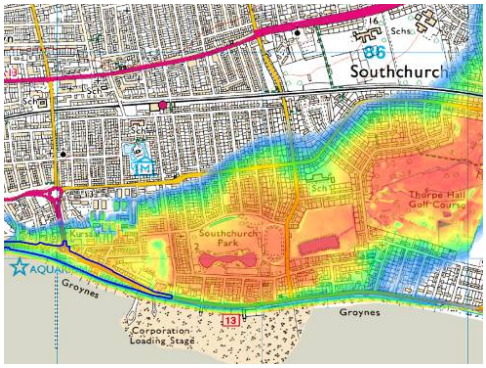
Southend-on-Sea Borough Council

Strategic Flood Risk Assessment

Level 1 Report – Final Version

September 2010



Prepared on behalf of:

southend onsea BOROUGH COUNCIL

Revision Schedule

Strategic Flood Risk Assessment: Level 1
September 2010

Rev	Date	Details	Prepared by	Reviewed by	Approved by
01	March 2010	Draft Report for Client Comment	**Eleanor Cole** Assistant Hydrologist **Sarah Littlewood** Assistant Hydrologist	**Elizabeth Gent** Principal Consultant	**Jon Robinson** Associate Director
02	June 2010	Draft for EA Comment	**Elizabeth Gent** Principal Consultant		
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Non-Technical Summary

SFRA Background

Scott Wilson Ltd was commissioned by Southend-on-Sea Borough Council (BC) to undertake an update of their Strategic Flood Risk Assessment (SFRA) for their local authority area. This project has been carried out in collaboration with the Environment Agency's Anglian and Thames Regions.

The Thames Gateway South Essex SFRA was carried out by Scott Wilson in 2006 and addressed flood risk across the whole of South Essex. This report provides an update for Southend-on-Sea Borough Council in a stand alone SFRA for the borough.

SFRA Planning Objectives

The primary objective of the study is to enable Southend-on-Sea BC to undertake the Sequential Test in line with the Government's flood risk and development policy document - Planning Policy Statement 25 (PPS25): '*Development and Flood Risk*' - to inform the development of their emerging Local Development Framework (LDF) documents. In particular this study will form the evidence based for the review of the Core Strategy DPD, Site Specific Allocations and Policies DPD and the Minerals and Waste DPD.

PPS25 requires Southend-on-Sea BC to review flood risk across their district, steering all development towards areas of lowest risk. Development is only permissible in areas at risk of flooding in exceptional circumstances where it can be demonstrated that there are no reasonably available sites in areas of lower risk, and that the development provides wider sustainability benefits that outweigh the risk of flooding. Such development should incorporate mitigation/management measures to minimise risk to life and property should flooding occur.

The SFRA is the first step in this process. It will assist with the development of LDF documents by identifying flood risk areas and outlining the principles for sustainable development policies, informing strategic land allocations and integrating flood risk management into the spatial planning of the area. The SFRA thereby forms an essential reference tool providing the building blocks for future strategic planning.

SFRA Report Layout

In accordance with recommendations within the PPS25 Practice Guide, this SFRA has been structured in two phases. This report forms a Level 1 SFRA, which provides an overview of the flood risk issues throughout Southend-on-Sea BC in order to facilitate a sequential approach during the allocation of sites for future development.

Southend-on-Sea Borough Council Considerations

The study area covers the administrative area of Southend-on-Sea BC within South Essex. It is bordered by the River Thames to the south and Castle Point to the west, Rochford to the north and the North Sea to the east.

The study area covers approximately 42 km^2, divided into the low lying tidal areas along the sea front and the higher landward areas of the borough.

The borough is dominated by the urban settlements of Southend-on-Sea and Leigh-on-Sea, with some undeveloped areas in the north eastern extents of the borough. The eastern area of Shoeburyness is utilised by the MOD for the New Ranges and Foulness Island bases.

Flood Risk

The two main sources of flooding for this area are tidal flooding from the River Thames Estuary and North Sea, and fluvial flooding from the Prittle Brook, Eastwood Brook and Willingale watercourse that runs through Southchurch Park.

The most significant events in this area, in terms of potential for flooding, tend to be storm surges coupled with high spring tides which produce high tidal water levels in the Thames Estuary. These have the potential to impact on large areas of development along the tidal frontage. Additionally, the fluvial watercourses pose generally localised flood risks and are largely located in the north west of the area, these have a history of flooding and alleviation works have been undertaken to try and reduce the risk of flooding to the areas of Prittlewell and Eastwood.

Areas identified as functional floodplain, or Flood Zone 3b have been identified as part of this study. These are largely associated with the Prittle, Eastwood and Willingale watercourses and follow the main channel, with the exception of the Willingale in Southchurch Park where the functional floodplain extends into the park.

Detailed breach and overtopping modelling has been considered for tidal sources, these identify the flood risks associated with a failure in the flood defence, either through a breach, or by overtopping. This study has identified that some of the flood defences along the Southend-on-Sea BC frontage are below the required 1 in 200 year standard for present day water levels. The areas at risk from overtopping have been mapped as part of this report, and identify the areas at risk from actual flood risk. This information should be used to focus improvements to the flood defences where they are required to ensure the 1 in 200 year standard is achieved for the entire frontage.

In addition to tidal and fluvial sources, this study considers the risks associated with groundwater, surface water, sewer flooding and flooding from artificial sources.

A separate Surface Water Management Plan is being carried out by Southend-on-Sea Borough Council to further assess the potential impacts and future management measures associated with surface water sources.

The Sequential Test

The Sequential Test outlined in PPS25 aims to steer development to areas of lowest flood risk. The SFRA aims to facilitate this process by identifying the variation in flood risk across Southend-on-Sea BC and allowing an area-wide comparison of future development sites with respect to flood risk.

Southend-on-Sea BC has been delineated into the Flood Zones outlined in PPS25 as Flood Zone 1, low probability, Flood Zone 2, medium probability, Flood Zone 3a, high probability and Flood Zone 3b functional floodplain. Table D.1 of PPS25 provides information on which developments might be considered appropriate in each Flood Zone, subject to the application of the Sequential Test and the Exception Test, as well as a site-specific Flood Risk Assessment (FRA).

In order to provide additional information regarding the nature of flood risk within these Flood Zones, Hazard mapping for the present day (2009) has been included in the Level 1 SFRA. The hazard rating has been calculated for the flood risk associated with fluvial systems and the flood risk resulting from breaches

in tidal defences. Flood risk is divided into four hazard categories, Extreme, Significant, Moderate and Low, based upon the depth and velocity of flood water.

In accordance with PPS25, Southend-on-Sea BC will use the Flood Zone mapping and Hazard mapping presented within this SFRA to complete the Sequential Test during the production of their spatial strategies. The Sequential Test identifies the flood risk and vulnerability of various proposed developments in order to assess the suitability of each development location, and where possible to steer more vulnerable developments to areas of lower flood risk.

The Exception Test

Where the Sequential Test demonstrates that it is necessary to locate a particular development in a flood zone because no land of a lesser flood risk exists, there will be some circumstances when the Exception Test will also need to be applied. Table D.3. of PPS25 summarises the instances in which the application of the Exception Test is necessary. All three elements of the Exception Test, as set out in paragraph D9 of PPS25 must be passed in order to establish the principle of development and satisfy the requirements of PPS25.

The purpose of the Exception Test is to ensure that new development is only permitted in medium and high flood risk areas in exceptional circumstances i.e. where flood risk is clearly outweighed by other sustainability factors and where the development will be safe during its lifetime, taking the impacts of climate change into account.

Area Action Plans

A detailed assessment of flood risk has been provided for the main area action plans (AAP) in the borough, including the Town Centre AAP and Shoeburyness and London Southend Airport AAP.

Way Forward

The risk of flooding posed to development within the study area arises from a number of different sources including tidal flooding, river flooding, groundwater, surface water flooding as well as flooding from sewers.

A spatial planning solution to flood risk management should be sought wherever possible. It is necessary for Southend-on-Sea BC to consider, through the application of the PPS25 Sequential Test, how to steer vulnerable development away from areas affected by flooding. This should also take into consideration other relevant strategies and studies in the area seeking to reduce flooding to those already at risk.

Where other planning considerations must guide the allocation of sites and the Sequential Test has not been satisfied, further studies can be carried out to assist Southend-on-Sea BC and developers to meet the Exception Test. These will be detailed in a Level 2 SFRA following completion of the Sequential Test.

Engagement with the Emergency Planning Officer, Local Resilience Forum and emergency services is imperative to minimise the risk to life posed by flooding within Southend-on-Sea BC. It is understood that Southend-on-Sea BC are in the initial stages of preparing a flood risk response plan for the borough, a Central Area Evacuation Plan is due for issue later in 2010 with respect to the high street and sea front areas. We recommend that the findings and recommendations from the Level 1 SFRA are taken into consideration during the preparation of the flood risk response plan.

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Acronyms & Abbreviations

ABBREVIATION	DEFINITION
AONB	Area of Outstanding Natural Beauty
BGS	British Geological Survey
CFMP	Catchment Flood Management Plan
CLG	Communities and Local Government
Defra	Department for Environment, Food and Rural Affairs
DEM	Digital Elevation Model
DPD	Development Plan Document
FRA	Flood Risk Assessment
GIS	Geographical Information System
IDB	Internal Drainage Board
LDDs	Local Development Documents
LDF	Local Development Framework
LDS	Local Development Scheme
LiDAR	Light Detection and Ranging
LPA	Local Planning Authority
ODPM	Office of Deputy Prime Minister
PCPS 2004	Planning and Compulsory Purchase Act 2004
PPS	Planning Policy Statement
RBMP	River Basin Management Plan
RFRA	Regional Flood Risk Appraisal
RPG	Regional Planning Guidance
RSS	Regional Spatial Strategy (East of England Plan)
SA	Sustainability Appraisal
SAC	Special Area for Conservation
SFRA	Strategic Flood Risk Assessment
SOSBC	Southend-on-Sea Borough Council
SPA	Special Protection Area
SPD	Supplementary Planning Document
SPZ	Source Protection Zone
SUDS	Sustainable Drainage Systems
SWMP	Surface Water Management Plan
WCS	Water Cycle Study
WFD	Water Framework Directive

Glossary

TERM	DEFINITION
Aquifer	A source of groundwater comprising water-bearing rock, sand or gravel capable of yielding significant quantities of water.
Catchment Flood Management Plan	A high-level planning strategy through which the Environment Agency works with their key decision makers within a river catchment to identify and agree policies to secure the long-term sustainable management of flood risk.
Culvert	A channel or pipe that carries water below the level of the ground.
Flood Defence	Infrastructure used to protect an area against floods as floodwalls and embankments; they are designed to a specific standard of protection (design standard).
Floodplain	Area adjacent to river, coast or estuary that is naturally susceptible to flooding.
Flood storage	A temporary area that stores excess runoff or river flow often ponds or reservoirs.
Fluvial flooding	Flooding by a river or a watercourse.
Freeboard	Height of flood defence crest level (or building level) above designed water level
Groundwater	Water that is in the ground, this is usually referring to water in the saturated zone below the water table.
Inundation	Flooding.
Local Development Framework (LDF)	The core of the updated planning system (introduced by the Planning and Compulsory Purchase Act 2004). The LDF comprises the Local Development Documents, including the development plan documents that expand on policies and provide greater detail. The development plan includes a core strategy, site allocations and a proposals map.
Local Planning Authority (LPA)	Body that is responsible for controlling planning and development through the planning system.
Mitigation measure	An element of development design which may be used to manage flood risk or avoid an increase in flood risk elsewhere.
Overland Flow	Flooding caused when intense rainfall exceeds the capacity of the drainage systems or when, during prolonged periods of wet weather, the soil is so saturated such that it cannot accept any more water.
Overtopping	For the purpose of this report overtopping refers to flooding over a sea defence when the still water level is above the height of the flood defence.
Risk	The probability or likelihood of an event occurring.
Sewer flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
Sustainable drainage system	Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques.
Sustainable development	Development that meets the needs of the present without compromising the ability of future generations meeting their own needs.
1 in 100 year event	Event that on average will occur once every 100 years. Also expressed as an event, which has a 1% probability of occurring in any one year.
1 in 200 year event	Event that on average will occur once every 200 years. Also expressed as an event which has a 0.5% probability of occurring in any one year.
1 in 1000 year event	Event that on average will occur once every 1000 years. Also expressed as an event which has a 0.1% probability of occurring in any one year.
1 in 200 year design standard	Flood defence that is designed for an event, which has an annual probability of 1%. In events more severe than this the defence would be expected to fail or to allow flooding.

1 Introduction

1.1 Overview

1.1.1 The Planning and Compulsory Purchase Act 2004 (PCPA 2004) requires Local Development Documents (LDDs) to undergo a Sustainability Appraisal (SA), which assists Planning Authorities in ensuring that their policies fulfil the principles of sustainability.

1.1.2 Strategic Flood Risk Assessments (SFRAs) constitute a component of the SA process and should be used in the review of LDDs or in their production.

1.1.3 The introduction of Planning Policy Statement 25 (PPS25): 'Development and Flood Risk' (CLG 2010) promotes a positive approach to planning, taking due consideration of flood risk, in order to deliver appropriate sustainable development in suitable locations. PPS25 (CLG 2010) and its supporting Practice Guide, which was revised in December 2009, emphasise the active role that Borough Councils should have in ensuring that flood risk is considered in strategic land use planning.

1.1.4 To assist Local Authorities in their strategic land use planning, SFRAs should present sufficient information to enable Local Authorities to apply the Sequential Test to their proposed development sites. The SFRA should have regard to river catchment wide flood issues and also involve a *"process which allows the Local Planning Authority to determine the variations in flood risk across and from their area as the basis for preparing appropriate policies for flood risk management for these areas".*

1.1.5 In addition, where development sites cannot be located in accordance with the Sequential Test as set out in PPS25 (i.e. to steer development to low risk sites), *"the scope of the SFRA should be increased to provide the information necessary for the application of the Exception Test."*

1.1.6 In addition to being a tool for use in strategic land use planning, an SFRA should also be accessible and provide guidance to aid in the general planning process of a local authority.

1.2 Southend-on-Sea Borough Council SFRA

1.2.1 Scott Wilson Ltd was commissioned by the Thames Gateway South Essex Partnership in January 2006 to undertake a Strategic Flood Risk Assessment for South Essex. This Client Group comprised the Thames Gateway South Essex Strategic Planning Authorities of Essex County Council, Southend-on-Sea BC and Thurrock Borough Councils and the Local Planning Authorities of Rochford, Castle Point and Basildon District Councils.

1.2.2 The Thames Gateway South Essex SFRA (Scott Wilson 2006) was prepared in accordance with Planning Policy Guidance Note 25: Development and Flood Risk (DTLR 2001) which has since been superseded by Planning Policy Statement 25: Development and Flood Risk (CLG 2006, revised 2010). As a result, Southend-on-Sea BC have commissioned a revision to their existing SFRA to provide up-to-date information regarding flood risk across the borough and to inform the preparation of their LDDs, including the Southend Central and Seafront Area Action Plans (AAP), London Southend Airport and Environs Joint AAP (JAAP), Development Management Policies and the Southend-on-Sea BC Infrastructure Plan.

1.3 SFRA Objectives

1.3.1 In line with the PPS25 Practice Guide (CLG 2009), the objectives of the Southend-on-Sea Borough Council SFRA are to:

- Identify areas at risk of flooding from all potential sources within the study area, with particular attention paid to Area Action Plans within Southend-on-Sea BC;
- Identify the extent and variation of tidal and fluvial flood sources in the study area through the delineation of PPS25 Flood Zones and Flood Hazard classifications, to provide sufficient information to allow the Sequential Test to be carried out;
- Identify flood defences, including their condition and standard of protection, and areas benefiting from defences;
- Advise Southend-on-Sea BC on suitable polices to address flood risk management in a consistent manner across Southend-on-Sea BC;
- Advise Southend-on-Sea BC on the baseline requirements of site-specific Flood Risk Assessments based on local conditions and policy recommendations;
- Advise Southend-on-Sea BC on the objectives of Sustainable Drainage Systems throughout the study area, including soil conditions and suitability;
- Present sufficient information to inform Southend-on-Sea BC and Local Resilience Forum of the flood considerations necessary in emergency planning; and
- Provide evidence-based reports which inform Southend-on-Sea BC's Local Development Framework and other Development Planning Documents about managing potential flood risk and are also suitable to inform the Sustainability Appraisal of related documents.

1.4 SFRA Structure

1.4.1 The PPS25 Practice Guide (CLG 2009) recommends that SFRAs are completed in 2 consecutive stages which provide Southend-on-Sea BC with tools throughout the LDF and SFRA process sufficient to inform and update decisions regarding development sites. The two stages are:

Level 1 SFRA

1.4.2 The objective of the Level 1 report is to collate and review available information on flood risk from all sources of flooding within the study area. Information has been sought from a variety of stakeholders including the Environment Agency, Anglian Water, Essex and Suffolk Water and Southend-on-Sea BC.

1.4.3 The deliverables from the Level 1 should be used by Southend-on-Sea BC to apply the Sequential Test.

1.4.4 The areas of the borough at risk of flooding from fluvial and tidal sources are also identified for future growth therefore the scope of this Level 1 SFRA has been increased to include mapping of 'hazard' from present day scenarios to further inform the Sequential Test. Hazard is based on the depth and velocity of flood waters and therefore provides more detailed information regarding the variation in flood risk within particular flood zones, which will subsequently facilitate the application of the Sequential Test by Southend-on-Sea BC.

Level 2 SFRA

1.4.5 The purpose of the Level 2 report is to provide more information regarding the level of flood risk posed to the area, taking into account the presence of current flood risk management measures such as flood defences, in order to facilitate the application of the Exception Test where required.

1.4.6 The increased scope Level 2 SFRA incorporates consideration of residual risk in the event of a breach in the defences. Outputs of the Level 2 SFRA include maps of floodwater depth and floodwater velocity, hazard classification for climate change scenario (present day is included in the Level 1 report) and the length of time before inundation by floodwaters to assist in the assessment of part c) of the Exception Test.

1.4.7 In addition the Southend-on-Sea BC Level 2 SFRA report also looks in more detail at the flood risk for three growth areas including the Town Centre AAP and Shoeburyness and London Southend Airport JAAP to inform the future development of these areas.

Other Studies

1.4.8 Southend-on-Sea BC is currently undertaking a Water Cycle Study and Surface Water Management Plan for the borough, undertaken by Scott Wilson. To ensure consistency there is some repetition across these reports with respect to rainfall and groundwater. Further detailed information on these flood sources in Southend-on-Sea BC can be obtained from these studies.

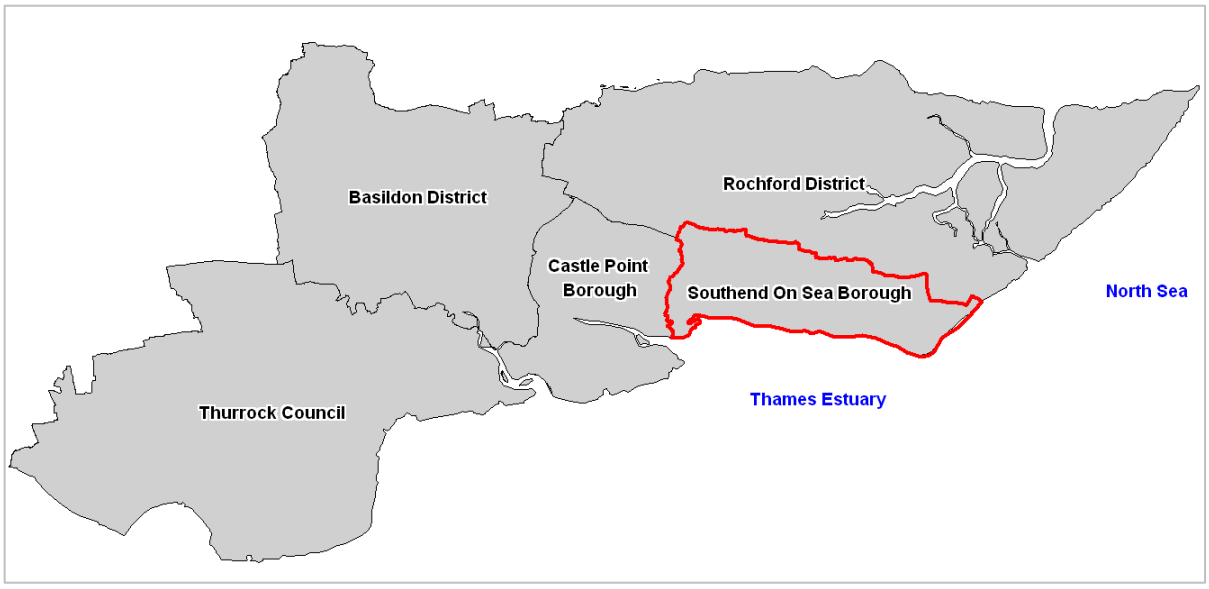
2 Sources of Flooding

2.1 Study Area

2.1.1 The study area is defined by the administrative boundary of Southend-on-Sea Borough Council in southeast Essex. This is a total study area of 42km2.

2.1.2 The Thames Estuary forms the southern boundary of the borough and meets the North Sea at Southend. To the north is Rochford District and to the west is Castle Point Borough.

Figure 2-1 Southend on Sea SFRA Study Area



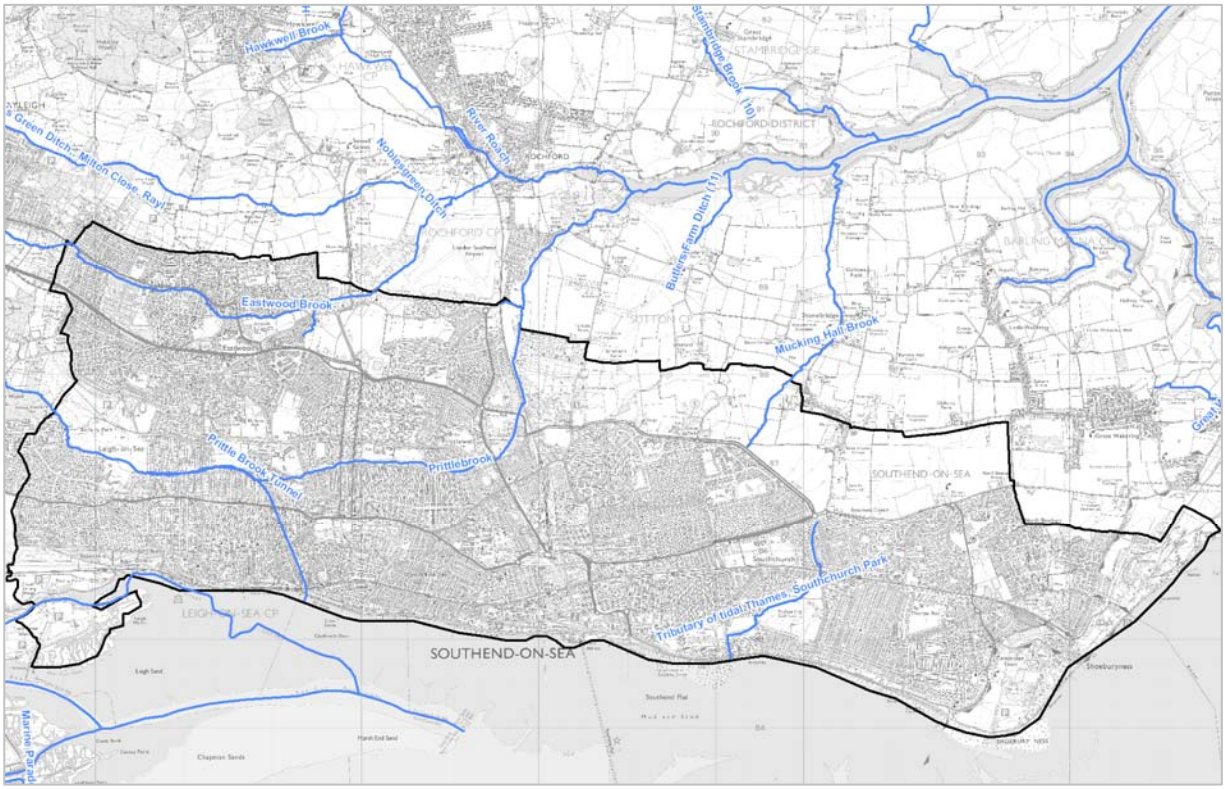
2.1.3 The borough is relatively densely populated except for a small strip on the northern edge, and the Shoeburyness area in the southeast corner of the borough. Land use is predominantly residential with some ex Ministry of Defence (MOD) land use on the eastern coastline. The borough is served by two railway lines that connect it to London with two major stations in the centre of the borough.

2.2 Hydrology and Flood Sources

2.2.1 The main river catchments within the study area are:

- The River Thames Estuary
- Prittle Brook
- Eastwood Brook
- Willingale, a tributary of the tidal Thames at Southchurch Park

Figure 2-2 Main Rivers in Southend-on-Sea



Thames Estuary and North Sea

2.2.2 The Thames Estuary and North Sea pose the greatest flood risk to Southend. Extreme water levels can be generated in the Thames Estuary by intense low pressure systems over the North Sea, which artificially increase sea levels due to the pressure differential. This effect, combined with wind and wave action, is referred to as a storm surge. The height of the surge typically increases as the weather system travels south, and the North Sea becomes narrower and shallower causing a funnelling effect. The highest water levels in the North Sea will be generated when storm surges are combined with high spring tides generated by gravitational forces.

2.2.3 Although defences are present along the River Thames and North Sea frontages, the crest height of these defences in some areas is lower than the extreme water levels, so flood risk from this source is through potential overtopping (used to refer to 'overflowing' events in the SFRA whereby still water levels are higher than crest heights resulting in an overtopping event) as well as the residual risk of a failure in the flood defences.

Prittle Brook

2.2.4 The Prittle Brook is a tributary of the River Roach, which flows easterly through Rochford District to meet the North Sea. The Prittle Brook flows east through the borough of Southend, from Belfairs Park towards Priory Park at Prittlewell where it flows north to meet the River Roach at Sutton Ford Bridge in Rochford.

2.2.5 In September 1968, 150mm of rainfall fell over the catchment in 24 hours, leading to the flooding of approximately 200 properties in Southend. Following this, major channel improvements were undertaken and all three watercourses are now heavily modified.

2.2.6 In the 1970s Anglian Water installed the Prittle Brook flood relief tunnel which diverts excess flows to the River Thames during times of flooding and largely relieves drainage from the western part of the borough and the eastern part of Castle Point District. There is a second intake at Manchester Drive where the Prittle Tunnel takes the excess from surface water and highways drainage.

Eastwood Brook

2.2.7 The Eastwood Brook is a smaller tributary of the River Roach. This tributary flows east through Eastwood before turning north to join the River Roach at Rochford. This watercourse flows in and out of culverted sections through the residential parts of the borough.

2.2.8 Approximately 7.6km of channel improvements have been carried out on the Eastwood Brook through Southend-on-Sea including channel straightening, deepening, and lining the bed and banks with concrete to increase the capacity and flow rate (Environment Agency 2008).

2.2.9 Both the Eastwood Brook and Prittle Brook flow through relatively steep urban catchments which have been extensively altered to facilitate drainage and flood alleviation. These watercourses therefore respond rapidly to rainfall and flooding is likely to occur with little warning and fast flows (Environment Agency 2008). This is illustrated in the table below:

Table 2-1 Typical timing and magnitude of peak fluvial flows, Extracted from the South Essex CFMP, Environment Agency 2008

Watercourse	Typical time to peak (hours)	1% AEP peak flow (m^3/s)
Prittle Brook	2.8	33.3
Eastwood Brook	4.0	28.6

2.2.10 During the summer months base flows in the Prittle Brook and Eastwood Brook are very low due to the small volumes of groundwater that can be stored naturally in the minor aquifers present in the area (Environment Agency 2008).

Willingale, tributary of tidal Thames at Southchurch Park

2.2.11 The Willingale watercourse is a designated Main River which runs through Southchurch Park and discharges into the tidal Thames estuary. There are two balancing ponds within the park which collect surface water runoff from the residential area to the north. Anglian Water own and maintain a pumping station in the south of the park as well as an additional pumping station on the Southend frontage which discharges surface water out into the Thames estuary.

2.3 Sewers

2.3.1 The majority of sewers in the borough are built to the guidelines within “sewers for adoption” (WRC, 2006). These sewers have a design standard of the 1 in 30 year flood event and therefore it is likely that the majority of sewer systems will surcharge during rainstorm events with a return period greater than 30 years (e.g. 100 years). Anglian Water has provided point locations of sewer flooding incidents that have occurred during the last 10 years.

2.3.2 Sewer flooding is discussed in more detail in the Water Cycle Study and Surface Water Management Plan prepared for Southend-on-Sea, with respect to spatial variation of previous events.

2.4 Groundwater Flooding

Geology

2.4.1 Geological information on solid and drift geology in Southend-on-sea Borough Council was obtained from the British Geological Survey (BGS) 1:50,000 scale Geological Series in digital format and are presented in Figure 13.

Solid Geology

2.4.2 The solid geology of the area comprises the Upper Chalk, which in turn is overlain by Lower London Tertiaries (Thanet Sand and Woolwich Beds) and London Clay Formation. The Claygate Member (formerly the Claygate beds) rests conformably on the London Clay Formation and is exposed in the north-western edge of the study area. Fragmented outcrops of London Clay Formation are present in the western part of the study area, on both sides of the Prittle Brook where drift deposits are absent.

2.4.3 The Lower London Tertiaries are mainly sands which vary in thickness from approximately 45m in the north to more than 50m adjacent to the River Thames in the South. The full thickness of London Clay is known only where the formation is capped by the Claygate Member and is around 130m. The thickness of the overlying Claygate Member range from 17m to 23m.

Drift Geology

2.4.4 The drift geology of the area consists of Quaternary Alluvium, Head, River Terrace Deposits and Tidal Flat Deposits. The River Terrace Deposits mainly consist of sandy gravel or silty clay and they dominate the outcrop geology in the study area. Their thickness ranges from 1.8 to 6.0m and is variable over the region. In the Shoeburyness area in the eastern part of the study area, the River Terrace Deposits are underlain by buried sand channels ranging in thickness from 11 to 13m. The River Terrace Deposits are locally overlain by Head deposits which are variable in composition. Their thickness ranges from 0.5 m to 3.5m over the region.

2.4.5 Alluvium comprising clayey silty sand is associated with the small tributary of the River Crouch in the north-western part of the study area.

2.4.6 The Tidal Flat Deposits comprising silty clay with sand lenses are located near Southend and Shoeburyness. These deposits are 1 m to 5m thick at Southend and 3m to 5m thick at Shoeburyness. A thin Basal Sand and Gravel horizon usually underlies the Tidal Flat Deposits.

2.4.7 East of Southend pier, a narrow strip of Blown Sand with an approximate thickness of 2m is present along the coastline and this overlies the Tidal Flat Deposits.

2.5 Surface Water

2.5.1 Surface water flooding is usually associated with short duration, high intensity rainfall that is unable to soak into the ground and/or enter drainage systems. It can quickly run off land and result in localised flooding. The Pitt Review (2008) revealed that two-thirds of the widespread flooding experienced in July 2007 was the result of surface water runoff in urban areas.

2.5.2 The majority of the borough lies at an elevation of 15m AOD or more. Higher areas of the borough are chiefly located in the west while coastal plains and foreshore (at or below 0m AOD) dominate in the east.

2.5.3 The Eastwood Brook and Prittle Brook follow the topography and drain the western portion of the borough into the River Roach, north of the borough in Rochford. Excess flows from the Prittle Brook and from highways drainage are directed into the Prittle flood relief channel and outfall into the Thames at Chalkwell, thereby considerably relieving drainage in the west of the borough.

2.5.4 The underlying geology in the borough is London Clay formation which prevents the infiltration of water and further encourages surface water runoff. The urbanisation of large parts of the borough also contributes to overland flows of water during heavy rainfall events.

2.5.5 Southend-on-Sea BC has provided records of surface water flooding at the Angel Roundabout (Bournes Green Chase) north of Shoeburyness which has been attributed to run-off from the surrounding fields during heavy summer rainfall.

2.5.6 In addition, at the Harp House Roundabout, on the A1159 between Prittlewell and Rochford, there are reported incidents of significant ponding on the highway, with puddles taking up as much as ¾ of the roundabout on some occasions.

2.5.7 Southend-on-Sea BC is currently preparing a Surface Water Management Plan in partnership with the Environment Agency and Anglian Water. This study is being carried out to further understand the risk of surface water flooding in the borough in line with the recommendations of the Pitt Review and the Draft Flood and Water Management Bill, and in accordance with the Defra Technical Guidance (Defra 2009).

3 Data Collection and Review

3.1 Objective

3.1.1 The objective of the Level 1 SFRA is to collate and review the information available relating to flooding in the study area. This information is then presented in a format to enable the Local Planning Authority to apply the Sequential Test to their growth areas. Gaps in the data and information have also been identified in order to ascertain additional requirements required as part of the Level 2 SFRA.

3.2 Tasks

3.2.1 The sequence of tasks undertaken in the preparation of the Level 1 SFRA included:

- Inception meeting with the Southend-on-Sea Borough Council on 30th November, 2009;
- Established the local stakeholders;
- Contacted stakeholders and requested data/information;
- Collated and reviewed data and populated data register;
- Presentation of available relevant information on flood sources and flood risk;
- Review of received data against the SFRA objectives; and
- Identified gaps in data.

3.3 Stakeholders

3.3.1 The stakeholders that were contacted to provide the data/information for the SFRA (SWMP and WCS stakeholders supplied data that was also relevant to this study so has been reviewed as part of the SFRA) includes:

- Southend-on-Sea Borough Council;
- Anglian Water;
- Essex and Suffolk Water; and
- Environment Agency Anglian Region.

3.4 Data / Information Collected

3.4.1 Information was requested from the stakeholders and integrated with Scott Wilson's GIS system where possible to facilitate a review. The information requested from the stakeholders identified was based on the following categories:

- Terrain Information e.g. LiDAR, SAR, river cross-sections;
- Hydrology e.g. the main and ordinary watercourses;
- Hydrogeology e.g. groundwater emergence zones and vulnerability maps;
- Flood Defence e.g. flood banks, sluices;

- Environment Agency Modelled Flood Levels;
- Environment Agency Flood Zone Maps;
- Local Authority Information e.g. Area Action Plans areas and allocation sites;
- Sewer flooding problems; and,
- Environment Agency Mapping "Areas Susceptible to Surface Water Flooding".

3.4.2 All data was registered on receipt and its accuracy and relevance reviewed to assess a confidence levels for contribution to the SFRA. Details of all the data collected at the time of production are presented in Appendix C.

3.5 Data Review

Topographic Data

3.5.1 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. The data varies in accuracy depending on the nature of the terrain such as in woodlands, complex urban areas and near lakes, where the accuracy reduces due to the limitations in the technique. However, LiDAR is generally recognised to have an accuracy of +/- 300mm.

3.5.2 The data set covers the entire study area. It was captured by the Environment Agency during 2009 and 2006; the LiDAR used is an amalgamation of 2m, 1m and 0.25m data that was provided by the EA. The topographic data is presented as Figure 3.

3.5.3 This data is important because an accurate and up to date Digital Terrain Model (DTM) is required in order to produce high-resolution flood risk mapping.

Extreme Tidal Water Level Derivation

3.5.4 The extreme tidal water levels along the stretch of the River Thames adjacent to Southend-on-Sea BC have been obtained from the report Thames Tidal Defences Joint Probability Extreme Water Levels 2008 (Halcrow, April 2008) prepared for the Environment Agency. The levels within the report have been calculated by estimating a matrix of water levels at various nodes along the estuary and calculating the statistical frequency, or return period, within which a particular water level might be expected to occur at each of these nodes.

3.5.5 This was supplemented with extreme tidal water levels for the North Sea frontage from the report Eastern and Central Areas Report on Extreme Tide Levels 2007 (Environment Agency). Further detail on the use of the extreme tidal water level data is contained in Appendix A of the Level 2 SFRA report.

Flood Zone Maps

3.5.6 PPS25 Flood Zones subdivide the spatial variation of flood probability from rivers and the sea into 4 zones; the functional floodplain and the High, Medium and Low probability Flood Zones.

3.5.7 The Environment Agency has provided present day Flood Zone extents for Flood Zones 2 and 3 for the River Thames by extrapolating extreme water levels onto a DTM of the study area for the River Thames.

3.5.8 The Flood Map shows the estimated extent of Flood Zones 2 and 3 (ignoring the presence of flood defences) for all main rivers and/or watercourses with identified critical drainage problems and provides a good indication of the areas at risk of tidal flooding in the study area. However, it does not provide detail on individual properties, or information on flood depth, speed or volume of flow. It also does not show flooding from other sources, such as groundwater, direct runoff from fields, or overflowing sewers.

Fluvial Hydraulic Modelling

3.5.9 Broad scale modelling has been undertaken for the Prittle Brook, Eastwood Brook and Willingale watercourse as part of the Environment Agency's South Essex CFMP and provides information regarding fluvial flood risk in the study area associated events of a range of return periods. Flood outlines for the River Shoe were not available as this is not a designated main river.

3.5.10 In order to obtain a realistic understanding of flooding, the models represent current conditions and include the main flood defence schemes. The broad-scale model is then combined with a GIS software tool called 'Modelling Decision Support Framework' which provides flood levels, extents, depths and flood velocities for a number of different probability flood events.

3.5.11 It should be noted that this modelling is based on relatively coarse data and includes several simplifying assumptions. The results from these models provide a reasonable representation of how the catchment is likely to respond to flooding, however, they do not represent the details very accurately.

Hydrodynamic Breach Modelling

3.5.12 As part of the Level 2 SFRA, Scott Wilson has been commissioned to undertake hydrodynamic modelling at 9 breach locations along the Southend-on-Sea BC frontage. This provides a revision of the modelling that was undertaken as part of the Thames Gateway South Essex SFRA, using up-to-date water levels and improved modelling methodologies. The results of this modelling will be presented in the Level 2 SFRA, for the 1 in 200 year return period event including climate change to 2110 and 1 in 1000 year return period event including climate change to 2110.

3.5.13 As part of the Level 1 SFRA, modelled results have been presented for the 1 in 200 year and 1 in 1000 year events for the current day, 2010. The output available from this modelling is the 'Hazard Rating', which is a function of the flood depth and flow velocity at a particular point in the floodplain. The full methodology for this modelling is included within the Level 2 Report.

Flood Defences

3.5.14 Information on flood defences throughout the study area has been provided by the Environment Agency from the National Flood and Coastal Defence Database (NFCDD). The NFCDD provides details of the asset reference, location, type of defence, level of protection provided by the structure, and the geographical extent of the defence or structure. Details of all NFCDD flood defences in the study area are presented as a GIS layer and mapped in Figure 7 and 8.

Historical Flooding Records

3.5.15 The South Essex CFMP provides information regarding historic flood events within the study area. The records cover all sources of flooding including surface water and sewer flooding as well as fluvial and tidal flooding events. Records such as this will be of particular use in the identification of key problem areas when assessing the flood risk across Southend-on-Sea BC.

3.5.16 Caution should be applied when using historic records. It should be noted that as with all historic flooding records, this information is largely anecdotal and does not always include a record of the conditions giving rise to the flooding (therefore typically not attributed to a flood source) or reference to a flood return period.

3.5.17 Furthermore, whilst records of past events may help to identify critical areas that experience problems with surface water flooding or groundwater flooding, it should not be assumed that those areas where flood events have not been recorded are free from flooding of that nature. This is mapped in Figure 2.

Overland Flow / Surface Water Flooding

3.5.18 Overland flow/surface water flooding typically arise following intense rainfall, often of short duration, that is unable to soak into the ground or enter receiving drainage systems. It can run quickly off land and result in local flooding. In developed areas, overland flow tends to occur when surface water cannot enter overloaded drainage systems during significant rainfall events. There is therefore an inherent link between sewer flooding and overland flow/surface water flooding.

3.5.19 The LiDAR topographic data has been analysed to identify areas of land that are particularly steep and could potentially cause rapid surface water run-off during rainfall events. Topography is a major influencing factor with respect to run-off and therefore it is a considered to be a suitable technique for a strategic study such as this.

3.5.20 In addition, the South Essex CFMP, completed in 2008, identifies areas at high risk to surface water flooding in Southend-on-Sea BC and provides a record of historic surface water flooding events.

Environment Agency Data: Areas Susceptible to Surface Water Flooding

3.5.21 Following the Summer 2007 flood events, the Environment Agency have undertaken broad scale surface water mapping in order to provide an initial indication of areas susceptible to surface water flooding. The mapping for Southend-on-Sea BC has been supplied by the Environment Agency and is shown in Figure 9.

3.5.22 It should be noted that this dataset has been produced using a simplified method that excludes urban sewerage and drainage systems, excludes buildings, and uses a single rainfall event. The mapping is primarily intended for use by Local Resilience Forums (LRFs) and to inform emergency planning, but has recently been released for use in SFRAs to inform the most strategic levels of land use planning. It is not intended for use in allocating individual sites or determining individual planning applications. This mapping has the following limitations:

1) The mapping does not show the interface between the surface water network, the sewer systems and the water courses;

2) It does not show the susceptibility of individual properties to surface water flooding;

3) The mapping has significant limitations for use in flat catchments;

3.5.23 In the light of these limitations, it is recommended that the mapping be used only as an initial review of surface water flooding in order to identify areas requiring further investigation.

3.5.24 In order to assist with the verification of this dataset, records of surface water and sewer flooding supplied by Anglian Water and Southend-on-Sea Borough Council have been overlaid on the dataset in Figure 9. Supporting information from the Catchment Flood Management Plan and an

appreciation of the local topography has also been drawn upon to assist with the verification of the data.

3.5.25 Figure 9 identifies land south of Southchurch to be more susceptible to surface water flooding, which is to be expected given the topographic depression in which it is located. In addition, corridors around the course of the Prittle Brook and the Eastwood Brook are shown to be susceptible to surface water flooding as surface water flows are channelled into the watercourses. A significant area of ponding is also identified immediately to the south of the A1559 near the Essex Golf Club which may be the result of the constriction of surface water flows through the subway.

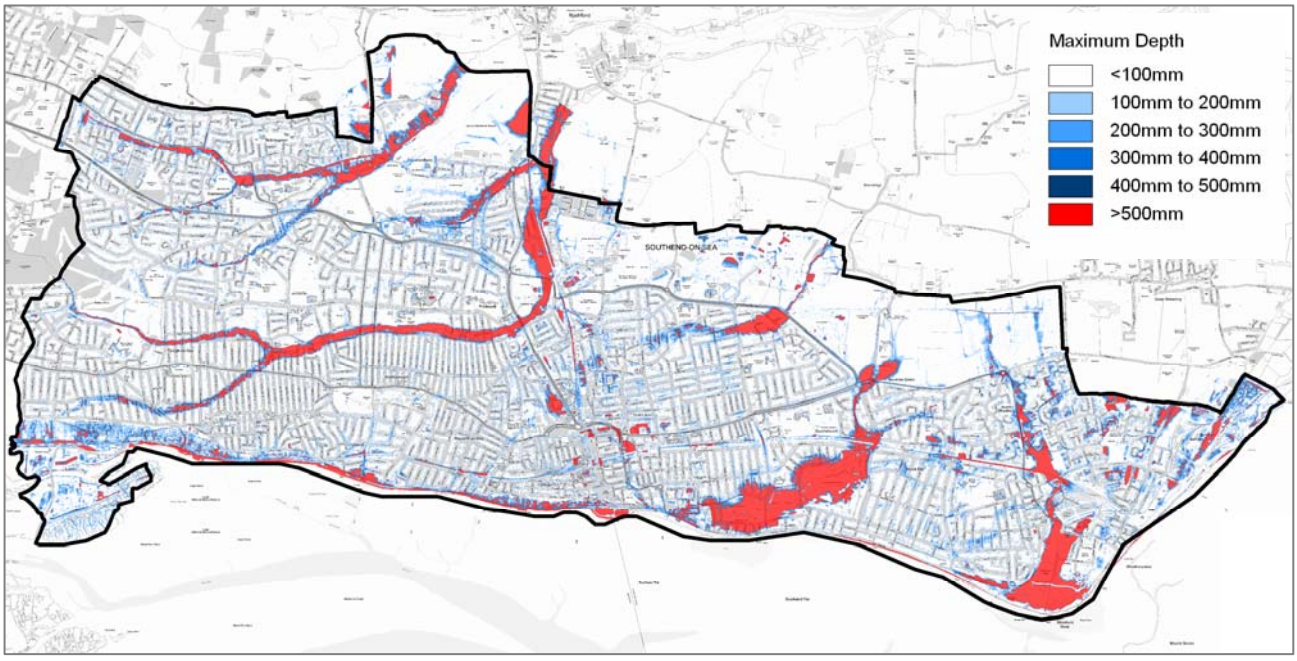
3.5.26 Datasets provided by Anglian Water and Southend-on-Sea Borough Council record incidents of flooding at South of Chalkwell, Southend Town Centre, south of Prittlewell and to the south of the London Southend Airport. These incidents correlate relatively well with the Areas Susceptible to Surface Water Flooding dataset.

3.5.27 In addition to these datasets, draft outputs from pluvial modelling currently being undertaken as part of the Surface Water Management Plan for Southend-on-Sea BC have been used to verify the existing data. The modelling includes 1-D structures at Mucking Hall, the Prittle Brook; however this iteration of the modelling does not represent the presence of the Prittle Tunnel and therefore provides an overestimate of the downstream extent of flooding along the Prittle Brook corridor.

3.5.28 The key patterns of surface water flooding across the borough shown through this draft pluvial modelling correlate with the Areas Susceptible to Surface Water Flooding dataset and provide confidence when using this dataset for the purposes of a high level review afforded by this SFRA.

3.5.29 For further, more detailed, assessment of surface water flooding across the borough the reader is referred to the Surface Water Management Plan currently being prepared on behalf of Southend-on-Sea Borough Council.

Figure 3-1 Draft Pluvial Modelling Output, from Southend-on-Sea SWMP



Sewer Flooding

3.5.30 Sewer systems are typically designed and constructed to accommodate rainfall events with a 30-year return period or less, depending on their age. Consequently, rainfall events with a return period greater than 30 years would be expected to result in surcharging of some parts of the sewer system.

3.5.31 Records of sewer flooding have been obtained from Essex and Suffolk Water and Anglian Water via a query of their DG5 registers. In order to fulfil statutory commitments set by OFWAT, water companies maintain verifiable DG5 registers which record flooding arising from public foul, combined or surface water sewers and identify where properties suffered internal or external flooding.

3.5.32 The South Essex CFMP provides a large-scale overview of sewer flooding in the catchment. The Environment Agency highlight that it is unlikely the report will represent the true scale of sewer flooding; these factors are generally better assessed at the local scale and therefore cannot always be completed at the strategic scale.

3.5.33 Scott Wilson are currently completing a Water Cycle Study for Southend-on-Sea BC which identifies capacity issues in the borough where the likelihood of Sewer Flooding may be increased. The Water Cycle Study should be referred to for more information.

3.5.34 It is recommended that information regarding localised sewer flooding issues is requested when preparing site-specific Flood Risk Assessments (FRAs).

Geological Mapping

3.5.35 Groundwater flooding is usually associated with chalk and limestone catchments that allow groundwater to rise to the surface through the permeable subsoil following long periods of wet weather; this is also associated with drift aquifers in the area.

3.5.36 Information regarding the solid and drift geology within the study area has been obtained from BGS mapping and is presented in Figure 13. This provides an overview of the geology in the study area and therefore a coarse level overview of the probability of groundwater flooding issues.

Artificial Sources / Infrastructure Failure

3.5.37 Artificial sources of flooding can include reservoirs, canals and lakes where water is retained above natural ground level. Failure of such a structure could result in rapid inundation of the surrounding area with little or no warning. These artificial sources can be identified on Ordnance survey mapping along with the presence of any embankments, which would retain water above ground level.

Emergency Planning

3.5.38 The South Essex CFMP identifies areas within Southend-on-Sea BC that fall within Environment Agency flood warning areas. Southend-on-Sea BC is in the process of preparing a Multi Agency Flood Plan for the borough to support the Local Development Framework.

Development Sites

3.5.39 Southend-on-Sea BC has provided GIS information for the three proposed Area Action Plans (AAP) in the borough where growth is to be directed to enable their identification in relation to the different flood sources. These include the Town Centre AAP and Shoeburyness and London Southend Airport JAAP.

Minerals and Waste Sites

3.5.40 Essex County Council is currently preparing their Minerals and Waste Strategic Flood Risk Assessment which will include consideration of the minerals and waste sites located in Southend-on-Sea BC. Therefore these will not be assessed further in this study.

4 Level 1 Assessment

4.1 Requirements of PPS25

4.1.1 The Level 1 SFRA assessment methodology is based on available existing information and data. This section forms the main results of the Level 1 SFRA; it describes the data used in the production of mapping and GIS deliverables for the project as well as a summary of the results presented.

4.1.2 Planning Policy Statement 25 and its accompanying Practice Guide requires SFRAs to present sufficient information on all flood sources to enable local planning authorities to apply the Sequential Test in their administrative areas. Information is required on the probability (High, Medium and Low) associated with flooding from the different flood sources. This information should be presented graphically where possible as a series of figures and/or maps.

4.1.3 In addition, the assessment of probability should also account for the effects of climate change on a flood source for the lifetime of any development that would be approved through the emerging Local Development Framework. In this case, climate change has been considered for 100 years as advised by Paragraph 3.102 of the PPS25 Practice Guide.

4.1.4 For flood sources other than tidal and fluvial, the current lack of data makes definition of robust classifications of probability unreliable. For example to define high, medium and low probabilities for groundwater flooding within the study area when no information has been provided regarding previous incidents is not particularly robust. Consequently, for all flood sources other than tidal and fluvial, where only anecdotal evidence of flooding is available, subjective assessments of probability have been made where the data allows.

4.1.5 In some cases, definitions of probability are not practical or are unreliable; in these situations the flood risk from a particular source should be considered as 'medium' until proven otherwise and should be investigated through a site-specific assessment of flood risk submitted as part of a planning application. Details of the requirements for site-specific Flood Risk Assessments (FRAs) are presented in Section 9.

4.2 GIS Layers and Mapping

4.2.1 Geographical data such as flood extents and watercourse routes have been presented as maps (Appendix A) and published through Geographical Information System (GIS) layers.

4.2.2 GIS is an effective management tool for the coordinated capture, storage and analysis of data of a geographical nature. GIS handles data in a hierarchical manner by storing spatial features within various layers, which are allied to an underlying database. GIS is an increasingly valuable resource for Local Planning Authorities for informing planning decisions.

4.2.3 A summary of GIS layers generated for use in this SFRA is presented below including a summary to identify which GIS layers have been used in the production of the maps and figures presented with Appendix A of this Level 1 SFRA.

Table 4-1: GIS Layers

Name	Details	Presented within Figure No's
Council_boundary_ Southend-on-Sea BC	Study area boundary, Southend-on-Sea BC	All
Main_Rivers	EA designated main river centrelines	1
Main_urban_centres	Key urban centres in Southend-on-Sea Borough Council	1
Bedrock	British Geological Survey solid geology, 1:50,000 scale	13
Drift_geology	British Geological Survey drift deposits geology, 1:50,000 scale	13
LiDAR_DTM	LiDAR Topographic Data	3
Flood_Zone_2	EA Flood Zone 2 extents - 2010	4
Flood_Zone_3	EA Flood Zone 3 extents - 2010	4
Flood_Zone_3b	EA Flood Zone 3b extents 2010	4
Flood Zone 2010	From overtopping modelling extents	5
Flood Zone 2110	From overtopping modelled extents	6
Flood_defences_NFCDD	EA national flood and coastal defences database	7
Suds_recommended	Type of SuDS appropriate, based on geology	14
Rest_centres	Emergency planning rest/reception centres	10
Historic Flooding	Outlines of historic flooding	2
Defence Ownership	Flood defence ownership	8
Contaminated Land	Sites of contaminated land useful for consideration of SuDS methods	11
Flood cells and breach locations	Outlines of the flood cells and breach locations modelled for the SFRA	12
Areas Susceptible	Mapping of the Areas Susceptible to Surface Water Flooding	9
Areas at risk of overtopping-west	Inundation areas at risk from overtopping during 1 in 200 and 1 in 1000 year scenarios (both 2010 and 2110) in the west of the borough.	15
Areas at risk of overtopping-east	Inundation areas at risk from overtopping during 1 in 200 and 1 in 1000 year scenarios (both 2010 and 2110) in the west of the borough.	16

4.3 Tidal Flooding

Requirements

4.3.1 PPS25 requires definition of the following tidal Flood Zones:

Table 4-2: Tidal Flood Zone Definitions (as defined in PPS25, Table D.1)

Flood Zone	Definition	Probability of Flooding
Flood Zone 1	Land at risk from flood event less than the 1 in 1000 year event (less than 0.1% annual probability of flooding each year)	Low Probability
Flood Zone 2	Land at risk from flood event between the 1 in 200 and 1 in 1000 year event (between 0.5% and 0.1% annual probability of flooding each year)	Medium Probability
Flood Zone 3a	Land at risk from flood event equal to, or greater than, the 1 in 200 year event (greater than 0.5% annual probability of flooding each year)	High Probability
Flood Zone 3b	Land where water has to flow or be stored in times of flood, or land purposely designed to be flooded in an extreme flood event (0.1% annual probability). The 1 in 20 year annual probability floodplain is the starting point for consideration but local circumstances should be considered and an alternative probability can be agreed between the Local Planning Authority and the Environment Agency	Functional Floodplain

Climate Change

4.3.2 The Flood Zones should also be defined considering the effects of climate change. When mapping climate change Flood Zones for tidal systems, PPS25 requires that sea level rise is applied up to 2115 along the East coast of England as shown in Table 6-3.

Table 4-3 Recommended contingency allowances for net sea level rise (PPS25 Table B.1)

Administrative Region	Net Sea Level Rise (mm/yr) Relative to 1990			
	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
East of England, East Midlands, London, SE England (south of Flamborough Head)	4.0	8.5	12.0	15.0

4.3.3 Water levels were taken from 'Environment Agency: Thames Tidal Defences Joint Probability Extreme Water Levels 2008, Final Modelling Report, April 2008' preferentially where available and appropriate for particular breach locations. Where this study did not cover particular breach locations 'Environment Agency, Anglian Region, Eastern and Central Areas Report on Extreme Tidal Levels, 2007' was used to obtain water level information. Where nodes were present within close proximity to specific breach locations unmodified water levels were used. Where a significant distance was present between the modelled nodes within the Extreme Tidal Levels study and the Southend-on-Sea BC breach locations water levels from the Extreme Tidal Levels study were factored based on chainage to provide more realistic water levels.

Data Sources & Mapping

Flood Levels

4.3.4 The water levels for this stretch of the Thames are presented in the Thames Tidal Defences Joint Probability Extreme Water Levels 2008, Final Modelling Report, prepared by Halcrow for the Environment Agency and published in April 2008. A similar report was completed for the North Sea along the eastern boundary of the borough in 2007, the Eastern and Central Areas Report on Extreme Tide Levels 2007 (Environment Agency.)

Flood Zones (2010)

4.3.5 Figure 4 shows the Flood Zones affecting Southend-on-Sea BC for the present day (2010). The Flood Zones associated with the River Thames and North Sea are those provided by the Environment Agency, produced by projecting the extreme tidal levels onto a DTM to determine the extent of flooding.

4.3.6 This mapping does not take into consideration the presence of existing flood defence structures. Figure 7 shows that Southend-on-Sea BC is protected from defences ranging in standard from a 1 in 1000 year event to a 1 in 10 year event. Therefore the defences are below standard in some places and would be overtopped by still water levels which are mapped in Figures 15 and 16.

Flood Zones (2110)

4.3.7 Figure 6 shows the Flood Zones affecting Southend-on-Sea BC with allowances made for climate change (2110). These flood zones have been determined through hydraulic modelling outputs from overtopping only scenarios for the tidal flood plain i.e. these are actual risk floodplain extents for 2110 not residual risk.

Flood Hazard Rating (2010)

4.3.8 Hydrodynamic breach modelling has been carried out at 9 locations along the Southend-on-Sea BC frontage, identified in Figure 12, to assess the residual risk behind the tidal defences. The precise breach locations and detailed methodology as well as associated hazard maps are included within the Level 2 SFRA report. Where the defences are below standard the breach modelling also includes the effects of overtopping.

Historical Records

4.3.9 The South Essex CFMP records details of major tidal flooding along the east coast of England in January/February 1953. An intense low-pressure system developed in the North Sea sending a storm surge south along the east coast and creating a tide level if 5.03m AOD, the highest ever recorded. Existing flood defences were overtopped and a significant proportion of Southend-on-Sea BC was flooded, as detailed in Table 4-5.

Table 4-5: Historic Tidal Flood Events within Southend-on-Sea BC, extract South Essex CFMP, 2008

Event	Locations affected	Consequences of flooding
January 1953	Thorpedene and Southchurch Park	Southend Kursaal flooded, along with the Thorpedene area, Southchurch Park and the Gasworks. Several people lost their lives at the squatter camp at

Event	Locations affected	Consequences of flooding
		Wakering Common.

Functional Floodplain

4.3.10 One of the requirements of PPS25 is that the Functional Floodplain, Flood Zone 3b, should be identified and mapped to highlight those areas where only water-compatible or essential infrastructure uses are recommended. The flood defences along the Southend-on-Sea BC frontage provide protection from the 1 in 20 year tidal event, therefore there is no tidal functional floodplain present in Southend-on-Sea BC associated with the River Thames and North Sea.

4.4 Fluvial Flooding

Requirements

4.4.1 In order for the Level 1 SFRA to assist in the completion of the Sequential Test, PPS25 requires definition of the following fluvial Flood Zones:

Table 4-6: Fluvial Flood Zone Definitions (as defined in PPS25, Table D.1)

Flood Zone	Definition	Probability of Flooding
Flood Zone 1	Land at risk from flood event less than the 1 in 1000 year event (less than 0.1% annual probability of flooding each year)	Low Probability
Flood Zone 2	Land at risk from flood event between the 1 in 100 and 1 in 1000 year event (between 1.0% and 0.1% annual probability of flooding each year)	Medium Probability
Flood Zone 3a	Land at risk from flood event equal to, or greater than, the 1 in 100 year event (greater than 1.0% annual probability of flooding each year)	High Probability
Flood Zone 3b	Land where water has to flow or be stored in times of flood, or land purposely designed to be flooded in an extreme flood event (0.1% annual probability). The 1 in 20 year annual probability floodplain is the starting point for consideration but local circumstances should be considered and an alternative probability can be agreed between the Local Planning Authority and the Environment Agency	Functional Floodplain

4.4.2 The PPS25 Practice Guide states that all areas within Flood Zone 3 should be considered as Flood Zone 3b unless, or until, appropriate assessment shows to the satisfaction of the Environment Agency that the area falls within Flood Zone 3a. Therefore, in areas where the functional floodplain has not been defined and no suitable surrogate data is available the functional floodplain (Flood Zone 3b) should be defined as the extent of Flood Zone 3a.

4.4.3 PPS25 states that functional floodplain should be determined considering the effects of defences and other flood risk management infrastructure. The functional floodplain relates only to river and coastal flooding, it does not include areas at risk of flooding solely from other sources of flooding (e.g., surface water, sewers).

Climate Change

4.4.4 The Flood Zones should be defined considering the effects of climate change. For fluvial systems, PPS25 requires an increase of 20% in peak flows to be used when mapping climate change Flood Zones up to 2115.

Data Sources & Mapping

Flood Zones (2010)

4.4.5 Flood Zone mapping for the River Thames has been produced based on extreme tidal levels since this presents a more conservative scenario than the fluvial level associated with this flood source.

4.4.6 The Flood Zones for Prittle Brook, Eastwood Brook and Willingale watercourse for the present day (2010) have been created from outputs from the CFMP hydraulic models provided by the Environment Agency and are included in Figure 4. The 1 in 1000 year event, 1 in 100 year event and 1 in 20 year event were used to map Flood Zones 2, 3a and 3b respectively.

4.4.7 The maximum water level at each node within the hydraulic model has been extracted and used to create a water surface which can then be compared with the DTM of the study area to determine the extent of the flood outline.

Flood Zones (2110)

4.4.8 There are no climate change outlines available for the fluvial systems in the borough. Therefore these have not been mapped.

Historic Records

4.4.9 Table 4-7 details two fluvial flood events associated with the Prittle and Eastwood Brooks in Southend-on-Sea BC.

Table 4-7: Historic Fluvial Flood Events in Southend-on-Sea BC, extract South Essex CFMP, 2008

Date	Source	Locations affected
September 1968	Prittle and Eastwood Brooks	176 houses and 300 gardens flooded from the Prittle Brook and 31 houses and 55 gardens flooded from the Eastwood Brook.
July 1981	Eastwood Brook, Southend Airport	Hanger at Southend Airport flooded.

4.5 Surface Water Flooding

Summary of surface water flood risk from the Southend-on-Sea BC SWMP

4.5.1 The low elevations and flat topography of the Shoeburyness area is conducive to surface water ponding. This area falls within the Council's Seafront Area Action Plan (AAP) in which future development and new growth is proposed.

4.5.2 Southchurch Park, previously fed by tidal inflows, is also a low-lying area that is susceptible to surface water ponding. This area includes two balancing ponds which collect surface water runoff from the residential area to the north. Anglian Water maintain a series of pumping stations which

pump surface water outflows from the balancing ponds south to the Thames estuary. There is also an EDF electrical substation close by which may be at risk from surface water flooding.

Balancing pond, Southchurch

Anglian Water pumping station, Southchurch

4.5.3 Surface water flooding impacts a number of roads around the borough including Angel Roundabout, Harp House roundabout, Eastern Road and Chalkwell Avenue, as well as railway lines. These highways create key pathways for surface water flows during periods of heavy rainfall.

4.5.4 Parts of the Town Centre AAP area may be at risk of surface water flooding including land between Victoria Avenue and Baxter Avenue, and land west of Sutton Road, particularly from Vale Avenue south to Greyhound Way. Any future development proposed for this area should take due consideration for the impact of surface water flowpaths to the development as well as the effective management of surface water on the site.

4.5.5 The corridors of Prittle Brook, Eastwood Brook and Mucking Hall Brook and their associated tributaries are susceptible to surface water flooding as these areas lie in the flowpaths created by the local topography and are affected by the local built environment (roads, culverts, and bridges). The catchments of these watercourses are highly urbanised and therefore the surrounding residential properties are at risk form surface water flows directed towards these watercourses.

4.5.6 Further details on the critical drainage areas within Southend-on-Sea BC are contained within the Surface Water Management Plan for the borough, anticipated in Spring 2011.

4.6 Sewer Flooding

4.6.1 Anglian Water Services has supplied their DG5 Register covering Southend-on-Sea BC. Four properties and one highway were identified as being at risk of sewer flooding according to the DG5 register. These historic records suggest that sewer flooding is not a widespread problem in the borough and incidents are isolated rather than clustered around a particular area suggesting that the problem may be the maintenance of gulleys rather than capacity.

4.6.2 Further details on the sewer flooding issues are contained within the Water Cycle Study which identifies areas with capacity issues within the borough.

4.7 Groundwater Flooding

Evidence of Groundwater Flooding

4.7.1 No groundwater flooding incidents within the study area have been reported to the Environment Agency. There is one incident reported to the Council between 1998 and 2005 related to the flooding of a basement in the south seafront area where the Tidal Flat deposits or Blown Sand outcrops at surface. In addition, ponding of water adjacent to the drainage ditch known as the 'River Shoe', as well as other locations in Shoeburyness is thought to be linked to high groundwater levels.

Summary of Groundwater Flood Risk from the SWMP

- An initial assessment of the geology and hydrogeology underlying the borough shows that there is potential for groundwater flooding within the Southend-on-Sea BC administrative area.
- There is evidence of high Chalk aquifer groundwater levels which are confined by the London Clay and therefore not relevant to this study. Drift aquifer groundwater levels are not known and should be determined through site investigation as part of site-specific planning applications.
- It is recommended that a more site-specific desk study should take place for the proposed development areas where there is thought to be potential for groundwater flooding.

4.7.2 Groundwater flooding is considered in more detail in the Surface Water Management Plan.

4.8 Artificial Sources

Requirements

4.8.1 PPS25 requires that artificial water sources within the study area are identified as part of a SFRA. These include canals, reservoirs, ponds, and any feature where water is held above natural ground level.

Data Sources & Mapping

4.8.2 Figure 1 shows artificial water sources within the study, which may need to be taken into consideration when carrying out site-specific FRAs for individual development sites in close proximity. A summary of these water bodies and the presence of embankments are shown in Table 4-9 below:

Table 4-9: Ponds/Lakes located within Southend-on-Sea BC

Location	Type	Approximate Coordinates		Approximate Plan Area (km^2)	Defences from LiDAR
		Easting	Northing		
Prittlewell Priory	Pond	587713	187204	0.005	None obvious
North of Garon Park	Small pond	589454	187982	0.005	Some embankments shown in Lidar
North of Garon Park	Small pond	589863	187993	0.003	Surrounded by some higher ground
North Shoebury	Pond/lake	593965	186230	0.005	Small embankments

Location	Type	Approximate Coordinates		Approximate Plan Area (km^2)	Defences from LiDAR
		Easting	Northing		
North Shoebury	Pond/lake	593845	186170	0.006	Small embankments
North of Shoebury Point and railway	Pond/lake	593070	185537	0.007	No evidence
Chalkwell park	Balancing pond	590271	185068	0.009	Some small embankments may be present
Southchurch Park	Balancing pond	589834	184995	0.011	No embankments
South of Suttons	Small pond	594469	185341	0.002	May be some embankments
Museum	Series of ponds	589366	185502	0.004	May be some embankments but not certain
Shoebury park	Pond	593324	184054	0.02	Embanked and culverted to the sea so could be tide-locked.

4.8.3 None of the stakeholders contacted throughout this study hold any records of flooding arising from artificial sources and/or infrastructure failures.

5 PPS25 Sequential Test

5.1 What is the PPS25 Sequential Test?

5.1.1 The PPS25 Sequential Test is a process by which the precautionary principle is applied to the strategic land allocation process. PPS25 requires local planning authorities to review flood risk across their districts, steering all development towards areas of lowest risk. Development is only permissible in areas at risk of flooding in exceptional circumstances where it can be demonstrated that there are no reasonably available sites in areas of lower risk, and the benefits of that development outweigh the risks from flooding. Such development is required to include mitigation/management measures to minimise risk to life and property should flooding occur, and wherever possible identify opportunities to reduce the overall flood risk posed to the local community.

5.1.2 A Level 1 SFRA is designed to be sufficiently detailed to allow the application of the Sequential Test to the Core Strategy Document, on the basis of PPS25 Table D.1 (reproduced as Tables 6-2 and 6-4) and Figure 4.1 of its Practice Guide. In order to apply the Sequential Test to the Site Specific Allocations DPD a Level 2 SFRA will be required which provides a more detailed assessment of the variation in flood risk across Southend-on-Sea BC.

5.1.3 PPS25 acknowledges that some areas will (also) be at risk of flooding from sources other than tidal and fluvial. Consequently all sources of flooding must be considered when looking to locate new development. The other sources of flooding requiring consideration when situating new development allocations include:

- Surface Water / Overland Flow;
- Groundwater;
- Sewers; and
- Artificial Sources.

5.1.4 These sources are typically less well understood than tidal and fluvial sources and as a result, data only exists as point source data or through interpretation of local conditions. In addition, there is conflicting guidance on suitable return periods to associate with floods arising from these sources. For example, modern surface water drainage systems are constructed to a 1 in 30-year standard. Any rainfall event in excess of the 30-year return period would be expected to result in some flooding through insufficient capacities. Consequently when assessing these sources through the Sequential Test, where a location is recorded as having experienced repeated flooding from the same source this should be investigated further in a site-specific Flood Risk Assessment (FRA).

5.2 Development Vulnerability Classifications

5.2.1 Planning Policy Statement 25 classifies developments according to their vulnerability. Five vulnerability classifications are defined, these are:

- Essential Infrastructure;
- Highly Vulnerable;
- More Vulnerable;
- Less Vulnerable, and
- Water Compatible.

5.2.2 Table 5-1 shows the types of development that fall under these different classifications.

Table 5-1: PPS25 Table D2 Flood Risk Vulnerability Classification (CLG, 2010)

Vulnerability Classification	Development Uses
Essential Infrastructure	• Essential transport infrastructure (including mass evacuation routes), which has to cross the area at risk, • Essential utility infrastructure which has to be located in a flood risk area for critical operational reasons, including electricity generating power stations and grid and primary substations; water treatment plants; and sewage treatment plants if adequate measures to control pollution and manage sewage during flooding events are in place. • Wind turbines.
Highly Vulnerable	• Police stations, Ambulance stations and Fire stations and Command Centres and telecommunications installations required to be operational during flooding. • Emergency dispersal points. • Basement dwellings. • Caravans, mobile homes and park homes intended for permanent residential use. • Installations requiring hazardous substances consent.[1] (Where there is demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as 'Essential Infrastructure'.
More Vulnerable	• Hospitals. • Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels. • Buildings used for: dwelling houses; student halls of residence; drinking establishments; nightclubs; and hotels. • Non–residential uses for health services, nurseries and educational establishments. • Landfill and sites used for waste management facilities for hazardous waste. • Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.
Less Vulnerable	• Police, ambulance and fire stations which are not required to be operational during flooding • Buildings used for: shops; financial, professional and other services; restaurants and cafes; hot food takeaways; offices; general industry; storage and distribution; non–residential institutions not included in 'more vulnerable'; 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 working). • Water treatment plants.
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 and essential facilities such as changing rooms. • Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.

[1] DETR Circular 04/00, paragraph 18: *Planning controls for hazardous substances.*

See www.communities.gov.uk/index.asp?id=1144377

5.2.3 PPS25 also stipulates where the differing types of vulnerable development may be appropriate based on flood risk, This is presented in Table D.3 of PPS25, which is reproduced below.

Table 5-2: PPS25 Table D3 Flood Risk Vulnerability and Flood Zone 'Compatibility' (CLG, 2010)

Flood Risk Vulnerability Classification (Table D.2 PPS25)		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	1	✓	✓	✓	✓	✓
	2	✓	✓	Exception Test required	✓	✓
	3A	Exception Test required	✓	X	Exception Test required	✓
	3B	Exception Test required	✓	X	X	X

✓ – Development is appropriate (subject to the Sequential Test) ✗ – Development should not be permitted

5.2.4 Using the information documented and mapped within this Level 1 SFRA, the Sequential Test should be undertaken for development within Southend-on-Sea BC. This process should be accurately documented to ensure decisions can be transparently communicated and reviewed where necessary.

5.2.5 The Sequential Test should be carried out on all development sites and seek to guide development to the lowest flood risk areas. Only where there are no reasonably available alternative sites to accommodate the development should sites in Flood Zones 2 or 3 be considered.

5.2.6 The Level 1 SFRA mapping provides the tools for the Sequential Test to be undertaken. This is achieved by presenting information to identify the variation in flood risk across the administrative area and allowing an area-wide comparison of future development sites with respect to flood risk considerations.

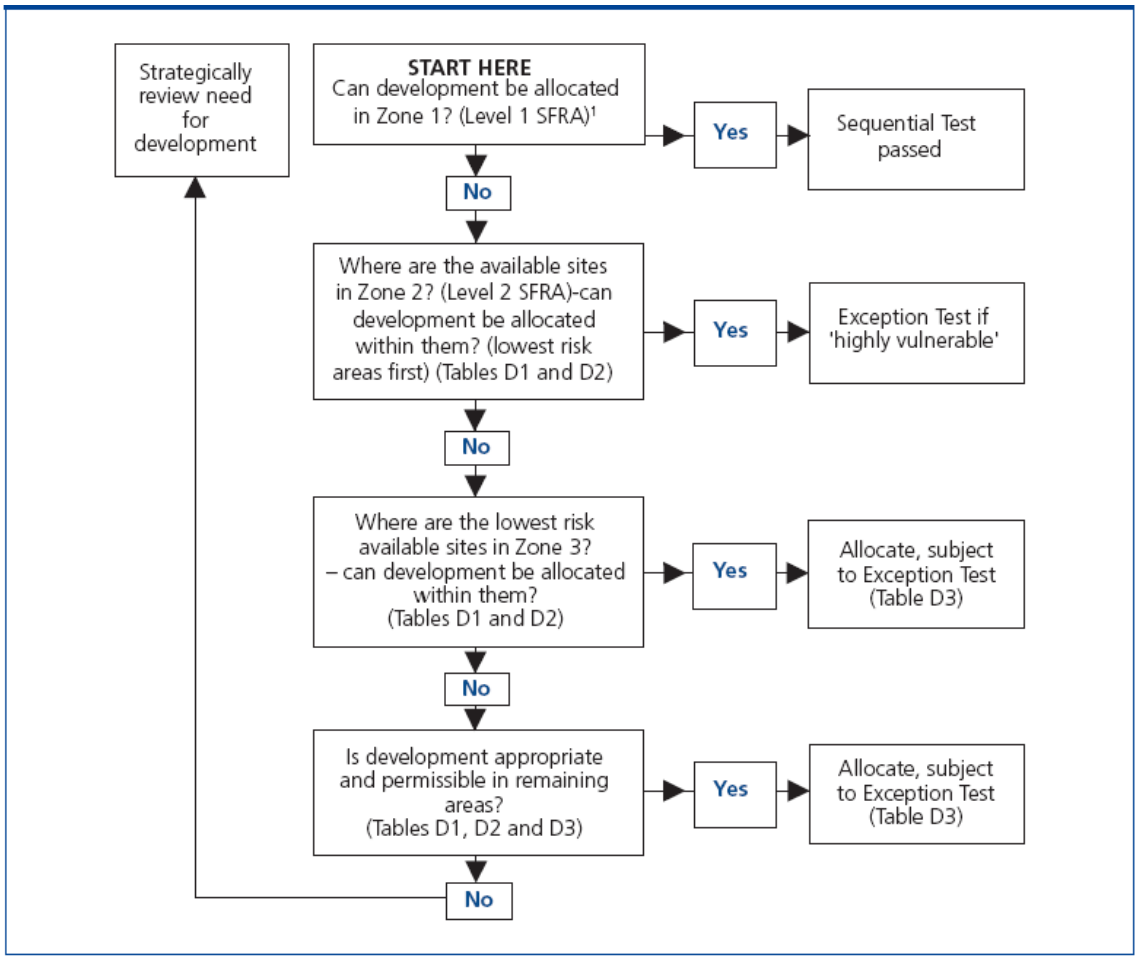
5.3 Southend-on-Sea BC Guidance

5.3.1 An agreement was made between Southend-on-Sea BC, government office and the Environment Agency that the Sequential Test need only be applied within the Area Action Plan (AAP) boundaries specific to the development proposed in each of the councils AAPs. The Central AAP also includes the Sea Front area proposed for regeneration. For the purposes of this AAP alone, the Sequential Test for Sea Front areas should only be compared to other sites in the Sea Front area and not the entire Central AAP boundary.

5.3.2 Any windfall sites or sites outside of the AAP areas would need to be assessed against the whole local authority study area.

5.3.3 The following flow diagram (Figure 5-1) is taken from the PPS25 Practice Guide and illustrates how the Sequential Test should be undertaken. The full process is described in Chapter 4 of the PPS25 Practice Guide (2009).

Figure 5-1: Application of the Sequential Test (from Figure 4.1 of PPS25 Practice Guide, 2010)



Note

1 Other sources of flooding need to be considered in Flood Zone 1

Using the SFRA Maps, Data and GIS Layers

5.3.4 Table 5-3 highlights which GIS layers and SFRA data should be used in carrying out the Sequential Test. The table poses some example questions that are not exhaustive, but should provide some guidance for a user of the SFRA.

5.3.5 Appendix D summarises the steps required to maintain and update the SFRA together with a revision schedule. This should be checked to prior to the SFRA being used at a strategic land allocation scale or on a Development Control level to ensure the most current and up-to-date version of the SFRA is being used. In addition, close consultation with some of the key stakeholders, in particular the EA, may highlight updated flood risk information that may reduce uncertainty and ensure the Sequential Test is as robust as it can be.

Additional Guidance

5.3.6 The sequence of steps presented below, coupled with Figure 5-1 provides a guide for the application of the Sequential Test and, where necessary, that the requirement for the application of the Exception Test is clearly identified.

5.3.7 Recommended stages for application of the Sequential Test:

1. The developments (i.e. housing, hospitals, industrial etc) that need to be accommodated should be assigned a vulnerability classification in accordance with Table D.2 "Flood Risk Vulnerability Classification" in PPS25;
2. The Flood Zone classification of all development sites should be determined based on a review of the Environment Agency Flood Zone maps and the Flood Zones presented in this Strategic Flood Risk Assessment. This should consider the effects of climate change on Flood Zone definition for the design life of any development that the site may be suitable for, i.e.:

- 75 years – up to 2085 for commercial / industrial developments; and
- 100 years – up to 2110 for residential developments

3. In the first instance the 'highly vulnerable' developments should be located in those sites identified as being within Flood Zone 1. If the 'highly vulnerable developments' cannot be located in Flood Zone 1, because the identified sites are unsuitable or there are insufficient sites in Flood Zone 1 then sites in Flood Zone 2 can be considered but will be subject to the Exception Test. According to PPS25 'highly vulnerable' uses would not be permitted in Flood Zone 3.
4. Once all 'highly vulnerable' developments have been allocated to a development site, Southend-on-Sea BC can consider development types defined as 'more vulnerable'. In the first instance 'more vulnerable' development should be located in any unallocated sites in Flood Zone 1. Where these sites are unsuitable or there are insufficient sites, sites in Flood Zone 2 can be considered. If there are insufficient sites in Flood Zone 1 or 2 to accommodate the 'more vulnerable' development types, sites in Flood Zone 3a can be considered but will require the application of the Exception Test. When allocating in Flood Zone 3a the hazard rating of the site, as defined in the Level 2 SFRA, must also be considered with development being preferentially steered to those sites of least hazard. Evidence to support parts 'a' and 'b' of the Exception Test should be established before 'part c' is tackled. 'More vulnerable' developments are not permitted in Flood Zone 3b.
5. Once all 'more vulnerable' developments have been allocated to a development site, Southend-on-Sea BC can consider those development types defined as 'less vulnerable' which can be located in any remaining unallocated sites in Flood Zones 1, 2 or 3a. Again, sites with the highest hazard rating should be avoided wherever possible. 'Less vulnerable' development types are not permitted in Flood Zone 3b.
6. 'Essential infrastructure' developments should also be preferentially located in the lowest flood risk zones, however this type of development can be located in Flood Zones 3a and 3b subject to the Exception Test being passed. Where these types of developments are required in Flood Zones 3a or 3b, evidence to support parts 'a' and 'b' of the Exception Test should be established before part 'c' is tackled.
7. Water compatible development typically has the least flood risk constraints and it is therefore recommended to consider these types of development last when allocating development sites.
8. For decisions made through stages 4 to 7 it will also be necessary to consider the risks posed to the site from other flood sources.

Table 5-3: Sequential Test Key - A Guide to using the GIS Layers

Category	GIS Layer	Example Questions
Development Vulnerability	Not applicable refer to Table D2 in PPS25	**Question 1** – Is the proposed development defined as 'highly vulnerable' according to Table D2 in Planning Policy Statement 25?
		Question 2 - Is the proposed development defined as 'more vulnerable' according to Table D2 in Planning Policy Statement 25?
		Question 3 - Is the proposed development defined as 'less vulnerable' according to Table D2 in Planning Policy Statement 25?
		Question 4 - Is the proposed development defined as 'essential infrastructure according to Table D2 in Planning Policy Statement 25?
		Question 5 - Is the proposed development defined as 'water compatible development' according to Table D2 in Planning Policy Statement 25?
Flood Zone Classification	SFRA combined fluvial & tidal FZ2, FZ3a & FZ3b layers. Also examine historical floodplain and take into consideration climate change outlines.	**Question 6** – Through consultation of the Environment Agency's flood zone maps, is the development site located in Flood Zone 1?
		Question 7 - Through consultation of the Environment Agency's flood zone maps, is the development site located in Flood Zone 2?
		Question 8 - Through consultation of the Environment Agency's flood zone maps, is the development site located in Flood Zone 3a?
		Question 9 - Through consultation of the SFRA maps, is the development site located in Flood Zone 3b?
		Question 10 - Can the development be located in Flood Zone 1?
		Question 11 - Can the development be located in Flood Zone 2?
		Question 12 - Can the development be located in Flood Zone 3a? *- Can the development be located in area of Low Hazard?* *- Can the development be located in area of Significant Hazard?* *(followed sequentially by Significant and Extreme Hazard Ratings).*
	CEH watercourse network & EA main river maps.	**Question 13 -** Is the site located within 20m of a watercourse?

Category	GIS Layer	Example Questions
Other Flood Sources	SFRA combined fluvial and tidal FZ3 & FZ2 outlines plus climate change	**Question 14 –** Is the site impacted by the effects of climate change?
	Sewer Flood Layer & Historical Flood Outlines	**Question 15** - Is the site in an area potentially at risk from sewer flooding?
	Areas Susceptible to Surface Water Flooding Mapping, Historical Flood Outlines, Parish Council data, GEZ, CEH stream network (BFI) and groundwater vulnerability maps	**Question 16** - Is the site in an area potentially at risk from overland flow flooding?
		Question 17 - Is the site located in an area of rising groundwater levels?
		Question 18 - Does the site have a history of flooding from any other source?
Flood Risk Management	Flood Defence Layer (NFCDD), Flood Warning Layer, Areas Benefiting from Flood Defences Layer, Parish Council data	**Question 19** - Does the site benefit from flood risk management measures?
		Question 20 - Can the development be relocated to an area benefiting from flood risk management measures or of lower flood risk?

6 Guidance on Applying the PPS25 Exception Test

6.1 Why is there an Exception Test?

6.1.1 The aim of the Sequential Test is to steer all development towards areas of lowest risk. However, PPS25 recognises that in some exceptional circumstances, it may not be possible to locate development in areas of low or appropriate flood risk with respect to the vulnerability classification of the development. Where the Sequential Test has been carried out and it is shown that there are no reasonably available sites in lower flood risk areas, the Exception Test will then be required in some circumstances.

6.1.2 Through the application of the Exception Test any additional wider sustainability benefits resulting from development can be taken into account in order to demonstrate that the benefits for development of a site outweigh the flood risks to the development and its occupants.

6.2 What is the Exception Test?

6.2.1 The Exception Test is a series of three criteria as shown below, all of which must be satisfied for development in a flood risk area to be considered acceptable. For the Exception Test to be passed:

a) It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA. For this criteria to be passed, the site/broad area must be shown to positively contribute to the aims and objectives of the Sustainability Appraisal. Where this is not the case, it must be considered whether the use of planning conditions or S106 agreements could make it do so. If neither of these are possible, the site is not deemed to pass part 'a' and the allocation should be refused;

b) The development should be on developable previously developed land or, if not, it must be demonstrated there is no such alternative land available; and

c) A Flood Risk Assessment (FRA) must demonstrate that the development will be safe, without increasing flood risk elsewhere, and, where possible, reducing flood risk overall. At the level of strategic planning the SFRA must be used in order to assess the potential feasibility of providing flood risk management measures for site allocations/broad development locations.

6.2.2 All three parts of this test must be satisfied in order for the development to be considered appropriate in terms of flood risk. There must be robust evidence in support of every part of the test.

6.2.3 This report is intended as a Level 1 SFRA to inform the application of the Sequential Test. Further detail required to inform the Exception Test is provided in the accompanying Level 2 SFRA.

7 Flood Risk Management Policy Recommendations

7.1 Overview

7.1.1 This chapter provides policy recommendations that should be incorporated into the LDF/LDDs for Southend-on-Sea BC to ensure that the objectives of the Environment Agency and national policies are met and to strengthen the Council's position with respect to flood risk management.

7.1.2 The policy recommendations in this chapter are not exhaustive and it is therefore recommended that Southend-on-Sea BC refer to the following key flood risk management documents in order to fully inform their own flood risk management policies:

- **Planning Policy Statement 25: Development and Flood Risk (CLG 2010)** – sets out national policy for development and flood risk and supports the Government's objectives for sustainable communities.
- **CFMPs** – strategic planning document through which the Environment Agency will work with other stakeholders to identify and agree policies for long-term flood risk management over the next 50 to 100 years.
- **Making Space for Water (2004)** – outlines the Government's proposals for forward planning of flood management over the next 20 years advocating a holistic approach to achieve sustainable development. The protection of the functional floodplain is central to the strategy.
- **Water Framework Directive** - European Community (EC) water legislation which requires all inland and coastal waters to reach good ecological status by 2015.
- **Flood and Water Management Act (2010)** – designed to put in place the changes recommended by Sir Michael Pitt with respect to local flood risk management , following his review into the floods of July 2007 (Pitt, 2008).
- **Regional Flood Risk Appraisal, 2009**- The Regional Flood Risk Appraisal (RFRA) for the East of England was commissioned by the East of England Regional Assembly (EERA). This document contains information on the approach to assessing flood risk and the evidence that should be used to inform the East of England Regional Spatial Strategy and provides a high level assessment of flood risk across the East of England.

7.2 Policy Considerations

Thames Estuary 2100 (TE2100) March 2010

7.2.1 Thames Estuary 2100 is an Environment Agency initiative, which aims to determine the appropriate level of flood protection needed for London and the Thames Estuary for the next 100 years. The Project has split the Thames Estuary into 23 separate Policy Management Units (PMU) based upon the character of the local area and where the floodwaters would flow during a flood event. Each PMU offers different opportunities for managing flood risk, both at a local level and on an estuary-wide scale and has therefore been subject to a number of detailed studies and appraisals to assist TE2100 in identifying a flood risk management policy specific to the area. Table 7-1 summarises the preferred policy options for PMUs present within Southend-on-Sea BC.

Table 7-1: Policy Management Options from TE2100 for Southend-on-Sea BC

Policy Management Unit PMU	Recommended Preferred Option
Leigh-on-Sea and Southend-on-Sea (Action Zone 8)	This PMU has a continuous sea frontage with beaches and very extensive (designated) intertidal areas and a pier. Whilst most of Southend-on-Sea is on high ground and not at risk from tidal flooding, much of the sea front is at risk of flooding and there is a flood defence along the entire frontage. There are five schools, six care homes and 21 electricity sub stations within the flood risk area. This is an important amenity and recreation area, with a parallel road and footpaths along much of the frontage. The two main areas of floodplain are to the east of the city centre. **Policy P4 to take further action to keep up with climate and land use change so that flood risk does not increase.** The number of properties at risk is relatively small. The flood risk is 0.5% (or 1:200) per annum or greater. Leigh-on-Sea has a narrow but historic frontage bounded by the railway line to the north. It has close links with the estuary with a strong fishing tradition, and floodplain management is practised to avoid creating a barrier between the village and the Estuary. The defence level is therefore low and properties have been built with raised thresholds and other resilience measures to protect against tidal flooding. There is some evidence that more recent riverside users are unaware of this and stock for shops is stored in the floodable area. Any raised or new defences on the Southend-on-Sea frontage should be designed so that: • They do not encroach into the Estuary. • The raised part of the defences could consist of a new defence on a new alignment behind the sea front where space permits (for example, park areas) so that the heights of walls on the sea front are limited. • Walkways are raised to provide sea views, and access points are improved. • Demountable defences and gated access points may be included in the designs in some areas providing that satisfactory arrangements can be made for security of closure. The Southend-on-Sea frontage is subject to wave attack and overtopping. Beach recharge has been implemented both to improve the beach and reduce the impacts of waves. Improvements to this approach would reduce the need for defence raising.
Lower Estuary Marshes- Hadleigh Marshes (Action Zone 6)	Hadleigh Marshes is identified in this unit as being an area of marshes open to grazing crossed by a railway line. It is identified in the TE2100 plan as policy P3. Two Tree Island is also included in this policy unit, part of the Island lies outside the borough boundary but it is owned by Southend-on-Sea BC. **Policy P3 to continue with existing or alternative actions to manage flood risk. We will continue to maintain flood defences at their current level, accepting that the likelihood and/or consequences of a flood will increase because of climate change.** This policy unit presents important environmental opportunities, partly because there is already a Special Protection Area along the foreshore and partly because it has been designated as an area of community parklands. Opportunities exist for compensatory grazing marsh habitat creation and enhancement of the historic

Policy Management Unit PMU	Recommended Preferred Option
	environment. '**Local issues and choices** • There is a potential contamination issue with the flood defences on Hadleigh Marsh and the adjacent Two Tree Island. Therefore continued maintenance of these defences is needed to prevent contamination of the Estuary. Longer-term remediation of this land would open up management options and provide great environmental benefits to this area. • Measures may be needed to manage fluvial flood risk from the marsh drainage system and watercourses that drain into the marshes. This could consist of improvements to channels and outfalls as the needs arise. **Floodplain management** The need for floodplain management responses will be limited because the policy unit is largely undeveloped. There are no communities apart from visitors to the marshes and Two Tree Island. However flood warning will be needed for the railway line (which continues through Leigh-on-Sea & Southend-on-Sea policy unit to the east and Bowers Marshes policy unit to the west). Choices for local flood risk management require further investigation, consultation and appraisal.'

South Essex Catchment Flood Management Plan (CFMP) December 2008

7.2.2 Catchment Flood Management Plans are high-level strategic planning documents that provide an overview of the main sources of flood risk and how these can be managed in a sustainable framework for the next 50 to 100 years. The Environment Agency engages stakeholders within the catchment to produce policies in terms of sustainable flood management solutions whilst also considering the land use changes and effects of climate change.

7.2.3 The South Essex CFMP provides information relating to the fluvial flood risk, as well as risk from surface water drainage systems and sewers across South Essex. The Plan highlights the main sources of flood risk to people, property and infrastructure in South Essex and recommends broad policies for the management of the present and future flood risk in the South Essex CFMP area.

7.2.4 This CFMP covers Southend-on-Sea BC and provides valuable records of historical flooding from fluvial systems, as well as surface, sewer and ground water flooding in the area. This information has been used to inform this Level 1 SFRA. The South Essex CFMP also presents preferred policy options for several Policy Units within Southend-on-Sea BC. These have been summarised in Table 7-2 below.

Table 7-2: Summary of Preferred Policies for Policy Units in Study Area, South Essex CFMP, 2008

Policy Unity	Problem/ Risk	Recommended Preferred Option
2 Southend-on-Sea and Rayleigh	This policy unit currently has a fluvial source of flooding from Prittle and Eastwood Brook. It also has a fluvial/tidal source of flooding in the downstream Prittle Brook from Pembroke House. Surface water flooding also occurs in localised	Policy Option 5: Take further action to reduce flood risk now and in the future • Develop a Flood Risk Study for Southend-on-Sea to investigate

Policy Unity	Problem/ Risk	Recommended Preferred Option
	areas of Rayleigh, Eastwood and Southend-on-Sea, due to impermeable surfaces. Channel improvements (including the deepening and straightening of the watercourse with a concrete bed) exist along 7.6km of Eastwood Brook and have a standard of protection that ranges along the reach from a 1 –20% AEP SoP. A natural earth flood embankment exists at the downstream end of Prittle Brook and protects to a 1% AEP SoP. The Prittle flood relief tunnel also exists on Eastwood Brook and protects to a 1% AEP SoP. This diverts flood flow into the River Thames. Across the whole policy unit, there are 955 people and 505 properties at risk. In the future, this will increase by 142% and 130% for the 1% AEP flood event, with a total of 2,314 people and 1,161 properties at risk respectively. People and properties within Southend-on-Sea and Eastwood are identified to be at risk.	the feasibility of building new defences along Prittle and Eastwood Brook. • Develop a System Asset Management Plan (SAMP) to investigate how we can continue with the current level of flood risk management throughout all systems in this policy unit. • Develop an Emergency Response Plan for all relevant critical infrastructure and transport networks at risk of flooding. • Develop an Emergency Response Plan to mitigate flood risk in Southend, Rayleigh and Eastwood from the risk of the defences failing. • Flood Forecasting and Warning delivery plan to maintain the current level of flood forecasting/warning service. • Develop a **Flood Awareness Plan** to encourage people to sign up to and respond to flood warnings. The flood awareness plan should also inform the local community of flood risk if the defences fail or breach, and appropriate actions people can take to protect themselves and their property. • Develop a Surface Water Management Plan for Southend-on-Sea, and Eastwood. • Put in place policies within the Local Development Framework for regeneration of Rayleigh, Southend on- Sea and South Benfleet to incorporate resilience measures so that the location, layout and design of development can help to mitigate residual flood risk. The Local Development Framework needs to incorporate space for water into the regeneration plans, including naturalisation and environmental enhancement. Any new development should follow the principles set out in PPS25 and not increase risk to existing development. PPS25

Policy Unity	Problem/ Risk	Recommended Preferred Option
		does set out a range of measures that can reduce the impacts of residual risk, such as making buildings resilient to flooding which should be followed. Developers must include SUDS in new developments to reduce the runoff from new and previously developed sites. • CFMP/SMP Compliance project to ensure that the policies selected in both plans are complementary; any issues of conflict need to be addressed.
12 Thames Urban Tidal (Hadleigh Marshes)	This PU is low lying, generally below 5m AOD, covering the south western coastal areas of the CFMP area from Tilbury to Purfleet and Canvey Island and also includes the area of Hadleigh Marshes and Two Tree Island. The catchment is highly urbanised, responding quickly to rainfall. The PU is protected from tidal flooding, which is the principal source of flooding, by a series of coastal defences along the Thames estuary intended to provide protection against a 0.1% AEP flood up to the year 2030. There are no raised fluvial defences in this PU, although the PU has an extensive network of arterial drains,	Policy Option 4: to take further action to sustain the current level of flood risk into the future (responding to the potential increases in risk from urban development, land use change and climate change). Although the policy relates to the largely urban areas that make up this policy unit.

8 Flood Risk Management

8.1 Flood Defences

8.1.1 Flood defences are typically engineered structures designed to limit the impact of flooding. The National Flood and Coastal Defence Database (NFCDD) is compiled by the Environment Agency and provides information on natural and man-made defences. Figure 6 shows the location of NFCDD defences throughout the study area and identifies the design life, Figure 7 identifies the authority responsible for maintenance of the defences.

8.1.2 The Environment Agency Flood Zone maps define the extent of flooding without considering the presence of defences. The reason for this approach is to make an allowance for residual flood risk in the event of a failure or breach/blockage/overtopping of the flood defences. This conservative approach raises the awareness of flood risk in defended areas and helps to ensure that is it not discounted as part of development but is managed appropriately.

8.1.3 Flood defences are typically designed and constructed to protect people and property from a given magnitude of flood. This is referred to as the design standard and may vary depending upon the age of the structure, the monetary value attributed to the people and property it is designed to serve and the scale of works necessary to construct the defence. For new defences, these issues and others are balanced through a cost benefit analysis to determine if investment in defence schemes can be justified.

Current

8.1.4 The NFCDD includes a range of tidal and fluvial flood defences within the Southend-on-Sea BC study area. The tidal flood defences in Southend-on-Sea BC are mainly raised reinforced concrete walls, steel walls, or earth embankments (along the North Sea frontage). Figure 7 provides information on the standard of flood protection, which ranges from 1 in 1000 years to 1 in 10 years along the Southend on Sea BC tidal frontage.

8.1.5 A number of other small watercourse channels are also recorded in the NFCDD as providing protection from fluvial flooding. These include natural earth and vegetated channels associated with the Prittle and Eastwood Brooks.

8.1.6 As shown in Figure 8 Southend-on-Sea BC are responsible for a significant length of the sea defences. The Environment Agency are only responsible for a small section of sea defences at Hadleigh Marshes. Other riparian land owners responsible for flood defences include Network Rail, Gladedale developers and the Ministry of Defence.

Future

South Essex Catchment Flood Management Plan

8.1.7 The South Essex CFMP summarises fluvial improvement projects planned to further reduce flood risk. Projects planned within the Southend-on-Sea BC area include the following and are projected for 2008 – 2011.

- Resilience and resistance project for Prittlewood Priory SAM
- Integrated Urban Drainage Plan
- Flood Awareness Plan

- Flood Forecasting and Warning Delivery Plan
- Emergency Response Plan
- System Asset Management Plan
- Flood Risk Study for Southend focusing on Prittle and Eastwood Brooks

Shoreline Management Plan

8.1.8 Southend-on-Sea BC is located within the coastal unit covering the area from Harwich to Canvey Island in the Essex Shoreline Management Plan completed in 1997. A second generation SMP is being undertaken between Languard Point to the River Mardyke and outputs are due in December 2010. The current preferred coastal defence policy put forward in this study is to hold the existing line of flood defence and this is not expected to change in the emerging SMP.

Thames Estuary 2100

8.1.9 The Thames Estuary 2100 Project is an Environment Agency initiative, which seeks to plan for future flood protection needed for London and the Thames Estuary over the next 100 years. As part of this project a number of preferred management objectives have emerged that are of relevance to Southend-on-Sea BC. For Leigh-on-Sea and Southend-on-Sea the preferred option is to keep up with the impact of climate change so that flood risk does not increase.

8.1.10 Maintaining a standard of protection may require the maintenance of defences or alternatively an increased reliance upon active floodplain management in accordance with PPS25 through the relocation of vulnerable development, application of the Sequential Test and sequential approach, proactive development control procedures and effective emergency planning.

8.1.11 It is clear that the predicted increases in sea level will continue to reduce the standard of protection as time goes by. In light of Southend-on-Sea BC's plans for development and regeneration along the Seafront, Town centre and Shoeburyness areas, floodplain management measures such as those described above will play an increasingly important role into the future.

8.2 Flood Warning

8.2.1 Whilst measures can be put in place to lessen the risk of flooding, it is impossible to eliminate risk completely. Warning people about the impending flooding is therefore one of the most important means of flood management, enabling people to prepare for flooding through taking steps to minimise damage to property and prevent loss of life.

8.2.2 The Environment Agency operates a flood warning service in areas at risk of flooding using easily recognisable codes, indicating the level of danger and response associated with the warning.

Flood Alert – Flooding is possible. Be prepared.

Flood Warning – Flooding is expected. Immediate action required.

8.2.3 In Southend-on-Sea BC, the flood warnings are disseminated through Flood Warnings Direct. Residents and businesses can sign up to FWD either online, or by calling Floodline on 0845 988 1188.

8.3 Emergency Planning

8.3.1 The Flood Plan for Essex, published in June 2006, provides general information on the type of flooding that may affect the county, together with the appropriate responses by Essex County Council Emergency Planning and Core Resilience Team, Essex Police, the Environment Agency, District Councils and Unitary Authorities, one of which is Southend-on-Sea BC.

8.3.2 The Flood Plan for Essex is a high level document that provides a generic approach for the county and is of limited use for the emergency planning within the Southend-on-Sea borough. Southend-on-Sea BC is currently preparing a draft Emergency Flood Plan tailored to the specific risks facing Southend-on-Sea BC. Southend-on-Sea BC is responsible for the closure of some local tidal flood gates, mainly along the seafront, during times of flood warning and a procedure is being prepared for the closure of these gates. It is noted that there are a number of additional gates that are privately owned and managed.

8.3.3 The primary responsibility of Southend-on-Sea BC would be to provide temporary accommodation to any displaced people until such time that they are in a position to return to their homes or their insurance companies can arrange temporary accommodation for them. This shelter is provided in the form of rest centres, and provides a warm dry place to sleep and basic facilities including shower, food, etc.

8.3.4 The following developments are typically suitable for such use as refuge and/or reception centres:

- Leisure centres;
- Churches;
- Schools; and
- Community Centres.

8.3.5 The nominated rest and reception centres in Southend-on-Sea BC have been identified and presented within Figure 10.

8.3.6 In the event of an emergency, it is essential to ensure that those services vital to the rescue operation are not impacted by flood water. PPS25 classifies Emergency dispersal points, police stations, ambulance stations, fire stations, command centres and telecommunication installations that are required to remain operational during a flood event as ‘Highly Vulnerable’ buildings and these are therefore not permitted to be developed in Flood Zone 3. Hospitals are also vital to the rescue operation, but are classified in PPS25 as ‘More Vulnerable’ establishments and therefore might be situated within a flood zone, although they should remain accessible and operational. In addition future development control polices should seek to locate other ‘More Vulnerable’ institutes such as schools, nurseries, residential care homes, children’s homes, prisons, hostels and health services in areas of the lowest risk to minimise the potential for flood casualties. Situations may arise in an emergency where the occupants of the above institutions cannot be evacuated (such as prisons) and therefore special consideration should be made when allocating sites for such development types. Individual flood emergency plans will be required for such developments in addition to the overall flood emergency plan produced by Southend-on-Sea BC.

8.4 Residual Risk

8.4.1 Residual risk in a generic sense can be defined as ‘the remaining risk following the implementation of all risk avoidance, reduction and mitigation measures’ (Communities and Local Government, 2007). In the context of flood risk, residual risk refers to the flood risk that remains after flood avoidance and alleviation measures have been put in place. A combination of aging defences and

increasing sea levels due to the effects of climate change make residual risk a key consideration in Southend-on-Sea BC. An example of residual flood risk would be a breach of the flood defence walls along the River Thames frontage caused by an open flood gate or the hydrostatic water pressure generated during high tides.

8.4.2 Residual risk management therefore aims to prevent or mitigate the consequences of flooding that can occur despite the presence of flood alleviation measures. The primary tool in achieving residual risk management is the rigorous application of the PPS25 Sequential Test; however some development might still need to be located in areas at risk of flooding and as a result, such developments will require site-specific residual risk management to minimise the consequences of potential flooding, e.g. following a breach or overtopping of local defences.

8.4.3 As part of the Level 2 SFRA, further assessment of the nature of the residual flood risk in the event of flood defence breach has been undertaken. This provides an appreciation of the depth and velocity of flood water and the time between a breach and inundation. This assessment will inform the suitability of locating development within Flood Zones 2 and 3 and enable the identification of appropriate measures to further reduce the residual risk to a development such as adopting a sequential approach within the site, defining appropriate finished floor levels, and ensuring safe access or a safe place of refuge above the flood level.

9 Site-Specific Flood Risk Assessment Guidance

9.1 Introduction

9.1.1 Site-specific Flood Risk Assessments (FRAs) are required to assess the flood risk posed to proposed developments and to ensure that, where necessary and appropriate, suitable mitigation measures are incorporated. This section presents recommendations for FRAs prepared for submission with planning applications in Southend-on-Sea BC. The guidance presented within this chapter has been based on:

- Recommendations presented within Planning Policy Statement 25 and the accompanying Practice Guide;
- Information provided to enable preparation this Level 1 SFRA.

9.2 When is a Flood Risk Assessment Required?

9.2.1 The Environment Agency provides flood risk standing advice for applicants and agents on their website http://www.environment-agency.gov.uk/research/planning/82587.aspx. This includes information on when a FRA is required and advice on the contents of FRAs for various development types in Flood Zones 1, 2 and 3.

9.2.2 When informing developers of the requirements of a FRA for a development site, consideration should be given to the position of the development relative to flood sources, the vulnerability of the proposed development and its scale.

9.2.3 In the following situations a FRA should always be provided with a planning application:

1. The development site is located in Flood Zones 2 or 3;
2. The area of the proposed development site area is 1 hectare or greater in Flood Zone 1. This is to ensure surface water generated by the site is managed in a sustainable manner and does not increase the burden on existing infrastructure and/or flood risk to neighbouring property. Surface water management will also need to be considered as part of the FRA for sites of 1 hectare or greater in Flood Zone 2 and 3;
3. The development site is located in an area known to have experienced flooding problems from any flood source.

9.3 FRA Requirements

9.3.1 The Practice Guide to PPS25 sets out a staged approach to site-specific FRA with the findings from each stage informing both the next level and the site Master Plan, throughout the development process. The staged approach comprises:

- Level 1 Screening Study
- Level 2 Scoping Study
- Level 3 Detailed Study

Table 9-1 Stages of site-specific FRA, PPS25 Practice Guide

FRA Level	Description of Report Content
Level 1 **Screening Study**	The Level 1 FRA is intended to identify any flooding or surface water management issues related to the development site that may require further investigation. The study should be based on readily available existing information, including: • SFRA, • Environment Agency Flood Maps, • Standing Advice The Level 1 FRA will determine the need for a Level 2 or 3 FRA.
Level 2 **Scoping Study**	Where the Level 1 FRA indicates that the site may lie in an area at risk of flooding, or may increase flood risk elsewhere due to runoff, a Level 2 FRA should be carried out. This report will confirm sources of flooding which may affect the site and should include the following; • Appraisal of available and adequacy of existing information; • Qualitative appraisal of the flood risk posed to the site, the potential impact of the development on flood risk on and off the site; • An appraisal of the scope of possible measures to reduce the flood risk to acceptable levels. This Level may identify that sufficient quantitative information is already available to complete a FRA appropriate to the scale and nature of the development.
Level 3 **Detailed Study**	Undertaken if the Level 2 FRA concludes that further quantitative analysis is required in order to assess flood risk issues related to the development site. This Level should include: • Quantitative appraisal of the potential flood risk to the development; • Quantitative appraisal of the potential impact of development on the site under investigation on flood risk on and off the site; • Quantitative demonstration of the effectiveness of any proposed mitigation measures.

9.3.2 At all stages Southend-on-Sea BC, and where necessary the Environment Agency, Essex and Suffolk Water and/or Anglian Water, should be consulted to ensure the FRA provides the necessary information to fulfil the requirements for Planning Applications.

9.4 FRA Guidance

9.4.1 The Environment Agency provides flood risk standing advice for applicants and agents on their website http://www.environment-agency.gov.uk/research/planning/82587.aspx which includes a matrix to determine the level of assessment that is required based on Flood Zone classification and development type. Within this matrix are links to FRA Guidance notes and advice for applicants as to which data they will need to purchase from the Environment Agency in order to carry out their FRA.

Risks of Developing in Flood Risk Areas

9.4.2 Developing in flood risk areas can result in significant risk to a development and site users. Issues to consider include the following:

- Failure to consider wider plans prepared by the Environment Agency or other operating authorities may result in a proposed scheme being objected to;
- Failure to identify flood risk issues early in a development project could necessitate redesign of the site to mitigate flood risk;

- Failure to adequately assess all flood risk sources and construct a development that is safe over its lifetime could increase the number of people at risk from flooding and/or increase the risk to existing populations;
- Failure to mitigate the risk arising from development may lead to claims against the developer if an adverse effect can be demonstrated (i.e. flooding didn't occur prior to development) by neighbouring properties/residents;
- Properties may be un-insurable and therefore un-mortgageable if flood risk management is not adequately provided for the lifetime of the development;
- By installing SuDS without arranging for their adoption or maintenance there is a risk that they will eventually cease to operate as designed and could therefore present a flood risk to the development and/or neighbouring property;
- The restoration of river corridors and natural floodplains can significantly enhance the quality of the built environment whilst reducing flood risk. Such an approach can significantly reduce the developable area of sites or lead to fragmented developments, however positive planning and integration throughout the master planning process should resolve these.

9.4.3 In cases of redevelopment of brownfield sites in the functional floodplain, paragraph 4.90 of the PPS25 Practice Guide states that *"areas which would naturally flood with an annual exceedence probability of 1 in 20 (5%) or greater, but which are prevented from doing so by existing infrastructure or solid buildings, will not normally be defined as functional floodplain".* Where it can be demonstrated that existing buildings exclude floodwaters, then solely the area around the buildings will be deemed functional floodplain. When undertaking an FRA this matter should be clarified and ideally pre-agreed with the Environment Agency.

Safe Development

9.4.4 Furthermore, the following items should be addressed as part of a FRA in order to demonstrate that proposed developments are 'safe' in line with PPS25. The Environment Agency has specified that the following should be achieved for all development vulnerability types in order to demonstrate safe development:

- Dry access and egress should be provided for all development where possible. Dry escape for residential dwellings should be up to the 1 in 100-year event for fluvial events and 1 in 200 year event for a tidal event, taking into account climate change for the lifetime of the development. Where this cannot be achieved, the advice of the emergency planner must be sought.
- Finished floor levels should be set at, or above, the 1 in 100 year plus climate change level (fluvial) and 1 in 200 year plus climate change level (tidal) with a 300mm freeboard allowance.
- Where floodplain compensation is undertaken, the Environment Agency requires that this is provided on a 'Level for Level, Volume for Volume Basis'.
- Flood flow routes should be preserved.
- Flood resilient construction measures should be incorporated into new developments where required.
- Surface water run-off generated on site should be managed to ensure no increased flood risk both on- and off -site.

It should be noted that the Environment Agency are constantly reviewing their guidance based upon experience, increasing knowledge and the findings of new research and therefore the above criteria are subject to change in the future.

9.4.5 The specific definition of a ‘safe’ development will vary for each individual site, based on location and development vulnerability. The Environment Agency encourages pre-application discussions and it is therefore recommended that developers for individual sites consult with the Environment Agency at an early stage to establish an appropriate definition of ‘safe’ development for their specific site.

10 Guidance for the application of Sustainable Drainage Systems

10.1 Introduction

10.1.1 PPS1: Delivering sustainable development; PPS23: Planning and Pollution Control; and PPS25 requires that LPAs should promote the use of SuDS. They are also a requirement of the Approved Document Part H of the Buildings Regulations. Southend-on-Sea BC should therefore adopt policies within their LDDs that encourage sustainable drainage practices.

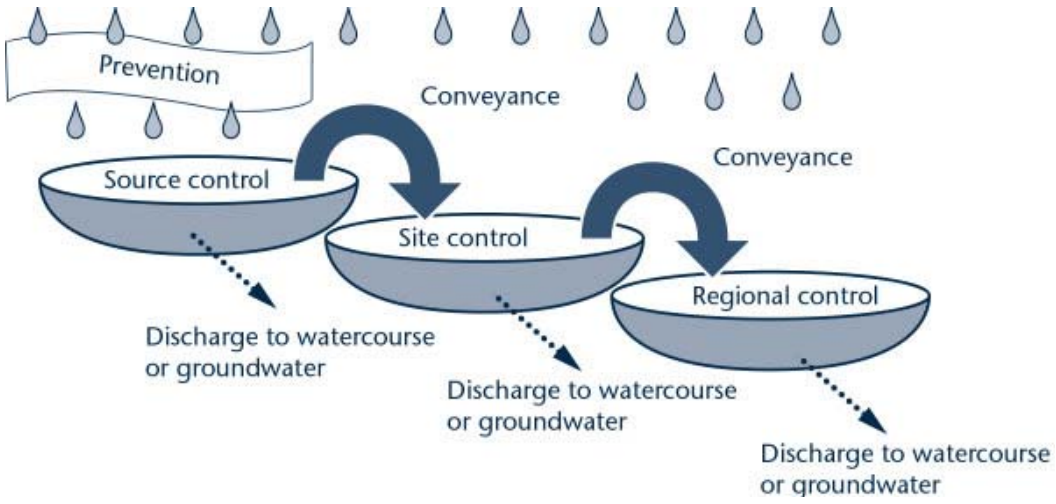
10.1.2 Sustainable Drainage Systems is an umbrella term encompassing the various approaches that can be used to manage surface water drainage in a way that mimics the natural environment. The aim of SuDS is to maximise the amount of rainwater which is returned to the ground through infiltration techniques and to hold back, or attenuate excess surface water on-site, before releasing it into the ground, local watercourses or sewer systems over a longer time period.

10.1.3 SuDS should be considered at an early stage, before the layout of a proposed site has been defined in accordance with the Sequential Approach. This is likely to lead to a reduction in the overall cost of draining the site as it is much more difficult and expensive to retrofit SuDS to a site that has a development layout already designed. For major development schemes where there are likely to be many competing issues, it is highly recommended that SuDS are discussed prior to application submission to maximise the opportunities on the site. This in return should result in a reduced cost to the developer for the system.

10.2 Effective Application of SuDS

10.2.1 The SuDS Manual (CIRIA 697) states that *'wherever possible storm water should be managed in small, cost-effective landscape features located within small sub-catchments rather than being conveyed to and managed in large systems at the bottom of drainage areas'*. This is illustrated by the SuDS Management Train through which each component adds to the performance of the overall system and whereby techniques are applied right through from site management procedures to consideration of a wider catchment. The stages in the Management Train are:

Figure 10-1 SUDS Management Train (from the Environment Agency website)



10.2.2 Each component adds to the performance of the overall system, whereby techniques are applied right through from site management procedures to consideration of a wider catchment as outlined below:

- **Prevention** - the use of good site design and management measures to reduce run-off in the first place and to prevent pollution (e.g. reducing impermeable areas, regular pavement sweeping);
- **Source control** – if prevention methods are not sufficient to avoid the runoff, the next preferred option is to control run-off at/near the source. This could be achieved through the use of rainwater harvesting (which has the added benefit of reducing demand on public water), green roofs, permeable pavements, soakaways and other infiltration methods;
- **Site control** – where water cannot be directly infiltrated into the ground, it may be conveyed some distance before infiltration or discharge into a watercourse. Examples of site control techniques include routing water from roofs and impermeable areas to a single infiltration/attenuation point in the site;
- **Regional control** – as runoff is conveyed further, it moves from site control to regional control. For example integrating run-off from multiple sites into a detention pond or wetland.

10.2.3 Local authorities should encourage the use of SuDS, which are a requirement of Approved Document Part H of the Buildings Regulations. This chapter presents a summary of the SuDS techniques available and a non-specific overview of the types of techniques that may be appropriate for development sites in Southend-on-Sea BC. Further assessment has been undertaken as part of the Southend-on-Sea BC Surface Water Management Plan.

10.3 Types of SuDS

10.3.1 SuDS may improve the sustainable management of water for a site by:

- Reducing peak flows to watercourses or sewers and potentially reducing the risk of flooding on site and downstream;
- Reducing volumes of water flowing directly to watercourses or sewers from developed sites;
- Improving water quality by removing pollutants from diffuse pollutant sources;
- Reducing potable water demand through rainwater harvesting;
- Improving amenity through the provision of public open space and wildlife habitat; and
- Mimicking natural drainage patterns, including recharge of aquifers so that base flows are maintained.

10.3.2 Various SuDS techniques are available and they operate under two main principles; infiltration and detention/attenuation.

10.3.3 **Infiltration techniques** rely on discharges to the ground so their success is dependent upon the local ground conditions, such as the permeability of the soils and geology, the groundwater table depth and the importance of underlying aquifers as water resources.

10.3.4 **Detention/attenuation techniques** result in a reduction in the rate of discharge from the site through on-site water storage. Clearly the volume of water leaving the site will still remain the same and therefore it will be necessary to assess the volume of on-site storage available as well as the impact the storage may have on development proposals and risks to neighbouring properties. The

volume of on-site storage required should be calculated through hydrological analysis using industry-approved procedures to ensure that a robust design storage volume is provided.

10.3.5 The treatment and control of surface water runoff should provide a level of betterment, incorporating the use of various SuDS techniques. As a minimum there should be no increase in the peak discharges/volumes from any existing Greenfield site and a minimum 20% reduction of peak discharges/volumes from any existing Brownfield site where an existing positive drainage system has been identified.

10.3.6 Due consideration should be given to appropriate SuDS techniques throughout preparation and development of the overall drainage strategy for individual development sites. An investigation into ground conditions will be required in order to determine whether infiltration techniques are feasible or whether attenuation techniques are more appropriate. During the design process, liaison should take place with Southend-on-Sea BC, the Environment Agency and if necessary, Essex and Suffolk and/or Anglian Water to establish a satisfactory design methodology and permitted rate of discharge from the site.

10.3.7 The application of SuDS is not limited to a single technique per site. In fact, the most successful SuDS solutions often utilise a combination of techniques, in order to provide flood risk, pollution and landscape/wildlife benefits. In addition, SuDS can be implemented on a strategic scale, for example with a number of sites, contributing to large scale jointly funded and managed scheme. It should be noted that each individual development site must provide storage to offset its own increase in runoff and attenuation cannot be 'traded' between developments.

10.3.8 A summary of available techniques and their suitability to meet the three goals of sustainability is provided in Table 9-1 overleaf.

Table 9-1: Summary of SuDS Techniques and their Suitability to meet the Three Goals of Sustainability

Management Train	Component	Description	Water Quantity	Water Quality	Amenity Biodiversity
Prevention	Green roofs	Layer of vegetation or gravel on roof areas providing absorption and storage.	●	●	●
	Rainwater harvesting	Capturing and reusing rainwater for domestic or irrigation uses.	●	○	○
	Permeable pavements	Infiltration through the surface into underlying layer.	●	●	○
Source	Filter drains	Drain filled with permeable material with a perforated pipe along the base.	●	●	
	Infiltration trenches	Similar to filter drains but allows infiltration through sides and base.	●	●	
	Soakaways	Underground structure used for store and infiltration.	●	●	
	Bio-retention areas	Vegetated areas used for treating runoff prior to discharge into receiving water or infiltration	●	●	●
Site	Swales	Grassed depressions, provides temporary storage, conveyance, treatment and possibly infiltration.	●	●	○
	Sand filters	Provides treatment by filtering runoff through a filter media consisting of sand.	●	●	
	Basins	Dry depressions outside of storm periods, provides temporary attenuation, treatment and possibly infiltration.	●	●	○
Regional	Ponds	Designed to accommodate water at all times, provides attenuation, treatment and enhances site amenity value.	●	●	●
	Wetland	Similar to ponds, but are designed to provide continuous flow through vegetation.	●	●	●

Key: ● – highly suitable, ○ - suitable depending on design

10.4 Application of SuDS for Southend-on-Sea BC

10.4.1 The underlying ground conditions of a development site will often determine the type of SuDS approach to be used at development sites. This will need to be determined through ground investigations carried out on-site. A broad-scale assessment of the soils and underlying geology allow an initial assessment of SuDS techniques that may be implemented across Southend-on-Sea BC.

10.4.2 In the design of any drainage system and SuDS approach, consideration should be given to site-specific characteristics and where possible be based on primary data from site investigations. The information presented in Tables 9-2 and 9-3 is provided as a guide and should not be used to accept or refuse SuDS techniques. These tables are complemented by Figure 13 (Geology) and 14 (infiltration), which provide an indication of geology type and infiltration SuDs potential across the Southend-on-Sea BC area, respectively. Consideration should also be made of the contamination of the site mapped in Figure 11, when considering infiltration SuDS.

10.4.3 There are no Source Protection Zones (SPZs) identified in the Southend-on-Sea Borough Council area. Figure 14 divides the Southend-on-Sea BC area into three categories base on geology type alone:

- Expect high infiltration potential;
- Expect medium infiltration potential; and
- Expect low infiltration potential.

10.4.4 The solid geology of the area is London Clay and this is expected to have low infiltration potential. Therefore, the areas with good infiltration potential are restricted to those underlain by permeable drift deposits (yellow areas on Figure 14). These drift deposits are likely to contain shallow perched groundwater tables. Local ground investigation in conjunction with review of Environment Agency guidance is required to determine the suitability for infiltration SuDs in these areas.

Table 9-2 Specific Drift Deposits in Southend-on-Sea BC

Drift Deposit	Permeability	General Characteristics	Locations	SUDs
Alluvium	Low to Medium Permeability	Generally clayey silty sand	Found adjacent to the small tributary of the River Crouch in the north-western part of the study area.	Infiltration, combined infiltration/attenuation systems and attenuation systems e.g. permeable surfaces, sub surface infiltration, basins and ponds, swales and filter strips i.e. a combined system.
River Terrace Deposits	Low to High Permeability	Generally dominated by sandy gavel or silty clay	Various locations across the Council area.	Infiltration, combined infiltration/attenuation systems and attenuation systems e.g. permeable surfaces, sub surface infiltration, basins and ponds, swales and filter strips i.e. a combined system.
Head	Low to Medium Permeability	Variable in composition, generally silty clay, silt, gravel and sand. Sandy and gravely lenses are common.	Found in the central and western parts of the Council area.	Infiltration, combined infiltration/attenuation systems and attenuation systems e.g. permeable surfaces, sub surface infiltration, basins and ponds, swales and filter strips i.e. a combined system.
Tidal Flat Deposits	Low Permeability	Generally soft to firm, yellow brown to greyish black muds, clays, silts and silty clays with sand lenses.	Found in two embayments adjacent to the Thames Estuary near Southend and Shoeburyness	Attenuation systems e.g. basins and ponds, green roofs, tanks, rainwater harvesting etc.

Table 9-3 Specific Solid Geology in Southend-on-Sea BC

Solid Geology	Permeability	General Characteristics	Locations	SUDs
London Clay Formation	Impermeable	Fine, sandy, silty clay/silty clay. Glauconitic at base.	Underlies drift deposits in the Council area with fragmented outcrops in the western area.	Attenuation systems e.g. basins and ponds, green roofs, tanks, rainwater harvesting etc.
Lower London Tertiaries / Woolwich Beds and Thanet Sand	Variably Permeability	Woolwich Beds; largely grey to grey-brown, interlaminated fine-grained sands, silts and clays. Thanet Sands; Glauconite-coated, nodular flint at base, overlain by pale yellow-brown, fine-grained sand that can be clayey and glauconitic. Rare calcareous or siliceous sandstones.	Not present at outcrop (only at depth).	Not applicable.
Chalk	Permeable	Chalk, with or without flint and discrete limestone, marl (calcareous mudstone), sponge, calcarenite, phosphatic, hardground and fossil-rich beds.	Not present at outcrop (only at depth).	Not applicable.

11 Where do we go from here?

11.1 Level 1 SFRA

11.1.1 This Level 1 SFRA has drawn on existing information and data to provide a strategic assessment of the flood risk posed to Southend-on-Sea BC from all sources of flooding. The Level 1 SFRA presents Flood Zone Maps that delineate the Flood Zones outlined in PPS25 as Flood Zone 1, low probability, Flood Zone 2, medium probability, Flood Zone 3a, high probability and Flood Zone 3b, functional floodplain. Table D.1 of PPS25 provides information on which developments are considered appropriate in each Flood Zone, subject to the application of the Sequential Test and either the Exception Test or a site specific Flood Risk Assessment (FRA) to demonstrate safety.

11.1.2 Information regarding flood risk has been used to provide a coarse assessment to assist with the application of the Sequential Test for the borough.

11.2 Implications for Policy in Southend-on-Sea BC

11.2.1 In line with flood risk issues and objectives identified by the Environment Agency, it is suggested that the following strategies and considerations are incorporated into Southend-on-Sea BC's LDF to strengthen the position with respect to flood risk management.

- Ensure the Sequential Test is undertaken for all land allocations. This will ensure that all development is steered towards the areas of lesser flood risk wherever possible and that the vulnerability of proposed developments are appropriate to the defined Flood Zone, thereby reducing the overall flood risk posed to the residents of the borough;
- Site-specific FRAs should be carried out for all developments in Flood Zones 2 and 3; all sites in Flood Zone 1 which are greater than 1.0 ha and all sites that are known to have a critical drainage problem, whatever their size;
- Sustainable Drainage Systems should be included in new developments wherever possible to manage surface water.
- Additional rest centres across the borough should be identified and included in the emerging Flood Emergency Plan for Southend-on-Sea BC.

11.3 Next steps for Southend-on-Sea BC

11.3.1 Using the information presented in the Level 1 SFRA, Southend-on-Sea BC is now in a position to carry out the Sequential Test with respect to flood risk. This will enable Southend-on-Sea BC to identify those areas where further information is required regarding the nature of the flood risk as well as those areas where the Exception Test will need to be applied. These requirements will then be presented and addressed in the Level 2 SFRA.

11.3.2 As part of the Level 2 SFRA, the residual risk resulting from a breach in the flood defences will be assessed to provide information regarding the precise nature of flood risk posed to development sites in Southend-on-Sea. The residual risk behind a flood defence is dependant upon the flood depth, speed of flow of the water, local flow paths, the speed of the onset of flooding, the distance from the defences, the duration of the flood and how water will be removed (Practice Guide, 2009).

11.4 Living Document

11.4.1 This study has been completed in accordance with PPS25 and its accompanying Practice Guide, published in June 2008 and revised December 2009. The Level 1 SFRA has been developed by building heavily upon existing knowledge with respect to flood risk within the Southend-on-Sea BC study area.

11.4.2 These documents have an intended lifespan of 6-10 years, with Local Development Documents and potential development sites typically revised within 3-6 years. Therefore it should be noted that although up-to date at the time of production, the SFRA has a finite lifespan and should be upgraded or revised as required by the Local Planning Authority.

11.4.3 In summary, it is imperative that the SFRA is adopted as a 'living' document and is reviewed regularly in light of emerging policy directives and an improving understanding of flood risk within the borough of Southend-on-Sea BC.

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Appendix A: Figures

Appendix B: List of Contacts

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Mark Leggett			mleggett@anglianwater.co.uk
Essex County Council			
Gemma Skillern			

Appendix C: Data Register

Appendix C: Data Register

Project			
SOUTHEND-ON-SEA BOROUGH COUNCIL			
STRATEGIC FLOOD RISK ASSESSMENT			
Title	File type	From - Name	From - Company / Organisation
Environment Agency Anglian Region Eastern and Central Areas Report on Extreme Tidal Levels	PDF		Environment Agency
Environment Agency Thames Tidal Defences Joint Probability Extreme Water Levels 2008, Final Modelling Report April 2008	PDF		Environment Agency
LiDAR Topographic Survey	ASCII Grids	Mike Plant	Environment Agency: Geomatics Group
Areas Susceptible to Surface Water Flooding	SHAPEFILE		Southend-on-Sea
Council Boundary	TAB File		Southend-on-Sea
OS 50K mapping	TAB File		Southend-on-Sea
OS 25K mapping	TAB File		Southend-on-Sea
South Essex CFMP	PDF	Accessed Online	Environment Agency
Thames CFMP	PDF	Accessed Online	Environment Agency
SE Essex CAMS	PDF	Accessed Online	Environment Agency
Model of Prittle Brook & GIS outputs for 1 in 20, 1 in 100, 1 in 100 CC, 1 in 1000 return periods	MUTLIPLE		Environment Agency
Model of Eastwood Brook & GIS outputs for 1 in 20, 1 in 100, 1 in 100 CC, 1 in 1000 return periods	MUTLIPLE		Environment Agency
Model of Willingale COW & GIS outputs for 1 in 20, 1 in 100, 1 in 100 CC, 1 in 1000 return periods	MUTLIPLE		Environment Agency
Watercourses and Main Rivers - GIS layer	TAB File		Environment Agency
GIS layers Flood Zones 2 & 3	SHAPEFILE	Rebecca Baldwin	Environment Agency
NFCDD data	TAB File		Environment Agency
GIS layer: NaFRA	SHAPEFILE	Rebecca Baldwin	Environment Agency
GIS layers: historic flood outlines (1958, 1953, 1968)	SHAPEFILE	Rebecca Baldwin	Environment Agency
Details of assets in Southend	WORD DOC	Karen Mills	Environment Agency
Fisheries data	EXCEL SHEET	Karen Mills	Environment Agency
Groundwater Vulnerability Map	PDF	Karen Mills	Environment Agency
Drift Geology	PDF	Karen Mills	Environment Agency
Env Status Report for Roach and Canvey	WORD DOC	Karen Mills	Environment Agency
Env Status Report for Prittle Brook	WORD DOC	Karen Mills	Environment Agency
Env Status Report for Roach, Noble Ditch & Eastwood Brook	WORD DOC	Karen Mills	Environment Agency
GQA scheme notes	WORD DOC	Karen Mills	Environment Agency
Groundwater levels at North Thames Gas Works	EXCEL SHEET	Karen Mills	Environment Agency
GQA-WFD Cover Note	WORD DOC	Karen Mills	Environment Agency
GQA RQO Full notes	WORD DOC	Karen Mills	Environment Agency
Quality flag	EXCEL SHEET	Karen Mills	Environment Agency
Southend Biotic indices notes	WORD DOC	Karen Mills	Environment Agency
Southend GQA Chemisty	WORD DOC	Karen Mills	Environment Agency
Southend: Biology, Nitrate, Phosphate	WORD DOC	Karen Mills	Environment Agency
Southend Watercourse Discharge Information	EXCEL SHEET	Karen Mills	Environment Agency
Taxa data along watercourses	EXCEL SHEET	Karen Mills	Environment Agency
GIS layers of geology	SHAPEFILE		BGS?
Employment Land Review GIS layers	SHAPEFILE	Helen Fox	Southend-on-Sea
Town Centre Boundary GIS layer	SHAPEFILE	Helen Fox	Southend-on-Sea
New Town Centre Boundary GIS layer	SHAPEFILE	Helen Fox	Southend-on-Sea
Seafront AAP Boundary GIS layer	SHAPEFILE	Helen Fox	Southend-on-Sea
Strategic Housing Land Availability Assessment GIS layer	SHAPEFILE	Helen Fox	Southend-on-Sea
Rest Centres in Southend-on-Sea Borough	SHAPEFILE	Keith Holden	Southend-on-Sea
Roach and Crouch Estuary Management Plan	PDF	Accessed Online	Crouch and Roach Estuary Project Steering Group

Appendix D: SFRA Maintenance and Updates

How to maintain and update the SFRA

For an SFRA to serve as a practical planning tool now and in the future, it will be necessary to undertake a periodic update and maintenance exercise. This section clarifies what specific actions are recommended to ensure correct maintenance and updating of the SFRA.

GIS Layers

The GIS layers used in the SFRA have been created from a number of different sources, using the best and most suitable information available at the time of publishing. The Environment Agency aims to update their Flood Maps quarterly. Should new Flood Zone information relevant to the study area become available, the data should be digitised and geo-referenced within a GIS system. A copy of the current dataset should be created and backed up and the new data should then be merged or combined with the current data set.

For example, should updated modelled outlines delineating the tidal FZ3a be updated, the current combined FZ3a outline should be edited to ensure that the newest data is displayed and that the old data is overwritten. Note that updating the Tidal FZ3a will not involve replacing the entire combined FZ3a GIS layer, only the section that has changed.

For other GIS layers such as the Historical Flood Outlines or the Sewer Flooding Information, it is likely that data will be added rather than be replaced. For example, where a new sewer flooding incident is reported in the catchment, a point should be added to the sewer flooding GIS layer rather than creating a new layer.

All GIS layers used in the SFRA have meta-data attached to them. When updating the GIS information, it is important that the meta-data is updated in the process. Meta-data is additional information that lies behind the GIS polygons, lines and points. For example, the information behind the SFRA Flood Zone Maps describes where the information came from, what the intended use was together with a level of confidence.

For any new data or updated data, the data tables presented in Appendix D should be checked to ensure they are up-to-date.

OS Background Mapping

The SFRA has made use of the OS 1:25000 and 1:50000 digital raster maps. Periodically these maps are updated. Under the HDC OS License, it is likely that these maps will be updated throughout the whole of the HDC GIS system. Updated maps are unlikely to alter the findings of the SFRA.

Data Licensing Issues

Prior to any data being updated within the SFRA, it is important that the licensing information is also updated to ensure that the data used is not in breach of copyright. The principal licensing bodies relevant to the SFRA at the time of publishing were the Environment Agency (Anglian & Southern Region) and Ordnance Survey. Updated or new data may be based on datasets from other licensing authorities and may require additional licenses.

Flooding Policy and PPS25 Practise Guidance Updates

This SFRA was updated in line with policy and guidance that was current in September 2010, principally PPS25 (CLG 2010) and the accompanying Practice Guide (December 2009). Furthermore, guidance and recommendations issued in the Pitt Review (Pitt 2008) and the subsequent Floods and Water Management Act (2010) have been incorporated into this updated revision.

Should new flooding policy be adopted nationally, regionally or locally, the SFRA should be checked to ensure it is still relevant and updates made if necessary.

Stakeholder Consultation and Notification

The key stakeholders consulted in the SFRA were the Borough Council, Water Companies and the Environment Agency. It is recommended that a periodic consultation exercise is carried out with the key stakeholders to check for updates to their datasets and any relevant additional or updated information they may hold. If the SFRA is updated, it is recommended that the Environment Agency and the County Council Emergency Planning Department are notified of the changes and instructed to refer to the new version of the SFRA for future reference.

Frequency of Updates and Maintenance

It is recommended that the SFRA is maintained on an annual basis. Should any changes be necessary, the SFRA should be updated and re-issued.