover discrete pieces of work such as projects and campaigns.
Preventing risk: 46 measures

- Identify communities at risk, in Northamptonshire, Lincolnshire, Cambridgeshire, Bedfordshire, and work with them to investigate and implement solutions
- Work to improve our understanding of all sources of flooding to inform future flood risk management within the Nene Catchment
- Support Northamptonshire County Council and Peterborough City Council as Lead Local Flood Authorities in the implementation and review of their Local Flood Risk Management Strategies to further improve our understanding of flood risk to local communities from all sources of flooding and improve our joint approach to manage this risk
- Nene PLP scheme
- Ensure development in the Upper Nene catchment is designed for a 0.5% annual exceedance probability (1 in 200 chance) of flooding occurring in any year, including an appropriate allowance for climate change

Preparing for risk: 21 measures

- Maintain the current flood forecasting / warning service through ongoing review of community based Flood Warning Areas within the Nene catchment.
- Work with Local Resilience Forum (LRF) partners in Northamptonshire, Lincolnshire, Cambridgeshire, Bedford, complete the review of the MAFP and target community engagement from an emergency response perspective
- Keep the multi-staged evacuation procedure, recently implemented by the management team of Billing Aquadrome and Cogenhoe Caravan Park, under joint review and exercise as appropriate.
- Improving flood risk mapping and inundation modelling for the Lincolnshire and Norfolk coast to provide an improved flood warning service
- Installation and testing of a tide gauge in the Wash Estuary to improve our forecasting of tidal flooding

Protecting from risk: 47 measures

- Flood risk management schemes within the Nene Catchment along Harpers Brook and Wootton Brook and in Nether Heyford, Northamptonshire and Wansford, Cambridgeshire.
- Essential works, under the Reservoirs Act, arising from Whittlesey Washes PMF study and Section 10 Inspection Report
- Integrated WFD and flood risk projects for the Willow Brook, Brampton Branch, River Ise, Middle Nene, and Upper Nene catchments.
- Review of existing flood risk management assets in Rusden, Northamptonshire and Raunds, Northamptonshire to understand the risks and where necessary take action to maintain the standard of service
- Maintain and operate existing major flood risk management assets (where justifiable flood risk benefits exist) within the Nene catchment.

Recovery and review of risk: 2 measures
Lead Local Flood Authorities – Northamptonshire County Council and Peterborough City Council - to undertake flood investigations in accordance with the Flood and Water Management Act (2010), following future flood incidents

The above are catchment-specific flood risk management measures. Please refer back to section 8 of Part A of the FRMP to see the measures that apply to the entire or large parts of the Anglian RBD.
3.6. The North Norfolk Rivers Catchment

Introduction to the catchment

The North Norfolk Rivers catchment stretches from Brancaster in the west to Mundesley in the east and is the smallest catchment with the Anglian RBD covering just 481Km². It is predominantly a rural catchment, characterised by small villages and market towns. The largest settlements are the coastal resorts of Sheringham and Cromer.

The local economy is based on agriculture and tourism. Agriculture is predominantly arable with some grazing along the river valleys. The tourism of the catchment is focused on the coast which features not only sandy beaches but world renowned habitat for wild birds on the coastal marshes west of Sheringham. The area is popular with visitors and many properties on the coast are second homes.

Landscape dictates the gradient of the rivers which influences the velocity of flow and speed of flooding. Where channel gradients are steeper, the river will respond quicker to rainfall and flow velocities can be high. In contrast where river gradients are flatter, the river responds less quickly to rainfall and flow velocities tend to be slower.

The larger rivers rise in the south of the catchment, and are generally small and steep in their upper reaches. In their lower reaches the geography is flatter and the rivers become wider. The Cley Catchwater Drain, Cley New Cut and river Hun are small rivers that cross areas of environmental significance. The river Glaven, Cley Catchwater Drain, Cley New Cut, river Stiffkey, river Burn, river Hun and Weybourne Beck all outfall through coastal defences.

The lowest lying land is along the coast where there are shingle ridges, sand flats, dunes and spits. Land at the coast is higher around Sheringham, Cromer and Overstrand where there are eroding cliffs.

Between Holt and Mundesley the Cromer-Holt Glacial Ridge separates the coastal strip from inland areas. It has a steep north slope and a gentler south slope and is most distinctive around Sheringham where it is 100m high. The ridge was formed in glacial times and is made up of relatively impermeable deposits. The slope and structure of the ridge can make the coastal settlements of Sheringham and Cromer to the north vulnerable to surface water flooding following rapid run-off after high intensity rainfall.

The catchment area can be unequally divided into 5 landscapes; soft and eroding cliffs to the East of Sheringham; low-lying land is along the coast where there are shingle ridges, sand flats, dunes and spits; a ridge of relatively high land known as the Holt-Cromer ridge aligned from south-west to north-east (Kelling Heath is the highest point in Norfolk); arable land through North Norfolk; and coastal marshes west of Sheringham between the A149 and the sea.

Land use and management

The population of the North Norfolk Rivers catchment is 61,725 people. Cromer, Sheringham and Holt are the largest settlements in the catchment.
Most of the catchment (84%) is used for arable crop production, with the majority being grade 3 agricultural land. Much of the better quality land (grades 1 and 2) is towards the east of the catchment.

Tourism is essential for the local economy and there are a large number of visitors to the area in the summer months.

The coastal economy is focused on farming, fisheries and shoreline-related tourism such as boat trips, beach tourism, bird watching, and walking.

Figure 20: Overview of the North Norfolk Rivers Catchment

Geology

Sediment made up of different sizes deposited by the movement of ice called glacial tills and sand and gravel dominate the drift (upper layer) geology of catchment. The solid geology is mostly underlain by chalk to the west of Sheringham, which is covered by thin layers of sands and gravels, and boulder clay. The chalk dips from west to east and there are crags and clays to the east along the narrow strip of the catchment covering Sheringham, Cromer and Mundesley.

The river Burn is influenced most by the underlying chalk and suffers from intermittent flows during dry periods. In the areas where there is chalk bedrock, run-off may infiltrate the rock delaying the response of rivers to rainfall and reducing peak flood flows. There is also a risk from groundwater flooding in these areas.
National and international designations

The landscape value of North Norfolk is recognised in its designation as part of the Norfolk Coast AONB and this covers the lower river valleys and the coast. The coastline is one of the most beautiful and unspoilt in Great Britain. Its ecological diversity is recognised by a suite of international designations including SACs, SPAs, a Ramsar site and Biosphere Reserve (BR). SSSI’s in North Norfolk Rivers Catchment include wetland fen, marsh, grassland and coastal habitats. Scheduled ancient monuments are distributed across the catchment.

Partnership working

Within the catchment there is 1 LLFAs, Norfolk County Council (NCC). The Environment Agency has worked in closely with NCC who has provided measures from their Local Flood Risk Management Strategies (LFRMS) to be included in the Anglian FRMP. NCC’s LFRMS was published in autumn 2015.

There are also 2 district council with the Broadland River catchment, which are both maritime councils.

The catchment also benefits from the existence of the Norfolk Water Management Partnership (NWMP) and. The partnerships bring together the LLFA, district councils, IDBs, highway authorities and water companies, NE and NFU and the Environment Agency to help manage local flood risk.

There is only 1 IDB within the catchment – Norfolk Rivers. The Environment Agency assist the IDB in the development of their programme of capital upgrade works for flood risk management assets. As part of this, the IDB and the Environment Agency have jointly prepared public sector cooperation agreements (PSCAs) which provide a legal mechanism for both parties to maximise their combined resources to deliver a more efficient way of providing services and work for the benefit of local communities.

Wider catchment Issues with an impact on flood risk management

- The Environment Agency priorities funding to protect people and property and in some rural locations it is hard to justify funding for defences. However, we understand these areas are of value to the landowners and communities. The Environment Agency will work with landowners to ensure they understand their risk and provide advice for them if they wish to carry out their own maintenance. therefore we are working with landowners

- Rising nitrate levels have been identified in the groundwater abstracted at Glandford, near Holt. As a result, a safeguard zone has been established with the aim of reducing nitrate inputs at source.

- Physical barriers are present on many of the rivers in North Norfolk preventing migration of fish, eels and other wildlife throughout the catchment which has a negative impact on habitats and ecology. Work is ongoing with several partners to assess all these barriers and look at ways to remove or adapt them to enable fish passage.

- Rural pollution in the form of sediment run-off from fields and roads within the catchment can impact on the ecology and water quality. Catchment sensitive farming provides advice to the agricultural community within this catchment, alongside work
by Norfolk Rivers Trust to reduce sediment run-off at source, where possible, and install silt traps in headwaters where appropriate.

**Coastal erosion**

Coastal erosion predominates from Cromer eastwards, where the relatively soft cliffs are particularly at risk in rough weather. Cromer and Sheringham, though not at risk of flooding from the sea, suffered extensive damage to coastal defences during the tidal storm of December 2013.

**Climate change**

The climate is changing and this is likely to have an impact on flooding and coastal erosion. Sea levels are rising and winter rainfall may become more intense. Changes in weather patterns and, in particular, more torrential rainfall is likely to increase flood risk from surface water and ordinary watercourses as well as rivers. Communities within the North Norfolk Rivers catchment have experienced an increase in both severity and frequency of existing flooding problems and communities that have not flooded previously have been affected in recent years. It is likely that this pattern will continue.

Rising sea levels mean that waves and storm surges could cause greater coastal erosion. Changes to the currents acting on the coast could also lead to changes in the movement of coastal sediments, affecting both coastal deposition and erosion. This could expose new risks from coastal flooding, lead to a greater risk of coastal defences failing and increase the need for maintenance work on defences and more extensive warning systems. With Sea level rising there will be an increase the probability of tidal flooding (this is looked at in the relevant SMP) and increase the length of time of tide-locking on the rivers Glaven, Stiffkey, Burn, Hun, Weybourne Beck and the Cley watercourses. The frequency of tide-locking, which is a particular concern on the river Glaven is also likely to increase. Urbanisation and land use change are expected to be small in comparison, although development may have impacts locally.

**Flood risk maps and statistics**

The catchment is prone to sudden summer storms with intense rainfall and this can cause flash flooding on watercourses and surface water flooding in urban areas. However, prolonged and heavy rainfall would cause the most severe flooding on watercourses. Tide-locking on the lower reaches of the rivers can increase flood water levels locally. Flooding is made worse in many places by bridges, culverts, fords and walls that restrict the amount of water that can flow downstream and are prone to blockage by flood-borne debris.

**Flooding from rivers and the sea**

River flooding is limited, a total of 300 properties are at risk across the river catchment. The last major flood was on the river Stiffkey in 2004 when 6 properties flooded.

Around 700 properties are at risk from coastal flooding in the villages and towns west of Sheringham. A shingle ridge provides a basic level of protection from the sea between Kelling and Cley next the Sea. Further west, clay embankments provide defence from tidal inundation. The largest communities at risk are Wells next the Sea (320 properties) and at Cley next the Sea (174 properties).

Tides can have a significant effect on fluvial flood levels in the lower reaches of rivers by causing ‘tide-locking’. Tide-locking occurs when high tides close the outfall sluices and cause
water in rivers to ‘back up’. As flood waters back up they reach high levels because they are unable to successfully discharge through the sluice. The level a flood reaches in a watercourse depends on the storage capacity of the channel and flood plain, the flood volume and the duration of ‘tide-locking’. Flood water remains in the watercourse and is released only when the tide level falls. Tide-locking has the greatest impact when spring or surge tides happen at the same time as high river flows, creating temporary but significant rises in river levels.

Tide-locking has been a problem during recent fluvial flooding on the rivers Glaven, Stiffkey and Burn. Environment Agency modelling shows that on the Glaven the effects of tide-locking extend 2.8km upstream of the outfall to Glandford, on the Stiffkey they extend 1.8km upstream of the outfall, downstream of Stiffkey village and on the Burn to Burnham Overy 1.5km upstream of the outfall. Tide-locking is unlikely to happen on the river Mun and Weybourne Beck because they outfall to the sea at a higher level.

Figure 21: Flood Risk from Rivers and the Sea in the North Norfolk Rivers Catchment – National Flood Risk Assessment (NAFRA)
Table 13: Summary flood risk from rivers and sea to people, economic activity and the natural and historic environment across the North Norfolk Rivers Catchment

<table>
<thead>
<tr>
<th>River and Sea</th>
<th>Total in Catchment</th>
<th>High risk</th>
<th>Moderate risk</th>
<th>Low risk</th>
<th>Very low risk</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Risk to people:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of people in area:</td>
<td>61,750</td>
<td>1,350</td>
<td>100</td>
<td>1,150</td>
<td>0</td>
</tr>
<tr>
<td>Number of services:</td>
<td>210</td>
<td>20</td>
<td>&lt;10</td>
<td>&lt;10</td>
<td>0</td>
</tr>
<tr>
<td><strong>Risk to economic activity:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of non-residential properties:</td>
<td>12,550</td>
<td>400</td>
<td>50</td>
<td>300</td>
<td>0</td>
</tr>
<tr>
<td>Number of airports:</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Length of roads (primary routes)(km):</td>
<td>40</td>
<td>&lt;10</td>
<td>0</td>
<td>&lt;10</td>
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</tr>
<tr>
<td>Length of railway (km):</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Agricultural land (ha):</td>
<td>39,950</td>
<td>1,350</td>
<td>100</td>
<td>400</td>
<td>0</td>
</tr>
<tr>
<td><strong>Risk to the natural and historic environment:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of EU designated bathing waters within 50m:</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Number of EPR installations within 50m:</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Area of SAC within area (ha):</td>
<td>2,800</td>
<td>300</td>
<td>&lt;50</td>
<td>1,800</td>
<td>0</td>
</tr>
<tr>
<td>Area of SPA within area (ha):</td>
<td>3,600</td>
<td>1,150</td>
<td>&lt;50</td>
<td>1,800</td>
<td>0</td>
</tr>
<tr>
<td>Area of RAMSAR site within area (ha):</td>
<td>3,600</td>
<td>1,150</td>
<td>&lt;50</td>
<td>1,800</td>
<td>0</td>
</tr>
<tr>
<td>Area of World Heritage Site within area (ha):</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Area of SSSI within area (ha):</td>
<td>4,150</td>
<td>1,200</td>
<td>50</td>
<td>1,850</td>
<td>0</td>
</tr>
<tr>
<td>Area of Parks and Gardens within area (ha):</td>
<td>1,400</td>
<td>&lt;50</td>
<td>0</td>
<td>&lt;50</td>
<td>0</td>
</tr>
<tr>
<td>Area of Scheduled Ancient Monument within area (ha):</td>
<td>150</td>
<td>&lt;50</td>
<td>&lt;50</td>
<td>&lt;50</td>
<td>0</td>
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<tr>
<td>Number of Listed Buildings within area:</td>
<td>1,420</td>
<td>80</td>
<td>&lt;10</td>
<td>70</td>
<td>0</td>
</tr>
<tr>
<td>Number of Licensed water abstractions within the area:</td>
<td>190</td>
<td>40</td>
<td>&lt;10</td>
<td>10</td>
<td>0</td>
</tr>
</tbody>
</table>

**Flooding from reservoirs**

There are numerous reservoirs in the area, predominantly for agricultural purposes. They are currently being risk assessed in line with the requirements of the Flood and Water Management Act 2010.
Figure 22: Flood Risk from Reservoirs in the North Norfolk Rivers Catchment
### Table 14: Summary flood risk from reservoirs to people, economic activity and the natural and historic environment across the North Norfolk Rivers Catchment

<table>
<thead>
<tr>
<th>Reservoirs</th>
<th>Total in Catchment</th>
<th>Maximum extent of flooding</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Risk to people:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of people in area:</td>
<td>61,750</td>
<td>&lt;50</td>
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<tr>
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<td>0</td>
<td>0</td>
</tr>
<tr>
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<td>40</td>
<td>&lt;10</td>
</tr>
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<td></td>
</tr>
<tr>
<td>Number of EU designated bathing waters within 50m:</td>
<td>0</td>
<td>0</td>
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<td>150</td>
</tr>
<tr>
<td>Area of World Heritage Site within area (ha):</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
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</tr>
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<td>&lt;10</td>
</tr>
<tr>
<td>Number of Licensed water abstractions within the area:</td>
<td>190</td>
<td>20</td>
</tr>
</tbody>
</table>

**Flooding from groundwater, surface water and sewers**

In summer, the Holt-Cromer ridge can trigger thunderstorms. Flood effects are usually limited by the rural nature of the catchment. However, surface water flooding can occur in built up areas such as Sheringham.

Groundwater, sewers and surface water have also caused flooding in the past. Major surface water flooding in Sheringham in August 2006 disrupted the annual carnival and damaged properties, impacting both local residents and businesses and the tourist population.

**Coastal erosion**

Coastal erosion predominates from Cromer eastwards, where the relatively soft cliffs are particularly at risk in rough weather. Cromer and Sheringham, though not at risk of flooding from the sea, suffered extensive damage to coastal defences during the tidal storm of December 2013.
Conclusions and objectives for the North Norfolk Rivers Catchment

Conclusions:

Of the total population of the North Norfolk Rivers catchment less than 6% is considered at risk of flooding from the rivers and sea. Of the population at risk the majority is considered to be high risk (51%) and low risk (44%). An estimated 14% if the services in the catchment are considered to be at flood risk. Less than 6% of the non-residential properties are considered at risk. There are no primary road routes or rail infrastructure at risk.

Less than 5% of the total agricultural land is considered to be at risk of flooding from rivers and the sea. An estimated 30% of licensed abstraction points are considered to be at risk. There are no EU designated bathing water sites at risk or EPR sites, such as landfills. In addition to 11% of the listed buildings at risk an estimated 70% of the total hectares of environmental and historic designated sites in the catchment are also at risk. However, in most of the designated areas the value of the site is as a result of their location close to rivers or the coast.

The main sources of flood risk for people, property, infrastructure and the land are:

- river flooding of all watercourses, particularly in the villages of South Creake and Mundesley;
- the impacts of rivers not being able to flow freely to the sea during high tide (called tidal locking), particularly on the lower reaches of the River Glaven, Stiffkey and Burn;
- surface water drainage and sewer flooding. Surface water flooding has caused significant disruption in Cromer and Sheringham in the past. The risk of sewer flooding is scattered but can be a particular problem in the upper Burn valley.

The risk of flooding from reservoirs is very low in the North Norfolk River catchment. An estimated 4% of the total people living within the catchment are considered to be located within the maximum extent of flood from reservoirs across the catchment.

Objectives

This is a summary of the Environment Agency objectives for this catchment. More detail of these objectives can be found in Part A, section 8 conclusions, objectives and measures. The catchment also includes measures from other RMAs. The objectives for these measures can be found in ‘Part C, Annex 2 - Source of objectives and measures for the FRMP’.

Social

- Understanding Flood Risk and Working in Partnership
- Community preparedness and resilience
- Minimise community disruption
- Time to adapt to coastal erosion
- Avoid inappropriate development in areas of flood and coastal erosion
- Reduce risk to life, people and property
- Maintain existing assets minimise the risk of flooding to residential properties
- Continue river, watercourse and tidal defence maintenance

**Economic**

- Reduce economic damage to non-residential properties
- Maintain existing assets minimise the economic damage from flooding to non-residential properties
- Economic, regeneration and funding opportunities
- Minimise the risk of flooding to transport services
- Continue river and watercourse maintenance to minimise the risk of flooding to non-residential properties
- Consider flood risk to agricultural Land
- Understanding Flood Risk and Working in Partnership with landowners
- Ensure that FRM activities do not adversely affect the tourism industry

**Environmental**

- Contribute to achieving Water Framework Directive (WFD) objectives
- Minimise the negative impacts of flooding to Designated nature conservation Sites
- Minimise the negative impacts of flooding to designated heritage sites

**Reservoirs**

- Reduce the risk of flooding from reservoirs to people, property, infrastructure and the environment.

**Measures across the North Norfolk Rivers Catchment**

There are 132 measures to manage flood risk across the Catchment. These are summarised below, with the detailed measures set out in the Part C: appendices. Measures included, are over and above RMA ‘flood risk management activities’ undertaken routinely, as explained in Part A, Section 4 – How to Manage Risk. Measures cover discrete pieces of work such as projects and campaigns.

**Preventing risk:** 46 measures

- Encourage adaptation and resilience of communities at risk such as Cley Salthouse, Brancaster, Holkham and Wells-next-the-Sea.
- Annual monitoring of maintenance spending can, over time, indicate a potential increase or decrease in residual flood risks. Knowledge of any such changes could alert RMAs of the need to reassess their understanding of the known risks and adapt to any change.
- Develop consistent medium to long-term plans for relocation of services and facilities that will be lost to erosion, e.g. outfalls, highways at Overstrand, Mundesley, Bacton Gas Terminal, Caister-on-Sea, Gorleston to Hopton, Corton in line with Defra Coastal Change Policy and resulting pathfinder studies.
- Understanding catchments and flood risk through identifying areas of significant local flood risk; communicating that risk to the public, local businesses and Risk
Management Authorities; designating Critical Drainage Catchments where the risk is most significant; identifying actions to mitigate flood risk affecting the Critical Drainage Catchments; and developing programmes to implement the identified actions to be delivered through Surface Water Management Plans for including Breckland and North Norfolk.

Preparing for risk: 34 measures

- Liaise with operators of Bacton Gas Interconnector site so to understand the lifespan of the site and any implication this may have on the SMP as a whole.
- Identify community emergency and evacuation plans and update emergency plans for communities to reflect changes in flood risk in Well-next–the–Sea, Blakeney Freshes, and Holkham Dunes.
- Monitor effects of SMP policies at Deepdale, Norton and Overy marshes on the ecological potential of the River Burn freshwater and Cley Salthouse Ridge.
- Continue beach monitoring at Holkham dunes to determine how the dunes respond to changes in sea level etc over time.
- Champion, investigate and seek funds for the deployment of coastal adaptation measures to enable a managed approach to coastal change. Including measures for businesses, households, community resilience, heritage, environment and infrastructure along the North Norfolk Coast.

Protecting from risk: 52 measures

- Identify suitable locations and create freshwater habitat to replace any lost due to epoch 2 managed realignment at Blakeney Freshes and potential epoch 3 realignment at Cley marshes
- Continue to manage defences at Holkham dunes with limited intervention to maintain a natural coastline and sustain flood defence to properties and historic assets, in addition to investigating the development of Holkham dune system and its sustainability as a flood defence.
- Continue to manage the defences at Brancaster and Brancaster Staithe, Burnham Overy Staithe, River Stiffkey Outfall, Morston, River Glaven outfall, Blakeney and Cley West back, Deepdale, Norton and Overy marshes, Wells-next–the–Sea and the River Burn outfall in accordance with the hold the line as set out in the North Norfolk SMP.
- Investigation flood risk at Cley, Mundesley, Stiffkey, Weybourne and Wiveton, South Creake, Corpusty and Saxthorpe and work with the community to look at way to manage the risk.
- Develop Surface Water Management Plans for Cromer and Sheringham to investigate the local risk from ordinary watercourses, surface water and sewer flooding and look at links between different sources of flooding.

The above are catchment-specific flood risk management measures. Please refer back to section 8 of Part A of the FRMP to see the measures that apply to the entire or large parts of the Anglian RBD.
3.7. North West Norfolk Catchment

Introduction to the catchment

The North West Norfolk catchment comprises an area of approximately 1,000 km² stretching from Denver (near Downham Market) to the coast at Hunstanton, and west into the Fenland region as far as the River Nene. Large urban areas include King’s Lynn, Downham Market and Hunstanton.

The catchment covers both chalk uplands in the east and fen to the west, and is the only catchment within the central section of the Anglian RBD to have a coastline.

Most of the coastline is low lying with the exception of shallow cliffs at Hunstanton. The area is vulnerable to erosion and tidal surges. Coastal sea and tidal defences protect the coastline from inundation.

The Wash East Coastal Management Strategy, adopted in 2015, was developed in order to identify the most suitable way of managing flood and erosion risk to local communities along the coastline between Hunstanton and Wolferton Creek. The strategy recommends an “adaptable” approach to the future management of the coastline, working with partners and the community to determine future opportunities to improve the standard of protection.

The catchment contains a number of rivers, and incorporates the tidal reach of the river Great Ouse (also known as the Tidal River Great Ouse) north of Denver. The Tidal River Great Ouse forms a continuous reach with the New Bedford/100 Foot River.

The Relief Channel runs adjacent and parallel to the Tidal River Great Ouse. Built in the 1960s, the Relief Channel was constructed as part of the Great Ouse Flood Protection Scheme to act as a flood storage reservoir. It fills at Denver Sluice, and discharges into the Tidal River Great Ouse at the Tail Sluice just south of King’s Lynn.

There are 2 further main rivers within the catchment: the Nar, which flows approximately east to west discharging into the Tidal River Great Ouse, via gravity through tidal flaps during periods of low tide; and, the Hun which flows north into the Wash. The Middleton Stop is a man-made drain, lying between the rivers Gaywood and Nar, draining into the Nar just before its confluence with the Tidal River Great Ouse.

In contrast to the uplands which lie to the east of the Tidal River Great Ouse, the fenland area to the west encompasses numerous lowland drains but no flowing rivers. The drains discharge into the Tidal River Great Ouse via a combination of gravity outfalls and pumped discharges, and are managed by a network of IDBs.

The Middle Level Main Drain is a high level drainage channel that carries water from the Middle Level (found within the Old Bedford including Middle Level catchment) to the Tidal River Great Ouse. The drain is owned and independently managed by the Middle Level Commissioners.

Land use and management

The North West Norfolk catchment is predominantly rural with a population of 145,000. Most of the population depends, in different ways and degrees, upon the catchment for a living.
The largest urban area is the town of King’s Lynn on the river Great Ouse estuary, with a population of around 30,000. Other significant urban areas in the catchment are Downham Market to the south of the area, and to the northwest, Hunstanton, Heacham and Dersingham.

The countryside is predominantly agricultural in character, gently undulating in form and containing many areas of diverse landscapes. Approximately a quarter of its land is classified as ‘high quality’ agricultural land and is an important national and local resource.

The major growth centre in the catchment is King’s Lynn due to its strategic position at the entrance to The Wash. King’s Lynn is a working sea port with a thriving fishing and seafood industry. The port also has facilities for bulk cargo ships carrying goods and foodstuffs including cereals, petroleum products, timber and steel.

Tourism is also important to the economy in this catchment. The towns of Hunstanton and Heacham rely heavily on seasonal tourism along their long stretches of shoreline.

![Figure 23: Overview of the North West Norfolk Catchment](image)

**Geology**

In terms of geology, the catchment can be divided into 2 distinct areas. To the west of the Tidal River Great Ouse and on the coastal fringes, the land is low lying and below sea level in some places. These areas were formed from extensive deposits of unconsolidated clays and sand derived from old river beds and flood plains, beaches and estuarine saltmarsh, all of which overlie kimmeridge and amphiwill clays.

In contrast to the east of the Tidal River Great Ouse, away from the coastal fringes, the catchment comprises a layered sequence of rocks and clays. The first outcrop is a distinctive low scarp of Sandringham Sands which rises from the drained coastal marshes, dipping gently
from west to east. Further east, the Sandringham Sands outcrop is overlain by chalk, which also dips from west to east.

The Sandringham Sands and chalk both act as aquifers, which transmit significant quantities of water resulting in the rivers Nar, Babingley and Ingol.

**National and international designations**

The North West Norfolk catchment contains a diverse range of habitats from remnant fen and valley mire to chalk river. Three water-dependent sites within the area form part of the Natura 2000 network of conservation areas, designated under the European Habitats Directive. These are Roydon Common, Dersingham Bog, and East Walton and Adcocks Common. Roydon Common and Dersingham Bog, together form a SAC, and individually each site is designated as a SSSI.

East Walton and Adcocks Common - also a SSSI - is part of the Norfolk Valley Fens SAC. These sites support a variety of complex plant communities dependent on a supply of water from the underlying aquifers.

A supply of freshwater from the catchment also has the potential to influence a 4th Natura 2000 site, The Wash. This European Marine Site is designated both a SAC and a SPA because it supports very large populations of both breeding and overwintering waders and wildfowl. The Wash is also a Ramsar site. The Wash is an area of exceptional biological interest. Intertidal mudflats and salt marshes form one of Britain’s most important winter feeding grounds for waders and wildfowl. Salt marsh and shingle communities are of considerable botanical interest. Salt marsh forms a valuable breeding ground for birds. The Wash is also a breeding site for common seals.

The North West Norfolk catchment also supports additional dependent sites designated as SSSIs including Leziate, Sugar and Derby Fens in the Gaywood catchment, East Winch Common, and the river Nar, although not typical (having headwaters which are fed by surface run off, and heavily modified lower reaches), is designated as a chalk river SSSI. The purified base flow created by the chalk aquifer regulates the water temperature. This creates ideal conditions and supports the characteristic plant communities. This is a great diversity of aquatic insects, fish, including trout, salmon and lamprey, and frequently larger animals such as water vole and otter. Worldwide, chalk rivers are rare.

Other non-designated wildlife sites are also found across the catchment with varying degrees of dependency on water resources. These sites form an important part of the natural heritage of North West Norfolk.

There are a number of scheduled monuments and listed buildings, designated for their heritage value, across the catchment.

**Partnership working**

A good working relationship has developed between the partners within the North West Norfolk catchment. Norfolk County Council (NCC) is the only lead local flood authority in the catchment. NCC published their Local Flood Risk Management Strategy in September 2015. NCC has an active Flood Risk Management Partnership group, which involves all risk management authorities, both at a strategic and tactical level.

There are 2 main groups of IDBs: the Water Level Management Alliance and the Downham Market Group of IDBs. In addition to these main IDB groups, the Middle Level Commissioners also play a significant role in the management of this catchment.
The Environment Agency and IDBs work closely together within this catchment, developing a coordinated programme of capital upgrade and maintenance works for flood risk management. As part of this, IDBs and the Environment Agency are exploring the use of public sector cooperation agreements (PSCAs) which provide a legal mechanism for both parties to maximise their combined resources to deliver a more efficient way of providing services and work for the benefit of local communities.

**Wider catchment issues with an impact on flood risk management**

The ecology of many rivers in the catchment is impacted by silt and excess nutrients from both sewage treatment works and diffuse agricultural pollution.

Reducing the amount of silt entering watercourses would have a positive impact on flood risk and would reduce the need for costly maintenance work to remove it.

Excess nutrients can disturb the natural balance of a watercourse and cause rapid growth of vegetation and algae which can reduce flow in the river and may require expensive vegetation management. Low flows and high summer temperatures can exacerbate these effects.

The extent of historic river modification, such as heavily embanked or re-sectioned rivers, has decreased habitat diversity. Weirs and flood defence structures have been identified as obstacles to fish and eel passage. All barriers to fish migration and sediment transfer are being reviewed to open up more rivers for fish and eel migration in response to the Eel Regulations 2009. Opportunities are being sought to re-establish, as far as possible, the natural functioning of river systems. This can be done by working with natural processes and improving floodplain connectivity to have a positive impact on flood risk management.

Invasive non-native species pose a significant future threat in this catchment, although the impacts are not yet widespread. Signal crayfish are present in the River Nar and have the potential to increase the amount of fine sediment and silt build-up in the river. Floating pennywort is present in the Great Ouse and has the potential to increase flood risk, impact on recreational use, and affect aesthetic value of watercourses. The plant grows up to 20cm per day, forming dense interwoven mats that can extend a significant distance above and below the water surface.

**Coastal erosion**

The coastline between Hunstanton and Heacham is eroded annually by the effects of the tide and wave action. Sand and other materials are removed from the beaches along the coast resulting in a reduction in material on the beach and shingle ridge flood defences. An annual beach replenishment scheme recycles the sand, which has been deposited by the tides further down the coastline at Wolferton Creek, to reinstate the beach and shingle ridge. The Wash East Coastal Management Strategy identifies options to maintain and improve protection to residents and the important tourism industry on which the local economy depends.

**Climate change**

The climate is changing and this is likely to have an impact on flooding and coastal erosion. Sea levels are rising and winter rainfall may become more intense. Changes in weather patterns, especially more torrential rainfall, are likely to increase flood risk from surface water and ordinary watercourses, as well as rivers. Communities within the North West Norfolk catchment could experience an increase in both the severity and frequency of existing flooding.
problems, and communities that have not flooded previously could be affected in the future. It is likely that this pattern will continue through the effects of climate change.

Rising sea levels increase the risk of overtopping of the tidal defences in Kings Lynn. The higher sea levels will also mean that waves and storm surges could cause greater coastal erosion, exacerbating existing problems between Heacham and Hunstanton. Changes to currents acting on the coast could also lead to changes in the movement of coastal sediments, affecting both coastal deposits and erosion. This could expose communities to new risks from flooding, lead to a greater risk of coastal defences failing, and increase the need for maintenance on defences and more extensive warning systems. With the coastal area of the North West Norfolk Catchment already at risk from tidal flooding up to 25 km inland, climate change will present increased challenges to those trying to reduce tidal flood risk to this area.

The town of King's Lynn and many smaller communities are likely to be affected by an increase in the risk of surface water flooding caused by higher levels of rainfall. Risk of flooding may also increase during winter as a result.

Flood risk maps and statistics

**Flooding from rivers and the sea**

Approximately 41,000 people are at risk of flooding from rivers and the sea within the North West Norfolk Catchment, representing 28.7% of the total population. Over 9,000 non-residential properties and approximately 39.8% of the agricultural land within the catchment are at risk of flooding from rivers. Approximately 62% of SSSI sites and more than 74% of Ramsar sites are at risk of flooding from rivers in the area.

Much of the flood risk in the catchment is associated with tidal surges which affect coastal communities from King’s Lynn to Hunstanton. Defences exist to reduce the risk of flooding to low-lying coastal areas, while King’s Lynn has a number of tidal gates and doors to reduce the risk to the town.
Figure 24: Flood Risk from Rivers and the sea in the North West Norfolk Catchment – National Flood Risk Assessment (NAFRA)
Table 15: Summary flood risk from rivers and sea to people, economic activity and the natural and historic environment across the North West Norfolk Catchment.

<table>
<thead>
<tr>
<th>River and Sea</th>
<th>Total in Catchment</th>
<th>High risk</th>
<th>Moderate risk</th>
<th>Low risk</th>
<th>Very low risk</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Risk to people:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of people in area:</td>
<td>143,500</td>
<td>500</td>
<td>6,950</td>
<td>33,800</td>
<td>&lt;50</td>
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<tr>
<td>Number of services:</td>
<td>350</td>
<td>&lt;10</td>
<td>20</td>
<td>90</td>
<td>0</td>
</tr>
<tr>
<td><strong>Risk to economic activity:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of non-residential properties:</td>
<td>24,500</td>
<td>500</td>
<td>3,150</td>
<td>5,600</td>
<td>&lt;50</td>
</tr>
<tr>
<td>Number of airports:</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Length of roads (primary routes) (km):</td>
<td>140</td>
<td>&lt;10</td>
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<td>40</td>
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<tr>
<td>Length of railway (km):</td>
<td>30</td>
<td>0</td>
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<td>&lt;10</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Agricultural land (ha):</td>
<td>76,850</td>
<td>3,150</td>
<td>13,950</td>
<td>13,500</td>
<td>&lt;50</td>
</tr>
<tr>
<td><strong>Risk to the natural and historic environment:</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Number of EU designated bathing waters within 50m:</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>Number of EPR installations within 50m:</td>
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<td>1</td>
<td>1</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Area of SAC within area (ha):</td>
<td>1,500</td>
<td>600</td>
<td>&lt;50</td>
<td>350</td>
<td>0</td>
</tr>
<tr>
<td>Area of SPA within area (ha):</td>
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<td>700</td>
<td>&lt;50</td>
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<td>0</td>
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<tr>
<td>Area of RAMSAR site within area (ha):</td>
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<td>750</td>
<td>&lt;50</td>
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</tr>
<tr>
<td>Area of World Heritage Site within area (ha):</td>
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<td>0</td>
<td>0</td>
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<td>0</td>
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<td>50</td>
<td>400</td>
<td>0</td>
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<tr>
<td>Area of Parks and Gardens within area (ha):</td>
<td>700</td>
<td>&lt;50</td>
<td>&lt;50</td>
<td>&lt;50</td>
<td>&lt;50</td>
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<tr>
<td>Area of Scheduled Ancient Monument within area (ha):</td>
<td>300</td>
<td>&lt;50</td>
<td>&lt;50</td>
<td>&lt;50</td>
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</tr>
<tr>
<td>Number of Listed Buildings within area:</td>
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<td>20</td>
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<td>310</td>
<td>90</td>
<td>50</td>
<td>20</td>
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</tr>
</tbody>
</table>

**Flooding from reservoirs**

Reservoir flooding is not a major feature within this catchment. With the exception of a small area of the Ouse Washes, there are only a few small reservoirs located across the catchment used to supply water, irrigate land and as flood storage.

Approximately 1,300 people are at risk of flooding from reservoirs in the North West Norfolk Catchment, representing nearly 0.9 % of the total population within the catchment. 950 non-residential properties and 8.5% of agricultural land are at risk of flooding from reservoirs in the...
North West Norfolk catchment. Approximately 1.3% of SSSI sites are also at risk of reservoir flooding in the area.

It is important to note that the likelihood of flooding from reservoirs is extremely low. However, in the unlikely event of a reservoir failure, there is the potential for a large volume of water to escape over a short period of time with little or no warning, which could lead to property damage or even loss of life.

Figure 25: Flood Risk from Reservoirs in the North West Norfolk Catchment
Table 16: Summary flood risk from reservoirs to people, economic activity and the natural and historic environment across the North West Norfolk Catchment.

<table>
<thead>
<tr>
<th>Reservoirs</th>
<th>Total in RBD</th>
<th>Maximum extent of flooding</th>
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<tbody>
<tr>
<td><strong>Risk to people:</strong></td>
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<td></td>
</tr>
<tr>
<td>Number of people in area:</td>
<td>143,500</td>
<td>1,350</td>
</tr>
<tr>
<td>Number of services:</td>
<td>350</td>
<td>&lt;10</td>
</tr>
<tr>
<td><strong>Risk to economic activity:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of non-residential properties:</td>
<td>24,500</td>
<td>950</td>
</tr>
<tr>
<td>Number of airports:</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Length of roads (primary routes) (km):</td>
<td>140</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Length of railway (km):</td>
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</tr>
<tr>
<td>Agricultural land (ha):</td>
<td>76,850</td>
<td>6,500</td>
</tr>
<tr>
<td><strong>Risk to the natural and historic environment:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of EU designated bathing waters within 50m:</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
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<td>14</td>
<td>0</td>
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<tr>
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<td>1,500</td>
<td>&lt;50</td>
</tr>
<tr>
<td>Area of SPA within area (ha):</td>
<td>1,200</td>
<td>0</td>
</tr>
<tr>
<td>Area of RAMSAR site within area (ha):</td>
<td>1,550</td>
<td>&lt;50</td>
</tr>
<tr>
<td>Area of World Heritage Site within area (ha):</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
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<td>&lt;50</td>
</tr>
<tr>
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<td>&lt;50</td>
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<tr>
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</tr>
<tr>
<td>Number of Listed Buildings within area:</td>
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<td>10</td>
</tr>
<tr>
<td>Number of Licensed water abstractions within the area:</td>
<td>310</td>
<td>40</td>
</tr>
</tbody>
</table>

Flooding from groundwater, sewer and surface water

Surface water and sewer flooding have affected many parts of the catchment. The expansion of the urban area of King’s Lynn has meant surface water drainage from developments has become an issue for the receiving watercourses. King’s Lynn IDB and Norfolk County Council have been active in managing improvements to the local drainage system. The Environment Agency’s Flood Maps for Surface Water Flooding show many areas at risk across the catchment.

Despite the prevalence of aquifers across the eastern section of the catchment, groundwater flood risk is low.

Conclusions and objectives for the North West Norfolk Catchment

Conclusions

The North West Norfolk catchment is one of the driest in the country. Much of the catchment is underlain by permeable bedrock resulting in the rainfall being stored in aquifers.
underground which feed the rivers slowly. Combined with the rural nature of the catchment, the risk of river flooding is reduced significantly.

However, the heavily modified nature of the fenland area to the west of the Tidal River Great Ouse is at higher risk. This area consists of more impermeable clays and encompasses numerous managed lowland drains but no natural rivers. As a result this area is dependent on effective management of engineered assets such as raised embanked watercourses, pumping stations and other flood risk structures to manage flood risk.

The greatest potential flood risk within the catchment would be the combination of a large fluvial flood event coinciding with a significant tidal surge. The tidal event of December 2013 was the largest tidal surge ever recorded along the east coast. Whilst this caused minor damage to some flood risk assets, there was no overtopping of the Great Ouse Tidal River embankments or significant failure of flood defences.

The Great Ouse Tidal River Action Plan aims to deliver the recommendations of the 2010 Tidal River Strategy (TRS), taking account of recent climate change guidance and the introduction of partnership funding. The purpose of the Tidal River Action Plan is to deliver a shared long-term vision of flood risk management within the Tidal River floodplain. This plan covers an area of the Norfolk and Cambridgeshire Fens with approximately 2,400 properties and 26,000 ha of prime agricultural land at flood risk.

Nearly one third of the population within the catchment is at risk of flooding. This is mainly from the sea as the majority of people in the catchment live on or close to the coast, increasing the risk of flooding from tidal surges.

Other sources of flooding from reservoirs, surface water, ordinary water courses and sewers are also significant in this catchment. There have been many reported incidents in recent years of these types of problems affecting householders and businesses. The updated surface water flood maps (December 2013) show widespread risk of surface water flooding, particularly in the King’s Lynn area.

Whilst the area has some challenging flooding problems to address, the amount of undeveloped land available in the catchment means that there is potential to adopt new techniques and practices to alleviate these problems. The national significance of the area for food production should be considered when planning new approaches and long term options to managing flood risk.

CFMPs published in 2008 considered possible increases in flood levels, extent and risk if climate change were to increase flood flows by 20%. Climate projections since then suggest flood flows could increase by more than that but acknowledge significant uncertainty. No additional analysis is proposed at this stage; instead the preferred approach is to emphasise the uncertainty in climate change impacts. Planners, Emergency Planners, Asset Managers and others should ask questions such as: “have we considered what might happen if flood risk is worse than previously considered?” and “what can we do to mitigate the increased flood risk?”

**Objectives for the North West Norfolk Catchment**

This is a summary of the Environment Agency objectives for this catchment. More detail of these objectives can be found in **Part A**, section 8 conclusions, objectives and measures. The catchment also includes measures from other RMAs. The objectives for these measures can be found in ‘Part C, Annex 2 - Source of objectives and measures for the FRMP’.
Social

- Understanding Flood Risk and Working in Partnership
- Community preparedness and resilience
- Minimise community disruption
- Time to adapt to coastal erosion
- Avoid inappropriate development in areas of flood and coastal erosion
- Reduce risk to life, people and property
- Maintain existing assets minimise the risk of flooding to residential properties
- Continue river, watercourse and tidal defence maintenance

Economic

- Reduce economic damage to non-residential properties
- Maintain existing assets minimise the economic damage from flooding to non-residential properties
- Economic, regeneration and funding opportunities
- Minimise the risk of flooding to transport services
- Continue river and watercourse maintenance to minimise the risk of flooding to non-residential properties
- Consider flood risk to agricultural Land
- Understanding Flood Risk and Working in Partnership with landowners
- Ensure that FRM activities do not adversely affect the tourism industry

Environmental

- Contribute to achieving Water Framework Directive (WFD) objectives
- Minimise the negative impacts of flooding to Designated nature conservation sites
- Minimise the negative impacts of flooding to designated heritage sites

Reservoirs

- Reduce the risk of flooding from reservoirs to people, property, infrastructure and the environment.

Measures across the North West Norfolk Catchment

Across the North West Norfolk Catchment there are 87 measures to manage flood risk.
These are summarised below, with the detailed measures set out in the Part C: appendices.
Measures included, are over and above RMA ‘flood risk management activities’ undertaken routinely, as explained in Part A, Section 4 – How to Manage Risk. Measures cover discrete pieces of work such as projects and campaigns.

Preventing risk: 32 measures

- Investigate the risk of groundwater flooding across Norfolk
- Develop mitigation measures to reduce flood risk to highways across Norfolk
- Investigate the potential for property level protection along the in suitable locations across Norfolk
- Continuation of the strategic Shoreline Management Monitoring programme between Wolferton Creek and South Hunstanton
- Investigate and record historic assets around Holme-next-the-Sea to enable adaptation and mitigation measures

**Preparing for risk:** 24 measures

- Update the Rapid Coastal Zone Assessment Survey for Wolferton Creek to South Hunstanton
- Update emergency plans for Holme-next-the-Sea reflecting changing flood risk
- Work with local community in Thornham to prepare for a possible realignment of Thornham sea bank
- Continue beach monitoring at Holme dunes to determine how the dunes respond to sea level changes to inform future policy
- Develop an education and marketing programme to increase awareness of flood risk within Norfolk

**Protecting from risk:** 31 measures

- Work with the East Wash Community Interest Company and the Borough of King’s Lynn and West Norfolk to sustain the management of the shingle ridge between Hunstanton and Wolferton Creek.
- Maintain and upgrade where necessary the tidal defences in King’s Lynn
- Continue to provide the current standard of protection for the shingle ridge between Wolferton Creek and Hunstanton
- Development and delivery of the Tidal River Partnership Action Plan
- Investigate options for reducing flood risk and delivering the most appropriate mitigation options for Islington

**Recovery and review of risk:** There are no measures proposed over and above existing flood risk work.

The above are catchment-specific flood risk management measures. Please refer back to section 8 of Part A of the FRMP to see the measures that apply to the entire or large parts of the Anglian RBD.
3.8. Old Bedford and Middle Level Catchment

Introduction to the catchment

The Old Bedford and Middle Level catchment covers an area of approximately 921km² stretching from the village of Stilton in the west, to the village of Sutton in the east, and from Upwell in the north, to the edge of Huntingdon in the south.

The vast majority of the area lies below sea level and is dependent upon the effective management and maintenance of a heavily man-made drainage system.

The catchment can be divided into 3 main drainage systems or level dependent management units (LDMU).

The Middle Level LDMU covers a large part of the catchment. This unit is managed by the Middle Level Commissioners and 33 smaller IDBs. They operate a highly complex water level management system that provides a number of functions, including flood risk management and land drainage. The Middle Level system comprises 190km of watercourses. The majority of these watercourses are statutory navigation routes.

The Ouse Washes LDMU comprises a large flood storage reservoir that stores flood water from the Bedford Ouse. Land on either side of the flood storage reservoir is protected from flooding by two significant engineered raised embankments known as the South Level Barrier Bank (east side) and the Middle Level Barrier Bank (west side).

The Old Bedford/Counterdrain LDMU receives natural flow from the areas around Somersham, Colne and Earith, along with IDB pumped discharge from 3 IDBs.

Land use and management

The Old Bedford and Middle Level catchment has a total population of only 104,000 and is largely rural in nature. The catchment has some of the most fertile and productive agricultural soils in the UK, making agriculture the predominant land use and of great importance to the local economy. There are no large urban areas within the catchment, the majority of the population is located within smaller market towns including Whittlesey, March, Ramsey and Chatteris. Elsewhere across the catchment, the population density is low, as much of the land is used for agricultural production.

The Ouse Washes is one of Europe’s most important wetland sites. It lies within the Old Bedford and Middle Level catchment, and is one of the main tourist attractions within the region.
Figure 26: Overview of the Old Bedford and Middle Level Catchment

Geology

The underlying geology of the area is clay and there are no significant principal aquifers within the catchment. There is therefore little groundwater available for use. Small, highly localised, supplies of groundwater can be found within the drift deposits of sands and gravels.

National and international designations

The catchment supports a number of SSSI, Ramsar sites and SACs, including:

- The Ouse Washes, stretching 32km from Earith to Denver, were created in the 17th Century as a flood storage area, and over time have been designated SAC, SPA, SSSI and Ramsar site. The Ouse Washes are designated an SPA and Ramsar site for the seasonally flooded wet grasslands between the Old Bedford and Hundred Foot rivers that support significant numbers of water and wading birds, including the Bewick’s swan and black-tailed godwit.
- Woodwalton Fen is designated as a SSSI and is a component of the Fenland SAC.

The Great Fen Project is a visionary plan to transform in excess of 3,000ha of largely arable land into a 'super-reserve', an area of wildlife-rich and publicly accessible fenland landscape. The Great Fen area lies in Huntingdonshire, with Peterborough to the north and Huntingdon to the south. This area encompasses 2 National Nature Reserves, Holme Fen and Woodwalton Fen, which are 2 of the only remaining fragments of our fenland natural heritage.

There are a number of scheduled monuments and listed buildings, designated for their heritage value, across the catchment.
Partnership working

A good working relationship has developed between the partners within the Old Bedford and Middle Level catchment. There are 3 LLFAs within the catchment, Cambridgeshire County Council, Norfolk County Council and Peterborough City Council. Cambridgeshire and Norfolk have both published their local flood risk management strategies, while the Peterborough strategy will be published this year. These LLFAs have flood risk management partnership groups in place which bring together all risk management authorities to effectively manage flood risk from all sources of flooding.

As most of the area is managed by pumped systems, there is a strong working relationship with the Middle Level Commissioners and other local IDBs.

The Middle Level Commissioners manage a river system which consists of over 120km of watercourses that flow into the Middle Level Main Drain, a high-level drainage channel that discharges into the Great Ouse Tidal River at St Germans Pumping Station.

The Environment Agency and IDBs work closely together within this catchment, developing a coordinated programme of capital upgrade and maintenance works for flood risk management. As part of this, IDBs and the Environment Agency are exploring the use of public sector cooperation agreements (PSCAs) which provide a legal mechanism for both parties to maximise their combined resources to deliver a more efficient way of providing services and work for the benefit of local communities.

Wider catchment issues with an impact on flood risk management

Few of the watercourses in this predominantly fen landscape are natural. Many are artificial, man-made drains which do not flow as natural river systems. Water movement between levels is driven by pumped or flow control operations, for irrigation, water storage, land drainage, navigation and flood control purposes. As such, the drainage in this catchment is particularly complex.

The ecology in this catchment is impacted by excess nutrients from sewage treatment discharges and rural diffuse pollution from agriculture and private sewerage systems.

Excess nutrients can disturb the natural balance of a watercourse and cause rapid growth of vegetation and algae which may require expensive removal or management. Excessive plant growth can also cause fluctuations in dissolved oxygen levels which, if made worse by low flows and high summer temperatures, can cause fish mortality.

Within this catchment the Ouse Washes and Fenland SAC are designated as water dependent Natura 2000 sites (designated under the Birds and Habitats Directive). The Ouse Washes flood storage reservoir is a very significant feature. The future strategic water level management of the Ouse Washes will need to balance flood risk benefit, and potential adverse impact on water quality and wildlife, within the context of climate change and more prolonged and increased summer flooding events.

Invasive non-native species pose a significant future threat within the catchment, although the impacts are not yet widespread. For example, in this catchment, zebra mussels grow into dense clusters on any available hard surface including pipe work, pumps and sluices. Chinese mitten crab dig burrows up to 1 metre long into soft banks which can damage flood defences and increase the amount of fine sediment released into the water.

The Environment Agency is working with operators to help them achieve compliance with eel passage and screening requirements through their scheduled programmes of work, including
routine maintenance and refurbishment programmes and planned capital investment programmes. By scheduling action for eels alongside other programmes of work, the Environment Agency aims to make eel protection more cost-effective and achievable for operators. This applies to all operators, including the Environment Agency, who have reaffirmed their commitment to meeting their responsibilities to protect eels in response to the Eel Regulations 2009. Opportunities are being sought to re-establish, as far as possible, the natural function of river systems. This can be done by working with natural processes and improving floodplain connectivity to have a positive impact on flood risk management.

Climate change

The climate is changing and this is likely to have an impact on flooding and coastal erosion. Sea levels are rising and winter rainfall may become more intense. Changes in weather patterns, especially more torrential rainfall, are likely to increase flood risk from surface water and ordinary watercourses, as well as rivers. Communities within the Old Bedford and Middle Level catchment could experience an increase in both the severity and frequency of existing flooding problems, and communities that have not flooded previously could be affected in the future. It is likely that this pattern will continue through the effects of climate change.

Rising sea levels increases the risk of overtopping of the tidal defences at Kings Lynn. This could expose communities to new risks from flooding, lead to a greater risk of tidal defences failing and increasing the need for maintenance on defences and more extensive warning systems. With the Old Bedford and Middle Level Catchment already at risk from tidal flooding over 50 km inland should a breach occur, climate change will present increased challenges to those trying to reduce tidal flood risk to this area.

The towns of March and Chatteris together with some smaller communities are likely to be affected by an increase in the risk of surface water flooding caused by higher levels of rainfall. Risk of flooding may also increase during winter as a result.

Flood risk maps and statistics

Flooded from rivers

Approximately 10,500 people are at risk of flooding from rivers within the Old Bedford and Middle Level Catchment, representing 10% of the total population. 7,000 non-residential properties and approximately 67.6% of the agricultural land within the catchment are at risk of flooding from rivers. Approximately 88.7% of SSSI sites and more than 98% of Ramsar sites are at risk of flooding from rivers in the area.

The risks to people and property are low, except in the event of a breach in the embankments causing rapid inundation. The main areas at significant flood risk should a breach occur are; Chatteris, March, Ramsey and Bury.
Figure 27: Flood risk from rivers and the sea in the Old Bedford and Middle Level Catchment – National Flood Risk Assessment (NAFRA)
### Table 17: Summary flood risk from rivers and sea to people, economic activity and the natural and historic environment across the Old Bedford and Middle Level Catchment.

<table>
<thead>
<tr>
<th>River and Sea</th>
<th>Total in Catchment</th>
<th>High risk</th>
<th>Moderate risk</th>
<th>Low risk</th>
<th>Very low risk</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Risk to people:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of people in area:</td>
<td>103,850</td>
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<td>8,850</td>
<td>1,150</td>
<td>0</td>
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<tr>
<td>Number of services:</td>
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<td>20</td>
<td>130</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td><strong>Risk to economic activity:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of non-residential properties:</td>
<td>20,550</td>
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<td>6,250</td>
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<tr>
<td>Number of airports:</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>0</td>
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<tr>
<td>Length of roads (primary routes) (km):</td>
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<td>20</td>
<td>&lt;10</td>
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<tr>
<td>Length of railway (km):</td>
<td>60</td>
<td>&lt;10</td>
<td>30</td>
<td>&lt;10</td>
<td>0</td>
</tr>
<tr>
<td>Agricultural land (ha):</td>
<td>77,250</td>
<td>6,250</td>
<td>42,300</td>
<td>3,600</td>
<td>&lt;50</td>
</tr>
<tr>
<td><strong>Risk to the natural and historic environment:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of EU designated bathing waters within 50m:</td>
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<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Number of EPR installations within 50m:</td>
<td>12</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Area of SAC within area (ha):</td>
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<td>250</td>
<td>250</td>
<td>50</td>
<td>0</td>
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<tr>
<td>Area of SPA within area (ha):</td>
<td>2,300</td>
<td>2,200</td>
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<td>&lt;50</td>
<td>0</td>
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<tr>
<td>Area of RAMSAR site within area (ha):</td>
<td>2,550</td>
<td>2,200</td>
<td>250</td>
<td>&lt;50</td>
<td>0</td>
</tr>
<tr>
<td>Area of World Heritage Site within area (ha):</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Area of SSSI within area (ha):</td>
<td>3,100</td>
<td>2,200</td>
<td>500</td>
<td>50</td>
<td>0</td>
</tr>
<tr>
<td>Area of Parks and Gardens within area (ha):</td>
<td>&lt;50</td>
<td>&lt;50</td>
<td>&lt;50</td>
<td>&lt;50</td>
<td>0</td>
</tr>
<tr>
<td>Area of Scheduled Ancient Monument within area (ha):</td>
<td>150</td>
<td>&lt;50</td>
<td>&lt;50</td>
<td>&lt;50</td>
<td>0</td>
</tr>
<tr>
<td>Number of Listed Buildings within area:</td>
<td>700</td>
<td>10</td>
<td>30</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Number of Licensed water abstractions within the area:</td>
<td>4,200</td>
<td>1,410</td>
<td>2,750</td>
<td>10</td>
<td>0</td>
</tr>
</tbody>
</table>

### Flooding from reservoirs

Approximately 3,700 people (3.6% of the population within the catchment) are at risk of flooding from reservoirs, along with 3,000 non-residential properties and 37.4% of agricultural land. Approximately 12.7% of SSSI sites are also at risk of reservoir flooding in the area.

The main flood risks from reservoirs are associated with the Nene Washes and Ouse Washes, both of which are significant flood storage areas and designated under the Reservoirs Act 1975. As designated reservoirs, the Nene and Ouse Washes are subject to regular inspections from reservoir panel engineers.

Within the catchment there are a number of smaller reservoirs which are primarily for agricultural water supply.
It is important to note that the likelihood of flooding from reservoirs is extremely low. However, in the unlikely event of a reservoir failure, there is the potential for a large volume of water to escape over a short period of time with little or no warning, which could lead to property damage or even loss of life.

Figure 28: Flood risk from reservoirs in the Old Bedford and Middle Level Catchment
Table 18: Summary flood risk from reservoirs to people, economic activity and the natural and historic environment across the Old Bedford and Middle Level Catchment.

<table>
<thead>
<tr>
<th>Reservoirs</th>
<th>Total in RBD</th>
<th>Maximum extent of flooding</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Risk to people:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of people in area:</td>
<td>103,850</td>
<td>3,760</td>
</tr>
<tr>
<td>Number of services:</td>
<td>320</td>
<td>70</td>
</tr>
<tr>
<td><strong>Risk to economic activity:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of non-residential properties:</td>
<td>20,550</td>
<td>3,000</td>
</tr>
<tr>
<td>Number of airports:</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Length of roads (primary routes) (km):</td>
<td>80</td>
<td>10</td>
</tr>
<tr>
<td>Length of railway (km):</td>
<td>60</td>
<td>10</td>
</tr>
<tr>
<td>Agricultural land (ha):</td>
<td>77,250</td>
<td>28,950</td>
</tr>
<tr>
<td><strong>Risk to the natural and historic environment:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of EU designated bathing waters within 50m:</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Number of EPR installations within 50m:</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>Area of SAC within area (ha):</td>
<td>550</td>
<td>200</td>
</tr>
<tr>
<td>Area of SPA within area (ha):</td>
<td>2,300</td>
<td>400</td>
</tr>
<tr>
<td>Area of RAMSAR site within area (ha):</td>
<td>2,550</td>
<td>400</td>
</tr>
<tr>
<td>Area of World Heritage Site within area (ha):</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Area of SSSI within area (ha):</td>
<td>3,100</td>
<td>400</td>
</tr>
<tr>
<td>Area of Parks and Gardens within area (ha):</td>
<td>&lt;50</td>
<td>&lt;50</td>
</tr>
<tr>
<td>Area of Scheduled Ancient Monument within area (ha):</td>
<td>150</td>
<td>&lt;50</td>
</tr>
<tr>
<td>Number of Listed Buildings within area:</td>
<td>700</td>
<td>10</td>
</tr>
<tr>
<td>Number of Licensed water abstractions within the area:</td>
<td>4,200</td>
<td>2,500</td>
</tr>
</tbody>
</table>

Flooding from groundwater, sewer and surface water

Groundwater poses little flood risk in the Old Bedford and Middle Level catchment due to the underlying clay geology of the area.

There has been some surface water and sewer flooding within the catchment, particularly in March and Chatteris. The updated surface water flood maps (December 2013) show a localised risk of surface water flooding.

Conclusions and objectives for the Old Bedford and Middle Level Catchment

Conclusions

The Old Bedford and Middle Level is one of the driest catchments in the country in terms of annual rainfall. The majority of the area is below sea level and protected from flooding by an
engineered system that includes man-made watercourses, pumping stations and significant raised embankments. As a result, only 10% of the population within the catchment is at risk of flooding from rivers.

The Old Bedford and Middle Level catchment is largely rural in nature, with no major urban areas. The main areas of population at significant flood risk should a breach occur are; Chatteris, March, Ramsey, and Bury.

Although recognised as a very important area of conservation, the primary role of the Ouse Washes is for storage of floodwater from the Bedford Ouse catchment, which significantly reduces the risk of flooding to the surrounding Middle and South Levels.

The greatest potential flood risk within the catchment would be the combination of a large fluvial flood event coinciding with a significant tidal surge. The tidal event of December 2013 was the largest tidal surge ever recorded along the east coast. Whilst this caused minor damage to some flood risk assets, there was no overtopping of the Great Ouse Tidal River embankments or significant failure of flood defences.

The Great Ouse Tidal River Action Plan aims to deliver the recommendations of the 2010 Tidal River Strategy (TRS), taking account of recent climate change guidance and the introduction of partnership funding. The purpose of the Tidal River Action Plan is to deliver a shared long-term vision of flood risk management within the Tidal River floodplain. This plan covers an area of the Norfolk and Cambridgeshire Fens with approximately 2,400 properties and 26,000 ha of prime agricultural land at flood risk.

Whilst the area has some challenging flooding problems to address, the amount of undeveloped land available in the catchment means that there is potential to adopt new techniques and practices to alleviate these problems. The national significance of the area for food production should be considered when planning new approaches and long term options to managing flood risk.

Catchment Flood Management Plans published in 2008 considered possible increases in flood levels, extent and risk if climate change were to increase flood flows by 20%. Climate projections since then suggest flood flows could increase by more than that, but acknowledge significant uncertainty. No additional analysis is proposed at this stage, instead the preferred approach is to emphasise the uncertainty in climate change impacts. Planners, Emergency Planners, Asset Managers and others should ask questions such as: “have we considered what might happen if flood risk is worse than previously considered?” and “what can we do to mitigate the increased flood risk?”

Objectives for the Old Bedford and Middle Level Catchment
This is a summary of the Environment Agency objectives for this catchment. More detail of these objectives can be found in Part A, section 8 conclusions, objectives and measures. The catchment also includes measures from other RMAs. The objectives for these measures can be found in ‘Part C, Annex 2 - Source of objectives and measures for the FRMP’.

Social

- Understanding Flood Risk and Working in Partnership
- Community preparedness and resilience
- Minimise community disruption
- Avoid inappropriate development in areas of flood risk
- Reduce risk to life, people and property
- Maintain existing assets minimise the risk of flooding to residential properties
- Continue river, watercourse and tidal defence maintenance

Economic
- Reduce economic damage to non-residential properties
- Maintain existing assets minimise the economic damage from flooding to non-residential properties
- Economic, regeneration and funding opportunities
- Minimise the risk of flooding to transport services
- Continue river and watercourse maintenance to minimise the risk of flooding to non-residential properties
- Consider flood risk to agricultural Land
- Understanding Flood Risk and Working in Partnership with landowners
- Ensure that FRM activities do not adversely affect the tourism industry

Environmental
- Contribute to achieving Water Framework Directive (WFD) objectives
- Minimise the negative impacts of flooding to Designated nature conservation sites
- Minimise the negative impacts of flooding to designated heritage sites

Reservoirs
- Reduce the risk of flooding from reservoirs to people, property, infrastructure and the environment.

Measures across the Old Bedford and Middle Level Catchment
Across the Old Bedford and Middle Level Catchment there are 21 measures to manage flood risk. These are summarised below, with the detailed measures set out in the Part C: appendices. Measures included, are over and above RMA ‘flood risk management activities’ undertaken routinely, as explained in Part A, Section 4 – How to Manage Risk. Measures cover discrete pieces of work such as projects and campaigns.

Preventing risk: 4 measures
- Work in partnership to support the development, implementation and review of Peterborough City Council’s local flood risk management strategy
- Update planning policies and associated processes to appropriately manage surface water flood risk with Peterborough City Council’s area
- Implementation of SuDs by Peterborough City Council to ensure national sustainability requirements for developments are met

Preparing for risk: 7 measures
- Partnership projects to develop a better understanding of flood risk across Peterborough City Council’s area
- Update flood response and recovery plan across Peterborough City Council’s area
- Undertake engagement activities to increase awareness of local flood risk across Peterborough City Council’s area
- Investigate groundwater flood risk across Peterborough City Council’s area

**Protecting from risk:** 9 measures

- Development and delivery of the Tidal River Partnership Action Plan
- Great Fen – creation of 3700 hectares of wetland habitat linking Woodwalton Fen and Holme Fen
- Develop a detailed surface water management plan for March
- Investigate crest levels and flood storage facilities in the Middle Level
- Investigate economic viability of reducing highways flooding in Welney

**Recovery and review of risk:** 1 measures

- Investigate flood incidents in accordance with the Flood and Water Management Act (2010) within the Peterborough City Council’s area

The above are catchment-specific flood risk management measures. Please refer back to section 8 of Part A of the FRMP to see the measures that apply to the entire or large parts of the Anglian RBD.
3.9. Upper and Bedford Ouse Catchment

Introduction to the catchment

The Upper and Bedford Ouse catchment covers an area of approximately 3,043 km², and includes the river Great Ouse and a number of its tributaries. The character of the land varies from gently rolling hills in the upper catchment to more extensive river valley flood plains and flood meadows in the downstream section. The catchment stretches from the source of the Great Ouse at Brackley in the south across to Letchworth in the east and Earith in the north.

A number of springs emerge from the permeable oolite limestone at its source. Downstream of Brackley the Great Ouse flows in an easterly direction before being joined by the Padbury and Claydon Brooks (together known as The Twins) near Buckingham, and the rivers Tove and Ouzel at Newport Pagnell.

The Great Ouse is joined by the Ivel and its tributaries the river Hiz, river Flit and Campton Brook (known locally as the river Hit) at Sandy. These rivers are fed by the chalk and the Woburn Sands. The last major tributaries, the river Kym and Alconbury Brook join the Great Ouse upstream of Huntingdon.

The tidal limit of the river Great Ouse is reached at Brownshill, close to the downstream boundary of the catchment at Earith.

Natural flows in the catchment derive from 3 main sources, surface run-off resulting from rainfall, surface or near surface drainage, and baseflow derived from springflow and groundwater. Springs are found in the south-east of the area in the Woburn Sands and chalk, and in the north and west in the Great Oolite Group.

The rivers within the catchment are generally slow flowing over clay and alluvial deposits; although the headwaters of the river Hiz which rise in the Chilterns are chalk streams. The rivers in this area have carved wide river valleys, and have deposited vast quantities of alluvial sands and gravels.

Land use and management

There are nearly 1,000,000 people within the Upper and Bedford Ouse catchment. Whilst the catchment is predominantly rural, there are several large urban centres, with development concentrated in these established cities and towns. Major urban areas include Milton Keynes, Leighton Buzzard, Bedford, Hitchin, Huntingdon and Brackley. Crossing the catchment is the Grand Union Canal for which the Canal and Rivers Trust (formerly British Waterways) are the statutory navigation authority. This forms a key strategic inland waterway link between London and the Midlands.

The new HS2 rail link will pass to the south of the catchment, which will bring with it increased development. These developments will bring with them future flood risk challenges, creating opportunities for innovative sustainable drainage improvements which could provide benefits for the wider area.
The Upper Ouse and Bedford catchment contains a diverse range of habitats from remnant fen and valley mire to chalk streams.

The river valleys have mostly been modified and developed for agriculture, urbanisation or industry. As a result, semi-natural wet grassland, such as flood meadows and other natural grasslands, with their characteristic plants, are rare.

Geology

There are a number of aquifers within the catchment due to the permeable nature of much of the underlying rock. The principal aquifers in the Upper and Bedford Ouse catchment are the Great Oolite, in the east of the area, and the Chalk and Woburn Sands in the south. The northern part of the chalk aquifer overlies the southern part of the Woburn Sands aquifer, here there is a layer of gault clay separating them. In the north of the Ouse catchment there are alluvial sand and gravel aquifers following the course of the river Great Ouse and its tributaries. The greensand and chalk aquifers to the south and west of the catchment are the most heavily utilised groundwater sources in the Upper and Bedford Ouse, in terms of abstraction.

National and international designations

There are several protected SSSI sites in the Upper Ouse and Bedford Ouse catchment, notably Portholme Meadow in Huntingdon, which is also a SAC. Other SSSIIs of note are Graffham Water, Fliitwick Moor and Stevington Marsh. Immediately downstream of the catchment are the Ouse Washes, a nationally important SSSI, SAC, SPA and Ramsar site.
Any actions which affect the water entering the Ouse Washes site need to take account of their potential effects on the Ouse Washes.

Other non-designated wildlife sites are also found across the catchment, which form an important part of the natural heritage of Upper Ouse and Bedford.

There are a number of scheduled monuments and listed buildings, designated for their heritage value, across the catchment.

**Partnership working**

A good working relationship has developed between the partners within the Upper and Bedford Ouse catchment. There are 3 main LLFAs within the catchment; Bedford Borough Council, Central Bedfordshire Council and Milton Keynes Council. There are also LLFAs which lie partly within the catchment; Cambridgeshire County Council, Hertfordshire County Council, Northamptonshire County Council, Buckinghamshire County Council, and Oxfordshire County Council. Central Bedfordshire, Buckinghamshire, Northamptonshire, Cambridgeshire, Hertfordshire and Oxfordshire Councils have all published local flood risk management strategies (LFRMS). Bedford Borough and Milton Keynes Councils’ LFRMSs will be published in 2016.

Central Bedfordshire Council published and adopted their LFRMS in 2014. The local measures within this document are subject to an annual review, and are therefore not published within the FRMPs. Please refer to this strategy for information on the high level objectives, local measures and corresponding Action Plan which the council have proposed ([Central Bedfordshire Local Flood Risk Management Strategy](#)).

Within the catchment there is a main group of IDBs; the Bedford Group of IDBs, and a few smaller IDBs in the north-east of the area.

The Great Ouse Tidal River Action Plan aims to deliver the recommendations of the 2010 Tidal River Strategy (TRS), taking account of recent climate change guidance and the introduction of partnership funding. The purpose of the Tidal River Action Plan is to deliver a shared long-term vision of flood risk management within the Tidal River floodplain. This plan covers an area of the Norfolk and Cambridgeshire Fens with approximately 2,400 properties and 26,000 ha of prime agricultural land at flood risk.

**Wider catchment issues with an impact on flood risk management**

The ecology of many watercourses in the catchment is impacted by silt and excess nutrients from both sewage treatment works and diffuse agricultural pollution.

Reducing the amount of silt entering watercourses would have a positive impact on flood risk and would reduce the need for costly maintenance work to remove it.

Excess nutrients can disturb the natural balance of a watercourse and cause rapid growth of vegetation and algae which can reduce flow in the river and may require expensive vegetation management. Low flows and high summer temperatures can exacerbate these effects.

The extent of historic river modification, such as heavily embanked or re-sectioned rivers, has decreased habitat diversity. Weirs and flood defence structures have been identified as obstacles to fish and eel passage. All barriers to fish migration and sediment transfer are being reviewed to open up more rivers for fish and eel migration in response to the Eel Regulations 2009. Opportunities are being sought to re-establish, as far as possible, the
natural functioning of river systems. This can be done by working with natural processes and improving floodplain connectivity to have a positive impact on flood risk management.

Invasive non-native species pose a significant future threat in this catchment, although the impacts are not yet widespread. Signal crayfish are present and have the potential to increase the amount of fine sediment and silt build-up in the river.

Climate change

The climate is changing and this is likely to have an impact on flooding and coastal erosion. Sea levels are rising and winter rainfall may become more intense. Changes in weather patterns, especially more torrential rainfall, are likely to increase flood risk from surface water and ordinary watercourses, as well as rivers. Communities within the Upper and Bedford Ouse catchment could experience an increase in both the severity and frequency of existing flooding problems, and communities that have not flooded previously could be affected in the future. It is likely that this pattern will continue through the effects of climate change.

The towns of Bedford, Milton Keynes and Buckingham, together with many smaller communities are likely to be affected by an increase in the risk of surface water flooding caused by higher levels of rainfall. Risk of flooding may also increase during winter as a result.

Flood risk maps and statistics

Flooding from rivers

Approximately 76,500 people are at risk of flooding from rivers within the Upper and Bedford Ouse Catchment, representing 8% of the total population. Nearly 10,000 non-residential properties and approximately 8.7% of the agricultural land within the catchment are at risk of flooding from rivers. Approximately 25.8% of SSSI sites are at risk of flooding from rivers in the area.
Figure 30: Flood Risk from Rivers and the sea in the Upper and Bedford Ouse Catchment – National Flood Risk Assessment (NAFRA)
<table>
<thead>
<tr>
<th>River and Sea</th>
<th>Total in Catchment</th>
<th>High risk</th>
<th>Moderate risk</th>
<th>Low risk</th>
<th>Very low risk</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Risk to people:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of people in area:</td>
<td>938,700</td>
<td>11,700</td>
<td>9,550</td>
<td>55,150</td>
<td>100</td>
</tr>
<tr>
<td>Number of services:</td>
<td>2,150</td>
<td>80</td>
<td>40</td>
<td>160</td>
<td>&lt;10</td>
</tr>
<tr>
<td><strong>Risk to economic activity:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of non-residential properties:</td>
<td>115,550</td>
<td>2,150</td>
<td>2,000</td>
<td>5,750</td>
<td>&lt;50</td>
</tr>
<tr>
<td>Number of airports:</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Length of roads (primary routes) (km):</td>
<td>820</td>
<td>10</td>
<td>30</td>
<td>50</td>
<td>0</td>
</tr>
<tr>
<td>Length of railway (km):</td>
<td>180</td>
<td>&lt;10</td>
<td>&lt;10</td>
<td>&lt;10</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Agricultural land (ha):</td>
<td>252,900</td>
<td>10,550</td>
<td>5,700</td>
<td>5,600</td>
<td>&lt;50</td>
</tr>
<tr>
<td><strong>Risk to the natural and historic environment:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of EU designated bathing waters within 50m:</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Number of EPR installations within 50m:</td>
<td>61</td>
<td>4</td>
<td>5</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Area of SAC within area (ha):</td>
<td>100</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Area of SPA within area (ha):</td>
<td>&lt;50</td>
<td>&lt;50</td>
<td>&lt;50</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Area of RAMSAR site within area (ha):</td>
<td>&lt;50</td>
<td>&lt;50</td>
<td>&lt;50</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Area of World Heritage Site within area (ha):</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Area of SSSI within area (ha):</td>
<td>3,900</td>
<td>950</td>
<td>&lt;50</td>
<td>&lt;50</td>
<td>&lt;50</td>
</tr>
<tr>
<td>Area of Parks and Gardens within area (ha):</td>
<td>4,600</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Area of Scheduled Ancient Monument within area (ha):</td>
<td>1,100</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>&lt;50</td>
</tr>
<tr>
<td>Number of Listed Buildings within area:</td>
<td>9,080</td>
<td>250</td>
<td>240</td>
<td>550</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Number of Licensed water abstractions within the area:</td>
<td>540</td>
<td>220</td>
<td>40</td>
<td>20</td>
<td>0</td>
</tr>
</tbody>
</table>

**Flooding from reservoirs**

The main reservoirs affecting flood risk within the Upper and Bedford Ouse catchment are Grafham Water in the lower part of the catchment, and Caldecott and Willen Lakes located in Milton Keynes in the upper section of the catchment. These reservoirs are managed and operated by Anglian Water and their main purpose is to supply drinking water. The Ouse Washes, lying in the adjacent Old Bedford and Middle Level catchment, provides a critical flood risk management role for this catchment.
Nearly 41,000 people are at risk of flooding from these and smaller reservoirs within the Upper and Bedford Ouse Catchment, representing approximately 4.4% of the total population within the catchment. Almost 5,500 non-residential properties and 4.1% of agricultural land are at risk of flooding from reservoirs in the Upper and Bedford Ouse catchment. Approximately 9% of SSSI sites are also at risk of reservoir flooding in the area.

It is important to note that the likelihood of flooding from reservoirs is extremely low. However, in the unlikely event of a reservoir failure, there is the potential for a large volume of water to escape over a short period of time with little or no warning, which could lead to property damage or even loss of life.

![Figure 31: Flood Risk from Reservoirs in the Upper and Bedford Ouse Catchment](image)
Table 20: Summary flood risk from reservoirs to people, economic activity and the natural and historic environment across the Upper and Bedford Ouse Catchment.

<table>
<thead>
<tr>
<th>Reservoirs</th>
<th>Total in RBD</th>
<th>Maximum extent of flooding</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Risk to people:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of people in area:</td>
<td>938,700</td>
<td>40,650</td>
</tr>
<tr>
<td>Number of services:</td>
<td>2,150</td>
<td>150</td>
</tr>
<tr>
<td><strong>Risk to economic activity:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of non-residential properties:</td>
<td>115,550</td>
<td>5,500</td>
</tr>
<tr>
<td>Number of airports:</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Length of roads (primary routes) (km):</td>
<td>820</td>
<td>30</td>
</tr>
<tr>
<td>Length of railway (km):</td>
<td>180</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Agricultural land (ha):</td>
<td>252,900</td>
<td>10,350</td>
</tr>
<tr>
<td><strong>Risk to the natural and historic environment:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of EU designated bathing waters within 50m:</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Number of EPR installations within 50m:</td>
<td>61</td>
<td>11</td>
</tr>
<tr>
<td>Area of SAC within area (ha):</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Area of SPA within area (ha):</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Area of RAMSAR site within area (ha):</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Area of World Heritage Site within area (ha):</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Area of SSSI within area (ha):</td>
<td>3,900</td>
<td>350</td>
</tr>
<tr>
<td>Area of Parks and Gardens within area (ha):</td>
<td>4,600</td>
<td>200</td>
</tr>
<tr>
<td>Area of Scheduled Ancient Monument within area (ha):</td>
<td>1,100</td>
<td>100</td>
</tr>
<tr>
<td>Number of Listed Buildings within area:</td>
<td>9,080</td>
<td>690</td>
</tr>
<tr>
<td>Number of Licensed water abstractions within the area:</td>
<td>540</td>
<td>180</td>
</tr>
</tbody>
</table>

Flooding from groundwater, sewer and surface water

Groundwater poses little flood risk in the Upper and Bedford Ouse, despite the geology and large aquifers in the catchment.

There has been some surface water and sewer flooding within the catchment, particularly in Buckingham and Riseley, together with smaller communities within the catchment. The updated surface water flood maps (December 2013) show a localised risk of surface water flooding.
Conclusions and objectives for the Upper and Bedford Ouse Catchment

Conclusions

Although one of the driest catchments in the country, there is still a notable flood risk from a variety of sources, from rivers, ordinary watercourses, reservoirs, surface water and sewers. As such, there is a need for risk management authorities to work in partnership and take a holistic approach to assess all sources of flooding. The role of the lead local flood authorities and IDBs within this approach is crucial, allowing local knowledge and experience of all sources of flood risk to be shared, resulting in a more comprehensive solution to flood risk.

There are more than 76,500 people and 12,000 non-residential properties at risk of flooding from rivers within the catchment.

The underlying geology within the catchment is predominantly permeable chalk, sands and oolite, creating a valuable source of groundwater in terms of abstraction. In terms of flood risk, much of the catchment consists of slow-flowing, slow-reacting watercourses. The main flood risk issues are; the river Tove at Towcester, Clipstone Brook at Leighton Buzzard, the Great Ouse at Buckingham, and parts of Milton Keynes and St Neots, and the river Ouzel through Milton Keynes and Newport Pagnell.

CFMPs published in 2008 considered possible increases in flood levels, extent and risk if climate change were to increase flood flows by 20%. Climate projections since then suggest flood flows could increase by more than that but acknowledge significant uncertainty. No additional analysis is proposed at this stage; instead the preferred approach is to emphasise the uncertainty in climate change impacts. Planners, Emergency Planners, Asset Managers and others should ask questions such as: “have we considered what might happen if flood risk is worse than previously considered?” and “what can we do to mitigate the increased flood risk?”

Whilst the area has some challenging flooding problems to address, the amount of undeveloped land available in the catchment means that there is potential to adopt new techniques and practices to alleviate these problems. The national significance of the area for food production should be considered when planning new approaches and long term options to managing flood risk.

Objectives for the Upper Ouse and Bedford Catchment

This is a summary of the Environment Agency objectives for this catchment. More detail of these objectives can be found in Part A, section 8 conclusions, objectives and measures. The catchment also includes measures from other RMAs. The objectives for these measures can be found in ‘Part C, Annex 2 - Source of objectives and measures for the FRMP’.

Social

- Understanding Flood Risk and Working in Partnership
- Community preparedness and resilience
- Minimise community disruption
- Avoid inappropriate development in areas of flood risk
- Reduce risk to life, people and property
• Maintain existing assets minimise the risk of flooding to residential properties
• Continue river, watercourse and tidal defence maintenance

Economic
• Reduce economic damage to non-residential properties
• Maintain existing assets minimise the economic damage from flooding to non-residential properties
• Economic, regeneration and funding opportunities
• Minimise the risk of flooding to transport services
• Continue river and watercourse maintenance to minimise the risk of flooding to non-residential properties
• Consider flood risk to agricultural Land
• Understanding Flood Risk and Working in Partnership with landowners
• Ensure that FRM activities do not adversely affect the tourism industry

Environmental
• Contribute to achieving Water Framework Directive (WFD) objectives
• Minimise the negative impacts of flooding to Designated nature conservation sites
• Minimise the negative impacts of flooding to designated heritage sites

Reservoirs
• Reduce the risk of flooding from reservoirs to people, property, infrastructure and the environment.

Measures across the Upper and Bedford Ouse Catchment

Across the Upper and Bedford Ouse Catchment there are 38 measures to manage flood risk. These are summarised below, with the detailed measures set out in the Part C: appendices. Measures included, are over and above RMA ‘flood risk management activities’ undertaken routinely, as explained in Part A, Section 4 – How to Manage Risk. Measures cover discrete pieces of work such as projects and campaigns.

Preventing risk: 17 measures

• Mitigation of flood risk from new developments across Northamptonshire through installation of attenuation storage
• Investigate past flooding incidents in Brackley to determine the most appropriate solution to mitigate risk
• Develop a flood risk mapping study for Houghton field drain to determine levels of flood risk
• Promotion of SuDS in line with government guidance within Northamptonshire
• Support Bedford Borough Council and Milton Keynes Council to develop local flood risk management strategies
Preparing for risk: 9 measures

- Northamptonshire County Council and the local resilience forum will work in partnership to review and update the multi-agency flood plan
- Northamptonshire County Council to investigate the potential to link flood warnings with CCTV, providing real time observation of flooding
- Provision of a flood warning service for main river and groundwater flood risk areas along the Bedford Ouse
- Review and update the multi-agency flood plan within Northamptonshire to ensure minimal disruption during a flood event
- Community engagement to improve awareness and resilience along the Bedford Ouse, and within Northamptonshire

Protecting from risk: 11 measures

- Strategic review of assets along the River Ivel to determine where assets can be removed to reduce maintenance requirements and improve the watercourse and meet WFD targets
- Development of detailed Surface Water Management Plans for Godmanchester
- Investigation of impacts of flooding on designated heritage sites within Northamptonshire
- Review of flood risk from Hen and Fox Brooks in St Neots to identify the most appropriate solution to manage flood risk
- Investigations into flood risk in Fenstanton to determine the most appropriate solution to manage this risk

Recovery and review of risk: 1 measure

- Investigate flood incidents in accordance with the Flood and Water Management Act (2010) within Northamptonshire

The above are catchment-specific flood risk management measures. Please refer back to section 8 of Part A of the FRMP to see the measures that apply to the entire or large parts of the Anglian RBD.
3.10. The Welland Catchment

Introduction to the catchment

The catchment of the Welland is located in the east of England. It extends eastward from Market Harborough through Stamford and Spalding to its outfall into the Wash. The catchment includes the major tributaries of the West Glen and East Glen rivers, plus a number of other tributaries including Eye Brook, the River Chater and River Gwash. The river Welland passes through the low-lying fens where the river is embanked and heavily modified.

The river Welland, the West Glen and East Glen, Eye Brook, and the rivers Chater and Gwash, cross a very varied landscape. Upstream of Stamford it is relatively hilly. Downstream of Stamford, the river has raised embankments that carry water through the low-lying fenland area. The fens are drained mainly by pumping stations that discharge water into the Welland, as large areas are at or below sea level. There are also some watercourses which drain into the sea via outfalls. IDBs play a critical role in managing land drainage within these low-lying fenland areas and maintaining high-quality arable land.

Land use and management

The overall catchment is approximately 1,680 km² and is predominantly rural. The main urban areas are Market Harborough, Oakham, Stamford, Market Deeping, Bourne, Spalding and the northern part of Peterborough, which includes the areas of Bretton, Dogsthorpe, Gunthorpe, New England, Ravensthorpe, Walton and Werrington.

Agricultural activity is extensive throughout the catchment. Around 80% of land in the catchment is used for arable crop production. A large proportion of this is high-grade agricultural land, particularly in The Fens, and is concentrated in the areas at risk of flooding from rivers and the sea.
Geology

The underlying geology of the area is dominated by mudstone to the west of Rutland Water and Uppingham and limestone and sandstone to the east. In the higher areas to the west of the catchment, where the underlying rock is non-porous clay, there are higher rates of rainfall runoff, and run-off flows directly into the watercourses.

In the areas where there is limestone or sandstone bedrock, run-off may infiltrate the rock. This delays the response of rivers to rainfall and reduces flood flows. There is also a risk from groundwater flooding in these areas. In the lower fenland areas in the east of the catchment, the peat soils and the low gradients mean water moves slowly to the river channels.

National and international designations

Within the River Welland catchment, there are a number of sites designated for their environmental importance, including SSSIs, SACs, SPAs and Ramsar sites. Important environmental sites in the catchment include Rutland Water (Ramsar, SPA, SSSI) and The Wash (Ramsar, SAC, SPA, SSSI). There are 57 SSSIs throughout the catchment, some of which are designated for their geological importance. Scheduled ancient monuments, designated for their heritage values, are distributed across the catchment area.

Partnership working

Within the Welland catchment, there is an excellent working relationship with between partners. There are 3 LLFAs in the River Welland catchment - Northamptonshire County Council (NCC), Peterborough City Council (PCC) and Rutland County Council (RCC)
cover the majority of the catchment. The River Welland catchment also includes areas which fall under Lincolnshire County Council and Leicestershire County Council.

NCC, PCC and RCC have worked in close partnership with the Environment Agency and have contributed to the Anglian FRMP. The Environment Agency have supported NCC in producing their Local Flood Risk Management Strategy (LFRMS) which was published in October 2013 and are committed to working closely with PCC and RCC to assist in the ongoing preparation of their LFRMSs.

The Welland catchment also benefits from the existence of the Lincolnshire, Northamptonshire and the Peterborough Flood Risk Management Partnerships. Risk Management Authority (RMA) partners co-ordinate our approach to flood risk management through these partnerships. The partnerships include those partners mentioned above plus representatives from district councils, Regional Flood and Coastal Committee representatives, Anglian Water Services Ltd and other partners such as the IDBs.

There are also 2 IDBs within the catchment – Welland and Deepings IDB and South Holland IDB. The Environment Agency assist IDBs in the development of their programme of capital upgrade works for flood risk management assets. The IDBs and the Environment Agency have jointly prepared a Public Sector Cooperation Agreements (PSCAs) that allows both parties to undertake works on behalf of the other party where it is more efficient and cost-effective to do so.

**Wider catchment issues with an impact on flood risk management**

Silt and excess nutrients within watercourses are exacerbated by sewage treatment works and private sewerage systems. Silt can cause a particular problem for effective flood risk management in this highly-modified lowland watercourse. This can sometimes mean silt needs to be removed which is expensive and needs to be carefully considered to reduce its impact on the environment.

Low flows and high summer temperatures can make this situation worse. Excess nutrients can disturb the natural balance of a watercourse and cause rapid growth of vegetation and algae. This reduces the ability of the lowland watercourses to flow efficiently and requires expensive vegetation management.

The legacy of drainage works on large stretches of rivers and dykes has created a poor habitat in some areas. Obstructions from weirs and flood defence works prevent some species of fish and eels from spawning and migrating.

While the impacts are not yet widespread, invasive non-native species do pose a significant future threat in the catchments. For example, signal crayfish present in the River Welland, increase the amount of fine sediment and silt build-up in the river through their burrowing activities.

**Coastal erosion**

The tide rather than wave action is the main contributor to sediment movement and build-up in. Most of the shoreline is fronted by salt marsh and inter-tidal mud flats and sand flats. These dissipate wave energy before it reaches the grassed earth flood banks. Coastal erosion is therefore not a major consideration in this catchment.
Climate change

The climate is changing and this is likely to have an impact on flooding and coastal erosion. Sea levels are rising and rainfall may become more intense. Changes in weather patterns, especially more torrential rainfall, are likely to increase flood risk from surface water and ordinary watercourses, as well as rivers. Communities within the Welland catchment have experienced an increase in both severity and frequency of existing flooding problems, and communities that have not flooded previously have been affected in recent years. It is likely that this pattern will continue through the effects of climate change.

Changes to currents and sea levels may also lead to changes in the movement of sediment. In the Welland catchment this could increase silt build-up further inland and could expose the catchment to new coastal flood risk. It may also increase the need for maintenance work on defences and require more extensive warning systems. With the coastal area of the Welland Catchment already at risk from tidal flooding up to 17.5km inland, climate change will present increased challenges to those trying to reduce tidal flood risk in this area.

Urban areas such as Bourne, Oakham, Stamford and Market Harborough are likely to suffer an increase in the risk of surface water flooding caused by higher levels of rainfall. Risk of flooding may also increase during winter as a result.

Flood risk maps and statistics

Flooding from rivers and the sea

River, or fluvial, flooding from the River Welland and its tributaries is the main risk in this catchment. Particular areas at risk are the northern part of Peterborough and the towns of Market Harborough and Stamford.

Approximately 63,500 people are at risk of flooding from rivers and the sea within the Welland Catchment. This represents 23% of the total population. More than 11,000 non-residential properties and approximately 33% of the agricultural land within the catchment are also at risk of flooding from tidal and river flooding. Approximately 3% of SSSI sites and less than 1% of Ramsar sites are at risk of this type of flooding.

There are some raised defences in the Welland catchment, for example in Market Harborough and Stamford.

Watercourses downstream of Stamford typically have flood banks which mean they flow at a higher level than the surrounding land. An example of this is the Maxey Cut. Tides can affect the ability of these watercourses to flow into the sea.

Flooding can occur when fluvial and tidal water rises over the top of raised flood defences or from breaching. While the likelihood of this happening is very low, the consequences could be significant and could cause rapid flooding of areas immediately behind the flood banks. This could potentially put people in danger, cause damage to property and have costly economic consequences.

The shoreline is characterised by a sea bank that divides extensive salt marsh and mud flats from a wide expanse of low-lying agricultural land where the River Welland meets The Wash. Much of this farmland has been reclaimed from the sea over the past centuries and supports a regionally and nationally valuable agricultural industry. The salt marsh and mud flats provide important habitats for wildlife and act as a natural sea defence. They also contribute to the economy of the area by supporting the shellfish industry and shoreline-related tourism.
The sea banks give flood protection to a very wide area that is typically at or below sea level. Salt marshes and mud flats are the main natural features. The salt marshes are currently growing, leading to increased natural protection. However, the future development of the salt marshes and mud flats in this area is extremely uncertain and is dependent on the future rate of sea level rise, the availability of sediment and a range of other factors. These uncertainties may impact on the flood defences and on the environment around the shoreline as well as on the value of the salt marshes.

Figure 33: Flood risk from rivers and the sea in the Welland Catchment – National Flood Risk Assessment (NAFRA)
Table 21: Summary flood risk from rivers and sea to people, economic activity and the natural and historic environment across the Welland Catchment.

<table>
<thead>
<tr>
<th>River &amp; Sea</th>
<th>Total in catchment</th>
<th>High risk</th>
<th>Medium risk</th>
<th>Low risk</th>
<th>Very low risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk to people:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of people in area:</td>
<td>278,950</td>
<td>750</td>
<td>44,200</td>
<td>18,400</td>
<td>50</td>
</tr>
<tr>
<td>Number of services:</td>
<td>830</td>
<td>20</td>
<td>120</td>
<td>60</td>
<td>0</td>
</tr>
<tr>
<td>Risk to economic activity:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of non-residential properties:</td>
<td>43,600</td>
<td>300</td>
<td>6,400</td>
<td>4,350</td>
<td>&lt;50</td>
</tr>
<tr>
<td>Number of airports:</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Length of roads (km):</td>
<td>300</td>
<td>&lt;10</td>
<td>30</td>
<td>30</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Length of railway (km):</td>
<td>140</td>
<td>&lt;10</td>
<td>10</td>
<td>&lt;10</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Agricultural land (ha):</td>
<td>152,900</td>
<td>5,750</td>
<td>29,350</td>
<td>15,000</td>
<td>&lt;50</td>
</tr>
<tr>
<td>Risk to the natural and historic environment:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of EU designated bathing waters within 50m:</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Number of EPR installations within 50m:</td>
<td>21</td>
<td>0</td>
<td>6</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Area of SAC within area (ha):</td>
<td>950</td>
<td>&lt;50</td>
<td>&lt;50</td>
<td>&lt;50</td>
<td>0</td>
</tr>
<tr>
<td>Area of SPA within area (ha):</td>
<td>2,500</td>
<td>&lt;50</td>
<td>&lt;50</td>
<td>&lt;50</td>
<td>0</td>
</tr>
<tr>
<td>Area of RAMSAR site within area (ha):</td>
<td>2,250</td>
<td>&lt;50</td>
<td>&lt;50</td>
<td>&lt;50</td>
<td>0</td>
</tr>
<tr>
<td>Area of World Heritage Site within area (ha):</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Area of SSSI within area (ha):</td>
<td>4,350</td>
<td>100</td>
<td>50</td>
<td>&lt;50</td>
<td>&lt;50</td>
</tr>
<tr>
<td>Area of Parks and Gardens within area (ha):</td>
<td>2,700</td>
<td>&lt;50</td>
<td>&lt;50</td>
<td>&lt;50</td>
<td>&lt;50</td>
</tr>
<tr>
<td>Area of Scheduled Ancient Monument within area (ha):</td>
<td>600</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>&lt;50</td>
</tr>
<tr>
<td>Number of Listed Buildings within area:</td>
<td>4,250</td>
<td>60</td>
<td>240</td>
<td>110</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Number of Licensed water abstractions within the area:</td>
<td>490</td>
<td>80</td>
<td>230</td>
<td>40</td>
<td>0</td>
</tr>
</tbody>
</table>

Flooding from reservoirs

The Welland Catchment is an important source of public water supply. Rutland Water, the largest man-made reservoir in England, provides water for the surrounding area but also the urban areas of Kettering, Northampton and Peterborough.

Rutland Water is also an internationally important site for wildlife and a renowned recreational resource.

Recently published flood risk maps for reservoirs show around 46,500 people at risk of flooding as the result of a reservoir failure within the Welland Catchment. This represents approximately 17% of the total population. Approximately 8,000 non-residential properties and approximately 21% of the agricultural land are at risk of flooding from reservoirs within the catchment. Approximately 18% of SSSI sites and 29% of Ramsar sites are also at risk.
The likelihood of flooding from reservoirs is extremely low. However, in the unlikely event that a reservoir dam failed, a large volume of water may be released and flooding could happen with little or no warning.

Figure 34: Flood risk from reservoirs in the Welland Catchment
### Table 22: Summary flood risk from reservoirs to people, economic activity and the natural and historic environment across the Welland Catchment.

<table>
<thead>
<tr>
<th>Reservoirs</th>
<th>Total in catchment</th>
<th>At risk of flooding from reservoirs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Risk to people:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of people in area:</td>
<td>278,950</td>
<td>46,550</td>
</tr>
<tr>
<td>Number of services:</td>
<td>830</td>
<td>140</td>
</tr>
<tr>
<td><strong>Risk to economic activity:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of non-residential properties:</td>
<td>43,600</td>
<td>8,100</td>
</tr>
<tr>
<td>Number of airports:</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Length of roads (km):</td>
<td>300</td>
<td>50</td>
</tr>
<tr>
<td>Length of railway (km):</td>
<td>140</td>
<td>40</td>
</tr>
<tr>
<td>Agricultural land (ha):</td>
<td>152,900</td>
<td>31,450</td>
</tr>
<tr>
<td><strong>Risk to the natural and historic environment:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of EU designated bathing waters within 50m:</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Number of EPR installations within 50m:</td>
<td>21</td>
<td>9</td>
</tr>
<tr>
<td>Area of SAC within area (ha):</td>
<td>950</td>
<td>&lt;50</td>
</tr>
<tr>
<td>Area of SPA within area (ha):</td>
<td>2,500</td>
<td>650</td>
</tr>
<tr>
<td>Area of RAMSAR site within area (ha):</td>
<td>2,250</td>
<td>650</td>
</tr>
<tr>
<td>Area of World Heritage Site within area (ha):</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Area of SSSI within area (ha):</td>
<td>4,350</td>
<td>800</td>
</tr>
<tr>
<td>Area of Parks and Gardens within area (ha):</td>
<td>2,700</td>
<td>100</td>
</tr>
<tr>
<td>Area of Scheduled Ancient Monument within area (ha):</td>
<td>600</td>
<td>300</td>
</tr>
<tr>
<td>Number of Listed Buildings within area:</td>
<td>4,250</td>
<td>740</td>
</tr>
<tr>
<td>Number of Licensed water abstractions within the area:</td>
<td>490</td>
<td>330</td>
</tr>
</tbody>
</table>

### Other sources of flooding

Surface water and sewer flooding has affected the catchment. Flood maps for surface water flooding, published in December 2013, show many areas at risk across the catchment. As examples, parts of Market Harborough, Bourne and Stamford are known to have experienced these types of flooding, along with many other smaller communities. Due to its geology, the northern part of Peterborough also has the potential to be at risk from surface water flooding.

Parts of the river Glen Catchment and areas around Stamford are vulnerable to groundwater flooding due to high water levels in the underlying rock.

### Conclusions and objectives for the Welland Catchment

#### Conclusions

The Welland catchment has two significant river systems; the River Welland and the East and West Glens. The main risk areas on these watercourses are urban settlements with development pressures, including Market Harborough, Stamford, Spalding and The Fens.

Approximately 23% of the population and 25% of commercial properties are at risk of flooding from rivers and the sea. Of the population at risk of flooding from rivers and the seas, the majority is considered to be medium risk (70%). Downstream of Stamford, there are large...
areas including high-grade agricultural land, which is subject to further man-made risk in the form of embanked watercourses.

Approximately 17% of the total population and over 8,000 non-residential properties are at risk of flooding from reservoirs.

Other sources of flooding including surface water, ordinary watercourses, ground water and sewers are also significant in this catchment. The surface water flood maps, published in December 2013, show the significance of surface water flooding in the catchment. There have been numerous reported incidents of flooding of this nature affecting householders and businesses in recent times.

The Shoreline Management Plan for the coast, which was completed in 2010, sets out how coastal erosion can be managed sustainably and also sets out the direction for managing coastal flood risk. This Flood Risk Management Plan summarises some of that information but does not change the approach of the SMP, which was arrived at through significant consultation and negotiation between members of the coastal groups who prepared the plans. Therefore the SMP actions can only be changed by the coastal groups.

Catchment Flood Management Plans, published in 2008, considered possible increases in flood levels, extent and risk if climate change were to increase flood flows by 20%. Climate projections since then suggest flood flows could increase by more than that but acknowledge significant uncertainty. No additional analysis is proposed at this stage. Instead, the preferred approach is to emphasise the uncertainty in climate change impacts. Planners, emergency planners, asset managers and others should ask questions such as: “have we considered what might happen if flood risk is worse than previously considered?” and “what can we do to mitigate the increased flood risk?”

While the catchment has some challenging flooding problems to address, particularly given the development pressure, the amount of undeveloped land available means there is space to alleviate these problems. The national significance of the area for food production does however need to be considered when planning new approaches to managing flooding.

Objectives

This is a summary of the Environment Agency objectives for this catchment. More detail of these objectives can be found in Part A, section 8 conclusions, objectives and measures. The catchment also includes measures from other RMAs. The objectives for these measures can be found in ‘Part C, Annex 2 - Source of objectives and measures for the FRMP’.

Social

- Understanding Flood Risk and Working in Partnership
- Community preparedness and resilience
- Minimise community disruption
- Time to adapt to coastal erosion
- Avoid inappropriate development in areas of flood and coastal erosion
- Reduce risk to life, people and property
- Maintain existing assets minimise the risk of flooding to residential properties
- Continue river, watercourse and tidal defence maintenance
Economic
- Reduce economic damage to non-residential properties
- Maintain existing assets minimise the economic damage from flooding to non-residential properties
- Economic, regeneration and funding opportunities
- Minimise the risk of flooding to transport services
- Continue river and watercourse maintenance to minimise the risk of flooding to non-residential properties
- Consider flood risk to agricultural Land
- Understanding Flood Risk and Working in Partnership with landowners
- Ensure that FRM activities do not adversely affect the tourism industry

Environmental
- Contribute to achieving Water Framework Directive (WFD) objectives
- Minimise the negative impacts of flooding to Designated nature conservation Sites
- Minimise the negative impacts of flooding to designated heritage sites

Reservoirs
- Reduce the risk of flooding from reservoirs to people, property, infrastructure and the environment.

Measures across the Welland Catchment

There are 83 measures to manage flood risk across the Welland Catchment. These are summarised below, with the detailed measures set out in the Part C: appendices. Measures included, are over and above RMA ‘flood risk management activities’ undertaken routinely, as explained in Part A, Section 4 – How to Manage Risk. Measures cover discrete pieces of work such as projects and campaigns.

Preventing risk: 36 measures:
- Identify communities at risk, in Northamptonshire, Peterborough, Rutland, Leicestershire and Lincolnshire, and work with them to investigate and implement solutions
- Work to improve our understanding of all sources of flooding to inform future flood risk management within the Welland Catchment
- Support Northamptonshire County Council and Peterborough City Council as Lead Local Flood Authorities in the implementation and review of their Local Flood Risk Management Strategies to further improve our understanding of flood risk to local communities from all sources of flooding and improve our joint approach to manage this risk
- Welland PLP scheme
- Work to plan for the future management of the coast between Gibraltar Point to Wolferton Creek including studies looking at salt marsh/mudflat loss and gain on the
Lincolnshire coastline adjacent to the Wash, and potential sites for localised realignment of tidal defences

Preparing for risk: 22 measures

- Support Rutland County Council in the development of their Local Flood Risk Management Strategy
- Maintain the current flood forecasting / warning service through ongoing review of community based Flood Warning Areas within the Welland catchment, including our site specific Flood Warning and Operational Response Procedures for Surfleet Reservoir
- Work with Local Resilience Forum (LRF) partners in Northamptonshire and Peterborough, complete the review of the MAFP and target community engagement from an emergency response perspective
- Improving flood risk mapping and inundation modelling for the Lincolnshire coast to provide an improved flood warning service
- Installation and testing of a tide gauge in the Wash Estuary to improve our forecasting of tidal flooding

Protecting from risk: 23 measures

- Flood risk management schemes within the Welland Catchment such as Brook Drain, Peterborough and Paston Brook, Peterborough
- Integrated WFD and flood risk projects for the Upper and Lower Welland catchments
- Review of existing flood risk management assets in Stamford, Lincolnshire and Spalding, Lincolnshire to understand the risks and where necessary take action to maintain the standard of service
- Implement the recommendations from the Welland Cradge Bank Performance Review project
- Maintain and operate existing major flood risk management assets (where justifiable flood risk benefits exist) within the Welland catchment

Recovery and review of risk: 2 measures

- Lead Local Flood Authorities – Northamptonshire County Council and Peterborough City Council - to undertake flood investigations in accordance with the Flood and Water Management Act (2010), following future flood incidents

The above are catchment-specific flood risk management measures. Please refer back to section 8 of Part A of the FRMP to see the measures that apply to the entire or large parts of the Anglian RBD.
3.11. The Witham Catchment

Introduction to the catchment

The river Witham is a predominantly rural catchment that extends from Grantham to Lincoln and Boston. The total population within the catchment is approximately 528,700. There are 2 ridges of relatively high ground; the Lincolnshire Limestone Ridge roughly in the centre of the catchment and the Lincolnshire Wolds in the north-east. The remainder of the catchment is primarily made up of low-lying land. In the low-lying Fens (between Lincoln and Boston) the rivers and their tributaries are embanked and heavily modified with drainage influenced by a number of pumping stations and the tidal cycle. Internal Drainage Boards (IDBs) play a key role in draining these lower lying areas and maintaining high-quality arable land.

The river Witham Catchment includes the river Brant, river Till, Fossdyke Canal, Barlings Eau, river Bain, Steeping River, Great Eau and many other smaller watercourses. The catchments of the South Forty Foot Drain and Stonebridge Drain are also included within the Witham Catchment, both of which flow to Boston and into the tidal river Haven.

Chalk streams drain off the Lincolnshire Wolds into the Witham as well as forming the headwaters for the east coast catchments. The Steeping River and the Great Eau drain directly to the sea near Skegness and Mablethorpe respectively.

The river Witham is also a key navigation for the Canals and Rivers Trust linking with the Black Sluice navigation and Boston Barrier Project.
Land use and management

The entire Witham management catchment is approximately 4000km² and predominantly rural. The main urban areas are Grantham, Lincoln, Sleaford and Boston. Significant urban growth areas have been identified around Lincoln and Grantham. The east coast also relies heavily on tourism, with three designated bathing waters in these catchments.

A total of 93 per cent of the catchment is arable land. Approximately 9 per cent of this land is Grade 1, 37% is Grade 2, 53% is Grade 3 and 1% is Grade 4 agricultural land.

The highest quality land is located in the south east of the catchment, situated on the lower fenland, between Lincoln and Boston. Grade 1 agricultural land is located on the alluvium deposits within the catchment. Alluvium soils are the most fertile soils found in the catchment. Grade 2 agricultural land is predominately located on peat, with additional areas on chalk, limestone and clay deposits. With the exception of peat and alluvium, Grade 3 agricultural land is found on all soil types within the catchment.

A total of 4% of land in the catchment is managed grassland, with 2% of the land coverage being urban. Only 1% of the land cover is forestry or woodland.

The extent and location of urban areas can have a notable effect on flooding risk. Impervious areas tend to experience a more rapid response to rainfall and higher flood peaks if management measures are not put in place. Development in flood plains can significantly increase flood risk, even if defences are put in place. Urban areas may also be at risk of flooding from inadequate drainage systems and groundwater.

A total of 91 km² (2 per cent) of the river Witham catchment is classed as having an urban land cover. The level of development identified for the catchment represents an increase of about 0.3 per cent in the urban area. Future urbanisation will be most significant in Lincoln and Grantham. More than two thirds of the total area identified for development in the catchment is located in these towns. The level of development within the Witham catchment is very low compared with England as a whole.

Geology

The underlying geology of the region broadly encompasses mudstones to the west of Lincoln, clays to the east, a ridge of limestone running north-south through Lincoln and chalk in the far north-east.

The mudstone and clay areas of the catchment are not very permeable and as a result cannot store large volumes of water. As a result, these areas will generate run-off and lead to high river flows which can pose a flood risk. The limestone and chalk areas of the catchment are more permeable than the mudstone and clay and do absorb and store some rainwater thereby reducing flood risk. Most groundwater is located in the limestone and chalk areas.

Five main soil types predominate in the river Witham catchment, which are broadly categorised as:

- Slowly permeable clays,
- Highly permeable limestone,
- Permeable till,
- Highly permeable chalk,
- Permeable peat,
Permeable alluvium.

The soils west of Lincoln are mainly slowly permeable clays. These form a barrier to water movement and encourage water to run-off overland rather than being absorbed into the ground. This means that rainfall gets to the rivers more quickly and adds to the flood risk. In contrast, limestone predominates immediately to the east of Lincoln. Limestone is highly permeable and capable of absorbing large volumes of rainfall thereby reducing flood risk. The highly-permeable chalk in the north east of the catchment is also capable of absorbing large volumes of rainfall. Between the limestone and chalk deposits, till and peat deposits predominate. A significant amount of peat is present in the low-lying fens, located on top of clay adjacent to the river Witham and in the South Forty Foot and Stonebridge sub-catchments. The presence of large quantities of peat over this area means water moves slowly through the ground before it enters watercourses.

National and international designations

Ecological diversity is recognised by a suite of national designations. These include: The Lincolnshire Wolds, an AONB, and many SSSIs. The Wash, an internationally-protected Ramsar site, SPA and SAC, is located downstream of the catchment boundary. The Wash supports designated shellfish waters. There are also 2 NNRs, Bardney Limewoods and Cribbs Meadow, and 3 LNRs Swanholme Lakes, Whisby Nature Park and Lollycocks Field.

Scheduled ancient monuments are found throughout the catchment. These include cemeteries, abbeys, priories, village crosses, Roman and Medieval settlements and castles. One registered battlefield, the Battle of Winceby 1643, is located east of Horncastle. This means some sites that might seem unlikely to be at risk of flooding, such as abbeys or priories which were built on high ground, are included as part of the site is located within the flood risk extent.

The Fens have a rich archaeological heritage because of the preservation properties of the peat found there. Nationally-important prehistoric metalwork has been retrieved from the river Witham and its floodplain during development of farm boundaries, railway construction and flood defence works. Most recently, flood embankment improvement works near Fiskerton (5 miles east of Lincoln) uncovered an Iron Age Longboat.

There are many listed buildings in the Witham Catchment, including 223 Grade 1 and over 4,000 grade 2 listed buildings. These sites are located across the catchment, however, they tend to be within urban areas or small rural communities with only a few located in the fens. These structures receive statutory protection against unauthorised demolition, alteration and extension and are considered to be of national importance.

There are 21 registered parks and gardens in the river Witham catchment. These range in size from 0.01km² (Marston Hall) to 5.05km² (Belton House), both near Grantham. The parks and gardens in the catchment are mostly located in and around the key urban areas.

Partnership working

We have developed a good working relationship with our partners within the Witham Catchment. Lincolnshire County Council is a very pro-active lead local flood authority (LLFA). They published their local flood risk management strategy (LFRMS) in 2012 and are working with us to prepare an updated version in the light of the new flood hazard mapping and other new data. The Witham also includes small areas of 3 other LLFAs – Nottinghamshire, Leicestershire and Rutland County Councils. All are committed to working closely together to prepare their LFRMS. There are also 6 IDBs – Upper Witham, Witham 1st, Witham 3rd, Witham...
4th, Black Sluice and Lindsey Marsh – within the catchment. The Environment Agency works with IDBs to assist them in the development of their programme of capital upgrade works for flood risk management assets. The IDBs and the Environment Agency have jointly prepared a public sector co-operation agreement (PSCA) which allows both parties to undertake works on the others’ behalf should it be more efficient and cost-effective for them to do so.

The Witham catchment also benefits from the existence of the Lincolnshire Flood Risk and Drainage Management Partnership. All RMA partners meet to co-ordinate our approach to flood risk management through this partnership. The partnership includes those mentioned above plus district councils, the RFCC, the Lincolnshire Resilience Forum, Anglian Water Services Ltd, Severn Trent Water and Natural England.

Locally there are also river partnership groups, who link between RMA and volunteer action groups. The Lincolnshire Chalk Streams Partnership and the Lincolnshire Rivers Trust are 2 examples in the catchment.

**Wider catchment issues with an impact on flood risk management**

Silt and excess nutrients caused by agriculture, are exacerbated within watercourses by inputs from sewage treatment works and private sewerage systems. Silt within the highly-modified lowland water courses can cause a particular problem for effective flood risk management. This can sometimes mean silt needs to be removed which is expensive and needs to be carefully considered to reduce its impact on the environment.

Low flows and high summer temperatures make these problems worse. Nutrients can disturb the natural balance of a watercourse and cause excessive growth of vegetation and algae. Again, this reduces the ability of the lowland water courses to efficiently pass flood flows and requires expensive vegetation management.

The legacy of drainage works on large stretches of rivers and dykes has created a poor habitat in some areas. Obstructions from weirs and flood defence works prevent some species of fish and eels from spawning and migrating. Many of the lowland watercourses are separated from their floodplains by embankments.

While the impacts are not yet widespread, invasive non-native species do pose a significant future threat in the catchments. For example, signal crayfish are present in the river Bain. These crayfish increase the amount of fine sediment and silt build-up in the river through their burrowing activities.

The Horncastle Flood Alleviation Scheme will offer an opportunity to improve habitats, through enhancement work undertaken in the new flood storage area. Where it is cost-effective, excess nutrients will be reduced by water company investment. This will run alongside campaigns to target agricultural diffuse pollution in problem catchments.

**Coastal erosion**

Erosion of the coast between Mablethorpe and Skegness removes sand from the beaches and exposes the clay which lies underneath. Low beach and foreshore clay levels make seawalls and embanked defences vulnerable to wave attack and overtopping during storms. In the worst case, this could lead to the failure of the defences. Failure would cause a risk to life, damage to property and considerable distress and disruption to coastal communities.

The Lincshore scheme reduces the risk of flooding between Mablethorpe and Skegness by covering the clay with sand. This prevents damage to the hard flood defences and maintains a
level of protection against a 1 in 200 chance (0.5%) of flooding in any given year by significantly reducing wave action against the defences.

**Climate change**

The climate is changing and this is likely to have an impact on flooding and coastal erosion. Sea levels are rising and winter rainfall may become more intense. Changes in weather patterns and, in particular, more torrential rainfall, are likely to increase flood risk from surface water and ordinary watercourses as well as rivers. Communities within the Witham catchment have experienced an increase in both severity and frequency of existing flooding problems and communities that have not flooded previously have been affected in recent years. It is likely that this pattern will continue through the effects of climate change.

Rising sea levels increases the risk of overtopping of tidal defences and dependency of the communities in these areas on these defences. The higher sea levels will also mean that waves and storm surges could cause greater coastal erosion, exacerbating existing problems between Mablethorpe and Skegness. Changes to currents acting on the coast could also lead to changes in the movement of coastal sediments, affecting both coastal deposits and erosion. This could expose communities to new risks from flooding, lead to a greater risk of coastal defences failing and increase the need for maintenance on defences and more extensive warning systems. With the coastal area of the Witham Catchment already at risk from tidal flooding up to 15km inland, climate change will present increased challenges to those trying to reduce tidal flood risk to this area.

The towns of Lincoln and Grantham and many smaller communities are likely to be affected by an increase in the risk of surface water flooding caused by higher levels of rainfall. Risk of flooding may also increase during winter as a result.

**Flood risk maps and statistics**

The total population in the catchment area is approximately 528,700 people. Significant urban growth areas have been identified around Lincoln and Grantham. While the population is small for the land area covered by the large Witham catchment, the combination of low-lying fenland and coastal floodplain means that around one third of residents are at some risk of flooding from either rivers or the sea. The main sources of flood risk for people, property, infrastructure and land are:

**Flooding from rivers and the sea**

Key river, or fluvial flood risk comes from the river Witham, South Forty Foot Drain, Stonebridge Drain and their tributaries. Particular areas at risk are Horncastle and Lincoln.

Tidal flooding from overtopping or breaching of tidal defences could inundate coastal communities and the towns of Mablethorpe, Skegness and Boston. Breaching/failure of embankments that carry the main upland rivers across the Fens also pose a significant flood risk. This type of flooding is difficult to predict and while the likelihood of this happening is low; the consequences could be significant and could cause the rapid inundation of the areas immediately behind the embankments leading to a severe risk to life.

The historic record over the last 300 years shows hundreds of flood events have been recorded across the Witham catchment. Two of the largest fluvial flood events, particularly in terms of the number of properties affected and disruption caused, occurred in 1922 and 1947. In 1922, the river Witham flooded Grantham affecting 750 properties and in March 1947 flooding from the River Witham caused major disruption in Lincoln. The East Coast Tidal
Surge on the 5 December 2013 flooded over 800 homes and businesses in Boston, at the bottom end of the Witham catchment.

In the summer of 2007, severe heavy rainfall caused extensive flooding in most urban areas throughout the Witham catchment. For example, more than 50 properties were flooded in Lincoln by surface water.

Figure 36: Flood risk from rivers and the sea in the Witham Catchment – National Flood Risk Assessment (NAFRA)

Table 23: Summary flood risk from rivers and sea to people, economic activity and the natural and historic environment across the Witham Catchment.

<table>
<thead>
<tr>
<th>River and Sea</th>
<th>Total in Catchment</th>
<th>High risk</th>
<th>Moderate risk</th>
<th>Low risk</th>
<th>Very low risk</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Risk to people:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of people in area:</td>
<td>528,700</td>
<td>16,600</td>
<td>28,100</td>
<td>111,100</td>
<td>150</td>
</tr>
<tr>
<td>Number of services:</td>
<td>1390</td>
<td>110</td>
<td>120</td>
<td>240</td>
<td>0</td>
</tr>
<tr>
<td><strong>Risk to economic activity:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of non-residential properties:</td>
<td>96,900</td>
<td>3,150</td>
<td>8,600</td>
<td>19,500</td>
<td>50</td>
</tr>
<tr>
<td>Number of airports:</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Length of roads (primary routes) (km):</td>
<td>500</td>
<td>10</td>
<td>20</td>
<td>80</td>
<td>0</td>
</tr>
<tr>
<td>Length of railway (km):</td>
<td>240</td>
<td>10</td>
<td>20</td>
<td>50</td>
<td>&lt;50</td>
</tr>
<tr>
<td>Agricultural land (ha):</td>
<td>368,850</td>
<td>38,100</td>
<td>46,200</td>
<td>53,450</td>
<td>300</td>
</tr>
</tbody>
</table>
## Flooding from reservoirs

There are a number of large raised reservoirs within the catchment. These are used for water supply, irrigation, boating and flood storage. Our recently published Flood Risk Maps for Reservoirs show that around 24,100 people are at risk from flooding resulting from failure of a reservoir within the Witham Catchment.

The likelihood of flooding from reservoirs is extremely low. However, in the unlikely event that a reservoir dam failed, a large volume of water may be released and flooding could happen with little or no warning.
Figure 37: Flood risk from reservoirs in the Witham Catchment
Table 24: Summary flood risk from reservoirs to people, economic activity and the natural and historic environment across the Witham Catchment.

<table>
<thead>
<tr>
<th>Reservoirs</th>
<th>Total in Catchment</th>
<th>Maximum extent of flooding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk to people:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of people in area:</td>
<td>528,700</td>
<td>24,100</td>
</tr>
<tr>
<td>Number of services:</td>
<td>1,390</td>
<td>60</td>
</tr>
<tr>
<td>Risk to economic activity:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of non-residential properties:</td>
<td>96,900</td>
<td>2,100</td>
</tr>
<tr>
<td>Number of airports:</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Length of roads (km):</td>
<td>500</td>
<td>10</td>
</tr>
<tr>
<td>Length of railway (km):</td>
<td>240</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Agricultural land (ha):</td>
<td>368,850</td>
<td>8,100</td>
</tr>
<tr>
<td>Risk to the natural and historic environment:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of EU designated bathing waters within 50m:</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Number of EPR installations within 50m:</td>
<td>121</td>
<td>3</td>
</tr>
<tr>
<td>Area of SAC within area (ha):</td>
<td>2,900</td>
<td>&lt;50</td>
</tr>
<tr>
<td>Area of SPA within area (ha):</td>
<td>2,800</td>
<td>&lt;50</td>
</tr>
<tr>
<td>Area of RAMSAR site within area (ha):</td>
<td>2,800</td>
<td>&lt;50</td>
</tr>
<tr>
<td>Area of World Heritage Site within area (ha):</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Area of SSSI within area (ha):</td>
<td>4,600</td>
<td>&lt;50</td>
</tr>
<tr>
<td>Area of Parks and Gardens within area (ha):</td>
<td>2,100</td>
<td>50</td>
</tr>
<tr>
<td>Area of Scheduled Ancient Monument within area (ha):</td>
<td>900</td>
<td>&lt;50</td>
</tr>
<tr>
<td>Number of Listed Buildings within area:</td>
<td>4,340</td>
<td>70</td>
</tr>
<tr>
<td>Number of Licensed water abstractions within the area:</td>
<td>1,620</td>
<td>200</td>
</tr>
</tbody>
</table>

**Other sources of flooding**

Surface water, ordinary (local) watercourse and sewer flooding affect the catchment. Lincoln, Horncastle, Skegness, Grantham and Boston are known to have experienced these types of flooding, along with many other smaller communities. Flood maps for surface water flooding show many areas are at risk across the catchment.

Parts of Sleaford and the surrounding area are susceptible to groundwater flooding. This is due to high groundwater levels in the underlying aquifer. Communities located in the vicinity of the Lincolnshire chalk streams, in the Lincolnshire Wolds, and similar spring-fed watercourses on the Lincolnshire Limestone Ridge are all vulnerable to groundwater flooding. Groundwater levels within the Fenland area are normally kept artificially low by the activities of the IDBs. While this management activity continues, the risk of groundwater flooding in the lowlands is low.

**Conclusions and objectives for the Witham Catchment**

**Conclusions**

While the population is small for the land area covered by the large Witham catchment, the combination of low-lying fenland and coastal floodplain means that around one third of residents (155,950 people) are at some risk of flooding from either rivers or the sea. 16,600 of
these are at the highest flood risk. The heavily-modified nature of the catchment introduces further manmade risk in the form of embanked watercourses and loss of floodplain.

Other sources of flooding from reservoirs, surface water, ordinary watercourses, ground water and sewers are also significant in this catchment. There have been many reported incidents in recent years of this type of flooding affecting householders and businesses. The updated surface water flood maps (December 2013) show a widespread problem.

The SMP for the coast, which was completed in 2010, sets out how coastal erosion can be managed sustainably as well as the direction for managing coastal flood risk. This FRMP summarises some of that information but does not change the approach of the SMP, which was arrived at through significant consultation and negotiation between members of the coastal groups who prepared the plans. Therefore the SMP actions can only be changed by the coastal groups.

CFMPs published in 2008 considered the potential increase in flood levels, extent and risk if climate change was to increase flows by 20%. Climate projections since then suggest flood flows could increase by more than that but acknowledge significant uncertainty. No additional analysis is proposed at this stage. Instead, the preferred approach is to emphasise the uncertainty in climate change impacts. Planners, emergency planners, asset managers and others should ask questions such as: “have we considered what might happen if flood risk is worse than previously considered?” and “what can we do to mitigate the increased flood risk?”

While the area has some challenging flood-related problems to address, the amount of undeveloped land available in the catchment means that there is the space to adopt new techniques and practices to alleviate these problems. The national significance of the area for food production does however need to be considered when planning new approaches to managing flooding.

**Objectives**

This is a summary of the Environment Agency objectives for this catchment. More detail of these objectives can be found in Part A, section 8 conclusions, objectives and measures. The catchment also includes measures from other RMAs. The objectives for these measures can be found in ‘Part C, Annex 2 - Source of objectives and measures for the FRMP’.

**Social**

- Reduce risk to people
- Understanding Flood Risk and Working in Partnership
- Community preparedness and resilience
- Time to adapt to coastal erosion
- Minimise community disruption
- Flood and coastal erosion risk and development
- Maintain existing assets that protect people
- River, watercourse and tidal defence maintenance

**Economic**

- Reduce economic damage
- Maintain existing assets that protect business
- Economic, regeneration and funding opportunities
- Protect transport services
- River and watercourse maintenance
- Consider flood risk to agricultural land
- Understanding Flood Risk and Working in Partnership with landowners
- Protect tourism when undertaking flood risk management

**Environmental**

- Water Framework Directive (WFD)
- Protect designated nature conservation sites
- Protect designated heritage sites

**Reservoirs**

- Reduce the risk of flooding from reservoirs

**Measures across the Witham Catchment**

There are 85 measures to manage flood risk across the Witham Catchment. These are summarised below, with the detailed measures set out in the Part C: appendices. Measures included, are over and above RMA ‘flood risk management activities’ undertaken routinely, as explained in Part A, Section 4 – How to Manage Risk. Measures cover discrete pieces of work such as projects and campaigns.

**Preventing risk:** 32 measures including:

- Work to plan for the future management of the coast between Seacroft and Gibraltar Point and Gibraltar Point to Wolferton Creek
- Identifying communities at risk, in Lincolnshire and Rutland, and working with them to investigate and implement solutions
- Lead Local Flood Authorities – Lincolnshire County Council and Rutland County Council - work to investigate and implement possible mitigations measures to address surface water, groundwater and ordinary watercourse flooding
- Studies looking at salt marsh/mudflat loss and gain on the Lincolnshire coastline adjacent to the Wash, and potential sites for localised realignment of tidal defences
- Undertaking further investigations into ground water, surface water and ordinary water course flooding in Lincolnshire

**Preparing for risk:** 13 measures including:

- Supporting Rutland County Council in the development of their Local Flood Risk Management Strategy
- Working with Local Resilience Forum (LRF) partners in Lincolnshire, practise our role in emergency response to flooding and target community engagement from an emergency response perspective
- Improving flood risk mapping and inundation modelling for the Lincolnshire coast to provide an improved flood warning service
- Installation and testing of a tide gauge in the Wash Estuary to improve our forecasting of tidal flooding

**Protecting from risk:** 40 measures including:
- Progression of a scheme to construct a tidal flood barrier within the Boston Haven, with future provision for multifunctional use for navigational purposes
- Repairs to the Foss Bank flood wall in Lincoln
- Horncastle Flood Alleviation Scheme
- Reinstatement of the Wainfleet relief channel banks
- Lincshore beach re-nourishment scheme on the Lincolnshire coast
- Black Sluice Catchment Works project to optimise flood risk management work in this operational catchment

The above are catchment-specific flood risk management measures. Please refer back to section 8 of **Part A** of the FRMP, Conclusions and measures to manage risk from the Anglian RBD, to see the measures that apply to the entire or large parts of the RBD.
4. The Fens Strategic Area

Introduction to the Fens Strategic Area

Strategic areas are areas where it is important to consider flood risk management across more than 1 sub-area, so that interested parties can work in a co-ordinated way to set out conclusions, objectives and measures to manage risk.

Five different rivers carry water from surrounding uplands through the Fens and into The Wash – the rivers Witham, Welland, Glen, Nene and Great Ouse. This area is home to approximately half a million people, covering an area of almost 3,885km², divided between 11 district and 5 county councils.

Land use and management

The Fens are an artificial, man-made landscape that has been reclaimed from coastal and estuarine wetlands over many centuries. These marsh areas, which are at or below sea level, have been artificially drained and continue to be protected from floods by flood banks, land drainage channels and pumps. With the support of this drainage system, the Fens have become a major arable agricultural region in Britain for grains and vegetables. These drainage systems also provide flood protection to a large number of settlements and properties and to the infrastructure that serves those communities.

IDBs play a critical role in managing land drainage and flood defences within these low-lying areas. The IDBs within the Fens have been in existence for many years due to the unique
water level, drainage and flood risk management needs within this area. Across the Fens, IDBs maintain 3,800 miles of watercourse, 200 miles of embanked watercourse and 286 pumping stations.

Farming contributes significantly to the success of the local economy, supporting a large number of businesses involved in the production of food and rural tourism. The Fens account for 50% of the Grade 1 agricultural land in England, producing 37% of all vegetables and 24% of all potatoes grown in the country, as well as 17% of its sugar beet and 38% of its bulbs and flowers. The area also supports significant dairy farming, livestock and outdoor pig production as well as producing approximately 18 million hens, ducks, turkeys and geese in the Lincolnshire Fens alone. This in turn supports a large well-established food processing industry. It is critical, therefore, that appropriate flood risk and drainage management measures are taken to protect this nationally important food production area.

In addition to food production the Fens is popular for tourism, attracting significant numbers of visitors each year.

Geology

The underlying geology of the Fens broadly encompasses impermeable clays and mudstones. This geology, combined with the level topography of the area, results in standing water over the land.

The soils of the Fens are typically characterised as peaty and/or alluvial silts, sands and gravels. The presence of large quantities of peat over this area means that water filters slowly through the ground before entering watercourses.

National and international designations

The Fens provide a unique and rich habitat for wildlife and include the Ouse and Nene Washes which, whilst acting as flood storage reservoirs, also provide important wetland areas for birds. The Fens contain heritage sites and form three sides of the Wash Ramsar Site, which is internationally designated for animal and plant biodiversity. There are also numerous local sites of importance ranging from SSSIs to LNRs.

Partnership working

The Fens cover 2 Environment Agency Administrative Areas: Lincolnshire and Northamptonshire Area and Cambridgeshire and Bedfordshire Area. Both of these areas have partnership arrangements with local LLFAs, IDBs and other risk management authorities.

There are five LLFAs within the Fens strategic area; Cambridgeshire County Council, Lincolnshire County Council, Norfolk County Council, Peterborough City Council, and Suffolk County Council. Lincolnshire County Council published their Local Flood Risk Management Strategy (LFRMS) in 2012, while Cambridgeshire County Council and Suffolk County Council published their LFRMS in 2013. These LLFAs are now working with us to prepare updated versions in the light of the new flood hazard mapping and other new data. Norfolk County Council and Peterborough City Council published their strategy in 2015. Across the areas, the Environment Agency and a number of IDBs have in place public sector co-operation agreements which enables both parties to undertake works on the others’ behalf should it be more efficient and cost-effective for them to do so. Cambridgeshire, Lincolnshire and Norfolk have in place flood risk management partnerships comprising local RMA partners who meet to co-ordinate the approach to local flood risk management.
There are 2 significant restoration projects within the Fens area: The Great Fen Project is a partnership project, whose aim is to re-create and restore a landscape of 3,700 hectares surrounding the existing Woodwalton and Holme Fens between Peterborough and Huntingdon; The South Lincolnshire Fens Partnership aims to restore and re-create up to 800 hectares of Lincolnshire's lost wild Fenlands between Bourne and Market Deeping.

**Climate change**

The climate is changing and this is likely to have an impact on flooding and coastal erosion. Sea levels are rising and winter rainfall may become more intense. Changes in weather patterns and, in particular, more torrential rainfall, are likely to increase flood risk from surface water and ordinary watercourses as well as rivers. In the Fens, the extensive artificial drainage networks mean that the area, despite being very low-lying, is reasonably resilient in the event of flooding. The changing climate means that these defences and drainage systems will have to cope with more water, more frequently. Maintenance within the system is therefore important to ensure that these assets can withstand future climate change. At the same time, there will be longer periods of dry weather, resulting in scarcity of water resources in the area, which could have serious consequences for the water-dependant horticultural and arable industries located in the Fens.

By 2020, the following rainfall statistics are estimated, under a medium emissions scenario, for the East Midlands:

- Average winter rainfall is estimated to increase by up to 5%
- Average summer rainfall is estimated to decrease by up to 8%
- Rainfall on the wettest day in winter is estimated to increase by up to 10%
- Rainfall on the wettest day in summer is estimated to increase by up to 10%

This means there may be an increase in the risk of surface water flooding caused by higher levels of rainfall. Risk of flooding may also increase during winter as a result.

**Flood risk maps and statistics**

With over 60 miles of coastal sea walls and over 200 miles of embanked river, the Fens has a high level of protection and is classified as a defended flood plain. Climate change poses a serious threat to the Fens and a continued programme of investment and maintenance in flood defences and drainage systems will be needed for existing standards of protection - including provision for climate change - to be maintained in the medium and long term.

Major transport networks including road and rail, as well as residential property and critical infrastructure (water, gas and electricity) would be affected if Fenland areas were to flood.

**Flooding from rivers and the sea**

In the Fens there is a risk of flooding from the rivers Witham, Welland, Glen, Nene and Great Ouse and their tributaries. Most settlements are located on higher ground as these were mostly established before the drainage of the Fens. However, as the communities have expanded, there are areas of towns that are located on land at higher risk of flooding. This provides opportunities for innovative sustainable drainage solutions to reduce flood risk to these areas.

Tidal flooding from overtopping of tidal defences could inundate coastal communities and the towns of Boston and Kings Lynn. Breaching or failure of the embankments that border the
main upland rivers across the Fens pose a significant flood risk. This type of flooding is difficult to predict, and while the likelihood of this happening is low, the consequences could be significant resulting in the rapid inundation of the areas immediately behind the embankments leading to a severe risk to life.

The most serious flooding in the Fens, since drainage of the area was undertaken, occurred in 1947. The winter of this year was harsh and heavy snow fell lying on the ground until March. The thaw was sudden and combined with rain and high spring tides, caused the drainage system and rivers to be overwhelmed, resulting in extensive prolonged flooding taking place throughout the Fens. There has been more localised flooding since 1947, in particular in 1998, when extreme rainfall fell over large areas of the country.

Figure 39: Flood risk from rivers and the sea in the Fens Strategic Area – National Flood Risk Assessment (NAFRA)
Table 25: Summary flood risk from rivers and the sea to people, economic activity and the natural and historic environment across the Fens strategic area

<table>
<thead>
<tr>
<th>Risk to people:</th>
<th>Total in Catchment</th>
<th>High risk</th>
<th>Moderate risk</th>
<th>Low risk</th>
<th>Very low risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of people in area:</td>
<td>478,250</td>
<td>14,700</td>
<td>95,450</td>
<td>117,950</td>
<td>600</td>
</tr>
<tr>
<td>Number of services:</td>
<td>310</td>
<td>150</td>
<td>870</td>
<td>720</td>
<td>&lt;10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Risk to economic activity:</th>
<th>Total in Catchment</th>
<th>High risk</th>
<th>Moderate risk</th>
<th>Low risk</th>
<th>Very low risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of non-residential properties:</td>
<td>103,400</td>
<td>3,300</td>
<td>32,300</td>
<td>26,000</td>
<td>200</td>
</tr>
<tr>
<td>Number of airports:</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Length of roads (primary routes) (km):</td>
<td>160</td>
<td>10</td>
<td>70</td>
<td>20</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Length of railway (km):</td>
<td>240</td>
<td>20</td>
<td>120</td>
<td>60</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Agricultural land (ha):</td>
<td>365,300</td>
<td>19,300</td>
<td>151,950</td>
<td>36,150</td>
<td>650</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Risk to the natural and historic environment:</th>
<th>Total in Catchment</th>
<th>High risk</th>
<th>Moderate risk</th>
<th>Low risk</th>
<th>Very low risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of EU designated bathing waters within 50m:</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Number of EPR installations within 50m:</td>
<td>80</td>
<td>9</td>
<td>82</td>
<td>38</td>
<td>2</td>
</tr>
<tr>
<td>Area of SAC within area (ha):</td>
<td>5200</td>
<td>600</td>
<td>400</td>
<td>50</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Area of SPA within area (ha):</td>
<td>8500</td>
<td>3850</td>
<td>100</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Area of RAMSAR site within area (ha):</td>
<td>8700</td>
<td>3900</td>
<td>400</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Area of World Heritage Site within area (ha):</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Area of SSSI within area (ha):</td>
<td>9950</td>
<td>4100</td>
<td>850</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>Area of Parks and Gardens within area (ha):</td>
<td>100</td>
<td>&lt;50</td>
<td>&lt;50</td>
<td>&lt;50</td>
<td>&lt;50</td>
</tr>
<tr>
<td>Area of Scheduled Ancient Monument within area (ha):</td>
<td>650</td>
<td>50</td>
<td>150</td>
<td>150</td>
<td>&lt;50</td>
</tr>
<tr>
<td>Number of Listed Buildings within area:</td>
<td>3350</td>
<td>50</td>
<td>450</td>
<td>850</td>
<td>0</td>
</tr>
<tr>
<td>Number of Licensed water abstractions within the area:</td>
<td>1090</td>
<td>420</td>
<td>1230</td>
<td>240</td>
<td>20</td>
</tr>
</tbody>
</table>
Flooding from reservoirs

There are a number of large raised reservoirs within the Fens Strategic Area, including the Ouse Washes. These are used for water supply, irrigation, boating, flood storage and wetland habitat. Our recently published Flood Risk Maps for Reservoirs show that around 18,600 people are at risk from flooding resulting from failure of a reservoir within the Fens strategic area.

The likelihood of flooding from reservoirs is extremely low. However, in the unlikely event that a reservoir dam failed, a large volume of water may be released and flooding could happen with little or no warning.

Figure 40: Flood risk from reservoirs in the Fens Strategic Area
Table 26: Summary flood risk from reservoirs to people, economic activity and the natural and historic environment across the Fens strategic area.

<table>
<thead>
<tr>
<th>Reservoirs</th>
<th>Total in RBD</th>
<th>Maximum extent of flooding</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Risk to people:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of people in area:</td>
<td>478250</td>
<td>18600</td>
</tr>
<tr>
<td>Number of services:</td>
<td>3100</td>
<td>360</td>
</tr>
<tr>
<td><strong>Risk to economic activity:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of non-residential properties:</td>
<td>103400</td>
<td>2200</td>
</tr>
<tr>
<td>Number of airports:</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Length of roads (primary routes) (km):</td>
<td>160</td>
<td>50</td>
</tr>
<tr>
<td>Length of railway (km):</td>
<td>240</td>
<td>60</td>
</tr>
<tr>
<td>Agricultural land (ha):</td>
<td>365250</td>
<td>95900</td>
</tr>
<tr>
<td><strong>Risk to the natural and historic environment:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of EU designated bathing waters within 50m:</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Number of EPR installations within 50m:</td>
<td>80</td>
<td>8</td>
</tr>
<tr>
<td>Area of SAC within area (ha):</td>
<td>5200</td>
<td>200</td>
</tr>
<tr>
<td>Area of SPA within area (ha):</td>
<td>8500</td>
<td>400</td>
</tr>
<tr>
<td>Area of RAMSAR site within area (ha):</td>
<td>8700</td>
<td>450</td>
</tr>
<tr>
<td>Area of World Heritage Site within area (ha):</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Area of SSSI within area (ha):</td>
<td>10,000</td>
<td>600</td>
</tr>
<tr>
<td>Area of Parks and Gardens within area (ha):</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Area of Scheduled Ancient Monument within area (ha):</td>
<td>650</td>
<td>150</td>
</tr>
<tr>
<td>Number of Listed Buildings within area:</td>
<td>3370</td>
<td>260</td>
</tr>
<tr>
<td>Number of Licensed water abstractions within the area:</td>
<td>1090</td>
<td>340</td>
</tr>
</tbody>
</table>

Other sources of flooding

Surface water, ordinary (local) watercourse and sewer flooding affect the Fens Strategic Area. Flood maps for surface water flooding show many areas are at risk across the catchment.

Groundwater levels within the Fenland area are normally kept artificially low by the activities of the IDBs. While this management activity continues, the risk of groundwater flooding in the lowlands is low.

Conclusions for the Fens Strategic Area

The Fens Strategic Area is covered by four different CFMPs; 1 for each of the Fenland catchments of the Nene, Welland and Glen, Witham and Great Ouse and also by The Wash
SMP. All 5 plans recommended that an integrated plan is produced specifically for the Fens in order to develop a sustainable, integrated and long term flood risk management approach for this landscape area.

LFRMs, produced by LLFAs, will incorporate the interests of the Fenland communities with those of the rest of the LLFA area, and aim to promote a consistent approach across the Fens as a whole. This consistency is crucial to all RMAs, who often span more than one local authority and whose practices will be similar throughout their area. The LLFAs of Lincolnshire, Peterborough, Cambridgeshire, and Norfolk, together with Forest Heat District Council (acting on behalf of Suffolk County Council as Suffolk’s Fenland lies principally within this district) have therefore agreed to work together closely to achieve this aim.

There are a number of measures within the Fens which apply to and are therefore contained within the management catchment summaries (see FRMP Part C – Annex 1 – Table of Measures of this report) for The Witham, The Welland, The Nene, Old Bedford and Middle Level, Cam and Ely Ouse (including South Level) and North West Norfolk. There is only 1 measure specific to the Fens Strategic Area.

**Measures to manage risk in the Fens Strategic Area**

There is 1 action relating to the Fens which covers the Fens Strategic Area as a whole. The action is categorised as a ‘prevention’ action and involves the development of a collaborative approach to flood risk management in the Fens. The details of this measure can be found in FRMP Part C – Annex 1 – Table of Measures. Any site/location specific actions will be covered in the individual catchment summaries.
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