Tendring District Council

Strategic Flood Risk Assessment

Final Report

March 2009

FINAL REPORT

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CONTRACT

This report describes work for a joint commission by Babergh and Tendring District Councils under Order (NO.2003600) on 5th December 2008. Babergh District Council's representative for the contract was Naomi Allen and Tendring District Council's representatives for the contract were Malcolm Inkster and Tricia Martin. Tony Green, Liu Yang, Philip Emonson and Jennifer Hill of JBA Consulting carried out the work.

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PURPOSE

This document has been prepared solely as a Strategic Flood Risk Assessment for Tendring District Council. JBA Consulting accepts no responsibility or liability for any use that is made of this document other than by the Client for the purposes for which it was originally commissioned and prepared.

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JBA would like to thank Tendring District Council, the Environment Agency and Anglian Water for the timely supply of data and for co-operation on the project.

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EXECUTIVE SUMMARY

Executive Summary

This report constitutes the Final report for the Strategic Flood Risk Assessment (SFRA) for the District of Tendring, Essex. This fulfils the requirements of a Level 1 and Level 2 SFRA.

The SFRA is a planning tool that will assist the Council to make the spatial planning decisions required to inform the Local Development Framework (LDF). This SFRA has been prepared in accordance with current best practice, *Planning Policy Statement 25: Development and Flood Risk (PPS25).*

High level planning, policy and guidance documents have been identified, which have been taken into account in preparing this SFRA. The documents which have been reviewed include national, regional and local planning legislation (including the Tendring District Local Plan, 2007), together with Environment Agency policy documents.

A thorough review of existing information, and additional modelling work, has identified the level of flood risk at present within the District from fluvial, tidal and other sources. This final report introduces the SFRA, sets in the context in light of the existing planning framework, describes the approach taken to undertake the assessment, and reviews the different data sources used. A 2D JFLOW model has been carried out for both Hartley Wood Brook and upstream of Six Penny Brook, North of Clacton-on-sea and Elmstead Market respectively to define the fluvial risk. In addition, a selection of maps displaying the initial assessment of fluvial and tidal flood risk, surface water flood risk, possible development areas, as areas of search only at this stage, locations of historic flooding incidents, existing defences are provided.

Fluvial flood risk across the district affects areas along the main river corridors of the Rivers Ramsey, Colne and Stour Estuaries, their associated tributaries and the Coastal Streams. There are few fluvial flood defences in the District, but the tidal reaches of smaller tributaries are protected by flapped outfalls (such as the Holland Brook at Clacton) and the River Ramsey at Harwich is pumped.

The coastal areas of Tendring District are exposed to flood risk from the sea. Most large urban settlements within the District are at risk of tidal flooding including Manningtree, Harwich, Walton-on-the-Naze, Clacton-on-sea, Jaywick and Brightlingsea. However, Tendring District has significant tidal defences giving high levels of protection and urbanisation of the lowest areas is limited.

The results of breach analyses at Manningtree, Walton, Clacton, Point Clear and Brightlingsea are presented in Appendix D. Previous studies at Jaywick and Harwich also complement these analyses. The results indicate the potential for high hazard (significant danger to life) and high water depth which must be a concern for any development proposed in these areas. Hazards also increase with time due to sea level rise and overtopping becomes a concern to planning in many locations after 2075 if current Defra predictions are correct and banks are not raised.

Surface water flood risk has been assessed through use of rainfall modelling for the whole Tendring District. The impacts of the 0.5% annual exceedance probability storm event show that the most vulnerable areas to surface water flooding are Brightlingsea and rural areas around Badley Hall and Little Bromley, West of Manningtree.

Sewer flooding is recorded by Anglian Water via their DG5 register. Anglian Water have supplied their DG5 register although from previous studies it is known that this is not a significant problem in the Tendring area compared with elsewhere in the country.

Detailed maps of Flood Zone, Surface Water, SUDS and breach impacts at site level are presented together with summary sheets in Appendix E. A thorough review of flood risk at each of the site specific allocations and for broader development areas has been undertaken, allowing the LPA to apply the Sequential Test. It provides advice on any site specific requirements for a Flood Risk Assessment for each site, and should inform the LPPA on the use of the Exception Test should the Sequential Test be passed.

A summary of the issues identified at each of the 157 areas of search are also given in Appendix E.

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GLOSSARY AND ABBREVIATIONS

Actual Risk		The risk posed to development situated within a defended area (i.e. behind defences), expressed in terms of the probability that the defence will be overtopped, and/or the probability that the defence will suffer a structural failure, and the consequence should a failure occur
Area Action Plan	AAP	Planning document to guide development in a specific area. Forms part of the Local Development Framework.
Area Benefiting from Defence	ABD	Those areas which benefit from formal flood defences in the event of flooding from rivers with a 1% chance in any given year or from the sea with a 0.5% chance in any given year. If the defences were not there, these areas would be flooded.
Brownfield		Brownfield (sites or land) is a term in common usage that may be defined as 'development sites or land that has previously been developed'. Prior to PPS25 the term 'Brownfield' was used in Governmental Guidance and Statements, but in PPS25 has been replaced with 'Previously-developed land' See 'Greenfield'.
Core Strategy	CS	This is the strategic vision of the area and is a central pillar of the Local Development Framework, comprising: A vision; Strategic objectives; A spatial land use strategy; Core policies and; A monitoring and implementation framework. The Core Strategy is a Development Plan Document which will determine overall patterns of future development, identifying broad locations where future growth or conservation will take place. All other Development Plan Documents should be in broad conformity with the Core Strategy Document. The Core Strategy is a mandatory document, and a timetable for production is set out within the Local Development Scheme.
Defended Area		An area offered a degree of protection against flooding through the presence of a flood defence structure
DG5 register	DG5	Register held by water companies on the location of properties at risk of sewage related flooding problems
Development Plan Documents	DPDs	These documents have Development Plan Status and consequently form part of the statutory development plan for the area. A DPD will be subject to a independent examination. Typical documents that will have DPD status include the Core Strategy, Site-specific Allocations of Land, Proposals Map, and Area Actions Plans (where needed).

GLOSSARY AND ABBREVIATIONS

Digital Elevation Model	DEM	A representation of the topography of an area that gives the elevation of the upper surface whether it is the ground, vegetation or a building.
Extreme Flood Outline	EFO	Flood 'zone' maps released by the Environment Agency in June 2004 depict anticipated 0.1% (1 in 1000 year) flood extents in a consistent manner throughout the UK
Flood Alleviation Scheme	FAS	Works designed to provide protection from flooding.
Flood Risk Management		The introduction of mitigation measures (or options) to reduce the risk posed to property and life as a result of flooding. It is not just the application of physical flood defence measures
Flood Estimation Handbook	FEH	Provides current methodologies for estimation of flood flows for the UK
Floodplain		Any area of land over which water flows or is stored during a flood event or would flow but for the presence of defences
Flood Risk Assessment	FRA	A detailed site-based investigation that is undertaken by the developer at planning application stage
Flood Storage Area	FSA	Area designed to store water in a flood and release it later when flood waters have subsided.
Flood Zone		Areas of land at risk from tidal or fluvial flooding as delineated by the Environment Agency Flood Maps. Zone 1: Low probability of flooding Zone 2: Medium probability of flooding Zone 3: High probability of flooding
Fluvial Flooding		Flooding caused by high flows in rivers or streams exceeding the capacity of the normal river channel.
Formal Defence		A flood defence asset that is maintained by the Environment Agency
Freeboard		A 'safety margin' to account for residual uncertainties in water level prediction and/or structural performance, expressed in mm
Functional Floodplain		An area of land where water has to flow or be stored in times

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		of flood.
Greenfield		Greenfield (sites or land) is a term in common usage that may be defined as 'development sites or land that has not previously been developed'. Prior to PPS25 the term 'Greenfield' was used in Governmental Guidance and Statements, but in PPS25 has been replaced with 'Undeveloped land' See 'Brownfield'.
Informal Defence		A structure that provides a flood defence function, however is not owned nor maintained by the Environment Agency
JFLOW		2-Dimensional hydraulic modelling package developed by JBA
Local Development Framework	LDF	The Local Development Framework is made up of a series of documents that together will form part of the Development Plan. Broadly Local Development Framework documents fall into two categories: Development Plan Documents Supplementary Planning Documents
Measure		A deliverable solution that will assist in the effective management (reduction) of risk to property and life as a result of flooding, e.g. flood storage, raised defence, effective development control and preparedness, and flood warning
Mitigation		The management (reduction) of flood risk
Ordnance Survey	OS	
Probability	1%	A measure of the chance that an event will occur. The probability of an event is typically defined as the relative frequency of occurrence of that event, out of all possible events. Probability can be expressed as a fraction, % or a decimal. For example, the probability of obtaining a six with a shake of a fair dice is 1/6, 16% or 0.166. Probability is often expressed with reference to a time period, for example, annual exceedance probability
Rapid Inundation Zone		An area immediately behind defences which, should they fail, will generate a combination of high velocities and flood depths that would cause a risk to life.
Residual Risk		The risk that inherently remains after implementation of a mitigation measure (option)
Return Period		The expected (mean) time (usually in years) between the

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		exceedance of a particular extreme threshold. Return period is traditionally used to express the frequency of occurrence of an event, although it is often misunderstood as being a probability of occurrence.
Risk		The threat to property and life as a result of flooding, expressed as a function of probability (that an event will occur) and consequence (as a result of the event occurring)
Standard of Protection	SoP	The return period to which properties are protected against flooding
Strategic Flood Risk Assessment	SFRA	The assessment of flood risk on a catchment-wide basis for proposed development in a Borough
Strategic Flood Risk Management	SFRM	Considers the management of flood risk on a catchment-wide basis, the primary objective being to ensure that the recommended flood risk management 'measures' are sustainable and cost effective
Supplementary Planning Documents	SPD	Supplementary Planning Documents or SPD support DPDs in that they may cover a range of issues, both thematic and site specific. Examples of SPD may be design guidance or development briefs. SPD may expand policy or provide further detail to policies in a DPD. They will not be subject to independent examination.
Sustainability Appraisal	SA	A Sustainability Appraisal is a systematic process to predict and assess the economic, environmental and social effects likely to arise from DPDs and SPDs, enabling each document to be tested and refined, ensuring that it contributes towards sustainable development.
Sustainable Drainage Systems	SUDS	Current 'best practice' for new urban development that seeks to minimise the impact upon the localised drainage regime, e.g. through the use of pervious areas within a development to reduce the quantity of runoff from the site
Tidal Flooding		Flooding caused by extreme tide levels
Uncertainty		A reflection of the (lack of) accuracy or confidence that is considered attributable to a predicted water level or flood extent

1 INTRODUCTION

1.1 Introduction

In December 2008 JBA Consulting were commissioned by Tendring and Babergh District Councils to undertake a full (both Level 1 and 2) Strategic Flood Risk Assessment (SFRA) for both Districts.

The overall commission covers all areas of Babergh District and the areas in Tendring District not already covered by an SFRA which is fully compliant with PPS25 and the accompanying Practice Guide.

This SFRA has been prepared for Tendring District Council, in accordance with current best practice, Planning Policy Statement 25 Development and Flood Risk (PPS25). PPS25 reinforced the responsibility of LPAs to ensure that flood risk is managed effectively and sustainably as an integral part of the planning process, balancing socio-economic needs, existing framework of landscape and infrastructure and flood risk.

1.2 Objectives

The SFRA is a planning tool, enabling the council to select and develop sustainable site allocations away from vulnerable flood risk areas. The assessment focuses on the existing site allocations within the District but also sets out the procedure for assessing additional development sites in the future. The sites so shown in this SFRA area sites that are currently being looked at by offices of TDC are offering some potential as sites to meet future development needs. This SFRA will assist the Council when making the spatial planning decisions required to inform the Local Development Framework (LDF).

As well as informing site allocations, this SFRA will advise decision makers on planning applications for non-allocated sites, planning requirements for new developments, strategic flood alleviation measures and other actions to reduce flood risk to existing developments and emergency planning.

In respect of this, the SFRA objectives are as follows:

- To provide an overall understanding of the risk of flooding from all potential sources in the study area and surrounding area;
- To inform the Sustainability Appraisal to ensure that flood risk is taken account of throughout the LDF process;
- To enable policy teams to develop effective policies for managing flood risk;
- To identify the level of detail required for site specific FRAs in specific areas and provide guidance on how to produce them;
- To determine the acceptability of flood risk in relation to emergency planning capability; and,
- To be robust enough to be subject to scrutiny at any independent examinations associated with preparation of the LDF.

1.3 Study Area

Tendring District covers an area of 364.2km^2 and falls entirely in the Environment Agency's Anglian Region. This SFRA includes the entire Tendring District Council planning area, though further work is not needed for Jaywick or Harwich, which have detailed individual SFRAs.

The larger urban areas within Tendring District are Clacton-on-Sea, Walton, Brightlingsea, Harwich and Manningtree. These areas are at risk of fluvial and/or tidal flooding and are located in Flood Zones 2 and 3. Flood risk is most notable in areas surrounding the coasts and estuaries where elevations range between 0 and 6 m AOD. Map 1 provides an overview of the District and shows the location of watercourses and topography (where the LiDAR data is available).

1.4 Background to the study

In 2004 an early level 1 SFRA of the Tendring District was completed by AERC and showed the flood zones and site allocations then being considered for the local plan. This was viewed as information only when JBA carried out the data collection stage of a stage 1 SFRA for Tendring DC in August 2008. Full SFRAs have already been produced covering some areas of Tendring, specifically Harwich and Jaywick (undertaken by Scott Wilson and JBA Consulting respectively). Results from these studies will be incorporated in the SFRA and do not need to be repeated.

A separate SFRA report, covering both Levels 1 and 2, will be produced and submitted independently for Tendring DC.

2 THE PLANNING FRAMEWORK

2.1 Introduction

The purpose of this section of the report is to identify those high-level and strategic plans documents which must be consulted in preparing this SFRA, from a national to local level. The documents which have been reviewed include national planning legislation together with Environment Agency policy guidance.

2.2 National planning policy

2.2.1 Planning and Compulsory Purchase Act

The SFRA has been prepared in a period during which planning authorities have been implementing the provisions of the Planning and Compulsory Purchase Act 2004 and accompanying planning guidance, including PPS 1 Delivering Sustainable Development and PPS 12 Local Spatial Planning. This affected all tiers of the planning system and has necessitated major changes at both the regional and local level which will impact on the way in which planned development is approached in the regional strategy and delivered locally.

2.2.2 PPS25 Development and Flood Risk

In December 2006 the Government published PPS25: Development and Flood Risk.

The aim of PPS25 is to ensure that flood risk is taken into account at all stages in the planning process to avoid inappropriate development in areas at risk of flooding and to direct development away from areas at highest risk. The key planning objectives are that "Regional Planning Bodies (RPBs) and Local Planning Authorities (LPAs) should prepare and implement planning strategies that help to deliver sustainable development by:

- Identifying land at risk and the degree of risk of flooding from river, sea and other sources in their areas;
- Preparing Regional or Strategic Flood Risk Assessments (RFRAs/SFRAs) as appropriate, either as part of the Sustainability Appraisal of their plans or as a freestanding assessment that contributes to that Appraisal;
- Framing policies for the location of development which avoid flood risk to people and property where possible and manage any residual risk, taking account of the impacts of climate change;
- Only permitting development in areas of flood risk when there are no suitable alternative sites in areas of lower flood risk and the benefits of the development outweigh the risks from flooding (as proved by passing the Exception Test);
- Safeguarding land from development that is required for current and future flood management e.g. conveyance and storage of flood water and flood defences;
- Reducing risk to and from new development through location, a sequential approach to layout and design, incorporating sustainable drainage systems (SUDS);
- Using opportunities offered by new development to reduce the causes and impacts of flooding e.g. surface water management plans; making the most of the benefits of green infrastructure for flood storage, conveyance and SUDS; recreating functional floodplain and setting back defences;
- Working effectively with the Environment Agency and other stakeholders to ensure that best use is made of their expertise and information so that decisions on planning applications can be delivered expeditiously; and
- Ensuring spatial planning supports flood risk management policies and plans; River Basin Management and emergency planning."

In addition to setting out the roles and responsibilities for LPAs and RPBs, PPS25 identifies that

landowners also have a primary responsibility for safeguarding their land and other property against natural hazards such as flooding. Those promoting sites for development are also responsible for:

- Demonstrating that is consistent with PPS25 and Local Development Documents (LDDs);
- Providing a Flood Risk Assessment (FRA) demonstrating whether the proposed development: is likely to be affected by current or future flooding; satisfies the LPA that the development is safe; and identifies management and mitigation measures.

PPS25 also introduces an amendment to Article 10 of The Town and Country Planning (General Development Order) 1995 which makes the Environment Agency a Statutory Consultee on all applications for development in flood risk areas, and those within 20m of a Main River.

The introduction of PPS25 enables local authorities to make a direction under Article 4 of the Town and County Planning (General Permitted Development) Order 1995. This will enable Local Authorities to remove permitted development rights where those rights threaten to have a direct, significant and adverse effect on a flood risk area, or its flood defences and their access, or the permeability and management of surface water, or flood risk to occupants.

A Practice Guide Companion to PPS25

In June 2008 the Government released the companion guide to PPS25. The practice guide provides guidance on the implementation of the policy set out in PPS25. The guide provides further guidance on the preparation of SFRA's and FRA's, the Sequential and Exception Test, outlines potential mitigation measures e.g. SUDS and risk management techniques.

2.2.3 Other Planning Policy Statements

PPS1 Delivering Sustainable Development published in February 2005 sets out the overarching planning policies for the delivery of sustainable development across the planning system and sets the tone for other PPSs that will follow. PPS1 explicitly states that development plan policies should take account of environmental issues, including flood risk. It proposes that new development in areas at risk of flooding should be avoided. Planning authorities are also advised to ensure that developments are "sustainable, durable and adaptable" including taking into account natural hazards such as flooding.

Whilst not directly relevant to the development of a SFRA, it is important to recognise that the exercise takes place within the context of other planning policy statements, some of which also require Sequential Testing of site allocations and development proposals. PPS3 Housing, PPG4 Industrial and Commercial Development and Small Firms and PPS6 Planning for Town Centres are intrinsic within the planning process, and therefore an understanding of the constraints faced as a result of this additional policy guidance is imperative.

2.3 Regional planning policy

2.3.1 East of England Plan (The Regional Spatial Strategy for the East of England)

The Government Office for the East of England published the East of England Plan in May 2008. It covers the Norfolk, Suffolk, Cambridgeshire, Essex, Hertfordshire and Bedfordshire and forms the Regional Spatial Strategy (RSS) for the East of England, updating the draft version published in December 2004. The RSS covers the period to 2021, setting visions, objectives and strategies for the longer term. The overall spatial vision of the East of England Plan is as follows:

> *"By 2021 the East of England will be realising its economic potential and providing a high quality of life for its people, including their housing needs in sustainable inclusive communities. At the same time it will reduce its impact on climate change and the environment, including through savings in energy and water use by strengthening its stock of environmental assets."*

In order to achieve this vision a series of objectives are presented, of which those relevant to this SFRA are as follows:

- To reduce the region's impact on, and exposure to, the effects of climate change by reducing the risk of adverse impacts of flooding on people, property and wildlife habitats.

- To address housing shortages in the region by securing a step-change in the delivery of additional housing throughout the region, particularly the key centres for development and change.
- To realise the economic potential of the region and its people by facilitating the development needed to support the region's business sectors and clusters, improving skills and widening opportunities in line with the Regional Economic Strategy.
- To realise the economic potential of the region and its people by providing for job growth broadly matching increases in housing provision and improving the alignment between the locations of workplaces and homes.
- To improve the quality of life for the people of the region by ensuring new development fulfils the principles of sustainable communities, providing a well designed living environment adequately supported by social and green infrastructure.
- To improve the quality of life for the people of the region by promoting regeneration and renewal of disadvantaged areas.
- To improve and conserve the region's environment by ensuring the protection and enhancement of the region's environmental assets, including the built and historic environment, landscape and water.
- To improve and conserve the region's environment by re-using previously developed land and seeking environmental as well as development gains from the use of previously undeveloped land.

The East of England Plan establishes strategic policies for the continued growth and sustainable development of the region. The policies relevant to flooding and flood risk management relevant to the SFRA are listed below:

- Policy SS9: The Coast – The strategy for the coast is to adopt an integrated approach that recognises its needs for environmental protection and enhancement, the economic and social role of the region's ports, seaside towns and coastal areas important to tourism, and predicted sea level rise and the adaptation challenge this presents to coastal communities and decision makers. Local Development Documents should ensure that new development is compatible with shoreline management and other longer term flood management plans, so as to avoid constraining effective future flood management or increasing the need for new sea defences.
- Policy ENV1: Green Infrastructure - Green infrastructure should be developed so as to maximise its biodiversity value and, as part of a package of measures, contribute to achieving carbon neutral development and flood attenuation. Local Development Documents should ensure that policies have regard to the economic and social as well as environmental benefits of green infrastructure assets and protect sites of European or international importance for wildlife.
- Policy WAT2: Water Infrastructure – A co-ordinated approach to plan making should be developed through a programme of water cycle and river cycle studies to address the issues of water supply, water quality, wastewater treatment and flood risk in receiving water courses relating to development proposed in this RSS. Complementing this approach, Local Development Documents should plan to site new development so as to maximise the potential of existing water/waste water treatment infrastructure and minimise the need for new/improved infrastructure.
- Policy WAT3: Integrated Water Management – Local planning authorities should work with partners to ensure their plans, policies, programmes and proposals take account of the environmental consequences of river basin management plans, catchment abstraction management strategies, groundwater vulnerability maps, groundwater source protection zone maps, proposals for water abstraction and storage and the need to avoid adverse impacts on sites of European importance for wildlife. The Environment Agency and water industry should work with local authorities and other partners to develop an integrated approach to the management of the water environment.
- Policy WAT4: Flood Risk Management - Coastal and river flooding is a significant risk in parts of the East of the England. The priorities are to defend existing properties from flooding and locate new development where there is little or no risk of flooding. Local Development Documents should:

- use Strategic Flood Risk Assessments to guide development away from floodplains, other areas at medium or high risk or likely to be at future risk from flooding, and areas where development would increase the risk of flooding elsewhere;
- include policies which identify and protect flood plains and land liable to tidal or coastal flooding from development, based on the Environment Agency's flood maps and Strategic Flood Risk Assessments supplemented by historical and modelled flood risk data, Catchment Flood Management Plans and policies in Shoreline Management Plans and Flood Management Strategies, including 'managed re-alignment' where appropriate;
- only propose departures from the above principles in exceptional cases where suitable land at lower risk of flooding is not available, the benefits of development outweigh the risks from flooding, and appropriate mitigation measures are incorporated; and
- require that sustainable drainage systems are incorporated in all appropriate developments.

The East of England Plan assesses the need for additional housing in the region, and provides District allocations for the period 2006 – 2021. Through managing the supply of land for housing in accordance with PPS3, their Local Development Documents, and in determining planning applications local planning authorities should facilitate the delivery of at least 508,000 net additional dwellings over the period 2001 to 2021. Taking account of completions of 105,550 between 2001and 2006 the minimum regional housing target 2006 to 2021 is 402,540. District allocations should be regarded as minimum targets to be achieved, rather than ceilings which should not be exceeded. The total allocation for Tendring District from 2006 to 2021 is 8,500.

2.4 Local planning policy

2.4.1 Tendring District Local Plan 2007

The Tendring District Local Plan (Adopted 2007), establishes policies and proposals for development control to the year 2011. The previous Tendring District Local Plan was adopted in April 1998 and covered the period up to 2001. The aim of the Local Plan is to guide development so that it meets the District's needs for new homes, jobs, shops and leisure facilities but does not spoil the towns, villages, countryside and coast.

The policies and proposals presented provide a framework from which land use and development can be controlled. The policies establish the criteria the council uses to control development, whereas the proposals allocate land for specific types of development and uses. There are a number of policies which broadly relate to environmental protection and management; those which have specific relevance to this SFRA are detailed below:

- Policy QL3 – Minimising and Managing Flood Risk

The Council will ensure that flood risk is taken into account at all stages in the planning process, to avoid inappropriate development in areas at risk of flooding. Development will only be permitted in areas of flood risk when there are no reasonably available sites in areas of lower flood risk and the benefits of development outweigh the risks of flooding.

- Policy COM32 - Sea Defences

In order to maintain and enhance the interests of marine and coastal habitats the District Council will, where appropriate, require the use of soft engineering sea defences such as wider and deeper beaches or the rehabilitation of salt marshes, as a means of sea defence, rather than the installation of or raising of sea walls or other hard defences. Planning permission will not be granted for development which would adversely affect the integrity of tidal or fluvial defences, unless the removal or alteration to those defences is necessary to achieve the purpose of the development.

- Policy COM33 - Flood Protection

In order to minimise the effects of tidal flooding, permission will be refused for development on land to the seaward side of sea defences, including the siting of temporary structures such as

holiday chalets and caravans. On land between the first line of sea defence and the main defence, the siting of temporary structures may be permitted following consultation with the Environment Agency. Time limited occupancy conditions will be imposed and enforced preventing occupancy during the winter period from November to March inclusive when the risk of tidal inundation is greatest.

- Policy EN13 – Sustainable Drainage Systems

Development proposals should incorporate measures for the conservation and sustainable use of water. Their overall design and layout, and individual building designs, should reflect this requirement. Such measures will normally include sustainable drainage systems (SUDS) for managing surface water runoff. These may also provide opportunities for creating or improving wildlife habitats.

2.5 Environment Agency policy

Tendring District is covered by the North Essex Catchment Flood Management Plan (CFMP). The North Essex CFMP considers flood risk at a broad scale so to establish catchment-wide policies for management of this risk. The CFMPs are high level strategic Environment Agency documents, which consider factors such as climate change, urbanisation and changes in land use and land management for defining policies for sustainable flood risk management (fluvial only) over the next 100 years, from which a series of actions (specific to the policy unit) have been established.

2.5.1 North Essex Catchment Flood Management Plan (CFMP)

- Tendring District forms part of five of the North Essex CFMP policy units; however only three policy units will affect the district including Coastal Streams; Harwich and Clacton-on-sea.
- Coastal Streams (Policy Unit 9): Very large, coastal area with many small villages, hamlets and isolated properties.

  Policy 2 – reduce existing flood risk management actions (accepting that flood risk will increase with time)
- Harwich (Policy Unit 10): This is a small coastal urban area with high population density. The main flood source is from the sea although there is also fluvial flood risk from the Ramsey River. There is a history of sewer flooding problems, but no reported incidents of surface water or groundwater flooding. A pumping station controls the outfall of the Ramsey River to the sea to prevent coastal flooding. Coastal flooding is being considered by the SMP. Flood pathways include channel, overland flow, surface and sub-surface drainage. Significant receptors include people and properties.

  Policy 3 – continue with existing or alternative actions to manage flood risk at the current level (accepting that flood risk will increase in time from this baseline).
- Clacton-on-sea (Policy Unit 11): This is a small coastal urban area with high population density. The main flood source is from the Holland Brook and its tributary the Pickers Ditch. There is a history of sewer flooding problems, but no reported incidents of surface water or groundwater flooding. A large flapped outfall controls the outfall of the Holland Brook to the sea to prevent coastal flooding. Coastal flooding is being considered by the SMP. Flood pathways include channel, overland flow, surface and subsurface drainage. Significant receptors include people and properties.

  Policy 3 – continue with existing or alternative actions to manage flood risk at the current level (accepting that flood risk will increase in time from this baseline).

For maps of the areas covered by each policy unit see the full CFMP reports.

2.5.2 Essex Shoreline Management Plan (SMP)

Shoreline Management Plans examine coastal erosion and tidal flood risks to people, property and the environment along the coastline. The SMP relevant to the Tendring District is the Essex SMP, which is in the process of being reviewed and updated. This will cover the coastline from Languard Point to the River Mardyke, and include the estuaries to their tidal limits. The Environment Agency have also recently started an estuary strategy for the Stour and Orwell Estuary as part of the 'Essex Estuarine Strategy' (2008), which will consider the long term management of flood defences in the

area by dividing the estuaries into management units. The revised SMP will provide management policies for the open coastline and extend up major estuaries and will therefore be integrated with the estuary strategies.

2.5.3 Haven Gateway Water Cycle Strategies

The Environment Agency has been working with Anglian Water and local authorities to produce Water Cycle Strategies. This part of the UK serves as an important gateway for trade and tourism between the UK and Europe and has also been identified as an area of projected urban development by the East of England Plan (RSS). Water Cycle Strategies assess water supply, sewage disposal, flood risk management and surface water drainage. They are designed to become part of local planning policy in order to create a more technically robust approach towards future developments, particularly for water services.

The studies start with an understanding of environmental capacity then build on this with an infrastructure strategy which considers any environmental constraints. Given the interconnected manner of these systems, developing Water Cycle Strategies allows cross organisational working on drainage. This was a recommendation of the Pitt Review following the wide-scale flooding in June and July of 2007. The Haven Gateway Water Cycle Strategy is intended to assist with the development of investment programmes to ensure that:

- adequate water supply and waste water infrastructure is in place to support housing and employment growth planned for Haven Gateway Sub-Region to 2021 in the emerging East of England Plan and the Haven Gateway Programme of Development Framework for Growth;
- any additional infrastructure is provided in accordance with a strategic rather than a piecemeal approach;
- there is a strategic approach to the management and use of water;
- the environment has sufficient capacity to receive increased waste water discharges;
- the potential for grey water reuse and implementation of Sustainable Drainage Systems (SuDS) is fully realised.

The Draft Stage 2 report was published in January 2009. This provides site specific analyses for each administrative area within the Haven Gateway, in terms of water supply, waste water disposal (including water quality) and flood risk management. Section 4 of the Draft Stage 2 report contains information which is specific within the Haven Gateway Water Cycle Study for Tendring District Council.

Tendring District forms the south eastern segment of the Haven Gateway, the District has been identified to receive 13% of the development required within the Haven Gateway, in terms of the Annual Monitoring Reports (AMR - 2007) and 17% in terms of the draft East of England Plan.

2.5.4 July 2007 Flood Review

The Environment Agency has undertaken a review of the summer 2007 floods, which presents some recommendations with potentially significant implications for flood risk management and drainage in England. The review proposes six recommendations, which are broadly similar to those identified by the final report of the Pitt Review (see section 2.6.1):

- The Environment Agency should be given a strategic overview of inland flooding from all sources.
- Key utilities and public services must take responsibility for climate change proofing critical infrastructure, facilities and services.
- Environment Agency to work with Met Office and other partners to develop flood warning techniques appropriate to severe weather events, for example leading to rapid flooding from surface water or minor watercourses.
- Environment Agency needs to ensure that its flood warnings trigger appropriate actions by businesses and the public.
- Multi-agency incident response plans need to consider the possible impact on critical infrastructure more effectively.

2.6 Additional documents of relevance

2.6.1 The Pitt Review

The final report of the Pitt Review, established following the flooding of summer 2007, was published in June 2008. Many of the review's recommendations have implications for local authorities, including planning, emergency planning, building control and drainage functions. The report contains a total of 92 recommendations, of which those with specific relevance to local authorities are presented below. Whilst they are only recommendations, they do indicate a strong probability of significantly greater flood risk management responsibilities for Local Authorities. The recommended timetable for implementation of recommendations foresees all in place by the end of 2010, and many during 2008 and 2009.

- RECOMMENDATION 7: There should be a presumption against building in high flood risk areas, in accordance with PPS25, including giving consideration to all sources of flood risk, and ensuring that developers make a full contribution to the costs both of building and maintaining any necessary defences.
- RECOMMENDATION 8: The operation and effectiveness of PPS25 and the Environment Agency's powers to challenge development should be kept under review and strengthened if and when necessary.
- RECOMMENDATION 9: Householders should no longer be able to lay impermeable surfaces as of right on front gardens and the Government should consult on extending this to back gardens and business premises." (Note, this issue was covered in a Defra consultation on surface water drainage, due for publication in July 2008)
- RECOMMENDATION 10: The automatic right to connect surface water drainage of new developments to the sewerage system should be removed.
- RECOMMENDATION 11: Building Regulations should be revised to ensure that all new or refurbished buildings in high flood-risk areas are flood resistant or resilient.
- RECOMMENDATION 12: All local authorities should extend eligibility for home improvement grants and loans to include flood resistance and resilience products for properties in high flood-risk areas.
- RECOMMENDATION 13: Local authorities, in discharging their responsibilities under the Civil Contingencies Act 2004 to promote business continuity, should encourage the take-up of property flood resistance and resilience by businesses.
- RECOMMENDATION 14: Local authorities should lead on the management of local flood risk.
- RECOMMENDATION 15: Local authorities should positively tackle local problems of flooding by working with all relevant parties, establishing ownership and legal responsibility.
- RECOMMENDATION 16: Local authorities should collate and map the main flood risk management and drainage assets (over and underground), including a record of their ownership and condition.
- RECOMMENDATION 17: All relevant organisations should have a duty to share information and cooperate with local authorities and the Environment Agency.
- RECOMMENDATION 18: Local Surface Water Management Plans, as set out under PPS25 and coordinated by local authorities, should provide the basis for managing all local flood risk.
- RECOMMENDATION 19: Local authorities should assess and, if appropriate, enhance their technical capabilities to deliver a wide range of responsibilities in relation to local flood risk management.
- RECOMMENDATION 20: The Government should resolve the issue of which organisations should be responsible for the ownership and maintenance of sustainable drainage systems.
- RECOMMENDATION 26: The Government should develop a single set of guidance for local authorities and the public on the use and usefulness of sandbags and other alternatives, rather than leaving the matter wholly to local discretion.
- RECOMMENDATION 38: Local authorities should establish mutual aid agreements.

- RECOMMENDATION 41: Upper tier local authorities should be the lead responders in relation to multi-agency planning for severe weather emergencies.
- RECOMMENDATION 66: Local authority contact centres should take the lead in dealing with general enquiries from the public during and after major flooding,
- RECOMMENDATION 68: Council leaders and chief executives should play a prominent role in public reassurance and advice through the local media.
- RECOMMENDATION 76: Local authorities should coordinate a systematic programme of community engagement in their area during the recovery phase.
- RECOMMENDATION 83: Local authorities should continue to make arrangements to bear the cost of recovery for all but the most exceptional emergencies, and should revisit their reserves and insurance arrangements in light of last summer's floods.

2.6.2 Flood Plan For Essex

The Flood Plan For Essex was a joint response plan agreed by Essex County Council, Essex Police, The Environment Agency (Anglian and Thames Regions), Department for Environment, Food and Rural Affairs (Regional Service Centre) Cambridge, District Councils and Unitary Authorities.

It was produced in January 2006 and provides general information on the type of flooding that may affect the county and the roles of the principal emergency services, local authorities and other relevant agencies in response to the threat or incidence of major tidal and/or river flooding.

It describes the methods used to disseminate flood warning information and the responsibilities of organisations during flood events and in terms of recovery (Environment Agency, local authorities, Essex Country Council Emergency Planning and Core Resilience Team, Essex Police, Essex Fire and Rescue Service, Ambulance Service, HM Coastguard, military, RNLI, utility companies, voluntary sector).

2.6.3 Essex Minor Watercourses Flood Risk Mapping Study

This study was developed by the Environment Agency (August 2008) as a flood risk mapping study for five mid and North Essex Minor Watercourses under the Strategic Flood Risk Management Framework (SFRM). Holland Brook flows north west to south east on the north side of Clacton-on-Sea is one of the watercourses in the study. Holland Brook is tide locked and discharges to the sea via a tidal gate structure.

A detailed hydraulic study has been carried out for the Holland Brook and its tributaries to provide flow and water level estimates for 10-year, 25-year, 75-year, 100-year and 1000-year. In addition, 100-year plus 20% increase in flow for climate change over 50 years and 100-year plus 30% increase in flow for climate change over 100 years was also modelled. The 100-year flood outline produced from this study shows that several properties in the following locations lay within the flood envelope: Pickers Way, Keswick Avenue and quite significantly within the vicinity of Castle Hill Park.

2.6.4 Jaywick SFRA

This study was carried out by JBA Consulting for Tendring District Council in August 2007.

The strategic flood risk study has shown that the whole coastal part of Jaywick is within the high flood risk zone (FZ3) though is currently defended to a high standard. Behind the sea walls there remains a residual flood risk of high hazard to lower lying areas of Jaywick that will increase markedly over time due to sea level rise (current defences could be overtopped at the design storm 50-75 years in future).

2.6.5 Harwich SFRA

The full SFRA for Harwich was completed by Scott Wilson in August 2008. A Master Plan has been developed identifying certain areas and sites for redevelopment within Harwich. This study presents the results of an extensive tidal and fluvial modelling and mapping exercise, which has considered the residual flood risk from both breach and overtopping of existing defences from tidal flooding and failure of the Ramsey River pumping station. The modelling methodology and flood mapping showing the residual risk from tidal and fluvial sources are described in the Level 1 SFRA.

3 APPROACH TO STRATEGIC FLOOD RISK ASSESSMENT

3.1 Overview

The SFRA is a planning tool which can aid the spatial planning process. It should be used to refine the information about areas in the District which may flood, considering all sources of flooding and the effects of climate change. This should form the basis of the Council's future flood risk management policies, ensuring integration with respect to different flood sources, sustainability and the potential for future development and growth. In addition, the SFRA will inform the LDF, providing the information to enable the Sequential and Exception tests to be applied during the development control process.

Environment Agency Flood Zones show the areas which are at risk of flooding from fluvial or tidal sources from different annual probability flood events. These assume the presence of no flood defences (i.e. an undefended situation) and in this respect represent a worst-case scenario.

Flood Zone 1 indicates areas with a 'low' probability of inundation from tidal or fluvial sources, defined as an annual probability of flooding of less than 0.1%. This may also be referred to as a return period of greater than 1000 years. Flood Zone 1 essentially covers everywhere outside of Flood Zones 2 and 3.

It is important to remember that the 'low' probability classification only refers to tidal and fluvial flood risk. Flood risk from other sources, such as groundwater, surface water and sewer flooding may also be present (see Section 4.7).

Flood Zone 2 indicates areas with a 'medium' probability of flooding from tidal or fluvial sources, defined as an annual probability of flooding of between 1% and 0.1% in fluvial areas (a return period of between 100 and 1000 years) and 0.5% to 0.1% in tidal areas (a return period of between 200 and 1000 years)

Flood Zone 3a indicates areas with a 'high' probability of flooding from tidal or fluvial sources, defined as:

- An annual probability of fluvial flooding of 1% or greater. This may also be referred to as a return period of 100 years or less.
- An annual probability of tidal flooding of 0.5% or greater. This may also be referred to as a return period of 200 years or less.

Where these two overlap, the one with the greatest extent defines the Flood Zone. Flood Zone 3a is entirely within the boundaries of Flood Zone 2.

Flood Zone 3b indicates the 'functional floodplain', defined as an area of land where water has to flow or be stored in times of flood. This is usually taken to be either the envelope defined by the 5% annual probability of flooding, also referred to as a return period of 20 years or less or an area that is designed to flood in a more extreme event.

It should be noted that Flood Zones do not take account of the presence of flood defences.

The Environment Agency, in line with PPS25 guidance, suggests that site allocations for development should be made outside of the flood risk areas (i.e. in Flood Zone 1) wherever possible. If there are no reasonably appropriate Flood Zone 1 sites, site allocations should be made in Flood Zone 2 as a priority, considering flood risk vulnerability of different land uses. Flood Zone 3 site allocations should therefore only be made where it can be demonstrated that there are no reasonably available sites in Zones 1 or 2. In order to show this the Sequential Test needs to be carried out.

Sequential Test

Annex E of PPS25 provides the basis for the sequential approach by recommending that LPAs use a risk-based approach towards development planning and control, and identifies the need to complete RFRAs and SFRAs. As part of the allocation process, those responsible for development decisions are expected to show that no suitable development sites in lower flood risk areas exist.

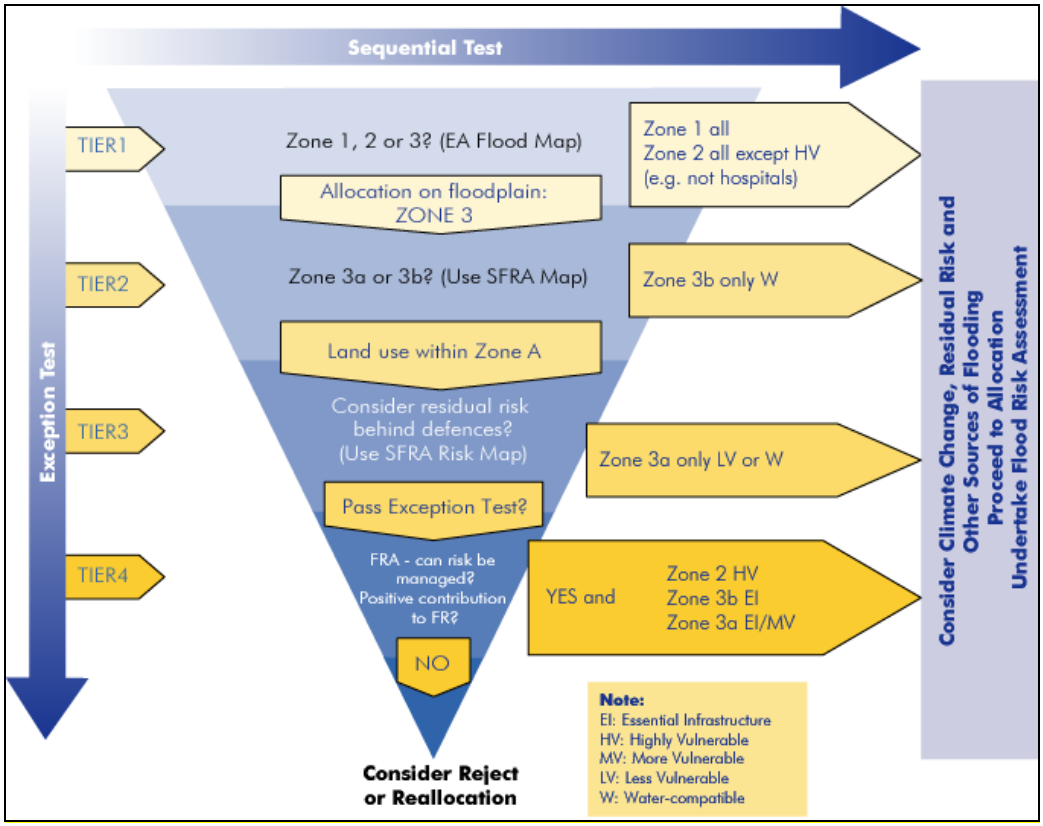
Figure 1 shows the Sequential Test methodology, which is a key driver for the SFRA. The Environment Agency Flood Zones provide the basis for completing the test which will be undertaken a number of times, considering a greater resolution and understanding of flood risk at each stage taking into account flooding from other sources. At each step, sites of lower flood risk are identified and prioritised in order of vulnerability to flood risk (Table 3-1) and their safety in terms of allocation for development.

In situations where development is being planned in locations behind or adjacent to existing defences, a further level of analysis may be required. This will be to test the sustainability and robustness of the mitigation measures.

This SFRA will provide the Council with Flood Zone (1, 2, 3a and 3b) classifications for those areas currently identified for development, as well as the information which will be required to classify any future allocations. The SFRA will aid the Councils development of the LDF and to prioritise allocations.

The Council are required to prioritise the allocation of land for development in ascending order from Flood Zone 1 to 3, including the subdivisions of Flood Risk Zone 3, if necessary. The Environment Agency has statutory responsibility and to this end must be consulted for site allocations to medium and high risk areas. This also includes those in areas with critical drainage problems and for any development on land exceeding 1 hectare outside flood risk areas. All development applications which fall into these categories must be accompanies by a Flood Risk Assessment. This must demonstrate how flood risk from all sources to the development itself (and others) will be managed now, and considering the effects of climate change. In these circumstances, the Environment Agency will require the Council to demonstrate that there are no reasonable alternatives, in lower flood risk categories, available for development. Where appropriate, the Exception Test is to be applied.

Figure 1 The Sequential Test: its practical application



The Exception Test

The application of the Exception Test is required where there is a need to locate development in higher flood risk zones, in order to meet the wider aims of sustainable development. PPS25 acknowledges that flood risk is one of many issues (including transport, housing, economic growth, natural resources, regeneration and the management of other hazards) which need to be considered in spatial planning.

The Exception Test is:

"only appropriate for use when there are large areas in Flood Zones 2 and 3, where the Sequential Test alone cannot deliver acceptable sites, but where some continuing development is necessary for wider sustainable development reasons, taking into account the need to avoid social or economic blight and the need for essential infrastructure to remain operational during floods."

It may also be necessary to apply it where national designations prevent the availability of unconstrained sites in lower risk areas (e.g. Green Belt areas, Areas of Outstanding Natural Beauty (AONBs), Sites of Special Scientific Interest (SSSIs) and World Heritage Sites (WHS)).

PPS25 explains the instances and the types of development for which the Exception Test is applicable. In some circumstance it is not appropriate to use the Exception Test to justify development; for example, development which is highly vulnerable to flooding cannot be justified in high risk areas by the Exception Test. Where the Exception Test is required it should be applied as soon as possible to all Local Development Document (LDD) allocations for development and all planning applications other than for minor development[1]. All three elements of the Exception Test have to be passed before development is allocated or permitted. For the Exception Test to be passed:

a. *It must be demonstrated that the development provides wider sustainability benefits to the local community that outweigh flood risk, informed by an SFRA, where one has been prepared. If the Development Plan Document (DPD) has reached the 'submission' stage – see Figure 4 of PPS12: Local Development Frameworks – the benefits of the development should contribute to the Core Strategy's Sustainability appraisal.*

b. *The development should be on developable previously developed land or, if it is not on previously developed land, that there are no reasonable alternative sites on developable, previously developed land; and*

c. *A Flood Risk Assessment must demonstrate that the development will be safe, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.*

In paragraphs D11 and D12 of PPS25 it states that that the Exception Test "should be applied to LDD site allocations for development and used to draft criteria-based policies against which to consider planning applications…" Where the Exception Test has been applied in LDD allocations or in criteria-based policies, the LPA should include policies in its LDDs to ensure that the developer's FRA satisfies criterion C). Compliance "with each part of the Exception Test should be demonstrated in an open and transparent way".

Table 3-2 summarises the applicability of the Exception Test for different development sites; housing allocations are classified as 'more vulnerable' and employment allocations are 'less vulnerable'.

Flood Risk Vulnerability Classification

PPS25 presents five different flood risk vulnerability classifications into which different types of development are categorised, namely:

- Essential infrastructure
- Highly vulnerable

[1] Definition of minor development:

-Minor non-residential extensions: Industrial/Commercial/Leisure etc. extensions with a footprint less than 250m^2

-Alterations: development that does not increase the size of buildings e.g. alterations to external appearance.

-'Householder' development: e.g. sheds, garages, games rooms etc. within the curtilage of the existing dwelling in addition to physical extensions to the existing dwelling itself. This definition EXCLUDES any proposed development that would create a separate dwelling within the curtilage of the existing dwelling e.g. subdivision of houses into flats.

- More vulnerable
- Less vulnerable
- Water compatible development.

Subject to the application of the Sequential Test, PPS25 specifies which of these types of development are suitable within each zone(this is summarised in Table 3-2):

- Flood Zone 1: All the uses of land listed above are appropriate in this zone.
- Flood Zone 2: The water-compatible, less vulnerable and more vulnerable uses of land and essential infrastructure are appropriate in this Zone. Only if the Exception Test is passed can highly vulnerable uses be appropriate.
- Flood Zone 3a: The water-compatible and less vulnerable uses of land are appropriate in this zone. The highly vulnerable uses should not be permitted in this zone. Only if the Exception Test is passed can more vulnerable and essential infrastructure uses be appropriate.
- Flood Zone 3b: Only the water-compatible uses and the essential infrastructure that has to be there should be permitted in this zone. Essential infrastructure in this zone should pass the Exception Test and be designed and constructed to meet a number of flood risk related targets. The less vulnerable, more vulnerable and highly vulnerable uses should not be permitted in this zone.

Table 3-1 Flood Risk Vulnerability Classification

Essential Infrastructure	• Essential transport infrastructure and strategic utility infrastructure, including electricity generating power stations and grid and primary substations.
Highly Vulnerable	• Police stations, Ambulance stations and Fire stations and Command Centres and telecommunications installations and emergency dispersal points. • Basement dwellings, caravans, mobile homes and park homes intended for permanent residential use. • Installations requiring hazardous substances consent.
More Vulnerable	• Hospitals, residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels. • Buildings used for dwellings, student halls of residence, drinking establishments, nightclubs, hotels and sites used for holiday or short-let caravans and camping. • Non–residential uses for health services, nurseries and education. • Landfill and waste management facilities for hazardous waste.
Less Vulnerable	• Buildings used for shops, financial, professional and other services, restaurants and cafes, offices, industry, storage and distribution, and assembly and leisure. • Land and buildings used for agriculture and forestry. • Waste treatment (except landfill and hazardous waste facilities), minerals working and processing (except for sand and gravel). • Water treatment plants and sewage treatment plants (if adequate pollution control measures are in place).
Water-compatible Development	• Flood control infrastructure, water transmission infrastructure and pumping stations. • Sewage transmission infrastructure and pumping stations. • Sand and gravel workings.

	• Docks, marinas and wharves, navigation facilities. • MOD defence installations. • Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. • Water-based recreation (excluding sleeping accommodation). • Lifeguard and coastguard stations. • Amenity open space, nature conservation and biodiversity, outdoor sports and recreation. • Essential sleeping or residential accommodation for staff required by uses in this category, subject to a warning and evacuation plan.

Notes: (Source: PPS25 Table D2)

This classification is based partly on DEFRA/Environment Agency research on Flood Risks to People (FD2321/TR2) and also on the need of some uses to keep functioning during flooding.

Buildings that combine a mixture of uses should be placed into the higher of the relevant classes of flood risk. Developments that allow uses to be distributed over the site may fall within several classes of flood risk sensitivity.

The impact of a flood on the particular uses identified within this flood risk vulnerability classification will vary within each vulnerability class. Therefore, the flood risk management infrastructure and other risk mitigation measures needed to ensure the development is safe may differ between uses within a particular vulnerability classification.

Table 3-2 Flood risk vulnerability and Flood Zone compatibility

Vulnerability classification		Essential Infrastructure	Water compatible	Highly vulnerable	More vulnerable	Less Vulnerable
Flood Zone	Zone 1	✔	✔	✔	✔	✔
	Zone 2	✔	✔	Exception Test	✔	✔
	Zone 3a	Exception Test	✔	x	Exception Test	✔
	Zone 3b	Exception Test	✔	x	x	x

Key: ✔ Development is appropriate **x** Development should not be permitted (Source: PPS25 Table D3)

This SFRA has been conducted as one study, incorporating both Levels 1 and 2 of the SFRA process. As reported in section 1.3, the data collection and review element of Level 1 has already been undertaken. The following sections outline the approach taken and the scope of each Level.

3.2 Level 1 – Scoping Study SFRA

The aim of a Level 1 SFRA should be to allow the Sequential Test to be applied, and identify whether the Exception Test is likely to be necessary[2]. Existing data has been used, together with new model runs where appropriate, to make an assessment of flood risk from all sources now and in the future collection and review

To allow the project programme to develop sufficiently, data collection and review was critical. The data was supplied by Tendring District Council, the Environment Agency and Anglian Water, and related predominantly to known or perceived flood risk issues in the District, development pressures or a trawl of search areas for development sites, and current policy towards developing in flood risk areas. This element of the Level 1 SFRA was undertaken for Tendring District Council by JBA Consulting in August 2008.

[2] Communities and Local Government, February 2007, *Development and Flood Risk: A Practice Guide to PPS25 'Living Draft'*. Consultation paper. p48.

Assessment of current fluvial and tidal flood risk

Flood risk in Tendring was assessed, categorised and mapped to a level concurrent with the nature and availability of existing data. In general, however, the following key considerations were addressed:

- Identification of known and/or perceived flood risk areas, providing the initial 'filter' for key flood risk issue areas within the district.
- Review of current Flood Zone Map and existing 1D hydraulic models, providing the broad (first pass) definition of High Risk Zone 3.
- Identification of critical floodplain areas and significant structures.
- Location and definition of the standard of existing defences and identification of areas that may be at risk from defence failure, requiring further investigation in Level 2 (breach analyses).
- Identification of developing areas contributing to ordinary watercourses and/or known flooding issue areas to ensure impact upon upstream and downstream properties is adequately considered (irrespective of flood risk posed to proposed development).
- Definition of areas subject to development pressure and/or regeneration (defined by Tendring DC).
- Definition of the functional floodplain

Review climate change and land use management impact

It is now widely recognised that climate change and the associated sea level rises will have the potential to significantly increase the consequences of flooding. Therefore, consideration has been given in this SFRA to the sustainability of new developments in the District under climate change, and from more extreme flood events too. The impact of climate change on hydrological system, and hence the future extent of flooding has been assessed using standard Defra guidelines.

Consideration was given to the implications of wider land management practices on flood risk in the area. This was based on existing information such as the North Essex CFMP.

Assess flood risk from 'other sources' and potential for Sustainable Urban Drainage Systems (SUDS)

This stage provided an indication of overland flow routes and areas prone to surface water flooding and sewer flooding. The assessment focused on storm events that exceed the available capacity of surface water systems and is particularly useful when assessing potential sources of flood risk associated with windfall sites.

3.3 Level 2 – Increased Scope SFRA

According to the PPS25 Practice Guide[3], the main aim of the Level 2 SFRA is to permit the application of the Exception Test. It considers the detailed nature of flood hazard taking account of the presence of flood risk management measures, such as defences. This also allows a sequential approach to site allocation within the Flood Zones.

Assessment of 'residual' risk

Further investigation was undertaken in areas protected by flood defences to allow a risk based approach to strategic planning. Modelling was carried out to provide an assessment of what is at risk with the defences in place, termed 'residual risk', which is more useful for planning and regeneration purposes. The SFRA also examined the probability, depth, velocity and rate of onset of flooding if defences are breached. The risk to people is assessed according to Defra R&D document FD2320[4].

[3] Communities and Local Government, June 2008, PPS25: *Development and Flood Risk Practice Guide*.

[4] Defra/Environment Agency, 2005, *Flood Risk Assessment Guidance for New Development.* R&D Technical Report FD2320/TR2.

Liaison between Tendring District Council and JBA has identified six locations at which the hazard from the breaching of defences should be examined and Map 1 shows the location of where breach modelling was undertaken. The results of this hazard assessment will be presented in Appendix D of this report.

Establishment of Guidance for LPA and Developers at Planning Application Stage

Concise and pragmatic guidance has been developed to assist the council and developers to ensure that the outcomes and recommendations of the SFRA are followed through to the planning application and implementation stage.

It is imperative to ensure that the requirements placed upon developers at planning application are robust and fit for purpose. Similarly, the ownership, roles and responsibilities of the LPA and Environment Agency as appraisal bodies must also be clearly understood to ensure that the intent of the SFRA and planning process are not lost.

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4 DATA SOURCES

4.1 Flood Zones

The Environment Agency Flood Zone maps (available from http://www.environment-agency.gov.uk/flood) identify the areas at risk from river (fluvial) and tidal flood events.

The Flood Zone maps were generated using a methodology which incorporated a national digital terrain model (NextMap), derived river flows (Flood Estimation Handbook (FEH) methods) and a 2-dimensional flood routing model.

These theoretically derived Flood Zone extents have, in some situations, been revised where there has been more refined modelling undertaken, where historical flooding extents are available, or where there are known errors in the digital terrain data. In Tendring, the flood zones at Holland Brook have already been updated with the results of detailed flood mapping studies (See section 4.3)

The Flood Zones adopt a precautionary approach in that they do not take account of flood defences. They therefore represent a worst-case scenario as the actual extent of flooding is mitigated by flood defences. Maps 4 and 5 shows the extent of Flood Zones 3 and 2 (the undefended situation) for the Tendring District.

4.2 Flood defences

Although the Environment Agency Flood Zones do not take account of existing defences, PPS25[5] states that those areas which are defended (those areas which are protected to some degree by the presence of formalised defences) are still at risk of flooding. In light of this, flood risk in these areas must be assessed with respect to the adequacy of the defences and the standard of protection afforded.

The Environment Agency has supplied their National Flooding and Coastal Defence Database (NFCDD) for use in this SFRA. This provided details of the existing defences, as well categorising them by type, and providing information on who owns and maintains them.

4.2.1 Fluvial Protection

According to the Environment Agency's NFCDD, as shown in Map 8a, Tendring District is protected from fluvial flooding by having a good coverage of fluvial defences at most watercourses including River Ramsey, Holland Brook and the tidal reaches of River Colne and their tributaries.

Holland Brook drains to the sea via a large gravity sluice at Holland Haven. During periods of high fluvial flows 'tidelocking' can lead to flooding of the rough pasture, golf course and the road linking Holland-on-sea and Great Holland (B1032).

4.2.2 Tidal Protection

Tendring District has significant tidal defences of many types (see Map 8a). Sea defences and coastal protection measures are extensive along the east coast of the district. The section of the sea defences from Walton-on-the-Naze to upstream of Jaywick Ditch are maintained by the Local Authority and the rest of the sea defences and coastal protection measures are maintained by the Environment Agency or private land owners.

The existing coastal defences comprise of the following:

- Manningtree town is protected by a concrete block armoured clay wall, steel sheet piled walls and concrete parapet walls ranging in height from 4.9mAOD to 5.2mAOD. For reference the storm surge in 1953 reached a sustained level of 3.95mAOD at this point. The defences protect numerous properties.

[5] Communities and Local Government, 2006, PPS25: *Development and Flood Risk.*

- Holland Gap, the area between Clacton-on-Sea and Walton-on-the-Naze is protected by a large armoured concrete bank built at 5.18mAOD. Due to exposure it is subject to considerable wave action and as a result large waves do overtop the defence causing flooding behind the wall. Flood waters recede through the Holland Sluice, which also drains the Holland Brook (the largest watercourse in the Tendring District).
- Point Clear is cliff protected for a short length then as ground levels fall a concrete block armoured wall takes over built with a crest level at 4.9mAOD to 5.1mAOD.
- The majority of Brightlingsea town is protected by a scheme carried out in 1994. The Waterside area has no protection. A repeat of the 1953 surge event would result in extensive flooding and the Local Plan acknowledges that development in this area would require additional defences.

Areas Benefiting from Defences (ABDs) have also been provided. ABDs show those areas which benefit from formal flood defences in the event of flooding from fluvial sources with a 1% annual probability, or from tidal sources with a 0.5% annual probability. If the defences at these locations were not present, these areas would flood. According to the ABDs data from the Environment Agency, there are no ABDs in the Tendring District. However, existing defences with 200 year Standard of Protection (SoP) from NFCDD and Flood Zone 3 have been used to define the areas benefiting from the 200 year SoP as shown in Map 8b.

4.3 Hydraulic Modelling Studies

4.3.1 Holland Brook Model

The Environment Agency has developed a hydraulic model of the Holland Brook and its tributaries. The study was developed to identify the extent of flooding along the Holland Brook and its main tributaries.
The models were developed used ISIS software (v2.3) and flood extents for the following annual probability events were established: 10%, 4%, 1.3%, 1%, 0.1% and 1% plus climate change.

4.3.2 Ramsey River model

A broad brush hydraulic model of the Ramsey River was developed as part of Harwich SFRA study by Scott Wilson.

A pumping station discharges flows from the Ramsey catchment into the North Sea by pumping over the railway embankment. The residual risk of property flooding is limited in the event of failure of the pumping station during the 1 in 100 year with climate change allowance event.

4.4 Topographic data (digital elevation models)

A digital elevation model (DEM) is a critical dataset for flood modelling and mapping. There are two commonly used models to represent the ground elevation, Digital Surface Model (DSM) and Digital Terrain Model (DTM). Digital Surface Model is a representation of the topography, providing the elevation of the upper-most surface (be it ground surface, vegetation or buildings). The above ground features of a DSM (e.g. buildings) can be filtered out so as to provide a true representation of the ground terrain, known as a digital terrain model (DTM).

The Environment Agency has provided Light Detection and Ranging (LiDAR) data for the study area.

LiDAR is an airborne mapping technique which uses a laser to measure the distance between the aircraft and the ground, which is available with 0.25m to 2m resolution for the majority of Tendring District Council's planning area. Map 1 shows the available LiDAR tiles and coverage of the Tendring District.

4.5 History of flooding

A summary of the flood events in Tendring District for which information has been gathered is displayed in . This information does not represent a comprehensive list and in many cases, especially for earlier flood events, records are often anecdotal and do not provide complete accounts.

More recent records, such as those supported by photographs taken at the time, databases of flooded properties, and the gauge network maintained by the Environment Agency are more comprehensive and allow comparison between different events. Historic flooding information, where the extent of flooding has been mapped, is displayed on Map 3. A variety of sources exist to gather information of flood history; those consulted for this SFRA include:

- The British Hydrological Society's website; Chronology of British Hydrological Events6
- Internet searches
- Reports, flood levels, photographs and maps compiled by the Environment Agency (and its predecessors)
- Previous flood studies

Also, the North Essex CFMP prresents an extensive review of historical flood events from all sources.

Areas of known flooding issues but without detailed information for Tendring District Council have been identified and summarised below:

- Richard Warren of Tendring District Council confirms that there have been flooding events in the last few years but no information is available on these events at this time.
- Tendring District Council facilitates the distribution of sandbags in the event of flash flooding in the region but does not record data on numbers or locations used.
- A request was made to Essex County Council for information about highway flooding and it was confirmed by Terry Knights that occasionally parts of the highway are covered in water for short periods of time. It was not possible to provide information on the locations of this flooding within the timescale of this project.

Map 3 includes this information, together with flooding from all other sources.

[6] BHS Chronology of British Hydrological Events, http://www.dundee.ac.uk/geography/cbhe

4.6 Previous flood risk studies in the Tendring District

4.6.1 Flood Risk Assessments

As part of the planning process, and in line with PPS25 guidelines, any development which takes place in flood risk locations must be accompanied by a Flood Risk Assessment (FRA). Several flood risk assessments have been carried out for development proposals in the past within Tendring District, however there is only one that is relevant to this SFRA according to the supplied data from the Tendring DC:

- Tesco, Station Road Manningtree FRA

Produced in June 2007 for Pinnacle Consulting, covers a development site on brownfield land located off Station Road, Manningtree, Essex. The development site is located on land behind a defence embankment along the Stour Estuary that is within the Environment Agency Flood Zone 3a.

4.6.2 Hydraulic breach modelling from SFRAs

- Jaywick SFRS:

For the Jaywick study three sea wall breach locations were modelled for current and future (2107) conditions for 0.5% and 0.1% annual probability tidal surges. All resulted in significant flooding and hazard to life in the lowest lying marsh areas behind the sea defence should a breach occur. There is a lower hazard in some of the higher areas of Brooklands and possible options for redevelopment sites were examined including emergency access routes.

- Harwich SFRA:

Hydraulic breach modelling was undertaken at three strategic locations within the Harwich SFRA study area: Harwich International Port, Harwich peninsula and Dovercourt. Each model has been used to simulate a breach in the defences occurring at the same time as 0.5% and 0.1% tidal water levels for present day and climate change scenarios.

4.7 Other evidence of flooding from all sources

Historical flooding events and flood risk from other sources (i.e. non-fluvial or tidal) have been identified and assessed. The North Essex CFMP has analysed and described flood risk from these sources and these documents have been referred to in this SFRA (see).

4.7.1 Groundwater flooding

Geology is an important factor for determining whether there is a risk of groundwater flooding. The chalk aquifers which dominate western part of the district have the potential to cause groundwater flooding, as being permeable the water table can rise to above the ground surface following periods of heavy rain. However, in many parts of the Tendring District the chalk is overlaid by impermeable drift deposits which restrict this process. The Environment Agency has supplied the Groundwater Vulnerability Map for the Tendring District, this shows the District has only minor aquifers and hence the vulnerability of groundwater flooding is low. This will be discussed further in Chapter 6, and used in the assessment of suitable Sustainable Drainage Systems (SuDS – see Appendix C: -).

There are very few reported incidents of groundwater flooding across the Tendring District and flooding from this source is not considered as high risk.

4.7.2 Sewer and surface water flooding

Anglian Water supplied records of sewer flooding through their DG5 register. The data provided was on postal area basis, and is displayed on Map 10, being described further in section 7.3. The data is up to February 2009 (for the full period covered by the data and further details please contact Anglian Water).

There have been a number of recorded incidents of surface water flooding across the Tendring District (see Appendix A: -). Surface water flooding is caused when rainfall cannot infiltrate the soil or when urban drainage systems cannot cope the rainfall and runs off due to impermeable surfaces or land compacted by agriculture. In urban environments surface water will remain on the surface until it can enter the drainage system. Surface water flooding is usually of short duration.

4.8 Areas of search of potential development sites

Tendring DC has supplied GIS files of the areas of search of potential development sites that are currently being looked at by TDC offices. In the majority of cases these are still areas of search of potential development sites at this stage with no specific land uses assigned. These represent land allocated in the Tendring Local Plan (2007). Flood risk will be examined for each of these areas, including for all the existing site allocations within the district. Map 2 shows the areas of search of potential development sites. The detailed flood risk assessments for each site is summarised in Appendix E SITE SUMMARY SHEETS AND MAPS.

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5 FLUVIAL FLOOD RISK

5.1 Introduction

This section examines the risk in Tendring District from fluvial flooding, both now and in the future. It makes use of all the data and information described in Section 4. It defines the fluvial Flood Zones 1, 2, 3a and 3b, providing enough information for the council to perform the Sequential Test.

Flood Zones 1, 2, and 3 delineate areas of risk from both tidal and fluvial flooding.

- Flood Zone 1: Low Probability. This zone comprises of land assessed as having a less than 1 in 1000 annual probability of flooding in any year (<0.1%).
- Flood Zone 2: Medium Probability. This zone comprises of land assessed as having between a 1 in 100 and 1 in 1000 annual probability of flooding (1% - 0.1%) in any year.
- Flood Zone 3a: High Probability. This zone comprises of land assessed as having between a 1 in 20 and 1 in 100 annual probability of flooding (5% -1%) in any year.
- Flood Zone 3b: The Functional Floodplain. This zone comprises of land assessed as having a 1 in 20 or greater annual probability of flooding (>5%) in any year.

The existing Flood Maps, produced by the Environment Agency, have been used to delineate flood zones 1, 2 and 3a. The Environment Agency does not have a Flood Map which defines Flood Zone 3b. In identifying Flood Zone 3b as part of this SFRA, the 5% AEP flood outline (1 in 20 year flood event), available from detailed models of the River Stour, was compared to Flood Zone 3. This demonstrated that due to catchment characteristics the extent of flooding from the two events is very similar. Therefore where no detailed hydraulic model exists, Flood Zone 3 will be used to delineate the functional floodplain (Flood Zone 3b). Where detailed models are available (e.g. along the Holland Brook), Flood Zone 3 will also be used to represent the functional floodplain, due to the similarity in the flooding extent. In situations where there are defences present, their standard was examined from the Environment Agency National Flooding and Coastal Defence Database (NFCDD) and the distinction between Flood Zone 3 and 3b defined accordingly. Although the other delineations using the EA Flood Maps do not account for defences, the functional floodplain would as no land behind defences is functional during a flood. The influence of fluvial defences across the Tendring district is described in Section 5.4.

Maps for the whole district showing historic flood extents, Flood Zones, the effect of climate change, flood defences and functional flood plain are shown in Maps 3 to 8a and b. Further more detailed maps are given in Appendix E: - for the main areas of search of potential development sites at Clacton, Manningtree, Point Clear, St Osyth, Thorpe-le- Soken, Walton on the Naze, Alresford, Ardleigh, Brightlingsea, Elmstead Market, Little Clacton and Great Bentley.

5.2 Fluvial flood risk

Fluvial flood risk is a consequence of increased water levels in rivers or stream, usually as a result of a period of heavy rainfall, which exceed the capacity of the channel and spill out onto the floodplain.

The following sections describe fluvial flood risk areas by watercourse.

5.2.1 Holland Brook (with Pickers Ditch, Weeley Brook, Little Bentley, Tendring Brook and Kirby Brook tributaries)

Holland Brook is the principal watercourse in the Tendring District as can be seen on Map 4 and smaller tributaries flow through Weeley and Clacton. The Holland Brook rises from Little Bromley and flows generally from north west to south east through rural land to Little Bentley where it is designated as Environment Agency main river, and flows 16.5 km generally from north west to south east through rural land on the north side of Clacton. The watercourse discharges to the sea via a tidal gate structure located at OS NGR TM 219 172. At this outfall through the sea wall at Holland Haven, the land is low lying and acts as an area of flood storage at high tides when the tidal gate is closed. This storage area is extensive but is well defined on the flood zone mapping and there is little existing flood risk to property.

The main risk to existing properties is from the Picklers Ditch and its smaller tributaries through Clacton. There are possible development sites near to the Hartley Wood Brook on the north west fringe of Clacton and Sixpenny Brook on the west of Elmstead Market to better define the flood risk from this tributary additional modelling using JFLOW was carried out (See Appendix B for details).

5.2.2 Tenpenny Brook (with Sixpenny Brook and Elmstead Brook tributaries)

Tenpenny Brook rises near to Great Bromley and flows south through rural areas to discharge into the Colne Estuary north of Brighlingsea. Tributaries of Elmstead Brook and Sixpenny Brook rise near to Elmstead Market close to Colchester. The head of the main river part of Sixpenny Brook is within a possible area of development search as shown in Map 4.

5.2.3 Salary Brook Ardleigh

Salary Brook is a small watercourse that rises near Ardleigh and discharges to the Colne Estuary outside of Tendring District. Ardleigh Reservoir is located on small tributaries of the Salary Brook and is largely supplied by pumping and used for water supply and recreation. The salary Brook is within a possible development search though flood risk areas are well defined by the flood zones.

5.2.4 Ramsey River

The Ramsey River flows through Wix and becomes tide influenced towards Harwich where it is pumped to the Stour Estuary. The main flood risks are fluvial/tidal at Harwich (though much reduced since the installation of the pump station) and elsewhere the flood zones define risk areas including a small number of existing properties close to the river.

5.2.5 Other Small Brooks

There are a number of other small brooks in rural areas such as Beaumont Brook and Kentish Hall Brook around Hamford Water which are mainly at risk of tidal flooding and other small brooks around the coast such as between Mistley and Manningtree which have fluvial headwaters and tidal outfalls.

5.3 Fluvial flood warning system

The Environment Agency provides a flood warning service for fluvial and tidal flooding in Tendring District using its Floodline Warnings Direct Service (FWD). There are no fluvial flood warning areas in the Tendring District.

5.4 Fluvial flood defences

Flood defences can reduce flood risk in the areas which they protect. The location of flood defences in the Tendring District is shown on Map 8a. In Tendring District the predominant flood risk source is tidal, and there are therefore no formal fluvial flood defences. Channel maintenance is undertaken on a number of the watercourses (e.g. Pickers Ditch and Hartley Wood Brook), and whilst this does contribute to alleviating flood risk, the activities do not form formal structures with a design standard.

5.5 Effects of climate change on fluvial flood risk

Current Defra guidance[7] states that peak fluvial flows are likely to be increased by up to 20% over the next 50 to 100 years. This is as a result of climate change impacts on the hydrological cycle. This will subsequently lead to higher water levels and an increased risk of flooding.

For this SFRA the effect of climate change on flood risk over the next 100 years was considered using the results of the detailed modelling of the Holland Brook and previous work including that on smaller rivers in Tendring. It is clear that in this area there is rarely any practical difference in the extent that becomes at risk in the future. Compared to the current situation, Flood Zone 2 gives a good conservative indication of the effect of increased flows at 1% AEP due to a well defined floodplain.

Therefore it is suggested that for fluvial areas the future 1% AEP event taking into account the effect of climate change should, for planning purposes be based on the increased extent of Flood Zone 2 and this is shown on Map 7.

[7] DEFRA (2006). *FCDPAG3 Economic Appraisal Supplementary Note to Operating Authorities - Climate Change Impacts.*

5.6 Effects of future Environment Agency policy on flood risk

5.6.1 Introduction

The Environment Agency has recently produced Catchment Flood Management Plans (CFMPs) for the whole of the UK. These use a broad-scale approach to define the current and future levels of flood risk, which are used to establish catchment-wide policies for flood risk management. As reported in Section 2.5.1, the Tendring District is covered by the North Essex CFMP. The following sections will examine how the policies adopted will affect flood risk across Tendring, and how this should be considered for future developments.

5.6.2 Policy 2

To reduce existing flood risk management action, (accepting that flood risk will increase with time)

Policy 2 has been adopted for the Coastal Streams policy unit, in the North Essex CFMP. Adopting this policy means that the Environment Agency accepts that flood risk will increase with time in these areas.

5.6.3 Policy 3

To continue with existing or alternative actions to manage flood risk at the current level (accepting that flood risk will increase in time from this baseline).

Policy 3 has been adopted for the Harwich and Clacton-on-Sea policy units in the North Essex CFMP.

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6 TIDAL FLOOD RISK

6.1 Introduction

The coastal frontage of the Tendring District Council's area is approximately 60km in length. This section examines the risk in Tendring District from tidal flooding, both now and in the future. It makes use of all the data described in Section 4. It also defines the tidal Flood Zones 1, 2, 3a and 3b, providing enough information for the council to perform the Sequential Test.

Across the Tendring District, most of the areas at flood risk from tidal sources are protected by flood defences. However, there remains a residual risk that these defences could overtop or fail during a flood event.

6.2 Tidal Flood Risk

Tidal flood risk is caused by high sea levels which exceed ground levels. This is caused by a combination of storm surges in high tide and waves leading to high water levels, such as occurred in 1953.

Flood Zones 1, 2 and 3 delineate areas of low, medium and high risk respectively from both tidal and fluvial sources. The areas of Tendring District which are within tidal Flood Zones 2 and 3 are shown on Maps 4 and 5. These include parts of Manningtree and Harwich on the Stour estuary, along some of the tidal streams which drain into Hamford Water and near Walton on the Naze, on the Kirby Brook near Frinton on Sea, on the Jaywick and St Osyth Ditches, and on the tidal streams which drain into Colne estuary at Brightlingsea.

The Flood Zones do not take account of flood defences, and in representing the undefended situation must be considered as the worst-case scenario.

6.3 Tidal Flood Warning Service

The Environment Agency provides a flood warning service for tidal flooding in Tendring District using its Floodline Warnings Direct Service (FWD). There are three tidal flood warning area and two tidal flood watch areas in the Tendring District:

Flood Warning Area

- 054FWCDV4A – Coast from Shingle Street to, and including, Clacton, including Felixstowe and Ipswich

Flood Watch Areas

- 051WACDV4B – Essex Coast from Clacton to Southend
- 054WACDV4A – Suffolk and Essex Coast from Shingle Street to Clacton

6.4 Tidal defences

Flood defences reduce flood risk in the areas which they protect. The location of the extensive tidal flood defences in Tendring District is shown on Map 8a. In Tendring District, the Council manages 18.5km of sea defences; the remaining frontage is managed either by the Environment Agency or maintained privately.

The Council's coast defence frontage is made up as follows:

Brightlingsea	1.18km
Clacton and Holland	5.92km
Frinton and Walton	6.86km
Dovercourt and Harwich	4.56km

The main settlements along the coast including Clacton, Jaywick, Brightlingsea, Point Clear, Holland-on-sea, Frinton–on-Sea and Walton-on-Naze are mostly protected by the raised tidal defences with 0.5% annual probability (1 in 200 year) or better standard of protection. The beach is also part of the defence and plays a significant role in reducing wave run-up. For example at

Jaywick there are artificial reefs and breakwaters to protect the beach and prevent erosion in front of the wave wall.

The following information from Tendring DC provides a summary of the defences. The wall levels given are generally those that were used at the time of construction. The Environment Agency NFCDD records do not indicate current defence surveys but actual levels (as found in the Jaywick study for example) may be lower than indicated due to bank settlement with time and variations along the long line of defence.

South bank of Stour Estuary

Manningtree Town and Mistley are protected by concrete block armoured clay walls, sheet piled walls and concrete parapets. Defence levels are 4.9m AOD to 5.2m AOD (1953 tide was 3.95m AOD).

Between Mistley and Parkeston the shoreline is mostly high ground with the exception of Wrabness wall which is a clay embankment protected by concrete blocks build to 4.69m AOD.

Parkeston and Harwich and Dovercourt

The port is protected by a large shingle bank at the Western End and reinforced concrete parapet walls with opening steel gates to allow commercial operation of the port. Wall level is 5.4m AOD.

Substantial sea won shingle embankments built to 5.0m AOD some with asphalt facing lead to reinforced concrete walls at the town. Some of the walls are at 4.4m AOD to improve amenity but otherwise are up to 5.0m AOD. These defences are considered further in the Harwich SFRA.

Dovercourt to Hamford Water (Foulton Hall Point)

This reach has concrete block armoured clay walls built to 4.7m AOD, protecting farm land and holiday parks and are generally in good condition.

Hamford Water

Farmland and the back of Walton on the Naze is protected with concrete block armoured banks between 4.0m and 4.81m AOD. Bramble Island is a chemical works and here sheet piling on the clay wall gives a defence level of 4.81m AOD.

Within Hamford Water, Horsey Island is protected by a seawall built to 3.65m AOD. In 1953, the sea level was approximately 4.1m AOD and did overtop these defences but no breaches were experienced and the one farmhouse on the island was not flooded.

Naze Point to Holland Gap

Much of this coastal frontage is high ground (Naze cliffs, Walton and Frinton coastal frontage). The 1.5km 'Holland Gap' between Frinton and Clacton has a substantial wall built at 5.18m AOD which is subject to wave action. The wall is fully armoured on the front, access road and rear and is subject to wave overtopping during extreme easterly gales.

Clacton to Point Clear

Clacton-on-sea frontage is high ground, seawalls begin southwest of the pier and comprise substantial concrete parapet walls on block armoured clay banks built to 5.0m AOD. Further information is given in the Jaywick Flood Study in which sections of wall at 4.65m crest were identified. There has been occurrences of wave overtopping on this reach though more recent beach recharge and offshore coastal protection have significantly reduced the likelihood of this in built up areas.

Point Clear to Colne Barrier, Wivenhoe

Point Clear is protected by cliffs for a short length and then, as ground falls, a block armoured bank runs alongside the Brightingsea and St Osyth Creeks at a design level of 4.9m AOD to 5.1m AOD to Brightingsea. In Brightlingsea the 'Town Front' has no protection and is liable to flooding as it did in 1953. West of the town centre rock or block protected clay banks, road ramps and concrete parapet with a level of 4.7m AOD or more. 1953 level was 4.09m AOD.

From the low area of the 'Great Divide' north of Brightlingsea, the defence line follows the creeks up the Colne Estuary to Wivenhoe and the Colne Barrier. Banks are generally armoured with concrete blocks though the smallest are grassed. Defence level is generally 4.57m AOD but smallest where there is only agricultural land are only to 3.5m AOD. The closure wall at the Colne Barrier is set to 6.0m AOD to allow for climate change over a century.

6.5 Effects of climate change on tidal flood risk

It is expected that peak tidal levels will increase due to climate change, in line with the rise in sea level and subsidence in the south east of England. The resulting net increase of tidal levels relative to the current ground levels was calculated (as informed by Defra 2006) and can be seen in Table Table 6-1

Table 6-1 Increase in 0.5% AEP (200 year) design surge level due to sea level rise

Location	Defence Level (m AOD)	Baseline Level (m AOD)	2025 Level (m AOD)	2050 Level (m AOD)	2075 Level (m AOD)	2100 Level (m AOD)
Brightlingsea	Banks 4.7 Town centre 3.5 (?)	4.00	4.12	4.255	4.36	4.98
Clacton-on-Sea	4.65/4.9	4.07	4.19	4.325	4.43	5.05
Holland-on-Sea	5.18	4.04	4.16	4.295	4.4	5.02
Manningtree	4.57	3.89	4.01	4.145	4.25	4.87
Walton-on-the -Naze	4.8 (?)	3.92	4.04	4.175	4.28	4.9

The rate of rise in sea level is predicted to accelerate sharply in the later part of the century. The defence levels are above the 0.5% predicted tide until after 2075. The long term management of banks at major settlements is currently set by the shoreline management plans which are currently undergoing review but as the current policy is 'hold the line' at major population centres, for planning purposes a high level of protection from tidal flooding is expected into the future.

At Brighlingsea there are earth banks to the west and the quay area is on relatively high ground (3.5-4.0m AOD?) but is still susceptible to the highest tides. There is an area of low ground to the north of the town that is also defended but, as can be seen from the Flood Zones, should there be a failure of these defences, access to the town would be cut off.

6.6 Residual tidal risk

There are areas which benefit from the flood defences described above. There is a risk that the defences present may fail, although the affected area may be different to that shown as undefended by the Flood Zones.

6.6.1 Risk of overtopping or defence failure

Tendring has a long length of coastal and estuary banks that were significantly raised and strengthened following the 1953 tidal surge that severely affected much of the east coast including Harwich, Jaywick, Point Clear and Brightlingsea. The banks along the estuaries are typically clay seawalls with blockwork revetments, and have a nominal standard of protection of 1 in 200 years according to the Environment Agency National Flood and Coastal Defence Database. Similarly the tidal defences along the coastal frontage have a high standard of protection though are exposed to more frequent wave attack so overtopping from wave run-up may occur more frequently. Assessment of the probably of wave overtopping requires more detailed local analysis of wave conditions and beach profiles, and, though important for coastal defence management, is less significant to the SFRA than tidal surges that result in mean sea levels above the crest of the defence (clear water overtopping).

Clear water overtopping of a defence results in high flows and volumes of water in a short time and smaller low lying compartments behind defences may fill up quickly. The onset of overtopping is however dependent on the crest level which, for an earth bank, may vary significantly such that overtopping is concentrated at a particular low point.

The risk of defence failure is low but a breach is a more critical condition than overtopping as it cannot readily be predicted. It was therefore investigated for the purposes of the SFRA to inform the PPS25 Sequential and Exception Test.

6.6.2 Breach modelling

Breach models have been developed to display the residual risk if a breach were to develop in the defences at Manningtree, Walton (2 sites), Clacton (Holland Haven), Point Clear and Brightlingsea. The sites used are shown in Map 1, note though that the breach location sites are chosen to be representative of possible locations and a breach could occur at any site along the defence. Completed SFRAs for Harwich and Jaywick also present information on those locations from similar studies. There is thus available a good overall representation of the likely hazards for breach at all the main coastal population centres in Tendring.

The 2D software TuFLOW was used for the tidal breach models completed in this SFRA and for the Jaywick studies. Mike 21 software was used for modelling at Harwich.

Three scenarios were developed for each of the breach locations:

- Breach model – 0.5% AEP (1 in 200 year)
- Breach model – 0.5% (1 in 200 year) plus climate change to 2100
- Breach model – 0.1% AEP (1 in 1000 year)

Graphical results and further description of the methodology used are presented in Appendix D. Figures show predicted maximum depth and Flood Hazard in each case. In simulation of breaches, it was assumed that even if overtopping was expected in the future at the current defence level then there would be work carried out to raise a defence and the breach simulation thus includes only the effect of a breach.

The Environment Agency recommend certain widths of breach to simulate based on previous experience. The relevant cases indicate 50m breach width as appropriate either for soft defence on an estuary or for hard defences on a coastal frontage. These two criteria apply to all cases considered and thus all breaches simulated use a 50m width.

Taken from the Flood Risk the Defra guidance Flood Risk to People[8], flood hazard is calculated as a function of both the velocity of flood water and the depth. This is referenced to a level of risk based on the categories shown in Table 6-2. The hazard maps shown in Appendices C and D are based on this classification.

Table 6-2 Flood Hazard Classifications

Hazard Classification d x(v +0.5)	Degree of Flood Hazard	Description
< 0.75	Low	Caution *"Flood zone with shallow flowing water or deep standing water"*
0.75 – 1.25	Moderate	Dangerous for some *"Danger: Flood zone with deep or fast flowing water"*
1.25 – 2.5	Significant	Dangerous for most people *"Danger: Flood zone with deep, fast flowing water"*
> 2.5	Extreme	Dangerous for all *"Extreme danger: Flood zone with deep, fast flowing water"*

6.6.3 Results of breach modelling

The flood depths and hazards to people from each breach model run are displayed in Appendix D.

[8] DEFRA (2006) *Flood Risk to People – Phase 2FD2321/TR2 Guidance Document*

Results show extensive areas of deep water and high hazard to life in every case considered and that the probability of breach and overtopping will increase with time. The areas vulnerable to breaching should therefore not be considered for further development but only for those uses essential for sustainability of the area.

Manningtree

A breach in the sea wall within a short time results in a landward water level close to the surge level in the estuary to a level of 3.9m AOD and water depths are between 1m and 2m deep. Even though velocities are generally low, except through the railway, the hazard to life is high and the flood extent covers the whole low lying part of Manningtree including an area to the west of the railway. Although there is no new development currently being considered along the riverfront, the existing development and old industrial usage is steadily being redeveloped (such as for retail). The extent of the modelled flooding does not vary greatly for 0.1% event or the future climate change though the potential depths and hazards do increase indicating potentially more severe conditions.

Manningtree areas of search are safely sited above the area at risk.

Walton on the Naze

At Walton on the Naze, although the coastal frontage is largely at a high level and not vulnerable to breaching, the west side open to the Hamford Water is protected by earth banks (primarily where mobile home sites are located). This is potentially an area of concern but divides into two parts at the boat access ramp which serves as a high level counterwall. Two breach locations were therefore considered, breach 1 to the north and breach 2 to the south. Although the two breaches were simulated separately the results were combined for presentation although an example is also given of the extent of breach 2 only. Breach 2 resulted in only limited flow across the dividing road in current day sea level although with climate change this increases significantly and most of the marsh is flooded and depths to 4.0m are predicted.

High Hazard is predicted for all low lying areas, particularly where there are currently mobile home and holiday sites.

Clacton/Holland-on-sea

A failure in the sea wall at the Holland Brook outfall would potentially flood a very wide area including a small part of the area of search near the Picklers ditch. The flood depths are high throughout most of the affected area and hazard to life extreme in the vicinity of the river. The flood extent spreads across the golf course area towards Frinton and skirts the outside of the Frinton as well as Clacton. The effect of climate change is limited although the area affected along the development search increases marginally.

Point Clear and Brightlingsea

A breach in the sea wall at Point Clear would rapidly affect the low lying part of the town including mobile home/holiday park areas across the well defined marsh area. The flood Hazard would be extreme in most of the affected area. With climate change modelled depths exceed 4m in places. There is no area of search at Point Clear.

The situation at Brightlingsea is more complex as there are parts of the town that are not defended and there are also banks to the north that can result in the town becoming cut off as occurred when there were multiple failures in 1953. A breach in the bank to the west of the town centre results in rapid spreading of water across the marsh affecting a small part of the area of development search in current conditions. There is also some exchange of flow towards the town centre should this not already be flooded directly. With climate change the depths and Hazards increase markedly although only a limited additional area of development search is affected.

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7 FLOOD RISK FROM OTHER SOURCES

7.1 Introduction

In addition to the fluvial and tidal sources of flooding described in Sections 5 and 6, there are other sources of flooding which can occur across the Tendring District. These include surface water flooding, sewer flooding and groundwater flooding. This section of the report describes flood risk from each source. Table 7-1 summarises the data collected for each source of flooding, and briefly describes the effect of flooding from other sources in Tendring.

Table 7-1 Summary of flood risk from other sources

Source of flooding	Data collected	Impact in Tendring
Surface water	Surface water modelling with JFLOW (1 in 200 year return period storm event; 0.5% AEP). Incidents of highways flooding collated during the data collection stage of the Level 1 SFRA.	Drainage paths and areas in which water may pond during heavy rainfall have been identified.
Sewer	Anglian Water DG5 register of incidents of sewer flooding.	Some historical incidents of flooding from this source, but not a major cause of flood risk.
Groundwater	Aquifer and geology GIS layers.	Some historical incidents of flooding from this source, but not a major cause of flood risk.

7.2 Surface water flooding

Flooding of land from surface water runoff is usually caused by intense rainfall events that may only last a few hours, but which exceed the capacity of the drainage system. Drainage issues are intrinsically linked with flooding from surface water due to poor drainage capacity and drains becoming blocked by debris.

A 2D model was run to demonstrate surface water flow routes and where surface water may accumulate as a result of a storm event. The 2D modelling software JFLOW has a function to represent rainfall falling across every cell of a DEM and route the flow across the ground surface. It has been assumed that the drainage capacity has been reached, and in making no allowances for water entering the drainage system, the model represents a worst case scenario. The rainfall data used was for a 6.5 hour storm with a 0.5% average probability (1 in 200 year storm event). The resultant outputs from this modelling were classified into three bands of susceptibility to surface water flooding; more, intermediate and less.

The results of this modelling are displayed on Map 9, displaying the surface water flow routes for the whole district. Red and orange areas can be considered as those having some risk and susceptibility to surface water flooding. From this map of the whole of Tendring area it can be seen that a high risk to surface water exists in Clacton, near Manningtree and also in some isolated areas.

The site specific summary sheets in Appendix E demonstrate the surface water flood risk for each site allocation for future development.

7.3 Sewer flooding

Anglian Water has supplied records of sewer flooding through their DG5 register. This is shown graphically by postal districts on Map 10.

Five post districts out of seven within Tendring DC have have some sewer flood risk issue, higher number of incidents have been recorded in CO7, CO13 and CO16. To put this risk into context, the data has been analysed to the number of properties within each postal district. This identifies that

based on the most recent DG5 data, the highest risk in Tendring is in the CO16 postal district, where a 1 in 539 risk exists. The average across Tendring is lower, at 1 in 1802.

The latest Ofwat data collected from the water companies[9] suggests that the average risk of sewer flooding for the entire Anglian region is 1 in 6,135, and the national average is 1 in 4,184. Whilst this suggests that the risk in Tendring, and specifically in CO7, CO13 and CO16, is well above the national average and CO12, CO15 is slightly higher than national average, it must be recognised that these do not suggest a high risk from sewer flooding. For example, the latest data available from Ofwat suggests that the average risk in the Thames area is 1 in 2,160 in which in it expected that there are postal districts where sewer flooding risk is much higher. The risk in districts CO7, CO13 and CO16 represents a moderate level of risk.

7.4 Groundwater flooding

Groundwater flooding can occur after prolonged periods of rainfall cause the water table to rise and intersect with the ground surface. It is most common where aquifers occur close to the ground surface under normal conditions. The risk of flooding from groundwater is subject to uncertainty as it is dependent upon the water table conditions at any location for any given time. Consequently, there is a lack of understanding with regards to the risk of groundwater flooding, and no national mapping of groundwater flood risk exists.

Although there have historically been some isolated groundwater flooding incidents, groundwater flooding across the Tendring District does not seem to have been a major flood risk issue.

7.5 Raised reservoirs

The only raised reservoir in the Tendring District is the Ardleigh Reservoir on the Salary Brook near Colchester. The reservoir is owned by Anglian Water and the safety of the dam is maintained through regular inspection by specialised Independent Engineers under the strict remit of the Reservoirs Act which is overseen by the Environment Agency. There is thus an extremely low chance of dam failure.

Because the area around the reservoir is a potential area of search for future development, the dam break case was considered further. It is shown in Appendix E that if the area that is at or below reservoir top water level is avoided then much of the area of search is under no threat of inundation should a breach occur as it is primarily sited above the reservoir top water level. Avoiding the lower lying area would therefore fit with the precautionary principle.

[9] Data Source: June Return 2008 public tables, available from http://www.ofwat.gov.uk/regulating/junereturn/jrlatestdata/ Accessed on 03/03/09

8 RECOMMENDATIONS FOR THE COUNCIL

8.1 Introduction

The overall aim of PPS25 is to direct development to lower flood risk sites wherever possible. "The aims of planning policy on development and flood risk are to ensure that flood risk is taken into account at all stage in the planning process to avoid inappropriate development in areas at risk of flooding, and to direct development away from areas at higher risk".

The Local Planning Authority is well placed to play an important role in strategic flood risk management. The guidance given in this Section of the SFRA, and in Sections 9 and 10 should help the LPA to achieve the aims of PPS25, the North Essex CFMP, Essex SMP, and Making Space for Water now and in the future.

One of the key objectives of the SFRA is to provide an evidence base which will inform the preparation of the Local Development Framework for the Tendring District with respect to local flood risk issues and the location of future development. The development of policies on flood risk need to embrace the concept of 'balanced management', facilitating development which serves the social and economic needs of the community whilst controlling flood risk and ensuring it is properly managed and mitigated.

In order to assist with the preparation of future LDF policies this section of the SFRA seeks to identify policy recommendations to be considered by the council. These policy recommendations do not necessarily reflect the approach which will be adopted by the borough in considering planning applications or potential allocations within the LDF.

8.2 Recommendations for LDF policy on flood risk

In assessing the suitability of land for development at all levels of the planning process, the council will consult the guidance of PPS25 Development and Flood Risk and the Strategic Flood Risk Assessment. It will apply the Sequential Test and Exception Test set out in Annex D of PPS25 in master planning, allocating sites for development and assessing individual planning applications by ensuring that there are no other suitable sites in areas with a lower risk of flooding.

The Council will resist development in areas of flood risk unless the type of development is commensurate with the type of flood risk in each Flood Zone as outlined in Table D.1 and D.2 of PPS25.

The Council will seek flood risk reduction in every new development and redevelopment through design, changes in land use and drainage requirements.

All development, including changes of use, will require at least an initial assessment of flood risk.

A detailed site specific Flood Risk Assessment must be submitted with planning application for:

- Major developments located in Flood Zone 1 (>1ha);
- All development in Flood Zones 2 and 3 (see Maps 4 and 5, and site specific summary sheets in Appendix E);
- All development, or change of use, where flood risk from other sources is identified by the SFRA:
    - Where surface water flooding shown as 0.3m or deeper (Map 9 and the site specific summary sheets in Appendix E)
    - Within 100m of a sewer flooding incident (where this can be determined; Map 10)

The following sections outline recommended policy objectives that the Council should aim to achieve.

8.2.1 Flood risk reduction

PPS25 requires that new development does not exacerbate flood risks elsewhere. The Council should seek flood risk reduction, both onsite and downstream, and evidence that all new development can manage flood risk and be safe.

All proposed development sites should be required to demonstrate:

- That the probability and consequences of flooding will be reduced.

- How actual and residual flood risk to the development and flood risk to others from all sources will be managed over the lifetime of the development, taking into account climate change.
- That development will be safe through the layout, form and floor levels of the development and mitigation measures.
- That development will be safe in terms of dry access, egress and refuge, and that emergency planning is considered.
- That the development will not constrain the natural function of the floodplain, either by impeding flood flows, reducing storage capacity or otherwise increasing flood risk elsewhere.
- That the development will not undermine, breach or destabilise flood defences.

8.2.2 Drainage

Surface water runoff from development should be controlled as close to the source as possible.

Developers should seek to improve existing runoff from the site by achieving Greenfield runoff rates where possible or ensure that the rates and volumes of run-off from new developments are no greater than the rates prior to the proposed development, unless specific off-site arrangements are made which result in the same net effect and that the effects of climate change have been taken into consideration.

The use of Sustainable Drainage Systems (SuDS) should be required on all new developments. If SuDS are not used, the developer must provide a valid reason why they are not suitable.

All sites greater than 1 ha in size should require the following

- SuDS,
- The achievement of Greenfield discharge rates
- 1 in 100 year on-site attenuation taking into account climate change.

The council must maintain an accurate record of SuDS installed across the district, and the roles and responsibilities of different stakeholders as regards their maintenance. Discharge rate of surface water to combined sewerage systems should only be considered as a last resort.

8.2.3 Riverside developments

The Council should ensure that all riverside developments:

- Are set back from the river's edge or ordinary watercourses providing a buffer strip whichever is the greater
    - at least the width of the flood zone or area potentially affected by a breach or:
    - 5m from ordinary watercourses/canals
    - 9m from fluvial main rivers
    - 16m from the landward toe of flood defences in tidal areas
- Seek to de-culvert rivers for flood risk management and conservation benefit. There should be a 4m buffer strip alongside culverted rivers.
- Are designed with a presumption against the culverting of existing open watercourses
- Enhance the river form and habitat.
- Assess the condition of existing assets (e.g. bridges, culverts, river walls, embankments) and renew them so that its lifetime corresponds with the lifetime of the development. Enhancement opportunities should also be sought when renewing assets.

When development is on riparian land, this policy 'makes space for water' and allows additional flow capacity to accommodate climate change. It also allows access for the upgrading and ongoing maintenance of river walls, embankments and flood defences. Such space should be considered in the light of sustainable methods of working over the lifetime of the development and river structures.

8.2.4 Functional floodplain

As Tendring District is broadly rural and undeveloped, the remaining floodplain should be protected against future development, maintaining it as a flood risk management asset.

Therefore development should not be permitted if it would result in the net loss of functional floodplain as defined in PPS25 Table D2 and D3. The Council should protect or seek reduction of development on brownfield sites acting as Functional Floodplain.

8.2.5 Safe access and egress

The Council should ensure that safe access and egress to a development is provided during a flood.

'Safe' access should remain dry for 'more' and 'highly vulnerable' uses, and should preferably be dry for 'less vulnerable' land use classifications. Dry escape for residential dwellings should be up to the 1% annual probability event taking into account climate change for fluvial flood risk or defence breach during a 0.5% annual probability event plus climate change in tidal areas.

Where flood risk is from failure of defences, all developments will have to demonstrate that:

- 'Safe' access includes the ability to escape to higher levels without having to pass through flood waters.
- The LPA's emergency planners accept the proposals.
- The emergency services accept the proposals.
- A robust flood warning plan is developed.
- The development would be structurally safe against the effects of breach flood waters.

For major highly vulnerable development and essential infrastructure safety will also need to be ensured through demonstration that a robust evacuation plan to dry land is developed.

8.2.6 Critical infrastructure

In light of the information provided in this SFRA, including critical infrastructure identified as being at flood risk, it is recommended that the Council review their Emergency Plan with respect to flooding and raise awareness amongst residents on the measures which can taken to mitigate against future flooding events within the District. For existing developments which suffer flooding or remain at risk opportunities should be sought to retrofit flood resilience and measure.

8.3 Recommendations for Development Control

The minimum requirements for development control are summarised in the following sections.

8.3.1 Flood Zone 1 (Low Probability)

All development types (essential infrastructure, highly vulnerable, more vulnerable, less vulnerable and water-compatible development) are appropriate in Flood Zone 1. The Council should seek opportunities to reduce the overall levels of flood risk in the area and beyond through the layout and form of the development, and the appropriate application of sustainable drainage techniques.

Developments >1ha

- A detailed site-specific FRA must be undertaken in accordance with PPS25 and the Council's policies assessing risk from the other sources of flooding which are not considered by the Flood Zone maps.
- The effects of any flood risk identified should be mitigated by suitable methods up to the 1% annual probability pluvial event plus climate change without increasing flood risk elsewhere.
- An assessment should be made of the impact of the proposed development upon surface water drainage, including the potential impact upon areas and receiving watercourses downstream, and recommend the approach to control surface water discharge.
- The development should meet the following drainage requirements to reduce flood risk elsewhere on both greenfield and brownfield sites:
    - Greenfield discharge rates where possible (or no greater than the rates prior to the proposed development, unless specific off-site arrangements are made which result in the same net effect and that the effects of climate change have been taken into consideration.)
    - Attenuation up to the 1% annual probability event plus climate change
    - Use of SuDS

Developments <1ha

The Council should identify whether the site is a*t* risk from 'other sources' of flooding, has a known drainage problem, or has experienced flooding from other sources. If so, then the same requirements should be met as described above for a site >1ha. For those proposed developments where there is not a known drainage issue then a detailed FRA is not required. Nevertheless, the proposed development should include the appropriate application of SuDS techniques so as to maintain, or preferably reduce the existing runoff and flood risk in the area.

8.3.2 Flood Zone 2 (Medium Probability)

Flood Zone 2 is considered suitable for water-compatible, less vulnerable, more vulnerable and essential infrastructure. Highly vulnerable development is only allowed where the Exception Test is passed.

The Council should seek opportunities to reduce the overall levels of flood risk in the area and beyond through the layout and form of the development, and the appropriate application of sustainable drainage techniques, through the consideration of the following:

- A detailed site-specific FRA must be undertaken in accordance with PPS25 and the Council's Development Control policies assessing risk from fluvial and tidal flooding, risk from all 'other sources' of flooding, and the effect of climate change on flood risk over the lifetime of the development.
- The effects of the flood risk identified should be mitigated by suitable methods up to the highest water level caused by a 1% annual probability fluvial/pluvial event plus climate change, without increasing flood risk elsewhere.
- Safe access should be provided to an appropriate level for the type of development.
- The development should meet the following drainage requirements to reduce flood risk elsewhere:
    - Greenfield discharge rates where possible (or no greater than the rates prior to the proposed development, unless specific off-site arrangements are made which result in the same net effect and that the effects of climate change have been taken into consideration.)
    - Attenuation up to the 1% annual probability event plus climate change
    - Use of SuDS
- Formal consultation with Emergency Planners

In addition, any proposed development be required to provide evidence that the Sequential Test, and if required the Exception Test, have been passed.

8.3.3 Flood Zone 3 (High Probability)

Water-compatible uses and less vulnerable development are allowed in this Flood Zone, following testing within the sequential process. According to PPS25 Annex D, Table D.1 highly vulnerable development is not permitted and essential infrastructure and more vulnerable development need to pass the Exception Test. Essential infrastructure should be designed and constructed to remain operational and safe for users in times of flood.

The Council should aim to reduce the overall level of flood risk in the area through the layout and form of the development and the appropriate application of sustainable drainage techniques; relocate existing development to land in zones with a lower probability of flooding; and create space for flooding to occur by restoring functional floodplain and flood flow pathways and by identifying, allocating and safeguarding open space for flood storage. The following should be considered:

- A detailed site-specific FRA must be undertaken in accordance with PPS25 and the Council's Development Control policies assessing risk of fluvial flooding (including tidelocking and culvert blockage), residual risk behind tidal defences, risk from all 'other sources' of flooding, and the effect of climate change on flood risk over the lifetime of the development.
- The effects of the flood risk identified should be mitigated by suitable methods up to the highest water level caused by a 1% annual probability fluvial/pluvial event plus climate change or a breach in the tidal defences during a 0.5% annual probability tidal event plus climate change, without increasing flood risk elsewhere.
- Safe access should be provided to an appropriate level for the type of development.

- Flood flow routes are preserved, and floodplain storage capacity is not reduced, but where necessary is compensated for on a level for level basis outside of the floodplain.
- Riverside development is set back an appropriate distance from the watercourse and development enhances the river form and habitat. If culverted the development will not build over the culvert, will be set back an appropriate distance from the culvert and should seek to de-culvert the watercourse as part of the development.
- The development should meet the following drainage requirements to reduce flood risk elsewhere:
    - Greenfield discharge rates where possible (or no greater than the rates prior to the proposed development, unless specific off-site arrangements are made which result in the same net effect and that the effects of climate change have been taken into consideration.)
    - Attenuation up to the 1% annual probability event plus climate change
    - Use of SuDS
- Consultation with emergency planners and emergency services with regards to emergency/evacuation plans. For Tendring DC, the Police are responsible for producing evacuation plans, in conjunction with the Fire and Rescue Service who undertake rescue of residents from flooded properties.

In addition, any proposed development be required to provide evidence that the Sequential Test, and if required the Exception Test, have been passed.

8.3.4 Flood Zone 3b (Functional Floodplain)

The Council should protect currently undeveloped functional floodplain from development.

Only the water compatible uses and the essential infrastructure (listed in Table D.2 of PPS25) that has to be there should be permitted in this zone. It should be designed and constructed to:

- remain operational and safe for users in times of flood
- result in no net loss of floodplain storage
- not impede water flows, and
- not increase flood risk elsewhere.

Essential development which must be located in a functional floodplain will be designed to remain operational at times of flood or incorporate means of mitigation.

Buildings on Brownfield sites (unless permeable to flood water) are not considered to be part of the functional floodplain. However, the surrounding land and infrastructure around these buildings is considered to be functional.

8.3.5 Sites within more than one Flood Zone

The Council will ensure that, where sites cross more than one Flood Zone, the sequential approach is applied within development sites to design the site layout to reduce flood risk as much as possible, in accordance with PPS25. Most large developments involve a range of land uses, providing the opportunity to locate more vulnerable land uses in areas of lower risk. High risk areas closer to the river in Flood Zone 3b should be used for recreation and amenity. Further advice is given in the Practice Guide to PPS25.

It should be noted that the sequential approach is not limited to sites with areas within more than one flood zone and should be applied throughout the process.

8.3.6 Sites in any Flood Zone at risk from flooding from other sources

The Council should be aware of the areas of Tendring that are at risk from surface water, sewer, groundwater and lake flooding as identified in the SFRA. Note that these sources fall outside the current remit of the Environment Agency, and the Council should take responsibility for ensuring this flood risk is addressed (particularly important if the site is in Flood Zone 1 and <1ha). If development is proposed in these areas, the Council should:

- Request a site specific FRA considering the identified other source(s) of flooding
- Ensure that the development will not make flooding any worse, and if possible reduce the level of flood risk. E.g. by preserving surface water flow routes

- Ensure that suitable mitigation/resilience measures against flooding from other sources are included in the development.

8.4 Recommendations for Emergency Planning

Under the Civil Contingencies Act (2004) the Local Authority is classified as a category 1 responder. During an emergency such as a flood event, coordination with the other category 1 responders (including the emergency services and the Environment Agency) is essential to guarantee the safety of residents. Under the Civil Contingencies Act, the Local Authority holds a statutory duty to provide civil protection to their communities to ensure human welfare, environmental stability and UK security are not affected.

8.4.1 Recommendations for the LPA with respect to Emergency Planning

In areas where the LPA plans to add new population to Flood Zone 2 or 3, formal consultation with the Council's Emergency Planning team is essential, and must be undertaken at an early stage.

The advice of Emergency Planners must be used as a material consideration when considering planning applications. The LPA and Emergency Planners should work together to ensure that the site layout and building design will reduce risk to people and allow safe access for evacuation. This is essential for major developments.

8.4.2 Recommendations for Emergency Planning Team

This SFRA contains useful data to allow emergency planning processes to be tailored to the needs of the area and be specific to the flood risks faced. The detailed maps and GIS layers provided should be made available for consultation by emergency planners during an event.

When reviewing their Emergency Plan, and any other plans specific to flooding, the Emergency Planning Team is recommended to:

- Consider and understand the possibility, likelihood and spatial distribution of all sources of flooding, including fluvial, tidal, surface water, sewer and groundwater flooding, as shown in the Maps of this report. Consider updating the Tendering DC emergency plan to reflect these risks findings.
- Take into account the likely extents of flooding caused by a breach in defences and the extreme depths and hazard of flooding that would ensue with very little warning.
- Consider that specific evacuation plans if any are in place for existing vulnerable institutions in the floodplain and other areas at high flood risk.
- Consider reviewing and updating safe evacuation routes and access routes for emergency services are planned from any existing area of flood risk to rest centres, avoiding routes that may be flooded.
- Consider reviewing Tendering DC risk register following the findings of the SFRA.

  As a condition of planning approval flood evacuation plans should be provided by the developer which aim to safely evacuate people out of flood risk, using as few emergency service resources as possible. These plans should detail any prearranged emergency arrangements including dry evacuation routes, flood warning, location of rest centres and safe havens. It is recommended that any flood evacuation plan written is forwarded onto Tendring DC and the Environment Agency for review. The plan owner must put in place the plan if the development goes ahead, and maintain and update as appropriate.
- Clearly acknowledge the role of the Environment Agency in a flood event in the Major Emergency Plan, and liaise with the Environment Agency on flood warning and response to flooding.

Emergency Planners should also use the SFRA to educate local people to improve flood awareness. This should include measures that people can take to make their homes more resilient to flooding from all sources, and encouraging all those at fluvial and tidal flood risk to sign up to the Environment Agency's Floodline Warnings Direct service.

8.4.3 Essential infrastructure and vulnerable institutions

For emergency planning purposes it is necessary to identify all essential council infrastructure and vulnerable institutions that are at flood risk and their requirements for evacuation if a flood occurs.

Maps 12 and 13 show the locations of essential infrastructure that are located in Flood Zone 2.

9 GUIDANCE FOR FUTURE DEVELOPMENTS

9.1 Introduction

This section provides a series of recommendations to be considered when undertaking future developments within the Tendring District. It is for information of both Developers and the Council's planning department. This guidance can be applied to new developments and redevelopments, including any sites within the Tendring District which have already been given outline planning permission.

9.2 Flood Risk Assessments

The aim of a Flood Risk Assessment (FRA) is to demonstrate that proposed development will not be at risk to flooding during the design event. This includes assessment of mitigation measures required to safely manage flood risk. The FRA also needs to demonstrate that the proposed development will not increase flood risk either upstream or downstream of the site. All sources of flood risk, including tidal, fluvial, surface water runoff and drainage need to be considered. FRAs for proposed development in the Tendring District should follow the approach recommended by:

- The Environment Agency (see its *National Standing Advice to Local Planning Authorities for Planning Applications – Development and Flood Risk in England* (June 2004) (http://www.pipernetworking.com/floodrisk/index.html)
- DEFRA/Environment Agency, 2005. *Flood Risk Assessment Guidance for New Development Phase 2: Framework and Guidance for Assessing and Managing Flood Risk for New Development – Full Documentation and Tools*. R&D Technical Report RD2320/TR2
- PPS25 and its Practice Guide Companion
- CIRIA report 624, *Development and flood risk: Guidance for the construction industry*
- National SuDS Working Group, 2004, *Interim Code of Practice for Sustainable Drainage Systems*

This section will present the guidance for the developers on the appropriate level of FRA required for development in Flood Zones 1, 2, 3a and 3b, and gives advice on other issues that should be considered in development proposals. It should be read with reference to the maps contained in this report, showing the location of different types of flood risk.

If a detailed FRA is required, it must be undertaken by a suitably qualified professional. Assessments should be on a site by site basis making use of local knowledge, but an initial assessment of potential sources of flooding can be made by consulting the maps in this SFRA.

9.2.1 Flood risk assessments for Flood Zone 1

If the site is greater than 1ha in size, it will require a detailed site-specific FRA and meet the following criteria:

- The developer should check whether the site has been identified as at flood risk from other sources by the SFRA (see section 9.2.7). If so, a more detailed assessment of this risk and how it will be managed up to a 1% annual probability surface water, groundwater or sewer flooding event plus climate change over the lifetime of the development must be made.
- A drainage impact assessment must be carried out by a suitable professional to identify the impact of the proposed development on surface water drainage and recommend the approach of controlled runoff to the required discharge rates.
- Show that flood risk will be reduced overall.

If the site is less that 1ha in size, the developer is required to check whether it has been noted as at risk from flooding from other sources by the SFRA (see section 9.2.7). If so, a detailed flood risk assessment is required as above. If not, an FRA is not required but the development should still strive to use SuDS techniques and reduce runoff.

9.2.2 Flood risk assessments for Flood Zone 2

A detailed site specific FRA must be undertaken. It is strongly recommended that the Sequential Test, and, depending on the vulnerability of the development (see Table D.2 of PPS25), the first two parts of the Exception Test, be satisfied before the FRA is commenced.

The FRA must meet the following development control criteria:

- If the development is within fluvial or tidal/fluvial Flood Zone 2, assess the flood risk from fluvial flooding, including an assessment of the effects of climate change over the lifetime of the development.
- If the development is within tidal Flood Zone 2, demonstrate through use of the information contained in the SFRA that the site is not at risk from tidal flooding or residual risk behind tidal defences.
- Check whether the site has been identified as at flood risk from other sources by the SFRA. If so, a more detailed assessment of this risk and how it will be managed up to a 1% annual probability surface water, groundwater or sewer flooding event plus climate change over the lifetime of the development must be made.
- Show that flood risk will be reduced and that suitable methods of mitigation will protect the development against the following (whichever are applicable):
    - 1% annual probability fluvial event plus climate change over the lifetime of the development
    - A 1% annual probability (plus climate change over the lifetime of the development) surface water, groundwater or sewer flooding event
- Show that safe access can be provided to an appropriate level for the type of development.
- Show that drainage requirements can be met

9.2.3 Flood risk assessments for Flood Zone 3a

A detailed site specific FRA must be undertaken. It is strongly recommended that the Sequential Test and, depending on the vulnerability of the development (see Table D.2 of PPS25), the first two parts of the Exception Test be satisfied before the FRA is commenced.

The FRA must meet the following development control criteria:

- If the development is within fluvial or tidal/fluvial Flood Zone3a, assess the flood risk from fluvial flooding, including an assessment of the effects of climate change over the lifetime of the development.
- If the development is within tidal Flood Zone 3a, assess the flood risk from a breach in the tidal defences.
- Check whether the site has been identified as at flood risk from other sources by the SFRA. If so, a more detailed assessment of this risk and how it will be managed up to a 1% annual probability surface water, groundwater or sewer flooding event plus climate change over the lifetime of the development must be made.
- Show that flood risk will be reduced and that suitable methods of mitigation will protect the development against the following (whichever are applicable):
    - 1% annual probability fluvial event plus climate change over the lifetime of the development
    - A breach in the tidal defences during a 0.5% annual probability tidal event plus climate change over the lifetime of the development
    - A 1% annual probability (plus climate change over the lifetime of the development) surface water, groundwater or sewer flooding event
- Show that safe access can be provided to an appropriate level for the type of development.
- Show that drainage requirements can be met.
- Show that flood flow routes are preserved and floodplain storage capacity is not reduced.
- If the development is adjacent to a river it must be set back an appropriate distance from the watercourse and development must enhance the river form and habitat. If culverted, the

development should not build over the culvert, should be set back an appropriate distance from the culvert and should seek to de-culvert the watercourse as part of the development.

9.2.4 Flood risk assessments for Flood Zone 3b

Only planning applications for essential infrastructure, water compatible development or redevelopment will be considered in Flood Zone 3b. Applications for all other uses will be refused. It is strongly recommended that the Sequential Test, and (if the development is essential infrastructure), the first two parts of the Exception Test, be satisfied before the FRA is commenced.

A detailed FRA must be produced covering all the requirements for Flood Zone 3a. In addition development must at a minimum:

- Not increase the building footprint on the site and if possible reduce it
- Preserve and where possible improve flow routes
- Improving conveyance/storage (e.g. replacing solid building with building on stilts)
- Be fully flood resilient
- Undertake a sequential approach to the design of site

A detailed FRA should also show that the following have been considered (and if found unsuitable justification should be provided as to why):

- Removal of buildings and restoration of the natural floodplain
- Changing the land use to a less vulnerable classification
- Changing the layout and form of the development (e.g. reducing the building footprint)

Essential infrastructure built within the functional floodplain should:

- Remain operational and safe for users in times of flood;
- Result in no net loss of floodplain storage;
- Not impede water flows; and
- Not increase flood risk elsewhere.

9.2.5 How to assess risk from fluvial flooding

Fluvial flood risk in Tendring is described in Section 5 of the SFRA. If the site is within fluvial Flood Zone 2 or 3, water levels for extreme fluvial events across the site from adjacent watercourse or watercourses should be determined by a hydraulic model, at a level of detail deemed for purpose by the Environment Agency.

The 1%, 1% plus climate change and 0.1% annual probability fluvial events should be modelled as part of the FRA. The site layout should then be designed sequentially based flood risk. Mitigation and safe access should be provided up to the 1% annual probability plus climate change water level.

The required precautionary climate change allowances for peak river flows are given in Table B.2 of PPS25, and must be modelled for an FRA. These are: 10% added to peak river flow up to 2025, and 20% thereafter to 2115. The appropriate period for climate change assessment is the design lifetime of the development.

If the site is within the tidal/fluvial Flood Zone 2 then an additional model run should be carried out to assess the impact of tidelocking during a fluvial event.

If the site is within 100m of the upstream end of a culvert, then the effect on water level of a 75% blockage of this culvert should also be modelled as part of the FRA.

If any river restoration or de-culverting is planned as part of the development, then it should be modelled. The FRA should demonstrate that such changes will not increase (and preferably will reduce) water levels across the site and elsewhere.

9.2.6 How to assess risk from tidal flooding and residual risk behind defences

Tidal flood risk in Tendring is described in Section 6 of the SFRA. If the site is in tidal Flood Zone 2 or 3 only, then an assessment of risk from tidal flooding is required to an appropriate level (including further breach analysis if necessary) together with consideration of flood warning, evacuation routes and emergency planning. Tidal areas are particularly affected by sea level rise the effect of which should be shown for the life of the development.

9.2.7 How to assess flood risk from 'other sources'

Flood risk from 'other sources' in Tendring is described in Section 7 of the SFRA. All developers should refer to Maps 9 and the maps provided with the site summary sheets prior to submitting a planning application and use this information to assess whether the site may be susceptible to flooding from surface water, sewer flooding or groundwater flooding.

Guidelines to use should be:

- Where surface water flooding shown as 0.3m or deeper (Map 9).
- Within 100m of a sewer flooding incidents (Map 10)

If the SFRA indicates that the site may be at risk then the level of risk will need to be quantified in greater detail at the site by a qualified flood risk management professional using appropriate local data:

- The capacity of the existing drainage system and any planned improvements
- The nature and behaviour of local aquifers

After initial scoping, the need for drainage or groundwater modelling using appropriate software should be sensibly assessed depending on the severity of the problem.

Any existing surface water flow routes (including routes that groundwater flooding takes overland) must be preserved by the development. Mitigation against the likely depths of flooding should be provided up to the 1% annual probability plus climate change event.

The required precautionary climate change allowances for peak rainfall intensity are given in Table B.2 of PPS25, and must be modelled for an FRA. These are: 5% added to peak rainfall intensity up to 2025, 10% to 2055, 20% to 2085 and 30% to 2115. The appropriate period for climate change assessment is the design lifetime of the development.

9.3 Managing flood risk downstream through SuDS

Sustainable Drainage Systems (SuDS) are management practices which enable surface water to be drained in a more sustainable manner.

The effectiveness of a flow management scheme within a single site is heavily limited by site constraints including (but not limited to) topography, geology (soil permeability), and available area. The design, construction and ongoing maintenance regime of such a scheme must be carefully defined, and a clear and comprehensive understanding of the catchment hydrological processes (i.e. nature and capacity of the existing drainage system) is essential. Additionally, for infiltration SuDS it is imperative that the water table is low enough and a site specific infiltration test is undertaken. Where sites lie within or close to source protection zones further restrictions may be applicable, and guidance should be sought from the Environment Agency.

There are many different SuDS techniques which can be implemented. The Environment Agency has issued a practical guide on SuDS, in which a sustainability based hierarchy of appropriate techniques is proposed. This is displayed in **Error! Reference source not found.**.

Table 9-1 The SuDS Hierarchy

Most Sustainable	SuDS Technique	Flood Reduction	Pollution Reduction	Landscape and Wildlife Benefit
	▪ Living roofs	✓	✓	✓
	▪ Basins and ponds	✓	✓	✓
	▪ Constructed wetlands	✓	✓	✓
	▪ Balancing ponds	✓	✓	✓
	▪ Detention basins	✓	✓	✓
	▪ Retention ponds	✓	✓	✓
	▪ Filter strips and swales	✓	✓	✓
	▪ Infiltration devices	✓	✓	✓
	▪ Soakaways	✓	✓	✓
	▪ Infiltration trenches and basins	✓	✓	✓
	▪ Permeable surfaces and filter drains	✓	✓	
	▪ Gravelled areas	✓	✓	
	▪ Solid paving blocks	✓	✓	
	▪ Porous pavements	✓	✓	
	▪ Tanked systems	✓		
	▪ Oversized pipes / tanks	✓		
Least Sustainable	▪ Storm cells	✓		

The suitability of the following list of techniques, which is by no means comprehensive, will be dictated in part by the development proposal and site conditions. Advice on best practice is available from the Environment Agency and the Construction Industry Research and Information Association (CIRIA).

9.3.1 Living (green) roofs and walls

Living roofs and walls can vary in type from Roof Gardens, Roof Terraces, Green Roofs and Green Walls. This approach utilises plants and their substrate provide temporary storage of rainfall. The water retained by the substrate and lost through evaporation and evapotranspiration minimises runoff from the roof.

9.3.2 Basin and ponds

Basin and ponds enhance flood storage capacity by providing temporary storage for storm water through the creation of landscape features within a site (which can often provide opportunities for the creation of wildlife habitats). Basins, ponds and wetlands can be fed by swales, filter drains or piped systems. In some instances, storm water runoff from a development can feed a pond which overflows into a vegetated wetland area to act as a natural soakaway.

9.3.3 Filter strips

Filter strips are vegetated areas that are intended to treat sheet flow from adjacent impervious areas. Filter strips function by slowing runoff velocities and filtering out sediment and other pollutants, and providing some infiltration into underlying soils. Filter strips were originally used as an agricultural treatment practice, and have more recently evolved into an urban practice. This approach to SuDS also provides scope for the creation of wildlife habitats and biodiversity gain.

9.3.4 Infiltration devices

Infiltration devices drain water directly into the ground. They may be used at source or the runoff can be conveyed in a pipe or swale to the infiltration area. They include soakaways, infiltration trenches and infiltration basins as well as swales, filter drains and ponds. Infiltration devices can be integrated into, and form part of, the landscaped areas.

9.3.5 Permeable surfaces and filter drains

Pervious pavements such as permeable concrete blocks, crushed stone and asphalt will allow water to infiltrate directly into the subsoil before soaking into the ground.

Filter drains are gravel filled trenches which trap sediments from run-off and provide attenuation. Flow is directed to a perforated pipe which conveys run-off back into the sewerage network or into a water body. Filter drains are used mainly to drain road and car park surfaces.

9.3.6 Rainwater harvesting

Rainwater harvesting techniques, such as the installation of water butts, can aid in increasing the attenuation of rainfall and contribute to the on-site recycling of water.

9.4 Reducing flood risk

The minimum acceptable standard of protection against flooding for new property within flood risk areas is 1% annual probability for fluvial flooding and a breach during a 0.5% annual probability tidal event, with allowance for climate change over the lifetime of the development.

The measures chosen will depend on the nature of the flood risk, and so development vulnerable to sewer flooding will require a different approach to one at risk from breeching of the tidal defences. Some of the more common measures are outlines here, and more detail is given in Chapter 5 of the Practice Guide to PPS25.

9.4.1 Reducing flood risk through site layout and design

Flood risk should be considered at an early stage in deciding the layout and design of a site to provide an opportunity to reduce flood risk within the development. Most large development proposals include a variety of land uses of varying vulnerability to flooding.

The Practice Guide to PPS25 states that a sequential, risk-based approach should be applied to try to locate more vulnerable land use to higher ground, while more flood-compatible development (e.g. parking, recreational space) can be located in more high risk areas.

Low-lying waterside areas, or areas along known surface water flow routes, can be used for recreation, amenity and environmental purposes, allowing the preservation of flow routes and flood storage, and at the same time providing valuable social and environmental benefits contributing to other sustainable objectives.

Landscaping should ensure safe access to higher ground from these areas, and avoid the creation of isolated islands as water levels rise.

9.4.2 Modification of ground levels

Modifying ground levels to raise the land above the required flood level is a very effective way of reducing flood risk to the site in question, particularly where the risk is entirely from tidal flooding and the land does not act as conveyance for flood waters.

However, in most areas of fluvial flood risk, conveyance or flood storage would be reduced by raising land above the floodplain, adversely impacting on flood risk downstream. Compensatory flood storage must be provided. Where the site is entirely within the floodplain it is not possible to provide compensatory storage at the maximum flood level and this will not be a viable mitigation option. Compensation schemes must be environmentally sound.

9.4.3 Building design

The raising of floor levels within a development avoids damage occurring to the interior, furnishing and electrics in times of flood. Floor levels should be raised by the following amounts:

- In areas at fluvial flood risk – 300mm above the 1% annual probability event plus climate change water level; or 600mm above the 1% annual probability water level
- In areas at risk of a breach in the tidal defences – 300mm above the maximum water level caused by a defence breach during a 0.5% annual probability event plus climate change event.

This additional height that the floor level is raised is referred to as the ‘freeboard’.

Making the ground floor use of a building water compatible (for example a garage), is an effective way of raising living space above flood levels.

Putting a building on stilts is not considered an acceptable means of flood mitigation for new development. However, it may be allowing in special circumstances if it replaces an existing solid

building, as it can improve flood flow routes. In these cases attention should always be paid to safe access and egress, and legal protection should be given to ensure the ground floor use is not changed.

Single storey developments are not acceptable in flood risk areas.

9.4.4 Resistance and resilience

There may be special instances where flood risk remains to a development. For example where the use is water compatible, where an existing building is being changes, where residual risk remains behind defences, or where flood levels have been raised but there is still a risk. In these cases (and for existing development in the floodplain), additional measures can be put in place to reduce damage in a flood and increase the speed of recovery. These measures should not be relied on as the only mitigation method.

The 2003 'Preparing for Floods' document published by the Office of the Deputy Prime Minister provided further details on possible resilience measures.

Temporary barriers

Temporary barriers consist of moveable flood defence which can be fitted into doorways and/or windows. The permanent fixings required to install these temporary defences should be discrete and keep architectural impact to a minimum. On a smaller scale temporary snap on covers for air vents can also be fitted to prevent the entrance of flood water. The Environment Agency provides a list of manufacturers, with the Kitemark, of temporary defences on their website www.environment-agency.gov.uk/floodline.

Temporary or demountable defences are not acceptable flood protection for a new development; however they are useful for protecting existing developments against flood risk.

Temporary defences or demountable defences should only be installed where there is a flood warning with an adequate lead time to provide enough time for the defences to be put in place.

Permanent barriers

Permanent barriers can include built up doorsteps, rendered brick walls and toughened glass barriers.

Wet-proofing

Interior design to reduce damage caused by flooding, for example:

- Electrical circuitry installed at a higher level with power cables being carried down from the ceiling not up from the floor level.
- Water-resistant material for floors, walls and fixtures.

If redeveloping existing basesments, new electrical circuitry should be installed at higher levels with power cables being carried down from the ceiling not up from the floor level to minimise damage if the basement floods.

Resilience measures will be specific to the nature of flood risk, and as such will be informed and determined by the FRA.

The 2003 'Preparing for Floods' document published by the Office of the Deputy Prime Minister and the 2007 Communities and Local Government document 'Improving the Flood performance of New Buildings – Flood Resilient Construction' provides further details on resilience measures.

9.4.5 Raised defences

Construction of raised floodwalls or embankments to protect new development is not a preferred option, as a residual risk of flooding will remain. Compensatory storage must be provided where raised defences remove storage from the floodplain.

9.4.6 Developer contributions to flood defences

In some cases, it may be necessary for the developer to make a contribution to the improvement of flood defence provision that would benefit both the development in question and the local community.

9.5 Making development safe

9.5.1 Safe access and egress

Safe access and egress to and from a development during a flood should be ensured. 'Safe' access should remain dry for 'more' and 'highly vulnerable' uses, and should preferably be dry for 'less vulnerable' land use classifications. Dry escape for residential dwellings should be up to the 1% annual probability event taking into account climate change for fluvial flood risk or defence breach during a 0.5% annual probability event plus climate change in tidal areas.

The developer must ensure that safe access and egress is provided to an appropriate level for the type of development. This may involve raising access routes to a suitable level.

As part of the FRA, the developer must review the acceptability of the proposed access using the 'Flood Risk to People' FD 2320 calculator. In this instance it needs to be demonstrated that depths and velocities of flood water will be acceptable to the 'risks to some' category of this calculator.

9.5.2 Flood warning and evacuation

Emergency/evacuation plans should be in place for all properties, large and small, at residual risk of flooding; those developments which house vulnerable people (i.e. care homes and schools) will require more detailed plans. Advice should be sought from the Council's Emergency Planning Team when producing an emergency/evacuation plan for developments as part of an FRA. Detailed emergency/evacuation plans for developments should undertake consultation not only with the Council's Emergency Planning team but also the Emergency Services so they know what is expected of them in the event of an emergency.

All homes and businesses within Flood Zone 2 and 3 are eligible for the Environment Agency's Floodline Warnings Direct service, and should be encouraged to sign up to it. It is recommended that the developers make new owners of the property aware of this so they can sign up to the FWD. This applies even if the development is defended to a high standard. It should be noted however, that at present this service does not contain any provision of warnings in the event of a breach of the defences.

9.6 Making space for water

9.6.1 Opportunities for river restoration and enhancement

All new development close to rivers should consider the opportunity presented to improve and enhance the river environment. Developments should look at opportunities for river restoration and enhancement as part of the development. Restoration can take place on various scales, from small enhancement measures to full river restoration. Options include backwater creation, de-silting, in-channel habitat enhancement, and removal of structures e.g. weirs, toe boarding, restoration of banks.

When designed properly, such measures can have benefits such as reducing the costs of maintaining hard engineering structures, reducing flood risk, improving water quality and increasing biodiversity. Social benefits are also gained by increasing green space and access to the river.

9.6.2 Buffer strips

As a minimum, developers should aim to set back development 5m from ordinary watercourses/canals, 8m from fluvial main rivers and 16m in tidal areas, providing a buffer strip to 'make space for water' and allow additional capacity to accommodate climate change.

9.6.3 Culverted rivers

There should be a presumption against further culverting and building over culverts. All new developments with culverts running through their site should seek to de-culvert rivers for flood risk management and conservation benefit. Where culverts are to remain unchanged allowances should be made for future improvements to the watercourse, including replacement of the culvert. Widths of such a buffer strip will depend on site circumstances but will be at least 4 – 6m.

9.6.4 Drainage capacity

The capacity of internal drainage infrastructure is often limited and is at or near capacity under existing conditions. Development that leads to increased peak runoff within the drainage catchment may lead to infrastructure capacity being exceeded, with the potential for increased flood risk. Development locations should be assessed to ensure capacity exists within both the on and off site network.

9.7 Managing flood risk from other sources

9.7.1 Surface water and sewer flooding

If a new development is approved in an area where the drainage or sewerage network is inadequate, responsibility lies with Anglian Water to improve the network. The developer can also contribute to such improvements and speed up this process. The development should improve the drainage infrastructure to reduce flood risk on site. It is important however, that a drainage impact assessment shows that this will not increase flood risk elsewhere, and the drainage requirements regarding runoff rates and SuDS for new development are met.

If residual surface water flood risk remains, the likely flow routes and depths across the site should be modelled. The site should be designed so that these flow routes are preserved, and building design should prove resilient against this residual risk.

When redeveloping existing buildings the installation of some permanent or temporary flood proofing and resilience measures could prevent both surface water and sewer flooding. Non-return valves prevent water entering the property from drains and sewers. Non-return valves can be installed within gravity sewers or drains, within the property's private sewer upstream of the public sewerage system. These need to be carefully installed and must be regularly maintained. The CIRIA publication, 'Low cost options for prevention of flooding from sewers', provides further information. Additionally, manhole covers within the property's grounds could be sealed to prevent surcharging.

9.7.2 Groundwater

Groundwater flooding has a very different flood mechanism to any other, as it rises up from below ground level, and for this reason many conventional flood defence and mitigation methods are not suitable. The only way to fully reduce flood risk would be through building design, ensuring that floor levels are raised above the water levels caused by a 1% annual probability plus climate change event. Site design would also need to preserve any flow routes followed by the groundwater overland and make sure flood risk is not increased downstream.

When redeveloping existing buildings it may be acceptable to install pumps in basements as a resilience measure. However for new development this is unlikely to be considered an acceptable solution.

9.8 Existing defences and assets

Proposed developments adjacent to the rivers should show that access to existing maintenance for the maintenance and, where appropriate, improvement has been considered.

Developers should also assess existing assets (e.g. bridges, culverts, river walls, embankments) and renew them to last the lifetime of the development. Enhancement opportunities should be sought when renewing assets, e.g. bioengineered river walls or raising bridge soffits to account for climate change.

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MAPS

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APPENDICES

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Appendix A: - Flood History for Tendring District

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Appendix B: - JFLOW MODELLING

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B.1 JFLOW MODELLING

B.1.1 Aims

The watercourses that did not have detailed modelled outlines available or were not covered by the Environment Agency Flood Zones were recommended to be modelled using the standard JFLOW modelling technique, which was used to derive the original Flood Zones.

For Tendring District, Hartley Wood Brook, north of Clacton-on-sea and upstream of Six Penny Brook needed to be mapped to determine the possible fluvial flood risk for the areas of search of potential development sites in Clacton-on-sea and Elmstead Market areas.

The scenarios are:

- Fluvial Flood Zone 2 and 3 (0.1% and 1% annual probability events)
- Fluvial functional floodplain (5% annual probability event)
- Fluvial climate change (1% event plus 20% flow)

B.1.2 JFlow Model

JFLOW is a 2D routin model that has been developed by JBA, which can estimate flood depth, velocity and extent. The only data inputs required are inflow data (based upon FEH techniques) and a Digital Elevation Model (which has been developed from LiDAR at 4 m resolution for this mapping exercise).

The basis of JFLOW is that each grid cell acts as a small flood cell and the flow to each of the surrounding cells is automatically calculated. It is therefore capable of simulating the inundation extent at a level of detail equal to the underlying DEM. It is fundamentally volume conservative and so, in a given time period will simulate peak water levels depending on the volume of water that has entered the floodplain. This approach is a half-way house between more common 1D hydrodynamic models and a 2D hydrodynamic model.

B.1.3 Automated estimation of design flow hydrographs for JFLOW modelling

The procedure combines a peak flow from the FEH statistical method with a hydrograph shape from the Revitalised Flood Hydrograph (ReFH) model. This is similar to the approach used for the earlier Flood Zone maps, although in that case the hydrograph shape was derived from the FEH rainfall-runoff method, which has now been superseded by ReFH.

The peak flows are derived using the original version of the FEH statistical method (i.e. using URBEXT1990 rather than URBEXT2000). This is because URBEXT2000 can only be obtained from version 2 of the FEH CD-ROM, for which the licence agreement does not allow bulk extraction of data. The index flood (QMED) and flood growth curves are derived automatically, solely on the basis of catchment descriptors. No donor or analogue sites are used to adjust QMED, in line with recent research at CEH Wallingford which has shown that using analogue sites (apart from very local ones) tends to result in a worse estimate of the design flow on average. At locations close to gauging stations, the results will be less certain than those which could be obtained using the local data to adjust QMED and/or the growth curves. Growth curves are derived using flood peak data from the HiFlows-UK dataset (Version 2.2, released in May 2008).

The ReFH model is run using default parameters obtained from catchment descriptors and a default storm duration for the site of interest. The resulting hydrograph is then scaled up or down by multiplying the flow at each time step by the ratio (Peak flow from FEH statistical / Peak flow from ReFH). The resulting hydrograph matches the peak flow from the statistical method.

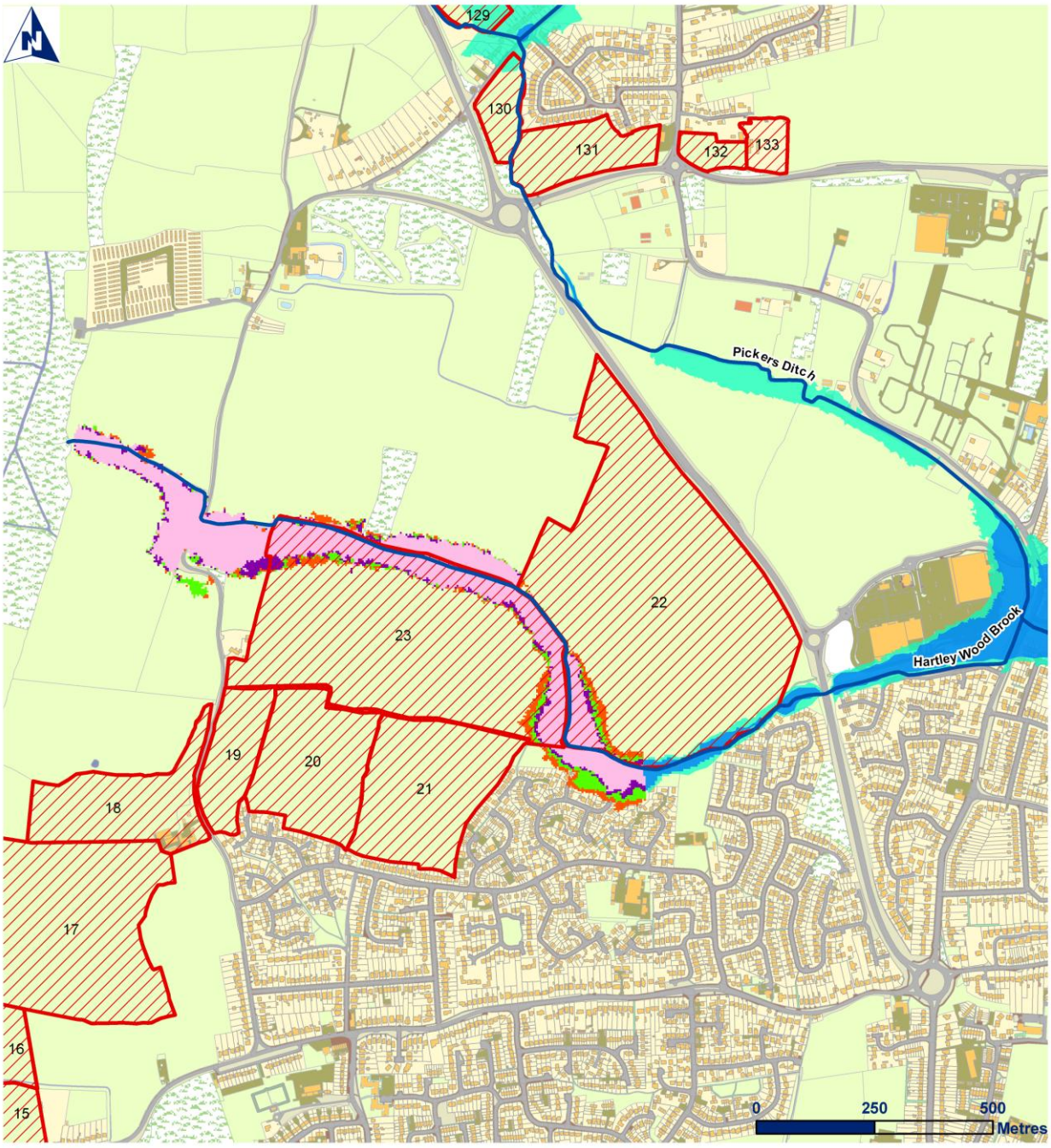
It should be recognised that this automated approach is unlikely to provide the best estimate of a design flood at any particular location. There are many factors, such as hydrometric data, flood history, or unusual catchment features, which can only be properly incorporated by a hydrologist. The advantage of the automated method is that it provides rapid estimates of design flows in a large number of locations. In many places, particularly on small ungauged watercourses, these are likely to be close to the best estimates.

B.1.4 Hartley Wood Brook JFlow Modelled Outlines

The 20-year, 100-year, 100-year with climate change allowance and 1000-year flood extends were derived for Hartley Wood Brook from the JFLOW modelled results.

The modelled outlines were presented together with Flood Zone maps in Map 3, 4 and 5. The figure below shows all the return periods' outlines and Flood Zone 3 and 2 at Hartley Wood Brook.

Hartley Wood Brook Jflow Modelled Flood Outlines



Legend

- Main River
- Area of Search of Potential Development Sites
- EA Flood Zone 3 (v3.9)
- EA Flood Zone 2 (v3.9)

Hartley Wood Brook JFlow Outlines

- 20-Year
- 100-Year
- 100-Year with Climate Change
- 1000-Year

Hartley Wood Brook Fluvial Flood Risk

Date: March 30, 2009

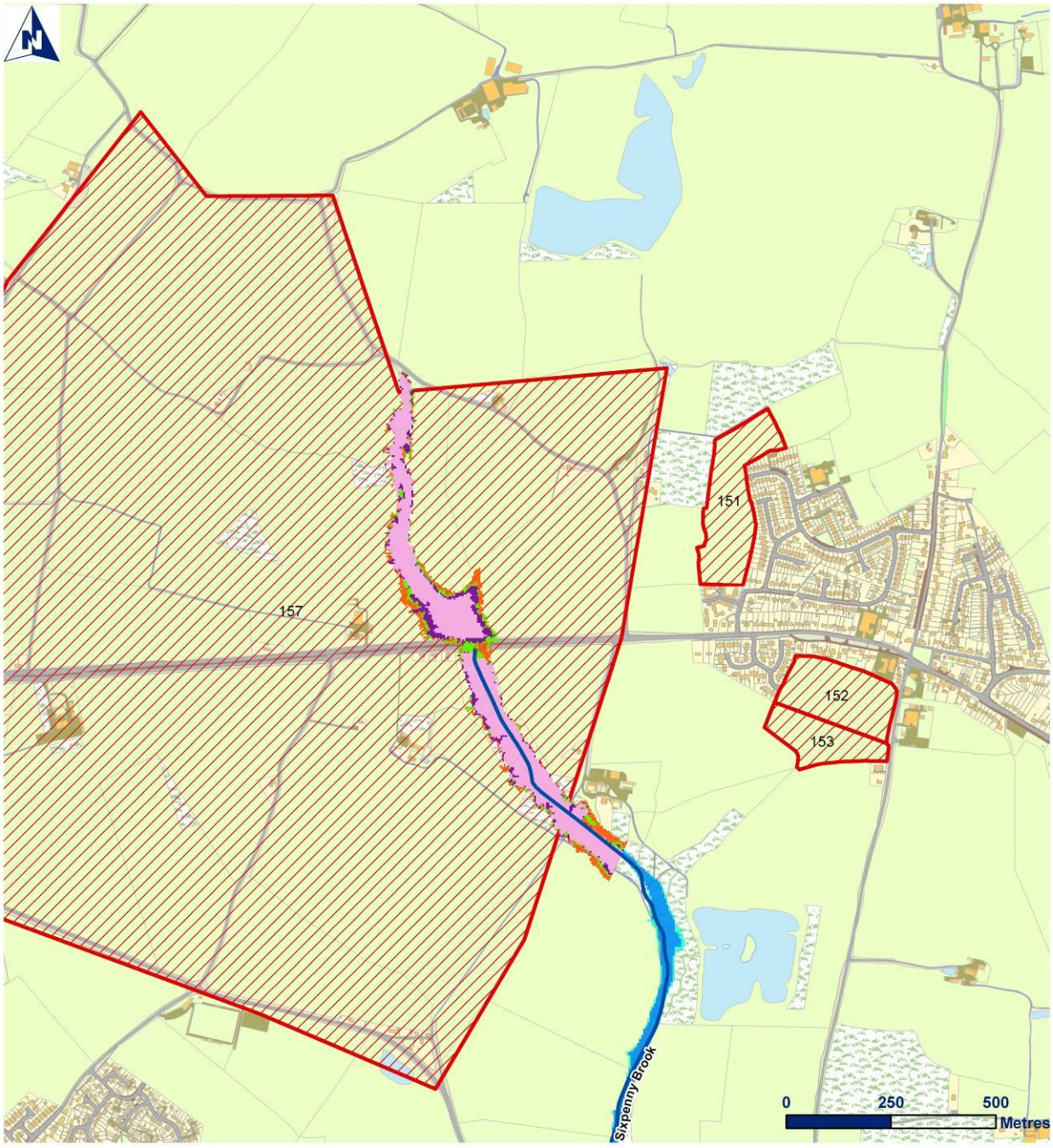
File Location: N:\2008\Projects\2008s3779 \Tendring

B.1.5 Six Penny Brook JFlow Modelled Outlines

The 20-year, 100-year, 100-year with climate change allowance and 1000-year flood extends were derived for Six Penny Brook from the JFLOW modelled results.

The modelled outlines were presented together with Flood Zone maps in Map 3, 4 and 5. The figure below shows all the return periods' outlines and Flood Zone 3 and 2 at Six Penny Brook.

Six Penny Brook Jflow Modelled Flood Outlines



Legend

- Main River
- Area of Search of Potential Development Sites

Six Penny Brook JFLOW Modelled Outlines

- 20yr Outline
- 100yr Outline
- 100yr with Climate Change Outline
- 1000yr Outline
- EA Flood Zone 3 (v3.9)
- EA Flood Zone 2 (v3.9)

Six Penny Brook Fluvial Flood Risk

Date:	March, 2009
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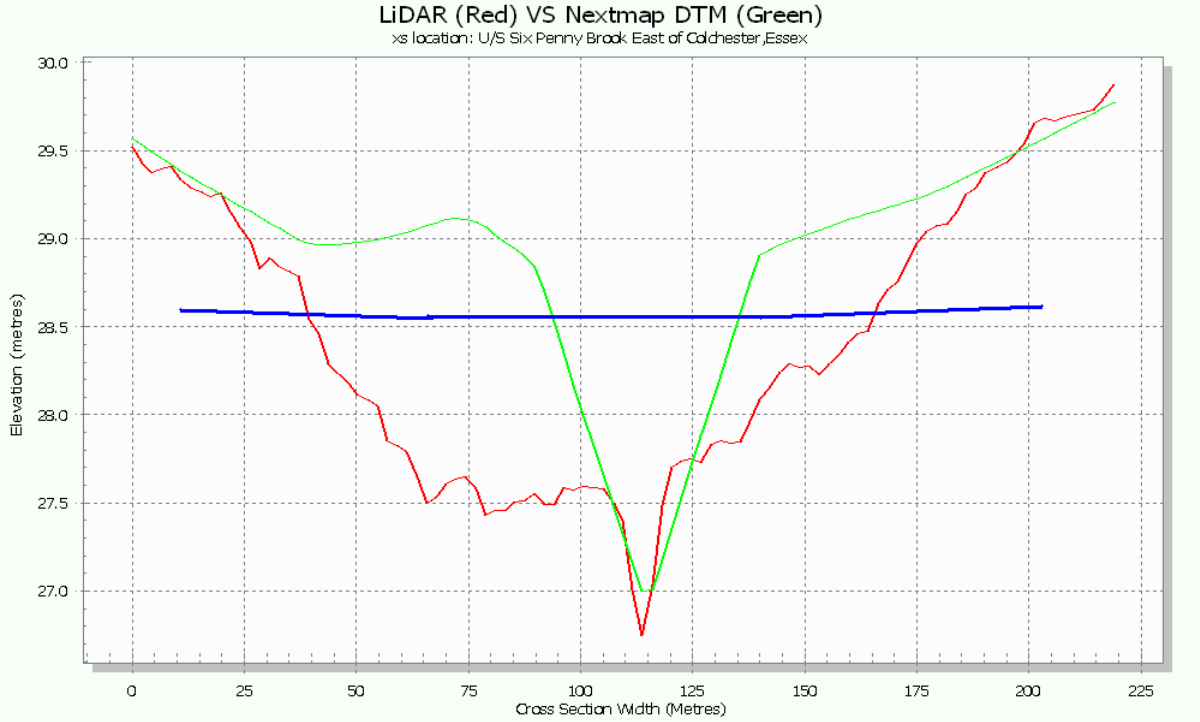
The modelled 100 year and 1000 year outlines for Six Penny Brook appear having bigger extents than the existing Flood Zone 3 and 2. This is partly due to using LiDAR data as the digital terrain models when producing outlines. As shown in the figure below, the blue line presents the water level at the cross section, the differences between LiDAR(Red) and NextMap(Green) can result in a significantly different flood outlines.



Blue line: Water level

Red line: LiDAR cross section

Green line: Nextmap SAR cross section

Appendix C: - SuDS Analysis

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Appendix D: - Breach Analyses

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D.1 BREACH ANALYSES

Introduction

For each TUFLOW model established for the breaches, various grid sizes were used. This provided optimum runtimes whilst providing a suitable grid over which to meet the hydraulic objectives of each scenario.

TUFLOW's output for any individual breach include flow direction, depths, water levels, velocities, and the UK flood hazard index over the duration of the event. Time to inundation at any particular location can be calculated.

Breach Model Parameters

A Tuflow model check file is provided in Appendix F with more detailed information on breach model parameters.

- **Scenarios**

Breach models of three different scenarios were run for five locations including Manningtree, Walton-on-Naze, Clacton-on-sea, Point clear and Brightlingsea in the Tendring district. These are summarised as follows:

- 0.5% AEP
- 0.1% AEP
- 0.5% AEP plus climate change

- **Breach Widths**

The following Environment Agency advice was used when establishing the breach widths in the TuFLOW models.

Location	Defence Type	Breach Width recommended (m)
Open coast	Earth bank	200
	Dunes	100
	Hard	50
	Sluice	Sluice width
Estuary	Earth bank	50
	Hard	20
Tidal river	Earth bank	50
	Hard	20
Fluvial river	Earth bank	40
	Hard	20

Only Holland Haven at Clacton is at open coast location with hard defence where 50m breach width was used, the rest of the breach locations are at estuary location with earth banks which also had 50m breach width.

- **Hazard Rating Outputs**

UK flood hazard index is defined in Defra and Agency's 2006 R&D report on Flood Risks to People (FD2320). It was developed to make it easier to define the level of risk to people from flooding in order to help plan responses. It is based on flood depth, velocity and debris factors, and is calculated using the following:

HR = d x (v + 0.5) +DF where:

HR = (flood) hazard rating

D = depth of flooding (m)

V = velocity of floodwaters (m/s)

DF = debris factor calculated using table below by following the Environment Agency (Anglian Region)'s Guidance for Hazard Mapping for Flood Risk Assessments where debris factor = 0.5 for depths less than 0.25m and =1.0 for depths above 0.25m.

Guidance on debris factors (DF) for different flood depths, velocities and dominant land uses

Depths	Pasture/Arable	Woodland	Urban	Conservative[1]
0 to 0.25 m	0	0	0	0.5
0.25 to 0.75 m	0	0.5	1	1
d>0.75 m and/or v>2	0.5	1	1	1

Ref: FD2321/TR1 Table 3.1

1 Conservative option was added to table in TuFLOW command base on the Environment Agency's guidance.

The following maps show the depth and hazard results of the breach models.

APPENDIX E: - SITE SUMMARY SHEETS AND MAPS

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E.1 SUMMARY OF SITES

The summary of sites provide an index of all areas of search of potential development sites including the Harwich Master Plan sites with a total of 157 sites.

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E.2 SITE SUMMARY SHEETS AND MAPS

The following sections give a detailed examination of flood risk of all sources at each area of search of potential development site (excluding Harwich Master Plan sites), including effect of defences, residual flood risk and climate change. For each site there is a summary of:

- Site details (site location, size and existing land use type)
- Flood Zone map
- Flood defences
- Residual risk
- Sources of flooding with detailed maps where appropriate (fluvial/tidal and surface water flooding summary maps)
- Sustainable Drainage Systems (appropriate SuDS technique)
- Effect of climate change
- Is FRA required for the site?
- Recommendations for the site

This summary and recommendations focus on the technicalities of flood risk management rather than the other planning issues an LPA must consider in selecting allocations. It should, therefore, be assumed that:

- These other planning issues have been considered separately
- For land to be allocated within the high risk zone, the full range of planning issues has been evaluated.
- It has been determined through the SEA (Strategic Environment Assessment) and SA (Sustainability Appraisal) that the land is the most suitable for development.

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E.3 JAYWICK SFRS AND HARWICH SFRA SUMMARY SHEETS

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APPENDIX F: - TUFLOW MODELLING CHECK FILE

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