Southend-on-Sea Surface Water Management Plan

November 2015

AECOM

southend on sea
BOROUGH COUNCIL

Prepared by: Danielle Skilton – Flood Risk Consultant   Checked by: Elizabeth Gent – Associate

Approved by: Elizabeth Gent - Associate

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Scott House, Alençon Link, Basingstoke, Hampshire, RG21 7PP, United Kingdom
Telephone: 01256 310 200 Website: http://www.aecom.com

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List of Acronyms

Acronym	Definition
AAP	Area Action Plan
AEP	Annual Exceedance Probability
BGS	British Geological Survey
CCA	Civil Contingencies Act
CDA	Critical Drainage Area
CFMP	Catchment Flood Management Plan
CRR	Community Risk Register
DCLG	Government Department for Communities and Local Government
Defra	Department for Environment, Flood and Rural Affairs
DPD	Development Plan Document
DRN	Detailed River Network
DTM	Digital Terrain Model
EA	Environment Agency
FCERM	Flood and Coastal Erosion Risk Management
FRMP	Flood Risk Management Plan
FRR	Flood Risk Regulations 2009
FWMA	Flood and Water Management Act 2010
GIS	Geographic Information System
JAAP	Joint Area Action Plan
LFRMS	Local Flood Risk Management Strategy
LiDAR	Light Detection and Ranging
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
LRF	Local Resilience Forum
MAFP	Multi Agency Flood Plan
NPPF	National Planning Policy Framework
NPPG	National Planning Practice Guidance
PFRA	Preliminary Flood Risk Assessment
SFRA	Strategic Flood Risk Assessment
SBC	Southend-on-Sea Borough Council
SPD	Supplementary Planning Document
SuDS	Sustainable Drainage Systems
SWMP	Surface Water Management Plan
TE2100	Thames Estuary 2100
uFMfSW	Flood Map for Surface Water
WFD	Water Framework Directive

Glossary

Term	Definition
Aquiclude	Formations that may be sufficiently porous to hold water, but do not allow water to move through them.
Aquifer	A source of groundwater comprising water bearing rock, sand or gravel capable of yielding significant quantities of water.
Aquitard	Formations that permit water to move through them, but at much lower rates than through the adjoining aquifers.
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.
Civil Contingencies Act 2004	This Act delivers a single framework for civil protection in the UK. As part of the Act, Local Resilience Forums must put emergency plans into place for a range of circumstances including flooding.
Climate Change	Long term variations in global temperature and weather patterns caused by natural and human actions.
Critical Drainage Area	Areas of significant flood risk, characterised by the amount of surface runoff that drains into the area, the topography and hydraulic conditions of the pathway (e.g. sewer, river system), and the receptors (people, properties and infrastructure) that may be affected.
Culvert	A channel or pipe that carries water below the level of the ground.
DG5 Register	A water-company held register of properties which have experienced sewer flooding or properties which are 'at risk' of sewer flooding more frequently than once in 20 years.
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).
Flood Risk Area	Areas identified to be at significant risk from local sources of flooding, identified through the Preliminary Flood Risk Assessment.
Flood Risk Management Plan	Under the Flood Risk Regulations 2009, Lead Local Flood Authorities are required to produce Flood Risk Management Plan for all Flood Risk Areas. The Flood Risk Management Plan highlights the risk and hazard of flooding from various sources and sets out how Risk Management Authorities work together to manage flood risk.
Flood Risk Regulations 2009	Transposition of the EU Floods Directive into UK law. The EU Floods Directive is a piece of European Community (EC) legislation to specifically address flood risk by prescribing a common framework for its measurement and management.
Flood and Water Management Act 2010	Part of the UK Government's response to Sir Michael Pitt's Report on the Summer 2007 floods, the aim of which is to clarify the legislative framework for managing surface water flood risk.
Fluvial Flooding	Flooding resulting from water levels exceeding the bank level of a main river.
Groundwater	Water that is underground. For the purposes of this study, it refers to water in the saturated zone below the water table.
Local Flood Risk	Flooding from local sources (surface water, ordinary watercourses and groundwater).
Local Flood Risk Management Strategy	A strategy completed by Lead Local Flood Authorities under the requirements of the Flood and Water Management Act 2010 to outline the risk of local flooding sources and the intended management of this flood risk.
Lead Local Flood Authority	Local Authority responsible for local flood risk management.
Local Resilience Forum	A multi-agency forum, bringing together all the organisations that have a duty to cooperate under the Civil Contingencies Act, and those involved in responding to emergencies. They prepare emergency plans in a co-ordinated manner.
Local Planning Authority	A multi-agency forum, bringing together all the organisations that have a duty to cooperate under the Civil Contingencies Act, and those involved in responding to emergencies. They prepare emergency plans in a co-ordinated manner.
Main River	A watercourse shown as such on the Main River Map, and for which the Environment Agency has responsibilities and powers.
National Receptor Dataset	A collection of risk receptors produced by the Environment Agency.
Ordinary Watercourse	All watercourses that are not designated Main River and which are the responsibility of Local Authorities or, where they exist, IDBs.
Partner	A person or organisation with responsibility for the decision or actions that need to be taken.
Pitt Review	Comprehensive independent review of the 2007 summer floods by Sir Michael Pitt, which provided recommendations to improve flood risk management in England.
Pluvial Flooding	Another term for surface water flooding meaning flooding from water flowing over the surface of the ground which often occurs when the soil is saturated and natural drainage channels or artificial drainage systems have insufficient capacity to cope with additional flow.
Risk	The product of the probability and consequence of the occurrence of an event.

Term	Definition
Risk Management Authority	Defined under the Flood and Water Management Act 2010 as the Environment Agency, Lead Local Flood Authority, internal drainage boards, district councils for areas for which there are no unitary authorities, water companies and highway authorities.
Sewer Flooding	Flooding caused by a blockage, under capacity or overflowing of a sewer or urban drainage system.
Surface Water Flooding	Flooding from water flowing over the surface of the ground which often occurs when the soil is saturated and natural drainage channels or artificial drainage systems have insufficient capacity to cope with additional flow.
Sustainable Drainage Systems (SuDS)	Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques. The current study refers to the 'infiltration' category of sustainable drainage systems e.g. soakaways, permeable paving.

Executive Summary

This document forms a Surface Water Management Plan (SWMP) for Southend-on-Sea Borough Council, and is a revision to the draft SWMP produced in 2011. The SWMP has been updated to align with improved flood risk information and to act as an evidence base to the Southend-on-Sea Local Flood Risk Management Strategy and Flood Risk Management Plan.

The SWMP has been undertaken following a four phase approach based on the methodology set out in Defra's SWMP Technical Guidance document, published in March 2010. These four phases comprise of: Phase 1 – Preparation; Phase 2 – Risk Assessment; Phase 3 – Options; and Phase 4 – Implementation and Review. **This document covers Phases 2, 3 and 4 of this process and should be read in conjunction with the Phase 1 study, which was completed by URS Scott Wilson in April 2010.**

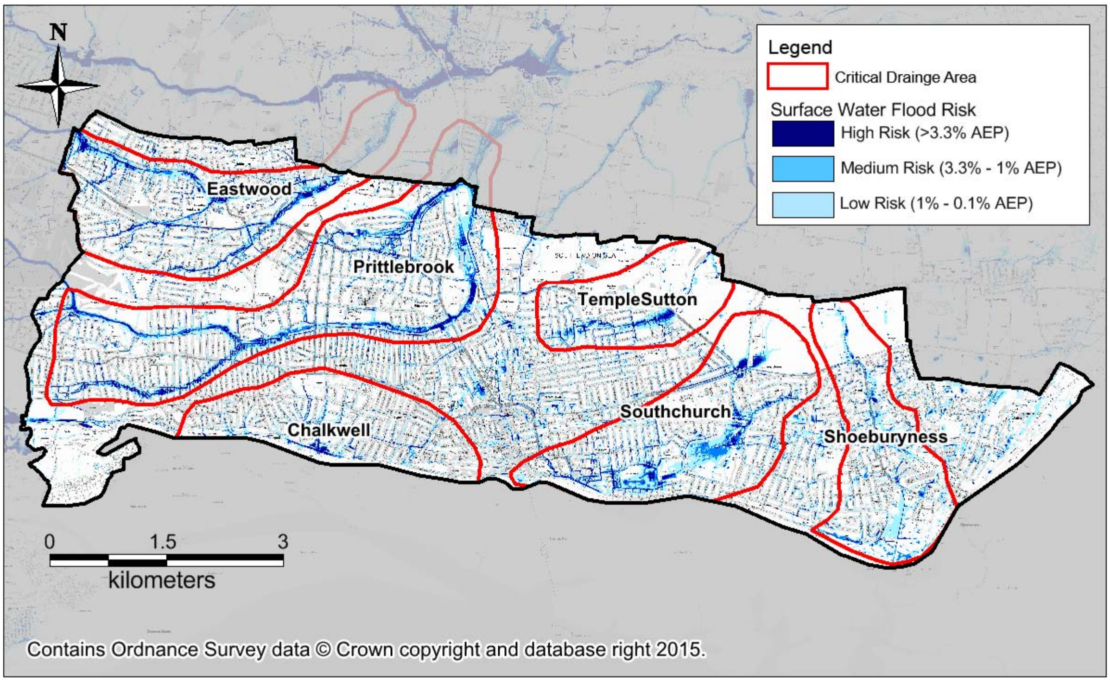
Phase 1 of the SWMP focused on preparing and scoping the requirements of the study. Key outcomes included the collection and review of surface water data from relevant stakeholders, building on existing partnerships between organisations responsible for local flood risk management and setting out how these stakeholders will be engaged throughout the duration of the study. Phase 1 also included a high-level analysis of areas at risk of surface water flooding as well as an initial assessment of the mechanisms of flooding.

As part of the Phase 2 (Risk Assessment), the updated Flood Map for Surface Water (uFMfSW) provided by the Environment Agency, has been mapped and interrogated across the entire study area for a range of return periods to identify areas where flooding is likely to occur during an extreme rainfall event. The analysis of surface water flood risk across Southend-on-Sea has shown that approximately 3,100 residential properties could be at risk of surface water flooding from a rainfall event with a 1% Annual Exceedance Probability (AEP). An assessment of flood risk from other local sources, including groundwater and ordinary watercourses, has also been undertaken as part of this phase of work. The predicted consequences of flooding to property, businesses or infrastructure has been analysed and those areas identified to be at more significant risk have been delineated into Critical Drainage Areas (CDAs).

Across the Southend-on-Sea administrative area six CDAs have been identified (Figure 0-1). These CDAs have been taken forward to Phase 3 (Options) and for each CDA, site-specific options have been identified that could help alleviate the risk of surface water flooding. Examples of such options include the potential implementing of flood storage areas within Southchurch Park, and the creation of designated overland flow routes. In addition, a number of Borough wide options have been put forward, including property level protection measures and revisions to current planning policy.

This document also establishes a long-term Action Plan, under Phase 4 (Implementation and Review), to manage surface water. The Action Plan will be used to influence future capital investment, maintenance, public engagement and education, land-use planning, emergency planning and future developments.

Figure 0-1: Identified CDAs within Southend-on-Sea



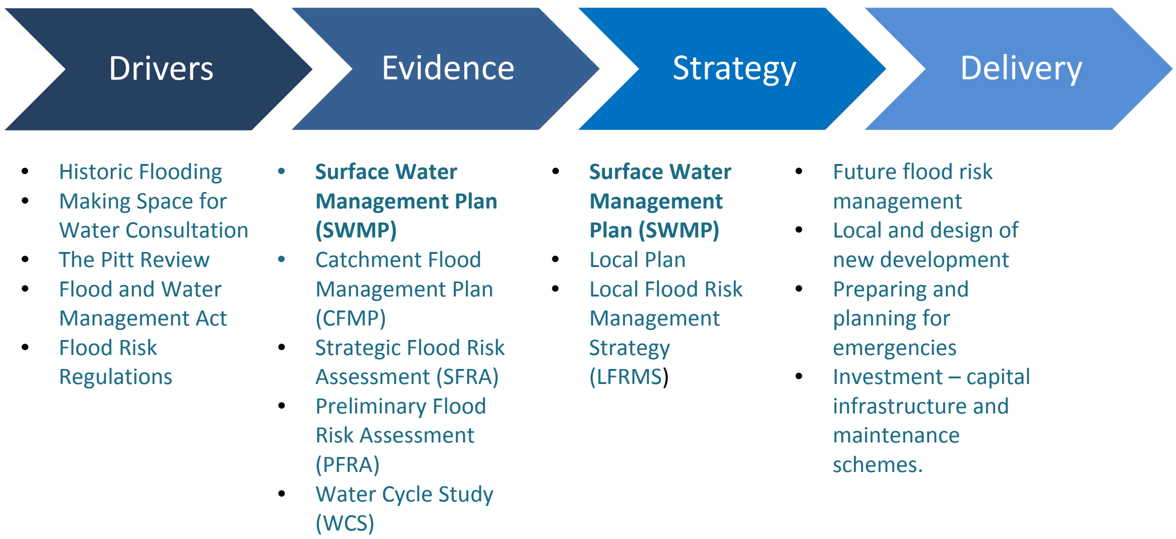
1 Introduction and Aims

1.1 Introduction

This report is a revision to the draft Southend-on-Sea Surface Water Management Plan (SWMP) produced in 2011. It has been updated to align with improved flood risk information and to act as an evidence base to the Southend-on-Sea Local Flood Risk Management Strategy (LFRMS)[1] and Flood Risk Management Plan (FRMP)[2].

The SWMP should not be viewed as an isolated document, but one that connects with other strategic and local plans. Figure 1-1 outlines the drivers behind the Southend-on-Sea SWMP, the evidence base and how the SWMP supports the delivery of other key planning and investment processes.

Figure 1-1: Where the SWMP Sits



As part of this update, the SWMP utilises the Environment Agency's national scale updated Flood Map for Surface Water (uFMfSW)[3] and knowledge of flooding mechanisms resulting from recent flooding events.

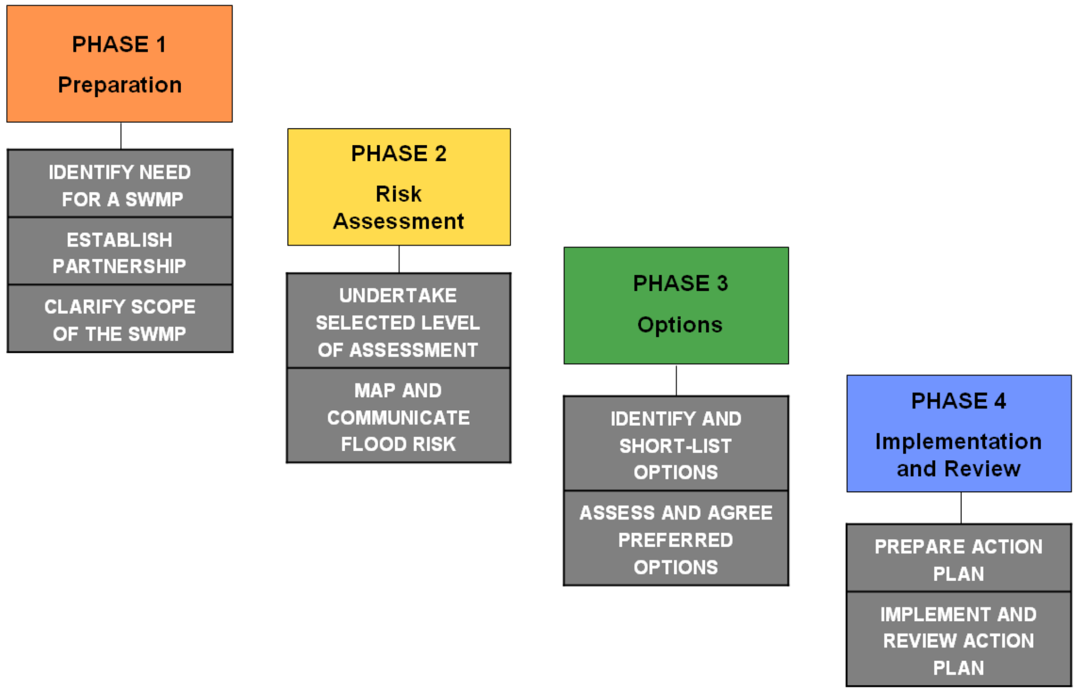
This SWMP outlines the preferred surface water management strategy for the Southend-on-Sea Borough area. In this context surface water flooding describes flooding from local sources including, sewers, drains, groundwater, and runoff from land, ordinary watercourses and ditches that occurs as a result of heavy rainfall.

This SWMP study has been completed in consultation with the Southend-on-Sea Local Flood Risk Partnership to understand the causes and effects of surface water flooding and agree the most cost effective way of managing surface water flood risk for the long term. The Southend-on-Sea Local Flood Risk Partnership consists of the Risk Management Authorities that operate within the Borough, particularly Anglian Water and the Environment Agency. Further details of the Risk Management Authority roles and responsibilities are provided within the LFRMS.

[1] URS (2014) Southend-on-Sea Local Flood Risk Management Strategy, Draft for Consultation
[2] The Flood Risk Management Plan, a requirement of the Flood Risk Regulations 2009, has been incorporated into the Southend-on-Sea Local Flood Risk Management Strategy 2014 – Draft for Consultation.
[3] Environment Agency (December 2013), updated Flood Map for Surface Water. Available online at: http://watermaps.environment-agency.gov.uk/wiyby/wiyby.aspx?&topic=ufmfsw#x=357683&y=355134&scale=2

The methodology for this SWMP has been based on the Defra SWMP Technical Guidance, published in March 2010[4]. The guidance document identifies four clear phases in undertaking a SWMP study: Preparation; Risk Assessment; Options; and Implementation and Review, as illustrated in Figure 1-2.

Figure 1-2: Defra SWMP Phases



1.2 Summary of Phase 1

Phase 1 (Preparation) of the SWMP was prepared by URS (formerly Scott Wilson) in April 2010[5]. This report covers Phase 2, 3 and 4 of the Defra SWMP Technical Guidance and should be read in conjunction with the Phase 1 report. The key outcomes from this phase of work included:

- Preparing and scoping the requirements for a SWMP;
- Establishing partnerships and clarifying the roles and responsibilities of each partner;
- Establishing a stakeholder engagement plan;
- Identifying the availability of relevant information and where data gaps exist; and
- Identifying the level of assessment of the SWMP study.

Phase 1 identified more than 5,400 properties at risk of surface water flooding within the administrative area of Southend-on-Sea. Consequently it was viewed that the risk of surface water flooding needed further appraisal with a particular focus on high risk areas.

Phase 1 used a high level review of different sources of flooding throughout the Borough to identify a number of preliminary Critical Drainage Areas (CDAs). This initial assessment led to the identification of nine CDAs, as detailed below:

[4] Defra (2010) Surface Water Management Plan Technical Guidance. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69342/pb13546-swmp-guidance-100319.pdf

[5] Scott Wilson, April 2010. Surface Water Management Plan. Phase 1 Scoping Study – Final Report. Southend-on-Sea Borough Council.

- **Prittle Brook culvert, Belfairs Park** – the elevation of this culvert has significantly reduced the conveyance capacity of the channel and increased the risk of blockage. During periods of high flow, residential properties in Woodlands Park and Cosgrove Avenue are inundated by water which backs up behind the culvert.

- **Shoeburyness** – this area is identified as more susceptible to surface water flooding and at risk of groundwater flooding. This area is also included in the Seafront Area Action Plan (AAP) area as part of the Southend Local Plan.

- **Southchurch** – this area may be susceptible to surface water ponding and groundwater flooding due to the low elevations. There are critical assets and infrastructure in this CDA including residential properties, an EDF electrical substation and an Anglian Water Services pumping station.

- **Trash screens along Eastwood Brook** – three 'condition five' trash screens along Eastwood Brook have incorrect screen angles and total screen areas which increases the risk of blockage and subsequent flooding of adjacent highways and residential properties such as those at Glenwood Avenue.

- **Parts of the Southend Town Centre AAP** – several areas within the Town Centre AAP have been identified as susceptible to surface water flooding including the area between Victoria Avenue (A127) and Baxter Avenue, and the area west of Sutton Road, between Vale Avenue and Greyhound Way.

- **Chalkwell Avenue, Chalkwell** – area susceptible to surface water flooding and located within the Seafront AAP.

- **Corridor of Eastwood Brook** – Residential properties adjacent to the course of Eastwood Brook are at risk of fluvial and pluvial flooding.

- **Corridor of Prittle Brook** - Residential properties adjacent to the course of Prittle Brook are at risk of fluvial and pluvial flooding.

- **Utility crossings along Eastwood Brook** – service crossings along Eastwood Brook present a risk of blockage and subsequent flooding.

These initial CDAs have been reviewed and refined as part of the full SWMP. The final six CDAs are described in Section 7.

1.3 Aims and Objectives of Phases 2, 3 and 4

The purpose of **Phase 2 (Risk Assessment)** is to develop the understanding of flood risk at each of the CDAs and subsequently communicate that risk to the relevant partners and stakeholders. This includes:

- Reviewing the existing data that was identified and collated in Phase 1, including data relating to the existing Anglian Water sewer system;

- Carrying out a Borough-wide groundwater assessment;

- Analysing the updated flood map for surface water, published by the Environment Agency in December 2013 to identify the mechanisms of surface water flooding and enable an intermediate level risk assessment of surface water flood risk in the Borough;

- Quantifying the risks from surface water flooding through the identification of overland flow paths and areas of surface water ponding leading to an assessment of properties and infrastructure at risk;

- Mapping the results of surface water modelling and communicating the risk of flooding to relevant stakeholders within the Southend-on-Sea Local Flood Risk Partnership; and

- Providing recommendations for detailed level risk assessment, if appropriate.

The purpose of **Phase 3 (Options)** is to identify and assess flood alleviation options and measures that can be put forward. This includes:

- Identifying initial potential options for surface water management across Southend-on-Sea, both specific to the individual CDAs and across Southend-on-Sea as a whole;

- Undertaking a detailed assessment of short-listed options; and
- Using the detailed pluvial model to test mitigation measures.

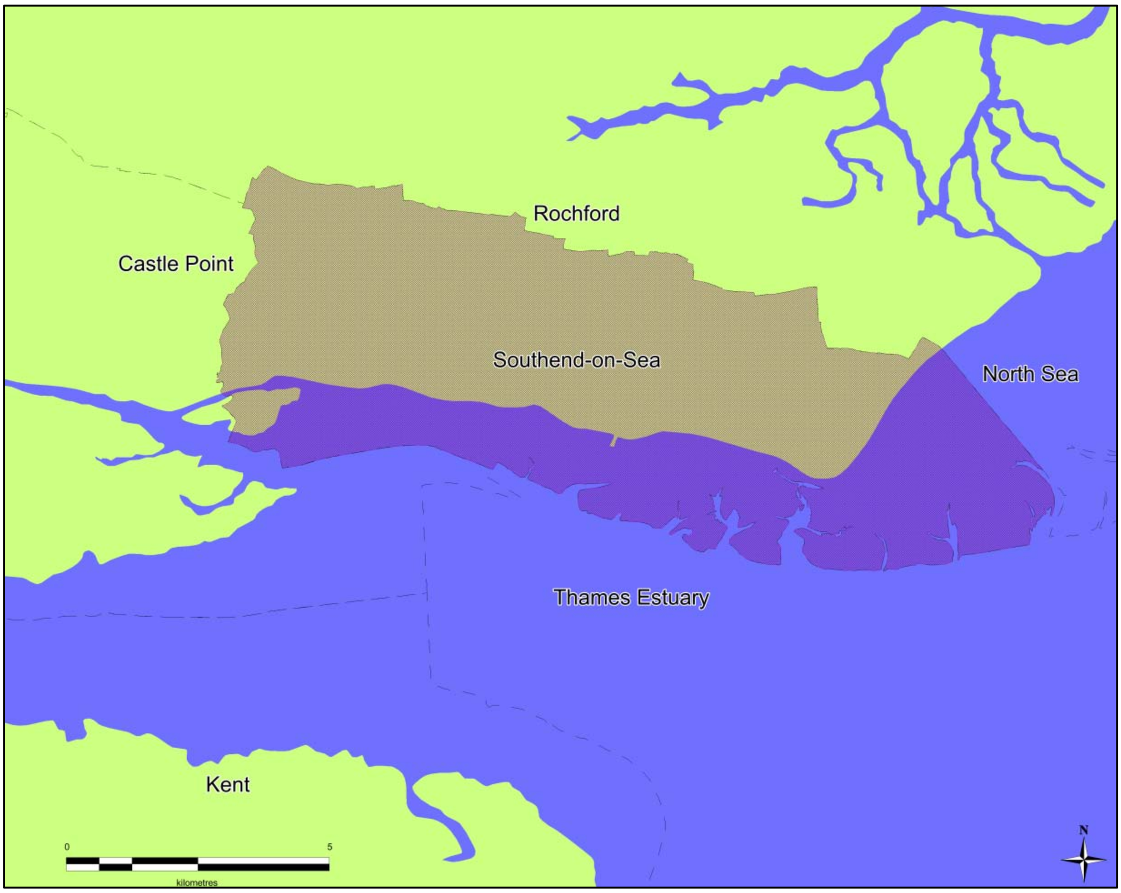
The purpose of **Phase 4 (Implementation and Review)** is to prepare the SWMP Action Plan and provide a strategy on how it will be implemented and reviewed.

1.4 Study Area

Figure 1-3 shows the Southend-on-Sea administrative area which makes up the study area for this SWMP. As a unitary authority. SBC is a Lead Local Flood Authority (LLFA) and has a number of duties in relation to local flood risk management for its administrative area under the Flood and Water Management Act 2010 (FWMA)[6]. Further details of these can be found in the LFRMS.

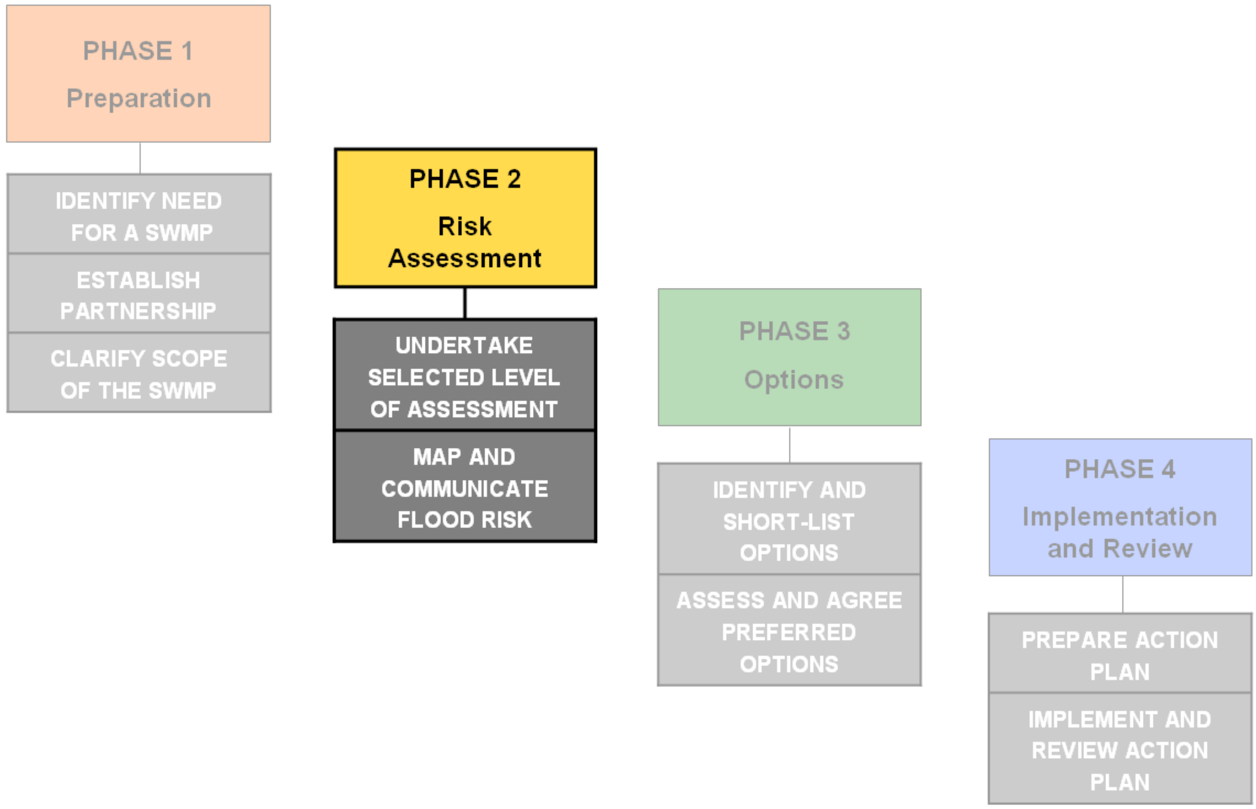
Southend-on-Sea is located in the south of the county of Essex, and is bordered by the neighbouring boroughs of Castle Point and Rochford as well as the Thames Estuary to the south and the North Sea to the east.

Figure 1-3: Southend-on-Sea Administrative Area



[6] HMSO (2010) The Flood and Water Management Act 2010 http://www.legislation.gov.uk/ukpga/2010/29/contents

Phase 2: Risk Assessment



2 Phase 2 Risk Assessment: Introduction

2.1 Level of Assessment

SWMPs can function at different geographical scales and as a result of this, differing levels of detail may be necessary. Table 2-1 defines the potential levels of assessment that can be used within a SWMP.

Table 2-1: Level of Assessment (adapted from the Defra SWMP Guidance, March 2010)

Level of Assessment	Appropriate Scale	Outputs
Strategic Assessment	County or large conurbation (e.g., Essex county area)	- Broad understanding of locations that are more vulnerable to surface water flooding. - Prioritised list for further assessment. - Outline maps to inform spatial and emergency planning.
Intermediate Assessment	Large town or city (e.g., Southend-on-Sea Borough area)	- Identify flood hotspots which might require further analysis through detailed assessment. - Identify immediate mitigation measures which can be implemented. - Inform spatial and emergency planning.
Detailed Assessment	Known flooding hotspots (e.g., Critical Drainage Areas)	- Detailed assessment of cause and consequences of flooding. - Use to understand the mechanisms and test potential mitigation measures.

As shown in Table 2-1 an intermediate assessment is applicable across a large town or city, such as Southend-on-Sea. When Phase 1 was initially carried out in 2010, National surface water modelling suggested that were are 5,400 properties in Southend-on-Sea at risk from a rainfall event with a 0.5% Annual Exceedance Probability (AEP). A review of these figures in 2014 using the uFMfSW dataset suggests approximately 3,100 residential properties could be at risk of flooding from a rainfall event with a 1% AEP and approximately 10,200 properties could be at risk of flooding from a rainfall event with a 0.1% AEP.

An intermediate assessment is considered to be an appropriate level of assessment to further quantify the risks across Southend-on-Sea. The purpose of the intermediate assessment will be to further identify areas within Southend-on-Sea that are likely to be at greatest risk of surface water flooding and require further analysis through more detailed assessment.

The outputs from this assessment should be used to inform spatial and emergency planning. The outputs can also be used to identify potential mitigation measures which can be implemented immediately in order to reduce surface water flood risk. These may include quick win measures such as improving maintenance and clearing blockages.

2.2 Sources of Flooding

The findings of these assessments are described in the following chapters, which consider flooding from each of the following sources:

- **Surface water runoff;** runoff as a result of high intensity rainfall when water is ponding or flowing over the ground surface before it enters the underground drainage network or watercourse, or cannot enter it because the network is full to capacity, thus causing flooding (known as pluvial flooding);

- **Sewer flooding**[7]; flooding which occurs when the capacity of the underground network system is exceeded, resulting in flooding inside and outside of buildings. Normal discharge of sewers and drains through outfalls may be impeded by high water levels in receiving waters[8] as a result of wet weather or high tidal conditions;

- **Flooding from small open channels and culverted urban watercourses**[9] which receive most of their flow from inside the urban area and perform an urban drainage function; and

- Localised flooding resulting from emerging **groundwater** sources.

The risk of flooding from rivers and the sea has been assessed in the Southend-on-Sea Strategic Flood Risk Assessment (SFRA)[10].

The interaction of multiple flood sources is a common occurrence. For example, surface water and sewer flooding is known to be exacerbated by high river and tide levels and high groundwater levels. Where these interactions have been identified, either through historical flooding incidents, local knowledge or flood risk datasets, these have been identified and discussed within this report.

[7] Consideration of sewer flooding in 'dry weather' resulting from blockage, collapse or pumping station mechanical failure is excluded from SWMPs as this is for the sole concern of the sewage undertaker.
[8] Interactions with larger rivers and tidal waters can be important mechanisms controlling surface water flooding.
[9] These watercourses will frequently be ordinary watercourses (with responsibility of local authorities) but may also be designated Main River (with responsibility of the Environment Agency).
[10] Scott Wilson (2010) Southend-on-Sea Borough Council Strategic Flood Risk Assessment Level 1. September 2010

3 Surface Water Flooding

3.1 Overview

Surface water flooding, also known as pluvial flooding, occurs when high intensity rainfall generates runoff which flows over the surface of the ground and accumulates in low lying areas. It is usually associated with high intensity rainfall events (typically greater than 30mm/hour) and can be exacerbated when the soil is saturated and natural drainage channels or artificial drainage systems have insufficient capacity to cope with the additional flow or in urban environments where surfaces are largely impermeable. Southend-on-Sea has experienced severe flooding from surface water in the past; a number of events were identified in the Phase 1 SWMP scoping study. Additional significant events have been experienced in the last few years and added to the record. All flooding incidents recorded by SBC are discussed in Section 3.3.4.

3.2 Responsibility

Under the FWMA, it is the responsibility of LLFAs to investigate surface water flooding, working with other Risk Management Authorities, including the Environment Agency and Anglian Water.

3.3 Information and Data Review

3.3.1 Overview

The following data sources have been used to identify areas potentially at risk of surface water flooding in Southend-on-Sea:

- Topographic Data (Light Detection and Ranging (LiDAR))[11];
- uFMfSW; and
- Historical records of surface water flooding and sewer flooding in the Borough provided by SBC and Anglian Water.

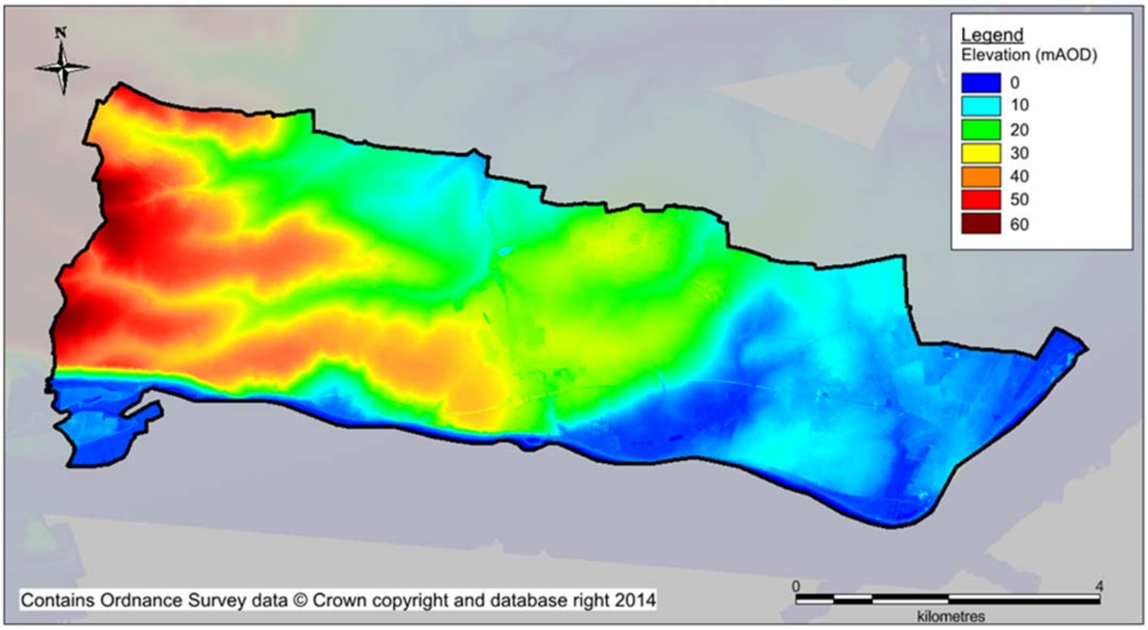
3.3.2 LiDAR

LiDAR data has been analysed to identify potential flow paths and low points across the Borough, where surface water may pond. Figure 3-1 and Figure A1 in Appendix A show the topography of the Borough.

Elevations are approximately 45mAOD in the west of the Borough around the fluvial floodplains of Eastwood Brook and Prittle Brook and they decrease to approximately 7mAOD in Shoeburyness to the east of the study area. This natural topography results in steep slopes within the Borough, which often form ideal flow-paths for surface runoff, and subsequently pluvial flooding at lower elevations.

[11] 'Light Detection and Ranging' A Remote Sensing Method which generates three-dimensional information about the shape of the Earth and its surface. LiDAR supplied by the Environment Agency and flown between 2010 – 2012.

Figure 3-1: Topography of study area represented using LiDAR dataset

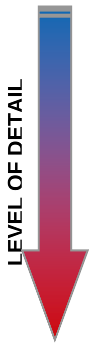


3.3.3 Updated Flood Map for Surface Water

In December 2013, the Environment Agency published the uFMfSW dataset. National surface water modelling was carried out to generate the dataset and combined with locally produced mapping provided by LLFAs, where available. This was used to form the national flood depth and hazard maps, required under the Flood Risk Regulations 2009[12].

A Direct Rainfall approach (see Figure 3-2) using JFLOW+ software was used to produce the uFMfSW whereby rainfall events of known probability are applied directly to the ground surface and water is naturally routed overland to provide an indication of potential flow path directions and velocities and areas where surface water might pond.

Figure 3-2: Levels of detial provided in pluvial modelling (SWMP Technical Guidance)

	**Rolling Ball**	Surface water flow routes are identified by topographic analysis, most commonly in a GIS package
	Direct Rainfall	Rainfall is applied directly to a surface and is routed overland to predict surface water flooding
	Drainage Systems	Based around models of the underground drainage systems
	Integrated Approach	Representing both direct rainfall and drainage systems in an integrated manner, or linking different models together dynamically

The flood extent, depth, velocity and hazard for rainfall events were modelled for the 3.3% AEP, 1% AEP and 0.1% AEP events. This correlates the following flood risk classification:

- High Risk: >3.3% AEP;
- Medium Risk: 1% AEP to 3% AEP;
- Low Risk: 0.1% AEP to 1% AEP; and
- Very Low Risk: <0.1% AEP.

The uFMfSW provides the most up to date flood risk information for Southend-on-Sea and will form the basis for the surface water flood risk assessment for the Southend-on-Sea SWMP. The guidance document for the uFMfSW provides

[12] HSMO (2009) The Flood Risk Regulations http://www.legislation.gov.uk/uksi/2009/3042/contents/made

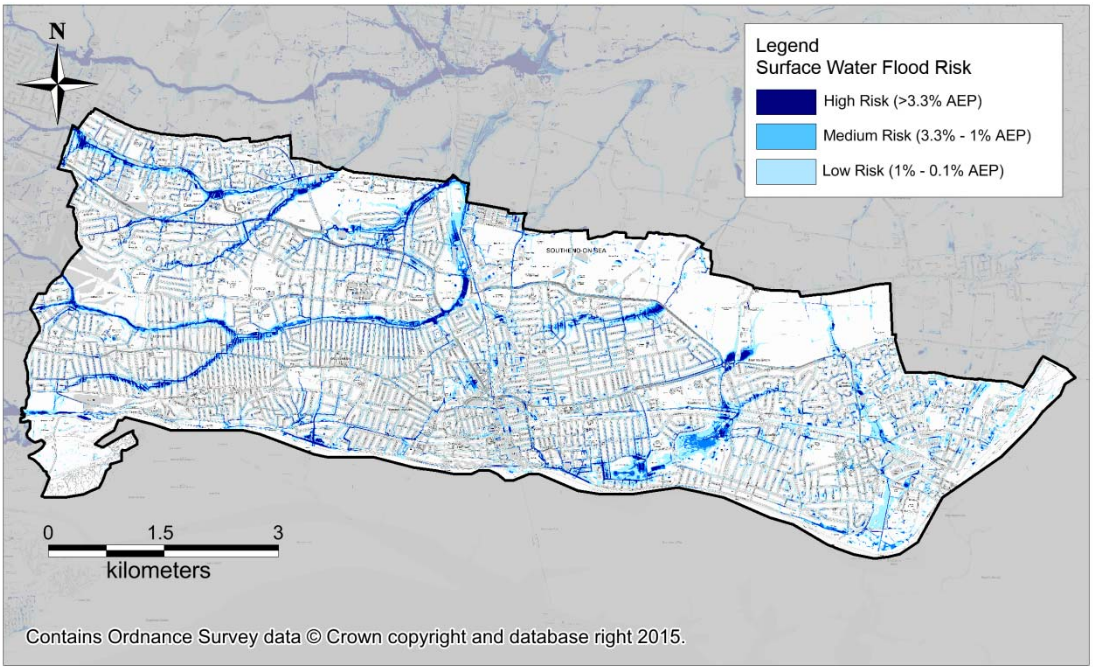
further information on the modelling of the uFMfSW dataset[13]. It should be noted that the uFMfSW dataset is frequently revised following the remodelling of areas or completion of detailed modelling. Reference should be made to the Environment Agency website[14] for the most up-to-date mapping.

Figure 3-3 details the current surface water flood risk for the Southend-on-Sea administrative area[15], also shown in Appendix A Figure A2. The uFMfSW flood depth and flood hazard maps for the 3.3% AEP, 1% AEP and 0.1% AEP events are presented in Appendix A, Figures A4a-f.

The outputs have highlighted surface water hotspots in Southend-on-Sea associated with pathways of watercourses, low topographical points and flow barriers created by infrastructure such as roads and railways. These hotspots have been developed into Critical Drainage Areas (CDAs) to address future management of surface water risk, which are discussed in detail in Section 7.

It is anticipated that the maps produced as part of this SWMP should be used for facilitating the engagement of stakeholders on surface water flooding issues, to further inform the spatial planning process, inform future capital investment decisions, inform emergency planning functions carried out by Local Resilience Forums and also to identify whether critical infrastructure is at risk from surface water flooding.

Figure 3-3: Surface water flood risk

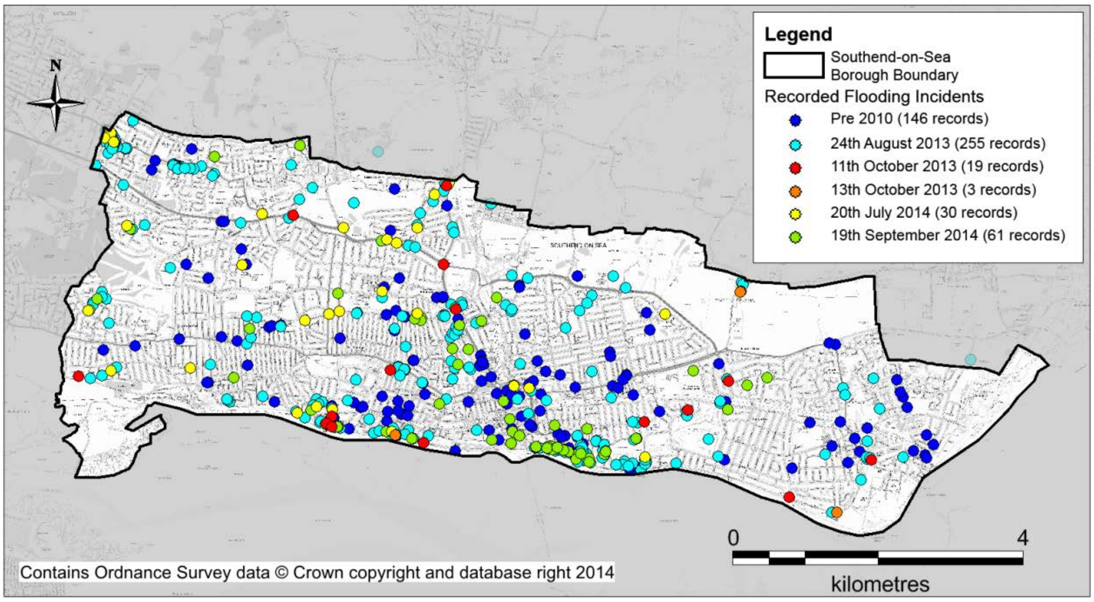


3.3.4 Historical Flood Records

SBC hold records of surface water flood events in the Borough dating back to 2005, including details of areas and properties that have experienced flooding. They also hold anecdotal information from the council's elected members as well as information collected by the Fire and Rescue Service on flood related callouts. These sources amount to 514 recorded flood events throughout the Borough (including events believed to be caused by groundwater flooding); these events have been mapped and are illustrated on Figure 3-4 below. This information is also mapped on Figure A3 (in Appendix A) of this report.

[13] Environment Agency (2013) What is the updated Flood Map for Surface Water? Report version 1.0, November 2013 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/297432/LIT_8988_0bf634.pdf
[14] Environment Agency: http://maps.environment-agency.gov.uk/wiyby/wiybyController?ep=maptopics&lang=_e
[15] Based on the Environment Agency's uFMfSW, published December 2013

Figure 3-4: Records of historic flooding across Southend-on-Sea



As part of their role as LLFA, SBC have improved methods of recording flood incidents. Since 2010, they have had a duty to carry out investigations into significant flood events under Section 19 of the FWMA. A number of these Section 19 investigations have been carried out due to serious flooding in 2013 and 2014 and can be accessed as separate reports. These include the following:

- **24th August 2013[16]:** Intense rainfall caused flooding across the Borough especially within Eastwood, Chalkwell, Marine Parade and Eastern Esplanade areas. Flooding resulted primarily from intense rainfall, however sources of fluvial and sewer flooding further contributed to flooding. A total of 255 flooding incidents were reported, with 151 of these being internal flooding including three properties that required evacuation.

- **11th October 2013[17]**: Widespread flooding was recorded on the 11th October 2013 as a result of heavy rainfall coinciding with high tides resulting in 19 recorded incidents of flooding. Three areas saw repeated flooding on the 13th October 2013 following further rainfall.

- **20th July 2014[18]**: Flooding was observed, primarily to the west of the Borough following heavy rainfall. In total 30 incidents of flooding were recorded, including the internal flooding of Southend General Hospital. Many incidents were an influence of high water levels within Prittle Brook.

- **19th September 2014:** Intense rainfall was observed within the southern extents of the Borough. 61 incidents of flooding were recoded including internal property flooding. Flooding was predominantly towards the sea front along Eastern Esplanade and Marine parade, resulting from localized intensive rainfall.

- **Rebels Lane, January 2014**: Ongoing flooding was experienced within the Rebels Lane area within January 2014 as a result if the exceptional volume of rainfall over the winter months, as well as the obstruction of flow within a local land drainage channel. Flooding resulted in the obstruction of the road for 6 week duration, inhibiting the access of medical staff to residents.

3.4 Summary of Surface Water Flood Risk

Table 3-1 provides a summary of areas at greatest risk of pluvial flooding in Southend-on-Sea, based on historical records, uFMfSW modelling and LiDAR information available for the Borough.

[16] URS (2014) Southend-on-Sea Flood Investigation Report 24th August 2013
[17] URS (2015) Southend-on-Sea Flood Investigation Report 11th October 2013
[18] URS (2015) Southend-on-Sea Flood Investigation Report 20th July 2014

Table 3-1: Areas at risk of surface water flooding in Southend-on-Sea

Location	Details	Data Source: LIDAR Review	Data Source: uFMfSW Mapping	Data Source: Flood Records
Chalkwell Esplanade	Chalkwell Esplanade is located in a topographic depression adjacent to the River Thames estuary in the south of the Borough. Elevations decline from 30m AOD on King's Road (approximately 600m north of Chalkwell Esplanade) to approximately 3.9m to 4.5m AOD along Chalkwell Esplanade. The surrounding topography has the potential to produce surface water flows which may pond in the area around Chalkwell Esplanade.	■	■	
Chalkwell Avenue	The road is susceptible to flooding due to low topography. Surface water sewer networks from the catchment to the north converge within the road, resulting in capacity issues. Repeated flooding observed resulting from a surcharging manhole located at the underpass of the railway bridge.		■	■
The Ridgeway	The Ridgeway follows the contour of the land and so is susceptible to surface water flooding from overland flow. Surface water runoff would potentially accumulate within the road and properties as the flow are intercepted.		■	■
Corridor of Eastwood Brook, Prittle Brook and Mucking Hall Brook	The wider corridors of these watercourses are susceptible to surface water flooding as these areas lie in the flowpaths created by the local topography. The local road layout and associated road infrastructure (bridges and culverts) have a significant influence over localised flooding.	■	■	
Glenwood Avenue, Grovewood Avenue & Rayleigh Road	Glenwood Avenue and Grovewood Avenue are adjacent to Eastwood Brook as it enters a culverted section. The properties in this area have flooded frequently as a result of heavy rainfall and Eastwood Brook overtopping.		■	■
Fairfax Drive and adjoining roads.	Fairfax drive runs adjacent to Prittle Book with several roads crossing adjacent including Victoria Avenue. This area has seen repeated flooding.		■	■
Highlands Boulevard and Vardon Drive	There are several records of flooding within this area, resulting from heavy rainfall. The surface water sewer system within the area discharges to Prittle Brook. High water levels of the brook reduce the capacity of the surface water network.		■	■
Victoria Ave/Baxter Ave	Land between Victoria Avenue (A127) and Baxter Avenue is identified as susceptible to surface water flooding within the uFMfSW mapping.		■	
Railway Lines	The embankments of the two railway lines that run across Southend-on-Sea (Chalkwell to Shoeburyness, and Southend Airport to Southend Victoria) can act to intercept overland flow, resulting in the ponding of surface water adjacent to the railway lines.	■	■	
Western Esplanade, Clifton Drive & Manor Road.	Repeated flooding and landslides within this area. Flooding following heavy rainfall that is considered to exceed the capacity of the surface water sewer network. Topography of the area may result in large quantities of runoff to enter the surface water network upstream of this point.	■		■
Parsons Corner - Bournes Green Chase	Historically this has flooded on a couple of occasions as a result of surface water runoff from the adjacent fields following heavy rainfall.		■	■
Rochford Road and Warners Bridge Roundabout	Rochford Road and Warners Bride Roundabout have been recorded to flood frequently following rainfall. Rochford Road is at a slightly lower elevation as it follows the channel of tributary of Prittle Brook (which is now culverted).		■	■
Marine Parade, Eastern Esplanade and adjacent roads	Marine Parade, Eastern Esplanade and adjacent roads are at a low elevation, with the land rising to the north west. This area has seen repeat flooding from surface water and sewer sources following intense rainfall.	■	■	■

Location	Details	Data Source		
		LIDAR Review	uFMfSW Mapping	Flood Records
Southchurch Park and Thorpe Hall Golf Course	Southchurch Park, Thorpe Hall Golf Course and the surrounding built-up area of Southchurch are located at an elevation of between 1 – 4.2m AOD. Elevations rise to the north, to 8m AOD at Bournes Green. To the west, the eastern part of Southend town centre rises to approximately 25m AOD. These relatively steep slopes present key pathways for flows of surface water into this low lying area.	■	■	
Shoeburyness: Cambridge Town and The Hilly Marsh	Shoeburyness forms a headland in the south east of the Borough. Cambridge Town and the Hilly Marsh are located at 1m – 4m AOD and prior to the construction of tidal defences, this area formed a tidal lagoon during periods of high tide. The low-lying nature of this area may make it susceptible to surface water flooding.	■	■	
Suttons and Poynter's Point	Suttons and Poynter's Point are located in the east of the Borough at an elevation of 1.5 – 3.5m AOD. North Shoebury is located to the west at an elevation of 8m AOD. Any overland flow may be directed towards Suttons and Poynter's Point.	■	■	
Campfield Road & Ness Road	Flooding in 2013 and 2014 has highlighted the susceptibility of the roads adjacent to Gunners Park to flooding. Within these areas, there is the potential for surface water sewers to surcharge, if the sewer outlets, within Gunners Park, are restricted.			■

4 Groundwater Flooding

4.1 Overview

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

It is also important to consider the impact of groundwater level conditions on other types of flooding (e.g. fluvial, pluvial and sewer flooding). High groundwater level conditions may not lead to widespread groundwater flooding. However, they have the potential to exacerbate the risk of pluvial and fluvial flooding by reducing rainfall infiltration capacity, and to increase the risk of sewer flooding through sewer / groundwater interactions.

4.2 Responsibility

Under the FWMA, it is the responsibility of LLFAs to investigate groundwater flooding working with other Risk Management Authorities, including the Environment Agency, who has a strategic overview role for flood risk management and hold historic data and monitor groundwater levels.

4.3 Information and Data Review

A detailed review of the geology and hydrogeology of Southend-on-Sea was completed in 2010 and is presented in Appendix B. The geology, hydrology and groundwater flood risk has been summarised below.

The bedrock geology across site is formed predominantly of Upper Chalk overlaid with London Clay Formation. The permeability of the London Clay Formation (based on the British Geological Survey (BGS) permeability data presented in Figure B5 and B6 in Appendix B) is considered to be Moderate to Very Low, however it is considered to act as an Catchment Flood Management Plan, a layer of rock through which water cannot flow. The underlying Upper Chalk is considered to be a principal aquifer, supporting large quantities of water; however the presence of the London Clay Formation acts to confine this aquifer.

The superficial geology varies across the Borough and consists of Alluvium, Head, River Terrace Deposits, Beach and Tidal Flat deposits, Tidal Flat Deposits and Blown Sand. The permeability of these rock types varies considerably, with Blown Sands having a high permeability and Tidal Flat Deposits having a low to very low permeability. The hydraulic properties of superficial deposits are discussed further in Appendix B.

The River Terrace Deposits form a significant perched aquifer over the London Clay aquiclude across much of the central and eastern parts of the SBC administrative area. In addition, the Blown Sand deposits (Eastern Esplanade) and possibly the Head deposits in localised areas, will behave as aquifers. The Environment Agency and SBC do not currently monitor groundwater levels in the superficial deposits.

4.4 Summary of Groundwater Flood Risk

4.4.1 Groundwater Flooding Mechanisms

Based on the current hydrogeological conceptual understanding, there are four key groundwater flooding mechanisms that may exist:

- **Superficial aquifers along Prittle Brook (Priory Park and downstream of the Park), Eastwoood Brook (Eastwood Area) and upstream of the Barge Pier Ditch:** groundwater flooding may be associated with the sand and gravel River Terrace Deposits, where they are in hydraulic continuity with surface water courses. Stream levels may rise following high rainfall events but still remain “in-bank”, and this can trigger a rise in groundwater levels in the associated superficial deposits.

- **Superficial aquifers in various locations:** Perched groundwater tables can exist within River Terrace Deposits (gravel and sand), Blown Sand and sand lenses within the Tidal Flat Deposits and Head deposits. This develops through a combination of natural rainfall recharge and artificial recharge e.g. leaking water mains.

- **Superficial aquifers along the coastline (Two Tree Island and east of Southend Pier to Pigs Bay):** Where River Terrace Deposits (gravel and sand), Blown Sand, or sand lenses within Tidal Flat Deposits are present behind coastline flood defences, it is possible that tidal fluctuations propagate northwards through the superficial deposits, increasing the potential for groundwater flooding.

- **Impermeable (silt and clay) areas downslope of superficial aquifers in various locations: Groundwater** flooding may occur where groundwater springs / seepages form minor flows and ponding over impermeable strata where there is poor drainage (artificial or natural).

- **Made ground in various locations:** Groundwater flooding may occur where the ground has been artificially modified to a significant degree. If this 'made ground' is of substantial thickness and permeability, then a shallow perched water table may exist. Areas mapped by the BGS as containing made ground are shown in Figure B2. It is noted that the made ground deposits are mostly over the River Terrace Deposits and may either form a continuous aquifer with these superficial deposits, or provide a low permeability cap, depending on the composition of the made ground.

4.4.2 Evidence of Groundwater Flooding

No groundwater flooding incidents within the study area have been reported to the Environment Agency. However, there is one incident reported to SBC between 1998 and 2005, related to the flooding of a basement in the Eastern Esplanade area (Figure B7). It is possible that this groundwater flooding incident was caused by a perched groundwater table within the Blown Sand deposits. Evidence of high groundwater levels and some minor groundwater flooding was also observed in Shoeburyness. There are also two groundwater flooding incidents reported to the fire service (Figure B7); one located near to the Victoria Station and a second to the west of Leigh-on-Sea. These were both basement flooding incidents. However, the flood incident west of Leigh-on-Sea is located on the London Clay Formation aquiclude, and so this may not be a groundwater related incident.

4.4.3 Groundwater Flooding Susceptibility Datasets

The BGS has produced a dataset showing areas susceptible to groundwater flooding (2010) on the basis of geological and hydrogeological conditions (Figure B9 in Appendix B). This dataset is considered to represent the present day flood risk. The map indicates that susceptibility to groundwater flooding is Very High to High in some areas where Head deposits and River Terrace Deposits are present at the surface; along Prittle Brook, Eastwood Brook, Shoeburyness (eastern part of the study area) and around Southchurch in the central part of the study area. These locations coincide with those areas where the BGS has identified higher permeability (see Figure B10). There may be some uncertainty of the susceptibility to groundwater flooding with relation to certain geological areas (further details are provided within Appendix B), therefore this data should not be relied upon for site specific identification of groundwater flood risk.

Those areas where the BGS has identified no susceptibility to groundwater flooding may still be affected where groundwater springs / seepages form minor flows and ponding over impermeable strata. This mechanism may have resulted in the regular ponding of water observed adjacent to the Barge Pier Ditch, where groundwater seepages from the River Terrace Deposits may seep onto the relatively impermeable Tidal Flat Deposits.

5 Sewer Flooding

5.1 Overview

During periods of heavy rainfall, flooding may occur from the sewer system if:

- **The rainfall event exceeds the capacity of the sewer / drainage network:** The majority of modern sewer systems are designed to accommodate rainfall events with a 3.3% probability of occurrence rainfall event. Older sewer systems (such as those found within the southern extent of the borough) and combined sewers can have a lower capacity. Therefore, if a rainfall event with a greater than 3.3.% AEP event, the sewer system is expected to be overloaded and flooding can occur due to insufficient capacity in the system.

- **The system becomes blocked by debris or sediment:** Depending on their location, gullies and drains can accumulate debris e.g. leaves, rubbish or silt. This can reduce the capacity or block the drain potentially leading to flooding from the drainage system. This results in the local reduction of drainage capacity and will potentially result in flooding. The location of sewer flooding incidents resulting from blocked gullies is more difficult to predict.

- **The system surcharges due to high water levels in the rivers or sea:** Where a drainage system discharges into a river or sea via gravity, there is the potential that the system can become tide-locked when the outlet is submerged by high water levels; this means water cannot freely discharge from the drainage system. If the capacity in the sewer system is exceeded, flooding on the surface will occur which can be exacerbated if this occurs simultaneously with an extreme rainfall event. Flooding within Chalkwell, Eastern Esplanade and Marine Parade on the 24th August was largely a result of high tides restricting discharge. Flooding along Fairfax Drive and Victoria Avenue likewise is considered to be a result of high water levels of Prittle Brook restricting outfalls.

5.2 Responsibility

In order to clearly identify problems and solutions, it is important to first outline the responsibilities of different organisations with respect to drainage infrastructure. The responsible parties are primarily as follows:

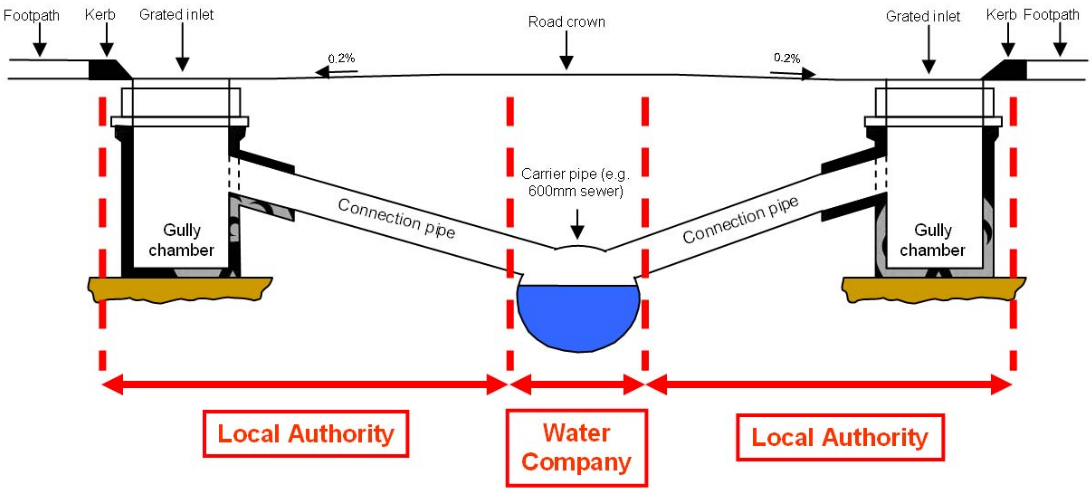
- Highways Authority (Southend-on-Sea Borough Council); and

- Sewerage undertaker (Anglian Water).

As illustrated in Figure 5-1 SBC, as the Highways Authority, is responsible for maintaining an effective highway drainage system including kerbs, road gullies and the pipes which connect the gullies to the trunk sewers and soakaways. The sewerage undertaker, in this case Anglian Water, is responsible for maintaining the trunk sewers and the drainage systems on the main roads. Anglian Water’s responsibility, as the sewerage undertaker, was defined in the Water Industry Act 1991, which states a duty to provide, maintain and operate systems of public sewers and works for the purpose of effectual drainage of the area.

Sewer systems are typically designed and constructed to accommodate rainfall events with a 3.3% AEP or less. Therefore, rainfall events with a return period greater than a 3.3% AEP would be expected to result in flooding from some of the sewer system.

Figure 5-1: Surface water sewer responsibility



5.3 Information and Data Review

5.3.1 Historic Records of Flooding

The recent flooding events experienced within Southend-on-Sea (discussed previously in Section 3.3.4) has highlighted several areas where the surface water and combined sewer networks are susceptible to flooding. These sewer flooding incidents have been reported as either 'lifted manhole covers' or 'surcharging sewers'. The main sewer flooding hotposts are located around the following areas:

- Eastern Esplanade, Marine Parade & Hartington Road (CDA4): surcharging sewers recorded, with flooding exacerbated by tide locking of the gravity drained outfalls;
- Prince Avenue & Rochford Road (CDA2); several reports of lifted manhole covers and surcharging sewers within the road channels, suggesting a possible capacity issue within the network;
- Ness Road & Campfield Road (CDA5); surcharging manholes associated with restricted discharges to the ordinary watercourses within Gunners Park; and
- Chalkwell Avenue (CDA6): recurrent flooding of the manhole located beneath the railway crossing.

5.3.2 DG5 Register

Sewer flooding events were identified using data from the Anglian Water DG5 register. This database records of total number of flood incidents that have affected properties, both through external flooding and internal flooding, over the last ten years. It also includes details on properties that are currently included on their 'at risk' register.

According to the database, **32 properties were affected by sewer flooding between 2000 and 2010.** The majority of these incidents have been attributed to foul sewer flooding rather than surface water sewer flooding; however, the reason for foul sewer flooding is most commonly due to surface water entering the foul network during a heavy rainfall event. It must be noted that Anglian Water focus their efforts on removing properties from the DG5 register through network improvement work, and therefore it may not accurately represent properties which are currently at risk.

6 Ordinary Watercourses

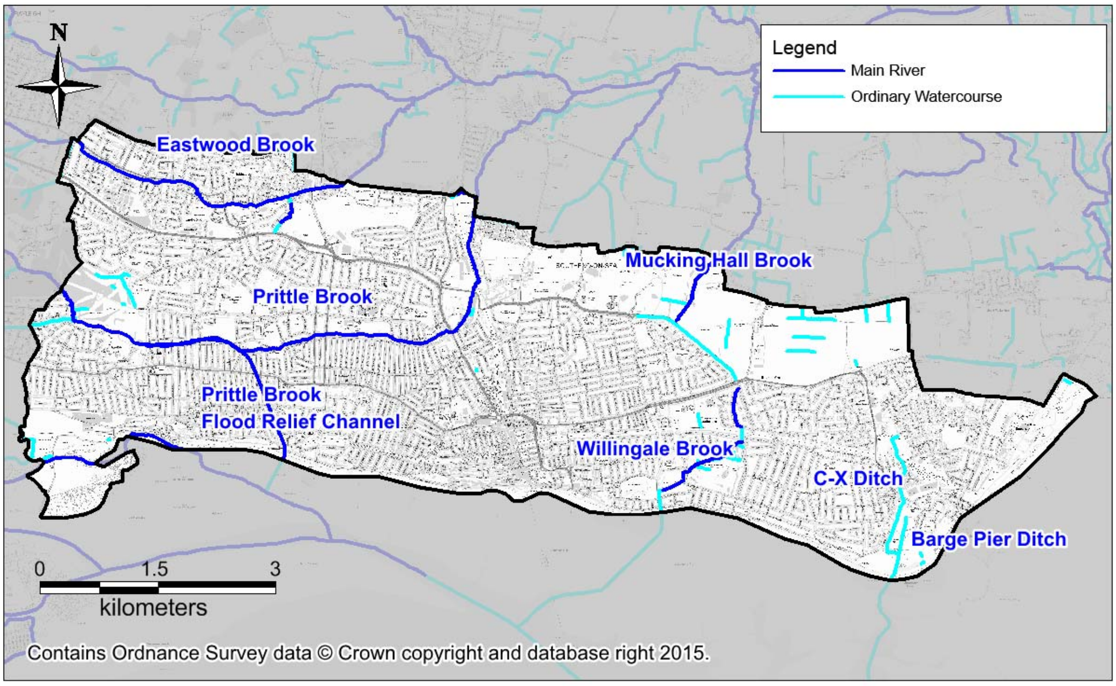
6.1 Overview

SWMPs should consider the risk of flooding from ordinary watercourses[19], including small open channels and culverted watercourses, within the study area. As the LLFA, SBC is now responsible for the management of flood risk from ordinary watercourses. Flooding from main rivers or the sea is the responsibility of the Environment Agency and is outside the scope for the SWMP. The risk from main rivers[20] and the sea are outlined in the Southend-on-Sea SFRA[21].

6.2 Information and Data Review

Figure 6-1 (and Figure A5 in Appendix A) shows the main rivers and ordinary watercourses that are located within Southend-on-Sea. This information has been taken from the Environment Agency's Detailed River Network (DRN) dataset. Table 6-1 lists and provides details of the watercourses within Southend-on-Sea.

Figure 6-1: Watercourses within Southend-on-Sea



As can be seen in Table 6-1, there are a number of small ordinary watercourses, most of which are tributaries of main rivers within the Southend area. The largest ordinary watercourse is the Barge Pier Ditch which runs through the Shoeburyness area.

Prittle Brook is maintained by the Environment Agency, although the Council's parks department is responsible for the section through Priory Park. It flows west to east though the Southend-on-Sea towards Priory Park (near Prittlewell), before turning northwards to join the River Roach. Following a flood event in 1968, major channel improvements were undertaken and Prittle Brook is now heavily modified. In the 1970s Anglian Water installed the Prittle Brook flood relief tunnel, which diverts excess flows to the Thames Estuary during times of flooding and largely relieves drainage from the western part of the Borough.

[19] Ordinary watercourses are classified as any river, stream or ditch that is not classified as a main river.
[20] Main rivers are watercourses shown on the statutory main river maps held by the Environment Agency, the Department of Environment, Food and Rural Affairs (in England) and the Welsh Assembly Government (in Wales). They can include any structure or appliance for controlling or regulating the flow of water into, in or out of the channel.
[21] URS (2010) 'Southend-on-Sea Borough Council Level 1 Strategic Flood Risk Assessment', URS: London. Available online at: http://www.southend.gov.uk/download/downloads/id/1636/southend_level_1_sfra_main_report_finalpdf

Table 6-1: Watercourses within Southend-on-Sea

Watercourse *(name or location if un-named)*	Classification	Risk Management Authority	Length (km)
Eastwood Brook	Main River	Environment Agency	7.58
Prittle Brook	Main River	Environment Agency, SBC Parks department responsible for section through Priory Park	8.40
Prittle Brook Tunnel	Main River	Environment Agency	2.80
Mucking Hall Brook	Main River	Environment Agency	3.36
Willingale Brook	Main River	SBC	2.44
Barge Pier Ditch	Ordinary watercourse	SBC	0.80
C-X Ditch	Ordinary watercourse	SBC	0.84
Tributary of Prittle Brook (Alton Gardens)	Ordinary watercourse	SBC	0.09
Tributary of Prittle Brook (within Priory Park)	Ordinary watercourse	SBC	0.14
Tributary of Eastwood Brook	Ordinary watercourse	SBC	0.87
Tributary of Mucking Hall Brook (north of Royal Artillery Way)	Ordinary watercourse	SBC	0.39
Six small watercourses within Thorpe Hall Golf Course	Ordinary watercourse	SBC	0.96 (combined length)

Eastwood Brook is also maintained by the Environment Agency and flows west to east, broadly following Eastwood Road (A1015) into Eastwood and then northeast towards its confluence with the River Roach at Rochford Hundred Golf Club. As with Prittle Brook, Eastwood Brook is now heavily modified.

Mucking Hall Brook drains a small central northern area within Southend-on-Sea and is culverted beneath the Royal Artillery Way, flowing north-eastwards through the Essex Golf Complex and then north towards its confluence with the River Roach.

The Willingale Brook drains the catchment to the south of Mucking Hall Brook catchment, flowing in a southerly direction towards Southchurch Park where it outfalls to the lake within Southchurch Park east.

The Barge Pier Ditch and C-X Ditch (formally known as the River Shoe) pass through Gunners Park. Southend-on-Sea Borough Council is the riparian owner for the C-X Ditch. The river upstream of Gunners Park is culverted and is classified as a sewer and is maintained by Anglia Water. Flooding from these sources has been assessed as part of the Thames Gateway and South Essex Strategic Flood Risk Assessment[22], which was carried out by Scott Wilson in 2009 collaboration with the Thames Gateway South Essex Partnership.

[22] Scott Wilson, March 2009, Thames Gateway South Essex Strategic Flood Risk Assessment Review, Scoping Report.

7 Identification of Critical Drainage Areas

7.1 Overview

The intermediate assessment was used to identify areas where the flood risk is considered to be most severe; these areas have been identified as Critical Drainage Areas (CDAs). The working definition of a CDA in this context has been agreed as:

> *'a discrete geographic area (usually a hydrological catchment) where multiple or interlinked sources of flood risk cause flooding during a severe rainfall event thereby affecting people, property or local infrastructure.'*

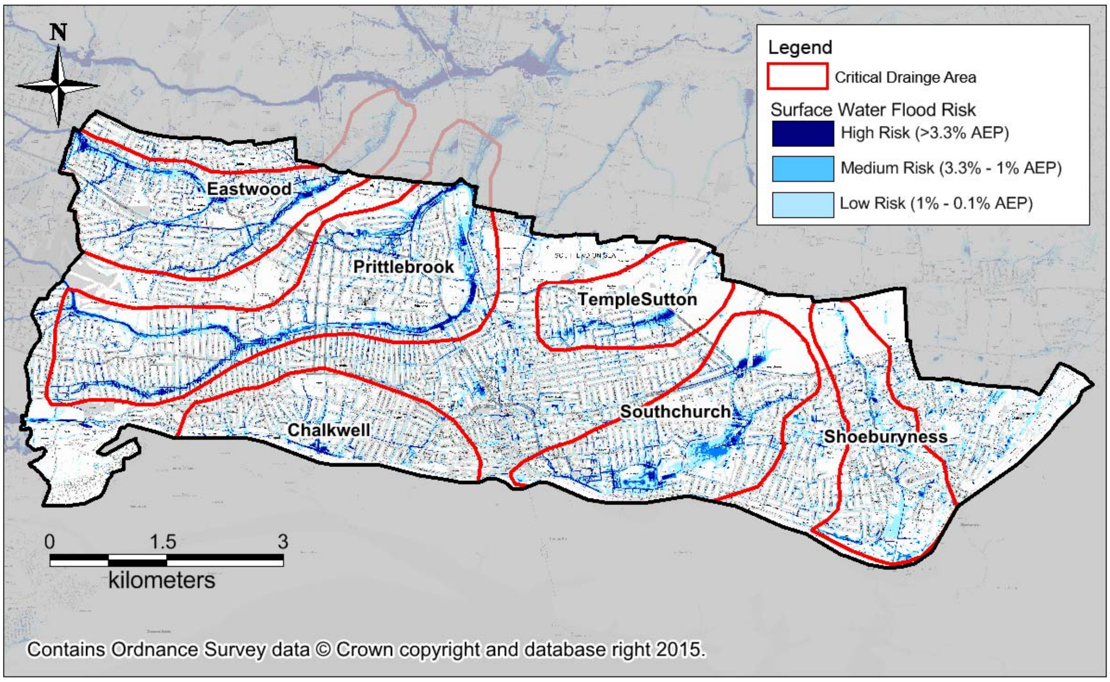
The CDA comprises the upstream 'contributing' catchment, the influencing drainage catchments, surface water catchments and, where appropriate, a downstream area if this can have an influence on CDA. In spatially defining the CDA the following have been taken into account:

- **Flood depth and extent** – areas shown within the uFMfSW, to predicted deep or extensive levels of surface water flooding;
- **Flood hazard** –areas shown within the uFMfSW, to predict a high hazard as a result of flooding (hazards is defined as a function of flood depth and velocity);
- **Potential impact on people, properties and critical infrastructure** – including residential properties, main roads (access to hospitals or evacuation routes), rail routes, rail stations, hospitals and schools;
- **Groundwater flood risk** – based on the groundwater assessment and BGS dataset identifying areas most susceptible to groundwater flooding;
- **Significant underground linkages** – including underpasses, tunnels, large diameter pipelines (surface water, sewer or combined) or culverted rivers;
- **Cross boundary linkages** – CDAs have not been curtailed by political or administrative boundaries;
- **Definition of area** – including the hydraulic catchment contributing to the CDA and the area available for flood mitigation options; and,
- **Source, pathway and receptor** – the source, pathway and receptor of the main flooding mechanisms.

Within the Southend-on-Sea study area, six CDAs have been identified, as illustrated in Figure 7-1 below.

Further details on each of the six CDAs are included in the subsequent sections.

Figure 7-1:CDAs within Southend-on-Sea



7.2 Area Assessment – CDA1: Eastwood

Eastwood is located to the north-west of Southend-on-Sea, the topography of which is dominated by the valley and river channel of Eastwood Brook.

Eastwood Brook is a tributary of the River Roach that originates at Rayleigh Weir, in Castle Point, to the west of the Borough. The river flows across Southend-on-Sea in a north easterly direction, parallel to Rayleigh Road, before joining the River Roach. The channel of Eastwood Brook is heavily modified as is passes though Southend-on-Sea. In addition, there are numerous service crossings along the length of the river. There are two tributaries to Eastwood Brook within Southend-on-Sea. The first is an ordinary watercourse that flows from Pound Wood and joins Eastwood Brook behind Glenwood Avenue along the boundary of the SBC administrative area. The second is classified as a main river and joins Eastwood Brook behind Whitehouse Road. The upper section of this tributary is classified as an ordinary watercourse.

Where Eastwood Brook enters the Borough to the west of Glenwood Avenue, it enters a culvert that runs for a length of 280m as it passes underneath the properties of Glenwood Avenue, before emerging to the east of Grovewood Avenue. A trash screen is located at the head of this section of culverted watercourse. The trash screen, as well as the culverted section of the watercourse, falls under the responsibility of Anglian Water.

The watercourse flows through a relatively steep urban catchment, so its response to rainfall is rapid and there will be little warning of flooding. The Environment Agency currently monitors the water levels of Eastwood Brook once it passes under the B1013, just before leaving Southend-on-Sea. The Eastwood area upstream receives flood alerts, but flood warnings are not available. Following the 24th August 2013 flood event, actions have been taken to install a flood warning system on Eastwood Brook, upstream of Southend-on-Sea.

The Environment Agency is currently undertaking updated modelling of the Eastwood Brook catchment.

The Anglian Water sewer network within the Eastwood area is predominantly separate i.e. foul and surface water is drained separately. Examination of the public surface water sewer network shows that there are a number of surface water drains that discharge to Eastwood Brook. Should water levels of the river rise above the drainage outlets, surface water would back up into the drainage network increasing the risk of surcharging and reducing the drainage capacity.

The uFMfSW mapping (Figure 7-2) shows a tendency for surface water flooding to occur along the length of the river channel within the Eastwood area. This is largely a result of the topography of the area channelling overland flow towards the lower lying river. Localised surface water flooding is also predicted within a heavily urbanised environment due to the presence of structures that influence the flow of water.

The Eastwood CDA was affected during the 24th August 2013 flooding incident. As a result of heavy rainfall and the rapid response in water levels of the Eastwood Brook, there were 63 records of flooding within the CDA, 50 of which were of internal property flooding (including 2 properties that required evacuation). Flooding was recorded within two clusters; the first of these was in the very west of the Borough around Glenwood Avenue, Grovewood Avenue and Belgrave Road. The second cluster is further to the east along Eastwood Brook adjacent to Rayleigh Road. In both clusters, the majority of the flood records were associated with properties adjacent to the Eastwood Brook and its tributary.

The main overland flow paths follow the natural topography of the watercourse channel and are highlighted in Figure 7-2. The main areas of surface water ponding also lie around the natural topography of the watercourse and illustrate where flooding will occur during an extreme rainfall event.

Table 7-1 shows a summary of local flood risk from different flood sources within the Eastwood CDA.

Figure 7-2: Layout and key features of the Eastwood CDA

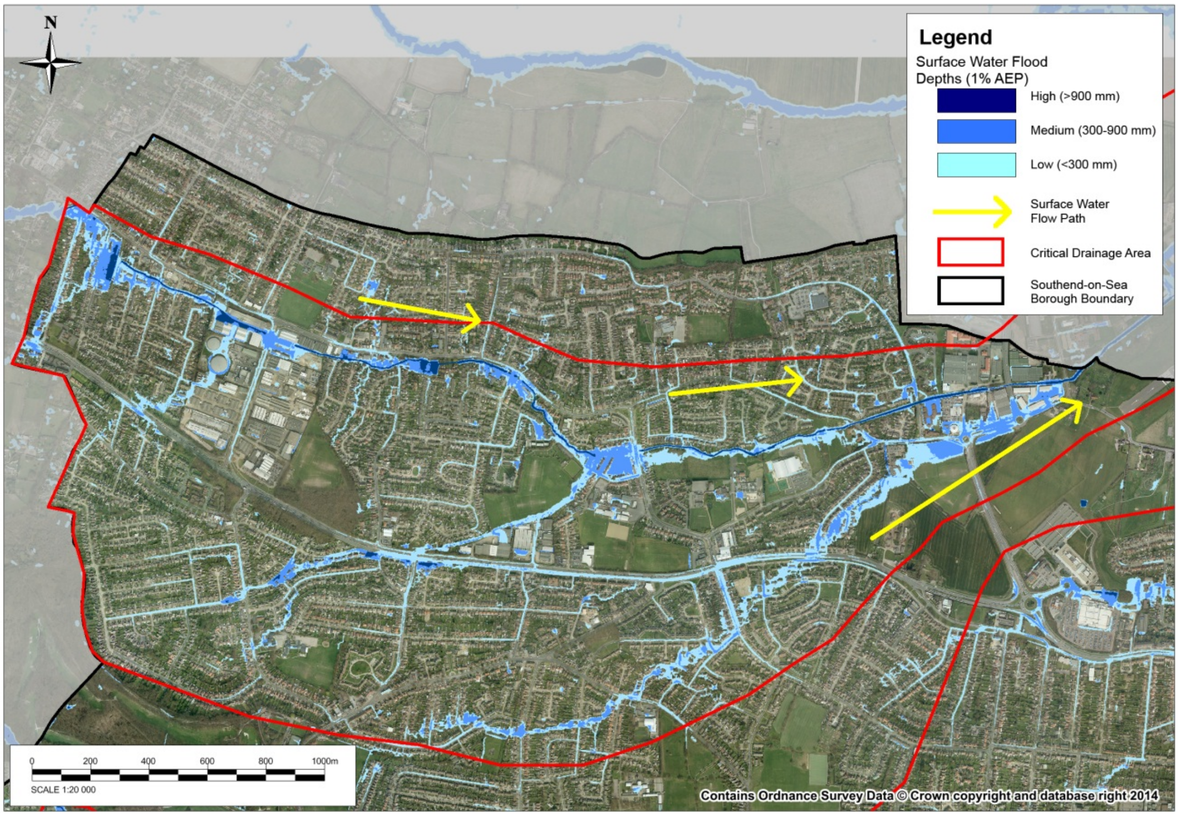


Table 7-1: Summary of local flood risk within the Eastwood CDA

Flood Source	Description
Surface water	This CDA largely follows the natural channel of Eastwood Brook. The majority of predicted surface water flooding to this CDA is a result of overland flow paths generally following surface topography and natural valleys.
Groundwater	The corridor of Eastwood Brook was identified as being at risk of groundwater flooding, based on work carried out in the intermediate groundwater assessment.
Ordinary watercourse	There are no known ordinary watercourses within this CDA.
Sewer	There are no known sewer flooding records within this CDA.
Validation: To date, there have been 77 incidents of flooding recorded within this CDA. These are primarily as a result of the 24th August 2013 rainfall event.	

Figure A6a and Figure A6b in Appendix A show the depth and hazard mapping respectively within this CDA.

7.3 Area Assessment – CDA2: Prittle Brook

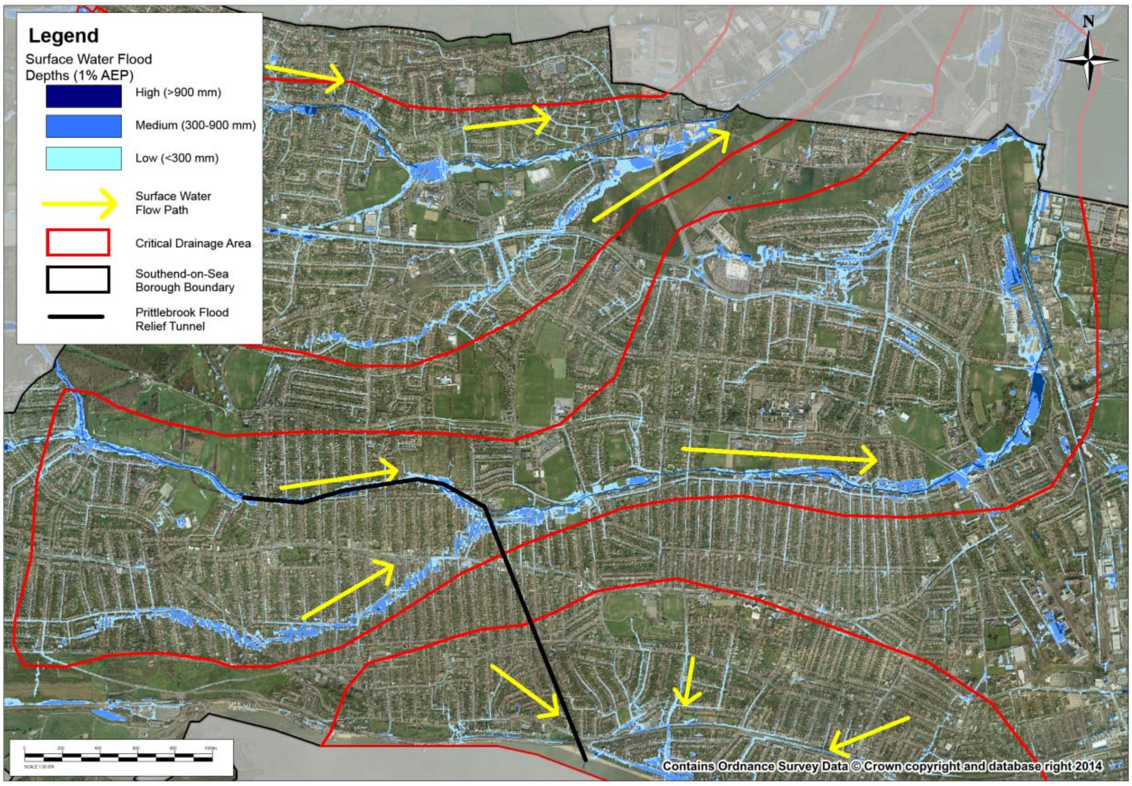
Prittle Brook is another tributary of the River Roach and flows from west to east through the Borough, from Belfairs Park towards Priory Park at Prittlewell, where it then flows north to join the River Roach at Sutton Ford Bridge in Rochford. The topography of Prittle Brook CDA is defined by the presence of the river and associated valley.

Like Eastwood Brook, Prittle Brook flows in and out of culverted sections through the residential areas of Leigh-on-Sea and Prittlewell, and flows through a relatively steep urban catchment. The Environment Agency gauging station, located in Belfairs Park, monitors the river levels of Prittle Brook. Flood Alerts and Flood Warnings are available to properties within the Flood Zone, downstream of this point. Prittle Brook has a very flashy response to rainfall events with water levels rising and falling rapidly following rainfall. This has the implication that there will be little warning of flooding following rainfall.

Surface water modelling demonstrates that this area is a potential hotspot for surface water flooding during severe storm events; this is shown in Figure 7-3.

In the 1970s Anglian Water installed a relief tunnel from the Prittle Brook (as highlighted with a black line in Figure 7-3) to divert excess flows to the south into the Thames Estuary during times of high flows; this largely relieves drainage in this part of the Borough.

Figure 7-3: Layout and key features of Prittle Brook CDA



Many of the historic flooding events within this CDA are in close proximity to the channel of Prittle Brook. It is considered, that in addition for the tendency of surface water to accumulate within the low lying areas of Prittle Book, localised flooding has resulted from high water levels in Prittle Book restricting the discharge from the surface water sewers that outfall to it. Surface water therefore accumulates within the roads adjacent to the river, such as Victoria Avenue or Fairfax Drive.

A summary of the local flood risk within this CDA is included in Table 7-2.

Figure A7a and Figure A7b in Appendix A show the depth and hazard mapping respectively within this CDA

Table 7-2: Summary of local flood risk within the Prittle Brook CDA

Flood Source	Description
Surface water	This CDA largely follows the natural course and topography of Prittle Brook. The majority of predicted surface water flooding to this CDA is a result of overland flow paths generally following surface topography and natural valleys.
Groundwater	The corridor of Prittle Brook was identified as being at risk of groundwater flooding, based on work carried out in the intermediate groundwater assessment.
Ordinary watercourse	There are no ordinary watercourses within this CDA.
Sewer	There are no records of sewer flooding within this CDA.
Validation: Within the CDA there are 87 records of flooding, these are predominantly from events on the 24th August 2013, 20th July 2014 and 19th September 2014.	

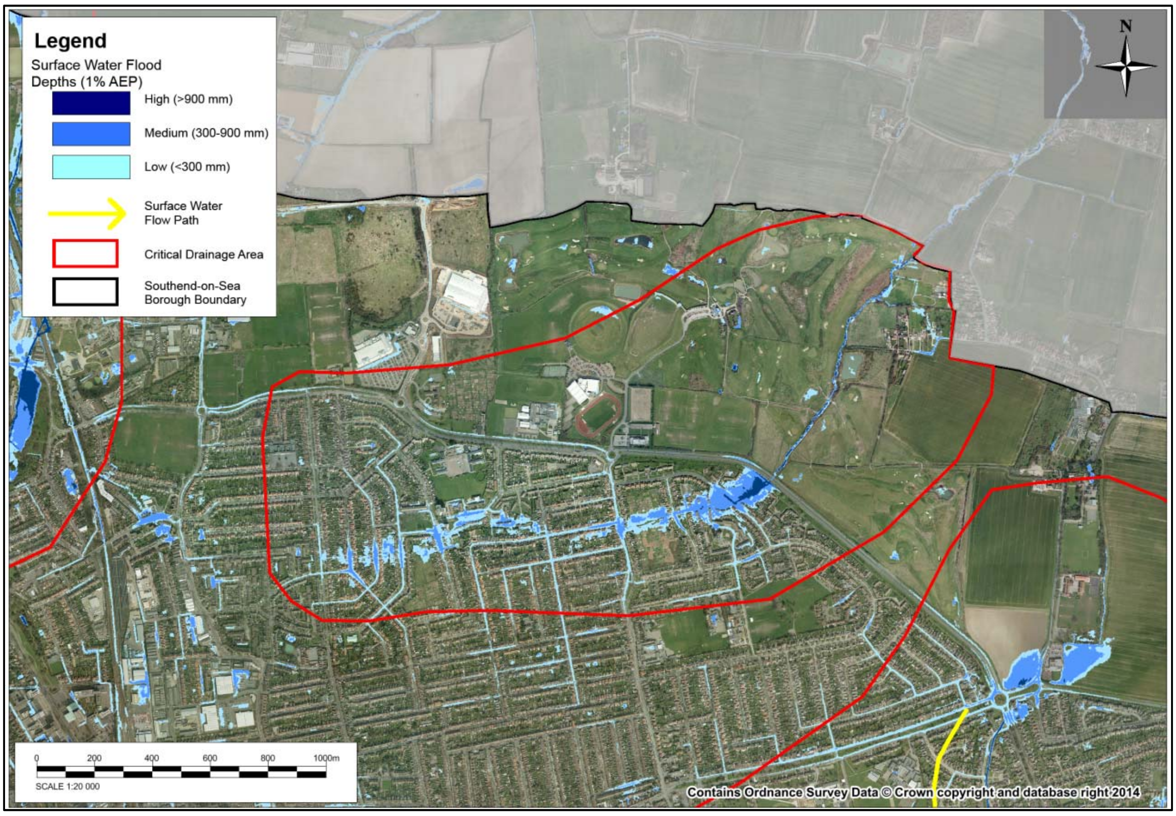
7.4 Area Assessment – CDA3: Temple Sutton

The Temple Sutton CDA is located to the east of the town centre. Intermediate level surface water modelling demonstrates that this area is a potential hotspot for surface water flooding in severe storm events; this is shown in Figure 7-4. During recent flooding events, little flooding has been observed within this CDA.

This area is low-lying and surface water from the surrounding areas is directed into this area, based on the natural topography. It is naturally low-lying as it is the valley of Mucking Hall Brook which is culverted through this area. This is a residential area and 106 properties are at risk of surface water flooding to a depth greater than 0.3m in the 1% AEP.

The inlet of Mucking Hall Brook is not known but the outfall is located adjacent to Rebels Lane on the north-eastern side of the A1159. From here, the watercourse flows north before joining the River Roach. The depth of flooding in this area has been modelled to be over 900mm. Historically there have been issues with fly tipping and littering at this location which results in an increased potential for blockages and localised flooding.

Figure 7-4: Layout and key features of Temple Sutton CDA



This stretch of the A1159 is situated on a raised embanked (approximately 3m high) which contributes to the depth of surface water flooding in this area by restricting movement of water and causing water to pond up behind the raised road embankment. An underpass through the A1159 allows some surface water to pass through; however the majority of flow accumulates to the south of the embankment.

Although the embanked A1159 does restrict the movement of surface water it is considered that if this road was not raised, surface water ponding would still be likely within the vicinity of Archer Close due to the topography of the area.

A summary of the local flood risk within this CDA is included in Table 7-3.

Figure A8a and Figure A8b in Appendix A show the depth and hazard mapping respectively within this CDA

Table 7-3: Summary of local flood risk within the Temple Sutton CDA

Flood Source	Description
Surface water	This CDA largely follows the natural course and topography of Mucking Hall Brook, which used to flow through this area before it was culverted. The majority of predicted flooding to this CDA is a result of overland flow paths generally following surface topography and natural valleys, although it is exacerbated by the presence of the by-pass embankment.
Groundwater	An area to the south of Royal Artillery Way, around Temple Sutton Primary School, has been highlighted as being highly susceptible to groundwater flooding.
Ordinary watercourse	There are no ordinary watercourses within this CDA.
Sewer	There are 15 sewer flooding records on the DG5 register; nearly all of these are from locations along Sumpters Way (near the Temple Farm Industrial Estate).
Validation: Within the CDA there are 9 records of flooding, the majority of which are associated with the 24th August 2013 event.	

7.5 Area Assessment – CDA4: Southchurch

The Southchurch CDA extends across the central part of the Borough, to the east of the town centre. The area is naturally low-lying, with increasing elevation to the north west of the CDA. The valley is a result of a historic tidal lagoon that is now cut off by the sea defence built around the start of the 20th century.

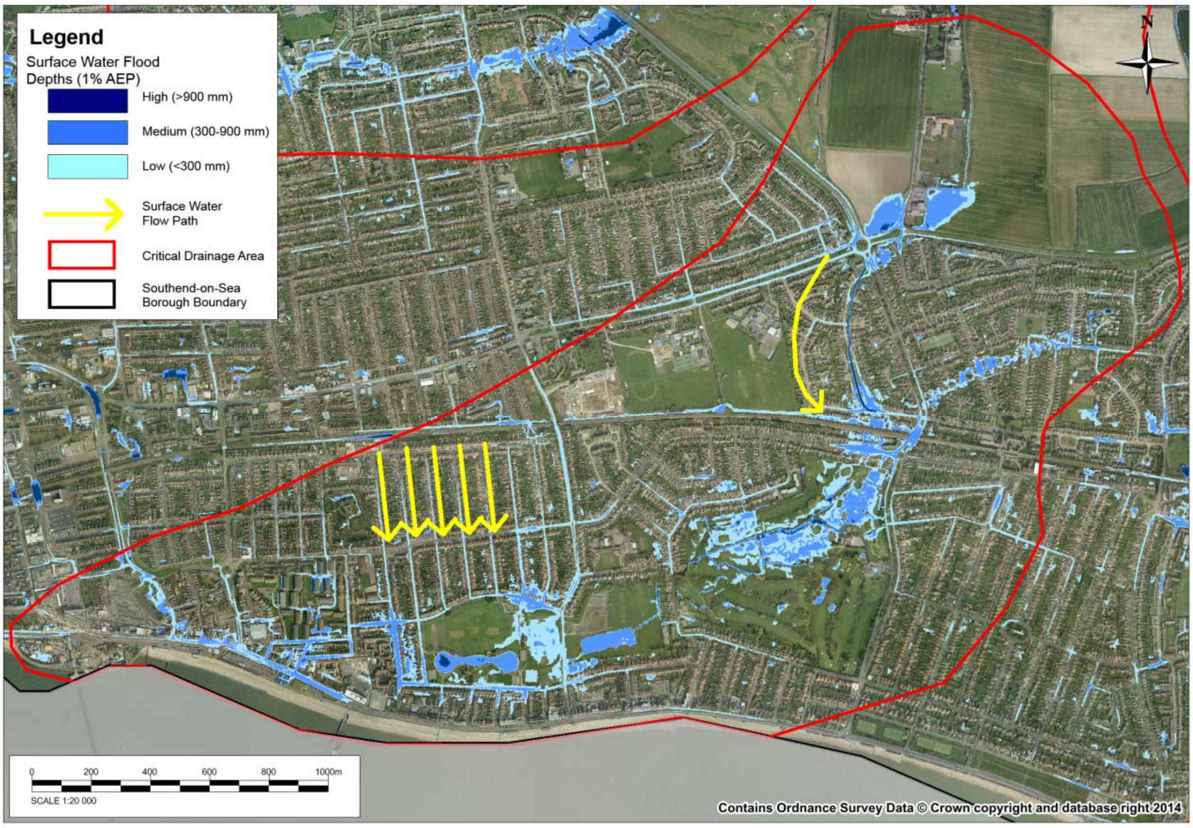
Historic records of surface water flooding show the southern extent of the CDA to be most susceptible to surface water flooding. Records of flooding are most predominant around the Eastern Esplanade, Marine Parade and Victoria Road areas.

Eastern Esplanade and Marine Parade are located along the southern boundary of the Borough in areas of low lying topography. To the north of Marine Parade, the ground rises quite steeply with an approximate gradient of 1:2.5. The rise of the land to the north of the Eastern Esplanade is, however, more gentle. A bank runs diagonally across the Borough, north of Eastern Esplanade, from Queensway at Marine Parade to Bournes Green with a slope of approximately 1:25. The uFMfSW shows there to be the potential for flood depths of between 0.3m to 0.9m for a 1% AEP rainfall event along Marine Parade, Eastern Esplanade and Southchurch Park areas, as shown in Figure 7-5. It should be noted that this modelling is of surface water only, and does not consider the function of the sewer networks or pumping stations.

The sewer network in this area is older than that for most of the Borough, and as a result, there is a complex network of combined sewers that are drained from the catchment through a series of pumping stations.

There are a number of Anglian Water assets that are used to manage storm overflows from the combined component of the sewer network. Firstly there is a storm water storage tank in the north western corner of Southchurch Park that was constructed in response to previous flooding events. Flows in this are managed by associated pumping stations that discharge storm water to the south of the Borough. There is a second combined sewer pumping station (Eastern Valley Pumping Station) within the area, this is located to the west of Victoria Road and pumps combined sewage to the Southend-on-Sea Sewage Treatment Works. Should it become overwhelmed during storm conditions, the system overflows to a storage tank, which when full, discharges via a combined storm overflow to the sea.

Figure 7-5: Layout and key features of Southchurch CDA



Although the sewer network is generally combined, there are some areas that are served by a separate surface water sewer network. The surface water within these areas is predominantly gravity drained to outfalls to the Thames Estuary. Anglian Water records indicate that the surface water outfalls along Marine Parade and Eastern Esplanade are at beach level and tend to be below the mean high water level. This includes a 675mm diameter pipe that discharges below the Southend Pier. These outfalls are all fitted with tidal flap valves designed to ensure sea water cannot flow back up into the sewers. During high tides, these outfalls become tide locked, restricting the discharge of surface water into the sea, however the surface water network has capacity to retain some water within the system until the outfalls become available. In the event that the flap valves fail (e.g. stuck open) sea water will enter the system and reduce the storage capacity within the network. When the capacity of the network is exceeded there is the risk flooding of surface water flooding from the sewer network.

In addition to the gravity drained network, there are two pumping stations in this area that operate to pump surface water to the Thames Estuary. The first is the Eastern Esplanade Pumping Station, located opposite the junction of the Eastern Esplanade and Burdett Road. The second is the Lifstan Way Pumping Station, to the east at the junction of Lifstan Way and the Eastern Esplanade, which discharges water from the pond within Southchurch Park East.

Within the CDA, Willingale Brook, a Main River, flows from the south of Bournes Green, in a south westerly direction through Thorpe Hall Golf Course before discharging towards a pond within Southchurch Park East. There is an overflow weir from the pond that allows excess water to discharge to the Thames Estuary. The Lifstan Way Pumping Station (operated by Anglian Water) functions to lift the water and discharge it during high tides. It is considered that the lake functions as a store to provide water to the Boating Lake in Southchurch Park west as there is a pumped outfall that can discharge water from the lake in the east to the Boating Lake. In addition, there is a surface water overflow from the Anglian Water network to the Boating Lake within Southchurch Park west. Water from the lake can in turn be discharged to the Thames Estuary via the Southchurch Park B Pumping Station located within the southern part of the park.

The main surface water flow paths to this area are the streets to the north of Southchurch Park (including Sandringham Road, Marlborough Road and Huntingdon Road), as highlighted with yellow arrows in Figure 7-5. These streets are relatively steep which cause surface water runoff to flow south towards Southchurch Park. Another main flow path is water flowing from Bourne Green, which is in the north eastern corner of the map above and is also highlighted with yellow arrows. Although the streets entering the area from the south have a comparatively steep gradient onto the site, they contribute less flow due to the smaller catchment area. Surface water also enters Southchurch from the town centre along Queensway and Marine Parade.

A summary of the local flood risk within this CDA is included in Table 7-4.

Table 7-4: Summary of local flood risk within Southchurch CDA

Flood Source	Description
Surface water	This CDA largely follows the natural topography, with surface water flowing from north to south along key overland flow paths.
Groundwater	The Southchurch area was identified as being at risk of groundwater flooding, based on work carried out in the intermediate groundwater assessment.
Ordinary watercourse	There are no ordinary watercourses within this CDA.
Sewer	There are 5 sewer flooding records on the DG5 register. These are based around Eastern Esplanade, Thurlow Drive and Victoria Road.
Validation: Within the CDA, there are 106 records of flooding, the majority of which are associated with the 24th of August 2013 and 19th September 2014 flooding events.	

Figure A9a and Figure A9b in Appendix A show the depth and hazard mapping respectively within this CDA.

7.6 Area Assessment – CDA5: Shoeburyness

The area of Shoeburyness lies at the eastward extent of the Borough area, bounded by the Thames Estuary to the south and North Sea to the east. Surface water flows south from the North Shoebury area into Gunners Park.

The North Shoeburyness area is located in the north-east corner of the Borough. Historic flooding records indicate that a public house near to Parson's Corner and the Asda car park have been known to flood from surface water in the past. The uFMfSW mapping demonstrates that this area is a potential hotspot for surface water flooding during a 1% AEP; this is shown in Figure 7-6.

Figure 7-6: Layout and key features in Shoeburyness CDA

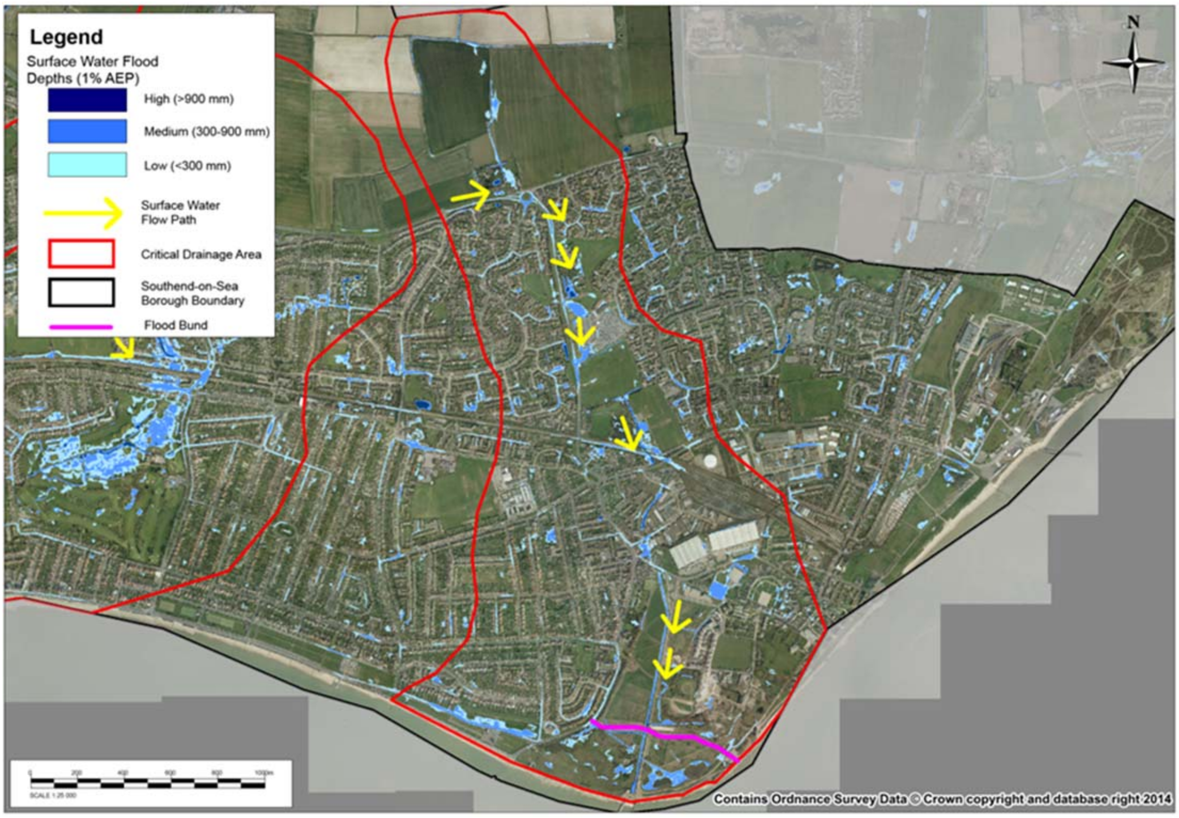


Figure 7-6 shows the main surface water flow paths in North Shoebury. Parson's Corner roundabout receives surface water flow along Bournes Green Chase as well as the fields immediately to the north. This then flows south along the A13 and the land to its eastern side. The A13 acts as a conduit for flow until Shoeburyness Park, where it enters across North

Shoebury Road. Surface water flows out of the park across Elm Road and along the railway line, which contributes to the surface water flood risk in Gunners Park.

Gunners Park is located in the south-east corner of the Borough and the C-X Ditch and Barge Pier Ditch (formally known as the River Shoe) flow through this area. The course of the C-X Ditch and Barge Pier Ditch have recently been altered by development in this and the adjacent area. Gunners Park is located at a low elevation, with some areas lying below sea level. Surface water modelling demonstrates that this area is a hotspot for surface water flooding in severe storm events.

There are several records of flooding of the roads in close proximity to Gunners Park, namely Ness Road, Campfield Road and Shoebury Common Road. Investigation of recent flooding has further determined that the surface water network draining the Shoebury area discharges to the drainage ditches within Gunners Park. Issues associated with the capacity of the drainage ditch and the outfalls of the surface water sewers has reduced the capacity of the surface water network, resulting in the surcharging of the surface water sewers within the adjacent roads.

The uFMfSW mapping, shown in Figure 7-6 predict extensive flooding within the Gunner Park area. This area is naturally low-lying and rainfall is not able to drain away during high tides. The main flowpaths to this area are from two points in the north along Chapel Road and Westgate; some of this water originates from the north of Elm Road in North Shoebury.

However, the southern end of Gunners Park is designed to hold surface water during an extreme event. A flood bund (marked with a pink line on Figure 7-6) was constructed to retain surface water in the low lying area adjacent to the coast.

A summary of the local flood risk from different flood sources is included in Table 7-5.

Table 7-5: Summary of local flood risk within Shoeburyness CDA

Flood Source	Description
Surface water	This CDA largely follows the natural topography of the area, with the low lying ground around Gunners Park being highly susceptible to surface water flooding. There are several key overland flow paths which take water from the North Shoebury area down into the south of the CDA.
Groundwater	There is evidence of high groundwater levels within this CDA, both from borehole level analysis and site observations of high groundwater levels. This area is also identified as being highly susceptible to groundwater flooding in the BGS dataset.
Ordinary watercourse	The Barge Pier Ditch and C-X Ditch flow through the CDA from the north through Gunners Park and into the Thames Estuary in the south.
Sewer	There are no sewer flooding records within this CDA.
Validation: There are 22 records of flooding within the CDA, the majority of which are from the 24th of August 2013 event.	

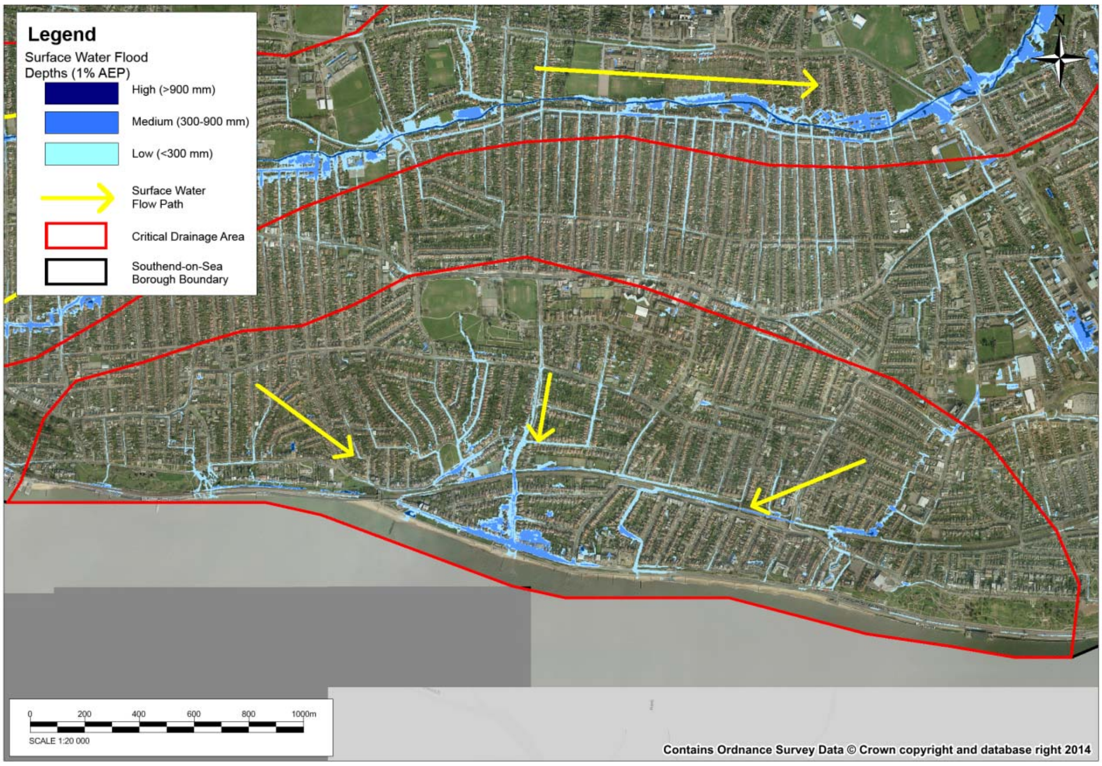
Figure A10a and Figure A10b in Appendix A show the depth and hazard mapping respectively within this CDA.

7.7 Area Assessment – CDA6: Chalkwell

The Chalkwell CDA is located to the south-west of the Borough and has been distinguished by a band of elevated land, which encompasses the southern Chalkwell Area. As a result, Chalkwell Esplanade, along the sea front is at a considerably lower elevation to the surrounding land. This area has been identified as a CDA as a result of the high frequency of recorded flooding incidents within the area.

As shown in the uFMfSW mapping, shown in Figure 7-7, there is a tendency for surface water to follow the topography of the land and accumulate within the road channels of Chalkwell Esplanade and Chalkwell Avenue. The mapping also shows surface water flooding along the Ridgeway and Victory Path (to the north of the railway embankment), which are both likely to be a result of the interception of overland flows behind buildings and the railway embankment respectively.

Figure 7-7: Layout and key features in the Chalkwell CDA



The Prittle Brook flood relief channel, is culverted and runs beneath the Chalkwell area and discharges to the Thames Estuary to the west of Chalkwell Esplanade.

The sewer network within this area is largely combined; therefore it drains both foul and surface water sewage. There is a large storm overflow storage pipe that runs from Cliff Parade along the sea front and up to the Western Valley Pumping Station. This functions to temporarily store storm water overflow when the sewer network is at capacity. Flood waters are pumped from the storm relief sewer via the Western Valley Pumping Station to the Southend-on-Sea sewage treatment works to the north west.

Chalkwell Pumping Station, located at the eastern end of Chalkwell Esplanade, functions to pump surface water into the Thames Estuary against the tide. In addition, there are several gravity drained outfalls that discharge to the Thames Estuary below the mean high water level. As these outfalls are gravity drained, and are fitted with flap valves, they would become tide locked at high tide, therefore restricting the discharge of surface water over this stage of tidal cycle. Should the tidal flap valves fail and remained open, there is the potential for sea water to back up within the network, significantly reducing their capacity to retain surface water drainage.

This component of the surface water drainage network is not connected to the storm relief network described above. Surface water would therefore accumulate within the piped network and when the capacity is reached, this would surcharge from the manholes located along the length of the sewers.

A summary of the local flood risk from different flood sources is included in Table 7-6.

Figure A11a and Figure A11b in Appendix A show the depth and hazard mapping respectively within this CDA.

Table 7-6: Summary of local flood risk within Chalkwell CDA

Flood Source	Description
Surface water	This CDA largely follows the natural topography of the area, with the low lying ground of Chalkwell Esplanade and Chalkwell Avenue being susceptible to surface water flooding.
Groundwater	The BGS Groundwater Susceptibility mapping suggests there is a low to very low risk of groundwater flooding within the CDA. There are no known incidents of groundwater flooding.
Ordinary watercourse	There are no ordinary watercourses within this CDA.
Sewer	There are no sewer flooding records within this CDA.
Validation: To date, there have been 79 incidents of flooding recorded within this CDA. These are primarily as a result of the rainfall events of the 24th August 2013, 11th October 2013, 20th July 2014 and 19th September 2014.	

8 Summary of Risk

8.1 Overview of Flood Risk within Southend-on-Sea

The results of the intermediate level risk assessment combined with site visits and a detailed review of existing data and historical flood records indicate that there is significant risk of flooding in Southend-on-Sea from surface water, groundwater, ordinary watercourses and sewer flooding sources. Although flood risk is widely dispersed across the Borough, it is concentrated in six main areas which have been designated as Critical Drainage Areas (CDAs).

8.2 Risk to Existing Properties and Infrastructure

The uFMfSW depth maps are included in Appendix A. In order to provide a quantitative indication of potential risks, building footprints have been overlaid onto the modelling results in order to estimate the number of properties and critical services that are at risk across the Borough and within each CDA.

Table 8-1 below presents the approximate number of properties and critical infrastructure which may be affected across the Borough and in each of the CDAs during a 1% AEP rainfall event. Property counts for the 3.3% AEP and 0.1% AEP events are included in Appendix C.

In summary, across Southend-on-Sea, **3,908 properties** are at risk of surface water flooding to a depth of 0.1m or greater for the 1% AEP event. Of these, **696 properties** are at risk of flooding from surface water at a depth of 0.5m or greater for the 1% AEP event.

Table 8-1: Property counts for the 1% AEP flood event based flood depth data from the uFMfSW[23] and National Receptors Database[24]

Critical Drainage Area	Flood Depth (m)	Residential Properties	Commercial Properties	Critical Infrastructure								TOTAL
				Emergency Services	**Hospitals**	**Schools & Education**	**Surgery or Health Care**	**Residential Homes**	**Sewage Treatment Works**	**Electricity Sub Station**	**Other**	
Borough Wide	**>0.1**	**3,112**	**270**	**3**	**0**	**17**	**5**	**0**	**0**	**7**	**494**	**3,908**
	>0.3	**1,420**	**141**	**3**	**0**	**11**	**2**	**0**	**0**	**2**	**245**	**1,824**
	>0.5	**513**	**59**	**2**	**0**	**3**	**1**	**0**	**0**	**1**	**117**	**696**
CDA1	>0.1	726	61	0	0	3	0	0	0	1	76	**867**
	>0.3	328	33	0	0	3	0	0	0	1	43	**408**
	>0.5	123	15	0	0	1	0	0	0	0	18	**157**
CDA2	>0.1	981	64	0	0	4	1	0	0	1	102	**1,153**
	>0.3	496	31	0	0	2	1	0	0	0	57	**587**
	>0.5	196	9	0	0	0	0	0	0	0	29	**234**
CDA3	>0.1	248	1	0	0	2	1	0	0	0	12	**264**
	>0.3	104	1	0	0	0	0	0	0	0	2	**107**
	>0.5	32	1	0	0	0	0	0	0	0	1	**34**
CDA4	>0.1	440	29	0	0	2	2	0	0	2	68	**543**
	>0.3	209	16	0	0	2	1	0	0	1	39	**268**
	>0.5	67	7	0	0	0	0	0	0	1	22	**97**
CDA5	>0.1	86	14	0	0	0	0	0	0	0	30	**130**
	>0.3	30	9	0	0	0	0	0	0	0	9	**48**
	>0.5	7	4	0	0	0	0	0	0	0	3	**14**
CDA6	>0.1	185	19	0	0	2	0	0	0	0	56	**262**
	>0.3	93	10	0	0	1	0	0	0	0	25	**129**
	>0.5	38	4	0	0	0	0	0	0	0	13	**55**

[23] Published by the Environment Agency, December 2013
[24] Downloaded from the Environment Agency GeoStore (October 2014).

8.3 Impacts of Climate Change

Current predictions of future rainfall indicate that we should expect increasing number of sever and extreme weather events in the future. Intense storms are the main cause of surface water flooding within Southend-on-Sea. It is predicted that the frequency of heavy rainfall events could double by the 2080s according to the UK Climate Projections[25]. By the 2080s, it is predicted that there could be around three times as many days in winter with heavy rainfall (25mm or more) and that the amount of rain in extreme storms (20% AEP or greater) could increase locally by 40%. Consequently, the number of properties, business and critical infrastructure at risk will increase.

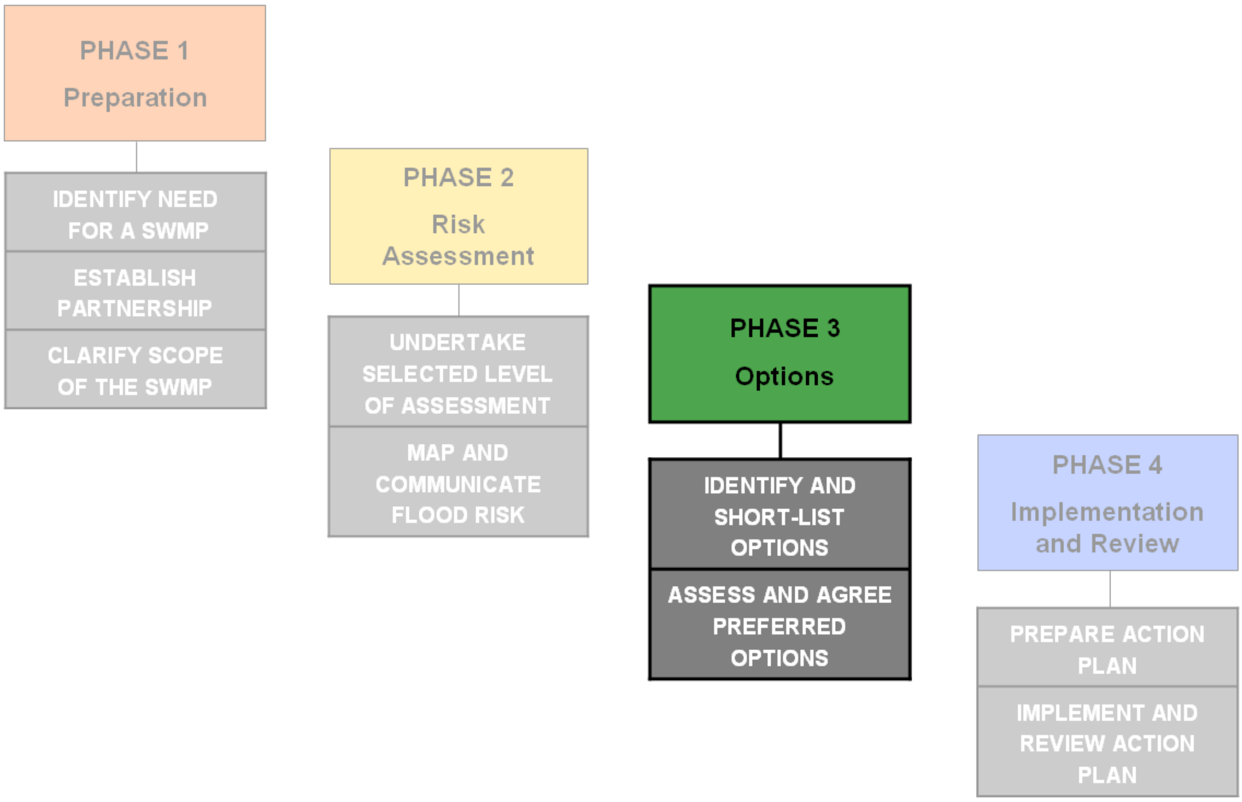
The impacts of climate change on rainfall will depend largely on local conditions and vulnerability. Wetter winters may increase river flows across river catchments whereas more intense rainfall will increase the risk of surface water and sewer flooding. Groundwater levels are likely to increase during the winter and may decrease during prolonged dry periods. Increased groundwater levels could lead to groundwater flooding and higher flows in groundwater fed rivers.

The TE2100 report states that sea level rises in the Thames Estuary could be between 0.2m and 0.9m by 2100 due to thermal expansions of the oceans and melting glaciers and polar ice. In addition, climate change could potentially increase storm surge heights.

Past emissions means some climate change is inevitable, therefore future planning is essential to respond to the likely impacts.

[25] United Kingdom Climate Projections 2009 http://ukclimateprojections.defra.gov.uk//

Phase 3: Options



9 Phase 3 Options

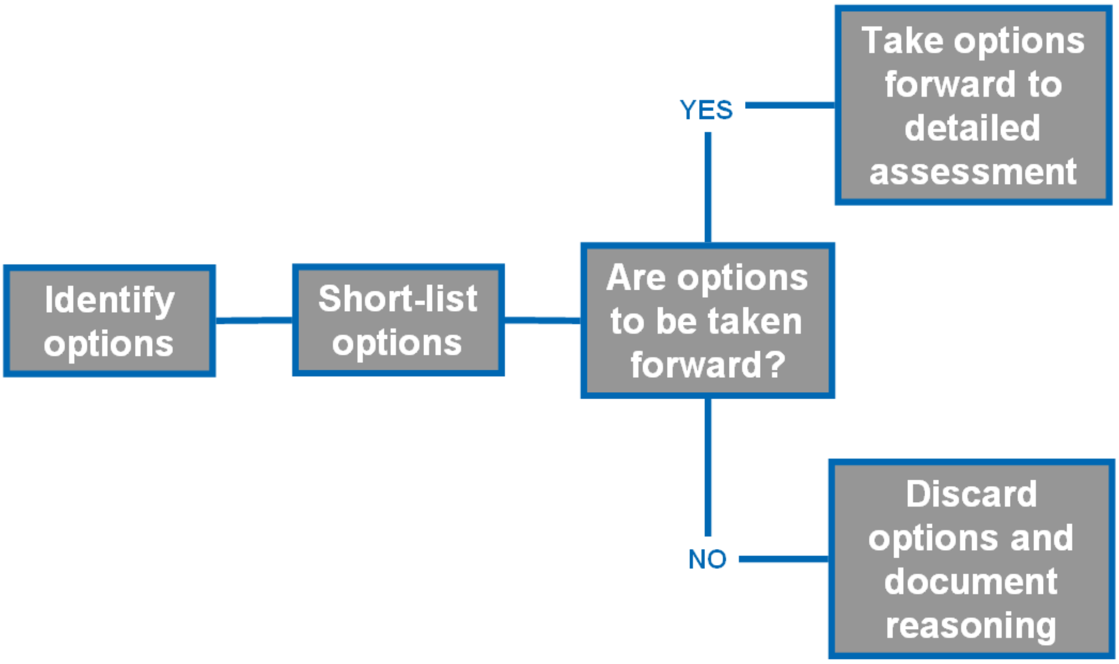
9.1 Introduction

Phase 3 delivers a range of preferred options for the management of local flood risk, following the completion of a high level options assessment for each of the CDAs. The outcomes from the high level options assessment is detailed within Appendix D and summarised in the following section.

The options assessment involves identifying a range of structural and non-structural options for alleviating flood risk in Southend-on-Sea, and assessing the feasibility of these options. Options which are not suitable have been discarded and the remaining options have been developed and tested against their relative effectiveness, benefits and costs. Options which achieve multiple benefits, such as water quality, biodiversity or amenity, are encouraged and promoted.

The options assessment presented here follows the guidance set out in Defra's SWMP Technical Guidance but is focussed on highlighting areas for further detailed analysis and 'quick win' actions.

Figure 9-1: Process of identifying and sort-listing options and measures (adapted from Defra SWMP Guidance)



10 Preferred Options

10.1 Introduction

Following the options assessment process (presented in Appendix D), a series of preferred options have been shortlisted for each CDA as well as range of Borough wide options. For many of the options further investigation and feasibility studies would be required to determine their suitability.

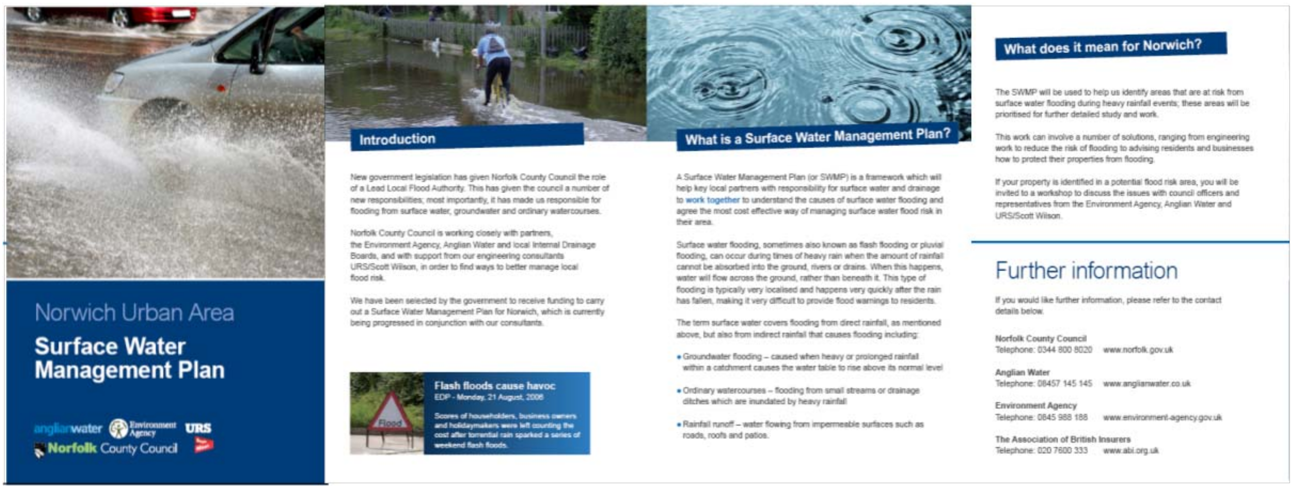
10.2 Borough Wide Options

Adaptation of spatial planning policy: Spatial planning policy should be adapted to reflect the outputs and findings of the SWMP study. It is recommended to place additional emphasis within the planning process to areas that have been identified at high risk of surface water flooding. This will ensure that any new development does not negatively contribute to the surface water flood risk of other properties and that appropriate measures are taken to ensure flood resilience of new properties and developments in surface water flood risk areas.

This could include the encouragement of source control and SuDS measures, which have a number of benefits including reducing surface water runoff and also reducing diffuse pollution. This links in with the Water Framework Directive targets for water quality, as runoff from urban areas will eventually enter watercourses and the sea which can have a significant effect on water quality and bathing standards[26].

Communicating flood risk and raising community awareness: Raising awareness within local communities across Southend-on-Sea can be implemented in the short-term and provides a 'quick win' action to surface water management. Increasing awareness can be achieved through public consultation events, newsletters and online resources. An example of a community newsletter used for a similar purpose is shown in Figure 10-1.

Figure 10-1: Example of community newsletter (URS/Scott Wilson, 2011)


Norwich Urban Area
Surface Water Management Plan

Introduction

New government legislation has given Norfolk County Council the role of a Lead Local Flood Authority. This has given the council a number of new responsibilities; most importantly, it has made us responsible for flooding from surface water, groundwater and ordinary watercourses.

Norfolk County Council is working closely with partners, the Environment Agency, Anglian Water and local Internal Drainage Boards, and with support from our engineering consultants URS/Scott Wilson, in order to find ways to better manage local flood risk.

We have been selected by the government to receive funding to carry out a Surface Water Management Plan for Norwich, which is currently being progressed in conjunction with our consultants.

Flash floods cause havoc
EDP - Monday, 21 August, 2006
Scores of householders, business owners and holidaymakers were left counting the cost after torrential rain sparked a series of weekend flash floods.

What is a Surface Water Management Plan?

A Surface Water Management Plan (or SWMP) is a framework which will help key local partners with responsibility for surface water and drainage to work together to understand the causes of surface water flooding and agree the most cost effective way of managing surface water flood risk in their area.

Surface water flooding, sometimes also known as flash flooding or pluvial flooding, can occur during times of heavy rain when the amount of rainfall cannot be absorbed into the ground, rivers or drains. When this happens, water will flow across the ground, rather than beneath it. This type of flooding is typically very localised and happens very quickly after the rain has fallen, making it very difficult to provide flood warnings to residents.

The term surface water covers flooding from direct rainfall, as mentioned above, but also from indirect rainfall that causes flooding including:

- Groundwater flooding – caused when heavy or prolonged rainfall within a catchment causes the water table to rise above its normal level
- Ordinary watercourses – flooding from small streams or drainage ditches which are inundated by heavy rainfall
- Rainfall runoff – water flowing from impermeable surfaces such as roads, roofs and patios.

What does it mean for Norwich?

The SWMP will be used to help us identify areas that are at risk from surface water flooding during heavy rainfall events; these areas will be prioritised for further detailed study and work.

This work can involve a number of solutions, ranging from engineering work to reduce the risk of flooding to advising residents and businesses how to protect their properties from flooding.

If your property is identified in a potential flood risk area, you will be invited to a workshop to discuss the issues with council officers and representatives from the Environment Agency, Anglian Water and URS/Scott Wilson.

Further information

If you would like further information, please refer to the contact details below.

Norfolk County Council
Telephone: 0344 800 8020 www.norfolk.gov.uk

Anglian Water
Telephone: 08457 145 145 www.anglianwater.co.uk

Environment Agency
Telephone: 0845 988 188 www.environment-agency.gov.uk

The Association of British Insurers
Telephone: 020 7600 333 www.abi.org.uk

Improve community resilience: Improving the resilience of local communities to flooding can be achieved through raising community awareness and encouraging the use of property protection measures.

There are a wide range of flood resilience and resistance measures that could be implemented across properties prone to flooding. Flood resistance measures aim to keep water out of a property and include measures such as flood gates, air bricks and gel sacks. Flood resilience measures allow water into a property (where flood depths outside of the property would potentially cause structural damage) and allow for faster recovery following a flooding event. This includes

[26] Environment Agency , Bathing Water Data Explorer ; Thorpe Bay
http://environment.data.gov.uk/bwq/explorer/info.html?_search=thorpe%20bay&site=ukh3100-11800 [accessed 03.12.14]

measures such as installation of raised services and waterproofing of surfaces. Further information on property protection mitigation measures can be found on the National Flood Forum website[27].

Community flood groups and community wardens could be recruited as volunteers up to help disseminate information and help manage the response to flooding.

Retrofit Water Butts: A measure to assist in reducing the peak runoff rate from properties could be the widespread implementation of simple systems such as water butts to capture roof runoff. Alternatively, rainwater harvesting systems could be installed in new developments or schools.

Figure 10-2: Example of water butt in use

The principle of rainwater harvesting is that rainfall from roof areas is passed through a filter and stored within large underground tanks. When 'grey-water' is required, it is delivered from the storage tank to toilets, washing machines and garden taps for use. Any excess water can be discharged via an overflow to a soakaway or into the local drainage network. Water butts can be developed with controlled overflows that ensure there is capacity to retain water during rainfall events.

Another preferred measure to reduce peak discharges and downstream flood risk is the implementation of water butts on all new development within the Borough, and where CDAs have been identified, retrofitting these to existing properties (as illustrated in Figure 10-2).

Improve flood warning systems: Utilisation of the Extreme Rainfall Event (ERA) service provided by the Flood Forecasting Centre[28] can provide valuable warning of rainfall events that may result in localised surface water flooding. Providing a warning to key council operational departments and emergency services will enable the preparation and implementation of the Council's flood incident management strategy. Relaying this information to households and businesses before a large rainfall event could be achieved through text messages or phone calls warning of potential flooding, as the Environment Agency currently do with their fluvial flood alert system. This, with prior education, will allow individuals to respond with appropriate actions and measures.

Emergency planning (flood incident management): Improving the management of areas experiencing flooding will help to ensure the safety of people by forward planning to ensure necessary resources are available for implementation of systems during flooding events.

Due to the rapid nature of surface water flooding following a rainfall event, resources will need to be in place for immediate deployment following an Extreme Rainfall Alert. Within areas at known flood risk, measures are in place to implement the closure of roads and diversion of traffic where required, to prevent additional flooding from the bow waves crated from passing vehicles. A strategy for the safe evacuation of residents will also need to be revised based on the surface water modelling outputs contained within this document. This should be developed as part of the Multi Agency Flood Plan, in conjunction with the other category one responders[29].

Establish groundwater level monitoring: Continuous and good quality groundwater level monitoring is required in order to understand long term trends in groundwater levels and seasonal groundwater fluctuations and be able to provide more detailed advice on the suitability for infiltration SuDS. It is recommended that this monitoring is concentrated within areas of River Terrace Deposits (where groundwater flood risk is greatest) or areas of future development, where the implementation of infiltration SuDS is recommended.

Install a rain gauge network across the borough: As part of the ongoing assessment of flood risk within the Borough, it is important to understand the influence rainfall can have on resultant floods. At present, the use of the Environment Agency's rain gauge within Southchurch Park, provides a limited resource for understanding rainfall profiles. It is therefore recommended that an extensive network or rain gauges is implemented across the Borough, to ensure that the distribution and intensity of rainfall is recorded. This will provide essential understanding of the rainfall intensity of localised convective summer storms.

[27] National Flood Forum, available online at: http://www.nationalfloodforum.org.uk/
[28] Flood Forecast Centre: http://www.ffc-environment-agency.metoffice.gov.uk/about/
[29] Under the Civil Contingencies Act (2004), category one responders have the duty to put in emergency plans.

10.3 CDA1 Eastwood Options

Flood storage area: The construction of multifunctional flood storage areas along the length of Eastwood Brook would assist in retaining flows and could reduce the risk of surface water flooding in the urban areas downstream. The proposed location for a flood storage area within CDA1 is within Eastwood Park (as shown in Figure 10-3). There are a number of options where flood storage could be incorporated into the park landscape; one of which would be constructing an online storage area alongside Eastwood Brook.

Multifunctional flood storage areas would be designed to temporarily hold shallow volumes of water during extreme flooding events. During normal conditions, these areas will remain dry and would be used as normal.

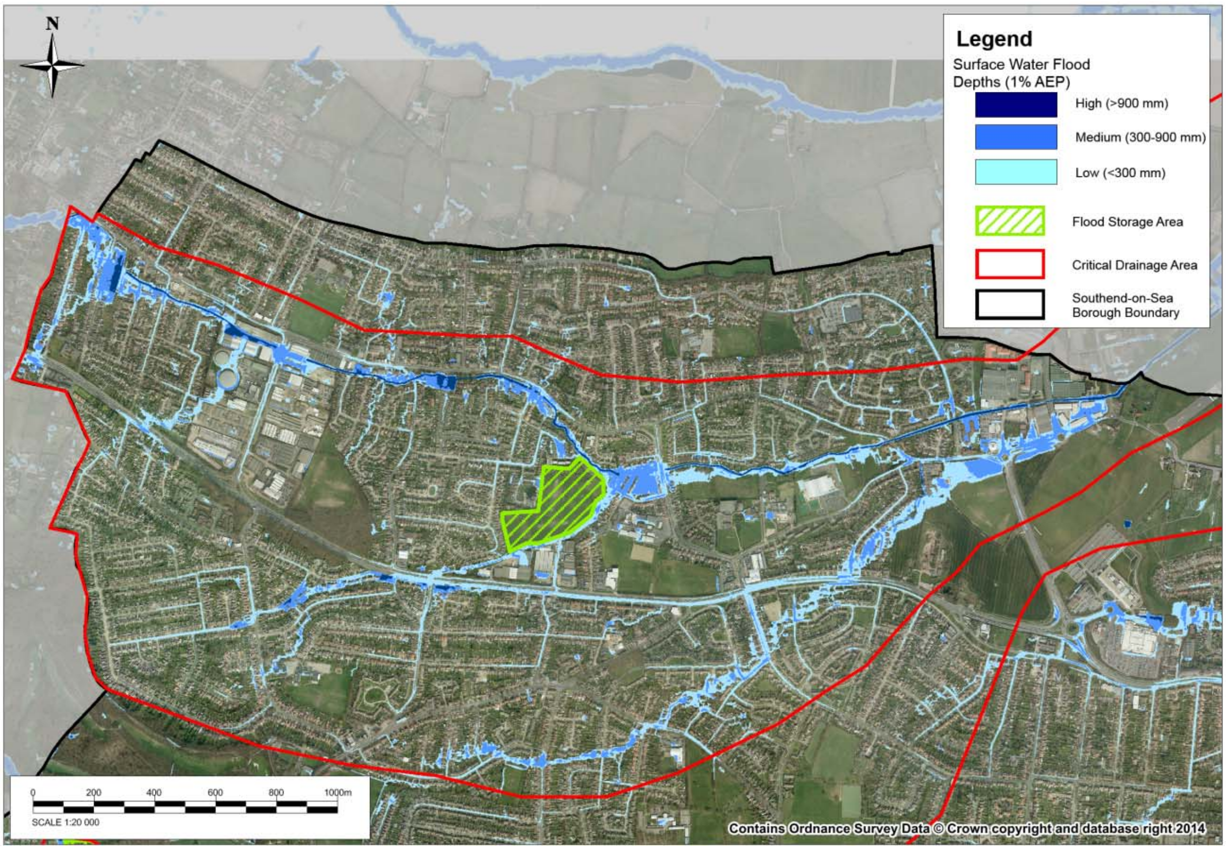
Consideration should also be given to the development of a flood storage area further to the top of the catchment, within the neighbouring areas of Castle Point and Rochford, before Eastwood Brook enters the Eastwood area.

Full feasibility studies would be required to determine the optimum size and location for this area. Flood storage area proposals would also require discussion with the SBC Parks Department and with Castle Point Borough Council, Rochford District and Essex County Council.

Modify utility crossings: As discussed previously in Section 7.2, there are a number of utility crossings along Eastwood Brook. These reduce the cross-sectional area of the river channel; the modification of these is recommended in order to increase conveyance along the watercourse and reduce the risk of blockages. As Eastwood Brook is a main river, any work will have to be carried out with, and consented by, the Environment Agency.

Flood Defences: Temporary or permanent flood defences could be developed along the sections of Eastwood Brook that are found to be more vulnerable to fluvial flooding. These would act to reduce the risk of flooding to properties by preventing the flow of fluvial water from the river channel. The impact on flooding downstream would need to be investigated as this may exacerbate downstream flooding. This option may be considered further following the outcomes of the investigation being completed by the Environment Agency.

Figure 10-3: Summary of options for Eastwood CDA



10.4 CDA2 Prittle Brook Options

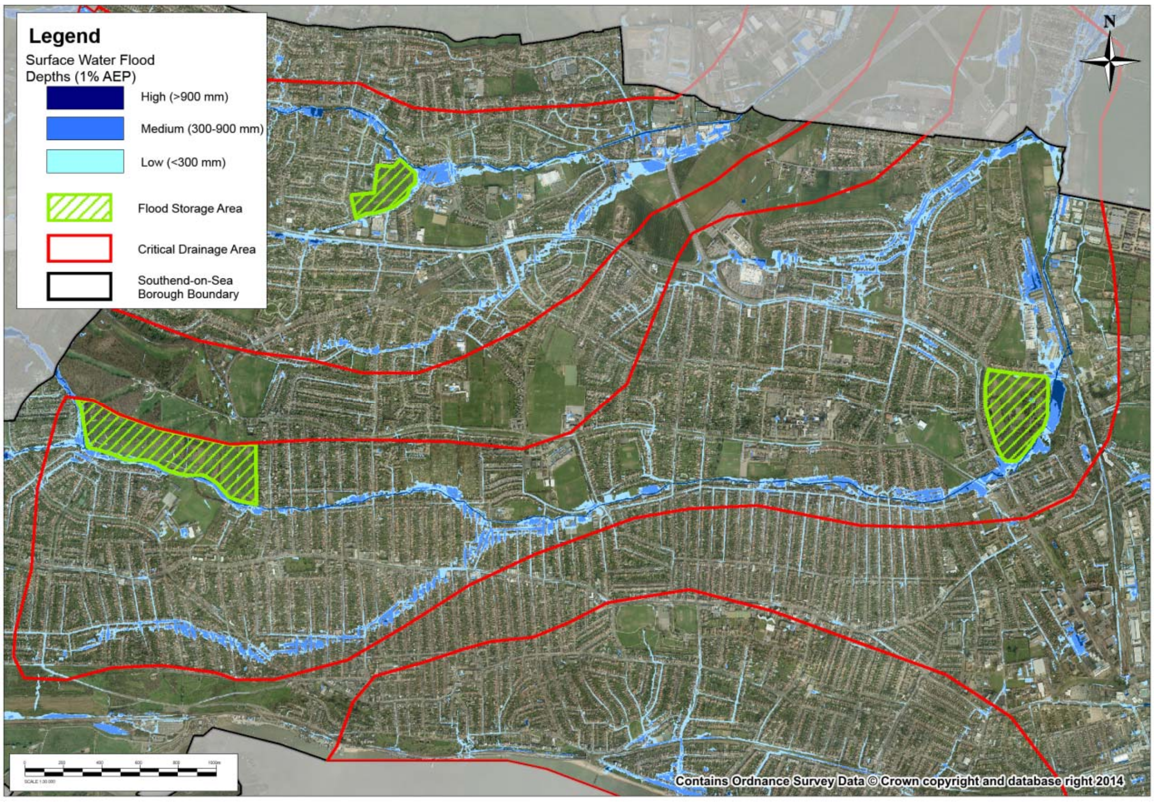
Flood storage area: The construction of an upstream flood storage area would retain flows higher up the catchment and could reduce the risk of flooding in the urban areas downstream. Excess surface water can be accommodated in storage areas created in existing green spaces or as part of potential new developments. Belfairs Park could be utilised as a flood storage area through the construction of online flood storage on land adjacent to Prittle Brook. Further along Prittle Brook, through Priory Park, a similar online flood storage area could be created to retain surface water upstream and increase the capacity of the system. These areas are highlighted within Figure 10-5 below.

Preferential overland flow path (Urban Blue Corridor): The lower end of Rochford Road could be designated as an Urban Blue Corridor (as illustrated in Figure 10-4). The Urban Blue Corridor concept aims to manage the conveyance of surface water across an area of the catchment through the redesign of the urban landscape to create specific channels to convey surface water. This can be achieved through the alteration of the road structure through the increase in kerb height or the decrease in the road bed level, where feasible, depending on the location of services, such as gas and water pipes.

Figure 10-4: Illustration of an urban blue corridor

Due to the topography of the area, the lower end of Rochford Road running towards the Harp House Roundabout naturally channels surface water runoff. However, the natural flow of surface water is not necessarily confined to the road, and may present a risk to the nearby buildings. By increasing the channel capacity of Rochford Road (through the modification of the road structure), particularly towards the roundabout end, where flood depths are greatest, surface water could be conveyed in a controlled manner. This will potentially reduce the risk of surface water flooding to the properties between Rochford Road and Alton Gardens.

Figure 10-5: Summary of options for Prittle Brook CDA



10.5 CDA3 Temple Sutton Options

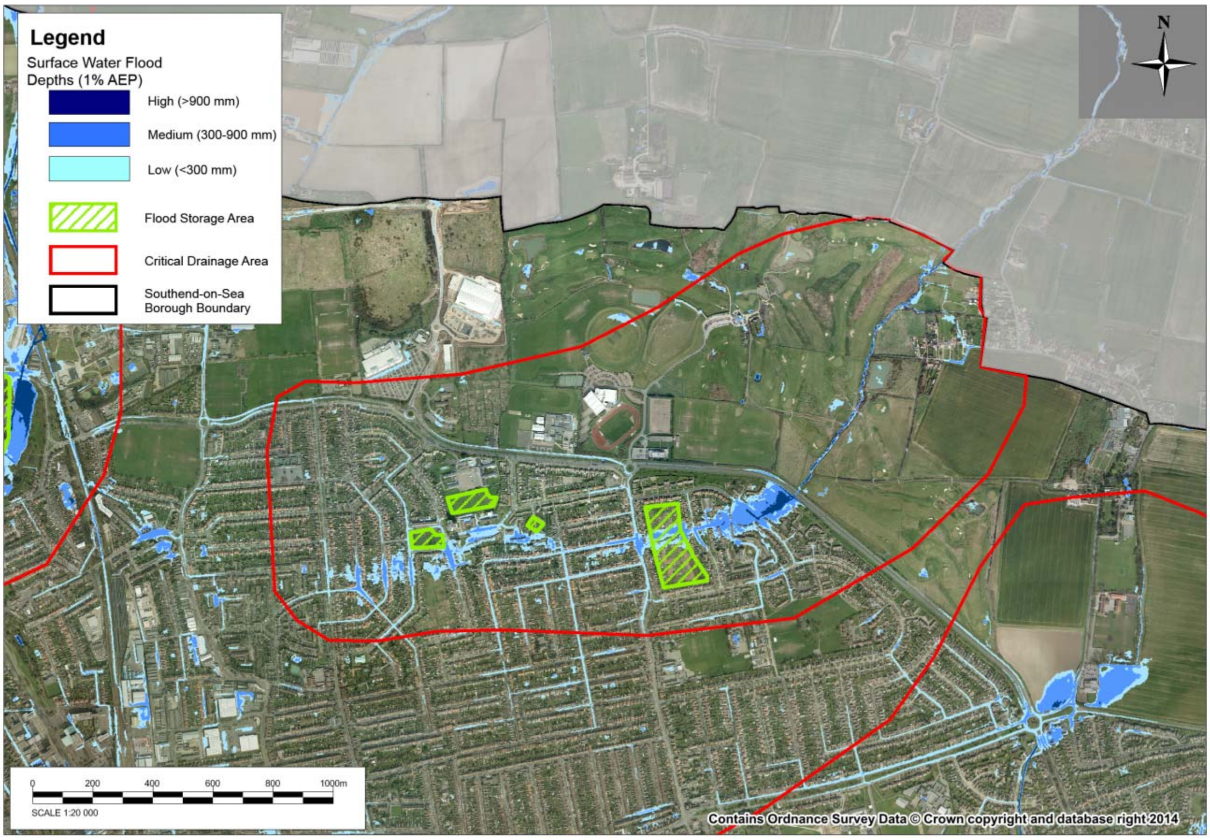
Flood storage area: The construction of a flood storage area would function to retain surface water and potentially reduce the risk of flooding to the area downstream. As shown in Figure 10-6, there are a number of possible locations for a flood storage area within this CDA, including parts of Cluny Square Park, the playing field in front of Temple Sutton Primary School and green space adjacent to Archer Avenue. Any design will need to ensure there is no conflict of interest regarding land use and health and safety issues.

Increase conveyance using additional flow routes: Increasing the conveyance through the A1159 (Royal Artillery Way) embankment would allow additional water to flow beneath the embankment and could reduce the flood depths in the area. The uFMfSW has predicted depths of greater than 0.9m around Archer Avenue and Archer Close (for a 1% AEP event) where surface water accumulates behind the A1159 embankment, however this has not been observed during recent flooding incidents. Increasing the conveyance through the embankment by increasing the size of the existing culvert, or installing a secondary culvert to run alongside it, could reduce flood depths in this area.

A feasibility study would be needed to determine the effectiveness and cost-benefit of such a measure, and the potential impact downstream of the embankment.

Increase conveyance using a temporary pumping system: An alternative option to increase the conveyance of water through the A1159 is to install a temporary pumping system which would only operate during times of heavy flow and would pump excess water through the pedestrian underpass beneath the carriageway embankment. An ultrasonic level or float switch would activate the pump in the event of a surface water flood event. This system would have to be hidden or protected to avoid damage or vandalism which would prevent it from operating when it is needed. A feasibility study would be required to assess the suitability of this option, and also the impact on flood risk downstream of this area.

Figure 10-6: Summary of options for Temple Sutton CDA



10.6 CDA4 Southchurch Options

Flood storage area: The capacity of the ponds within Southchurch Park east and west could be increased to provide additional flood storage. As the surface water drainage network and overland flow paths within this CDA tend towards these ponds, there is the tendency for water to accumulate with these areas. This could be achieved by re-profiling the existing ponds and surrounding areas in order to provide additional storage capacity during extreme rainfall events.

Flood bund: The construction of a flood bund to the north of Bournes Green (highlighted on Figure 10-7) would attenuate surface water in the fields to the north. A bund could create significant storage potential; for example, a bund of 1.25m could provide storage capacity of up to 100,000 m3 and have the potential to contain surface water in the field during a 1% AEP event. An indicative plan for this option shows the potential location and typical cross section of a flood bund (Figure 10-7). A feasibility study would be required before this option can be progressed. Any option would need to be discussed and agreed with the landowner.

Increase pump capacity: Increasing the pumping capacity in Southchurch Park and Lifstan Way will allow and increased rate of surface water discharge into the sea during times of heavy flow and tide locking. This option would have to be explored in conjunction with Anglian Water, who are responsible for the operation of these pumping stations.

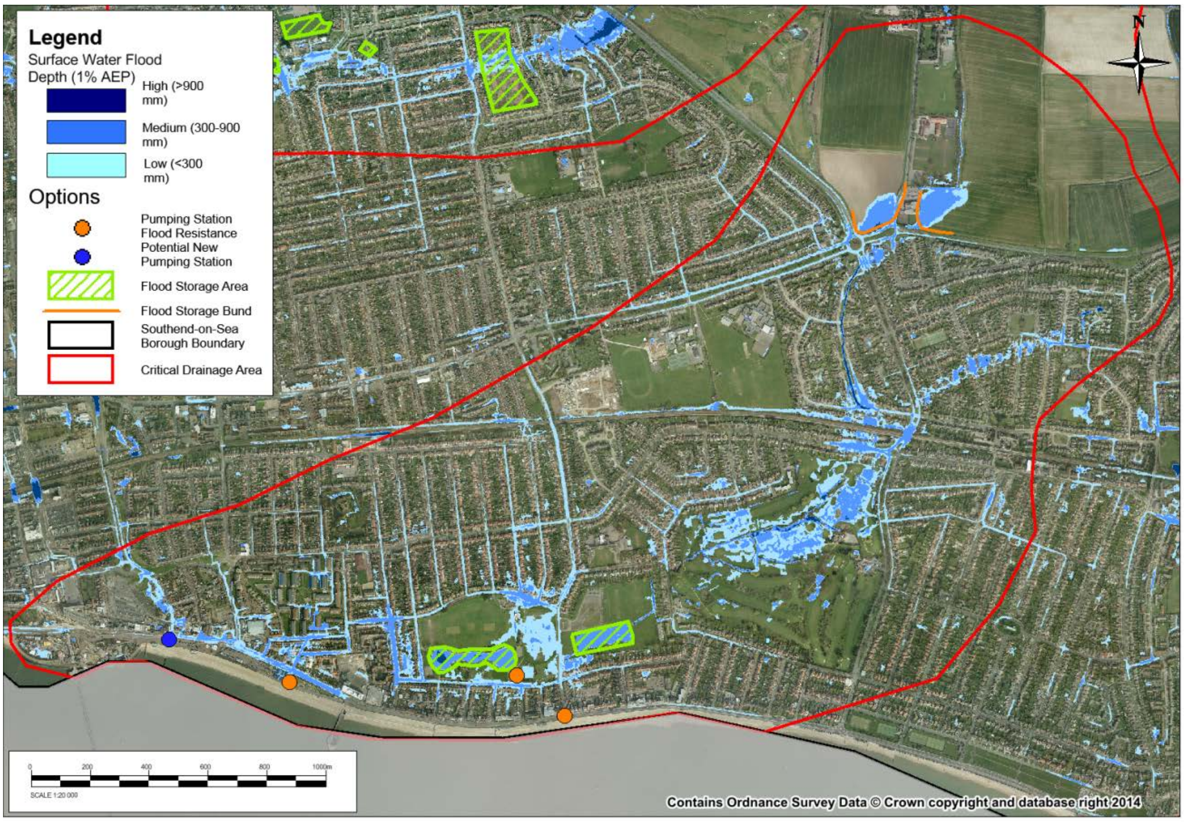
The option to install an additional surface water pumping station at the junction of Marine Parade and Hartington Road should be examined. The current surface water network relies on the discharge of surface water by gravity. The network is therefore susceptible to becoming tide locked. A pumping Station at this location would therefore allow for the discharge of surface water at high tide. This option would need to be explored in conjunction with Anglian Water, who are responsible for the operation of the surface water network in this area.

Protect pumping station: The pumping stations within the CDA provide a key function in discharging surface water from the surface water network. Measures should therefore be taken to ensure the pumping stations do not fail during a flooding event. As such, consideration should be given to providing a level of protection to the pumping stations within the CDA. This should be discussed with Anglian Water.

Review agricultural land management practices: Agricultural land to the north of Southchurch is predicted to produce significant quantities of surface water runoff due to the sloping topography towards the urban area. The generation of surface water runoff could be reduced through the implementation of agricultural practices aimed at reducing surface water runoff. For example, land can be ploughed perpendicular to the slope of the land, reducing the effect of channelling and gullying of the land when it rains. Other land management strategies could also be adopted such as increasing tree coverage, which is known to delay the flow of water through a catchment. Any option would need to be discussed and agreed with the landowner.

In addition, the reduction of runoff from agricultural surfaces may reduce the diffuse pollution entering watercourses, which may help to meet Water Framework Directive requirements for water quality standards.

Figure 10-7: Summary of options in Soutchurch CDA

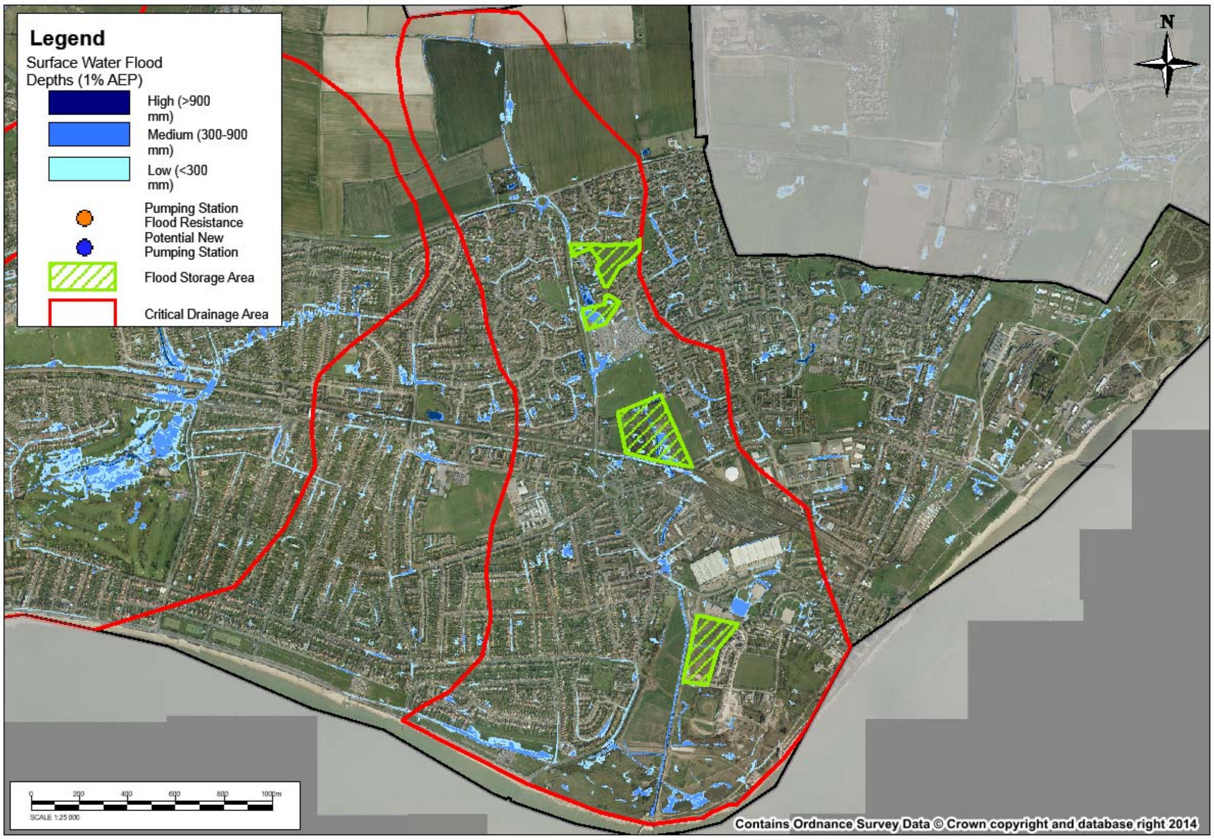


10.7 CDA5 Shoeburyness Options

Flood storage area: The construction of a flood storage area towards the top of the catchment would attenuate surface water and could reduce the risk of flooding in the CDA. Potential areas for flood storage are highlighted on Figure 10-8. A feasibility study would be required in order to determine the optimum location and size for flood storage in this area.

Review agricultural land management practices: Agricultural land to the north of Shoebury is predicted to produce surface water runoff due to the sloping topography. The generation of surface water runoff could be reduced through the implementation of agricultural practices aimed at reducing surface water runoff, as discussed for CDA4 (Southchurch) in Section 10.6. Any option would need to be discussed and agreed with the landowner.

Figure 10-8: Summary of options in Shoeburyness CDA



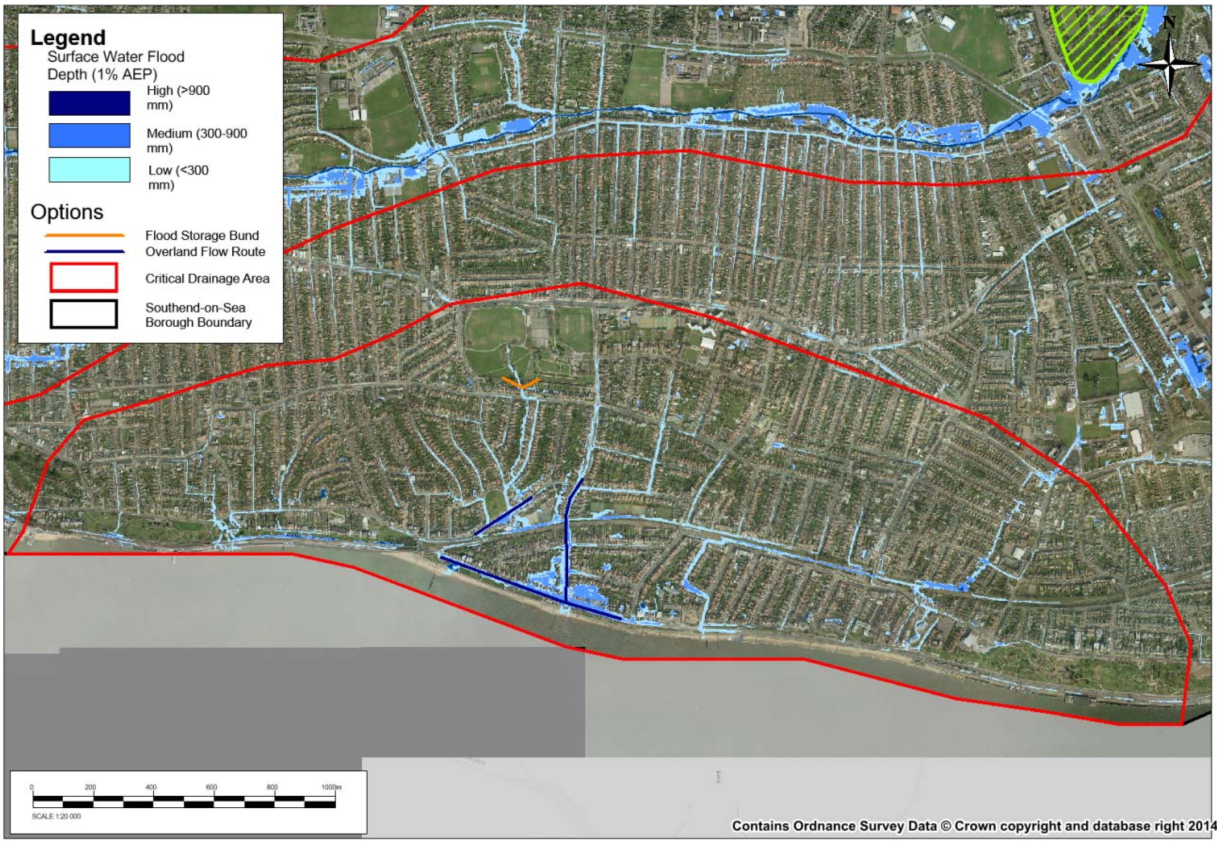
10.8 CDA6 Chalkwell Options

Flood storage area or bund: The construction of a flood storage area or a flood storage bund to the south of Chalkwell Park would act to intercept overland flow generated from the park area to the north. This could reduce the risk to the areas downstream. The approximate location of the flood storage bund is shown in Figure 10-9. A feasibility study would be required to determine the optimum location and size for flood storage in this area.

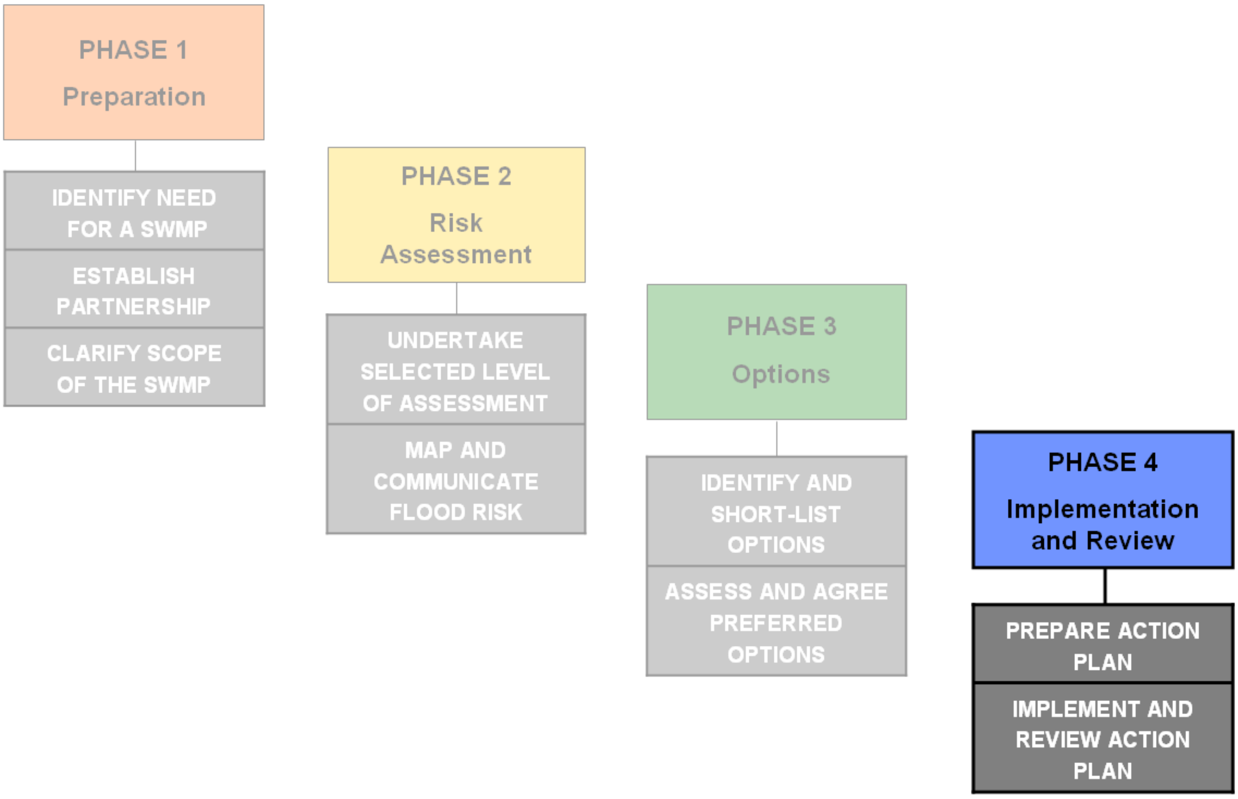
Designated overland flow routes: The Ridgeway, Chalkwell Esplanade and Chalkwell Avenue are susceptible to surface water ponding within the channel of the road. An option could be to increase the pavement height along these roads to increase the storage capacity of the road channel. This option would need to be developed to also include the provision of temporary road closures during the times of flooding to ensure that bow waves, from passing vehicles, do not increase the flood risk to the adjacent properties. Figure 10-9 highlights the areas where this option could be implemented.

Retrofit source control SuDS: Across the Chalkwell CDA there are a number of schools that offer the potential to retrofit source control SuDS. The implementation of SuDS within the upper parts of the catchment could assist in reducing the total volume of rainfall entering the surface water network or running as overland flow.

Figure 10-9: Summary of options for Chalkwell CDA



Phase 4: Implementation and Review



11 Action Plan

The Action Plan outlines a wide range of recommended measures that could be considered to more effectively manage surface water within Southend-on-Sea. The Action Plan has been developed to outline the responsibilities and implications of both structural and non-structural preferred options discussed in Phase 3 of the SWMP. The Action Plan proposes methods, timescales and responsibilities for each proposed action.

Within the Action Plan there are details of general measures that could be implemented across the Southend-on-Sea administrative area, as well as specific measures for each of the CDAs. These have been developed from the preferred options described in Section 10. The general actions are non-structural and encourage improved surface water management through planning policy and public education and awareness. The general actions also include the development of a flood response strategy and surface water flood warning system, which would be beneficial in ensuring successful response, with minimal harmful consequences, in the event of extreme surface water flooding.

The Action Plan is aligned with the draft Southend-on Sea LFRMS and FRMP, and will be used to support and inform future flood risk management studies in the Borough. The duration for each action is outlined as either 6 months, 1 year or 6 years. The 6 year duration is in line within the review period of the LFRMS.

The Action Plan is included in Table 11-1 below. Each of the actions outlined in the Action Plan, has been assigned a priority of high (H), medium (M) or low (L). The prioritisation is based on the current understanding of the local flood risk and the resources and funding available to address the action.

11.1 Quick Wins

A number of measures can be implemented across the borough to provide a ‘Quick Win’ for the management of flood risk. This includes:

- Update the council website to provide comprehensive information on flood risk, management authorities roles and responsibilities, emergency contacts and guidance on how to protect yourself from flooding;
- establish links and work with community groups and businesses to develop community resilience;
- encourage residents and businesses to retrofit SuDS into their own properties;
- review and priorities gully clearing and cleansing, ensuring areas at greatest risk are inspected more frequently; and
- inspect and if necessary repair flap values on drainage outfalls.

Table 11-1: Southend-on-Sea Action Plan

Area	Action				Implementation				
	No.	Priority	What?	How?	Location	Duration	Responsible Authority	Potential Barriers	Solution to Barriers
Borough Wide	1	H	Maintain records of flooding events.	Develop a system to accurately record the causes and consequences of surface water flooding events in line with the requirements of FWMA.	Borough wide	6 Years	SBC	Lack of data collection. Missed opportunity to get public involved in helping report flood incidents.	Allocate a specific resource within the Council who is responsible for flood incident investigations. Increase education and community awareness to encourage reporting of events. Consider providing a toll free telephone number or use of social media to report flooding.
	2	H	Examine historical records of flooding.	Undertake an exercise to digitise historic records of flooding, working with community groups.	CDAs	1 Year	SBC	Lack of community engagement and council resources	As part of community engagement, develop community links.
	3	H	Update Multi Agency Flood Plan.	Develop emergency response actions during flood events to account for SWMP modelling outputs and key surface water risk areas.	CDAs	6 Months	SBC & other Category 1 responders	Limited flood warning available and therefore short time to implement emergency actions.	Ensure systems are in place for rapid deployment of staff and utilise the Met Office Extreme Rainfall Alert (ERA) service. Focus on CDAs and high risk areas.
	4	H	Adaptation of spatial planning policy.	For all new development to fully consider the risks of flooding from groundwater, surface water and ordinary watercourses. Requirement for SuDS or source control measures for all new developments with drainage implications.	Borough Wide	6 Years	SBC	Limiting development options.	Use outputs from the SWMP to adapt spatial planning policy to give consideration to high risk areas and to identify upstream areas of the catchment which could be utilised to implement source control measures.
	5	H	Improve community awareness and resilience	Education events, newsletters and use of internet and social media.	CDAs	6 Months	SBC	Reaching key target audiences through language, cultural and mobility barriers.	Use a range of methods to ensure coverage, such as the internet, media and newsletters.
	6	H	Review agricultural land management practices.	Provide guidance, in line with best management, on methods that increase attenuation and reduce flood risk.	Borough Wide	6 Years	SBC and Farmers	Engagement of agricultural land owners and farmers.	Meet with farmers and land owners and begin to raise awareness and develop practices that reduce flood risk.

Area	Action				Implementation				
	No.	Priority	What?	How?	Location	Duration	Responsible Authority	Potential Barriers	Solution to Barriers
	7	H	Increase gully inspections and clearing in areas at greatest risk.	Review flood risk information to determine areas at greatest risk and ensure these are prioritised for gully clearing	Hot spots	6 years	SBC	Available resources of funding.	Adjust the schedule to prioritise these areas over areas at low risk.
	8	M	Install groundwater monitoring systems.	Understand long term trends and seasonal fluctuations in groundwater levels through installing monitoring equipment in key areas.	Borough Wide (focus on develop-ment sites)	6 Years	SBC	Available resources and funding for groundwater level monitoring.	Allocate resources and funding to install groundwater monitoring, leading to a detailed assessment on groundwater flood risk and suitability for infiltration SuDS.
	9	H	Install a rain gauge network across the borough.	Identify suitable sites to achieve adequate coverage across the borough and commission installation.	Borough Wide	1 year	SBC	Lack of stakeholder engagement and landownership of sites.	Early stakeholder involvement to assist in ongoing monitoring and management of individual gauging stations.
	10	M	Maintenance of ordinary watercourses and drainage system.	Regular checks and maintenance to Ordinary Watercourses.	CDAs	6 Years	SBC	Lack of funding.	Focus on at risk areas and effective management of resource. Encourage local community involvement in maintenance. Identify budget from council revenue.
	11	M	Water management and conservation measures.	Utilise rainwater harvesting systems and water butts in key flood risk areas throughout the catchment.	CDAs	6 Years	SBC and private property owners and developers	Lack of funding for schemes and understanding of their benefits.	Consider providing a subsidy and educating people of the benefits of such systems.
CDA1: Eastwood	12	M	Feasibility study of flood storage area: Eastwood Park.	Evaluate potential of the development of temporary flood storage within Eastwood Park through re-landscaping and drainage to the site.	Eastwood Park	1 Year	SBC	Perceived conflict of interest from different parks users.	Ensure clear communication of function of storage system and additional wider community benefits.
	13	M	Coordinate feasibility study of flood storage area outside of Southend with Rochford DC and Castle Point BC.	Discuss with Rochford DC and Castle Point BC potential flood storage areas at the top of Eastwood Brook catchment in Rochford and Castle Point.	Rochford and Castle Point	1 Year	SBC, Essex CC, Rochford DC and Castle Point DC	Cross boundary issues of flood control.	Develop a Local Flood Risk Management Partnership between neighbouring authorities. Discuss cross boundary issues.

Area	Action				Implementation				
	No.	Priority	What?	How?	Location	Duration	Responsible Authority	Potential Barriers	Solution to Barriers
	14	M	Modify services crossing across Eastwood Brook.	Investigate the potential of modifying service crossings through discussions with relevant utilities companies.	Eastwood Brook	1 Year	SBC, Utility Companies	Lack of engagement. Unwillingness of Utility Companies to modify service crossings.	Ensure all bodies are contacted to discuss the proposal.
CDA2: Prittle Brook	15	M	Feasibility study of flood storage area: Priory Park	Investigate the potential to development of flood storage within existing open space at Priory Park.	Priory Park	2 Years	SBC and Developer(s)	Conflict of interest with land use.	Ensure clear communication of function of storage system and additional benefits.
CDA2: Prittle Brook	16	M	Feasibility study of flood storage area: Belfairs Park.	Investigate the potential to development of flood storage within existing open space at Belfairs Park.	Belfairs Park	2 Years	SBC and land owners	Conflict of interest with land use.	Ensure clear communication of function of storage system and additional benefits.
CDA2: Prittle Brook	17	L	Investigate the potential to develop an urban blue corridor (preferential overland flow path).	Feasibility study of re-profiling road layout to provide channelling capacity and direct surface water flows.	Rochford Road	2 Years	SBC and Highways	Implications of this are unclear.	Further investigation required to gain detailed understanding.
CDA3: Temple Sutton	18	L	Feasibility study of the installation of additional flow routes through A1159 embankment.	Investigate the potential installing secondary culvert through the road embankment or set up permanent pumping system.	A1159 embankmen t	2 Years	SBC, land owners and Highways Authority	Concern over cost of tunnelling under the A1159. Damage to pumping system if unprotected.	Explore other options and mechanisms for safely achieving this. Conduct cost benefit analysis. Consider protecting pumping system.
CDA3: Temple Sutton	19	L	Feasibility study of flood storage areas: Cluny Square Park, Temple Sutton Primary School and Archers Avenue.	Examine potential of flood storage and potential compromise of land use.	Cluny Square Park, Temple Sutton Primary School, Archers Avenue	2 Years	SBC and land owners	Potential for conflict of interest with land use and vulnerability of surrounding area to flooding.	Ensure clear communication of function of storage system and additional benefit. Examine impacts of each system using modelling and cost benefit analysis.

Area	Action				Implementation				
	No.	Priority	What?	How?	Location	Duration	Responsible Authority	Potential Barriers	Solution to Barriers
CDA4: Southchurch	20	M	Provide protection to pumping station in Southchurch Park	Examine suitable methods of protecting the pumping station from flooding during an extreme flood event.	Southchurch Park	6 Months	Anglian Water	Collaboration with Anglian Water to come up with suitable scheme.	Discuss potential scheme with Anglian Water and agree a way to take it forward.
	21	M	Increase pumping capacity of existing Anglian Water pumping system.	Increase capacity of two existing pumping stations.	Southchurch Park and Southchurch Park East.	6 Months	SBC and Anglian Water	Reliance on pumping system and limited to pumping at low tides.	Reduce reliance on pumping system through increased storage areas further upstream.
	22	M	Increase storage capacity of ponds within Southchurch Park and Southchurch Park East.	Feasibility study to determine the potential of increasing capacity through dredging of silt from existing ponds alongside current works to restructure channel banks.	Southchurch Park	6 Months	SBC and Anglian Water	Potential for disruption to ecology and implications to WFD objectives.	Construct with least impact and aim to improve on standards in WFD objectives.
	23	M	Feasibility study of flood storage area: Thorpe Hall Golf Course.	Investigate potential to re-contour sections of golf course to provide a temporary flood storage area incorporate flood storage into the design of the gold course.	Thorp Hall Golf Course	1 Year	SBC and Golf Course Landowner	Concerns over flooding of golf course and loss of income to golf course.	Ensure clear communication of function of storage system and additional benefits.
	24	M	Investigate construction of bund for flood water retention.	Feasibility study to examine potential to construct a flood bund to retain surface water north of Bournes Green.	Bournes Green	1 Year	SBC, Developers and Landowners	Cooperation of land owners.	Outline purpose and need for the development. Compensate for use of land if required.
	25	M	Increase surface water drainage along roads.	Feasibility study for increasing the capacity of the surface water drainage system.	Roads accessing Southchurch park (Lifstan Way, Colbert Avenue, Thorp Hall Avenue)	1 Year	SBC, Anglian Water	Lack of knowledge of current capacities and potential to develop.	Consult with Anglian Water.

Area	Action				Implementation				
	No.	Priority	What?	How?	Location	Duration	Responsible Authority	Potential Barriers	Solution to Barriers
CDA5: Shoeburyness	26	M	Feasibility study of flood storage areas: North Shoebury Park	Investigate potential to develop flood storage within low lying areas through detailed feasibility studies and modelling.	North Shoebury Park	2 Years	SBC and Landowners	Conflict of interest with land use.	Ensure clear communication of function of storage system and additional benefits.
	27	M	Feasibility study of flood storage areas: Gunners Park school development.	Investigate the potential to develop flood storage as part of the design of the potential new school.	Gunners Park School	2 Years	SBC and Developer	Conflict of interest with land use.	Ensure clear communication of function of storage system and additional benefits.
CDA6: Chalkwell	28	M	Feasibility study of flood storage in Chalkwell Park.	Investigate the potential to develop flood storage within Chalkwell Park.	Chalkwell Park	2 Years	SBC and Landowners	Conflict of interest with land use.	Ensure clear communication of function of storage system and additional benefits.
	29	M	Feasibility study for retrofitting SuDS across schools.	Investigate the feasibility of retrofitting SuDS into school grounds within the CDA.	Chalkwell School	2 Years	SBC and Landowners	Conflict of interest with land use.	Ensure clear communication of function of storage system and additional benefits.

12 Implementation and Review

12.1 Overview

Following the completion of the SWMP, the actions detailed in the SWMP Action Plan will need to be implemented alongside the LFRMS Action Plan. This will require continued work within the Council and the Southend-on-Sea Local Flood Risk Management Partnership to ensure all partners are involved in the implementation and ongoing maintenance and performance measures.

SBC should coordinate with relevant partners in order to ensure a holistic approach to the implementation of outputs and actions from the SWMP. Key internal council partners include spatial planners, development control, parks, emergency planners and the highways. The outputs of the SWMP should be used, where appropriate, to update and adjust policies and actions. The implications of the SWMP for these partners are described below.

12.2 Spatial Planning

The Defra SWMP Technical Guidance4 states that a SWMP should establish a long-term action plan to manage surface water in an area and should influence land-use planning.

The National Planning Policy Framework (NPPF)[30] and the accompanying Planning Practice Guidance[31] (PPG) sets out the Government's spatial planning policy on development and flood risk and states that new development should not add to the causes or "sources" of flood risk, i.e. increase flood risk. This SWMP should be used to inform Southend-on-Sea's strategic spatial policy and land-use planning decisions relating to areas at risk from surface water and groundwater flooding. In particular, special planning consideration should be given to the six CDAs identified through this SWMP.

Furthermore, the surface water flood depth and flood hazard maps (contained in Appendix A) should be used to inform the allocation of future housing and development within Southend-on-Sea.

12.2.1 Local Planning Policies

Core Strategy (adopted December 2007)

The role of the Core Strategy[32] for Southend-on-Sea is to set out the strategic direction for growth and development in the Borough, so as to provide clarity as to what the Council will require of new development, and to ensure that the right development comes forward in the right place and at the right time. As such, it is the overriding strategy for making decisions on land use and development in the Borough and for guiding the investment decisions of the public and private sectors over the next decade and beyond. The Core Strategy includes a number of important high level policies that provide the 'hook' for consideration of the findings of the SWMP in future spatial planning decision making. The Core Strategy will be updated in 2016.

Policy KP1: Spatial Strategy

Policy KP1 states that:

"Where the Environment Agency's Flood Zone Maps or other considerations, including the South Essex Strategic Flood Risk Assessment, indicate that a risk of flooding may remain, all development proposals shall be accompanied by a detailed flood risk assessment appropriate to the scale and nature of the development and the risk. Development will only be permitted where that assessment clearly demonstrates that it is appropriate in terms of its type, siting and the mitigation measures proposed, using appropriate and sustainable flood risk management options which safeguard the biodiversity importance of the foreshore and/or effective sustainable drainage measures."

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[30] DCLG (2010) National Planning Policy Framework http://planningguidance.planningportal.gov.uk/wp-content/themes/planning-guidance/assets/NPPF.pdf [accessed 03.12.14]
[31] Planning Practice Guidance http://planningguidance.planningportal.gov.uk/blog/guidance/
[32] Southend-on-Sea Core Strategy Development Planning Document (2007). Available online at: http://www.southend.gov.uk/downloads/file/1540/core_strategy_dpd1pdf

Policy KP2: Development Principles

Policy KP2 states that in relation to all new development a sequential approach should be applied to the location and siting of development (clause 3), particularly having regard to the need to:

"b. avoid or appropriately mitigate flood risk;"

Also important are the following clauses:

"5. do not place a damaging burden on existing infrastructure;

6. are within the capacity of the urban area in terms of the services and amenities available to the local community;

9. secure improvements to the urban environment through quality design;

11. include appropriate measures in design, layout, operation and materials to achieve:

a. a reduction in the use of resources, including the use of renewable and recycled resources. All development proposals should demonstrate how they will maximise the use of renewable and recycled energy, water and other resources."

And finally, and most importantly:

"b. avoidance of flood risk, or where, having regard to other sustainability considerations (see Section 2(i) and Policy KP1 above) a residual risk remains, the provision of measures to appropriately and adequately mitigate that risk. All development proposals should demonstrate how they incorporate 'sustainable urban drainage systems' (SUDS) to mitigate the increase in surface water run-off, and, where relevant, how they will avoid or mitigate tidal or fluvial flood risk"

Policy KP3: Implementation and Resources

In order to help the delivery of the Plan's provisions the Borough Council will:

2. enter into planning obligations with developers to ensure the provision of infrastructure … required as a consequence of the development proposed.

This includes provisions such as:

c. off-site flood protection or mitigation measures, including sustainable drainage systems (SuDS);

12.2.2 Planned Growth

Southend-on-Sea has the second highest population density in the East of England. According to the Office of National Statistics, there were 175,800 residents in Southend-on-Sea in mid-2013[33].

According to the Southend-on-Sea Annual Monitoring Report, based on current completion rates it is projected there will be 5,290 additional dwellings between the period of 2013 and 2028.

The Core Strategy sets out a phased housing allocation which equates to 320 net additional dwellings per annum for the period 2013-2016, 310 net additional dwellings per annum for the period 2016-2021 and 300 net additional dwellings per annum for the period 2021-2028.

When considering applications for development, site-specific flood risk assessments are a requirement from the NPPF. In their role as LLFA, Southend-on-Sea Borough Council is a statutory consultee on surface water flood risk and drainage strategies submitted as part of site specific Flood Risk Assessments for sites over 1ha.

[33] http://www.southend.gov.uk/info/200441/southend_insights/442/community_and_living [accessed 03.12.14]

Given the level of growth that is planned, the key planning considerations arising from the findings of the SWMP are:

- It is recommended that source control measures and surface water management practices are adopted within the study area. This includes measures such as SuDS, green roofs, rainwater harvesting or permeable paving, which can capture and infiltrate rain where it falls, thus reducing surface water runoff and improving the water quality of surrounding watercourses. These measures should be encouraged as part of all new development proposals.

- The SWMP for Southend-on-Sea should be used (in conjunction with the Level 1 & 2 SFRA, LFRMS and FRMP) to inform future land use planning decisions across Southend-on-Sea. Additionally, SBC should use the information contained in the SWMP to update the Level 1 and Level 2 SFRA and inform the LFRMS and FRMP.

- Reduce public costs for future surface water management including capital intervention measures through entering into planning obligations with developers as provided for in Policy KP3.

- Maximise potential flood attenuation benefits of existing parks, green spaces and other public open spaces through modification (e.g., re-profiling, re-grading parks, constructing flood attenuation areas).

- Utilise the planned Green Space and Green Grid Strategy SPD to help develop a system of green infrastructure by linking existing parks and open spaces through new blue and green corridors. Such a strategy will have multiple benefits, including in the improved management of surface water.

- Site-level investigation should be undertaken to identify the suitability for infiltration SuDS associated with the underlying geology in the Southend-on-Sea area.

12.2.3 Making links with other parts of the Local Plan

Development Management DPD (Revised Proposed Submission, 2014)

Future development proposals should be required to consider and respond to the surface water flood risk outlined within the uFMfSW. The Environment Agency website[34] should be consulted for the most up-to-date surface water flood risk information.

If possible, the Council should look to amend the DPD to reflect the findings of the SWMP, including the identification of the six CDAs.

Southend-on-Sea's Development Management DPD is in general support of the SWMP aims and objectives. Important and useful policies include: Policy DM2 – Low Carbon Development and Efficient Use of Resources, Policy DM6 – The Seafront, and Policy DM8 – Residential Standards (in relation to the provision of private outdoor space, which can be complementary to the objectives of the SWMP).

The findings of the SWMP should be used (alongside the Level 1 and 2 SFRA, LFRMS and FRMP) to inform policy development of the following planned DPDs and SPDs:

- Site Allocations DPD;

- Southend Central Area Action Plan– (within CDA4 and CDA6);

- Green Space & Green Grid Strategy SPD;

- Shoebury Area Action Plan; and

- London Southend Airport and Environs Area Action Plan (JAAP).

[34] Environment Agency Flood Risk from Surface Water, available online at: http://watermaps.environment-agency.gov.uk/wiyby/wiyby.aspx?&topic=ufmfsw#x=357683&y=355134&scale=2

12.3 Emergency Planning

The SWMP offers an opportunity to communicate up to date information about locations at risk from surface water flooding to those with an interest. Emergency responses will be informed by known surface water flooding locations, especially near public buildings and major routes through the area.

The outputs from the SWMP will assist in communicating surface water flood risk to Local Resilience Forums (LRFs) and Emergency Planners to enable them to ensure that incident management plans are updated based on the improved understanding of surface water flooding. SWMP mapping outputs and knowledge should be used to inform emergency planning decisions and ensure emergency responses to surface water flood events can be improved through identification of likely flow paths and locations of surface water ponding. In particular the following documents should be reviewed and updated following the understanding gained from the SWMP:

- Community Risk Registers (CRR); and
- Multi-Agency Flood Plan (MAFP).

Community Risk Registers (CRR) are prepared by Category 1 responders and are required as part of the Civil Contingencies Act (CCA) 2004. The CCA requires that Category 1 responders undertake risk assessments and maintain these risks in a CCR. In this context risks are defined as events which could result in major consequences, and they include risks from flooding.

Outputs from the SWMP can be used to help update the CCR. In particular, the SWMP presents the opportunity to identify and engage with as many vulnerable receptors as possible. This may include individual households as well as organisations or groups.

Multi-Agency Flood Plans (MAFP) are specific emergency plans which should be developed by LRFs to deliver a coordinated plan to respond to flood incidents. MAFPs recognise the need for specific flooding emergency plans, due to the complex nature of flooding and the consequences that arise and are developed to enable the diverse range of organisations involved during a flood to work together effectively and manage the consequences of flooding.

Outputs from SWMPs should inform the update of the MAFP. The SWMP mapping should be used as an initial indicator of possible risk. A Flood Risk Assessment at a site shown as being at risk of surface water flooding should consider:

- Impacts on receptor sites;
- The degree of receptor vulnerability; and
- In the event of surface water flooding to the site, has safe access to and evacuation from the site been adequately considered?

Within SBC, emergency planning is conducted by the Emergency Planning Officer. This officer coordinates planning, training, activation and management of Southend-on-Sea's response to emergencies, such as flooding, by working alongside the emergency services and neighbouring councils as part of the Essex Local Resilience Forum. This plan recognises the need for a specific plan for flood events due to the complex nature of flooding and the consequences that arise from extreme surface water flooding[35]. The outputs of the Southend-on-Sea SWMP will therefore provide valuable information on surface water flood risk across the Borough.

The MAFP should be continually revised to incorporate new knowledge or information. The SWMP modelling outputs should be used to inform and update the MAFP, as the SWMP maps highlight areas at risk of surface water flooding and areas where there is a high hazard associated with surface water flooding. This information should be used to develop specific plans that focus on areas at high risk within the Borough (e.g., CDAs). This will ensure that resources are focussed in relevant areas in the event of flooding. The maps and figures included in Appendix A detail the surface water flood depth and flood hazard developed as part of the Environment Agency's National Flood Mapping exercise. These could be subject to further updates following the completion of future detailed modelling. The Extreme Rainfall Alert (ERA) service was set up by the Met Office and the Environment Agency (as part of the Flood Forecasting Centre) in 2008 in order to provide services to emergency and professional partners. This service provides an ERA to Category 1 and Category 2 responders, and is issued at a LLFA level in order to warn of extreme rainfall that could lead to surface water

[35] Cabinet Office: Developing a Multi-Agency Flood Plan
http://www.cabinetoffice.gov.uk/sites/default/files/resources/flooding_ma_planning_guidance_0208.pdf

flooding, particularly in urban areas. It is designed to help local response organisations manage the impact of flooding via two alert levels:

- Guidance – issued when there is a 10% or greater chance of extreme rainfall; and
- Alert – issued when there is a greater than 20% chance of extreme rainfall.

The ERA cannot provide site-specific real-time surface water flood forecast, but does offer a county level alert of impending rainfall. The alert is based on the probability of rainfall occurring, rather than being a definitive forecast.

Surface water flooding has very short lead times and is hard to predict in real time because local topography and drainage infrastructure affect the direction of runoff and location of flooding. However, the mapped outputs from the SWMP provide valuable information on likely flow paths and key ponding areas that are likely to flood as a result of land use and topography. This will allow emergency services to focus their resources on areas that have been identified as being at high risk of surface water flooding.

Key actions for emergency planners in response to the SWMP:

- Update the MAFP using the SWMP mapped outputs to focus emergency response actions on vulnerable areas with the greatest risk from flooding;
- Utilise the ERA for flood forecast alerts and incorporate this into the Council's MAFP;
- Use the flood hazard outputs to evaluate safe access and evacuation routes to and from flooded areas;
- Use mapped outputs to determine areas where specific emergency flood plans should be developed (i.e., particular vulnerable communities or specific CDAs);
- Increase education and awareness in communities at risk of surface water flooding;
- Create a key facts and 'what to do' section for surface water flooding in emergency handbooks; and
- Work with other agencies (such as the Environment Agency flood alert schemes) in the interests of cost effectiveness and good communication.

12.4 Highways

The highways department within the council is responsible for managing and maintaining the road drainage network within Southend-on-Sea. They have a variety of duties and responsibilities ranging from effectively draining the highway, to repairing potholes and salting the roads during cold and icy weather. As part of their duty to drain effectively drain the highway, they are also responsible for ensuring that drains and gullies are kept clear from debris such as soil, dead leaves and rubbish.

This type of debris often builds up in drains preventing the flow of water into the surface water or combined sewers and requires frequent maintenance. If drains become blocked during a heavy rainfall event it can exacerbate the severity of flooding that occurs locally.

It is important that the outputs from this SWMP are used by the Council Highways Department, to support and inform the future management practices of Southend-on-Sea's road infrastructure. In particular, consideration should be given to the key recommendations which are discussed in the following section.

The main recommendations and actions that the highways department should take from the SWMP process include the following key points:

- The existing schedule of drain and gully maintenance is recommended to be reviewed in order to give particular attention to areas considered to be at the highest risk of surface water flooding. These areas include the six CDAs of Eastwood, Prittle Brook, Temple Sutton, Southchurch, Shoeburyness and Chalkwell. Drains and gullies in these areas should be kept clear throughout the year to maximise the capacity of the drainage network and reduce the risk of blockages; this should be reflected in the gully cleansing schedule.
- Opportunities for joint funding on improvement work within the Borough should be considered. Highway maintenance and improvement projects could be combined with drainage improvement or flood alleviation

projects through a more holistic approach within the Council. For example, highways drainage programmes may offer opportunities to incorporate useful changes to overland flow paths or increase drainage capacity within a surface water flood risk hotspot with little extra cost. This would provide a time and cost effective way to manage the resources of the council and ensure different departments are involved in working together to reduce the flood risk within the Borough.

- Links to emergency planning should be improved, particularly within the CDAs and where roads have been identified as being at risk of surface water flooding. As discussed in Chapter 12-3, findings identified within the SWMP process should be used to update emergency planning strategies such as MAFPs and other similar plans. These plans should include information on roads and access routes which are likely to become impassable during an extreme flood and those which may be used as conveyance routes or areas for temporary flood storage (such as in CDA2 and CDA6); this should be considered with the support of relevant highway drainage engineers within the highways department.

13 Next Steps

The Southend-on-Sea Local Flood Risk Partnership should continue to work together to implement the proposed actions, review the operational efficiency and any legislative changes. Going forward, SBC should focus on implementing the high priority actions from the Action Plan. In particular:

1. Maintain records of flooding events;
2. Update the Multi Agency Flood Plan;
3. Adaption of spatial planning policy;
4. Improve community awareness and resilience;
5. Review agricultural and land management practices; and,
6. Install a rain gauge network.

The FWMA requires each LLFA to produce a LFRMS for their administrative area, which SBC has drafted for consultation in early 2015. This SWMP has provided the evidence base to support the development of the LFRMS. Following consultation of the LFRMS in early 2015, the SWMP should be reviewed, and if necessary, updated to reflect any changes.

13.1 Review

SBC should regularly review the progress of the SWMP. This will ensure actions are being undertaken by the relevant partners and will provide an opportunity to resolve unexpected setbacks with the implementation of actions.

The Action Plan should be reviewed and updated at least once a year in line within the LFRMS Action Plan. However there may be circumstances that call for additional reviews and updates of the Action Plan, such as:

- Occurrence of a surface water flood event;
- Additional data or modelling becoming available, which may alter the understanding of risk within the study area;
- Outcome of investment decisions by partners is different to the preferred option, which may require a revision to the action plan; and
- Additional (major) development or other changes in the catchment which may affect the surface water flood risk.