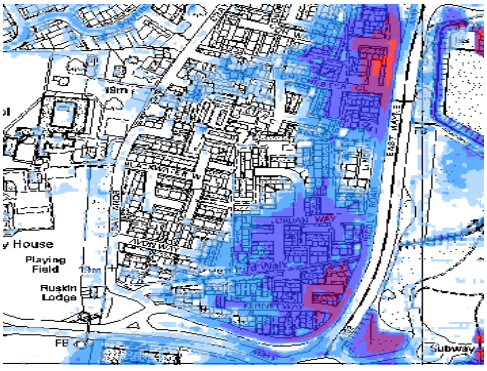
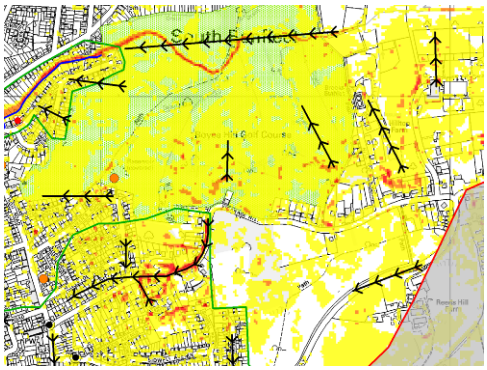
URS

Scott Wilson

South Essex
Surface Water Management Plan

Phases II, III and IV
FINAL April 2012





Prepared for

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BASILDON · BILLERICAY · WICKFORD

Rochford castlepoint District Council

Essex County Council

Revision Schedule

South Essex Surface Water Management Plan – Phases II, III and IV
April 2012

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Executive Summary

This document forms the Surface Water Management Plan (SWMP) for the administrative areas of Basildon Borough Council, Castle Point Borough Council and Rochford District Council (referred to as 'South Essex' throughout the report). This document is a plan which outlines the preferred surface water management strategy for South Essex and includes consideration of flooding from sewers, drains, groundwater and runoff from land, small watercourses and ditches that occurs as a result of heavy rainfall.

The SWMP has been undertaken following a four phase approach; Phase 1 – Preparation; Phase 2 – Risk Assessment; Phase 3 – Options; and Phase 4 – Implementation and Review. Phase 1 has been reported separately, with the findings from Phases 2, 3 and 4 reported within this document. The findings of each phase are reported in turn, with elements of each phase relevant to all authorities presented in a Part A of each phase and authority specific elements within a Part B of each phase.

Phase 1 Preparation

Phase 1 collected and reviewed all the surface water data from key stakeholders and built partnerships between stakeholders responsible for local flood risk management. It is the role of Essex County Council as LLFA to forge effective partnerships with the Districts and Borough Councils within its area, Anglian Water, Thames Water and the Environment Agency, as well as other key stakeholders and risk management authorities.

In order to achieve this, the Essex Partnership for Flood Management was established which is led by elected members focusing on overall strategy and in particular funding and communications. This is supported by the Essex Flood Risk Management Officer Group, which acts as an officer-led operational group with representatives from Environment Agency, Anglian Water and a number of the District and Borough Councils. The SWMP built on the existing partnerships established through the work undertaken for the update for the Strategic Flood Risk Assessments (2011), the Essex Resilience Forum and the Essex Preliminary Flood Risk Assessment (2011).

The main stakeholders involved in the South Essex SWMP, included Basildon Borough Council, Castle Point Borough Council, Rochford District Council, Essex County Council, Anglian Water and the Environment Agency.

Phase 2 Risk Assessment

As part of Phase 2 Risk Assessment, direct rainfall modelling has been undertaken for Basildon Borough Council, Castle Point Borough Council and the urban area within Rochford District Council, with the Environment Agency Flood Map for Surface Water (FMfSW) used for the eastern part of Rochford District Council.

The results of this modelling have been used to identify Critical Drainage Areas (CDAs) to denote an area or catchment where multiple or interlinked sources of flood risk cause flooding during a sever rainfall event, affecting houses, businesses and/or infrastructure and where mitigation measures may be implemented to reduce the impact of flooding.

Those areas identified to be at more significant risk have been delineated into Potential Surface Water Flooding Hotspots (PSFWHs) representing the key area at risk of surface water flooding, contributed to by the rainwater falling within the area of the wider CDA flooding which has the potential to have the deepest flooding and the most receptors affected.

The chief mechanisms for flooding in the South Essex study area can be broadly divided into the following categories:

- River Valleys – the areas particularly susceptible to surface water flooding are formed by the river valleys of the River Crouch, Nevendon Brook, North Benfleet Brook, Basildon Brook, Prittle Brook, Rawreth Brook and the River Roach.
- Low Lying Areas – areas such as underpasses, subways and lowered roads beneath railway lines are more susceptible to surface water flooding;
- Railway Embankments and Cuttings – discrete surface water flooding locations along the up-stream side of the raised network rail embankment;
- Topographical Low Points – areas which are at topographical low points which result in small, discrete areas of deep surface water ponding; and,
- Local Drainage Capacity – areas which flood as a result of poor local drainage network capacity.

Within the South Essex study area 37 CDAs have been identified: 22 within Basildon Borough Council, six within Castle Point Borough Council and nine within Rochford District Council.

Due to the large number of potential CDAs identified, in order to focus on the key flood risk areas and to develop and present options for Phase 3, the CDAs were shortlisted based on the following:

- the frequency of historical flooding within the CDA and PSWFH;
- the potential risk of groundwater flooding within the CDA;
- the frequency of sewer flooding incidents within the CDA or PSFWH;
- the presence of critical infrastructure at risk within the PSWFH;
- whether significant future development is likely which could exacerbate surface water flooding; and,
- the number of buildings and residential properties flooded at a depth greater than 0.3m within the CDA.

Based on the above criteria, it was agreed by the SWMP Working Group that only the most significant CDAs, 23 in total, would be assessed and taken forward into the Phase 3 Options Assessment. Table 1 details the lists the shortlisted CDAs for Basildon Borough Council, Castle Point Borough Council and Rochford District Council.

The other CDAs were reported for information and completeness and to highlight the potential surface water flooding issues, which although have less risk to people and property, may have more of a significant impact to relevant infrastructure stakeholders in South Essex (in particular Network Rail and the Highways Authority).

Table 1 – Shortlisted CDAs at Greatest Risk of Surface Water Flooding in South Essex

CDA Number	CDA Name	Number of buildings flooded at greater than 0.3m deep, footprint greater 25m2	Number of residential buildings flooded at greater than 0.3m deep, footprint greater 25m2
BASILDON BOROUGH COUNCIL SHORTLISTED CDAs			
BAS 1	North West Billericay	42	35
BAS 3	Stock Road	46	44
BAS 4	Sunnymede	54	42
BAS 8	Laindon	82	75
BAS 12	Kingswood/Dry Street	44	18
BAS 14	Barstable/Fryerns	127	115
BAS 15	Chalvedon/Felmore	20	17
BAS 16	Bowers Gifford	11	8
BAS 17	Pitsea	8	2
BAS 21	Bromfords	407	393
BAS 22	Cranfield Park Road	186	180
CASTLE POINT BOROUGH COUNCIL SHORTLISTED CDAs			
CAS 1	South Benfleet	39	25
CAS 2	New Thundersley	19	18
CAS 3	East Thundersley	37	36
CAS 4	Hadleigh	1	1
CAS 6	Canvey Island	2	2
ROCHFORD DISTRICT COUNCIL SHORTLISTED CDAs			
ROC 1	Rayleigh West	61	59
ROC 2	Watery Lane	26	4
ROC 4	Hockley	19	19
ROC 6	Rayleigh East	30	30
ROC 7	Ashingdon/Rochford	108	69
ROC 8	Great Stambridge	13	3
ROC 9	Little/Great Wakering	Area within EA FMfSW	Area within EA FMfSW

Phase 3 Options Assessment

There are a number of opportunities for measures to be implemented across the South Essex study areas to tackle surface water flood risk. Opportunities to raise community awareness of the risks and responsibilities for residents should be sought.

It is important to recognise that flooding within the South Essex study area is not confined to just the CDAs, and therefore, there are opportunities for generic measures to be implemented through the establishment of a policy position on issues including the widespread use of water conservation measures such as water butts and rainwater harvesting technology, use of soakaways, permeable paving and green roofs.

For each of the CDAs identified, site-specific measures have been identified that could be considered to help alleviate surface water flooding. These measures were subsequently short listed to identify a potential preferred option for each CDA alongside recommendations for further investigation where appropriate. 'Quick Wins' have also been identified.

Pluvial modelling undertaken as part of the SWMP has identified that flooding across the South Essex study area is typically shallow and widely dispersed. To address local flood risk it is recommended that, the following preferred options, outlined in Tables 2, 3 and 4 are investigated for each of the CDAs. Section 10 of the main report provides more detail for the preferred options.

Table 2: Preferred Options – Basildon Borough Council

CDA	Preferred Option: Combined Measures	Other Potential Options	Quick Wins
BAS 1 North West Billericay	• Flood Storage (Lake Meadows) • Source Control/Attenuation (Radford Crescent & The Pantiles) • Community Awareness (PWSFH)	• Rainwater Harvesting (Lake Meadows Swimming Pool) • Rainwater Harvesting (The Pantiles Neighbourhood Centre)	• Identify rights of ownership of drainage ditches/ordinary watercourses • Improved maintenance of drainage ditches/ordinary watercourses
BAS 3 Stock Road	• Detention Basin (Mayflower School & Land at Hollyford) • Community Awareness (PSWFH)	• Preferential Flow Route (Stock Road) • Rainwater Harvesting (water butts for properties in PSWFH)	
BAS 4 Sunnymede	• Flood Storage Bund (Mill Meadows – reduce conveyance) • Increased conveyance/capacity of ordinary watercourse. • Community Awareness (PSFWH)	• Flood Storage (2-stage channel – Outwood Common) • Rainwater Harvesting (water butts for properties in PSWFH)	• Identify rights of ownership of drainage ditches/ordinary watercourses • Improved maintenance of drainage ditches/ordinary watercourses
BAS 8 Laindon	• Formalise Flood Storage Area (Paddocks Recreation Ground) • Preferential Flow Path (High Rd) • Planning Policy • Community Awareness (PSFWH)	• Source Control (Laindon Centre)	
BAS 12 Kingswood-Dry Street	• Further Investigation (Kingswood Washland – divert flows from surface water sewer) • Flood Storage (Tinkler Side) • Planning Policy • Community Awareness (PSFWH)	• Land Management (Langdon Hills & Basildon Golf Course • Rainwater Harvesting (water butts for properties in PSWFH) • Source Control (Basildon Town Centre) • Infrastructure Resilience (Basildon Hospital)	• Washland Management Plan (Kingswood, Wootens, Dry Street, Hospital Washlands) • Identify rights of ownership of drainage ditches/ordinary watercourses • Improved maintenance of drainage ditches/ordinary watercourses

CDA	Preferred Option: Combined Measures	Other Potential Options	Quick Wins
BAS 14 Barstable-Fryerns	• Source Control/Attenuation (The Lower Academy – Detention Basin) • Planning Policy • Community Awareness (PSFWH)	• Source Control/Attenuation (The Lower Academy – Greenroof)	• Washland Management Plan (Northlands Washland) • Identify rights of ownership of drainage ditches/ordinary watercourses • Improved maintenance of drainage ditches/ordinary watercourses
BAS 15 Chalvedon-Felmore	• Source Control/Attenuation (Briscoe & Felmore Schools – Detention Basin) • Further Investigation (drainage network throughout PSFWH) • Planning Policy • Community Awareness (PSFWH)	• Source Control/Community Resilience • Source Control/Attenuation (Briscoe & Felmore Schools) • Infrastructure Resilience (Briscoe & Felmore Schools)	
BAS 16 Bowers Gifford	• Further Investigation (complex interactions between drainage ditches, ordinary watercourses and main river preventing conveyance)	• Land Management • Source Control/Community Resilience • Community Flood Plan	• Identify rights of ownership of drainage ditches/ordinary watercourses • Improved maintenance of drainage ditches/ordinary watercourses
BAS 17 Pitsea	• Further Investigation (flooding behind railway embankment) • Planning Policy	• Source Control/Attenuation (Tennyson Drive, Pitsea Town Centre, Schools)	
BAS 21 Bromfords	• Source Control/Attenuation (Elder Ave Recreation Ground – Detention Basin) • Flood Storage (Land between A132 (west and residential area) • Community Awareness (PSFWH)	• Rainwater Harvesting (water butts for properties in PSWFH) • Community Flood Plan	• Washland Management Plan (Albany Road Washland) • Identify rights of ownership of drainage ditches/ordinary watercourses • Improved maintenance of drainage ditches/ordinary watercourses
BAS 22 Cranfield Park Road	• Further Investigation (establish flood mechanisms within PSWFH) • Community Awareness (PSFWH)	• Flood Storage (2-stage channel) • Local Drainage Capacity Investigation	• Identify rights of ownership of drainage ditches/ordinary watercourses • Improved maintenance of drainage ditches/ordinary watercourses

Table 3: Preferred Options – Castle Point Borough Council

CDA	Preferred Option: Combined Measures	Other Potential Options	Quick Wins
CAS1 South Benfleet	• Flood Storage (Boyce Hill Golf Club & Benfleet Marsh) • Land Management • Community Awareness	• Preferential Flow Path (Grove Road)	• Washland Management Plan (Benfleet Marsh & Essex Way Flood Storage Area) • Improved maintenance of drainage ditches/ordinary watercourses
CAS2 New Thundersley	• Flood Storage (Robert Drake School & Tarpots Recreation Ground) • Flood Storage Bund (Coombe Wood) • Increased conveyance (A130 embankment) • Planning Policy	• Flood Storage (Montgomery and Glenwood Schools) • Rainwater harvesting (schools/public buildings)	• Identify rights of ownership of drainage ditches/ordinary watercourses • Improved maintenance of drainage ditches/ordinary watercourses • Increase public awareness in PSWFH.

CDA	Preferred Option: Combined Measures	Other Potential Options	Quick Wins
CAS3 East Thundersley	• Improved maintenance (Prittle Brook, Westwood) • Online Storage (Prittle Brook, Westwood) • Planning Policy for new development (Kiln Road) • Flood Storage (Cedar Hall School)	• Rainwater harvesting (install water butts in residential area to north & south CDA)	• Identify rights of ownership of drainage ditches/ordinary watercourses • Improved maintenance of drainage ditches/ordinary watercourses • Increase public awareness in PSWFH.
CAS4 Hadleigh	• Planning Policy for new development (Hadleigh Town Centre) • Online Storage (Hadleigh School & Crescent Recreation Ground)	• Flood resilient measures (The Crescent) • Increase Sewer Capacity (The Avenue, The Crescent, Estate Road)	• Identify rights of ownership of drainage ditches/ordinary watercourses • Increase public awareness in PSWFH.
CAS6 Canvey Island	• Community Awareness • Planning Policy		• Identify rights of ownership of drainage ditches/ordinary watercourses

Table 4: Preferred Options – Rochford District Council

CDA	Preferred Option: Combined Measures	Other Potential Options	Quick Wins
ROC 1 Rayleigh West	• Flood Storage (Sweyne Park & Sweyne Park School) • Further Investigation ordinary watercourse (between Heron Close – A129) • Land Management	• Community Awareness • Resilience of Sweyne Park School • Water Butts (west CDA)	• Formalise Flood Storage Area (Sweyne Park, Boston Avenue) • Identify rights of ownership of drainage ditches/ordinary watercourses • Improved maintenance of drainage ditches/ordinary watercourses
ROC 2 Watery Lane	• Further Study (complex mechanisms of flooding in CDA – pump capacity, tide locked conditions, fluvial flooding, drainage channel capacity) • Planning Policy (north CDA)	• Resilience Measures	• Community Awareness • Identify rights of ownership of drainage ditches/ordinary watercourses • Improved maintenance of drainage ditches/ordinary watercourses
ROC 4 Hockley	• Flood Storage (Greensward Academy and Plumberow School) • Flow Restriction (eastern boundary Marylands Wood) • Community Awareness • Planning Policy	• Investigation of sewers (east of CDA)	• Identify rights of ownership of drainage ditches/ordinary watercourses • Improved maintenance of drainage ditches/ordinary watercourses
ROC 6 Rayleigh East	• Flood Storage (Napier Road & Grove Nature Reserve • Sewer Investigation (Thorington Road, The Chase, Napier Road) • Community Awareness • Land Management (East of CDA)	• Preferential Flow Path (North to East CDA – Albert Road, Bull Lane, The Chase)	• Improved maintenance of drainage ditches/ordinary watercourses
ROC 7 Ashingdon-Rochford	• Flood Storage (Spencer's Park) • Flow Restriction (Bund – north of Rochford Garden Way) • Further Investigation (East Railway embankment around Banvard Way • Land Management	• Source Control (Pollards Close, Union Lane, Ashingdon Road – Rainwater Harvesting) • Flood Storage (Pollards Close, Ashingdon Road car parks • Infrastructure Resilience (Rochford Fire Station)	• Identify rights of ownership of drainage ditches/ordinary watercourses • Improved maintenance of drainage ditches/ordinary watercourses • Community Awareness
ROC 8 Great Stambridge	• Further Investigation (Bartonhall Creek – increase capacity) • Planning Policy	• Flood Resilience • Community Awareness	• Improved maintenance of drainage ditches/ordinary watercourses

CDA	Preferred Option: Combined Measures	Other Potential Options	Quick Wins
ROC 9 Great/Little Wakering	• Further Investigation (Sewer Capacity Little Wakering Road) • Community Awareness	• Flood Storage (Field behind Cronje Cottage)	• Improved maintenance of drainage ditches/ordinary watercourses

Phase 4 Implementation & Review

Phase 4 establishes a long-term Action Plan for the South Essex study area, with Essex County Council taking the lead role lead in the management of surface water flood risk across the South Essex study area. The purpose of the Action Plan is to:

- Outline the actions required to implement the preferred options identified in Phase 3;
- Identify the partners or stakeholders responsible for implementing the action;
- Provide an indication of the priority of the actions and a timescale for delivery; and,
- Outline actions that can be undertaken across South Essex by Essex County Council as the LLFA.

The SWMP Action Plan is a 'living' document, and as such, should be reviewed and updated regularly as part of the annual action plans produced by the Essex Partnership for Flood Management. Reviews should particularly consider occurrences of surface water flood events, any additional data or modelling becoming available, the outcome of investment decisions by partners and any additional major development or changes in the catchment which may affect the surface water flood risk.

Glossary of Terms and Acronyms

Term	Definition
AEP	Annual Exceedance Probability
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.
AMP	Asset Management Plan
AWS	Anglian Water Services
Asset Management Plan	A plan for managing water and/or a water and sewerage company (WaSC) infrastructure and other assets in order to deliver an agreed standard of service.
AStSWF	Areas Susceptible to Surface Water Flooding
BGS	British Geological Survey
CFMP	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.
CDA	Critical Drainage Area – A discrete geographic area (usually a hydrological catchment) where multiple and interlinked sources of flood risk (surface water, groundwater, sewer, main river and/or tidal) cause flooding in one or more Local Flooding Hotspots during severe weather thereby affecting people, property or local infrastructure.
CIRIA	Construction Industry Research and Information Association
Civil Contingencies Act	This Act delivers a single framework for civil protection in the UK. As part of the Act, Local Resilience Forums must put into place emergency plans for a range of circumstances including flooding.
CLG	Government Department for Communities and Local Government
Climate Change	Long term variations in global temperature and weather patterns caused by natural and human actions.
Culvert	A channel or pipe that carries water below the level of the ground.
Defra	Department for Environment, Food and Rural Affairs
DEM	Digital Elevation Model
DG5 Register	A water-company held register of properties which have experienced sewer flooding due to hydraulic overload, or properties which are 'at risk' of sewer flooding more frequently than once in 20 years. The register is required by the water industry regulator Ofwat.
DTM	Digital Terrain Model
EA	Environment Agency
Indicative Flood Risk Areas	Areas determined by the Environment Agency as indicatively having a significant flood risk, based on guidance published by Defra and WAG and the use of certain national datasets. These indicative areas are intended to provide a starting point for the determination of Flood Risk Areas by LLFAs.
FCERM	Flood and Coastal Erosion Risk Management
FMfSW	Flood Map for Surface Water
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).

Term	Definition
Flood Risk Area	An area determined as having a significant risk of flooding in accordance with guidance published by Defra and WAG.
FRR	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	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 in England.
Fluvial Flooding	Flooding resulting from water levels exceeding the bank level of a main river
IUD	Integrated Urban Drainage
LDF	Local Development Framework
LFRZ	Local Flood Risk Zone
LiDAR	Light Detection and Ranging
LLFA	Lead Local Flood Authority
LRF	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.
LPA	Local Planning Authority
Main River	A watercourse shown as such on the Main River Map, and for which the Environment Agency has responsibilities and powers
NRD	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
PA	Policy Area
Partner	A person or organisation with responsibility for the decision or actions that need to be taken.
PFRA	Preliminary Flood Risk Assessment
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	Flooding from water flowing over the surface of the ground; often occurs when the soil is saturated and natural drainage channels or artificial drainage systems have insufficient capacity to cope with additional flow.
Policy Area	One or more Critical Drainage Areas linked together to provide a planning policy tool for the end users. Primarily defined on a hydrological basis, but can also accommodate geological concerns where these significantly influence the implementation of SuDS
PSWFH	Potential Surface Water Flooding Hotspot - defined as discrete areas of flooding that do not exceed the national criteria for a 'Flood Risk Area' but still affect houses, businesses or infrastructure. A PSWFH is defined as the actual spatial extent of predicted flooding in a single location
Resilience Measures	Measures designed to reduce the impact of water that enters property and businesses; could include measures such as raising electrical appliances.
Risk	In flood risk management, risk is defined as a product of the probability or likelihood of a flood occurring, and the consequence of the flood.
RMA	Risk Management Authority

Term	Definition
Risk Management Authority	As defined by the Flood and Water Management Act, the 'risk management authority' means — (a) the Environment Agency, (b) a lead local flood authority, (c) a district council for an area for which there is no unitary authority, (d) an internal drainge board; (e) a water company, and (f) a highway authority.
Sewer flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
SFRA	Strategic Flood Risk Assessment
Stakeholder	A person or organisation affected by the problem or solution, or interested in the problem or solution. They can be individuals or organisations, includes the public and communities.
SuDS	Sustainable Drainage Systems
Surface water	Rainwater (including snow and other precipitation) which is on the surface of the ground (whether or not it is moving), and has not entered a watercourse, drainage system or public sewer.
SWMP	Surface Water Management Plan
WaSC	Water and Sewerage Company

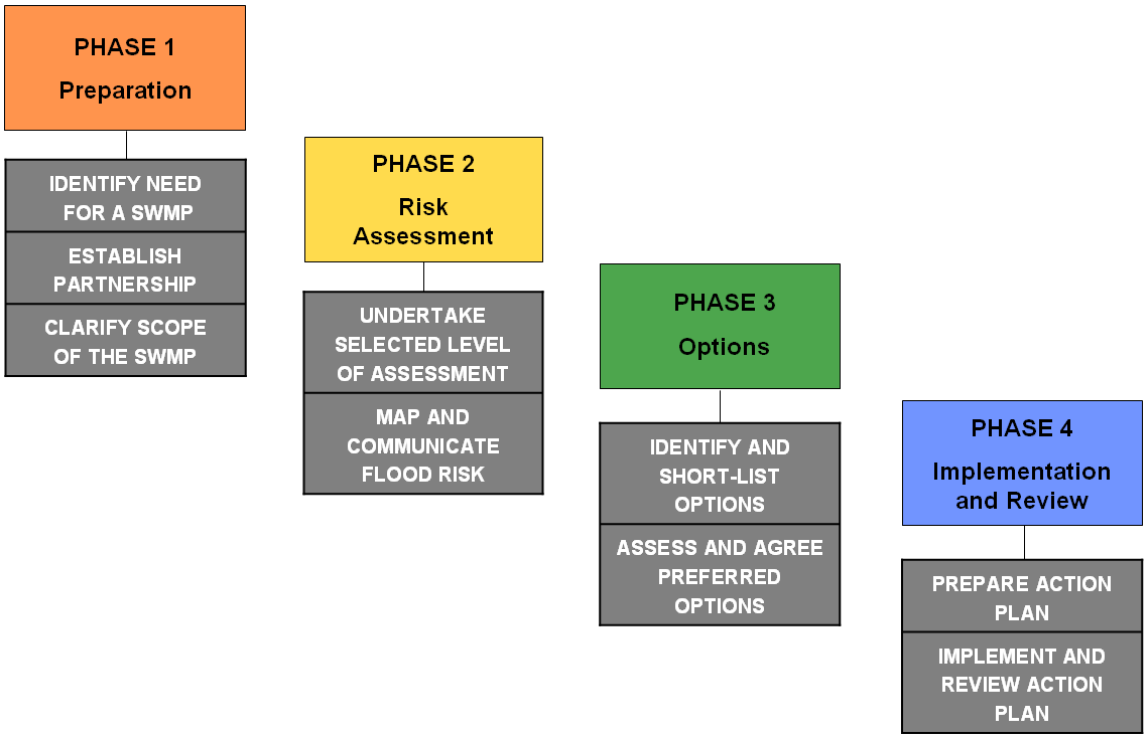
1. Introduction and Aims

1.1 Introduction

A Surface Water Management Plan (SWMP) is a framework to help understand the causes of surface water flooding in a given area and agree a preferred strategy for the management of surface water flood risk. This SWMP study has been undertaken in consultation with key local partners who have worked together 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 methodology for this SWMP has been based on the Defra SWMP Technical Guidance, published in March 2010. The guidance document identifies four clear phases in undertaking a SWMP study: Preparation; Risk Assessment; Options; and Implementation and Review, as illustrated in Figure 1-1.

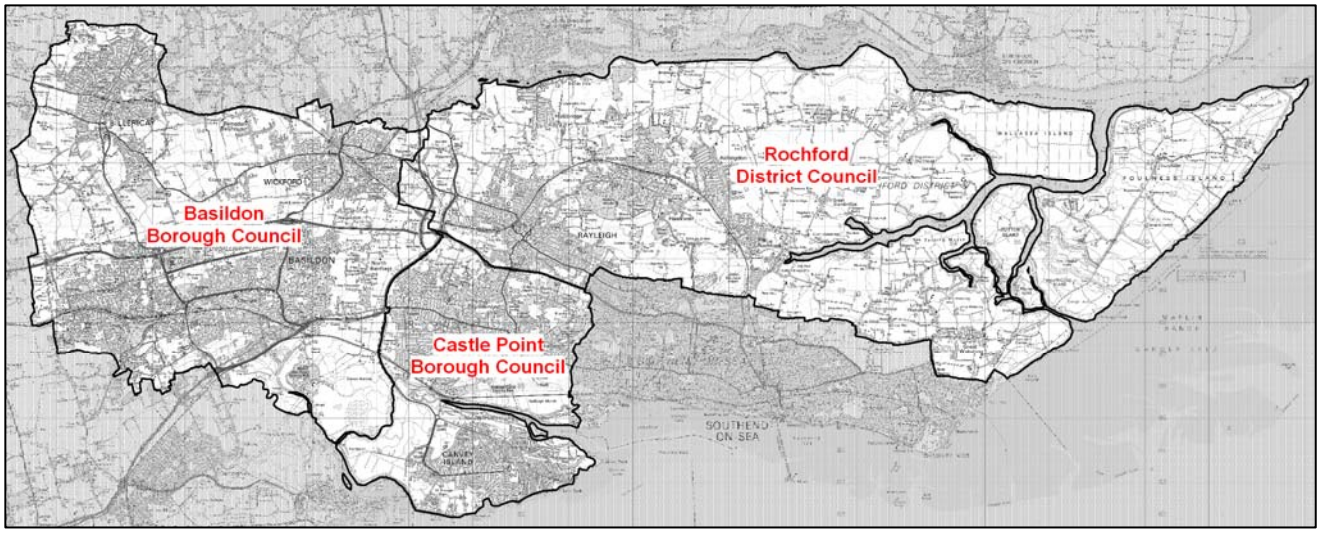
Figure 1-1: Defra SWMP Phases



1.2 Study Area

Figure 1-2 shows the administrative areas of Basildon Borough Council, Castle Point Borough Council and Rochford District Council (referred to as 'South Essex' in this report), which make up the study area for the South Essex SWMP.

Figure 1-2: South Essex SWMP Study Area



1.3 Summary of Phase 1

Phase 1 of the SWMP has been prepared by URS Scott Wilson and was reported separately in January 2011 (URS Scott Wilson, 2010). This report covers Phases 2, 3 and 4 of the South Essex SWMP as set out in the Defra guidance and should be read in conjunction with Phase 1.

The key outcomes from Phase 1 included:

- preparation and scoping the requirements of the SWMP;
- establishment of partnerships and clarification of the roles and responsibilities of each partner to deliver the SWMP;
- establishment of a stakeholder engagement plan to support development of the SWMP;
- identification of the required data and information, its availability and where data gaps exist; and,
- identification of the appropriate level of assessment of the SWMP study.

Phase 1 identified more than 12,830 properties at risk of surface water flooding within South Essex, using the Environment Agency Flood Map for Surface Water Flooding. Consequently it was viewed that the risk of surface water flooding needed further appraisal with a particular focus on high risk areas.

1.4 Aims and Objectives of Phases 2, 3 and 4

The subsequent phases of the SWMP have the following aims and objectives:

The purpose of Phase 2 (Risk Assessment) is to develop an understanding of flood risk across the study area and subsequently communicate that risk to the relevant partners and stakeholders. This includes the following aims and objectives:

- Review the existing data that was identified and collated in Phase 1, including data relating to the existing Anglian Water sewer system.
- Carry out a study area groundwater assessment.

- Create a surface water hydraulic model to identify the mechanisms of surface water flooding and enable an intermediate level risk assessment of surface water flood risk in the study area.
- Quantify 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.
- Develop and define Critical Drainage Areas (CDAs), where multiple and interlinked sources of flood risk (surface water, groundwater, sewer, main river and/or tidal) cause flooding in one or more local flooding hotspots, affecting people, property or local infrastructure. These CDAs would then be taken forward for further assessment in Phase 3.
- Map the results of the surface water modelling process and communicate the risk of flooding to relevant stakeholders.
- Provide recommendations for a more 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 the following aims and objectives:

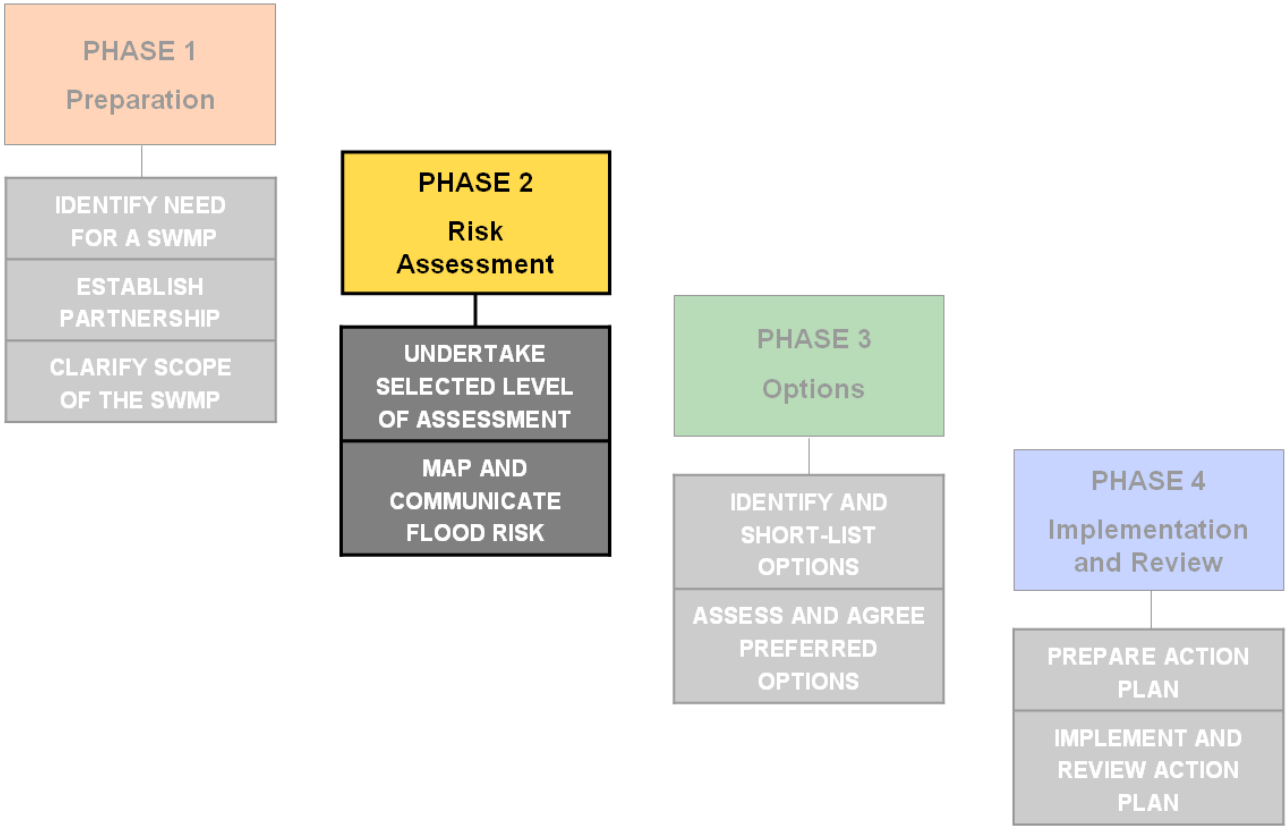
- Identify initial potential options for surface water management across South Essex, both specific to the individual CDAs and across the three authorities as a whole.
- Determine the high level costs and benefits of the options and select preferred options for further more detailed assessment.
- Identify any 'quick wins' which can be implemented relatively quickly and with low capital costs to reduce surface water flood risk in key areas.
- Communicate potential options to relevant stakeholders.

The purpose of Phase 4 (Implementation and Review) is to prepare the SWMP Action Plan. The Action Plan should summarise the measures and options identified in Phase 3 and what further work and actions are required to take forward options and measures in order to manage and reduce the flood risk identified in the authority areas during Phase 2. The Action Plan should also provide a strategy on how the plan should be implemented and reviewed going forward.

1.5 SWMP Report Presentation

This SWMP report is presented, for ease of reference, to each of the partner authorities in the study area. The findings of each phase are reported in turn, with elements of each phase relevant to all authorities presented in a Part A of each phase and authority specific elements within a Part B of each phase.

Phase II: Risk Assessment



Part A: Study Wide

2. Introduction

2.1 Intermediate Assessment

The aim of the Phase 2 Intermediate Risk Assessment was to identify the sources and mechanisms of surface water flooding across the study area which has been achieved through an intermediate assessment of pluvial flooding, sewer flooding, groundwater flooding and flooding from ordinary watercourses along with the interactions with main rivers and the sea. The modelling outputs have then been mapped using GIS software.

Table 2-1 defines the potential levels of assessment within an SWMP. This SWMP has been prepared at the 'Borough' scale for each authority and fulfils the objectives of a second level 'Intermediate Assessment'.

Table 2-1- SWMP Study Levels of Assessment [Defra 2010]

Level of Assessment	Appropriate Scale	Outputs
1. Strategic Assessment	County wide	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.
2. Intermediate Assessment	Borough wide	Identify flood hotspots which might require further analysis through detailed assessment. Identify immediate mitigation measures which can be implemented. Inform spatial and emergency planning.
3. Detailed Assessment	Known flooding hotspots	Detailed assessment of cause and consequences of flooding. Use to understand the mechanisms and test mitigation measures, through modelling of surface and sub-surface drainage systems.

As shown in Table 2-1, the intermediate assessment is applicable across a large town, city or Borough. The over-arching national pluvial modelling[1] suggests that there are approximately 12,830 properties at risk across the study area[2]. In the light of this and the records of extensive and severe historical flooding in the study area, it is appropriate to adopt the intermediate level of assessment to further quantify the risks. The purpose of this intermediate assessment has been to further identify those parts of the boroughs that are likely to be at greater risk of surface water flooding and require more detailed assessment.

The methodology used for this SWMP is summarised below with further detail of the methodology provided in Appendix A2.

- 2-Dimensional Pluvial modelling (using TuFLOW software) has been undertaken following a Direct Rainfall approach. Rainfall events of known probability are applied directly to the ground surface and water is routed overland to provide an indication of potential flow path directions and velocities and areas where surface water will pond.

[1] Source: Environment Agency National Property Count for the Flood map for Surface Water (FMfSW) dataset.
[2] for a rainfall event with a 1 in 200 probability of occurrence in any given year

- The 2-Dimensional pluvial modelling has been supported by field visits and visual surveys have been undertaken in conjunction with Basildon Borough Council, Castle Point Borough Council, Rochford District Council officers and Essex County Council officers.
- The outputs from the pluvial modelling have been verified (where possible) against historic surface water flood records and local knowledge.

The pluvial modelling has been undertaken for the urban areas within Basildon Borough Council, Castle Point Borough Council and Rochford District Council, with the Environment Agency Flood Map for Surface Water (FMfSW) used for the eastern part of Rochford District Council. A separate modelling report has been produced to support this SWMP, which sets out model build and modelling methodology and is included in Appendix A2.

2.2 Risk Overview

2.2.1 Mapping of Surface Water Flood Risk

The mapping shown within this report is intended to identify broad areas which are more likely to be vulnerable to surface water flooding. This will allow more detailed analysis to be undertaken at a future stage in areas which are most vulnerable to surface water flooding.

In addition, the mapping can also be used as an evidence base to support spatial planning to ensure that surface water flooding is appropriately considered when allocating land for development. Furthermore, the map can be used to assist emergency planners in preparing their Multi-Agency response plans.

It should be noted that this mapping only shows the predicted likelihood of surface water flooding (this includes flooding from drains, small watercourses and ditches that occurs in heavy rainfall in urban areas) for defined areas. Due to the coarse nature of the source data used, **the maps are not detailed enough to define risk for individual addresses**. Individual properties therefore may not always face the same probability of flooding as the areas that surround them. It should also be noted that the mapping outputs will be more representative in steeper areas where inundation is influenced by topography and less representative over large, flat landscapes, where the hydraulics of surface water sewer network influence inundation.

There may also be particular occasions when flooding occurs and the observed pattern of flooding does not in reality match the predicted patterns shown on these maps. The maps reflect all the suitable and relevant data provided and have been produced using expert knowledge to create conclusions of what is more likely, that are as reliable as possible. However, it is essential that users of these maps understand the complexity of the data and modelling utilised in their production and are also aware of the associated limitations and uncertainties in the mapping. **The maps are not intended to be used in isolation**. Further detail is included in the separate modelling report (Appendix A2).

2.2.2 Flooding Classification

Flood risk across South Essex has been classified based on the source of flooding (surface water, groundwater, fluvial / tidal and / or sewer) and scale (Potential Surface Water Flooding Hotspots (PSWFH), Critical Drainage Areas (CDA) Policy Areas (PA) and Indicative Flood Risk Zones). These categories are discussed in more detail below.

2.2.2.1 Source of Flood Risk

A range of classifications have been devised to identify the primary sources of flood risk to areas throughout the study area identified by this SWMP to be at a greater risk of surface water

flooding (Table 2-2). These classifications have been used to inform the SWMP Action Plan (Section 14) as they also define probable areas of flood mitigation and management responsibility.

Table 2-2: SWMP Flooding Source Classification

Flood Source Classification	Output from Pluvial Modelling	Output from Groundwater Flood Risk Assessment	EA Flood Map – Zone 3 – Areas not benefiting from defences	DG5 Records only
Surface Water*	✓			
Groundwater		✓		
Fluvial / Tidal			✓	
Sewer				✓
Surface Water and Groundwater	✓	✓		
Groundwater and Fluvial / Tidal**		✓	✓	
Surface Water and Sewer	✓			✓
Surface Water and Fluvial / Tidal	✓***		✓	
Surface Water, Groundwater and Fluvial / Tidal**	✓***	✓	✓	
Surface Water, Groundwater and Sewer	✓	✓		✓
All Sources	✓	✓	✓	✓

* Surface Water = Surface Water and / or Ordinary Watercourse
** Areas where surface water and / or groundwater flooding are fully within the EA Zone 3 (areas not benefiting from defences) are highlighted as having a primary influence from Fluvial / Tidal flooding.
*** Where pluvial modelling outputs demonstrate flooding significantly greater than Flood Zone 3, these areas should be classified as 'pluvial flooding areas'.

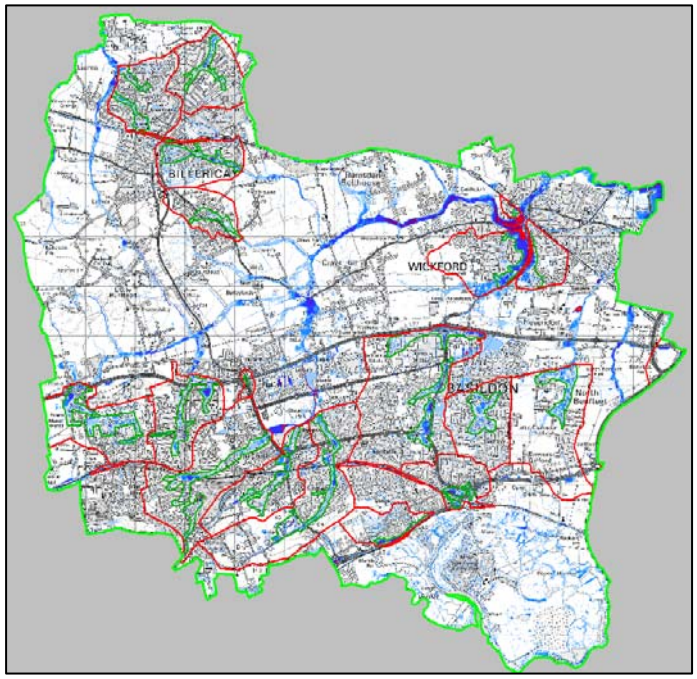
2.2.2.2 Scale of Flood Risk

The scale of flooding has been classified as follows through the definition of different flood risk management areas. The management of areas is presented in order from smallest to largest:

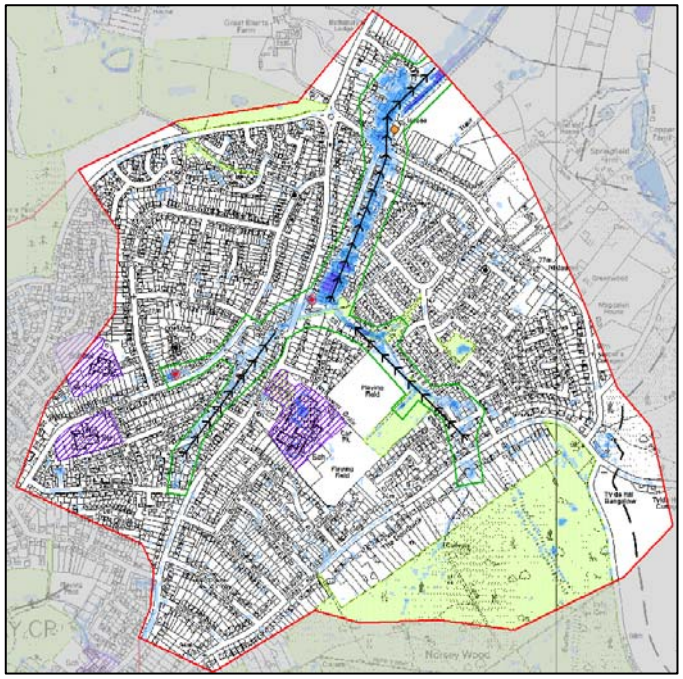
1. Potential Surface Water Flooding Hotspot (PSWFH – managed at the local scale);
2. Critical Drainage Area (CDA – containing one or more PSWFH – managed at the local scale);
3. Policy Areas (PA – containing one or more CDAs and covering an entire Borough/District); and,
4. Indicative Flood Risk Area (as defined by the Environment Agency / Defra Indicative Flood Risk Areas – an area approximately covering Basildon Borough Council, Castle Point Borough Council, Rochford District Council and parts of Southend-on-Sea Borough Council and managed at a strategic scale).

The flood risk hierarchy is illustrated in Figure 2-1. Further information on the scale of flooding and flood risk management areas identified across the study area are provided in Table 2-3.

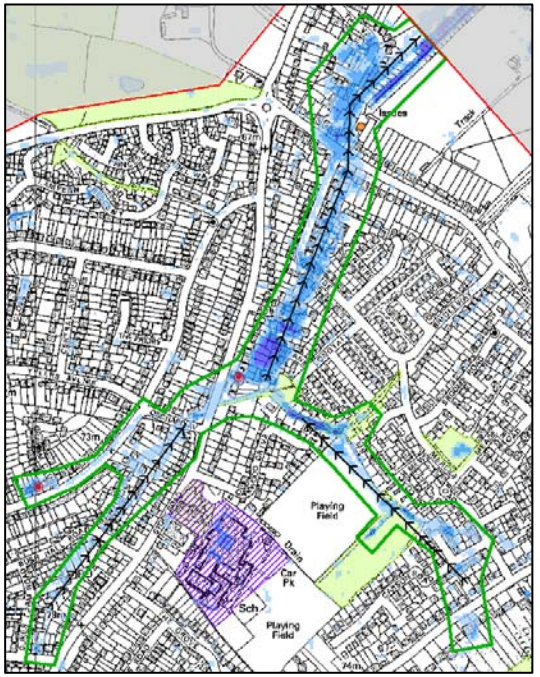
Figure 2-1: Scale of Flood Risk Hierarchy



Policy Area



Critical Drainage Area



Potential Surface Water Flooding Hotspot

Table 2-3: SWMP Flood Risk Management Areas

Scale	Definition	Description
Potential Surface Water Flooding Hotspot (PSWFH)	"A discrete area of flooding that affects houses, businesses or infrastructure".	A PSWFH is defined as the key area at risk of surface water flooding, contributed to by the rainwater falling within the area of the wider CDA.
Critical Drainage Area (CDA)	"A discrete geographic area (usually a hydrological catchment) where multiple and interlinked sources of flood risk (surface water, groundwater, sewer, main river and/or tidal) cause flooding in one or more PSWFH during severe weather thereby affecting people, property or local infrastructure."	CDA units are larger than PSWFHs and denote an area or catchment where mitigation measures may be implemented to reduce flooding experienced. 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 the PSWFH. CDA units should be used for site specific detailed planning and capital works schemes and may contain one or more PSWFH.
Policy Area (PA)	"A discrete area within an administrative area where appropriate planning policy can be applied to manage flood risk."	Policy Areas contain one or more CDAs and can cover the entire study area. Policy Areas are primarily based on hydrological catchments but may also accommodate geological concerns and other factors as appropriate. Policy areas may be used to provide guidance on general policy across the study area e.g. the use of soakaways in new development.
Indicative Flood Risk Area	"Areas determined by the Environment Agency as indicatively having a significant flood risk, based on guidance published by Defra and the use of certain national datasets."	Indicative Flood Risk Areas are defined by the Environment Agency / Defra primarily for the purposes of the preparation of PFRAs.

3. Sources of Flooding

3.1 Surface Water Flooding

3.1.1 Mechanisms of Flooding

Pluvial flooding occurs when high intensity rainfall generates runoff which flows over the surface of the ground and ponds in low lying areas, before it has the chance to enter any watercourse or sewer. It is usually associated with high intensity rainfall events 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.

No single organisation has overall responsibility for surface water flooding with ownership and responsibility for maintaining different aspects of the drainage system falling under the jurisdiction of either Basildon Borough Council, Castle Point Borough Council, Rochford District Council, Essex County Council, The Highway Authority (in this case Essex County Council), Anglian Water and riparian owners.

3.1.2 Pluvial Modelling

In order to continue developing an understanding of the causes and consequences of surface water flooding in the study area, intermediate level hydraulic modelling has been undertaken for a range of rainfall event probabilities for the urban areas within the study area. The Environment Agency Flood Map for Surface Water has been used for the eastern part of Rochford District Council. This hydraulic modelling has been designed to provide additional information where local knowledge is lacking and forms a basis for future detailed assessments in areas identified as high risk.

A direct rainfall approach using TuFLOW software has been selected whereby rainfall events of known probability are applied directly to the ground surface and is routed overland to provide an indication of potential flow path directions and velocities and areas where surface water will pond. A full methodology of the hydraulic modelling undertaken is included in Appendix A2.

Modelling results for the rainfall event with a 1 in 100 probability of occurrence in any given year (1% Annual Exceedance Probability, AEP), have been mapped for each Borough/District showing depth and hazard[3]. The mapping is shown in:

- Figure B 13, and Figure B 14 for Basildon Borough Council;
- Figure C 13, and Figure C 14 for Castle Point Borough Council; and,
- Figure D 13 and Figure D 14 for Rochford District Council.

Figures for the other modelled return periods are included in the following Appendices. A summary of the suggested uses for each mapped output is provided in Table 3-1.

- Appendix B – Basildon Borough Council (Figure B 9 – Figure B 18);
- Appendix C – Castle Point Borough Council (Figure C 9 – Figure C 18); and,

[3] Flood Hazard has been defined based upon the joint Environment Agency and Defra Research and Development Technical Report FD2320 (January 2006) and uses surface water flood depths and velocities to categorise the flood hazard. The degree of flood hazard can be interpreted as follows: (a) Caution: Flood zone with shallow flowing water or deep standing water; (b) Moderate: Flood zone with deep or fast flowing water. Dangerous for children, the elderly and the infirm; (c) Significant: Flood zone with deep fast flowing water. Dangerous for most people; and, (d) Extreme: Flood zone with deep fast flowing water. Dangerous for all (including emergency services)

- Appendix D – Rochford District Council (Figure D 9 – Figure D 18).

Table 3-1: Modelled Return Periods and Suggested Use

Modelled Return Period	Suggested Use
1 in 30 probability of rainfall event occurring in any given year (3.3% AEP)	Since 1980, with the introduction of Sewers for Adoption, Anglian Water sewers are required to be designed to accommodate 3.3% AEP rainfall event or less. However, many of the sewers were built pre-1980 and as such, are likely to have a lower capacity. This layer will identify areas that are prone to regular flooding and could be used by highway teams to inform maintenance regimes.
1 in 75 probability of rainfall event occurring in any given year (1.3% AEP)	In areas where the likelihood of flooding is 1 in 75 years or greater insurers will not guarantee to provide cover to property should it be affected by flooding. This GIS layer should be used to inform spatial planning as if property cannot be guaranteed insurance, the development may not be viable.
1 in 100 probability of rainfall event occurring in any given year (1% AEP)	Can be overlaid with Environment Agency Flood Zone 3 GIS layer (for fluvial flooding) to show areas at risk under the same event from both sources. Can be used to advise planning teams.
1 in 100 probability of rainfall event occurring in any given year (1% AEP) plus 30% climate change	Planning policy requires that the impact of climate change is fully assessed. Reference should be made to this flood outline by the spatial planning teams to assess the sustainability of developments.
1 in 200 probability of rainfall event occurring in any given year (0.5% AEP)	To be used by emergency planning teams when formulating emergency evacuation plans from areas at risk of flooding. Can also be overlaid with Environment Agency Flood Zone 3 GIS layer (for tidal flooding) to show areas at risk under the same event from both sources. Can be used to advise planning teams.

3.1.3 Hydrological Site Inspections

To support the pluvial modelling results and historical records, hydrological site inspections were undertaken by URS Scott Wilson on 11th-13th April 2011 to verify the model results and on 6th-7th June 2011 with officers from Basildon Borough Council, Castle Point Borough Council, Rochford District Council and Essex County Council to provide detailed knowledge on the sources and mechanisms of flooding, as well as information regarding any improvement works that have been implemented. Site photographs were taken, and are included in this report as appropriate.

3.2 Ordinary Watercourses

3.2.1 Mechanisms of Flooding

Ordinary watercourse flooding includes flooding from small open channels and culverted urban watercourses[4]. These small channels often receive most of their flow from inside the urban area and perform an urban drainage function.

The Environment Agency has designated most of the large watercourses as main rivers and has permissive powers to maintain them. However, riparian owners, i.e. those who own the

[4] These watercourses will frequently be ordinary watercourses (within the responsibility of local authorities) but may also be designated Main River (with responsibility of the Environment Agency).

property on either bank, still have responsibilities for their part of the river. Those 'ordinary watercourses' which have not been designated by the Environment Agency should be maintained by the riparian owner. From April 2012, Essex County Council will have powers to require works from riparian owners to maintain a proper flow of water in ordinary watercourses. This power may also be delegated to District and Borough Councils.

As part of this study, some information has been provided by Basildon Borough Council, Castle Point Borough Council and Rochford District Council regarding ordinary watercourses in the study area. It is also thought that are several hidden watercourses across all three administrative areas, which have been culverted or routed underground, though no further information relating to these was available at the time of study.

3.3 Groundwater Flooding

This section has been based on the Groundwater Assessment undertaken as part of this SWMP (Appendix A3).

3.3.1 Mechanisms of Flooding

Groundwater flooding occurs as a result of water rising up from the underlying aquifer or from water flowing from abnormal springs. This tends to occur after much longer periods of sustained high rainfall, and the areas at most risk are often low-lying where the water table is 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 (secondary aquifers).

Groundwater flooding tends to occur sporadically in both location and time, and tends to last longer than fluvial, pluvial or sewer flooding. When groundwater flooding occurs, basements and tunnels can flood, buried services may be damaged, and storm sewers may become ineffective, exacerbating the risk of surface water flooding. Groundwater flooding can also lead to the inundation of farmland, roads, commercial, residential and amenity areas.

It is also important to consider the impact of groundwater level conditions on other types of flooding e.g. fluvial, pluvial and sewer. 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.

The need to improve the management of groundwater flood risk in the UK was identified through Defra's Making Space for Water strategy (2005). The review of the July 2007 floods undertaken by Sir Michael Pitt highlighted that at that time no organisation had responsibility for groundwater flooding. The Flood and Water Management Act 2010 identified new statutory responsibilities for managing groundwater flood risk, in addition to other sources of flooding and has a significant component which addresses groundwater flooding.

Based on the hydrogeological conceptual understanding of the South Essex study area, the potential groundwater flooding mechanisms that may exist are provided in Table 3-2.

Table 3-2: Potential Groundwater Flooding Mechanisms in South Essex (Appendix A3)

Potential Flooding Mechanism	Description
Superficial aquifers along the River Roach, Prittle Brook, Eastwoood Brook (Eastwood Area) and the Mucking Hall Brook	Groundwater flooding may be associated with the substantial sand and gravel River Terrace Deposits, or to a lesser degree, sand lenses within Tidal Flat Deposits and Head 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. The properties at risk from this type of groundwater flooding are probably limited to those with basements / cellars, which have been constructed within the superficial deposits. In the UK, houses with cellars / basements were largely built in the Victorian era and into the early 1900s. Therefore, the older developed areas in South Essex are more likely to comprise properties with cellars / basements.
Superficial aquifers not in hydraulic continuity with surface water courses	Groundwater flooding is also associated with substantial River Terrace Deposits (gravel and sand), Sand and Gravel of Uncertain Age and Origin, Stanmore Gravel Formation, Lowestoft Formation, Glaciofluvial Deposits, sand lenses within Tidal Flat Deposits and Head deposits, but occurs where they are not hydraulically connected to surface water courses. Perched groundwater tables can exist within these deposits, developed through a combination of natural rainfall recharge and artificial recharge e.g. leaking water mains. The properties at risk from this type of groundwater flooding are probably limited to those with basements / cellars.
Superficial aquifers along the coastline (Foulness Island, Wallasea Island, east of Great Wakering)	Groundwater flooding could occur where River Terrace Deposits (gravel and 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. The properties at risk from this type of groundwater flooding are probably limited to those with basements / cellars.
Claygate Member and Bagshot Formation (bedrock) outcrop in central and western study area	Water levels within the outcropping Claygate Member and the Bagshot Formation will be perched on top of the London Clay Formation aquiclude. This means that basements / cellars in this area may be at risk from groundwater flooding following periods of prolonged rainfall, increased utilisation of infiltration SUDs and / or artificial recharge from leaking pipes.
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. This mechanism may occur as a result of natural (e.g. rainfall) or artificial (e.g. water main leakage) recharge.
Artificial ground in various locations	Groundwater flooding may occur where the ground has been artificially modified to a significant degree. If this artificial ground is of substantial thickness and permeability, then a shallow perched water table may exist. This could potentially result in groundwater flooding at properties with basements, or may equally be considered a drainage issue.

3.3.2 Groundwater Flooding Susceptibility

The key groundwater flooding mechanisms are associated with permeable superficial deposits (Table 3-3). The British Geological Survey (BGS) has produced a dataset showing areas susceptible to groundwater flooding on the basis of geological and hydrogeological conditions. (Figure B 6, Figure C 6, and Figure D 6).

Table 3-3: Current Groundwater Susceptibility Flooding Mechanisms (Appendix A3)

Flooding Mechanism	Description
Head deposits, River Terrace Deposits and Marine Alluvium Sands present at surface	Susceptibility to groundwater flooding is very high to high where Head deposits, River Terrace deposits and Marine Alluvium are present at surface. This is notably along the east of Foulness Island, the River Roach, Eastwood Brook, the Prittle Brook, and the River Crouch and its tributaries. As expected, these locations coincide with areas where the BGS has identified higher permeability and ground elevations are low.
Claygate Member and Bagshot Formation	Areas where the Claygate Member and Bagshot Formation outcrop are not areas identified as being susceptible to groundwater flooding despite the bedrock units being assigned high permeabilities. However, in the Billericay and Thundersley / Hadleigh area there are many flooding events where these bedrock units outcrop.
Head deposits outcrop	There is high susceptibility to groundwater flooding in areas where Head deposits outcrop. However, in reality the Head deposits are variable in composition (clay, silt, sand and gravel) and their thickness and lateral extent is limited over the study area. Based on the current assessment, it is thought that the Head deposits are not as susceptible to groundwater flooding as indicated by the BGS data
London Clay Formation outcrops at surface	The London Clay Formation is an aquiclude and does not permit groundwater flow. Therefore in areas where there are no overlying superficial deposits and the London Clay Formation is of an appreciable thickness, the potential for elevated groundwater levels is considered to be negligible. However, where the London Clay Formation has been removed and replaced with more permeable artificial ground, there may be increased potential of elevated water levels as groundwater becomes trapped in these deposits.
Groundwater Springs	It is possible groundwater springs could emerge from permeable superficial deposits and flow over the London Clay Formation, resulting in groundwater flooding. This mechanism may cause the regular ponding observed adjacent to drainage on Canvey Island, where groundwater seepages from the River Terrace Deposits seep onto the relatively impermeable Tidal Flat Deposits.

3.3.3 Groundwater Risk Assessment Conclusions

Based on the Groundwater Assessment undertaken as part of this SWMP (Appendix A3), the following conclusions can be drawn.

- No groundwater flooding incidents within the study area have been reported to the Environment Agency.
- The significant thickness of London Clay Formation hydraulically separates the underlying Chalk principal aquifer and Lower London Tertiaries from the overlying Claygate Member, Bagshot Formation and superficial deposits. Therefore, the Chalk aquifer and Lower London Tertiaries are not pertinent to the SWMP.
- The River Terrace Deposits are expected to form a significant perched aquifer over the London Clay Formation aquiclude across much of Rochford District Council. Localised areas within the Head deposits in western Rochford District Council and Basildon Borough

Council will behave as aquifers. The Environment Agency and the respective councils do not currently monitor groundwater levels in these superficial deposits.

- The Claygate Member and Bagshot Formation may also act as local aquifers. However, there is no monitoring of these units by the Environment Agency or the South Essex Councils.
- A number of potential groundwater flooding mechanisms have been identified. Of significance are:
    - those flooding mechanisms associated with the superficial aquifers and their hydraulic continuity with surface watercourses and Thames Estuary tidal fluctuations; and,
    - response of groundwater levels within the Claygate Member and Bagshot Formation to increased use of infiltration SuDS, leaking pipes and barriers to groundwater flow such as sheet piling. Properties at most risk are those with basements / cellars, and areas where these properties are likely to exist can be identified through an assessment of historic stages of building development.
- Those areas identified as having no susceptibility to groundwater flooding may still be affected where groundwater springs / seepages from adjacent aquifers form minor flows and ponding over impermeable strata such as the London Clay Formation. This mechanism may have resulted in the regular ponding of water observed adjacent to drainage on Canvey Island, where groundwater seepages from the River Terrace Deposits may seep onto the relatively impermeable Tidal Flat Deposits.
- The Environment Agency and Councils do not currently monitor groundwater levels in the aquifers that outcrop in this area. Therefore, at this stage, the assessment of groundwater flood risk and advice on suitability for infiltration SuDS is preliminary. Ground investigations and groundwater risk assessments should be carried out for all proposed developments.

3.4 Sewer Flooding

3.4.1 Mechanism of Flooding

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

1. The rainfall event exceeds the capacity of the sewer system / drainage system.

Since the late 1970s, and with the publication of Sewers for Adoption[5] in 1980, sewer systems have typically been designed and constructed to accommodate a rainfall event with a 1 in 30 probability of occurrence in any given year (3.3%) or less. Therefore, rainfall events with a rainfall probability of greater than 3.3% AEP would be expected to result in surcharging of some of the sewer system. While Anglian Water is concerned about the frequency of extreme events, it is not economically viable to build sewers that could cope with every extreme. South Essex is served by a separate foul and surface water system.

2. The system becomes blocked by debris or sediment.

Over time there is potential for road gullies to become blocked from fallen leaves, build up of sediment and debris (e.g. litter).

[5] The Sewers for Adoption guide was first issued in 1980 by WRc. Since then the document has become the standard for the design and construction of sewers to adoptable standards in England and Wales. It acts as a guide to assist developers in preparing their submission to a sewerage undertaker before they enter into an Adoption Agreement under Section 104 of the Water Industry Act 1991

3. The system surcharges due to high water levels in receiving watercourses.

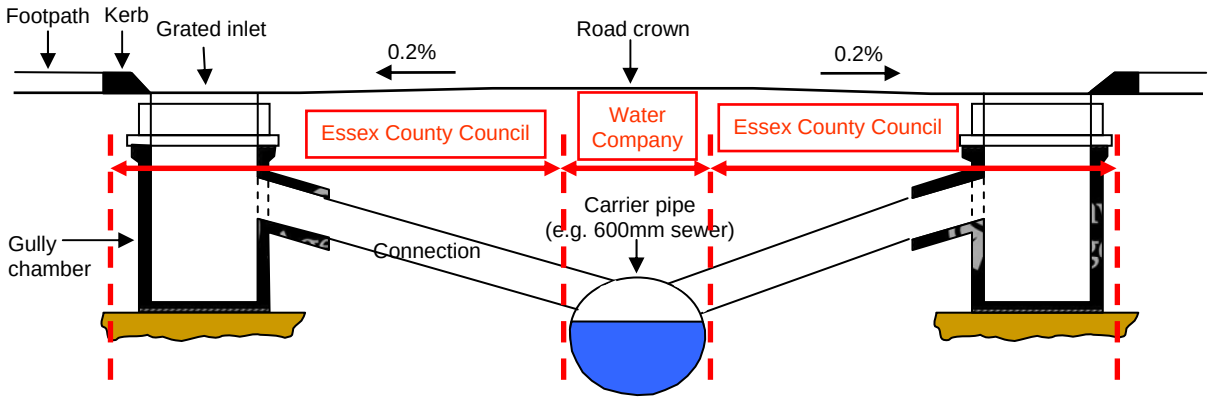
There is potential for sewer outfalls to rivers to become submerged during high water levels (either fluvial or tidal). When this happens, water is unable to discharge into the river and flows back up along the sewer. Once storage capacity within the sewer itself is exceeded, the water will overflow into streets and houses through manholes (surcharging).

3.4.2 Responsible Organisations

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:

- Essex County Council (as the Highways Authority); and,
- Water Utility Company (Anglian Water).

Figure 3-1: Surface Water Drainage Responsibility



As illustrated in Figure 3-1, Essex County Council, 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 water company, 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 effectually drainage the area.

Riparian owners are responsible for private drainage networks and receiving watercourses where they are small open channels and culverted urban watercourses.

In addition to the Anglian Water network, there are also some sewers and drains which are in private ownership. Most of these private systems connect to the Anglian Water public sewerage system for treatment; however private owners can also connect foul water to septic tanks and storm water to soakaways.

3.4.3 Anglian Water Data

3.4.3.1 DG5 Register

Sewer flooding events were identified using data from the Anglian Water DG5 Register. The Register only contains properties and areas at risk of internal and external flooding if they have suffered flooding from public sewers due to overloading of the system. A sewer is overloaded when the flow from a storm is unable to pass through it due to a permanent problem (e.g. small pipe, flat gradient). The Register does not include properties or areas flooded due to temporary operational problems, e.g. blockage, siltation, collapse, equipment failure or operational failure.

3.4.3.2 Sewer Network

Anglian Water has also provided details of their utility infrastructure including sewers, pumping stations and outfalls. This information has been overlaid onto CDAs to inform potential mitigation options for each location. Anglian Water is keen to work with Councils in order to mitigate flood risk issues.

3.4.4 Other Influences

The Environment Agency has responsibility for flooding from designated Main Rivers and the sea, and flooding from these sources has been further assessed as part of the previously completed Level 1 Strategic Flood Risk Assessment for Basildon Borough Council and Level 1 and 2 Strategic Flood Risk Assessments for Castle Point Borough Council and Rochford District Council.

4. Critical Drainage Areas

The intermediate assessment was used to identify areas where the flood risk is considered to be most severe; these are known 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 a CDA. In spatially defining the CDA, the following have been taken into account:

- flood depth and extent – CDAs have been defined by looking at areas within the study area which are predicted to suffer from deep levels of flooding;
- surface water flow paths and velocities – overland flow paths and velocities have also been considered when defining CDAs;
- flood hazard[6] – a function of flood depth and velocity, the flood hazard ratings across the study area have been produced and also used to define CDAs (outlined in more detail in Appendix A3);
- 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 groundwater assessment (Appendix A2) 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 have been considered when defining the CDA.

Through this agreed methodology, 37 CDAs have been identified within the South Essex study area: 22 within Basildon Borough Council, six within Castle Point Borough Council and nine within Rochford District Council.

4.1 Potential Surface Water Flooding Hotspots

Within each CDA, Potential Surface Water Flooding Hotspots (PSWFH) have also been defined based on where the flooding has the potential to be deepest and the most receptors affected. The working definition of a PSWFH in this context has been agreed as:

"A discrete area of deep flooding that affects houses, businesses or infrastructure".

[6] The hydraulic model has also been used to assess flood hazard, based on the Flood Hazard Rating defined in DEFRA Flood Risks to People FD2321/Tr1, 2005

The PSWFH represents the key area at greatest risk of surface water flooding, contributed to by the wider CDA.

4.2 Property Count

In order to provide a quantitative indication of potential risks, a count of properties affected by surface water flooding has been undertaken for the 1% AEP rainfall event across South Essex. This has been undertaken using the Environment Agency's National Receptors Dataset (NRD) and follows the methodology set out in the Modelling Report (Appendix A2). The property counts have been undertaken for the following scenarios:

- those buildings where the average depth of flooding across the building footprint is greater than 0.1m;
- those buildings where the average depth of flooding across the building footprint is greater than 0.3m; and,
- those buildings where the average depth of flooding across the building footprint is greater than 0.5m.

To provide an indication of the spatial flood risk across South Essex, a property count has been undertaken for each of the CDAs for the 1% AEP rainfall event. These values are included in the following sections for each CDA.

4.3 Shortlisting

A large number of potential CDAs were identified in the process of modelling and mapping surface water flood risk in South Essex. Therefore, in order to focus on the key flood risk areas to develop and present options for in Phase 3, the CDAs have been shortlisted (Table 4-1) based on the following:

- the frequency of historical flooding within the CDA and PSWFH;
- the potential risk of groundwater flooding within the CDA;
- the frequency of sewer flooding incidents within the CDA or PSFWH;
- the presence of critical infrastructure at risk within the PSWFH;
- whether significant future development is likely which could exacerbate surface water flooding; and,
- the number of buildings and residential properties flooded at a depth greater than 0.3m within the CDA.

Based on the criteria above, it was agreed by the SWMP Working Group that only the most significant CDAs (23 in total), would be assessed further and hence taken forward into a Phase 3 Options Assessment.

The other CDAs (highlighted in yellow in Table 4-1) are reported for information and completeness in this Phase 2 section of the SWMP to highlight the potential surface water flooding issues, which although have less risk to people and property, may have more of a significant impact to relevant infrastructure stakeholders in South Essex (in particular Network Rail and the Highways Authority).

Table 4-1: Shortlisted CDAs

CDA Number	CDA Name	CDA Area (km2)	PSWFH Area (km2)	Number of buildings flooded at greater than 0.3m deep, footprint greater 25m2	Number of residential buildings flooded at greater than 0.3m deep, footprint greater 25m2	Critical Infrastructure PSWFH	Historical Flooding		DG5 Incident CDA/PSWFH	Groundwater Flooding	Significant Development Proposed in CDA
							CDA	PSWFH			
CAS 1	South Benfleet	4.99	0.78	39	25	Pumping Station, Hospital/Nursing Home, Road	Yes	Yes	Yes	No	No
ROC 4	Hockley	2.47	0.28	19	19	School	Yes	Yes	Yes	No	Yes
CAS 2	New Thundersley	3.56	0.85	19	18	Pumping Station, School	Yes	Yes	Yes	No	No
CAS 4	Hadleigh	0.92		1	1	No	Yes	No	Yes	No	Yes
BAS 12	Kingswood/Dry Street	3.91	0.51	44	18	Hospital	Yes	Yes	No	No	Yes
BAS 3	Stock Road	1.83	0.19	46	44	Pumping Station	No	Yes	Yes	No	No
ROC 2	Watery Lane	7.22	0.63	26	4	Pumping Station	Yes	Yes	No	No	Yes
ROC 9	Little/Great Wakering	2.67				Schools	Yes	No	Yes	No	Yes
BAS 17	Pitsea	1.20	0.13	8	2	No	No	Yes	Yes	No	Yes
BAS 1	North West Billericay	1.74	0.23	42	35	No	Yes	Yes	No	No	No
ROC 7	Ashingdon/Rochford	4.94	0.44	108	69	No	No	Yes	No	No	Yes
BAS 16	Bowers Gifford	3.32	0.36	11	8	No	No	Yes	No	No	No
ROC 8	Great Stambridge	7.12	0.19	13	3	No	No	Yes	No	No	Yes
BAS 14	Barstable/Fryerns	5.04	0.22	127	115	School	Yes	No	No	No	Yes
BAS 21	Bromfords	1.80	0.27	407	393	Pumping Station, School	Yes	No	No	No	No
BAS 15	Chalvedon/Felmore	1.88	0.33	20	17	School x2	Yes	No	No	No	Yes
BAS 4	Sunnymede	1.46	0.28	54	42	No	Yes	No	No	No	No
BAS 8	Laindon	2.00	0.40	82	75	No	Yes	No	No	No	Yes
CAS 3	East Thundersley	3.57	0.28	37	36	No	Yes	No	No	No	Yes
ROC 1	Rayleigh West	3.30	0.85	61	59	School	No	No	Yes	No	No
ROC 6	Rayleigh East	2.72	0.23	30	30	School	No	No	Yes	No	No
CAS 6	Canvey Island	7.60		2	2	No	Yes	No	Yes	No	Yes
BAS 22	Cranfield Park Road	0.85	0.25	186	180	No	No	No	No	No	No
BAS 10	Lee Chapel North/Langdon Hills	3.70	0.45	31	25	Railway Station	No	No	No	No	No
BAS 5	South Green	1.00	0.15	2	0	School	No	No	No	No	No
ROC 3	Lower Hockley/Dome Country Club	0.83	0.08	7	6	No	No	No	No	No	No
BAS 18	Vange	0.94	0.09	42	41	No	No	No	No	No	No
BAS 11	Lee Chapel South/St Martin's	2.18	0.37	48	43	No	No	No	No	No	Yes
BAS 6	Southfields	2.62	0.60	6	4	No	No	No	No	No	No
ROC 5	Hockley Woods	3.00	0.15	1	1	No	No	No	No	No	No
BAS 20	Wickford Town Centre	0.09	0.01	12	0	Road under Railway Line				No	Yes
BAS 2	Railway Cutting Billericay			16	2	Railway Line				No	No
BAS 7	Railway Cutting Laindon			0	0	Railway Line				No	No
BAS 9	A127-A126 Junction			8	0	Road				No	No
BAS 13	Railway Cutting Barstable			1	0	Railway Line				No	No
BAS 19	Railway Line Vange			0	0	Railway Line				No	No
CAS 5	A129-A127 Roundabout			8	0	Road				No	No

4.4 Mapping Outputs

Two maps for each CDA have been prepared which show the surface water depth and surface water flood hazard rating (and general flow direction) during the rainfall 1% AEP rainfall event.

- Basildon Borough Council – Appendix B: Figure B 19 – Figure B 62
- Castle Point Borough Council – Appendix C: Figure C 19 – Figure C 30
- Rochford District Council – Appendix D: Figure D 19 – Figure D 35

The surface water flood risk for each CDA is discussed in further detail for each Borough/District in Part B of this Phase 2 section of the SWMP.

5. Communicating Risk

5.1 Professional Stakeholders

There are various professional stakeholders interested in increasing their knowledge of risks from surface water flooding. It is essential that the SWMP partnership actively engages with these groups, where appropriate, to share the findings of this report. This will ensure that emerging plans and policies are informed by the latest evidence contributing to an improved understanding of surface water flood risk issues.

5.2 Local Resilience Forums

In line with the SWMP Technical Guidance it is strongly recommended that the information provided in the Phase 2 SWMP is issued to the Local Resilience Forum. Surface water flood maps and knowledge of historic flood events should be used to update Incident Management Plans, Community Risk Registers and Multi-Agency Flood Plans for the area. It is recommended that the results of the intermediate pluvial modelling are used to identify likely flow-paths and locations of ponding of surface water. This information can be used in parallel with the Extreme Rainfall Alert (ERA) service provided by the Flood Forecasting Centre[7]. In addition, the maps showing the depth of pluvial flooding during a range of return period rainfall events can be used to inform operations undertaken by emergency response teams especially near public buildings and major routes through South Essex.

5.3 Communication and Engagement Plan

During the completion of this SWMP, findings of the Phase 2 (Risk Assessment) and Phase 3 (Options Assessment) have been presented and discussed with key stakeholders and elected members of each of the partner authorities. However, it is recommended that an ongoing Communication and Engagement Plan be produced for Basildon Borough Council, Castle Point Borough Council and Rochford District Council, in conjunction with Essex County Council (as LLFA) to effectively communicate and raise awareness of surface water flood risk to different audiences using a clearly defined process for internal and external communication with stakeholders and the public. Examples and options are presented in the Phase 1 Communications Plan reported in the Phase 1 SWMP report.

The ongoing Communications and Engagement Plan should:

- develop clear key messages from the SWMP relating to local surface water flood risk and management;
- create simplified maps and meaningful data for communications materials using outputs from the Phase 2 and Phase 3 SWMP;
- clearly define a structure for internal and external (multi-agency) partnership working (based on the partnership structure identified in Phase 1 of the SWMP); and,
- provide a strategy for communicating the SWMP findings to political stakeholders, local resilience forum members, Regional Flood and Coastal Defence Committee members and the general public and engaging these parties in future local flood risk management actions.

[7] The Flood Forecasting Centre was set up in 2008 by the Met Office and the Environment Agency to provide services to emergency and professional partners.

Part B: Flood Risk

6. Basildon Borough Council

6.1 Surface Water Flooding

6.1.1 Historic Flooding

Historical surface water flooding data collected as part of the Essex Preliminary Flood Risk Assessment (PFRA) has been used, which was collected from Basildon Borough Council, the Essex Fire and Rescue Service, Parish Councils and the Highways Agency. However, for all but the Fire and Rescue Service records, only the location of the flooding incident has been recorded and not necessarily the source. Overall, these sources amount to 42 recorded flood events. These records are shown in Figure B 5.

It should be noted that historically, only major flooding incidents have been recorded and in many cases the historic flooding information provided is anecdotal and does not include records of antecedent conditions giving rise to the flooding (therefore typically not attributed to a flood source), reference to a flood return period, or in some cases a date.

Table 6-1 provides a summary of past flood incidents in the Basildon Borough Council and those areas prone to surface water flooding during periods of heavy rainfall based on historical records collected.

Table 6-1: Summary of Past Surface Water Flood Events in Basildon Borough Council (where the source of flooding is unknown this has been indicated

Flood Event	Description
January 2003	Flood record in Billericay (South Essex Catchment Flood Management Plan) Flood record in Crays Hill (South Essex Catchment Flood Management Plan) Flood record in Basildon (South Essex Catchment Flood Management Plan)
15th June 2009	A significant number of flooding incidents (Fire Records) throughout Basildon, Billericay and Wickford, but the source is not known.
22nd February 2010	Flooding incidents (Fire Records) around Basildon and Wickford, but the source is not known.
18th January 2011	Flooding incidents occurred throughout the Borough, particularly along Mountnessing Road (Basildon), High Street (Billericay), Pound Lane (Basildon) and the A127/A130 Roundabout.

6.2 Ordinary Watercourses

Figure B 4 shows the Main Rivers and ordinary watercourses that are located within Basildon Borough Council and Table 6-2 provides a list of these. There are also a number of un-named ditches which have also been identified.

Table 6-2: Watercourses in Basildon Borough Council

Watercourse (name or location if un-named)	Classification	Owner / Maintainer
River Wid	Main River	Environment Agency
Mountnessing Brook	Main River	Environment Agency
Dunton Brook	Main River	Environment Agency
River Crouch	Main River	Environment Agency
Basildon Brook	Main River	Environment Agency

Watercourse (name or location if un-named)	Classification	Owner / Maintainer
Jolly Cricketers Ditch	Main River	Environment Agency
Nevendon Bushes Brook	Main River	Environment Agency
Nevendon Brook	Main River	Environment Agency
Wick Crescent Ditch	Main River	Environment Agency
North Benfleet Brook	Main River	Environment Agency
Pound Lane Ditch, Bowers Gifford	Ordinary Watercourse / Drainage Ditch	
Gardiners Lane South to East Mayne, Basildon	Drainage Ditch	
Courtauld Road to Southend Arterial Rd A127, Basildon	Drainage Ditch	
Cricketers Way to Courtauld Road, Basildon	Drainage Ditch	
Tye Common Road junction to Wiggins Lane (North), Billericay	Drainage Ditch	
Lincewood Park Drive to Berry Lane, Langdon Hills	Drainage Ditch	
Tye Common Road near Broomhills Chase, Little Burstead	Drainage Ditch	
Rear of 22 to 32 The Meadow Way, Billericay	Drainage Ditch	
Frithwood Ditch, Billericay	Drainage Ditch	
Open Ditch Near St Agnes Road, Billericay	Drainage Ditch	

6.3 Groundwater Flooding

6.3.1 Historic Flooding

There are no records of groundwater flooding incidents in Basildon Borough Council that have been reported to the Environment Agency. The records provided by Basildon Council, Essex Fire and Rescue Service and Parish Councils do also not include any groundwater flooding incidents.

Higher risk areas which are susceptibility to groundwater flooding are often associated where Head Deposits, River Terrace Deposits and Marine Alluvium Sands are present at surface. There are notable areas along the River Crouch and its tributaries. These areas coincide with areas of high permeability and ground elevations are low.

More information on groundwater flood risk generally is presented in Section 3.3 and Appendix A3.

6.4 Sewer Flooding

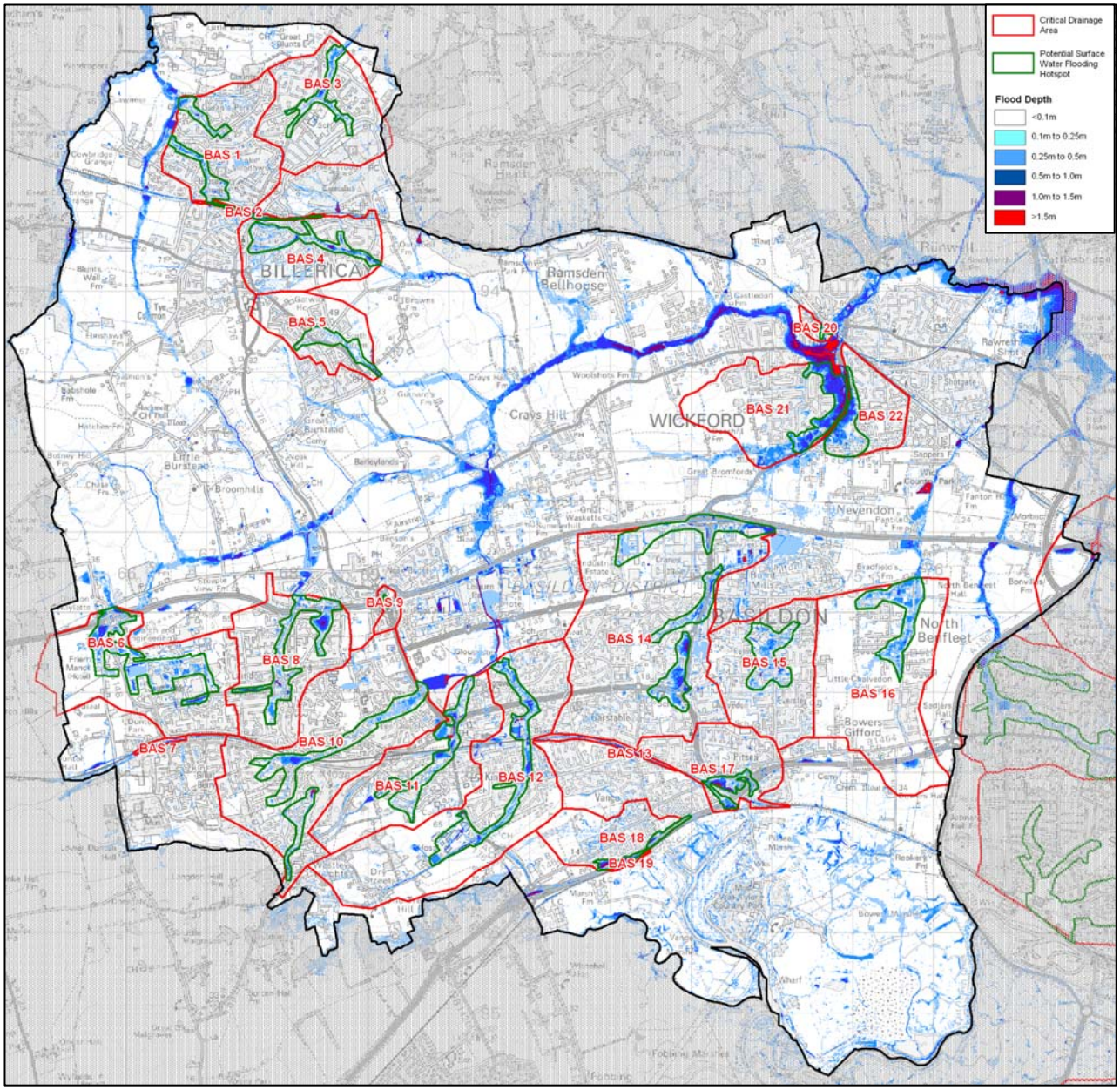
6.4.1 DG5 Register

According to Anglian Water's DG5 database, 34 sewer flooding incidents occurred between 2000 and 2010 (Figure B 5) in Basildon Borough Council. 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.

6.5 Critical Drainage Area

In total 22 CDAs have been defined and are discussed and presented in more detail in the subsequent sections of this SWMP report. Eleven of these CDAs have been shortlisted for further assessment in Phase 3. In order to quantify the risk across the CDAs an assessment has been carried out to determine the number of properties and critical infrastructure at risk from surface water flooding during an extreme event.

Figure 6-1: Identified CDAs within the Basildon Borough Council



CDA Name:	***BAS 1: North West Billericay***
Flood Risk Categorisation:	Surface Water and Sewer
Description:	• Surface water generally flows from east to west across the CDA, towards a tributary of the River Wid, close to Mountnessing Road. Two PSWFH have been identified in the CDA around Gooseberry Green and Queen's Park.
Critical Infrastructure:	• St. Johns School, Brightside Primary School, Part of Buttsbury Junior School
Significant Development Proposed:	• No
Property Count:	• 428 buildings of which 317 are residential properties flood to a depth >0.1m • 42 buildings of which 35 are residential properties flood to a depth >0.3m • 2 buildings of which 1 is a residential property flood to a depth >0.5m
Potential Surface Water Flooding Hotspots:	• Gooseberry Green – pluvial modelling indicates that surface water flows from Radford Business Centre north and ponding between Ian Road and Upland Road. There is a record of flooding in Mountnessing Road. • Queen's Park – pluvial modelling indicates that surface water flows originate between Queens Park and York Road and then flows north-west towards Betony Close, where it ponds (to a maximum depth of approximately 0.6m (during the 1% AEP rainfall event). There are two Fire Service records of flooding in 2009 in Carlyle Gardens.
Validation:	• There are historical records of surface water flooding at Lake Meadows in Radford Crescent, Mountnessing Road, Perry Street and Carlyle Gardens. • There are no records of sewer flooding within the CDA or PWSFH.
Short listed to Phase 3:	• The CDA has been short listed and taken forward to Phase 3.
Figures:	Figure B 19 – Surface Water Flood Depth (1% AEP) Figure B 20 – Surface Water Flood Hazard (1% AEP)

Radford Business Centre

Mallow Gardens

CDA Name:	***BAS 2: Railway Cutting Billericay***
Flood Risk Categorisation:	Surface Water
Description:	• Surface water ponds along the railway line, due to the steep embankments either side of the line, which create a topographic hollow, trapping water which flows into it from the surrounding higher land.
Critical Infrastructure:	• Railway Line and Billericay Train Station
Significant Development Proposed:	• No
Property Count:	• 22 buildings of which 3 are residential properties flood to a depth >0.1m • 16 buildings of which 2 are residential properties flood to a depth >0.3m • 4 buildings of which 0 are residential properties flood to a depth >0.5m
Validation:	• There are no historical records of surface water flooding.
Short listed to Phase 3:	• The CDA has not been short listed but is presented in Phase 2 for information to interested stakeholders.
Figures:	Figure B 21 – Surface Water Flood Depth (1% AEP) Figure B 22 – Surface Water Flood Hazard (1% AEP)

CDA Name:	***BAS 3: Stock Road***
Flood Risk Categorisation:	Surface Water and Sewer
Description:	• Surface water generally flows from the south to the north of the CDA. One PSWFH have been identified in the CDA. A significant amount of surface water ponding occurs to the east of Stock Road as a result of the local topography. The predicted flooding follows the route of a culverted watercourse which forms part of the surface water drainage system.
Critical Infrastructure:	• Mayflower Secondary School, Buttsbury Infant and Junior School • Pumping Station
Significant Development Proposed:	• No
Property Count:	• 278 buildings of which 226 are residential properties flood to a depth >0.1m • 46 buildings of which 44 are residential properties flood to a depth >0.3m • 0 buildings flood to a depth >0.5m
Potential Surface Water Flooding Hotspots:	• Pluvial modelling indicates that surface water flows are generated from Stock Road and Newlands Road and also along Mercer Road to the east of the CDA. The two flow paths converge to the east of Stock Road and flow north.
Validation:	• There are historical records of surface water flooding along Stock Road and Perry Street. • There are also sewer flooding records along Perry Street, Broome Road and Graham Close.
Short listed to Phase 3:	• The CDA has been short listed and taken forward to Phase 3.
Figures:	Figure B 23 – Surface Water Flood Depth (1% AEP) Figure B 24 – Surface Water Flood Hazard (1% AEP)

Brookside

Mayflower High School Playing Fields

CDA Name:	***BAS 4: Sunnymede***
Flood Risk Categorisation:	Surface Water and Ordinary Watercourse
Description:	• Surface water generally flows from the west to the east. One PSWFH have been identified in the CDA. A significant amount of surface water ponding occurs at the roundabout of Valley Road, Meadow Rise and Jacksons Lane, and between Thynne Road and The Meadow Way, as a result of the local topography. • An un-named ordinary watercourse flows through the CDA.
Critical Infrastructure:	• Sunnymede Infant and Junior School
Significant Development Proposed:	• No
Property Count:	• 692 buildings of which 599 are residential properties flood to a depth >0.1m • 54 buildings of which 42 are residential properties flood to a depth >0.3m • 22 buildings of which 21 are residential properties flood to a depth >0.5m
Potential Surface Water Flooding Hotspots:	• Pluvial modelling indicates that surface water flows are generated from four areas: Crown Road, Chantry Way, Chapel Close and Mill Meadows Nature Reserve. These all connect to the un-named ordinary watercourse which flows from west to east.
Validation:	• There are no records of historical flooding within the CDA.
Shortlisted to Phase 3:	• The CDA has been shortlisted and taken forward to Phase 3.
Figures:	Figure B 25 – Surface Water Flood Depth (1% AEP) Figure B 26 – Surface Water Flood Hazard (1% AEP)

Outwood Common (looking east)

Meadow Rise (looking east)

CDA Name:	***BAS 5: South Green***
Flood Risk Categorisation:	Surface Water and Ordinary Watercourse
Description:	• Surface water generally flows from the north-west to the south-east of the CDA. One PSWFH has been identified in the CDA. • An un-named ordinary watercourse flows through the CDA.
Critical Infrastructure:	• South Green Infant and Junior School, St. Peters RC Primary School, Part of The Billericay School
Significant Development Proposed:	• No
Property Count:	• 96 buildings of which 86 are residential properties flood to a depth >0.1m • 2 buildings of which 0 are residential properties flood to a depth >0.3m • 0 buildings flood to a depth >0.5m
Potential Surface Water Flooding Hotspots:	• Pluvial modelling indicates that surface water flooding follows the course of the open ordinary watercourse.
Validation:	• There are no historical records of surface water flooding.
Shortlisted to Phase 3:	• The CDA has not been shortlisted but is presented in Phase 2 for information.
Figures:	Figure B 27 – Surface Water Flood Depth (1% AEP) Figure B 28 – Surface Water Flood Hazard (1% AEP)

Coxes Farm Road (looking south-west)

Watercourse (Coxes Farm Road) (looking north)

CDA Name:	***BAS 6: Southfields***
Flood Risk Categorisation:	Surface Water
Description:	• Surface water flows from two different areas: the south-west to the north-east resulting in ponding around the A127- West Mayne (B148) junction and from Victoria Park towards the Southfields Business Park. There are many drainage ditches within the CDA. • Southfields Washland is also located in this CDA
Critical Infrastructure:	• Merrylands Primary School
Significant Development Proposed:	• No
Property Count:	• 51 buildings of which 21 are residential properties flood to a depth >0.1m • 6 buildings of which 4 are residential properties flood to a depth >0.3m • 0 buildings flood to a depth >0.5m
Potential Surface Water Flooding Hotspots:	• Pluvial modelling indicates that surface water ponding occurs around Southfields Business Park and around the A127-West Mayne (B148) junction.
Validation:	• There are no historical records of surface water flooding.
Shortlisted to Phase 3:	• The CDA has not been shortlisted but is presented in Phase 2 for information.
Figures:	Figure B 29 – Surface Water Flood Depth (1% AEP) Figure B 30 – Surface Water Flood Hazard (1% AEP)

Southfield Business Centre

CDA Name:	***BAS 7: Railway Cutting Laindon***
Flood Risk Categorisation:	Surface Water
Description:	• Surface water ponds along the railway line, due to the steep embankments either side of the line, which create a topographic hollow, trapping water which flows into it from the surrounding higher land.
Critical Infrastructure:	• Railway Line
Significant Development Proposed:	• No
Property Count:	• 0 buildings flood to a depth >0.1m • 0 buildings flood to a depth >0.3m • 0 buildings flood to a depth >0.5m
Validation:	• There are no historical records of surface water flooding.
Short listed to Phase 3:	• The CDA has not been short listed but is presented in Phase 2 for information to interested stakeholders.
Figures:	Figure B 31 – Surface Water Flood Depth (1% AEP) Figure B 32 – Surface Water Flood Hazard (1% AEP)

CDA Name:	***BAS 8: Laindon***
Flood Risk Categorisation:	Surface Water
Description:	• Surface water generally flows from the south to the north of the CDA. One PSWFH has been identified in the CDA.
Critical Infrastructure:	• Laindon Police Station • Millhouse Junior School, Part of Merrylands Primary School
Significant Development Proposed:	• Yes
Property Count:	• 461 buildings of which 391 are residential properties flood to a depth >0.1m • 82 buildings of which 75 are residential properties flood to a depth >0.3m • 23 buildings of which 21 are residential properties flood to a depth >0.5m
Potential Surface Water Flooding Hotspots:	• Pluvial modelling indicates surface water flooding along High Road, and surface water flows from St. Nicholas Lane feeding into The Paddocks Recreation Ground.
Validation:	• There is one historical flood record along Pound Lane. • There are no sewer flooding records.
Short listed to Phase 3:	• The CDA has been shortlisted and taken forward to Phase 3.
Figures:	Figure B 33 – Surface Water Flood Depth (1% AEP) Figure B 34 – Surface Water Flood Hazard (1% AEP)

Basildon Drive

The Paddocks Recreational Ground (looking north)

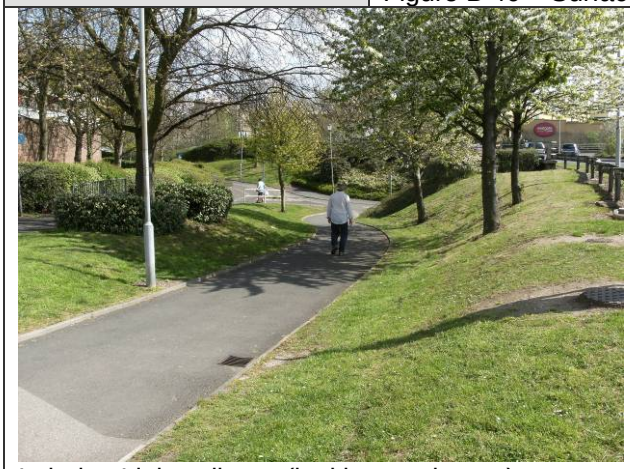
CDA Name:	***BAS 9: A127-A126 Junction***
Flood Risk Categorisation:	Surface Water
Description:	• Surface water ponds on the A176 as it passes under the A127, due to the steep embankments around the road network.
Critical Infrastructure:	• Key Transport Route
Significant Development Proposed:	• No
Property Count:	• 0 buildings flood to a depth >0.1m • 0 buildings flood to a depth >0.3m • 0 buildings flood to a depth >0.5m
Validation:	• There are no historical records of surface water flooding.
Shortlisted to Phase 3:	• The CDA has not been shortlisted but is presented in Phase 2 for information to interested stakeholders.
Figures:	Figure B 35 – Surface Water Flood Depth (1% AEP) Figure B 36 – Surface Water Flood Hazard (1% AEP)

CDA Name:	***BAS 10: Lee Chapel North / Landon Hills***
Flood Risk Categorisation:	Surface Water
Description:	• Surface water generally flows from the south-west to the east of the CDA, towards Gloucester Park Fishing Lake. Two PSWFH have been identified in the CDA. The Langdon Hills and Marks Hill Nature Reserves are located to the South of the CDA.
Critical Infrastructure:	• Lincewood Primary School, St Anne Line RC Primary School, Janet Duke Primary School, Phoenix Primary School, James Hornsby High School • Laindon Railway Station
Significant Development Proposed:	• No
Property Count:	• 826 buildings of which 745 are residential properties flood to a depth >0.1m • 31 buildings of which 25 are residential properties flood to a depth >0.3m • 0 buildings flood to a depth >0.5m
Validation:	• There are no records of surface water flooding.
Potential Surface Water Flooding Hotspots:	• Pluvial modelling indicates a significant amount of surface water ponding occurs around the junction of Mandeville Way and Florence Way and along Great Knightleys as a result of the local topography
Short listed to Phase 3:	• The CDA has not been short listed but is presented in Phase 2 for information.
Figures:	Figure B 37 – Surface Water Flood Depth (1% AEP) Figure B 38 – Surface Water Flood Hazard (1% AEP)

Station Approach (looking north)

Station Approach (looking west)

CDA Name:	***BAS 11: Lee Chapel South / St. Martin's***
Flood Risk Categorisation:	Surface Water
Description:	• Surface water generally flows from the south-west to the north of the CDA, towards Gloucester Park Fishing Lake. One PSWFH has been identified in the CDA. • The Long Wood Washland, Fletchers Washland and Lee Chapel South Flood Relief Works are located in this CDA.
Critical Infrastructure:	• Lee Chapel Primary School, Woodlands School, Ghyllgrove Community Junior and Infant Schools • Basildon Police Station • Basildon Fire Station • Basildon Ambulance Station • Basildon Town Centre • Basildon Railway Station
Significant Development Proposed:	• Yes
Property Count:	• 268 buildings of which 230 are residential properties flood to a depth >0.1m • 48 buildings of which 43 are residential properties flood to a depth >0.3m • 5 residential properties flood to a depth >0.5m
Validation:	• There are no records of surface water flooding.
Potential Surface Water Flooding Hotspots:	• Pluvial modelling indicates that surface water ponding / flows are generated in the north along The Knares and Sporhams and also around Cressells in the west of the CDA.
Shortlisted to Phase 3:	• The CDA has been not been shortlisted but is presented in Phase 2 for information to interested stakeholders.
Figures:	Figure B 39 – Surface Water Flood Depth (1% AEP) Figure B 40 – Surface Water Flood Hazard (1% AEP)



Laindon Link walkway (looking north-east)

Laindon Link (looking south-west)

CDA Name:	***BAS 12: Kingswood / Dry Street***
Flood Risk Categorisation:	Surface Water
Description:	• Surface water generally flows from the south-west to the north of the CDA, towards Gloucester Park and the Basildon Brook. One PSWFH has been identified in the CDA. • There are 4 Washlands within the CDA – Hospital, Wootens, Dry Street and Kingswood.
Critical Infrastructure:	• Basildon & Thurrock University Hospital • Basildon Railway Station • Police, Fire and Ambulance Stations (western boundary of CDA) • Kingswood Infant and Junior School, The Willows Primary School, Part of Woodlands School
Significant Development Proposed:	• Yes
Property Count:	• 395 buildings of which 317 are residential properties flood to a depth >0.1m • 44 buildings of which 18 are residential properties flood to a depth >0.3m • 13 buildings of which 1 is a residential property flood to a depth >0.5m
Validation:	• There are historical records of surface water flooding along Clay Hill Road. • There are no sewer flooding records.
Potential Surface Water Flooding Hotspots:	• Pluvial modelling indicates that surface water flows are generated from Dry Street and along Sparrows Herne towards Kingwood Washland. Surface water ponding occurs around Tinkler Side and Ghyllgrove.
Shortlisted to Phase 3:	• The CDA has been shortlisted and taken forward to Phase 3.
Figures:	Figure B 41 – Surface Water Flood Depth (1% AEP) Figure B 42 – Surface Water Flood Hazard (1% AEP)

Kingswood Washland (looking north)

Old Ordinary Watercourse in Kingswood Washland

CDA Name:	***BAS 13: Railway Cutting Barstable***
Flood Risk Categorisation:	Surface Water
Description:	• Surface water ponds along the railway line, due to the steep embankments either side of the line, which create a topographic hollow, trapping water which flows into it from the surrounding higher land.
Critical Infrastructure:	• Railway Line
Significant Development Proposed:	• No
Property Count:	• 0 buildings flood to a depth >0.1m • 0 buildings flood to a depth >0.3m • 0 buildings flood to a depth >0.5m
Validation:	• There are no historical records of surface water flooding.
Shortlisted to Phase 3:	• The CDA has not been shortlisted but is presented in Phase 2 for information to interested stakeholders.
Figures:	Figure B 43 – Surface Water Flood Depth (1% AEP) Figure B 44 – Surface Water Flood Hazard (1% AEP)

CDA Name:	***BAS 14: Barstable-Fryerns***
Flood Risk Categorisation:	Surface Water
Description:	• Surface water generally flows from south-west to the north-east. A significant amount of surface water ponding occurs within the Fryerns neighbourhood to the west of the East Mayne (A132). • There are 3 Washlands within the CDA – Northlands Park, Pinehurst, Ford's Park
Critical Infrastructure:	• St Teresa's RC Primary School, Greensted Infant and Junior School, Fairhouse Community Infant and Junior School, The Basildon Lower Academy, Whitmore Infant and Junior School • Basildon Sewage Treatment Works
Significant Development Proposed:	• Yes
Property Count:	• 539 buildings of which 439 are residential properties flood to a depth >0.1m • 127 buildings of which 115 are residential properties flood to a depth >0.3m • 39 buildings of which 33 are residential properties flood to a depth >0.5m
Validation:	• There are historical records of surface water flooding along Curling Tye and Cranes Farm Road. • There are no sewer flooding records.
Potential Surface Water Flooding Hotspots:	• Pluvial modelling indicates that surface water ponding is significant on the eastern boundary of the Fryerns neighbourhood. Surface water flows are generated in the south of the CDA in the Barstable neighbourhood.
Shortlisted to Phase 3:	• The CDA has been shortlisted and taken forward to Phase 3.
Figures:	Figure B 45 – Surface Water Flood Depth (1% AEP) Figure B 46 – Surface Water Flood Hazard (1% AEP)

Lincoln Road (looking south)

Northlands Washland (looking north)

CDA Name:	***BAS 15: Chalvedon-Felmores***
Flood Risk Categorisation:	Surface Water
Description:	• There are no specific surface water flows within the CDA with the majority of flooding due to accumulation and ponding in the generally low lying topography. One PSWFH has been identified in the CDA.
Critical Infrastructure:	• Northlands Infant and Junior School, Eversley Primary School, Briscoe Primary School, Felmore Primary School • Basildon Bail Hostel, Felmores
Significant Development Proposed:	• Yes
Property Count:	• 357 buildings of which 332 are residential properties flood to a depth >0.1m • 20 buildings of which 17 are residential properties flood to a depth >0.3m • 5 buildings of which 4 are residential properties flood to a depth >0.5m
Validation:	• There is a historical record of surface water flooding along Walthams. • There are no sewer flooding records within the CDA.
Potential Surface Water Flooding Hotspots:	• Pluvial modelling indicates that surface water ponding occurs in the centre of the CDA around Briscoe Road and Chalvedon Avenue.
Shortlisted to Phase 3:	• The CDA has been shortlisted and taken forward to Phase 3.
Figures:	Figure B 47 – Surface Water Flood Depth (1% AEP) Figure B 48 – Surface Water Flood Hazard (1% AEP)

CDA Name:	***BAS 16: Bowers Gifford***
Flood Risk Categorisation:	Surface Water, Drainage Ditches and Sewer
Description:	• Surface water flows from the south-west to the north of the CDA, towards North Benfleet Brook (which runs adjacent to Pound Lane). One PSWFH has been identified in the CDA. A significant amount of surface water ponding occurs to the west of Pound Lane, as a result of the local topography. • Part of the north of the CDA is within Flood Zone 2 and 3 of the North Benfleet Brook.
Critical Infrastructure:	• St Margaret C of E Primary School
Significant Development Proposed:	• Yes
Property Count:	• 82 buildings of which 47 are residential properties flood to a depth >0.1m • 11 buildings of which 8 are residential properties flood to a depth >0.3m • 0 buildings flood to a depth >0.5m
Validation:	• There are historical records of surface water flooding along Elm Road and Pound Lane. • There are also sewer flooding records along Elm Road.
Potential Surface Water Flooding Hotspots:	• Pluvial modelling indicates that surface water ponding occurs to the west of Pound Lane, between Katherine Road and Grange Road.
Shortlisted to Phase 3:	• The CDA has been shortlisted and taken forward to Phase 3.
Figures:	Figure B 49 – Surface Water Flood Depth (1% AEP) Figure B 50 – Surface Water Flood Hazard (1% AEP)

CDA Name:	***BAS 17: Pitsea***
Flood Risk Categorisation:	Surface Water and Sewer
Description:	• Surface water flows from the north-east to the south of the CDA, with significant ponding against the railway embankment. A significant amount of surface water ponding occurs in and around the Tesco Extra superstore under the East Mayne (A132). One PSWFH has been identified in the CDA.
Critical Infrastructure:	• Pitsea Infant and Junior School, The Basildon Upper Academy • Pitsea Police Station • Pitsea Railway Station / Railway Line
Significant Development Proposed:	• Yes
Property Count:	• 64 buildings of which 45 are residential properties flood to a depth >0.1m • 8 buildings of which 2 are residential properties flood to a depth >0.3m • 4 buildings of which 1 is a residential property flood to a depth >0.5m
Validation:	• There are historical records of surface water flooding along the A13 London Road Pitsea Bypass. • There are also sewer flooding records along Elm Green Road.
Potential Surface Water Flooding Hotspots:	• Pluvial modelling indicates that surface flows are generated in Pitsea Town Centre and flow towards the Tesco Extra Supermarket, ponding against the railway embankment.
Shortlisted to Phase 3:	• The CDA has been shortlisted and taken forward to Phase 3.
Figures:	Figure B 51 – Surface Water Flood Depth (1% AEP) Figure B 52 – Surface Water Flood Hazard (1% AEP)

Chestnut Road

Hazelmere (looking north-west behind Tesco Extra)

CDA Name:	***BAS 18: Vange***
Flood Risk Categorisation:	Surface Water
Description:	• Surface water generally flows from the north to the south of the CDA, with significant ponding against the A13 road embankment. One PSWFH has been identified in the CDA.
Critical Infrastructure:	• Ryedene Community Primary School, Vange Primary School
Significant Development Proposed:	• No
Property Count:	• 319 buildings of which 304 are residential properties flood to a depth >0.1m • 42 buildings of which 41are residential properties flood to a depth >0.3m • 26 residential properties flood to a depth >0.5m
Validation:	• There are no historical records of surface water flooding. • There are no sewer flooding records.
Potential Surface Water Flooding Hotspots:	• Pluvial modelling indicates that significant surface water ponding occurs as a result of the A13 road embankment, along Glenmere, Merricks Lane and Clover Way.
Shortlisted to Phase 3:	• The CDA has not been shortlisted but is presented in Phase 2 for information.
Figures:	Figure B 53 – Surface Water Flood Depth (1% AEP) Figure B 54 – Surface Water Flood Hazard (1% AEP)

Creek View (looking north)

CDA Name:	***BAS 19: Railway Cutting Vange***
Flood Risk Categorisation:	Surface Water
Description:	• Surface water ponds along the railway line, due to the steep embankments either side of the line, which create a topographic hollow, trapping water which flows into it from the surrounding higher land.
Critical Infrastructure:	• Railway Line
Significant Development Proposed:	• No
Property Count:	• 0 buildings flood to a depth >0.1m • 0 buildings flood to a depth >0.3m • 0 buildings flood to a depth >0.5m
Validation:	• There are no historical records of surface water flooding. • There are no sewer flooding records.
Shortlisted to Phase 3:	• The CDA has not been shortlisted but is presented in Phase 2 for information to interested stakeholders
Figures:	Figure B 55 – Surface Water Flood Depth (1% AEP) Figure B 56 – Surface Water Flood Hazard (1% AEP)

CDA Name:	***BAS 20: Wickford Town Centre***
Flood Risk Categorisation:	Surface Water
Description:	• There are no specific surface water flows within the CDA and surface water flooding is largely due to topography. One PSWFH have been identified in the CDA. A significant amount of surface water ponding occurs to the east of the CDA where Wickford High Street passes under the railway line.
Critical Infrastructure:	• Wickford County Infant and Junior Schools • Railway Line
Significant Development Proposed:	• No
Property Count:	• 34 buildings of which 9 are residential properties flood to a depth >0.1m • 12 buildings of which 0 are residential properties flood to a depth >0.3m • 8 buildings of which 0 are residential properties flood to a depth >0.5m
Validation:	• There are no historical records of surface water flooding. • There are no sewer flooding records.
Shortlisted to Phase 3:	• The CDA has not been shortlisted but is presented in Phase 2 for information for interested stakeholders.
Figures:	Figure B 57 – Surface Water Flood Depth (1% AEP) Figure B 58 – Surface Water Flood Hazard (1% AEP)

CDA Name:	***BAS 21: Bromfords***
Flood Risk Categorisation:	Surface Water
Description:	• Surface water generally flows from the west to the east of the CDA, towards the Nevendon Brook. One PSWFH has been identified in the CDA. A significant amount of surface water ponding occurs adjacent to the Golden Jubilee Way (A132). • Albany Road Flood Storage Area is located in the north of the CDA, alongside North Crescent Primary School. • Part of the southern part of the CDA is within Flood Zone 2 and 3 of the Nevendon Brook main river.
Critical Infrastructure:	• North Crescent Primary School, Grange Primary School, The Bromfords School • Pumping Station • Wickford Fire Station
Significant Development Proposed:	• No
Property Count:	• 613 buildings of which 556 are residential properties flood to a depth >0.1m • 407 buildings of which 393 are residential properties flood to a depth >0.3m • 265 buildings of which 259 are residential properties flood to a depth >0.5m
Validation:	• There are historical records of surface water flooding along Finchingfield Way and Golden Jubilee Way (A132). • There are no sewer flooding records.
Potential Surface Water Flooding Hotspots:	• Pluvial modelling indicates that significant surface water ponding occurs to the east of the CDA, adjacent to Golden Jubilee Way (A132).
Shortlisted to Phase 3:	• The CDA has been shortlisted and taken forward to Phase 3.
Figures:	Figure B 59 – Surface Water Flood Depth (1% AEP) Figure B 60 – Surface Water Flood Hazard (1% AEP)

Albany Road Flood Storage Area

CDA Name:	***BAS 22: Cranfield Park Road***
Flood Risk Categorisation:	Surface Water and Sewer
Description:	• Surface water generally flows from the east to the west of the CDA, towards the Nevendon Brook. One PSWFH has been identified in the CDA. A significant amount of surface water ponding occurs adjacent to the Nevendon Road (A132). • The Wick Crescent Ditch has been culverted below Cranfield Park in the south of the CDA. • The Nevendon Brook flows from south to east along the eastern boundary of the CDA.
Critical Infrastructure:	• Oakfield Primary School
Significant Development Proposed:	• No
Property Count:	• 431 buildings of which 416 are residential properties flood to a depth >0.1m • 186 buildings of which 180 are residential properties flood to a depth >0.3m • 79 buildings of which 76 are residential properties flood to a depth >0.5m
Validation:	• There are no historical records of surface water flooding. • There are sewer flooding records in Cranfield Park (located outside of the CDA but linked to the same AWS sewer system).
Potential Surface Water Flooding Hotspots:	• Pluvial modelling indicates that significant surface water ponding occurs to the east of the CDA, adjacent to Nevendon Road (A132).
Shortlisted to Phase 3:	• The CDA has been shortlisted and taken forward to Phase 3.
Figures:	Figure B 61 – Surface Water Flood Depth (1% AEP) Figure B 62 – Surface Water Flood Hazard (1% AEP)

Nevendon Brook (looking south)

6.6 Summary of Flood Risk

6.6.1 Overview of Surface Water Flooding in Basildon Borough Council

The following conclusions can be drawn from the Phase 2 Risk Assessment, which has involved pluvial modelling combined with site visits and a review of historical flood records provided by Basildon Borough Council, Essex County Council, the Essex Fire and Rescue Service, Anglian Water and the Environment Agency:

- Surface water flooding within Basildon Borough Council is driven predominantly by the topography relating to the river channels of the River Crouch and its tributaries. Areas of localised flooding can in most cases be attributed to local topographic depressions or obstructions in the flow of surface water.
- There are a number of main rivers (in particular the River Crouch) draining the Basildon Borough Council. As a result, areas of the Borough fall within the Environment Agency's fluvial and tidal flood Zones 2 and 3.
- There are several incidences where transport infrastructure obstructs the overland flow paths of surface water causing the accumulation of surface water behind the structures. For example the railway embankments through BAS 2, BAS 7, BAS 9 and BAS 13.
- The historical flood records suggest that the recorded surface water flooding incidences are mainly due to inundation of the surface water drainage systems during high intensity rainfall and in some cases this is due to inadequate maintenance of drainage systems and ordinary watercourses in Basildon Borough Council.
- The results of the intermediate level 2D pluvial modelling indicate the greatest surface water flood hazard associated with steep sloping topography from areas of high elevation to the lowest elevations, where surface water flooding depths are considerable.

6.6.2 Risk to Existing Properties

As part of the Phase 2 assessment, a quantitative assessment of the number of properties at risk of flooding has been undertaken for each CDA. The 1% AEP rainfall event has been used to inform this assessment.

The flood depths estimated by the intermediate level 2D pluvial modelling can provide an indication as to the potential impact of surface water flooding. Using the National Receptors Dataset, the average surface water flood depths for a 1% AEP storm event have been determined for residential and non residential buildings. The methodology used is described in the Modelling Report (Appendix A2). An indicative estimate of the number of properties at risk of flooding for a range of surface water depths, in each CDA is detailed in Table 6-3 below.

Table 6-3: Flood Risk Property Counts for 1% AEP event in Basildon Borough Council

CDAs	Name	Total number of buildings at risk of surface water flooding			Number of residential properties at risk of surface water flooding		
		0.1 m	0.3 m	0.5 m	0.1 m	0.3 m	0.5 m
BAS 1	North West Billericay	428	42	2	317	35	1
BAS 2	Railway Cutting Billericay	22	16	4	3	1	0
BAS 3	Stock Road	278	46	0	226	44	0
BAS 4	Sunnymede	692	54	22	599	42	21

CDAs	Name	Total number of buildings at risk of surface water flooding			Number of residential properties at risk of surface water flooding		
		0.1 m	0.3 m	0.5 m	0.1 m	0.3 m	0.5 m
BAS 5	South Green	96	2	0	86	0	0
BAS 6	Southfields	51	6	0	21	4	0
BAS 7	Railway Cutting Laindon	0	0	0	0	0	0
BAS 8	Laindon	461	82	23	391	75	21
BAS 9	A127 - A126 Junction	0	0	0	0	0	0
BAS 10	Lee Chapel North/Langdon Hills	826	31	0	745	25	0
BAS 11	Lee Chapel South/St Martin's	268	48	5	230	43	5
BAS 12	Kingswood/Dry Street	395	44	13	317	18	1
BAS 13	Railway Cutting Barstable	1	1	1	0	0	0
BAS 14	Barstable/Fryerns	539	127	39	439	115	33
BAS 15	Chalvedon/Felmores	357	20	5	332	17	4
BAS 16	Bowers Gifford	82	11	0	47	8	0
BAS 17	Pitsea	64	8	4	45	2	1
BAS 18	Vange	319	42	23	304	41	26
BAS 19	Railway Line Vange	0	0	0	0	0	0
BAS 20	Wickford Town Centre	34	12	8	9	0	0
BAS 21	Bromfords	613	407	265	559	393	259
BAS 22	Cranfield Park Road	431	186	79	416	180	46
TOTAL	**Basildon Borough Council**	**7733**	**1619**	**720**	**6214**	**1300**	**581**

6.6.3 Risk to Future Development

At the time of preparing this SWMP report, work was underway to prepare the Basildon Borough Council Local Development Framework Core Strategy Preferred Options Report, which is anticipated to be published for public consultation in February 2012.

The Core Strategy will set out the spatial vision, strategic objectives and policies for growth in the borough, including locations for proposed new housing, retail and business development up to 2031. This SWMP has considered the location of potential new development areas (and re-development/regeneration areas) which could come forward, and these are considered further in Phase 3; however, as plans progress within each of the broad areas eventually allocated for growth and regeneration, the findings of the Phase 2 SWMP should be considered and implemented as appropriate or revised in future iterations of the SWMP.

7. Castle Point Borough Council

7.1 Surface Water Flooding

7.1.1 Historic Flooding

Historical surface water flooding data collected as part of the Essex Preliminary Flood Risk Assessment (PFRA) has been used, which was collected from Castle Point Borough Council, the Essex Fire and Rescue Service, Parish Councils and the Highways Agency. However, for all but the Fire and Rescue Service records, only the location of the flooding incident has been recorded and not necessarily the source. Overall, these sources amount to 26 recorded flood events and these records are shown in Figure C 5.

It should be noted that historically, only major flooding incidents have been recorded and in many cases the historic flooding information provided is anecdotal and does not include records of antecedent conditions giving rise to the flooding (therefore typically not attributed to a flood source) or reference to a flood return period.

Table 7-1 provides a summary of past flood incidents in Castle Point Borough Council, and those areas prone to surface water flooding during periods of heavy rainfall based on historical records collected.

Table 7-1: Summary of Past Surface Water Flood Events in Castle Point Borough Council (where the source of flooding is unknown this has been indicated)

Flood Event	Description
October 1987	Flood record in Hadleigh (North Essex Catchment Flood Management Plan)
28th November 2009	Hadleigh flood record (Fire Records) source unknown
28th February 2010	Canvey Island 2 flood records (Fire Records) source unknown
29th March 2010	Hadleigh flood record (Fire Records) source unknown
6th June 2010	Hadleigh flood record (Fire Records) source unknown
18th January 2011	3 records of flooding in Canvey Island. Flooding due to heavy rainfall (Echo Newspaper)

7.2 Ordinary Watercourses

Figure C 4 shows the main rivers and ordinary watercourses that are located in Castle Point Borough Council and Table 7-2 provides a list of these.

Table 7-2: Watercourses in Castle Point Borough Council

Watercourse (name or location if un-named)	Classification	Owner / Maintainer
Prittle Brook	Main River	Environment Agency
Benfleet Hall Sewer	Main River	Environment Agency
Bowers Gifford Marsh Drain	Main River	Environment Agency
Kersey Marsh Sewer	Main River	Environment Agency
Hadleigh Marsh Sewer	Main River	Environment Agency
Pantile Dyke	Main River	Environment Agency
Six Acres Dyke	Main River	Environment Agency
Six Acres Pipeline	Main River	Environment Agency

Watercourse (name or location if un-named)	Classification	Owner / Maintainer
Kwllington Dyke West	Main River	Environment Agency
Amid Road Dyke	Main River	Environment Agency
Norland Road Dyke	Main River	Environment Agency
North Dyke	Main River	Environment Agency
Southwick Dyke East	Main River	Environment Agency
St Josephs Dyke	Main River	Environment Agency
Sluice Darm Dyke	Main River	Environment Agency
Westness Dyke	Main River	Environment Agency
South Dyke	Main River	Environment Agency
Labworth Dyke	Main River	Environment Agency
Smallgains Creek	Main River	Environment Agency
Smallgains Ditch	Main River	Environment Agency
Cropemburgh Canal East	Main River	Environment Agency
Marine Parade Delph Ditch	Main River	Environment Agency
St Annes Dyke	Main River	Environment Agency
May Aenuae Dyke	Main River	Environment Agency
Leigh Beck Dyke	Main River	Environment Agency
Prittle Brook (upper reaches)	Ordinary watercourse	Local Authority
Tributary of Benfleet Brook	Ordinary watercourse	Local Authority
Tributary of Rawreth Brook	Ordinary watercourse	Local Authority
Janette Avenue	Ordinary watercourse	Local Authority
East of Haven Road	Ordinary watercourse	Local Authority

As can be seen in Table 7-2, there are a number of small ordinary watercourses, most of which are tributaries of main rivers. The watercourses on Canvey Island can be seen in Figure C 4 have been incorporated into a wider drainage system, which is partly pumped and with different sections operated and maintained by Castle Point Borough Council, Anglian Water, and the Environment Agency.

7.3 Groundwater Flooding

7.3.1 Historic Flooding

There are no records of groundwater flooding incidents in Castle Point Borough Council that have been reported to the Environment Agency. The records provided by the Council, Essex Fire and Rescue Service and Parish Councils do also not include any groundwater flooding incidents.

Higher risk areas which are susceptibility to groundwater flooding are often associated where Head Deposits, River Terrace Deposits and Marine Alluvium Sands are present at surface. There are notable areas along the east of Foulness Island, the River Roach, Eastwood Brook, the Prittle Brook and the River Crouch and its tributaries. These areas coincide with areas of high permeability and ground elevations are low.

More information on groundwater flood risk is presented in Section 3.3 and Appendix A3.

7.4 Sewer Flooding

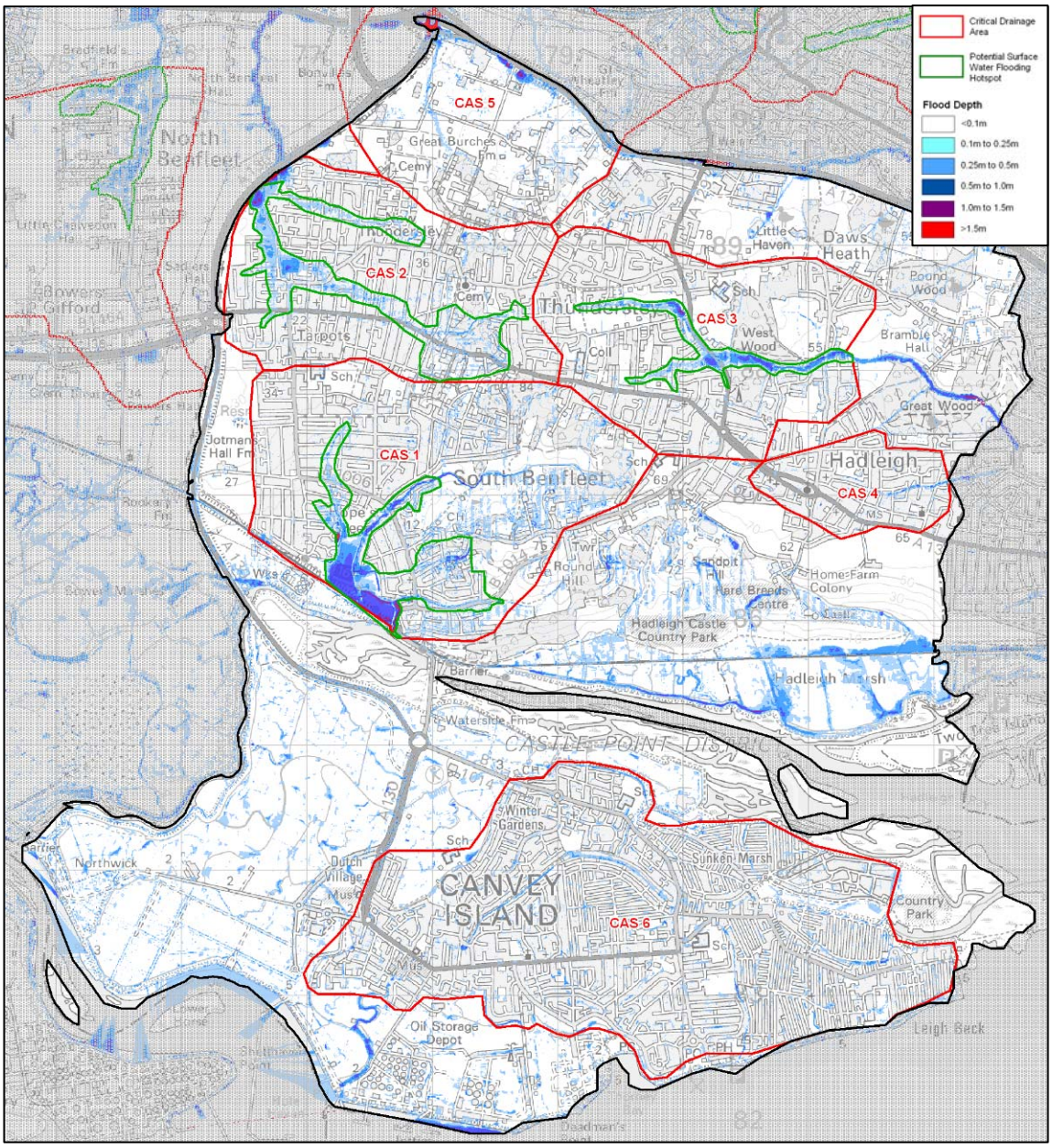
7.4.1 DG5 Register

According to Anglian Water's DG5 database, 16 sewer flooding incidents occurred between 2000 and 2010 (Figure C 5) in Castle Point Borough Council. The majority of the incidents on Canvey Island 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.

7.5 Critical Drainage Areas

In total six CDAs have been defined in Castle Point Borough Council and are discussed and presented in more detail in the subsequent sections of SWMP report. Five of these CDAs have been shortlisted to for further assessment in Phase 3. In order to quantify the risk across the CDAs an assessment has been carried out to determine the number of properties and critical infrastructure at risk from surface water flooding during an extreme event.

Figure 7-1: Identified CDAs within the Castle Point Borough Council



CDA Name:	***CAS 1: South Benfleet***
Flood Risk Categorisation:	Surface Water, Ordinary Watercourse and Sewer
Description:	• Surface water tends to flow from the northwest to the southwest of the CDA, towards Benfleet Marsh where the surface water flood depths are greatest. There is one PSWFH area within the CDA. There is a extensive network of drainage ditches that will convey surface water runoff across the catchment. The steep topography to the east of the CDA generates the relative high flow velocities and flood hazards. • A large proportion of the PSWFH coincides with the Benfleet Hall Sewer tidal and fluvial flood zones 2 and 3. • Surface water ponds within the South Benfleet storage area.
Critical Infrastructure:	• South Benfleet Foundation School, Jotmans Hall School, The Appleton School, Kents School, Holy Family Catholic School. • 5 Pumping Stations • Police Station • Nursing Home
Significant Development Proposed:	• No
Property Count:	• 639 buildings of which 542 are residential properties flood to a depth >0.1m • 39 buildings of which 25 are residential properties flood to a depth >0.3m • 6 buildings of which 2 are residential properties flood to a depth >0.5m
Validation:	• Flood records have been recorded at Clifton Way, Grove Road and Avondale Road. The latter two flood locations are in proximity to a drainage ditch. • Sewer flooding records are at Fernlea Road, Greenwood Avenue and at the junction between Vicarage Hill and High Road.
Potential Surface Water Flooding Hotspots:	• Pluvial modelling indicates that surface water flows are generated from Thundersley Glen (to the northeast of CDA) and Hill Top Farm (to the southeast of the CDA). Surface water from these areas flows towards the Benfleet Hall Sewer which then converges with a tributary of the Benfleet Brook. These main flow paths follow the topography and fluvial channels through the CDA. The PSWFH encompasses the areas of Vicarage Hill, Grove Road and Saxon Way.
Shortlisted to Phase 3:	• The CDA has been shortlisted and taken forward to Phase 3.
Figures:	Figure C 19 – Surface Water Flood Depth (1% AEP) Figure C 20 – Surface Water Flood Hazard (1% AEP)

South Benfleet Flood Storage Area (looking north-west)

Ferry Road (looking north)

CDA Name:	***CAS 2: New Thundersley***
Flood Risk Categorisation:	Surface Water, Ordinary Watercourse and Sewer
Description:	• Surface water generally flows from the east to the west of the CDA. There are two distinct flow paths. Surface water accumulates in the flood storage area to the west of the CDA and behind the embankment of the A130. This coincides with a Tributary of the Rawreth Brook which has been diverted under the road.
Critical Infrastructure:	• Glenwood School, Montgomery School, Kingston School, The Robert Drake School • Pumping Station
Significant Development Proposed:	• No
Property Count:	• 491 buildings of which 438 are residential properties flood to a depth >0.1m • 19 buildings of which 18 are residential properties flood to a depth >0.3m • 9 residential properties flood to a depth >0.5m
Validation:	• There are historical flooding records along London Road, The Chase, High Road, Ivy Road and Overton Road. • There is a record of sewer flooding along High Road.
Potential Surface Water Flooding Hotspots:	• Pluvial modelling indicates there are two main flow paths across the CDA. The first approximately follows the path a tributary of the Rawreth Brook, Eversley Road and Stansfield Road. The second flows between Chesterfield Avenue and London Road and follows the path of a culverted watercourse now forming part of Anglian Water's drainage system. The main residential areas affected by ponding are the Recreation Ground, Hornbeams and to the left of Rushbottom Lane. Surface water also accumulates in the storage area behind the east embankment of the A130.
Shortlisted to Phase 3:	• The CDA has been shortlisted and taken forward to Phase 3.
Figures:	Figure C 21 – Surface Water Flood Depth (1% AEP) Figure C 22 – Surface Water Flood Hazard (1% AEP)

CDA Name:	***CAS 3: East Thundersley***
Flood Risk Categorisation:	Surface Water and Ordinary Watercourse
Description:	• Surface water generally flows from the west to the east of the CDA, towards the Prittle Brook. The contributing areas are Swans Green, the Wensley Road area and the Hart Road area. There is one PSWFH within the CDA. Significant ponding of surface water forms in West Wood, West Wood Gardens, Prittle Close, Rayleigh Road and along The Chase. Much of this occurs within the vicinity of the Prittle Brook channel. • The eastern extent of the PSWFH coincides with the Prittle Brook fluvial flood zone 2 and 3,
Critical Infrastructure:	• The Deanes School, Cedar Hall School, Thundersley Primary School and Westwood Primary School.
Significant Development Proposed:	• Yes
Property Count:	• 233 buildings of which 209 are residential properties flood to a depth >0.1m • 37 buildings of which 36 are residential properties flood to a depth >0.3m • 6 residential properties flood to a depth >0.5m
Validation:	• There are records of historic flooding at Alderleys, The Chase, Southfield Close, Broomfield, Pendlestone and the junction of Shipwrights Drive and Kiln Road. There are no sewer flooding records in this CDA.
Potential Surface Water Flooding Hotspots:	• The pluvial modelling suggests the PSWFH follows the upstream channel of the Prittle Brook (where it is an ordinary watercourse). In addition, Queensmere and Rayleigh Road have been modelled to have significant volumes of ponded surface water runoff.
Shortlisted to Phase 3:	• The CDA has been shortlisted and taken forward to Phase 3.
Figures:	Figure C 23 – Surface Water Flood Depth (1% AEP) Figure C 24 – Surface Water Flood Hazard (1% AEP)

West Wood (Prittle Brook)

CDA Name:	***CAS 4: Hadleigh***
Flood Risk Categorisation:	Surface Water and Sewer
Description:	• Surface water flows from the west to the east of the CDA. There is a tributary of the Prittle Brook which is open along the open field to the south of Scrub Lane. A large section of this watercourse is culverted at the eastern extent of the CDA.
Critical Infrastructure:	• Hadleigh Infant and Nursery School, Hadleigh Junior School • Fire Station
Significant Development Proposed:	• Yes
Property Count:	• 53 buildings of which 46 are residential properties flood to a depth >0.1m • 1 residential property floods to a depth >0.3m • 0 buildings flood to a depth >0.5m
Validation:	• Flood records within the CDA are located at Greenacres, Church Road and The Crescent. • There is a sewer flooding record at the junction of London Road and Rectory Road.
Potential Surface Water Flooding Hotspots:	• There is no PSWFH within this CDA. The greatest surface water flood depths have been modelled to be along Estate Road, the Avenue and St Davids Drive. • Due to maintenance issues, localised flooding occurs along the open channel of the Prittle Brook tributary south of the school playing fields
Shortlisted to Phase 3:	• The CDA has been shortlisted and taken forward to Phase 3.
Figures:	Figure C 25 – Surface Water Flood Depth (1% AEP) Figure C 26 – Surface Water Flood Hazard (1% AEP)

CDA Name:	***CAS 5: A129 – A127 Roundabout***
Flood Risk Categorisation:	Surface Water
Description:	• This CDA has a large rural coverage. Water flows towards the northwest of the CDA, and the A129 and A127 roundabout.
Critical Infrastructure:	• None
Significant Development Proposed:	• No
Property Count:	• 50 buildings of which 7 are residential properties flood to a depth >0.1m • 8 buildings of which 0 are residential properties flood to a depth >0.3m • 7 buildings of which 0 are residential properties flood to a depth >0.5m
Validation:	• There are no historical records of flooding within this CDA.
Potential Surface Water Flooding Hotspots:	• There are no PSWFH defined within this CDA. Pluvial modelling has highlighted significant flood depths at the roundabout and behind the embankment of the westbound A127.
Shortlisted to Phase 3:	• This CDA has not been shortlisted; however it has been presented in Phase 2 due to the potential risk to the A127/A1245 junction.
Figures:	Figure C 27 – Surface Water Flood Depth (1% AEP) Figure C 28 – Surface Water Flood Hazard (1% AEP)

CDA Name:	***CAS 6: Canvey Island***
Flood Risk Categorisation:	Drainage Infrastructure
Description:	• There is a complex network of dykes, creeks and ditches (many of which are pumped) running through the CDA. • The majority of the CDA is within tidal and fluvial flood zone 2 and 3. • The pluvial modelling indicates that there are no extensive areas of surface water flooding, due to the flat topography, limited overland flow and the managed system across the CDA.
Critical Infrastructure:	• Schools: Castle View, Conelius Vermuyden, William Read Primary, Winter Gardens Primary, Lubbins Park Community Primary, Leigh Beck Junior, St. Katherines Catholic Primary Northwick Primary, Canvey Junior, St Joseph's Catholic Primary. • Pumping Stations • Ambulance Station, Police Station, Fire Station
Significant Development Proposed:	• Yes
Property Count:	• 315 buildings of which 285 are residential properties flood to a depth >0.1m • 2 residential properties flood to a depth >0.3m • 0 flood to a depth >0.5m
Validation:	• There are 12 historic flooding records within the CDA. • There are sewer flood records along Cedar Road and Heideburg Road.
Potential Surface Water Flooding Hotspots:	• There is no PSWFH within the CDA. The pluvial modelling does not highlight any areas of significant flooding and the only flood risk from surface water is associated with drainage system failure.
Shortlisted to Phase 3:	• The CDA has been shortlisted and will be taken forward to Phase 3.
Figures:	Figure C 29 – Surface Water Flood Depth (1% AEP) Figure C 30 – Surface Water Flood Hazard (1% AEP)

7.6 Summary of Flood Risk

7.6.1 Overview of Surface Water Flooding in Castle Point Borough Council

The following conclusions can be drawn from the Phase 2 Risk Assessment, which has involved pluvial modelling combined with site visits and a review of historical flood records provided by the Castle Point Borough Council, Essex County Council, the Fire and Rescue Service, Anglian Water and the Environment Agency:

- Surface water flooding within Castle Point Borough Council is driven predominantly by the topography relating to the watercourse channels of the Benfleet Creek, Prittle Brook and tributaries of these. Areas of localised flooding can in most cases be attributed to either local topographic depressions, insufficient capacity in ordinary watercourses and culverted systems or obstructions in the flow of surface water (including outfalls to tidal waters).
- The results of the intermediate level 2D pluvial modelling indicates that areas of the Benfleet Creek, Prittle Brook and tributaries of the Rawreth Brook are vulnerable to surface water flooding as well as fluvial and tidal flooding.
- There are circumstances where the presence of transport infrastructure acts to obstruct the flow of surface water, resulting in ponding of surface water behind the structure.
- The results of the intermediate level 2D pluvial modelling indicate the greatest surface water flood hazard associated with the steep westwards sloping topography from the area of high elevation running through the administrative area of Castle Point Borough Council.
- Surface water flood risk in Canvey Island is largely assoicated with failure of the managed (and pumped) drainage network during high intensity rainfall events.
- The historical flood records suggest many of the surface water flooding incidents recorded are exacerbated by inadequate maintenance of drainage systems and ordinary watercourses.

7.6.2 Risk to Existing Properties

As part of the Phase 2 assessment, a quantitative assessment of the number of properties at risk of flooding has been undertaken for each CDA and for Castle Point Borough Council as a whole. The 1% AEP rainfall event has been used to inform this assessment

The flood depths estimated by the intermediate level 2D pluvial modelling can provide an indication as to the potential impact of surface water flooding. Using the National Receptors Dataset, the average surface water flood depths for a 1% AEP storm event have been determined for residential and non residential buildings. The methodology used is described in the Modelling Report (Appendix A2). An indicative estimate of the number of properties at risk of flooding for a range of surface water depths, in each CDA is detailed in Table 7-3 below.

Table 7-3: Flood Risk Property Counts for a 1% AEP event in Castle Point Borough Council

CDAs	Name	Total number of buildings at risk of surface water flooding			Number of residential properties at risk of surface water flooding		
		0.1 m	0.3 m	0.5 m	0.1 m	0.3 m	0.5 m
CAS 1	South Benfleet	639	39	6	542	25	2
CAS 2	New Thundersley	491	19	9	438	18	9
CAS 3	East Thundersley	233	37	6	209	36	6
CAS 4	Hadleigh	53	1	0	46	1	0
CAS 5	A129 - A130 Roundabout	50	8	7	7	0	0
CAS 6	Canvey Island	351	2	0	285	2	0
TOTAL	**Castle Point Borough Council**	**1870**	**109**	**28**	**1560**	**83**	**18**

7.6.3 Risk to Future Development

Castle Point Borough Council Core Strategy was sent for examination by the Secretary of State in March 2010. However, owing to changes in Government policy and the revocation of the Regional Spatial Strategy, the Council resolved to withdraw the Core Strategy at its meeting of the 27th September 2011, and to commence work on a New Local Plan based on neighbourhood projections. Work has been undertaken to prepare a revised Local Development Scheme, which sets out a programme for the New Local Plan. It is expected that a New Local Plan addressing strategic planning, development control and allocation/designation policies will be adopted by March 2014. It is proposed that this is prepared alongside a Community Infrastructure Levy Charging Schedule so that new development is accompanied by the provision of the infrastructure necessary to create sustainable communities. At this time, the level of housing and employment provision to be made in the New Local Plan has not been determined. Careful consideration to social and economic drivers and environmental constraints, including flooding and drainage capacity, will be given before the Council makes a decision on this matter.

This SWMP has considered the location of potential new development areas (and re-development/regeneration areas) which may come forward, and these are considered further in Phase 3. Separate Planning Documents have been produced for Canvey Town Centre and Hadleigh Town Centre. As plans progress within each of these broad areas allocated for growth and regeneration the findings of the SWMP should be considered and implemented as appropriate. The Canvey Town Centre Masterplan[8] indicates that there is a potential capacity of up to 400 units in that location. The Hadleigh Town Centre Masterplan[9] indicates that there is a potential capacity of up to 150 units in that location.

There are a number of potential Growth Location points in Castle Point Borough Council which could provide a range of residential and commercial development. Potential Growth Locations relative to the CDAs indentified are:

- Hadleigh Town Centre (CAS 4);
- East of Manor Trading estate (CAS 2 and CAS 5);
- North of Kiln Road (CAS 3); and,
- Several areas within Canvey Island (CAS 6).

[8] http://www.canveycomesalive.co.uk/index.html
[9] http://www.heartinhadleigh.org.uk/

With the exception of the North of Kiln Road residential development, none of the identified potential Growth Location points are located within a PSWFH. Therefore the flood risk from surface water to future development is low. The majority of these potential Growth Locations will be developed on existing green space, and therefore may have an impact on the future flood risk to surrounding areas. Phase 3 of this SWMP addresses the potential to incorporate surface water management into new developments and recommends any relevant development control policies.

8. Rochford District Council

8.1 Surface Water Flooding

8.1.1 Historic Flooding

Historical surface water flooding data collected as part of the Essex Preliminary Flood Risk Assessment (PFRA) has been used, which was collected from Rochford District Council, the Essex Fire and Rescue Service, Parish Councils and the Highways Agency. However, for all but the Fire and Rescue Service records, only the location of the flooding incident has been recorded and not necessarily the source. Overall, these sources amount to 31 recorded flood events. These records are shown in Figure C 5.

It should be noted that historically, only major flooding incidents have been recorded and in many cases the historic flooding information provided is anecdotal and does not include records of antecedent conditions giving rise to the flooding (therefore typically not attributed to a flood source) or reference to a flood return period.

Table 8-1 provides a summary of past flood incidents in Rochford District Council, and those areas prone to surface water flooding during periods of heavy rainfall based on historical records collected.

Table 8-1: Past Surface Water Flood Events in Rochford District Council (where the source of flooding is unknown this has been indicated)

Flood Event	Description
January 2003	Flooding across South Essex (South Essex Catchment Flood Management Plan)
24th July 2009	Hockley train station: Flooding caused by blocked drains (Fire Records)
29th October 2009	Flooding in Wickford and Rochford (Fire Records) , source unknown
2nd December 2009	Three records in Hawkwell (Fire Records), source unknown
22nd February 2010	Several records of widespread flooding (Fire Records), source unknown
28th February 2010	Several records of widespread flooding (Fire Records), source unknown
30 August 2010	Flooding in Rochford (Fire Records), source unknown
18th January 2011	Four recorded points of flooding due to heavy rainfall: Rochford Hundred Golf Club, The Horse and Groom Pub, Watery Lane and Brays Lane (The Echo Newspaper)

8.2 Ordinary Watercourses

Figure D 4 shows the main rivers and ordinary watercourses that are located within Rochford District Council and Table 8-2 provides a list of these. The majority of these rivers are tributaries of the Tidal River Crouch and Tidal River Roach, as can be seen in Figure D 4.

Table 8-2: Watercourses in Rochford District Council

Watercourse (name or location if un-named)	Classification	Owner / Maintainer
Crouch Tidal	Main River	Environment Agency
Roach Tidal	Main River	Environment Agency
River Roach	Main River	Environment Agency
Beeches Brook	Main River	Environment Agency

Watercourse (name or location if un-named)	Classification	Owner / Maintainer
Lovesdown Ditch	Main River	Environment Agency
Chichester Hall Brook	Main River	Environment Agency
Norpits East Ditch	Main River	Environment Agency
Norpits West Ditch	Main River	Environment Agency
Hockley Brook	Main River	Environment Agency
Hawkwell Brook	Main River	Environment Agency
Great Stambridge Brook	Main River	Environment Agency
Stannets Creek Ditch	Main River	Environment Agency
Pagglesham Ditch	Main River	Environment Agency
North Benfleet Brook	Ordinary watercourse	Local Authority
Noble's Green Ditch	Ordinary watercourse	Local Authority

8.3 Groundwater Flooding

8.3.1 Historic Flooding

There are no records of groundwater flooding incidents in Rochford District Council that have been reported to the Environment Agency. The records provided by the Council, Essex Fire and Rescue Service and Parish Councils do also not include any groundwater flooding incidents.

Higher risk areas which are susceptibility to groundwater flooding are often associated where Head Deposits, River Terrace Deposits and Marine Alluvium Sands are present at surface. There are notable areas along the east of Foulness Island, the River Roach, Eastwood Brook, the Prittle Brook and the River Crouch and its tributaries. These areas coincide with areas of high permeability and ground elevations are low.

More information on groundwater flood risk is presented in Section 3.3 and Appendix A3.

8.4 Sewer Flooding

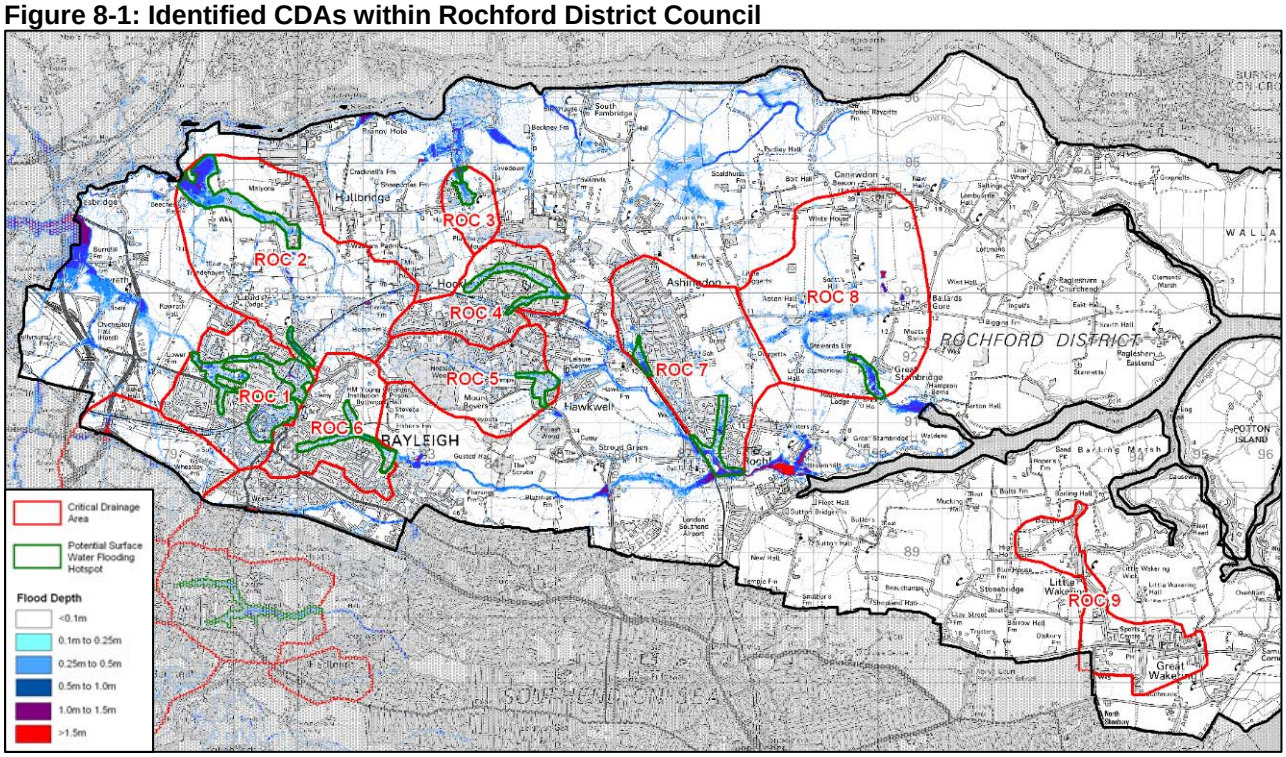
8.4.1 DG5 Register

According to Anglian Water's DG5 database, 22 properties were affected by sewer flooding between 2000 and 2010 (Figure D 5). 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.

8.5 Critical Drainage Areas

In total nine CDAs have been defined in Rochford District Council and are discussed and presented in more detail in the subsequent sections of this report. Seven of these CDAs have been shortlisted for further detailed assessment in Phase 3. In order to quantify the risk across the CDAs an assessment has been carried out to determine the number of properties and critical infrastructure at risk from surface water flooding during an extreme event.

Figure 8-1: Identified CDAs within Rochford District Council



CDA Name:	***ROC 1: Rayleigh West***
Flood Risk Categorisation:	Surface Water and Ordinary Watercourse
Description:	• Surface water generally flows from the east of the CDA towards the west and the Rawreth Brook. A significant amount of surface water ponding occurs in the centre of the CDA and there are a number of significant flow paths as a result of the local topography. One PSWFH have been identified in the CDA. • Some surface water ponding is predicted against the embankments of the railway line. • A number of open watercourses flow through the CDA. • There is one flood storage area within the CDA – Boston Avenue.
Critical Infrastructure:	• Rayleigh Primary School, Glebe Junior and Infant School, Sweyne Park School, Down Hall Primary School, Edward Francis School • Police Station • Pumping Station (northern boundary of the CDA)
Significant Development Proposed:	• No
Property Count:	• 558 buildings of which 481 are residential properties flood to a depth >0.1m • 61 buildings of which 59 are residential properties flood to a depth >0.3m • 24 residential properties flood to a depth >0.5m
Validation:	• Sewer flooding incidents have occurred along Crown Hill and Eastwood Road.
Potential Surface Water Flooding Hotspots:	• Pluvial modelling identifies surface water ponding along the embankment of the railway line in the west and along the course of the open watercourses within the CDA.
Shortlisted to Phase 3:	• The CDA has been shortlisted and taken forward to Phase 3.
Figures:	Figure D 19 – Surface Water Flood Depth (1% AEP) Figure D 20 – Surface Water Flood Hazard (1% AEP)

Caustonway (looking south)

Sweyne Park Pond

CDA Name:	***ROC 2: Watery Lane***
Flood Risk Categorisation:	Surface Water
Description:	• Surface water flows predominantly towards the northwest and towards Breeches Brook. The CDA is largely rural; however it provides a critical road network via Watery Lane to the A130. There is one PSWFH within the CDA. • The northern proportion of the CDA and PSWFH coincides with the fluvial flood zone 2 and 3 of the tidal River Crouch.
Critical Infrastructure:	• Sewage Treatment Works • Pumping Stations
Significant Development Proposed:	• Yes
Property Count:	• 138 buildings of which 63 are residential properties flood to a depth >0.1m • 26 buildings of which 4 are residential properties flood to a depth >0.3m • 7 buildings of which 0 are residential properties flood to a depth >0.5m
Validation:	• There are three historical records of surface water flooding along Watery Lane. • There is one sewer flooding record along Ferry Road.
Potential Surface Water Flooding Hotspots:	• Pluvial modelling indicates that surface water is generated from the land around Trenders Hall, to the north of the Sweyne Park area and flows through a network of numerous drainage ditches towards the brook. • Flooding on Water Lane is exacerbated by its lower elevation compared to the surrounding land. • From the pluvial modelling, it can be seen that the greatest flood depths are shown to coincide with the Breeches Brook. • The Environment Agencies Flood Zone 3 intersects part of this area.
Shortlisted to Phase 3:	• The CDA has been shortlisted and taken forward to Phase 3.
Figures:	Figure D 21 – Surface Water Flood Depth (1% AEP) Figure D 22 – Surface Water Flood Hazard (1% AEP)

Watery Lane (looking east)

Hambro Hill (north-west)

CDA Name:	***ROC 3: Lower Hockley / Dome Country Club***
Flood Risk Categorisation:	Surface Water
Description:	• Surface water generally flows from the south to the north of the CDA. There is a network of drains across the CDA which act to channel surface water to the North. The open space around the Plumberow Wood area contributes to the surface water that accumulates to the north of the CDA.
Critical Infrastructure:	• None
Significant Development Proposed:	• No
Property Count:	• 35 buildings of which 25 are residential properties flood to a depth >0.1m • 7 buildings of which 6 are residential properties flood to a depth >0.3m • 0 buildings flood to a depth >0.5m
Validation:	• There are no historical records of flooding
Potential Surface Water Flooding Hotspots:	• Pluvial modelling highlights the greatest flood around the path leading past the Hockley Downs Stables. The drainage ditches and Lower Road acts as a flow path.
Shortlisted to Phase 3:	• The CDA has not been shortlisted, but is presented in Phase 2 for information.
Figures:	Figure D 23 – Surface Water Flood Depth (1% AEP) Figure D 24 – Surface Water Flood Hazard (1% AEP)

Watercourse adjacent to Dome Country Club (looking north)

Watercourse adjacent to Dome Country Club (looking south)

CDA Name:	***ROC 4: Hockley***
Flood Risk Categorisation:	Surface Water, Ordinary Watercourse and Sewer
Description:	• Surface water flows generally from the west to the east of the CDA. There are two main areas where surface water flooding is greatest. These tend to follow the culverted channels of tributaries joining the Hockley Brook to the east of the CDA.
Critical Infrastructure:	• Greensward Academy, Plumberow Primary School, Hockley Primary School • Police Station • Railway Line and Station
Significant Development Proposed:	• Yes
Property Count:	• 227 buildings of which 204 are residential properties flood to a depth >0.1m • 19 residential properties flood to a depth >0.3m • 3 residential properties flood to a depth >0.5m
Validation:	• There are records of historical flooding at Plumberow Avenue, The railway underpass of Spa Road and Sunnyfield Gardens. • There are records of sewer flooding at Main Road and Southend Road Main Road.
Potential Surface Water Flooding Hotspots:	• The pluvial modelling highlights the areas with the greatest flood depths to be the culverted section of a tributary of the Hockley Brook where it forms part of the Anglian Water drainage system. This covers the areas of Southview Road, Spa Road and Broadlands Road. • In addition the modelled results show flooding in the railway cutting.
Shortlisted to Phase 3:	• The CDA has been shortlisted and taken forward to Phase 3.
Figures:	Figure D 25 – Surface Water Flood Depth (1% AEP) Figure D 26 – Surface Water Flood Hazard (1% AEP)

Ordinary Watercourse, at the edge of Marylands Wood, before culverted through Hockley

CDA Name:	***ROC 5: Hockley Woods***
Flood Risk Categorisation:	Surface Water and Ordinary Watercourse
Description:	• Surface water flows from the west to the east of the CDA. Surface water ponding is greatest along the channels of the Hawkwell Brook and in the area of Elmwood Avenue and Thorpe Close. There is one PSWFH identified within the CDA.
Critical Infrastructure:	• The Westrings Primary School • HM Bullwood Hall Prison • Fire Station
Significant Development Proposed:	• No
Property Count:	• 113 buildings of which 96 are residential properties flood to a depth >0.1m • 1 residential building floods to a depth >0.3m • 0 buildings flood to a depth >0.5m
Validation:	• There are no historical records of flooding or sewer flooding within this CDA.
Potential Surface Water Flooding Hotspots:	• The PSWFH incorporates the area of greatest flood depths that occur in urbanised areas. This is predominantly Elmwood Avenue and Thorp Close. The Hawkwell Brook flows as an open channel to the east of the PSWFH.
Shortlisted to Phase 3:	• This CDA has not been shortlisted but is presented in Phase for information
Figures:	Figure D 27 – Surface Water Flood Depth (1% AEP) Figure D 28 – Surface Water Flood Hazard (1% AEP)

CDA Name:	***ROC 6: Rayleigh East***
Flood Risk Categorisation:	Surface Water, Ordinary Watercourse and Sewer
Description:	• Surface water flows from the northwest and southwest of the CDA to the east. Surface water flooding is concentrated along two corridors associated with either culverted watercourses now forming part of Anglian Water's drainage network or open watercourse and also where these join. The Noble's Green ditch flows from the North of the CDA to the west. There is one PSWFH within the CDA.
Critical Infrastructure:	• The Fitzwimarc School, Grove Wood Primary School • Pumping Station • Fire Station
Significant Development Proposed:	• No
Property Count:	• 224 buildings of which 208 are residential properties flood to a depth >0.1m • 30 residential properties flood to a depth >0.3m • 1 residential property floods to a depth >0.5m
Validation:	• There are three sewer flooding records within the PSWFH area. These are located along Napier Road, The Chase and Bramfield Road East.
Potential Surface Water Flooding Hotspots:	• There are two corridors where the pluvial modelling shows a concentration of flooding. The first runs from Kings Road and the second from Napier Road. These meet in the area of The Chase and Chase End and flow east along Milton Close, following the path of the Nobles Green Ditch. The PSWFH extends to the western extent of the urbanised area.
Shortlisted to Phase 3:	• The CDA has been shortlisted and taken forward to Phase 3.
Figures:	Figure D 29 – Surface Water Flood Depth (1% AEP) Figure D 30 – Surface Water Flood Hazard (1% AEP)

Noble's Green Ditch (looking east)

CDA Name:	***ROC 7: Ashingdon-Rochford***
Flood Risk Categorisation:	Surface Water
Description:	• Surface waters tend to flow from the north to the south of this CDA. There are two PSWFH within the CDA. The first is to the north and is influenced by the railway line embankment. The second is to the south and is in the area of the River Roach. The Eastwood Brook joins the River Roach at this point. • The southern PSWFH coincides with the tidal River Roach and fluvial flood zone 2 and 3.
Critical Infrastructure:	• The King Edmund School, Holt Farm Infant, Holt Farm Junior, Waterman Primary, St Teresa's Catholic Primary, Rochford Primary and Nursery School. • Fire Station
Significant Development Proposed:	• Yes
Property Count:	• 349 buildings and 271 residential properties flood to a depth >0.1m • 108 buildings and 69 residential properties flood to a depth >0.3m • 55 buildings and 30 residential properties flood to a depth >0.5m
Validation:	• Historic floods have been recorded along Brays Lane, Craven Close, Devon Gardens, Meesons Mead, Back Lane, South Street and Southend Road. • There are no records of sewer flooding within the CDA.
Potential Surface Water Flooding Hotspots:	• There are two PSWFH within the CDA. The first is located around Devon Gardens, Oaklands and Banyard Way, where surface water accumulates behind the railway embankment. • The second PSWFH covers a larger area to the south of the CDA. This includes The Drive, Pollards Close and Bradley Way. The Eastwood Brook joins the River Roach at this point.
Shortlisted to Phase 3:	• The CDA has been shortlisted and taken forward to Phase 3.
Figures:	Figure D 31 – Surface Water Flood Depth (1% AEP) Figure D 32 – Surface Water Flood Hazard (1% AEP)

Doggetts Wildlife Area

Railway Line adjacent to Hainault Ave

CDA Name:	***ROC 8: Great Stambridge***
Flood Risk Categorisation:	Surface Water
Description:	• Surface water flows from the north to the south of the CDA. The Great Stambridge Brook flows through Great Stambridge in the south of the CDA. Pluvial modelling shows a wide extent of surface water flooding across the CDA; this however covers mainly rural areas. There are several distinct preferential flow paths across the CDA such as the track between White House Farm and Kensal House. • The PSWFH coincides with the Great Stambridge Brook fluvial and tidal flood zone 2 and 3.
Critical Infrastructure:	• Canewdon Endowed Church of England Primary School
Significant Development Proposed:	• Yes
Property Count:	• 40 buildings and 18 residential properties flood to a depth >0.1m • 13 buildings and 3 residential properties flood to a depth >0.3m • 3 buildings and 1 residential properties flood to a depth >0.5m
Validation:	• There is one historical flooding record at Ash Tree Court.
Potential Surface Water Flooding Hotspots:	• The pluvial modelling indicates that surface water flows from the north to the south of the CDA. Flooding is widespread across the CDA, however the PSWFH focuses on the flooding estimated in the Great Stambridge area.
Shortlisted to Phase 3:	• The CDA has been shortlisted and taken forward to Phase 3.
Figures:	Figure D 33 – Surface Water Flood Depth (1% AEP) Figure D 34 – Surface Water Flood Hazard (1% AEP)

Stambridge Road (west)

CDA Name:	***ROC 9: Little-Great Wakering***
Flood Risk Categorisation:	Surface Water and Sewer
Description:	• The Little-Great Wakering CDA is located near to the Tidal River Roach and is in proximity of several main rivers. • In the absence of pluvial model covering the location, the Environment Agency's Flood Map for Surface Water has been used to define surface water flooding areas in the CDA. This map shows ponding of surface water in Great Wakering associated with low lying topography and flooding in proximity to watercourses in Little Wakering and Barling.
Critical Infrastructure:	• Barling Magna Community Primary School, Great Wakering Primary School
Significant Development Proposed:	• Yes
Validation:	• There is historical flooding at New Road. • There are historical sewer flooding records at Church Road, Kimberley Road and Little Wakering Road.
Potential Surface Water Flooding Hotspots:	• The Environment Agency's Flood Map for Surface Water indicates areas of surface water flooding occurring along Barling Road, Church Road and Little Wakering Road near Barling. There is also deep flooding modelled along Twyford Avenue, to the north of the residential area of Great Wakering.
Shortlisted to Phase 3:	• The CDA has been shortlisted and taken forward to Phase 3.
Figures:	Figure D 35 – Environment Agency Flood Map for Surface Water

Barling Hall Creek (looking east)

Drainage ditch flowing from the west into Barling Hall Creek

8.6 Summary of Flood Risk

8.6.1 Overview of Surface Water Flooding in Rochford District Council

The following conclusions can be drawn from the Phase 2 Risk Assessment, which has involved pluvial modelling combined with site visits and a review of historical flood records provided by the Rochford District Council, Essex County Council, the Fire and Rescue Service, Anglian Water and the Environment Agency:

- Surface water flooding within Rochford District Council is driven predominantly by the topography relating to the river channels of the River Roach, River Crouch and tributaries of these. Areas of localised flooding can in most cases are attributed to local topographic depressions or obstructions in the flow of surface water; in particular where discharge of fluvial systems conveying surface water (main rivers and ordinary watercourses) is limited by tide locked conditions and/or limited pumping capacities.
- There are a number of main rivers draining Rochford District Council, mainly the tributaries of the Tidal River Roach and the Tidal River Crouch. As a result, a large proportion of the district falls within the Environment Agency's fluvial and tidal flood Zones 2 and 3. The results of the intermediate level 2D pluvial modelling indicates that many areas including Watery Lane, Great Stambridge and Ashingdon are vulnerable to surface water flooding as well as fluvial and tidal flooding combined.
- There are several incidences where transport infrastructure obstructs the overland flow paths of the surface water causing the accumulation of surface water behind the structures. For example the railway embankment through ROC 1 and ROC 7.
- The historical flood records suggest that the recorded surface water flooding incidences are mainly due to inundation of the surface water drainage systems and under capacity of ordinary watercourses during high intensity rainfall events. The DG5 sewer flooding records give a clearer picture of where surface water flooding is a result of under capacity, such as in ROC 6 and ROC 1.
- The results of the intermediate level 2D pluvial modelling indicate the greatest surface water flood hazard is associated with the steep sloping topography from the area of high elevation passing through the western boundary of the administrative area, and the lowest elevations where surface water flooding depths are considerable.

8.6.2 Risk to Existing Properties

As part of the Phase 2 assessment, a quantitative assessment of the number of properties at risk of flooding has been undertaken for each CDA and for the modelled area of Rochford District Council. The 1% AEP rainfall event has been used to inform this assessment.

The flood depths estimated by the intermediate level 2D pluvial modelling can provide an indication as to the potential impact of surface water flooding. Using the National Receptors Dataset, the average surface water flood depths for a 1% AEP storm event have been determined for residential and non residential buildings. The methodology used is described in the Modelling Report (Appendix A2). An indicative estimate of the number of properties at risk of flooding for a range of surface water depths, in each CDA is detailed in Table 8-3 below.

Table 8-3: Flood Risk Property Counts for 1% AEP event in Rochford District Council

CDAs	Name	Total number of buildings at risk of surface water flooding			Number of residential properties at risk of surface water flooding		
		0.1 m	0.3 m	0.5 m	0.1 m	0.3 m	0.5 m
ROC 1	Rayleigh West	558	61	24	481	59	24
ROC 2	Watery Lane	138	26	7	63	4	0
ROC 3	Lower Hockley/Dome Country Club	35	7	0	25	6	0
ROC 4	Hockley	227	19	3	204	19	3
ROC 5	Hockley Woods	113	1	0	96	1	0
ROC 6	Rayleigh East	244	30	1	208	30	1
ROC 7	Ashingdon/Rochford	349	108	55	271	69	30
ROC 8	Great Stambridge	40	13	3	18	3	1
ROC 9	Little/Great Wakering	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL	**Rochford Modelled Area**	**2249**	**396**	**136**	**1632**	**242**	**70**

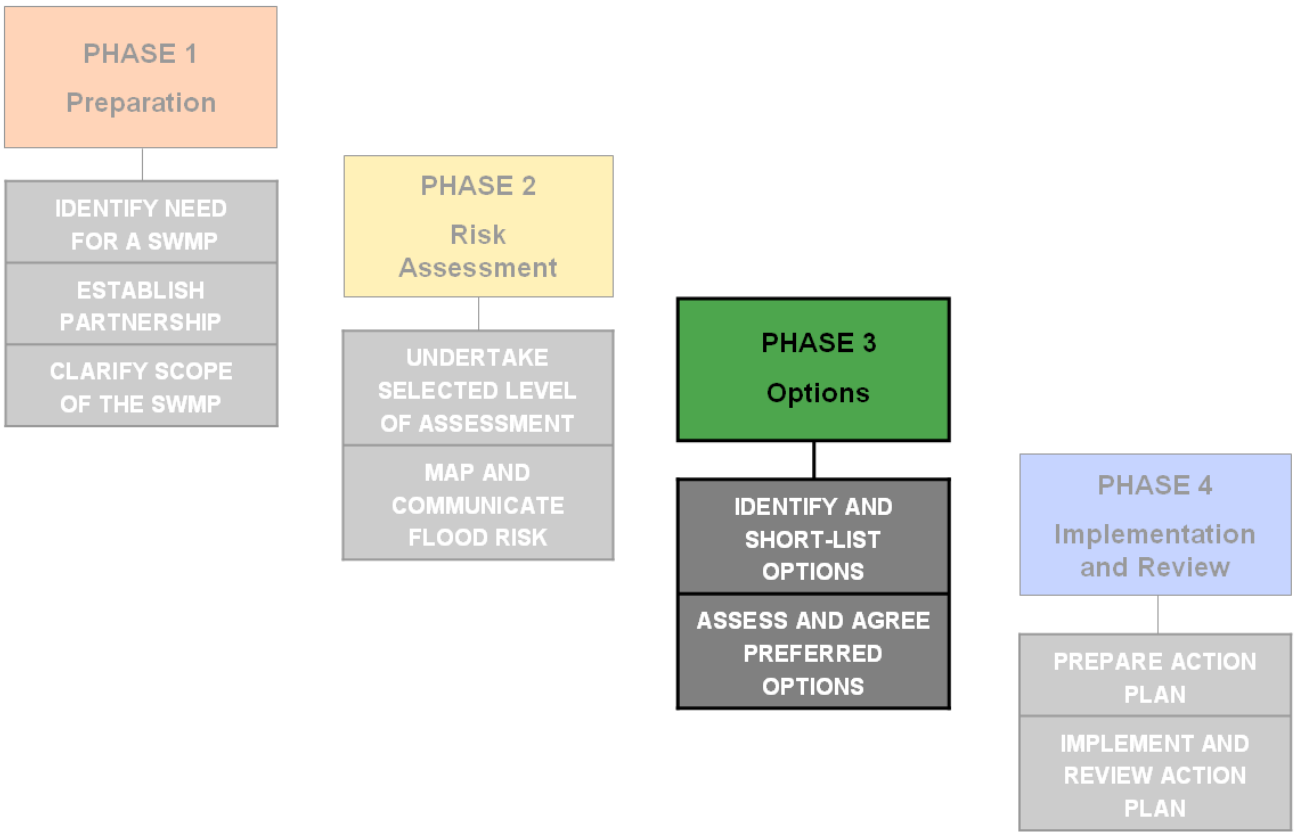
8.6.3 Risk to Future Development

The Core Strategy identifies that Rochford District Councils target for growth is 3,800 new dwellings by 2031. These areas will see a range of residential and commercial development which would be located near to or within several CDAs. They include:

- Rawreth Industrial Estate (ROC 1);
- South West Hullbridge (ROC 2);
- West Hockley (ROC 4);
- Eldon Way (ROC 4);
- South East Ashingdon (ROC 7);
- East Ashingdon (ROC 7);
- South Canewdon (ROC 8);
- West of Great Wakering (ROC 9); and,
- Star Lane Industrial Estate (ROC 9).

Although the identified growth location points areas are located close to or within the CDAs, none are located within a PSWFH. Therefore the flood risk from surface water to future development is low. The majority of these Growth Location Points will be developed on existing green space, and therefore may have an impact on the future flood risk to surrounding areas. As plans progress within each of the areas allocated for growth and regeneration the findings of the SWMP should be considered and implemented as appropriate. Phase 3 addresses the potential to incorporate surface water management into new developments including recommendations for specific development control policy.

Phase III: Options Assessment



Part A: Study Wide

9. Introduction

9.1 Objectives

The purpose of Phase 3 is to identify a range of structural and non-structural measures for alleviating surface water flood risk across South Essex and assess them to eliminate those that are not feasible or cost beneficial. The remaining options are then developed and tested against their relative effectiveness, benefits and costs.

To maintain continuity within the SWMP report and to reflect the flooding mechanisms throughout South Essex, the option identification has taken place on an area-by-area (site-by-site) basis following the process established in Phase 2. Therefore, the options assessment undertaken as part of the SWMP assesses and short-lists the measures for each of the shortlisted CDAs and identifies any non-standard measures available.

Phase 3 delivers a high-level option assessment for the CDAs taken forward from Phase 2. Due to the large number of CDAs and PSWFHs, and therefore potential options, no monetised damages have been calculated, whilst flood mitigation costs have been determined using engineering judgement, but have not undergone detailed analysis. As such, the costs provided as part of this study have been assigned to cost bands[10] to reflect that the costs presented are estimates and not based upon detailed analysis. The options assessment follows that described in the Defra SWMP Technical Guidance 2010, but is focussed on highlighting areas for further detailed analysis and immediate 'quick win' actions.

9.2 Linkages to Local Investment Plans

It is important to consider local investment plans and initiatives and committed future investment when identifying measures that could be implemented within Basildon Borough Council, Castle Point Borough Council and Rochford District Council.

The following schemes could provide linked funding solutions to flood alleviation work, which would provide a cost effective and holistic approach to surface water flood risk management:

- Environment Agency funding (Payment for Outcomes);
- Local Development Frameworks Core Strategy, Area Action Plans and Infrastructure Delivery Plans;
- Local Green Infrastructure Plans;
- Major commercial and housing development is an opportunity to integrate surface water management measures
- Essex Local Transport Plans; and,
- Anglian Water Service's Business Plans (for AMP6 and AMP7).

[10] The cost bands to be used are: <£25k, £26k - £50k, £51k - £100k, £101k - £250k, £251k - £500k, £501k - £1m and >£1m

10. Options Identification & Assessment

10.1 Methodology

Phase 3 has been undertaken in four stages as summarised below and discussed in more detail in the proceeding sections:

- Stage 1 – Identify Potential Measures: (structural and non-structural) based on the standard measures identified for all shortlisted CDAs irrespective of the costs or benefits associated with these.
- Stage 2 – Identify Potential Options: based on those measures identified in Stage 1 - an option may be a single measure or a combination of measures. This stage may also identify that further investigation or confirmation of existing drainage infrastructure is required prior to taking forward options.
- Stage 3 – Short List Potential Options: based on a range of social, environmental, technical and economic criteria to determine the preferred schemes for consideration in Stage 4.
- Stage 4 – Determine High-level Costs & Benefits, identify the preferred option and determine the approximate cost.

10.1.1 Stage 1 – Identify Potential Measures

This stage aims to identify a number of measures that have the potential to alleviate surface water flooding in South Essex. It has been informed by the knowledge gained as part of the Phase 1 and Phase 2 assessment. At this stage, the measure identification pays no attention to constraints such as funding or delivery mechanisms to enable a robust assessment and ensure no measures are overlooked. It simply identifies if there are opportunities for the measure to be implemented, and whether the measure could play a role in alleviating surface water flood risk.

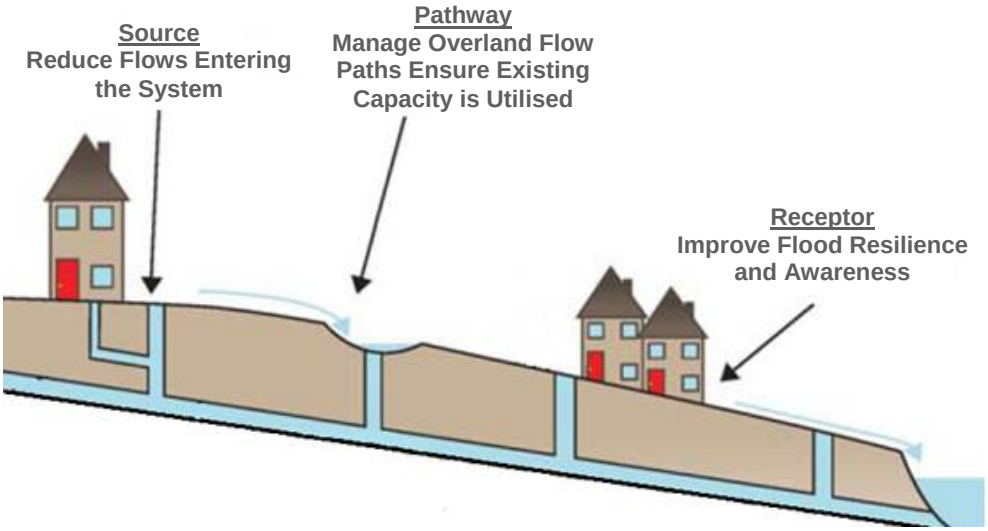
As detailed in the Defra SWMP Technical Guidance 2010, measures have been identified regardless of the potential mechanism or funding. A standard set of structural[11] and non-structural[12] measures have been considered for each of the shortlisted CDAs (Table 10-1) following the source-pathway-receptor model (Figure 10-1).

Table 10-1: Structural and Non-Structural Measures for Consideration

Source	Pathway	Receptor
Green roof Soakaways Swales Permeable Paving Rainwater Harvesting Detention Basins	Increasing capacity in drainage systems Separation of foul and surface water sewers Improved maintenance regimes Managing overland flows Land management practices	Improved weather warning Planning policies to influence development Temporary or demountable flood defences Social change, education and awareness Improved resilience and resistance measures

[11] Structural measures are considered to be those which require fixed or permanent assets to mitigate flood risks.
[12] Non-structural measures are those which are responses to urban flood risk that may not involve fixed or permanent facilities, and whose positive contribution to the reduction of flood risk is most likely through a process of influencing behaviour.

Figure 10-1: Source-Pathway-Receptor Model (adapted from SWMP Technical Guidance, 2010)



An opportunity assessment was undertaken for each of the shortlisted CDAs to evaluate where there were opportunities for the implementation of structural and non-structural measures. The results from the Opportunity Assessment are presented for each of the shortlisted CDAs in Appendix E, and summarised in Table 10-2.

10.1.1.1 Quick Wins

In addition to the identification of measures, the first stage of the options assessment also identified potential 'Quick Wins' across each of the CDAs and in the Borough/District wide Policy Areas. Quick Wins are identified as actions that can be undertaken quickly and with low capital cost to immediately reduce the risk of surface water flooding in any given area. Quick Win examples include:

- removal of a blockage of a trash screen currently preventing full conveyance of flow in an ordinary watercourse;
- removal of debris from gulley pots or slot drains currently restricting drainage flow rates and causing unnecessary surface water ponding;
- clearance of excessive weed growth from an ordinary watercourse or drainage ditch currently reducing conveyance; or
- Council wide communications strategies to raise awareness of surface water flood risk prone areas.

Potential Quick Wins have been identified through a combination of:

- site visits undertaken to each CDA as part of Phase 2 and Phase 3 of this SWMP;
- discussions with drainage engineers at each of the partner authorities; and
- the parallel development of an Asset Register[13] for the South Essex Study area on behalf of Essex County Council.

The Quick Wins identified are detailed for the Borough/District wide policy areas (see Section 10.2) and each CDA in Part B of this Phase 3 section of the SWMP.

[13] As required for Lead Local Flood Authorities by the Flood and Water Management Act 2010

Table 10-2: Measures Opportunity Assessment

CDA ID	CDA Name	Source								Pathway								Receptor					
		Green Roof	Soakaways	Swales	Permeable Paving	Rainwater Harvesting	Detention Basins	Ponds and Wetlands	Other 'Source' Measures	Increasing Capacity in Drainage Systems	Separation of Foul and Surface Water Sewers	Improved Maintenance Regimes	Managing Overland Flows (Online Storage)	Managing Overland Flows (Preferential Flow paths)	Land Management Practices	Deculverting Watercourse(s)	Other 'Pathway' Measures	Improved Weather Warning	Planning Policies to Influence Development	Temporary or Demountable Flood Defences	Social Change, Education and Awareness	Improved Resilience and Resistance Measures	Other 'Receptor' Measures
BAS 1	North West Billericay	?	?	?	?	?	✓	?	✓	✓	×	✓	✓	?	?	×	N/A	?	✓	✓	✓	?	N/A
BAS 3	Stock Road	?	?	?	?	✓	✓	×	N/A	✓	×	✓	✓	✓	?	×	✓	?	✓	✓	✓	✓	N/A
BAS 4	Sunnymede	?	?	?	?	✓	✓	✓	N/A	✓	×	✓	✓	?	?	×	?	?	✓	✓	✓	?	N/A
BAS 8	Laindon	?	?	?	?	✓	✓	×	N/A	✓	×	✓	?	✓	?	×	N/A	?	✓	✓	✓	?	N/A
BAS 12	Kingswood / Dry Street	?	?	✓	?	✓	✓	×	N/A	✓	×	✓	?	✓	✓	×	✓	?	✓	✓	✓	?	N/A
BAS 14	Barstable / Fryerns	?	?	?	?	✓	✓	?	N/A	✓	×	✓	✓	✓	✓	×	✓	?	✓	✓	✓	?	N/A
BAS 15	Chalvedon / Felmores	?	?	?	?	✓	✓	×	N/A	✓	×	✓	×	×	✓	×	N/A	?	✓	✓	✓	✓	N/A
BAS 16	Bowers Gifford	?	?	?	?	✓	✓	?	N/A	✓	×	✓	✓	✓	✓	×	N/A	?	✓	✓	✓	✓	N/A
BAS 17	Pitsea	?	?	?	?	✓	✓	×	N/A	✓	×	✓	✓	?	✓	×	N/A	?	✓	✓	✓	?	N/A
BAS 21	Bromfords	?	?	?	?	✓	✓	✓	N/A	✓	×	✓	?	✓	✓	×	N/A	?	✓	✓	✓	?	N/A
BAS 22	Cranfield Park Road	?	?	✓	?	✓	✓	×	N/A	✓	×	✓	?	✓	✓	×	N/A	?	✓	✓	✓	?	N/A
CAS 1	South Benfleet	?	?	?	?	✓	✓	?	N/A	✓	×	✓	?	✓	✓	×	N/A	?	✓	✓	✓	?	N/A
CAS 2	New Thundersley	?	?	?	?	✓	✓	?	✓	✓	×	✓	?	✓	✓	×	✓	?	✓	✓	✓	?	N/A
CAS 3	East Thundersley	?	?	?	?	✓	✓	?	N/A	✓	×	✓	✓	✓	✓	×	N/A	?	✓	✓	✓	?	N/A
CAS 4	Hadleigh	?	?	?	?	✓	✓	?	N/A	✓	×	✓	✓	?	?	×	N/A	?	✓	✓	✓	✓	N/A
CAS 6	Canvey Island	?	?	?	?	✓	✓	✓	N/A	✓	×	✓	?	×	?	×	N/A	?	✓	?	✓	?	N/A
ROC 1	Rayleigh West	?	?	?	?	✓	✓	✓	N/A	✓	×	✓	✓	?	✓	×	N/A	?	✓	✓	✓	✓	N/A
ROC 2	Watery Lane	?	?	?	?	✓	✓	✓	N/A	✓	×	✓	✓	×	✓	×	N/A	?	✓	✓	✓	✓	N/A
ROC 4	Hockley	?	?	?	?	✓	✓	?	N/A	✓	×	✓	✓	✓	?	×	N/A	?	✓	✓	✓	?	N/A
ROC 6	Rayleigh East	?	?	?	?	✓	✓	✓	N/A	✓	×	✓	✓	✓	✓	×	N/A	?	✓	✓	✓	?	N/A
ROC 7	Ashingdon / Rochford	?	?	?	?	✓	✓	?	N/A	✓	×	✓	?	✓	✓	×	✓	?	✓	✓	✓	?	N/A
ROC 8	Great Stambridge	?	?	?	?	✓	✓	✓	N/A	✓	×	✓	✓	×	✓	×	✓	?	✓	✓	✓	?	N/A
ROC 9	Little / Great Wakering	?	?	?	?	✓	✓	×	N/A	✓	×	✓	✓	?	✓	×	N/A	?	✓	✓	✓	?	N/A

Measures Opportunity Assessment Criteria	
✓	There are opportunities for implementation of this mitigation measure within the CDA. Measure should be considered in the Options Assessment.
?	There may be some, but limited opportunities for implementation of this mitigation measure within the CDA. Measures should be considered in the Options Assessment but would likely be limited in effectiveness or be subject to site-specific investigations prior to consideration.
×	There are no opportunities for implementation of measure within CDA. The measure is either not suitable, or it is not required to address the surface water flood risk within the CDA.
N/A	Not applicable - to be used where not other measures are identified.

10.1.2 Stage 2 – Identify Potential Options

A series of options have been defined based on consideration of a single measure or combination of measures as identified in Stage 1. Each of the standard measures identified in Stage 1 have been categorised within an option and each of these options has been considered for each CDA (see Table 10-3).

All potential options have been considered including[14]:

- options that change the source of risk;
- options that modify the pathway or change the probability of flooding;
- options that manage or modify receptors to reduce the consequences;
- temporary as well as permanent options;
- options that work with the natural processes wherever possible;
- options that are adaptable to future changes in flood risk;
- options that require actions to be taken to deliver the predicted benefits (for example, closing a barrier, erecting a temporary defence or moving contents on receiving a flood warning);
- innovative options tailored to the specific needs of the project; and,
- options that can deliver opportunities and wider benefits, through partnership working where possible.

Where possible options have been identified that have multiple benefits, for example to alleviate flooding from other sources, or provide environmental benefits such as water quality, biodiversity and amenity benefits.

Table 10-3: Potential Options

Description		Standard Measures Considered
Do Nothing	Make no intervention / maintenance	None
Do Minimum	Continue existing maintenance regime	None
Improved Maintenance	Improve existing maintenance regimes e.g. target improved maintenance to critical points in the system.	- Improved Maintenance Regimes - Other 'Pathway' Measures
Planning Policy	Use forthcoming development control policies to direct development away from areas of surface water flood risk or implement flood risk reduction measures.	- Planning Policies to Influence Development
Source Control, Attenuation and SuDS	Source control methods aimed to reduce the rate and volume of surface water runoff through infiltration or storage, and therefore reduce the impact on receiving drainage systems.	- Green Roof - Soakaways - Swales - Permeable paving - Rainwater harvesting - Detention Basins - Ponds and Wetlands - Land Management Practices - Other 'Source' Measures

[14] Environment Agency (March 2010) 'Flood and Coastal Flood Risk Management Appraisal Guidance', Environment Agency: Bristol.

Description		Standard Measures Considered
Flood Storage / Permeability	Large-scale SuDS that have the potential to control the volume of surface water runoff entering the urban area, typically making use of large areas of green space. Upstream flood storage areas can reduce flows along major overland flow paths by attenuating excess water upstream.	- Detention Basins - Ponds and Wetlands - Managing Overland Flows (Online Storage) - Land Management Practices - Other 'Source' Measures - Other 'Pathway' Measures
Separate Surface Water and Foul Water Sewer Systems[15]	Where the CDA is served by a combined drainage network separation of the surface water from the combined system should be considered. In growth areas separation of existing systems creates capacity for new connections.	- Separation of Foul and Surface Water Sewers
De-culvert / Increase Conveyance	De-culverting of watercourses and improving in-stream conveyance of water.	- De-culverting Watercourse(s) - Other 'Pathway' measures
Preferential / Designated Overland Flow Routes	Managing overland flow routes through the urban environment to improve conveyance and routing water to watercourses or storage locations.	- Managing Overland Flows (Creating preferential flowpaths) - Temporary or Demountable Flood Defences - Other 'Pathway' measures
Community Resilience	Improve community resilience and resistance of existing and new buildings to reduce damages from flooding, through (predominantly) non-structural measures. This option is particularly useful where opportunities for structural measures to alleviate surface water flooding are limited.	- Improved Weather Warning - Temporary or Demountable Flood Defences - Social Change, Education and Awareness - Improved Resilience and Resistance Measures - Other 'Receptor' Measures
Infrastructure Resilience	Improve resilience of critical infrastructure in the CDA that is likely to be impacted by surface water flooding e.g. electricity substations, pump houses.	- Improved Resilience and Resistance Measures - Other 'Receptor' Measures
Other - Improvement to Drainage Infrastructure	Add storage to, or increase the capacity of, underground sewers and drains and improving the efficiency or number of road gullies.	- Increasing Capacity in Drainage Systems - Other 'Pathway' measures
Other or Combination of Above	Any alternative options that do not fit into above categories and any combination of the above options where it is considered that multiple options would be required to address the surface water flooding issues.	

Each of the options have been assessed for initial feasibility within each of the CDAs, in terms of:

a. Whether there are opportunities for the option to be implemented; and

b. Whether the option is likely to reduce or alleviate flood risk in the CDA.

An example of how the options have been assessed (and which measures make up the options) is included in Figure 10-2 for CDA BAS1 (North West Billericay). Assessment tables for each of the CDAs are included in Appendix E.

[15] For all CDAs considered in the South Essex SWMP, separation of combined sewers is not a potential option as all of the CDAs have largely separate foul and surface water drainage systems.

Figure 10-2: Example Option Identification Output

Critical Drainage Area ID: BAS 1 **North West Billericay**

Option No.	Option (Scheme Category)	Standard Measures: SOURCE: Green Roof	Soakaways	Swales	Permeable Paving	Rainwater Harvesting	Detention Basins	Ponds and Wetlands	Other 'Source' Measures	PATHWAY: Increasing Capacity in Drainage Systems	Separation of Foul and Surface Water Sewers	Improved Maintenance Regimes	Managing Overland Flows (Online Storage)	Managing Overland Flows (Preferential Flowpaths)	Land Management Practices	Deculverting Watercourse(s)	Other 'Pathway' Measures	RECEPTOR: Improved Weather Warning	Planning Policies to Influence Development	Temporary or Demountable Flood Defences	Social Change, Education and Awareness	Improved Resilience and Resistance Measures	Other 'Receptor' Measures	Appropriate Measures Available?	Shortlisting Options: Technical	Economic	Social	Environmental	Objectives	Overall	Take Forward Option to Detailed Assessment?	Comments
1	**Do Nothing**																							✓	2	-1	-2	0	-2	-3	✓	In line with PAG the 'do nothing' option (no intervention and no maintenance) and 'do minimum' (continuation of current practise) should be taken forward to the detailed options assessment.
2	**Do Minimum**																							✓	2	0	-1	0	-1	0	✓	
3	**Improved Maintenance**																N/A							✓	2	1	1	0	1	5	✓	This option is relatively easy to implement through the revision of the existing maintenance schedule. However this will only have localised benefits
4	**Planning Policy**																							✓	2	2	0	1	1	6	✓	To implement this option into new developments would be relatively simple through planning policy.
5	**Source Control, Attenuation and SUDS**																							✓	1	2	1	1	2	7	✓	To implement this option into new developments would be relatively simply and through planning policy. Once an area has been identified as being in a critical drainage area, policies to manage the surface water on the site are already in place.
6	**Flood Storage / Permeability**																N/A							✓	1	0	1	1	2	5	✓	Further investigation would be needed to assess the potential of detention basins or ponds, and the suitability of infiltration systems.
7	**Separate Surface Water and Foul Water Sewer Systems**																							×								
8	**De-culvert / Increase Conveyance**																N/A							×	2	-1	1	0	2			Further investigation needed
9	**Preferential / Designated Overland Flow Routes**																N/A							✓	1	1	0	-1	1	2	×	Implementation potential is limited, and is unlikely to reduce flood risk significantly. Further investigation is needed
10	**Community Resilience**																						N/A	✓	2	1	1	0	1	5	✓	A combination of resistance measures, education and flood warning would be beneficial in reducing flood damages
11	**Infrastructure Resilience**																						N/A	✓	2	0	1	0	1	4	×	Cost of this will exceed benefits.
12	**Other - Improvement to Drainage Infrastructure**																N/A							✓	1	-1	0	0	1	1	×	This is technically possible but the cost-benefit ratio is likely to be negative.
13	**Other or Combination of Above**																							✓	1	1	1	1	1	5	✓	A combination of measures, including flood storage at Lake Meadows and The Pantiles, along with raising community awareness within the PSWFH

10.1.3 Stage 3 – Short List Options

This stage takes the options identified through Stage 2 and short lists them based on a range of technical, economic, social, environmental and flood risk success criteria. A high-level scoring system for each of the options has been developed.

This approach to short-listing the measures is based on the guidance in Flood and Coastal Erosion Risk Management (FCERM) appraisal guidance and Defra's SWMP Technical Guidance 2010. The scoring criteria are provided in Table 10-4.

Table 10-4: Options Assessment Short Listing Criteria

Criteria	Description	Score
Technical	- Is it technically possible and buildable? - Will it be robust and reliable? - Would it require the development of a new technique for its implementation?	U: Unacceptable (measure eliminated from further consideration) -2: Severe negative outcome -1: Moderate negative outcome 0: Neutral +1: Moderate positive outcome +2: High positive outcome
Economic	- Will benefits exceed costs? - Is the measure likely to be within the available budget? - Estimate the whole life costs of the option including asset replacement, operation and maintenance. The scoring of this measure will depend on the budget available from the local authority although it should be remembered that alternative routes of funding could be available.	
Social	- Will the community benefit or suffer from implementation of the measure? - Does the option promote social cohesion or provide an improved access to recreation/open space? - Does the option result in opposition from local communities for example if an option involves the displacement of houses?	
Environmental	- Will the environment benefit or suffer from implementation of the measure? - Would the option have a positive or negative effect on the environment for example, water quality and biodiversity?	
Objectives	- Will it help to achieve the objectives of the SWMP partnership? - Does the option meet the overall objective of alleviating flood risk?	

An Options Workshop was held with the South Essex SWMP Working Group on 16th August 2011 to discuss and agree the short listed options identified for each CDA through the options assessment. The process is aimed to ensure that inappropriate measures are eliminated early in the process to avoid investigation of options that are not acceptable to stakeholders. The agreed short listed options have been progressed to the Preferred Options stage where they have been developed further and costed.

Appendix E provides the short listed options and associated scoring criteria for each of the shortlisted CDAs. These have been developed into the Preferred Options and are discussed within Part B of the Phase 3 section of the SWMP report for the relevant Council area.

10.1.4 Stage 4 – Determine High-Level Costs and Benefits

Following the Options Workshop and consultation with relevant stakeholders, the preferred options (combination of measures) have been identified for each of the shortlisted CDAs and further assessed to:

- estimate high-level benefits; and,
- estimate the approximate high- level implementation costs.

A detailed appraisal of cost and benefits of each of the options is not deemed to be practical for the strategic level of this SWMP's study and the large number of CDAs and therefore should be carried out as part of a more detailed cost:benefit appraisal for individual CDAs and/or options, potentially as part of any future feasibility studies.

10.1.4.1 Benefits

In addition the qualitative assessment of benefits undertaken in Stage 2 of option identification (based on social, environmental, economic and objective ranking), a high level benefit identification exercise has been undertaken in this fourth stage to allow comparison of flood mitigation options and to give a quantitative basis for estimating the benefit that could accrue from an option per unit cost. The following method has been applied:

- the potential benefits of the options are measured using an estimated percentage of units which could benefit from a reduction in flood risk;
- the percentage has been determined by calculating the number of flooded units within the PSWFH that the particular option has been designed to mitigate, as a percentage of the number of flooded units within the CDA as a whole;
- the input is restricted to multiples of five percent; and,
- further modelling would be required to determine more accurately the potential benefits of the suggested options.

10.1.4.2 Costs

An estimated cost for the preferred flood mitigation option for each shortlisted CDA identified has been calculated based on standard unit costs (as provided in Appendix E). No monetised damages have been calculated, and flood mitigation costs have been determined using engineering judgement, but have not undergone detailed analysis. The following standard assumptions have been applied:

- the costs are the capital costs for implementation of the scheme only;
- costs do not include provisions for consultancy, design, supervision, planning process, permits, environmental assessment or optimum bias;
- no provision is made for weather (e.g. winter working);
- no provision is made for access constraints;
- where required, it will be stated if costs include approximate land acquisition components;
- no operational or maintenance costs are included; and
- no provision is made for disposal of materials (e.g. for flood storage or soakaway clearance).

As a result, costs have been provided as cost bands[16], reflecting the strategic nature of the SWMP study and options identification. The focus is on providing an indicative cost per option to assist in decision making regarding further investigation into option identification.

10.2 Borough Wide Options

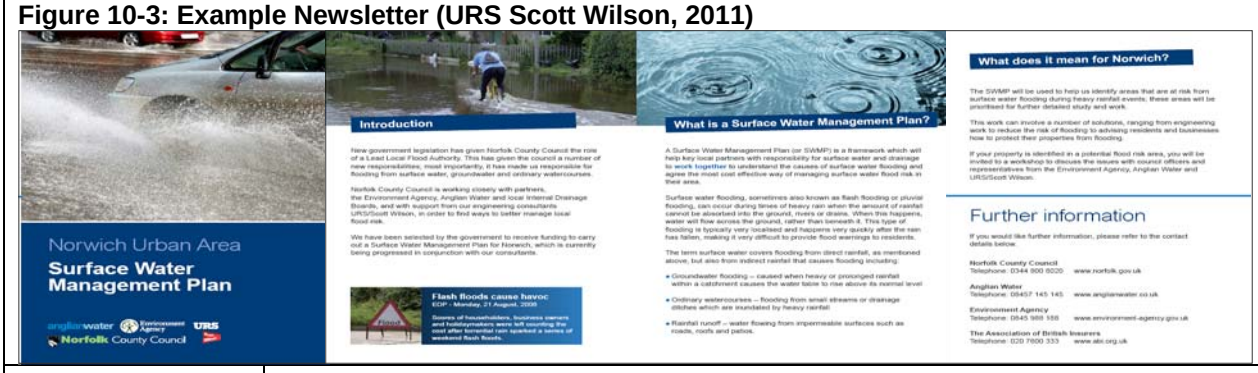
As part of Phase 3, Policy Areas have been defined across the Study Area within which appropriate planning, maintenance and management and community policies should be

[16] The cost bands to be used are: <£25k, £26k - £50k, £51k - £100k, £101k - £250k, £251k - £500k, £501k - £1m and >£1m.

applied to manage and mitigate flood risk. These Policy Areas cover each of the Councils administrative areas, and are not limited to CDA extents. The reason for the inclusion of these areas is to highlight the fact that even if an area does not fall within a CDA it does not mean that surface water discharge from these areas is not a concern and does not need to be managed or mitigated; merely that the need for considering direct options for the area are not so critical.

The preferred Borough-wide options include:

- raising community awareness;
- ongoing improvements to maintenance of drainage network;
- land management;
- Wash / Flood Storage Management Plan;
- planning and development control policies;
- water conservation; and,
- improving resilience to flooding.

Council Wide Options: Raising Community Awareness	
A 'quick win' action that should be implemented in the short-term is to increase awareness of flooding within communities at risk, and across the Borough as a whole. This could be achieved through a number of measures including: • Newsletters (see example in Figure 10-3); • Drop-in surgeries in CDAs; • Promotion on Basildon Borough Council, Castle Point Borough Council, Rochford District Council and Essex County Council (as LLFA) websites; and/or • Preparing a Community Flood Plan. This action complements the initial SWMP Communication Strategy developed and reported in Phase 1 of this SWMP. The aim of this action is to highlight the risks and consequences of surface water flooding amongst local communities and, through this, encourage residents to take up measures to combat flooding, such as installation of water butts to capture roof runoff, and consideration to the extent of (and materials used) when replacing permeable areas with hard standing areas within their property e.g. through the installation of driveways and patios. **Figure 10-3: Example Newsletter (URS Scott Wilson, 2011)**  	
Option A	Hold a public meeting following the letter drop where residents can highlight any local issues and flooding/drainage concerns. This could include a talk from the key partner organisations, including the Environment Agency, Anglian Water and Essex County Council – on the work that is being undertaken and who is responsible. Such a meeting should also outline how residents can help themselves and highlight their responsibility for maintaining private drainage, soakaways, driveway drainage etc.
Option B	Undertake a letter drop to highlight the improvement works that have been implemented (i.e., through Quick Wins and requirements of the Flood and Water Management Act 2010) as well as works that are planned for the future.
Option C	Develop an information and discussion portal. This could provide up to date information about ongoing work, contact details of council members and references to supporting documents as well as an opportunity for members of the public to record incidences or evidence of localised surface water flooding. A discussion forum could be set up to allow residents to comment on actions and raise any concerns they may have. The portal could provide: • a list of appropriate property-level flood risk resilience measures that could be installed; • a list of 'approved' suppliers for providing local services, such as repaving of driveways; • a link to websites / information sources providing further information; • an update on work being undertaken in the Borough by the Council and/or other Stakeholders to address surface water flood risk; and, • a calendar showing when gullies are to be cleaned in given areas, to encourage residents to ensure that cars are not parked over gullies / access is not blocked during these times.

Council Wide Options: Ongoing Improvements to Maintenance of Drainage Network

The management and maintenance of the urban drainage network in South Essex is the responsibility of a number of organisations:

- Basildon Borough Council, Castle Point Borough Council, Rochford District Council – responsible for highway drainage including gully pots, non-main river channel maintenance and surface water;
- Anglian Water – responsible for main sewers and lateral sewers;
- Environment Agency – responsible for flood risk management assets on main rivers including culverts, raised defences, trash screens, Main River channel;
- Essex County Council – responsible for highway drainage, including gully pot clearance and surface water runoff from the Highway; and,
- Network Rail – responsible for railway drainage.

Effective cleansing of gully pots and other associated highway drainage features is fundamental to the effective operation of drainage infrastructure across each of the Council administrative areas and Essex County Council (Highway Authority) operates a regular maintenance regime for gully cleansing. Gully pots are fundamental to integrated urban drainage in that during intense precipitation events, surface water runoff is routed off roadways and other hard-standing and into gully pots and then into the public sewer system or watercourse. In essence, highway drainage features are a critical link in the performance of the overall drainage network.

A summary of the identified drainage maintenance is provided below:

- Level of Service – The current Highways Department maintenance cycle for gullies is determined locally, but generally they should be cleansed once per year.
- Development Pressures and Urban Creep – During site visits, the conversion of front gardens to paved areas for car parking was observed. This gradual increase in hard-standing (impervious area) results in cumulative impacts and additional pressure on the drainage system to cope with increased runoff.

The Environment Agency have suggested that their operational teams and Borough/District council contractor teams could combine efforts (and share resources) for maintenance regimes (such as weed clearance) of ordinary watercourses.

Option A	Encourage gully cleansing contractors to use powers to enforce movement of parked cars to ensure all gullies are regularly cleared.
Option B	Coordinate timing of gully cleansing rounds to ensure that they do not coincide with school opening and closing times and other peak times that would prevent gaining access to gullies.
Option C	Focus attention on the maintenance of gully pots in the identified CDAs which are considered to be high risk and on those areas identified as being at risk from blocked gullies
Option D	Develop a GIS database of all Council-owned flood / drainage assets in conjunction with Essex County Council as LLFA. It is recommended that this database supplements the Asset Register currently being developed by Essex County Council, by including more detail on local assets such as gully pots and slot drains.
Option E	Record and investigate incidents of flooding and provide information to Essex County Council as LLFA. It is recommended that the source of flooding be recorded.
Option F	Agree with the Environment Agency an ongoing protocol for sharing resources of operational teams for routine clearance works on ordinary watercourses, drainage ditches and sections of main river.

Council Wide Options: Land Management

The management of open land can be very influential on the generation of surface water runoff; this includes land such as school playing fields, recreational grounds and farmland. Where these fall within a CDA, additional maintenance measures should be taken to ensure the infiltration potential of the land is maximised, and the surface water runoff is reduced.

School grounds and recreational areas: The intensity of an extreme rainfall event is likely to exceed the infiltration rate of the soil, especially one which is heavily compacted. The aeration (or spiking) of sports fields and recreation grounds will ensure the top soils retain a higher infiltration potential and create a greater surface roughness. Such an action will reduce the volumes and velocity of surface water runoff generated from this land use. This practice could be incorporated into the site maintenance schedule of the school or recreational ground and would be undertaken as part of the maintenance work.

Farmland: Agricultural farmland makes up a large proportion of the South Essex study area and contributes significantly to many of the CDAs identified. Practices such as ensuring the direction the land is ploughed follows contours, or the duration that land is left bare should be considered. The direction the land is ploughed could influence the channelling of surface water runoff generated from the land. By ploughing perpendicularly to the slope of the land, the rivets created act to obstruct the flow of surface water, so reducing the velocity of the surface water runoff. By minimising the duration that the land is bare of vegetation will increase the surface roughness for a greater duration. Leaving plants in the soil throughout the winter will provide a greater surface roughness than leaving the land bare. In addition, this may help in ensuring the stability of the soil and therefore preventing the leaching of nutrients during the non-growing season. Such practices should be implemented on steeper slopes that fall within CDAs.

Urban centres: Where there is a high level of urban development, the planting of trees and shrubs should be encouraged, to intercept rainfall and reduce the velocity of surface water runoff. Alternatively the use of bio-retention systems could be utilised to assist in the removal of pollutants carried from impermeable surfaces.

Land management options could provide multiple benefits in addition to flood risk management interests. Natural England and Defra operate grant assistance for some schemes under the Catchment Sensitive Farming initiative (http://www.naturalengland.org.uk/ourwork/farming/csf/default.aspx).

Option A	Introducing operational maintenance regimes for aeration of sports grounds, school playing fields and football pitches to improve infiltration potential.
Option B	Encourage the uptake of beneficial farming practices that will assist in the infiltration of surface water and prevent the generation of overland flow. Engage with farmers who have land within the CDAs to determine feasible options and encourage the implementation of these practices.
Option C	Increase vegetation coverage within urban areas, such as trees along roadside and walkways. This will additionally improve the ecological and amenity value of the urban spaces.

Council Wide Options: Washland / Flood Storage Management Plan

The management and maintenance of the Washland / Flood Storage areas (particularly within Basildon Borough Council) is crucial in reducing the risk of surface water flood risk. The washlands should operate in such a way that attenuated flows pass from one storage area to the next, via engineered channels and regulated by structures at the outfalls of major storage areas. Pluvial modelling undertaken for the intermediate assessment has indicated that the washland and storage areas within the study area are performing a vital role in storing surface water flows and preventing flooding further downstream in urban areas; however, it is essential that these systems continue to function to their optimum and their operational performance is not limited by poor understanding of how each washland operates and what maintenance is required to maintain storage levels and outfalls.

Areas identified as already having an important washland function, or with the potential to be used as washlands, in relation to future flood management options, should be protected from being allocated for development by the Local Planning Authority, particularly in CDAs where washland options are identified as providing the greatest benefits.

Any attenuation areas should also be given appropriate legal protections (registered as Flood Risk Management (FRM) Infrastructure) to prevent third party actions from damaging the potential functioning of these areas.

It is recommended that the following is undertaken on all existing and new washlands and flood storage areas:

- formalise the owner and operator of each washland/ flood storage area (designate it as FRM Infrastructure);
- establish what maintenance is currently undertaken, and by whom;
- create a Washland Management Plan, the purpose of which must be primarily concerned with the integrity of the washland as a drainage and flood management asset, rather than any residual uses such as how its open space role; and,
- engage local residents in the multi-functional use of the space.

Figure 10-4: Albany Road, Flood Storage Area, Wickford

Option A	Formalise washland / flood storage areas as Flood Zone 3b to ensure their existing function is not compromised by the planning and development process. Establish ownership and ensure that each washland / flood storage area has its own management plan.
Option B	Undertake a comprehensive survey of connecting channels to ensure that they are free of blockages.

Council Wide Options: Planning and Development Policies

A number of options and policies have been identified across South Essex that the Councils and relevant stakeholders may consider adopting. The majority of the following options are common across South Essex; however the way in which they are implemented may vary.

Paved Gardens

Impermeable paving in gardens can significantly increase surface water runoff entering the local drainage network. Since 1st October 2008, permitted development rights that previously allowed householders to pave their front gardens with hard standing without planning permission was removed. Residents should be encouraged to design their gardens in a way that optimises drainage and reduces runoff. The Councils should publicise this issue and refer to standard guidance on the surfacing of front gardens provided by the CLG and Environment Agency.

Figure 10-5: Examples of Permeable Front Gardens Allowing for Parking

(Source: CLG/EA Guidance on the permeable surfacing of front gardens 2008; Richmond Scrutiny Report 2008)

Option A	Councils could encourage residents to ensure that paved areas in front gardens drain onto flower beds rather than running onto the highway.
Option B	Councils could aim to raise awareness of the options for installation and maintenance of permeable surfaces within property grounds.
Option C	Councils could aim to provide an information portal that residents can consult for further information on permeable paving and other SuDS measures, including links to other organisations (e.g. Environment Agency) who can provide 'best practice' guidance and examples.
Option D	Councils could aim to educate/train their staff to ensure that planning officers: • are aware of the existing planning policies, guidance and best practice; • are in a position to educate the public if enquiries are made regarding planning permission to change the surfaces of their drive/garden; and • can identify/enforce for non-compliance or non-permitted conversion (in particular in CDAs where it exacerbates the problem).

Sustainable Drainage Systems (SuDS)

Policies already apply within Basildon Borough Council, Castle Point Borough Council and Rochford District Council to ensure that new development incorporates Sustainable Drainage Systems (SuDS) wherever possible. It is recommended that these are reviewed and updated where necessary in the light of the Groundwater Assessment (Appendix A3) and the SuDS Suitability Map for each of the administrative areas: Basildon Borough Council Figure B 6, Castle Point Borough Council Figure C 6 and Rochford District Council Figure D 6. A summary of the type of SuDS that could be utilised is provided below.

SuDS techniques can be used to reduce the rate and volume and improve the water quality of surface water discharges from sites to the receiving environment (i.e. natural watercourse or public sewer etc) and can also contribute significantly to the amenity and ecology/biodiversity within the community. Various SuDS techniques are available and operate on two main principles; attenuation and infiltration. All systems generally fall into one of these two categories, or a combination of the two.

Infiltration SuDS

This type of SuDS relies on discharges to ground, where suitable ground conditions exist or are appropriate. Therefore, infiltration SuDS are reliant on the local ground conditions (i.e. permeability of soils and geology, the groundwater table depth and the importance of underlying aquifers as a potable resource) for their successful operation. A site specific survey is likely to be required.

Development pressures and maximisation of the developable area may reduce the area available for infiltration systems. This can be overcome through the use of a combined approach with both attenuation and infiltration techniques e.g. attenuation storage may be provided in the sub-base of a permeable surface, within the chamber of a soakaway or as a pond/water feature.

Permeable surfaces are designed to intercept rainfall and allow water to drain through to a sub-base. The use of a permeable sub-base can be used to temporarily store infiltrated run-off underneath the surface and allows the water to percolate into the underlying soils. Alternatively, stored water within the sub-base may be collected at a low point and discharged from the site at an agreed rate.

Permeable paving prevents runoff during low intensity rainfall, however, during intense rainfall events some runoff may occur from these surfaces.

Programmes should be implemented to ensure that permeable surfaces are kept well maintained in line with National Standards and Essex County Councils SuDS Design and Adoption Guide to ensure the performance of these systems is not reduced. The use of grit and salt during winter months may adversely affect the drainage potential of certain permeable surfaces, so should be avoided.

Types of permeable surfaces include:

- Grass/landscaped areas, including swales, infiltration ponds/basins;
- Gravel;
- Permeable Pavement – solid segmental paving with void spaces between pavers;
- Porous Pavement – a surface which has void spaces within the material.

Where permeable surfaces are not a practical option more defined infiltration systems are available. In order to infiltrate the generated run-off to ground, a storage system is provided that allows the infiltration of the stored water into the surrounding ground through both the sides and base of the storage. These systems are constructed below ground and therefore may be advantageous with regards to the developable area of the site. Consideration needs to be given to construction methods, maintenance access and depth to the water table. The provision of large volumes of infiltration/sub-surface storage has potential cost implications. In addition, these systems should not be built within 5m of buildings, beneath roads or in soil that may dissolve or erode.

Various methods for providing infiltration below the ground include:

- Geocellular Systems

- Filter Drain
- Soakaway (Chamber)
- Soakaway (Trench)
- Soakaway (Granular Soakaway)

The infiltration SuDS suitability assessment shown in Appendix A3 is based on minimum permeability data obtained from the BGS. There also exist maximum permeability data, however, only the minimum permeability is used, as this is understood to be more representative of the bulk permeability.

Three permeability zones have been identified:

- Infiltration SuDS potentially suitable: Minimum permeability is high or very high for bedrock (and superficial deposits if they exist).
- Infiltration SuDS potentially unsuitable: Minimum permeability is low or very low for bedrock (and superficial deposits if they exist).
- Infiltration SuDS suitability uncertain: Minimum permeability is low or very low for bedrock and high or very high for superficial deposits OR minimum permeability is low or very low for superficial deposits and high or very high for bedrock.

Figure B 6, Figure C 6 and Figure D 6 show that much of Basildon Borough Council, Castle Point Borough Council and Rochford District Council are **potentially unsuitable for infiltration SuDS**; this is where the impermeable London Clay Formation is at surface. The suitability of infiltration SuDS in areas with River Terrace Deposits, Bagshot Formation and Stanmore Gravel Formation is uncertain i.e. the ability of the River Terrace Deposits to store and transmit groundwater without causing flooding / drainage issues is uncertain and requires further investigation.

It must be noted however that this was a high level assessment and only forms an approximate guide to infiltration SuDS suitability; a site investigation is required in all cases to confirm exact local conditions.

Attenuation SuDS

If ground conditions are not suitable for infiltration techniques then management of surface water runoff prior to discharge should be undertaken using attenuation techniques. This technique attenuates discharge from a site to reduce flood risk both within and to the surrounding area. It is important to assess the volume of water required to be stored prior to discharge to ensure adequate provision is made for storage. The amount of storage required should be calculated prior to detailed design of the development to ensure that surface water flooding issues are not created within the site.

The rate of discharge from the site should be agreed with the Environment Agency and Local Planning Authority who will determine the overall planning application. If surface water cannot be discharged to a local watercourse then liaison with the Sewer Undertaker should be undertaken to agree rates of discharge and the adoption of the SuDS system.

Large volumes of water may be required to be stored on site. Storage areas may be constructed above or below ground. Depending on the attenuation/storage systems implemented, appropriate maintenance procedures should be implemented to ensure continued performance of the system. On-site storage measures include basins, ponds, and other engineered forms consisting of underground storage.

Basins are areas that have been contoured (or alternatively embanked) to allow for the temporary storage of run-off from a developed site. Basins are designed to drain free of water and remain waterless in dry weather. These may form areas of public open space or recreational areas. Basins also provide areas for treatment of water by settlement of solids in ponded water and the absorption of pollutants by aquatic vegetation or biological activity. The construction of basins uses relatively simple techniques. Local varieties of vegetation should be used wherever possible and should be fully established before the basins are used. Access to the basin should be provided so that inspection and maintenance is not restricted. This may include inspections, regular cutting of grass, annual clearance of aquatic vegetation and silt removal as required.

Ponds are designed to hold the additional surface water run-off generated by the site during rainfall events. The ponds are designed to control discharge rates by storing the collected run-off and releasing it slowly once the risk of flooding has passed. Ponds can provide wildlife habitats, water features to enhance the urban landscape and, where water quality and flooding risks are acceptable, they can be used for recreation. It may be possible to integrate ponds and

wetlands into public areas to create new community ponds. Ponds and wetlands trap silt that may need to be removed periodically. Ideally, the contaminants should be removed at source to prevent silt from reaching the pond or wetland in the first place. In situations where this is not possible, consideration should be given to a small detention basin placed at the inlet to the pond in order to trap and subsequently remove the silt. Depending on the setting of a pond, health and safety issues may be important issues that need to be taken into consideration. The design of the pond can help to minimise any health and safety issues (i.e. shallower margins to the pond reduce the danger of falling in, fenced margins).

Various types of ponds are available for utilising as SuDS measures. These include:

- Balancing/Attenuating Ponds
- Flood Storage Reservoirs
- Lagoons
- Retention Ponds
- Wetlands

When designing flood storage options the potential storage volume should be checked to see if it falls within the Reservoirs Act designation criteria.

Site constraints and limitations such as developable area, economic viability and contamination may require engineered solutions to be implemented. These methods predominantly require the provision of storage beneath the ground surface, which may be advantageous with regards to the developable area of the site but should be used only if methods in the previous section cannot be used. When implementing such approaches, consideration needs to be given to construction methods, maintenance access and to any development that takes place over the storage facility. The provision of large volumes of storage underground also has potential cost implications.

Methods for providing alternative attenuation include:

- Deep Shafts
- Geocellular Systems
- Oversized Pipes
- Rainwater Harvesting
- Tanks
- Green and Brown Biodiverse Roofs

In some situations it may be preferable to combine infiltration and attenuation systems to maximise the management of surface water runoff, developable area and green open space.

Option A	Councils should use planning policies to identify the use of SuDS to manage surface water from new developments. Preferred options should be stated, such as attenuation and reuse of rainwater on site, with the least suitable options being discharge into the existing surface water sewers.

Council Wide Options: Water Conservation

Water conservation is a key option for reducing peak discharges and in turn downstream flood risk. This can be applied using a number of options including planning led encouragement of the use of rainfall in rainwater harvesting systems and property level use of water butts. Both are described in more detail below.

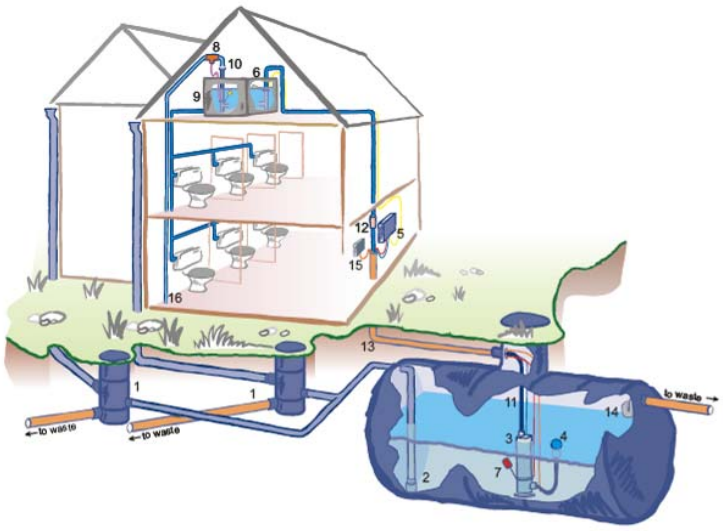
Rainwater Harvesting

The potential for the use of rainwater should be jointly led by Anglian Water Services and the councils. Promotion of the benefits of such schemes could be rolled out across South Essex to reduce costs. The principle of rainwater harvesting in both domestic and commercial property is the same. Rainwater from roof areas is passed through a filter and stored within large underground tanks. When water is required, it is delivered from the storage tank to toilets, washing machines and garden taps for use. If the tank becomes low on stored water, demand is topped up from the mains supply. Any excess water can be discharged via an overflow to a soakaway or local drainage network.

Rainwater harvesting systems could be retrofitted to local schools within South Essex. A case study for Southampton University Student Services Building is described below, with an example layout of a system illustrated in Figure 10-6[17]:

- Roof Area: 1000m2
- Underground storage tank: 15,000 litres
- Building occupancy: 150 people
- Planned usage: 21 WCs and 3 urinals
- Expected annual rainwater collection: 410,000 litres
- Capital cost: £4325
- Expected pay back time 5.3 years (based on Southern Water 2006 tariff)

Figure 10-6: Example Rainwater Harvesting System in a Commercial Property



1. Wisy WFF vortex Filter
2. Calmed inlet
3. Submersible pump
4. Floating suction filter
5. Control panel
6. Pumped demand float switch
7. Dry-run float switch
8. Solenoid valve
9. Mains demand float switch
10. Type AA air gap
11. Pressure hoses and cables
12. Non-return valve
13. 110mm pipe duct
14. Trapped overflow
15. Tank level gauge
16. Mains water supply

[17] *Source: Rainwater harvesting systems UK*

Council Wide Options: Water Conservation	
Option A	The Councils could consider providing an incentive scheme for the use of rainwater harvesting systems. This may be linked to a Councils sustainability checklist.
Option B	The Councils could consider retrofitting rainwater harvesting systems into Council owned properties, such as schools, for example, which offer educational opportunities as well as local surface water flood mitigation.
Option C	The Councils could explore potential opportunities for the installation of rainwater harvesting systems on new or regenerated development areas (in particular where there is high footfall / potential for use).

Water Butts

One of the preferred measures to reduce peak discharges and downstream flood risk, is the robust implementation of water butts on all new development within Basildon Borough Council, Castle Point Borough Council and Rochford District Council and where possible and higher surface water flooding risk has been identified, retrofitting these to existing properties. Given the constraints associated with infiltration across the study area, the wholesale implementation of water butts can significantly reduce peak discharges.

Water butts often have limited storage capacity given that when a catchment is in flood, water butts are often full, however it is still considered that they have a role to play in the sustainable use of water and there is potential to provide overflow devices to soakaways or landscaped areas to ensure that there is always a volume of storage available.

Whether to construct formal spill pipes to soakaways, or to allow simple overspill to the adjacent ground are detailed decisions that will need to be based on a site-by-site basis; this will have only minor significance on the proposals with respect to the surface water drainage.

Figure 10-7: Example of a 100L Water Butt Retrofitted to Existing Development

Option D	Consider installation of water butts for all new residential development. This ties in with the SuDS hierarchy and Code for Sustainable Homes assessments and reduces peak discharges to surface water and is likely to have positive impacts to sustainability and water re-use.
Option E	Consider retrofitting water butts on all existing development (as shown on Figure 10-7). This provides supplementary benefits beyond regeneration and redevelopment sites (volumetric reduction with opportunity for complimentary water quality improvements). However there are currently no available incentives to encourage homeowners to install water butts.
Option F	It is recommended that Councils promote the use of water butts across the Boroughs/ District and provide information on costs, suppliers, installation and benefits).

Council Wide Options: Improving Resilience to Flooding

Property Resilient Measures (Increasing Property to Gate Thresholds)

One method to reduce the risk of surface water flooding to properties is raising property thresholds. Raising the threshold of entrances to property land, i.e. where there are currently gates adjacent to paved walls (Figure 10-8) may offer flood resilience benefits, especially where the property contains a basement. Property level thresholds could also be increased where possible to improve resilience to surface water flooding, and especially where roads are predicted to flood and the properties contain no front gardens (Figure 10-8).

Thresholds as shown in Figure 10-8 are a useful and an accepted method of defending property against flooding, although this can conflict with possible accessibility issues within Part M, Section 6 of the Building Regulations 2004 and the requirements of the Disability Discrimination Act 1996. Until such time as national guidance or best practice is available each council should, when required, work with residents to realise suitable, sensible and cost effective solutions which allow access and deliver mitigation against possible flooding.

Figure 10-8: Example of Raised Property Thresholds

Option A	It is recommended that Councils consider raising the awareness of the options for increasing property thresholds.
Option B	It is recommended that Councils work with residents to realise suitable, sensible and cost effective property level resilience to potential flooding (through, for example raising property thresholds to 100mm), particularly in areas where roads / properties are known / identified to be susceptible to surface water flooding.

Community Flood Plans

Completing a Community Flood Plan will help communities decide what practical actions to take before and during a flood, which may help reduce the damage flooding could cause. The flood planning process makes use of local knowledge and experience to produce a plan that caters for (a) preparing for a flood, (b) during a flood, and (c) after a flood, and should aim to complement the authorities' emergency plans and to provide essential information to help manage a flood event.

Working together as a community or group has multiple benefits, including:

- sharing information on what to expect and what to do before, during and after a flood incident;
- identify and clarify the responsibilities of all those involved (this avoids duplication, saving time and money);
- clarifying the responsibilities of all those involved;
- improving communication throughout the community and with the organisations involved before, during and after a flood;

- help share local knowledge and that of people who have been flooded with professional organisations and ensure people's concerns are heard;
- increasing preparedness to reduce the damage and distress of a flood;
- being involved in flood planning will enable a community or group to take control and help during a flood, when other organisations could be overstretched or unable to reach them; and,
- increasing community resilience.

Further information regarding Community Flood Plans (including a Community Flood Plan Pack) is available on the Environment Agency's website: http://www.environment-agency.gov.uk/homeandleisure/floods/38329.aspx

Improved Weather Warning

Utilisation of the Extreme Rainfall Alert (ERA) service provided by the Flood Forecasting Centre[18] can provide a warning of extreme rainfall that may result in surface water flooding. An ERA alert is issued to Category 1 and 2 responders when there is a 20% chance of extreme rainfall.

Providing a warning to key Council operational departments and emergency services will enable the preparation and implementation of the 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 and the development of Community Flood Plans, will allow individuals to respond with appropriate actions and measures.

Other Measures

Other ways to improve resilience to property flooding include:

- flood barriers;
- raising electric sockets; and,
- airbrick covers

More information can be found on the Environment Agency website (http://www.environment-agency.gov.uk/homeandleisure/floods/105963.aspx).

[18] Flood Forecast Centre: http://www.ffc-environment-agency.metoffice.gov.uk/about/

Part B: Preferred Options

11. Basildon Borough Council

11.1 CDA Preferred Options

For most CDAs, a range of preferred CDA specific options have been identified for consideration that could help to alleviate flooding. As this study has been undertaken at a strategic level, further studies and investigations are also detailed and recommended to be taken forward by Basildon Borough Council and/or other study partners. Details of these are presented within this Section and included within Basildon Borough Councils Draft Action Plan (see Section 15 and Appendix F1). Where it is considered that further investigation / collaboration with third parties such as Anglian Water is required before determining the preferred capital option for a CDA, this has been highlighted.

It is expected that the preferred options presented within this section will be developed and/or altered as further information, potentially through on-site investigation and/or third party collaborations, becomes available.

In addition to the preferred options, a range of other potential options have been presented for each CDA that received a lower benefits score, but could still contribute to reducing flood risk in the CDA.

CDA: BAS 1 – North West Billericay		
Preferred Option: Combined Measures: • Flood Storage (within Lake Meadows) • Source Control / Attenuation (Radford Crescent/ The Pantiles) • Community Awareness (PSWFH)		

There are two PSWFHs within the CDA; Queens Park and Gooseberry Green. Therefore in order to address surface water flooding within the CDA, a number of combined measures should be undertaken to mitigate flood risk in both the PSWFHs.

Detention Basin, Lake Meadows – Land in the west of Lake Meadows Park could be re-landscaped into a detention basin to provide temporary flood storage. The open space is located towards the top of the catchment and is located along a flow path and may reduce flooding in the west of the CDA, between Perry Street and Brightside. An area of storage approximately 9,500m^3 with a depth of 1m could be constructed, which could cost approximately £101 - £250k. The use of the space will not be compromised as the detention basin would only accommodate storm water on a temporary basis following extreme rainfall events.

Swales, Radford Crescent – Swales could be installed in the landscaping around Radford Crescent Business Centre in the south of the CDA at the start of a flow path. The implementation of swales, with a depth of 0.2m and approximately 600m long could cost approximately less than £25k.

Source Control / Attenuation, The Pantiles – The car park at The Pantiles Nieghbourhood Centre could be reconfigured by raising the kerbs and installing permeable surfaces and/or an underground storage tank (dependent on site geology and infiltration potential). This may help to reduce surface water ponding in the north-west of the CDA, within the Queens Park PSWFH. Creating a permeable paving car park using Grasscrete, with an area of 3000m^2 would cost approximately £101k - £250k.

Community Awareness – This would involve leaflet drops and public meetings, focused on residential properties and businesses within the PSWFH.

Approximate Cost	£251k - £500k (Capital Schemes).
Potential Benefits	The proposed options could reduce flood risk to 45% (approximately 195) of the buildings which have been modelled to be at risk of flooding of 0.1m or greater during the 1% AEP rainfall event.

Other Potential Options for Consideration		
Option A	Rainwater Harvesting (Lake Meadows Swimming Pool)	The roof of Lake Meadows Swimming Pool offers a large area from which to collect rainwater, and provide localised attenuation of rainfall. This would need to be investigated further to assess the likely volume of flood storage and local benefits. A 20m^3 system would cost approximately £25k or less to implement.

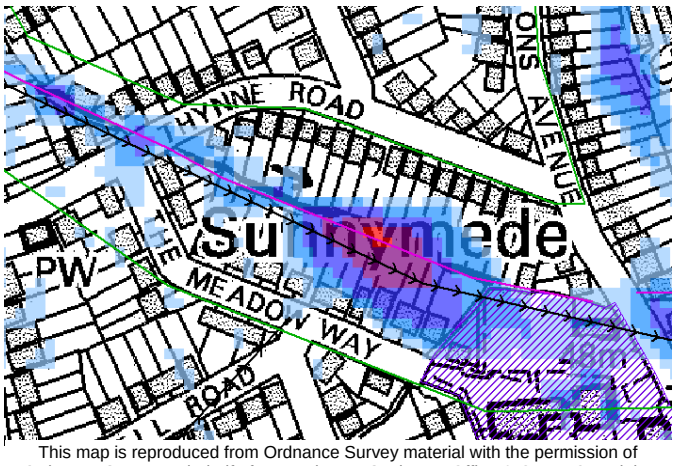
Other Potential Options for Consideration		
Option B	Rainwater Harvesting (The Pantiles Neighbourhood Centre)	The commercial buildings at The Pantiles could collect rainwater and provide localised attenuation of rainfall. This could be undertaken as a joint venture with the businesses. This would need to be investigated further to assess the likely volume of flood storage and local benefits. A 20m^3 system would cost approximately £25k or less to implement.
Option C	Rainwater Harvesting	Encourage residents to install and use water butts, focused on residential properties within the PSWFH to manage surface water.
Potential Quick Wins		
Identify rights of ownership of drainage ditches within the CDA and ensure information present on the South Essex Asset Register held by Essex County Council is correct. Improve maintenance of the drainage ditches / ordinary watercourses throughout the CDA.		

CDA: BAS 3 – Stock Road		
Preferred Option: Combined Measures: • Source Control / Attenuation (Mayflower School and Land at Hollyford) • Community Awareness (PSWFH)		
The preferred option in this CDA is to provide flood storage in Mayflower School Grounds and scrubland at Hollyford, alongside providing targeted community awareness to residents within the lower section of the PSWFH, where the greatest flood depth (and extent of flooding) occurs. The preferred option has the potential to alleviate predicted surface water flooding within the CDA and downstream, and provide educational and environmental benefits through providing educational opportunities for the school. ***Detention Basin, Mayflower School and Land at Hollyford*** – Mayflower School Playing Fields and scrubland at Hollyford could be re-landscaped to create detention basins to attenuate surface water flowing north-west. The open space is in the centre of the CDA and is located along a flow path and may reduce surface water flooding in the north of the CDA (running parallel with Stock Road). The area identified could offer approximately 11,360m^3 of storage assuming a depth of 1m. This scheme could cost approximately £101-250k. The use of the space will not be compromised as the detention basin would only accommodate storm water on a temporary basis following extreme rainfall events.  ***Community Awareness*** – This would involve leaflet drops and public meetings, focused on residential properties and businesses within the PSWFH.		
Approximate Cost	£101k - £250k (Capital Schemes)	
Potential Benefits	The proposed options could reduce flood risk to 55% (approximately 146) of the buildings which have been modelled to be at risk of flooding of 0.1m or greater during the 1% AEP rainfall event.	
Other Potential Options for Consideration		
Option A	Preferential / Designated Overland Flow Route (Stock Road)	An additional option could be to define a Preferential Flow Path along Stock Road from after the junction with Orchard Avenue towards the roundabout in the north of the CDA. This can be achieved through either raising kerbs or lowering the road level. Surface water flood risk downstream could be mitigated.
Option B	Rainwater Harvesting	Encourage residents to install and use water butts, focused on residential properties within the PSWFH to manage surface water.

CDA: BAS 4 – Sunnymede
Preferred Option: Combined Measures: • Flood Storage (Mill Meadows) • Increasing Conveyance • Community Resilience (PSWFH)

The preferred option in this CDA is to provide a number of combined measures across the CDA to manage and reduce the surface water flood risk.

Flood Storage Bund / Flow Restriction, Mill Meadows – Two flood storage bunds could be constructed on the ditches which flow from Mill Meadows Nature Reserve into Sunnymede residential area. The bunds would restrict the rate of flow of surface water leaving this area and result in the accumulation of surface water behind the bund. A 1m high bund, with a combined length of approximately 500m would be required and would cost approximately less than £25k to implement.



Increased Conveyance – the capacity of the ordinary watercourse which flows between the properties along Meadow Way and Thynne Road could be increased to allow greater flow of surface water. A feasibility study would need to be undertaken in conjunction with the Riparian Landowners, the Environment Agency, Basildon Borough Council and Essex County Council (as LLFA). Policies against proposals to modify or culvert sections of the watercourse in this area should be advocated.

Community Awareness – This would involve leaflet drops and public meetings, focused on residential properties and businesses within the PSWFH, and especially in the area around Meadow Way and Thynne Road where the deepest flooding occurs.

Approximate Cost	<£25k (Capital Schemes) + <25k (Feasibility Study and Planning Policy).
Potential Benefits	The proposed options could reduce flood risk to 20% (approximately 133) of the buildings which have been modelled to be at risk of flooding of 0.1m or greater during the 1% AEP rainfall event.

Other Potential Options for Consideration		
Option A	Flood Storage – 2 Stage Channel	There is potential in the east of the CDA, within Outwood Common for a 2-stage channel to be developed, to allow low flows in the inner channel and to store higher flows in the outer second stage channel thereby reducing surface water flooding to properties downstream.
Option B	Rainwater Harvesting	Encourage residents to install and use water butts, focused on residential properties within the PSWFH to manage surface water.

Potential Quick Wins
Identify rights of ownership of drainage ditches within the CDA and ensure information present on the South Essex Asset Register held by Essex County Council is correct. Improve maintenance of the drainage ditches / ordinary watercourses throughout the CDA.

CDA: BAS 8 – Laindon	
Preferred Option: Combined Measures: • Formalisation of Flood Storage Area (The Paddocks Recreation Ground) • Preferential / Designated Overland Flow Route (High Road) • Planning Policy	
The preferred option in this CDA is to provide a number of combined measures across the CDA to manage and reduce the surface water flood risk. ***Formalise Detention Basin, The Paddocks Recreation Ground*** – Surface water flooding during the 1% AEP is shown to pond within The Paddock's Recreational Ground. It is considered that the preferred 'Quick Win' option for this CDA is to formalise Paddock's Recreation Ground as a Flood Storage Area approximately 14,200m^2. A formalised flood storage detention basin will ensure that the correct maintenance occurs and that the local residents are aware of the multi-functional nature of this open space. The use of the space will not be compromised as the detention basin would only accommodate storm water on a temporary basis following extreme rainfall events.  The south-western boundary should also be re-landscaped to ensure that ponding remains within the open space and does not affect the residential properties. A 1m high bund, approximately 400m long would be required and would cost less than £25k to implement. ***Preferential / Designated Overland Flow Route, High Road*** – Surface water ponding during the 1% AEP is show to pond and flow down High Road. This could therefore be to define as a Preferential Flow Path. This can be achieved through either raising kerbs or lowering the road level. The preferential road could be continued along High Road, in the area north of the CDA, where the flood water could be allowed to pond in the open space, south of the Noak Hill Washland. ***Planning Policy*** – There is the potential for development within the CDA. Planning policy could be used to manage surface water through controlling surface water runoff and, where possible, provide mitigation of surface water flooding in the local area. Source control measures such as green roofs or rainwater harvesting, and setting a reduction in existing runoff rates by 50% for brownfield development sites (as in the London Plan 2011). ***Community Awareness*** – This would involve leaflet drops and public meetings, focused on residential properties and businesses within the PSWFH.	
Approximate Cost	<£25k (Capital Schemes) + <25k (Feasibility Study and Planning Policy).
Potential Benefits	The proposed options could reduce flood risk to 15% of the buildings which have been modelled to be at risk of flooding of 0.1m or greater during the 1% AEP rainfall event.

Other Potential Options for Consideration		
Option A	Source Control	The Laindon Centre offers a large area to potentially install a rainwater harvesting system, and provide localised attenuation of rainfall. This would need to be investigated further to assess the likely volume of flood storage and local benefits. A 50m^3 system could cost approximately £51k - £100k to implement.

CDA: BAS 12 – Kingswood-Dry Street		

Preferred Option: Combined Measures:

- Further Investigation (Kingswood Washland)
- Flood Storage (Tinkler Side)
- Community Awareness
- Planning Policy

The preferred option in this CDA is to provide a number of combined measures across the CDA to manage and reduce the surface water flood risk.

Further Investigation, Kingswood Washland – Further investigation is required at Kingswood Washland, to see if it possible to divert flood flows from the surface water sewer, into an old section of the watercourse which still remains. Kingswood Washland would then act as a detention basin, reducing surface water ponding downstream.

Swales, Tinkler Side – Swales could be installed in the open space around the residential buildings in Tinkler Side in the north of the CDA. The implementation of swales, of 4930m^2 with a depth of 0.2m could provide a storage volume of up to 986m^3 and cost approximately £51-£100k. The use of the space will not be compromised as the swales would only accommodate storm water on a temporary basis following extreme rainfall events.

Planning Policy – There is potential for development within the CDA. Planning policy could be used to manage surface water (through controlling surface water runoff) and, where possible, provide mitigation of flooding in the local area. Source control measures such as green roofs or rainwater harvesting, and setting a reduction in existing runoff rates by 50% for brownfield development sites (as in the London Plan 2011).

Community Awareness – This would involve leaflet drops and public meetings, focused on residential properties and businesses within the PSWFH.

Approximate Cost	£51k - £100k (Capital Scheme) + <25k (Investigation and Planning Policy).
Potential Benefits	The proposed options could reduce flood risk to 40% of the buildings which have been modelled to be at risk of flooding of 0.1m or greater during the 1% AEP rainfall event.

Other Potential Options for Consideration

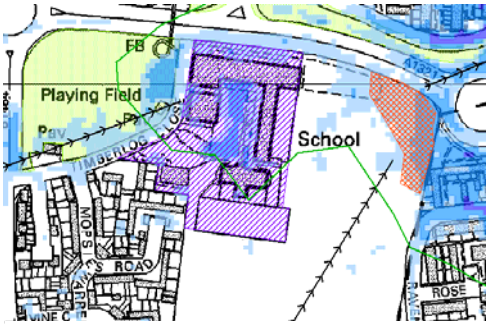
Option A	Land Management	Encourage land management practices within Langdon Hills and on Basildon Golf Course in the west and south of the CDA to reduce the rate of surface water runoff leaving these surfaces and encourage infiltration.
Option B	Rainwater Harvesting	Encourage residents to install and use water butts, focused on residential properties within the PSWFH to manage surface water.

Other Potential Options for Consideration		
Option C	Source Control	Basildon Town Centre offers a large area to potentially install a rainwater harvesting system, and provide localised attenuation of rainfall. This would need to be investigated further to assess the likely volume of flood storage and local benefits. A $100m^3$ system would cost approximately £101k - £250k to implement.
Option D	Ensure Resilience of Hospital	Ensure that power generators, services and assets are not located in the basement or ground floors of the hospital. Consider producing an Emergency Plan for surface water flooding to ensure procedures are in place for a flood event.
Potential Quick Wins		
Identify rights of ownership of drainage ditches / ordinary watercourses within the CDA and ensure information present on the South Essex Asset Register held by Essex County Council. Improve maintenance of the drainage ditches / ordinary watercourses throughout the CDA. Formalise Flood Storage Areas (Kingswood, Dry Street, Wootens, Hospital Washlands), through the creation of a Washland Management Plan.		

CDA: BAS 14 – Barstable-Fryerns
Preferred Option: Combined Measures: • Source Control / Attenuation (The Lower Academy) • Planning Policy • Community Awareness (PSWFH)

The preferred option in this CDA is to provide a number of combined measures across the CDA to manage and reduce the surface water flood risk.

Detention Basin, The Lower Academy – The Lower Academy Playing Fields could be re-landscaped to create a detention basin to attenuate surface water flowing from the south and south-west of the CDA. The open space is at the top of the catchment and is located along two flow paths and could reduce surface water flooding downstream. The area identified could offer approximately 4,450m^3 of storage with a depth of 1m. This scheme could cost £51k - £100k. The use of the space will not be compromised as the detention basin would only accommodate storm water on a temporary basis following extreme rainfall events.



Planning Policy – There is the potential for new development within the CDA. Planning policy could be used to manage surface water (through controlling surface water runoff) and, where possible, provide mitigation of surface water flooding in the local area. Source control measures such as green roofs or rainwater harvesting, and setting a reduction in existing runoff rates by 50% for brownfield development sites (as in the London Plan 2011). New developments in the west of the CDA (close to Northlands Park and the Washland, should ensure that they link the surface water sewers to the Washland at a controlled runoff rate.

Community Awareness – This would involve leaflet drops and public meetings, focused on residential properties and businesses within the PSWFH.

Approximate Cost	£51k - £100k (Capital Scheme) + <25k (Investigation and Planning Policy).
Potential Benefits	The proposed options could reduce flood risk to 45% (approximately 241) of the buildings which have been modelled to be at risk of flooding of 0.1m or greater during the 1% AEP rainfall event.

Other Potential Options for Consideration

Option A	Source Control	The Lower Academy offers a large area to potentially install a rainwater harvesting system or retrofit a greenroof, and provide localised attenuation of rainfall. This would need to be investigated further to assess the likely volume of flood storage and local benefits. A 50m^3 system would cost approximately less than £25k to implement.
Option B	Further Investigation	Anglian Water should assess whether there are any significant risks to the operation of its sewage treatment works infrastructure, taking into account the findings of the modelling for this CDA and investigate means of managing the risk, without passing the burden onto other receptors.

Potential Quick Wins
Identify rights of ownership of drainage ditches / ordinary watercourses within the CDA and ensure information present on the South Essex Asset Register held by Essex County Council is correct. Improve maintenance of the drainage ditches / ordinary watercourses throughout the CDA. Formalisation of Flood Storage Area (Northlands Washlands), through the creation of a Washland Management Plan.

CDA: BAS 15 – Chalvedon-Felmores

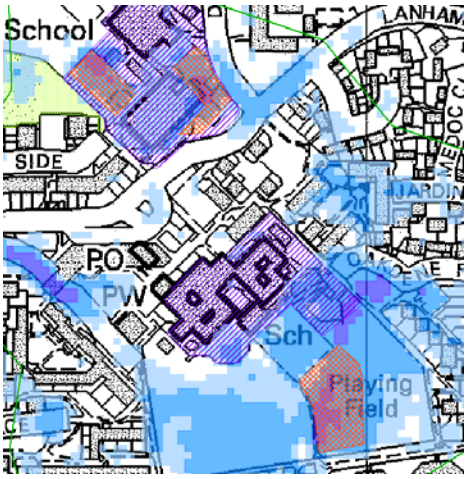
Preferred Option: Combined Measures:

- Source Control / Attenuation (Briscoe and Felmores Schools)
- Further Investigation
- Community Awareness (PSWFH)
- Planning Policy

The preferred option in this CDA is to provide a number of combined measures across the CDA to manage and reduce the surface water flood risk.

Detention Basin, Briscoe and Felmores Schools – Detention basins within the playing fields at Briscoe and Felmores Schools where deep surface water ponding occurs. Briscoe and Felmores School Playing Fields could be re-landscaped to create two detention basins to attenuate surface water ponding which is currently predicted around properties in the area. This would require the creation of pathways draining the area to the detention pond

The area identified at Briscoe School could offer approximately 2,250m^3 of storage with a depth of 1m and could cost approximately £26k-£50k. The area identified at Felmores School could offer approximately 2,100m^3 of storage with a depth of 1m and could cost approximately £26k-£50k. The use of the space will not be compromised as the detention basin would only accommodate storm water on a temporary basis following extreme rainfall events.



Further Investigation – Further investigation is required to look into the drainage network within the CDA, to look into potentially increasing the capacity of the sewers and drains and improving the efficiency or number of road gullies within the PSWFH.

Planning Policy – There are a number of development areas proposed within the CDA. Planning policy could be used to manage surface water (through controlling surface water runoff) and, where possible, provide mitigation of surface water flooding in the local area. Source control measures such as green roofs or rainwater harvesting, and setting a reduction in existing runoff rates by 50% for brownfield development sites (as in the London Plan 2011). New developments in the west of the CDA (close to Northlands Park and the Washland, should ensure that they link the surface water sewers to the Washland at a controlled runoff rate.

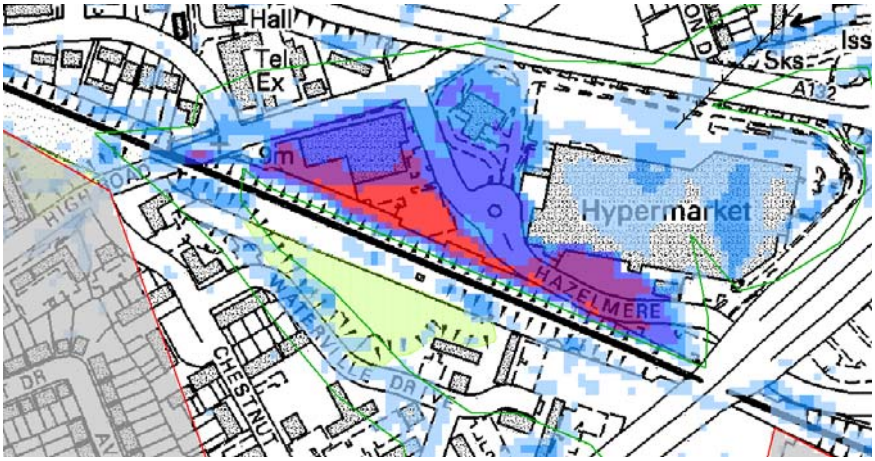
Community Awareness – This would involve leaflet drops and public meetings, focused on residential properties and businesses within the PSWFH.

Approximate Cost		£51k - £100k (Capital Scheme) + <25k (Investigation and Planning Policy)
Potential Benefits		Flooding in this CDA is largely as a result of topography and insufficient surface water drainage capacity resulting in ponding of surface water, with very few definable flow paths. As a result, an estimate of cost benefit per building has not been possible for this CDA as it has not been possible to identify the number of buildings that could benefit from the proposed options either downstream or upstream of the schemes,. However, the options would provide opportunities to engage local residents in flood mitigation measures and ensure consideration of surface water runoff in any future planning within the Chalvendon-Felmores CDA and provide an improved understanding of surface water flooding mechanisms and risk throughout the CDA and the PSFWH.
Other Potential Options for Consideration		
Option A	Source Control / Community Resilience	As there are few capital schemes that could alleviate flood risk, a further option is to encourage residents to use property-level community resilience (100mm property thresholds) and source control measures (water butts) within the PSWFH shown to flood to depths greater than 0.3m. Properties could be provided with water butts (<£25k) and / or temporary or demountable flood defences (£26k - £51k) following further investigation of the flooding mechanisms and properties most at risk.
Option B	Source Control	Briscoe School and Felmores School both offer a large area to potentially install a rainwater harvesting system or retrofit a greenroof, and provide localised attenuation of rainfall. This would need to be investigated further to assess the likely volume of flood storage and local benefits. A 20m^3 system on each school would cost approximately less than £25k to implement.
Option C	Ensure Resilience of Schools	The schools are modelled to flood during a 1% AEP rainfall event, therefore resilience measures could be installed, e.g. a demountable flood barrier, and opportunities identified to divert surface water away from the schools and either into a suitable holding area / tank. An Emergency Plan could be considered to ensure safe access/egress and resilience during flood events.

CDA: BAS 16 – Bowers Gifford		
Preferred Option: Further Investigation		
Further Investigation – Further Investigation is needed into the interactions between the drainage ditches, ordinary watercourses and the main river which flow within the CDA. This should determine the condition of the ditches, ordinary watercourse and main river, and identify any obstructions or structures with limited conveyance capacity (e.g. culverts) that could prevent the conveyance of stormwater. Essex County Council (as LLFA) are looking into the surface water flooding within this CDA, which frequently occurs, so any investigation should be carried out in conjunction with the LLFA, as well as the Environment Agency.		
Approximate Cost	<25k	
Potential Benefits	Improved understanding of surface water flooding mechanisms and risk throughout the CDA and the PSFWH. Potential identification of quick wins and capital schemes that could reduce surface water flood risk in the CDA	
Other Potential Options for Consideration		
Option A	Land Management	Encourage land management practices within the CDA to reduce the rate of surface water runoff leaving these surfaces and encourage infiltration.
Option B	Source Control / Community Resilience	Encourage residents to use property-level community resilience (100mm property thresholds) and source control measures (water butts) within the PSWFH shown to flood to depths greater than 0.3m. Properties could be provided with water butts (<£25k) and / or temporary or demountable flood defences (£26k - £51k) following further investigation of the flooding mechanisms.
Option C	Community Flood Plan	A Community Flood Plan could be considered to ensure safe access/egress and resilience during flood events.
Potential Quick Wins		
Identify rights of ownership of drainage ditches / ordinary watercourses within the CDA and ensure information present on the South Essex Asset Register held by Essex County Council is correct. Improve maintenance of the drainage ditches / ordinary watercourses throughout the CDA.		

CDA: BAS 17 – Pitsea		
Preferred Option: Further Investigation		

Further Investigation – Ponding has been modelled to occur behind the railway embankment and flood the commercial buildings around Tennyson Drive. Further Investigation is needed of the drainage network, to establish if surface water drainage and culverts (associated with draining the railway link and owned by Network Rail) would drain surface water to the south of the railway embankment. Essex County Council (as LLFA), Basildon Borough Council, Network Rail and Anglian Water should work in conjunction to establish the drainage network in this area.



Planning Policy – Ensure that new developments coming forward within the CDA manage surface water (through controlling surface water runoff) and, where possible, provide mitigation of surface water flooding in the local area. 50% reduction in existing runoff rate from brownfield development sites (as in the London Plan 2011).

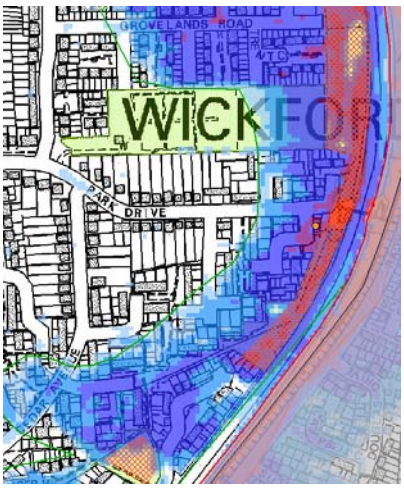
Approximate Cost	<25k
Potential Benefits	Improved understanding of surface water flooding mechanisms and risk throughout the CDA and the PSFWH

Other Potential Options for Consideration		
Option A	Source / Control Attenuation	Consider opportunities to implement rainwater harvesting systems and / or retrofit greenroofs within the commercial buildings around Tennyson Drive, within Pitsea Town Centre and on the schools, which could be undertaken as a joint venture with businesses. A 100m^3 system could cost approximately £101k – £250k.

CDA: BAS 21 – Bromfords
Preferred Option: Combined Measures: • Source Control / Attenuation (Elder Avenue Recreation Ground) • Flood Storage (A132 – West and Kingsley Meadows) • Community Awareness (PSWFH)

The preferred option in this CDA is to provide a number of combined measures across the CDA to manage and reduce the surface water flood risk.

Detention Basin, Elder Avenue Recreation Ground – Elder Avenue Playing Fields could be re-landscaped to create a detention basin to assist in reducing flows along one of the main flow paths in the CDA along Elder Avenue and attenuate surface water which is currently predicted to pond further downstream. The area identified could offer approximately 4,250m^3 of storage with a depth of 1m. This scheme could cost £51k - £100k. The use of the space will not be compromised as the detention basin would only accommodate storm water on a temporary basis following extreme rainfall events.



Flood Storage – Surface water flooding during the 1% AEP is shown to pond adjacent to the A132 (west). The land between the road and the residential area and within Kingsley Meadows Recreation Ground could be re-landscaped to ensure that surface water ponding remains within the open space and does not affect the residential properties or the road. The areas identified could offer approximately 20,700m^3 of storage with a depth of 1m. This scheme could cost £251k - £500k. The use of the space will not be compromised as the detention basin would only accommodate storm water on a temporary basis following extreme rainfall event; however, local drainage would need to be adapted to ensure that drainage overflows are routed to the storage areas to prevent ponding.

Community Awareness – This would involve leaflet drops and public meetings, focused on residential properties and businesses within the PSWFH.

Approximate Cost	£251k - £500k (Capital Schemes)
Potential Benefits	The proposed options could reduce flood risk to 85% (approximately 513) of the buildings which have been modelled to be at risk of flooding of 0.1m or greater during the 1% AEP rainfall event.

Other Potential Options for Consideration		
Option A	Rainwater Harvesting	Encourage residents to install and use water butts, focused on residential properties within the PSWFH to manage surface water.
Option B	Community Flood Plan	A Community Flood Plan could be considered to ensure safe access/egress and resilience during flood events.

Potential Quick Wins
Identify rights of ownership of drainage ditches / ordinary watercourses within the CDA and ensure information present on the South Essex Asset Register held by Essex County Council is correct. Improve maintenance of the drainage ditches / ordinary watercourses throughout the CDA. Formalisation of Flood Storage Area (Albany Road Washland), through the creation of a Washland Management Plan.

CDA: BAS 22 – Cranfield Park Road		
Preferred Option: Further Investigation		
Further Investigation – Ponding has been modelled to occur alongside the western boundary of the CDA, alongside the A132 (east). The Nevendon Brook main river flows from the south to the north, along the western boundary of the CDA. In conjunction with the Environment Agency and Anglian Water an investigation could be undertaken to establish the flooding mechanisms within the PSWFH, confirming the capacity of the sewer network and looking into the possibility of widening the flood storage provided by the Nevendon Brook two-stage channel. ***Community Awareness*** – This would involve leaflet drops and public meetings, focused on residential properties and businesses within the PSWFH.		
Approximate Cost	<25k	
Potential Benefits	Improved understanding of surface water flooding mechanisms and risk throughout the CDA and the PSFWH	
Other Potential Options for Consideration		
Option A	Flood Storage – 2 Stage Channel	There is potential to increase the size of the existing 2-stage main river channel which runs along the western boundary of the CDA. This would need to be undertaken in conjunction with the Environment Agency and could help to reduce surface water flooding to properties downstream.
Option B	Local Drainage Capacity Investigations	Undertake drainage capacity investigations in the west of Cranfield Park to identify existing capacity and future maintenance and upgrade requirements.
Potential Quick Wins		
Identify rights of ownership of drainage ditches / ordinary watercourses within the CDA and ensure information present on the South Essex Asset Register held by Essex County Council is correct. Improve maintenance of the drainage ditches / ordinary watercourses throughout the CDA.		

11.2 Preferred Options Summary

Table 11-1 summarises the preferred options identified through the Phase 3 - Options Assessment for addressing surface water flood risk in the shortlisted CDAs in Basildon Borough Council.

Table 11-1: Preferred Options Summary for Basildon Borough Council

CDA_ID	CDA Name	Option Category	Option Description	Combination Scheme?	Costing & Storage Volumes									Benefits
					Measures	Cost (£)	Unit Description	Units	Length	Area	Depth	Volume	Cost Band (£000s)	Cost Band for Combination Scheme (£000s)	% buildings with potential reduced flood risk
BAS 1	North West Billericay	Source Control, Attenuation and SuDS	Creation of swales within Radford Business Centre	✓	Swales	20	m2 of swale area	m2	600	-	0.2	-	<£25k	**£251k - £500k**	**45**
			Detention basin in Lake Meadows		Detention Basin	22	m3 of detention volume	m3	-	9500	1	9500	£101k - £250k		
			Permeable paving in The Pantiles Car Park through the use of Grasscrete		Permeable Paving using Grasscrete	65	m2 of surface	m2	-	3000	-	-	£101k - £250k		
		Community Awareness / Resilience	Focused community awareness and resilience within the 2 PSWFHs		Social Change, Education and Awareness	-	-	-	-	-	-	-	-		
BAS 3	Stock Road	Source Control, Attenuation and SuDS	Creation of detention basin In Mayflower School Playing fields and Land at Hollyford	✓	Detention Basin	22	m3 of detention volume	m3	-	11360	1	11360	£101k - £250k	**£101k - £250k**	**55**
		Community Awareness / Resilience	Focused community awareness and resilience within the PSWFH		Social Change, Education and Awareness	-	-	-	-	-	-	-	-		
BAS 4	Sunnymede	Source Control, Attenuation and SuDS	Two flood storage bunds within Mill Meadows Nature Reserve	✓	Bund / Flow Restriction	30	m3 of embankment	m3	500	-	1	500	<£25k	**<25k**	**20**
		De-culvert / Increase Conveyance	Increasing capacity of ordinary watercourse between properties along Meadow Way and Thynne Road		Increasing Capacity in Drainage Systems	-	-	-	-	-	-	-	-		
		Community Awareness / Resilience	Focused community awareness and resilience within the PSWFH, especially around Meadow Way and Thynne Road		Social Change, Education and Awareness	-	-	-	-	-	-	-	-		
BAS 8	Laindon	Other or Combination	Formalisation of Flood Storage Area at Paddock Recreation Ground - 14400m^2	✓	Other 'Receptor' Measures	-	-	-	-	-	-	-	-	**<25k**	**15**
		Preferential / Designated Overland Flow Routes	Preferential flow path along High Road		Managing Overland Flows (Preferential Flowpaths)	-	-	-		-	-	-	-		
		Source Control, Attenuation and SuDS	Flood storage bunds on the southern boundary of Paddock Recreation Ground		Bund / Flow Restriction	30	m3 of embankment	m3	400	-	1	400	<£25k		
		Planning Policy	Throughout the CDA		Planning Policies to Influence Development	-	-	-		-	-	-	-		
		Community Awareness / Resilience	Focused community awareness and resilience within the PSWFH		Social Change, Education and Awareness	-	-	-		-	-	-	-		
BAS 12	Kingswood / Dry Street	Other or Combination	Formalisation of Flood Storage Area at Paddock Recreation Ground - 32600m^2	✓	Other 'Receptor' Measures	-	-	-	-	-	-	-	-	**£51k - £100k**	**35**
		Source Control, Attenuation and SuDS	Creation of swales around the properties at Tinkler Side		Swales	20	m2 of swale area	m2	-	4930	0.2	986	£51k - £100k		
		Community Awareness / Resilience	Focused community awareness and resilience within the PSWFH		Social Change, Education and Awareness	-	-	-	-	-	-	-	-		
		Planning Policy	Throughout the CDA		Planning Policies to Influence Development	-	-	-	-	-	-	-	-		

BAS 14	Barstable / Fryerns	Source Control, Attenuation and SuDS	Detention basin in Barstable School	✓	Detention Basin	22	m3 of detention volume	m3	-	4450	1	4450	£51k - £100k	**£51k - £100k**	**45**
		Planning Policy	Throughout the CDA		Planning Policies to Influence Development	-	-	-	-	-	-	-	-		
		Community Awareness / Resilience	Focused community awareness and resilience within the PSWFH		Social Change, Education and Awareness	-	-	-	-	-	-	-	-		
BAS 15	Chalvedon / Felmores	Source Control, Attenuation and SuDS	Detention basin in Briscoe School	✓	Detention Basin	22	m3 of detention volume	m3	-	2250	1	2250	£26k - £50k	**£51k - £100k**	**N/A**
			Detention basin in Felmores School		Detention Basin	22	m3 of detention volume	m3	-	2100	1	2100	£26k - £50k		
		Planning Policy	Throughout the CDA		Planning Policies to Influence Development	-	-	-	-	-	-	-	-		
		Community Awareness / Resilience	Focused community awareness and resilience within the PSWFH		Social Change, Education and Awareness	-	-	-	-	-	-	-	-		
BAS 16	Bowers Gifford	Further Investigate Flooding Mechanisms	Confirm drainage capacity and interactions between the ditches, ordinary watercourse and main river within the CDA.	×	Investigation	-	-	-	-	-	-	-	-	**N/A**	**N/A**
BAS 17	Pitsea	Further Investigate Flooding Mechanisms	Confirm drainage capacity and interactions between the ditches, ordinary watercourse and main river within the CDA.	✓	Investigation	-	-	-	-	-	-	-	-	**N/A**	**N/A**
		Planning Policy	Throughout the CDA		Planning Policies to Influence Development	-	-	-	-	-	-	-	-		
BAS 21	Bromfords	Source Control, Attenuation and SuDS	Detention basin in Elder Avenue Recreation Ground	✓	Detention Basin	22	m3 of detention volume	m3	-	4250	1	4250	£51k - £100k	**£251k - £500k**	**85**
		Flood Storage / Permeability	Flood storage within Kingsley Meadows and on land adjacent to A132 (west)		Detention Basin	22	m3 of detention volume	m3	-	20700	1	20700	£251k - £500k		
		Community Awareness / Resilience	Focused community awareness and resilience within the PSWFH		Social Change, Education and Awareness	-	-	-	-	-	-	-	-		
BAS 22	Cranfield Park Road	Further Investigate Flooding Mechanisms	Confirm drainage capacity and interactions between the ditches, ordinary watercourse and main river within the CDA.	✓	Investigation	-	-	-	-	-	-	-	-	**N/A**	**N/A**
		Community Awareness / Resilience	Focused community awareness and resilience within the PSWFH		Social Change, Education and Awareness	-	-	-	-	-	-	-	-		

Note: This table has been produced to assist with the preliminary cost estimates as part of the South Essex SWMP. All dimensions and costs are indicative and should only be used for preliminary estimates due to the generalised nature of the information used to compile it. An estimated cost for the preferred flood mitigation option for each identified CDA has been calculated based on standard unit costs. No monetised damages have been calculated, and flood mitigation costs have been determined using engineering judgement, but have not undergone detailed analysis. The following standard assumptions have been applied:

- The costs are the capital costs for implementation of the scheme only.
- Costs do not include provisions for consultancy, design, supervision, planning process, permits, environmental assessment or optimum bias.
- No provision is made for weather (e.g. winter working).
- No provision is made for access constraints
- Where required, it will be stated if costs include approximate land acquisition components.
- No operational or maintenance costs are included.
- No provision is made for disposal of materials (e.g. for flood storage or soakaway clearance).

As a result, costs have been provided as cost bands, reflecting the strategic nature of the SWMP study and options identification.

12. Castle Point Borough Council

12.1 CDA Preferred Options

For most CDAs, a range of preferred CDA specific options have been identified for consideration that could help to alleviate flooding. As this study has been undertaken at a strategic level, further studies and investigations are also detailed and recommended to be taken forward by Castle Point Borough Council and/or other the study partners. Details of these are presented within this Section and included within Castle Point Borough Councils Draft Action Plan (see Section 16 and Appendix F2). Where it is considered that further investigation / collaboration with third parties such as Anglian Water is required before determining the preferred capital option for a CDA, this has been highlighted.

It is expected that the preferred options presented within this section will be developed and/or altered as further information, potentially through on-site investigation and/or third party collaborations, becomes available.

In addition to the preferred options, a range of other potential options have been presented for each CDA that received a lower benefits score, but could still contribute to reducing flood risk in the CDA.

CDA: CAS1 – South Benfleet

Preferred Option: Combined Measures:

- Flood Storage / Permeability (Boyce Hill Golf Course, Benfleet Marsh)
- Land Management
- Community Awareness (PSWFH)

Surface water tends to flow from the northwest to the southeast of the CDA, where surface water accumulates around Benfleet Marsh. To address the surface water flooding within the CDA a number of combined measures can be implemented across the CDA to manage surface water at the head of the catchment and reduce the surface water flood risk in the PSWFH.

Flood Storage – Boyce Hill Golf Course could be use to attenuate surface water runoff at the head of the catchment, therefore reducing the total volume of surface water runoff accumulating in the PSWFH. The creation of a 100m long bund, along the western boundary of the golf course, would act to restrict the flow of surface water. Along with this, rainwater harvesting could be developed that would attenuate surface water at this point and could provide an additional non potable source of water for use, such as irrigation, within the golf course. A bund of 100m length, with a height of 1m would cost <25k.

The capacity of the existing Benfleet Marsh storage area can be increased by redesigning the section to the west to accommodate surface water. A further study is required to determine the potential of increasing the capacity at this point.

Land Management – Adjusting the land management practices of the farmland to the east of the CDA could further reduce the generation of surface water runoff. This can be achieved by increasing the surface roughness and infiltration potential of the land with the intention to attenuate surface water at the point of generation. Aeration of compacted school playing fields (The Appleton School, Kents Hall Junior School, and South Benfleet Foundation Primary School) can be incorporated into the site maintenance regimes.

Community Awareness – Increase community awareness through a range of measures, including leaflet drops or public meetings focussing on residents and businesses located with in the PSWFH.

Approximate Cost	<25k (Capital scheme) + <25k (Feasibility study)
Potential Benefits	The proposed options could reduce the flood risk to 40% (approximately 261) of the buildings which have been modelled to currently be at risk of flooding by 0.1 m or greater from a 1% AEP storm event.

Other Potential Options for Consideration

Option A	Preferential Flow Path - Grove Road	Modify road structure, through increasing kerb height or the decrease in road depth, to direct surface water flows along Grove Road.

Potential Quick Wins

Liaise with the Environment Agency to ensure that a Washland Management Plan is in place for the Benfleet Marsh, Essex Way flood storage area.

Improve maintenance of the drainage ditches / ordinary watercourses throughout the CDA.

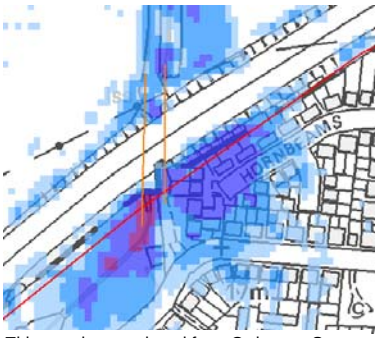
CDA: CAS 2 – New Thundersley
Preferred Option: Combined Measures: • Flood Storage / Attenuation (The Robert Drake Primary School and Tarpots Recreation Ground) • Flood Storage / Attenuation (Coombe Wood) • Increased Conveyance (A130 Embankment) • Planning Policy

To address the surface water flooding within the CDA a number of combined measures could be implemented across the CDA to manage and reduce the surface water flood risk in the PSWFH.

Flood Storage, Robert Drake School and Tarpots Recreation Ground – The development of flood storage areas through the re-landscaping of the green space around the Robert Drake Primary School and Tarpots Recreation Ground could potentially provide over 240 m^3 and 4,000 m^3 of capacity respectively. These would be multifunctional storage spaces that would provide temporary surface water storage during times of flooding. Creating detention basins of these capacities would cost <£25k and £51k - £100k respectively.

Flood Storage Bund, Coombe Wood – The development of a bund to the west of Coombe Wood will restrict the flow of surface water leaving this area and result in the accumulation of surface water behind the bund. A 1m high bund, across an area of 55m would cost <£25k.

Increased Conveyance – Ponding has been modelled to occur behind the A130 embankment (around Hornbeams Road). The capacity of the culvert through the embankment could be increased to allow greater flow of surface water with increased storage upstream of the culvert to prevent increasing flood risk downstream, (there is sufficient space for this potential storage). This will need to be undertaken in conjunction with Anglian Water. A feasibility study is first required to determine the costs and impacts of such as scheme and the overall suitability. The consequences of improving flow conveyance beneath the road would need to be considered against the potential effects of this improvement on potential receptors downstream (as far as Battlesbridge).



Planning Policy – This can be used to encourage the development of source control systems within new developments. The East of Manor Trading Estate presents the opportunity to implement these in an industrial development. Standards, such as 50% attenuation of the existing runoff rate, (as in the London Plan 2011) could potentially set as policy for new developments.

Approximate Cost	£101k - £250 (Capital scheme) + <£25k (Feasibility study and planning policy)
Potential Benefits	The proposed combination of options could reduce the flood risk to 70% (approximately 355) of the buildings which have been modelled to currently be at risk of flooding by 0.1m or greater from a 1% AEP storm event.

Other Potential Options for Consideration		
Option A	Flood Storage	Utilise green space of Montgomery School and Glenwood School to provide storage of surface water runoff. Together, a total area of 9,000 m^2 of existing green space could be re-landscaped to provide multifunctional flood storage of 2,700m^3 of rainfall runoff. This would cost £51k - £100k.

Other Potential Options for Consideration		
Option B	Rainwater Harvesting	Collection of rainwater from buildings with large roof areas such as the schools and public buildings within the CDA. This would cost <£25k and would provide a non potable source of water for site use.
Potential Quick Wins		
Identify rights of ownership of drainage ditches / ordinary watercourses within the CDA and ensure information present on the South Essex Asset Register undertaken by Essex County Council. Improve maintenance of the drainage ditches / ordinary watercourses throughout the CDA. Formalise operation of the flood storage area (Flood storage area to the east of the A130 embankment). Increase awareness through leaflet drops to residents and businesses within the PSWFH area.		

CDA: CAS 3 – East Thundersley

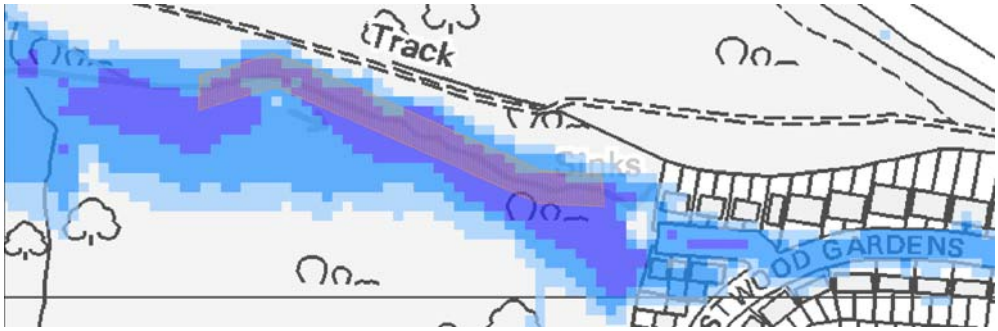
Preferred Option: Combined Measures:

- Improved Maintenance (Prittle Brook, Westwood)
- Online Storage (Prittle Brook, Westwood)
- Planning Policy for new development (Kiln Road)
- Flood Storage / Attenuation (Cedar Hall School)

Flooding within East Thundersley is generally attributed to the upper channels of the Prittle Brook. To address the surface water flooding within the CDA a number of combined measures can be implemented across the CDA to attenuate surface water runoff at the head of the catchment and so reduce the volumes of surface water and the flood risk in the PSWFH.

Improved Maintenance, Prittle Brook – The trash screen along the Prittle Brook at Westwood Gardens has been identified as a cause of flooding. Replacement of the existing trash screen with a more appropriate system, and improved maintenance will reduce the risk of local flooding.

Online Storage, Prittle Brook – The flood storage capacity of the Prittle Brook, through West Wood can potentially be increased through the creation of a two stage channel to allow for greater storage within the channel during times of high flow.



New Development, Kiln Road – Planned residential development north of Kiln Road, provides opportunities to implement source control measures, such as green roofs or rainwater harvesting. Local planning policy could be used to ensure the use of source control measures to attenuate surface water runoff on site, for example to 50% of the current runoff rate (as with the London Plan 2011).

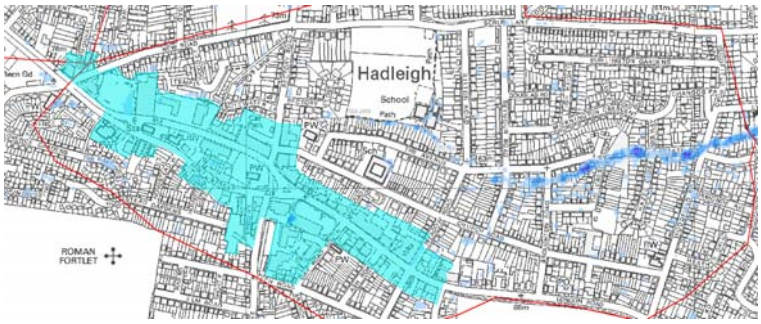
Flood Storage, Cedar Hall School – The grounds of Cedar Hall School could be used to develop temporary flood storage. An area of 4,400m^2, with a depth of 0.4m could contain 1,760m^3 of surface water generated from the urban area to the west of the school. Such a system would cost approximately £26k - £50k. A detention basin could be developed by re-landscaping the existing space. The use of the space will not be compromised as the detention basin would only accommodate storm water on a temporary basis following extreme rainfall events.

Approximate Cost	£26k - £50k (capital scheme) + <£25k (feasibility study and planning policy)	
Potential Benefits	The proposed combination of options could reduce the flood risk to 60% (approximately 137) of the buildings which have been modelled to currently be at risk of flooding by 0.1m or greater from a 1% AEP storm event.	
Other Potential Options for Consideration		
Option A	Rainwater Harvesting	The large residential area to the north and south of the CDA will provide opportunity for the installation of water butts. These will potentially attenuate small proportions of surface water runoff generated from the roof; the cumulative effect could reduce the volumes of surface water flowing towards the PSWFH area. In addition this will provide a non potable water supply for residents to use. To provide water butts with a 0.3m^3 capacity to 900 houses, it would cost approximately £101k - £250k.
Potential Quick Wins		
Identify rights of ownership of drainage ditches / ordinary watercourses within the CDA and ensure information present on the South Essex Asset Register undertaken by Essex County Council is correct. Improve maintenance of the drainage ditches / ordinary watercourses throughout the CDA. Increase awareness through leaflet drops to residents and businesses within the PSWFH area.		

CDA: CAS 4 – Hadleigh
Preferred Option: Combined Measures: • Planning Policy for new development • Flood storage / online storage (Hadleigh Infants and Nursery School, The Crescent Recreation Ground)

The risk of surface water flooding in Hadleigh has been highlighted by the relatively high number of historic flood records. Surface water flooding in the east of the CDA is largely influenced by the topography. A combination of the following two measures will provide flood mitigation for the existing surface water flood risk, and ensure future development within the CDA does not contribute to the existing flood risk.

Planning Policy – Hadleigh Town Centre has been identified as a Growth Location for mixed developments. This area covers a large proportion of the CDA that would contribute to surface water flooding in the east. Planning policy should be used to ensure the use of source control measures, such as green roofs or rainwater harvesting, within the new development. Providing a standard for the ideal attenuation of surface water, such as 50% of the existing runoff rate, will reduce the volumes of surface water accumulating further downstream.



Flood Storage – Surface water runoff could be attenuated in detention basins developed alongside the southern boundary of Hadleigh Infants and Nursery School and within the Crescent Recreation Ground. A flood storage area of 650m^2 in the Hadleigh Infant and nursery school grounds could have a capacity of 195m^3 of rainwater. This would cost <£25k. A larger flood storage area in the Crescent Recreation Grounds would be required to accommodate a large volume of surface water accumulating at this point. A detention basin with a capacity of 540m^3 would cost <£25k to develop.

Approximate Cost	<£25k (Capital scheme) + <£25k (Planning and policy)
Potential Benefits	The proposed combination of options could reduce the flood risk to 40% (approximately 22) of the buildings which have been modelled to currently be at risk of flooding by 0.1 m or greater from a 1% AEP storm event.

Other Potential Options for Consideration		
Option A	Resilience	Flood resilience measures, such as raising building thresholds, could be implemented to protect the buildings at greatest risk of flooding. This could be applied to the buildings along The Crescent where the pluvial modelling highlights the greatest flood depths and there are historical flood records. Further analysis will be needed to determine the level of resistance required. The pluvial modelling indicates 13 houses at risk of flooding from a depth greater than 0.3m for a 1% AEP rainfall event; however the total number of houses needing resilience work is likely to differ. This option would cost approximately £251k - £500k.
Option B	Increase Sewer Capacity	Areas where the pluvial modelling have highlighted the greatest flood depths, such as The Avenue, The Crescent and Estate Road. A feasibility study would be required to determine the additional capacity required to alleviate the current flood risk. This would need to be investigated with Anglian Water
Potential Quick Wins		
Increase awareness through leaflet drops to residents and businesses within the PSWFH area. Identify rights of ownership of drainage ditches / ordinary watercourses within the CDA and ensure information present on the South Essex Asset Register undertaken by Essex County Council.		

CDA: CAS 6 – Canvey Island	
Preferred Option: Combined Measures: • Community Awareness • Planning Policy	
A combination of increasing public awareness and adoption of development policy will ensure that the flood risk is understood and that any future development will assist in reducing the current flood risk. Pluvial modelling indicates very few areas of surface water flooding and little overland flow within the CDA. Previous modelling of the drainage system (commissioned by the Environment Agency in 2007) has identified that, with the continued operation and maintenance of the drainage system, there is sufficient capacity to manage surface water flood risk including the effects of climate change. However, this is reliant on pumping stations, drainage channels and flow paths being maintained, free of obstruction and free flowing. It also requires ongoing community awareness with respect to extreme events which may exceed the capacity of the pumped drainage system, and the continued control of new surface water connections. The 2011 Castle Point Borough Council Strategic Flood Risk Assessment provides useful advice on the management of surface water for new development sites (those that were previously identified for the Core Strategy). ***Community Awareness*** – This would involve leaflet drops and public meetings to all residents and businesses within the CDA. ***Planning Policy –*** Planning policy could be used to encourage the implementation of source control measures in all new buildings. Such as with the London Plan 2011, it could be suggested that 50% of the existing runoff rate from new site is attenuated. This will help in reducing any further capacity on the existing drainage network.	
Approximate Cost	N/A
Potential Benefits	Continued management of surface water flows, including from new development; and, improved public awareness of the flood risk posed on the Island and the importance of maintaining functional drainage channels and systems.
Potential Quick Wins	
Identify rights of ownership of drainage ditches / ordinary watercourses within the CDA and ensure information present on the South Essex Asset Register undertaken by Essex County Council is correct.	

12.2 Preferred Options Summary

Table 12-1 summarises the preferred options identified through the Phase 3 - Options Assessment for addressing surface water flood risk in the shortlisted CDAs in Castle Point Borough Council.

Table 12-1: Preferred Options Summary for Castle Point Borough Council

CDA_ID	CDA Name	Option Category	Option Description	Combination Scheme?	Costing & Storage Volumes									Benefits
					Measures	Cost (£)	Unit Description	Units	Length	Area	Depth	Volume	Cost Band (£000s)	Cost Band for Combination Scheme (£000s)	% properties reduced flood risk
CAS 1	South Benfleet	Other or Combination	Flood Storage in Benfleet Marsh	✓	Investigation	-	-	-	-	-	-	-	-	**<£25k**	**40**
			Flood Storage Boyce Hill Golf Course		Bund / Flow Restriction	30	m3 of embankment	m3	100	-	1	100	<£25k		
			Community Awareness		Social Change, Education and Awareness	-	-	-	-	-	-	-	-		
			Land management and farming practices		Land Management Practices	-	-	-	-	-	-	-	-		
CAS 2	New Thundersley	Other or Combination	Creation of detention basin in the Robert Drake Primary School	✓	Detention Basin	22	m3 of detention volume	m3	-	1200	0.3	360	<£25k	**£101k - £250k**	**70**
			Creation of detention basin in the Tarpots Recreation Ground		Detention Basin	22	m3 of detention volume	m3	-	13400	0.3	4020	£51k - £100k		
			Coombe Wood flood storage bund		Bund / Flow Restriction	30	m3 of embankment	m3	55	-	1	55	<£25k		
			Influence source control in construction of new developments		Planning Policies to Influence Development	-	-	-	-	-	-	-	-		
			Increase conveyance through A130 embankment		Other 'Pathway' Measures	-	-	-	-	-	-	-	-		
CAS 3	East Thundersley	Other or Combination	Flood storage in Cedar Hall School	✓	Detention Basin	22	m3 of detention volume	m3	-	4400	0.4	1760	£26k - £50k	**£26k - £50k**	**60**
			Improved maintained along water courses and replacement of trash screen at Westwood Gardens		Improved Maintenance Regimes	-	-	-	-	-	-	-	-		
			Online storage through increasing the existing channel width		Managing Overland Flows (Online Storage)	-	-	-	-	-	-	-	-		
			Planning policy to influence new development to the north of Kiln Road		Planning Policies to Influence Development	-	-	-	-	-	-	-	-		
CAS 4	Hadleigh	Other or Combination	Flood storage along southern boundary of Hadleigh Infant School grounds	✓	Detention Basin	22	m3 of detention volume	m3	-	650	0.3	195	<£25k	**<£25k**	**40**
			To help ensure source control measures are implemented in new development across CDA		Planning Policies to Influence Development	-	-	-	-	-	-	-	-		
CAS 6	Canvey Island	Other or Combination	Leaflet drops and public meetings to ensure communities understand risk and actions	✓	Social Change, Education and Awareness	-	-	-	-	-	-	-	-	**N/A**	**N/A**
			To help ensure source control measures are implemented in new development across CDA		Planning Policies to Influence Development	-	-	-	-	-	-	-	-		

Note: This table has been produced to assist with the preliminary cost estimates as part of the South Essex SWMP. All dimensions and costs are indicative and should only be used for preliminary estimates due to the generalised nature of the information used to compile it. An estimated cost for the preferred flood mitigation option for each identified CDA has been calculated based on standard unit costs. No monetised damages have been calculated, and flood mitigation costs have been determined using engineering judgement, but have not undergone detailed analysis. The following standard assumptions have been applied:

- The costs are the capital costs for implementation of the scheme only.
- Costs do not include provisions for consultancy, design, supervision, planning process, permits, environmental assessment or optimum bias.
- No provision is made for weather (e.g. winter working).
- No provision is made for access constraints
- Where required, it will be stated if costs include approximate land acquisition components.
- No operational or maintenance costs are included.
- No provision is made for disposal of materials (e.g. for flood storage or soakaway clearance).
-

As a result, costs have been provided as cost bands, reflecting the strategic nature of the SWMP study and options identification.

13. Rochford District Council

13.1 CDA Preferred Options

For most CDAs, a range of preferred CDA specific options have been identified for consideration that could help to alleviate flooding. As this study has been undertaken at a strategic level, further studies and investigations are also detailed and recommended to be taken forward by Rochford District Council and/or other study partners. Details of these are presented within this Section and included within Rochford District Councils draft Action Plan (see Section 17 and Appendix F3). Where it is considered that further investigation / collaboration with third parties such as Anglian Water is required before determining the preferred capital option for a CDA, this has been highlighted.

It is expected that the preferred options presented within this section will be developed and/or altered as further information, potentially through on-site investigation and/or third party collaborations, becomes available.

In addition to the preferred options, a range of other potential options have been presented for each CDA that received a lower benefits score, but could still contribute to reducing flood risk in the CDA.

CDA: ROC 1 – Rayleigh West		
Preferred Option: Combined Measures: • Flood Storage (Sweyne Park and Sweyne Park School) • Further investigation of ordinary watercourse • Land Management		
There are several areas of deep ponding across the Rayleigh West CDA. The majority of these can be attributed to flooding of washlands and are intended to flood. The areas of surface water ponding near Caustonway and Station Crescent, behind the railway line embankment have already been addressed by Rochford District Council and Anglian Water through the creation of a stormwater sewer. The remaining areas of surface water flooding can be managed through a combination of options applied across the CDA. ***Flood Storage –*** There are two potential options for the creation of flood storage: Sweyne Park, and the playing fields of Sweyne Park School. Multifunctional detention basins could be created to provide recreational space and temporary flood storage during extreme flood events. Within Sweyne Park, a detention basin of 1,800m^2 by an average depth of 0.2 m would provide 360 m^3 of capacity for surface water runoff. This would cost in the region of <£25k. A larger flood storage area within Sweyne Park School could help to alleviate the flood risk to the school as well as the surrounding areas. A detention basin with an area of 6,700m^2 and a capacity of 1,340m^3 would cost between £26k and £50k. Alternatively the channel of the Rawreth Brook passing through Sweyne Park could be developed into a two stage channel. This would provide online storage of excess water during times of high flow. A flow control at the outlet would ensure water accumulates in the two stage channel instead of flowing towards more vulnerable areas. ***Further Investigation –*** Further investigation is needed of the ordinary watercourse that flows from Heron Close towards the A129 (see figure), this should be undertaken to determine the channel condition and potential obstructions that could prevent the conveyance of stormwater. ***Land Management –*** Encouraging the beneficial land management practices in the farmland to the south of the CDA and across the school and recreational grounds within the CDA can reduce the rate of surface water runoff leaving these surfaces, and will encourage infiltration. This can be achieved by meeting with and discussing best practices with farmers.		
Approximate Cost	£26k - £50k (Capital scheme) + <£25k (Investigation).	
Potential Benefits	The proposed combination of options could reduce the flood risk to 15% (approximately 86) of the buildings which have been modelled to currently be at risk of flooding by 0.1m or greater from a 1% AEP storm event.	
Other Potential Options for Consideration		
Option A	Community awareness	As an additional option to the preferred options listed above, the provision of community awareness could be implemented. This can be achieved through mechanisms such as leaflet drops or community meetings.

Other Potential Options for Consideration		
Option B	Resilience of School	Providing resilience to Sweyne Park School is an alternative option that will ensure that this building is protected from surface water flooding.
Option C	Water Butts	Alternatively, the wide scale implementation of water butts across the CDA could be used to attenuate rainfall at the point of generation. To provide 750 residential buildings to the west of the CDA with water butts, each with a 0.3m^3 capacity, would cost £101k - £250k. Additionally, this provides a non-potable water supply for residential use.
Potential Quick Wins		
Identify rights of ownership of drainage ditches / ordinary watercourses within the CDA and ensure information present on the South Essex Asset Register undertaken by Essex County Council. Improve maintenance of the drainage ditches / ordinary watercourses throughout the CDA. Formalise a Flood Storage Area (Sweyne Park, Boston Avenue), through the creation of a Washland Management Plan.		

CDA: ROC 2 – Watery Lane		
Preferred Option: Combined Measures: • Further Study • Planning Policy		
Further Study – Due to the complex mechanisms of flooding within this CDA (a combination of pump capacity, tide locked conditions, fluvial flood risk and drainage channel capacity), it is recommended that further study is undertaken to determine the causes of flooding and possible mitigation measures. ***Planning Policy –*** New development (extension of the residential development in Hullbridge) to the north of the CDA can utilise source control measures to provide betterment in the existing surface water flooding within the CDA. This can be enforced through Local planning policy. In addition, ensuring the buildings are flood resilient if they are expected to fall in an area with a high risk of flooding, planning can ensure the relevant measures are taken.		
Approximate Cost	N/A	
Potential Benefits	N/A	
Other Potential Options for Consideration		
Option A	Resilience Measures	A number of houses have been identified to be at risk of surface water flooding in this area. Resilience measures could be used, such as raising the foundations of the building to limit the damage resulting from surface water flooding. Providing flood resilience could cost approximately £ 22,000 per property. This would be required for the houses that have been identified, through pluvial modelling, to be at risk from 0.3 m or more of surface water flooding (from a 1% AEP storm event), or have historically flooded. This would cost £501k - £1m. Infrastructure resilience of the two pumping stations located in the PSWFH would be beneficial to ensure the function during times of flooding if required.
Potential Quick Wins		
Community Awareness through leaflet drops or public meetings. Identify rights of ownership of drainage ditches / ordinary watercourses within the CDA and ensure information present on the South Essex Asset Register undertaken by Essex County Council. Improve maintenance of the drainage ditches / ordinary watercourses throughout the CDA.		

CDA: ROC 4 – Hockley		

Preferred Option: Combined Measures:

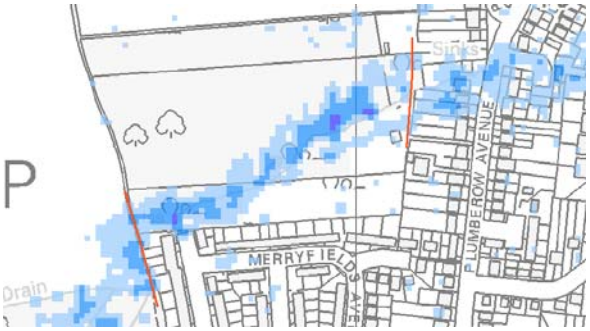
- Flood Storage (Plumberow Primary School, Greensward Academy)
- Flow Restriction (Marylands Wood)
- Planning Policy
- Community Awareness

Within the Hockley CDA there are two predominant flow paths draining surface water runoff from the west to the east. These flow paths meet around the South View Road area where surface water flood depths are greatest. There are opportunities to attenuate surface water upstream, so reducing the surface water flood depths at South View Road. A combination of options is suggested to manage the current and future surface water flood risk.

Flood storage – There are several areas which could be developed to create multifunctional flood storage spaces. This can be achieved through the re-landscaping of the existing space. Flood storage could be incorporated into the green spaces and recreational area of the Greensward Academy. A detention basin in Greensward Academy, with a capacity of 1200m^3, would cost £26k - £50k. Pluvial modelling highlights greater surface water depths in the car park of the Plumberow Primary School. The car park space could be modified to create a temporary storage area through increasing the kerb height and controlling the flow of surface water from the site.

Flow restriction – Two bunds could be created along the eastern boundaries of Marylands Wood, by Maryland Avenue and Plumberow Avenue, totalling 225m in length. These would act to restrict the flow of water from Marylands Wood to a controlled rate intended to produce the predicted surface water ponding in downstream areas. This would cost <£25k.

Community Awareness – Increasing public awareness through leaflet drops and community meeting to assist in ensuring the understanding of flood risk and the correct response in the event of flooding.



Planning Policy – The Foundry Industrial Estate/ Eldon Way has been identified as an area of future development. Planning policy can be used to encourage the retention of surface water runoff through the use of source control measures. Additional attenuation of surface water runoff at this point will have a beneficial impact on the flooding along Spa Road and Broad Way. Using guidelines, such as the reduction in runoff by 50% of the existing rate, will ensure source control measures are utilised.

Approximate Cost	£26k - £50k (Capital scheme)
Potential Benefits	The proposed combination of options could reduce the flood risk to 40% (approximately 97) of the buildings which have been modelled to currently be at risk of flooding by 0.1 m or greater from a 1% AEP storm event.

Other Potential Options for Consideration

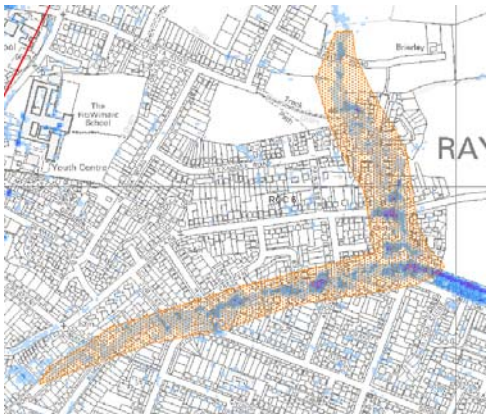
Option A	Investigation of Sewers	A number of DG5 sewer flooding incidents have been recorded across the CDA. An investigation of the sewer network is recommended to determine the condition and efficiency of the surface water drainage network.

Potential Quick Wins
Identify rights of ownership of drainage ditches / ordinary watercourses within the CDA and ensure information present on the South Essex Asset Register undertaken by Essex County Council is correct. Improve maintenance of the drainage ditches / ordinary watercourses throughout the CDA.

CDA: ROC 6 – Rayleigh East
Preferred Option: Combined Measures: • Flood Storage (Napier Road, Grove Nature Reserve) • Investigation of Sewer Network (Napier Road, Thorington Road, The Chase) • Community Awareness • Land Management

Surface water drains from the north and west of the CDA towards Noblesgreen Ditch in the east. The following combination of measures will help to reduce the existing flood risk and enhance the understanding of the flooding mechanisms with the CDA.

Flood Storage – There are several areas which could be developed to create multifunctional flood storage spaces, by re-landscaping of the existing space. Flood storage could be incorporated into the green spaces and recreational areas of Napier Road Green Space and Grove Nature Reserve. The flood storage space, for example within the Grove Nature Reserve, could be used to enhance the existing eco system potential of the area. For both locations, a detention basin of 5,700 m^2 could be utilised to have capacity of 1,140m^3 to attenuate surface water. This has an estimated cost of <£25k per detention basin. The Environment Agency should be included in any project team looking into this option given the Main River and Byelaw considerations that will have to inform the scheme planning and design process.



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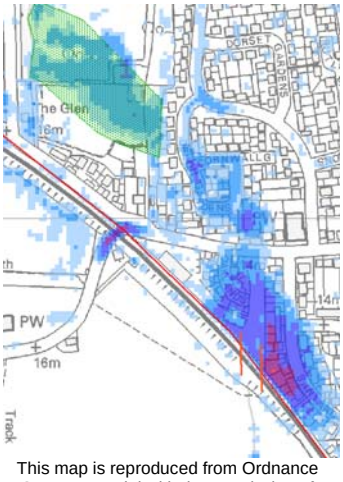
Investigation of Sewer Network – There are a number of DG5 sewer flooding records along Thorington Road, The Chase and Napier Road. Additionally investigation into the sewer capacity across areas indicated by the pluvial modelling to be at risk of surface water flooding is recommended. This will determine the efficient and capacity of the sewer system and whether Anglian Water could consider an uprating scheme for implementation in AMP6 (2015 to 2020).

Community Awareness – Increasing the awareness of flood risk to the residents and businesses within the PSWFH area can be achieved through leaflet drops or community presentations. This will help to ensure that in the event of a flood, the advised actions are taken.

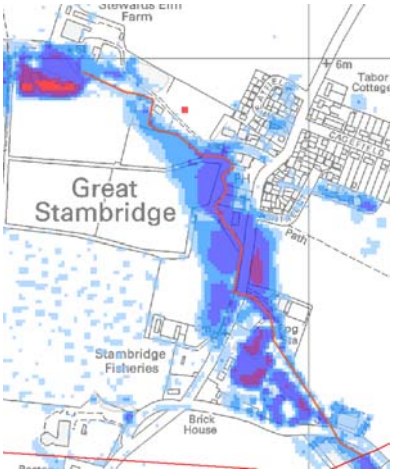
Land Management – The agricultural land to the east of the CDA could generate significant quantities of surface water runoff. Simple changes in farming practices such as the direction fields are ploughed could reduce the overland flow. Alternative operational management of the sports fields and recreational grounds within the CDA could also produce a benefit by ensuring the infiltration potential is maximised. This can be achieved through the aeration of the compacted grounds. These measures can be incorporated into the existing maintenance regime of the site.

Approximate Cost	£51k - £100k (Capital scheme) + <£25k (Investigation)
Potential Benefits	The proposed combination of options could reduce the flood risk to 55% (approximately 131) of the buildings which have been modelled to currently be at risk of flooding by 0.1m or greater from a 1% AEP storm event.

Other Potential Options for Consideration		
Option A	Preferential Flow Path	The pluvial modelling indicates surface water to flow predominantly along the roads from the north to the east of the CDA. These roads could be modified to form a preferential flow path that would ensure surface water stays within the roads, and does not flow towards receptors. Albert Road, Bull Lane and The Chase could all be adjusted, where required, to act as a channel for surface water. Adjustments include the increase in pavement height or a lowering of the road bed depth. A feasibility study will be required to determine the measures needed to achieve this and impact this will have on local flooding, especially regarding the local drainage system.
Potential Quick Wins		
Improve maintenance of the drainage ditches / ordinary watercourses throughout the CDA.		

CDA: ROC 7 – Ashingdon-Rochford	
Preferred Option: Combined Measures: • Flood Storage (Spencer's Park) • Flow Restriction (Rochford Garden Way) • Further Investigate Railway Embankment (with Network Rail) • Land Management • Planning Policy	
The following combination of measures can be applied throughout the CDA to reduce the flood risk in both PSWFH of the CDA. ***Flood Storage, Spencer's Park –*** Flood storage could be developed in Spencer's Park to accommodate surface water runoff prior to draining towards the south. A detention basin, with an area of 17,000m^2 could accommodate 3,400m^3 of surface water runoff. This could be landscaped to provide a diverse recreational area. A detention basin of this size, with an average depth of 0.2m would cost £51k - £100k. This would reduce the flood risk within the northern PSWFH. ***Flow Restriction –*** Surface water draining from the north to the southern PSWFH has been modelled to accumulate to the north of Rochford Garden Way, before flowing south via The Drive. Creating a bund along the southern perimeter of the field would attenuate surface water runoff in the open space and restrict the volumes flowing south. A bund of 200m length would cost <£25k. ***Further Investigation –*** Accumulation of surface water runoff to the east of the network rail embankment around the Banyard Way is potentially due to an undersized culvert. Investigation into the potential cause of flooding at this point is recommended. ***Land Management –*** A large proportion of the CDA is agricultural farmland, therefore encouraging beneficial farming practices to prevent the generation of surface water runoff is recommended. ***Planning Policy –*** There are two potential growth areas within the CDA which have been highlighted for future development. These are indicated to be extensions of the residential envelope and will develop on green field space. The use of planning policy to influence the level of surface water attenuation could be implemented to further reduce runoff. Attenuating surface water runoff from new developments using source control measures, to greenfield runoff rates would be recommended.	 This map is reproduced from Ordnance Survey material with the permission of Ordnance Survey on behalf of Her Majesty's Stationery Office © Crown Copyright. Unauthorised reproduction infringes Crown Copyright and may lead to prosecution or civil proceedings. All rights reserved Licence No. DROC100.
Approximate Cost	£101k - £250k (Capital scheme) + <£25k (Investigation)
Potential Benefits	These measures could reduce the flood risk in the two PSWFH areas of the CDA. The implementation of the flood storage in Spencer's Park could potentially reduce the flood risk to 20% (approximately 70) of the buildings which have been modelled to be at risk of flooding of 0.1m or greater throughout the CDA (1% AEP storm event). The implementation of the Rochford Garden Way flood storage bund could reduce the flood risk to 30% (approximately 114) of the buildings which have been modelled to be at risk of flooding of 0.1m or greater throughout the CDA (1% AEP storm event).

Other Potential Options for Consideration		
Option A	Source Controls	Residential buildings off Pollards Close, Union Lane and Ashingdon Road could all potentially develop rainwater harvesting systems, which could later supply the maintenance activities of the residential areas. The large, flat roof surfaces would potentially be suitable for the installation of green roofs, however further investigation would be required to determine the structural suitability of the building. Rainwater harvesting systems totalling 30m^3 would cost £26k - £50k.
Option B	Flood Storage	Utilise the car parks off Pollards Close, Union Lane and Ashingdon Road to store flood water. Modification of the curb height, or car park depth will allow for the accumulation of surface water.
Option C	Infrastructure Resilience	Apply resilience measures to the Rochford Fire Station as it is located within the PSWFH and so is at high risk of surface water flooding. To ensure resilience of a larger building would cost between £26k and £50k.
Potential Quick Wins		
Identify rights of ownership of drainage ditches / ordinary watercourses within the CDA and ensure information present on the South Essex Asset Register undertaken by Essex County Council is correct. Improve maintenance of the drainage ditches / ordinary watercourses throughout the CDA. Awareness through public meetings and leaflet drops to residents and businesses within the PSWFH areas.		

CDA: ROC 8 – Great Stambridge		
Preferred Option: Combined Measures: • Further Investigation • Planning Policy		
Further Investigation – Pluvial modelling indicates the flooding within this CDA is predominantly over rural land; however the channel of the Bartonhall Creek may be exacerbating flooding in Great Stambridge, as the alignment of the channel and structures over the channel are potentially reducing the conveyance of water and resulting in overtopping and localised ponding. Investigation into the impact of the current channel structure on the flood risk should be undertaken. In addition, the impact of straightening the channel, the widening of the channel, or increasing the conveyance of water under structures should be investigated. ***Planning Policy –*** The Rochford District Council Core Strategy outlines South Canewdon for the extension of the residential envelope. This will be developed on greenfield land. New local planning policy could be developed in order to minimise surface water runoff.		 This map is reproduced from Ordnance Survey material with the permission of Ordnance Survey on behalf of Her Majesty's Stationery Office © Crown Copyright. Unauthorised reproduction infringes Crown Copyright and may lead to prosecution or civil proceedings. All rights reserved Licence No. DROC100.
Approximate Cost	<£25k (investigation)	
Potential Benefits	Any option developed following an investigation could reduce the flood risk to 15% of the buildings which have been modelled to currently be at risk of flooding by 0.1m or greater from a 1% AEP storm event.	
Other Potential Options for Consideration		
Option A	Flood Resilience	Two buildings have been identified to be at risk of flooding by 0.3m or greater. Providing resilience measures for these buildings would cost approximately £26k - £50k.
Option B	Community Awareness	Increasing the awareness of flood risk to the residents and businesses within areas at risk of flooding can be achieved through leaflet drops or community presentations. This will help to ensure that in the event of a flood, the advised actions are taken.
Potential Quick Wins		
Improve maintenance of the drainage ditches / ordinary watercourses throughout the CDA.		

CDA: ROC 9 – Little-Great Wakering		
Preferred Option: Combined Measures: • Further Investigation into the Sewer Network • Community Awareness • Planning Policy		
Further Investigation – This CDA has been identified due to the number of historical surface water and sewer flooding incidents and because it is within a potential development location. An investigation into the sewer network drainage capacity to look at the cause of these would be recommended as the initial step in resolving the flooding problem. This should be focussed around Little Wakering Road where the majority of historical flooding incidences are recorded. ***Community Awareness –*** In addition, ensure community awareness through leaflet drops and public meetings will help to ensure that in the event of a flood, the advised actions are taken. ***Planning Policy –*** There are potential growth areas within the CDA which have been highlighted for future development. These are indicated to be extensions of the residential envelope and will develop on greenfield space. The use of planning policy to influence the level of surface water attenuation could be implemented to further reduce runoff. Attenuating surface water runoff from new developments using source control measures, to greenfield runoff rates would be recommended.		
Approximate Cost	N/A	
Potential Benefits	N/A	
Other Potential Options for Consideration		
Option A	Flood Storage	The Environment Agencies Flood Map for Surface Water indicates areas of potential flood risk across the CDA. The creation of a flood storage space in the field behind Cronje Cottage could attenuate surface water and help to reduce the risk of flooding of Little Wakering. A detention basin, with an area of 3000m^2 would cost <£25k.
Potential Quick Wins		
Improve maintenance of the drainage ditches / ordinary watercourses throughout the CDA to ensure the capacity and conveyance potential is available.		

13.2 Preferred Options Summary

Table 13-1 summarises the preferred options identified through the Phase 3 for addressing surface water flood risk in the shortlisted CDAs in Rochford District Council.

Table 13-1: Preferred Options Summary for Rochford District Council

CDA_ID	CDA Name	Option Category	Option Description	Combination Scheme?	Costing & Storage Volumes										Benefits	
					Measures	Cost (£)	Unit Description	Units	Length	Area	Depth	Volume	Cost Band (£000s)	Cost Band for Combination Scheme (£000s)	% houses reduced flood risk
ROC 1	Rayleigh West	Other or Combination	Flood storage: detention basin developed in Sewyne Park.	✓	Detention Basin	22	m3 of detention volume	m3	-	1800	0.2	360	<£25k	**£26k - £50k**	**15**
			Flood storage: detention basin developed in Sewyne Park School.		Detention Basin	22	m3 of detention volume	m3	-	6700	0.2	1340	£26k - £50k		
			Further investigation in to ordinary watercourse flowing from Heron Close towards the A129		Investigation	-	-	-	-	-	-	-	-		
			Land management of farmland to the south		Social Change, Education and Awareness	-	-	-	-	-	-	-	-		
ROC 2	Watery Lane	Other or Combination	Investigation into flood mechanisms	✓	Investigation	-	-	-	-	-	-	-	-	**N/A**	**N/A**
			Planning policy to ensure new development is flood resilient and to implement source control measures		Planning Policies to Influence Development	-	-	-	-	-	-	-	-		
ROC 4	Hockley	Other or Combination	Flood Storage: Flood Storage in Plumberow Primary School car park	✓	Other ' Source' Measures	-	-	-	-	-	-	-	-	**£26k - £50k**	**55**
			Flood Storage: Detention basins in Greensward Academy		Detention Basin	22	m3 of detention volume	m3	-	4000	0.3	1200	£26k - £50k		
			Bunds to create flood storage in Marylands Woods		Bund / Flow Restriction	30	m3 of embankment	m3	225	-	-	-	<£25k		
			Community awareness across the PSWFH through leaflet drops or public meetings		Social Change, Education and Awareness	-	-	-	-	-	-	-	-		
			Policy to ensure implementation of source controls in the potential new development on Foundry Industrial Estate		Planning Policies to Influence Development	-	-	-	-	-	-	-	-		
ROC 6	Rayleigh East	Other or Combination	Flood storage areas in Napier Road	✓	Detention Basin	22	m3 of detention volume	m3	-	5700	0.2	1140	£26k - £50k	**£51k - £100k**	**55**
			Flood storage areas in Grove Nature Reserve		Detention Basin	22	m3 of detention volume	m3	-	5700	0.2	1140	£26k - £50k		
			Investigation of sewer network along Thorington Road and		Investigation	-	-	-	-	-	-	-	-		
			Community awareness		Social Change, Education and Awareness	-	-	-	-	-	-	-	-		
			Land management of farmland		Land Management Practices	-	-	-	-	-	-	-	-		
ROC 7	Ashingdon - Rochford	Other or Combination	Flood storage area within the landscape of Spencer's Park	✓	Detention Basin	22	m3 of detention volume	m3	-	17000	0.2	3400	£51k - £100k	**£101k - £250k**	**30**
			Bund across the perimeter of Rochford Garden Way		Bund / Flow Restriction	30	m3 of embankment	m3	200	-	-	-	<£25k		
			Investigation of flooding at the railway embankment		Investigation	-	-	-	-	-	-	-	-		
			Planning policy for greeenfield development		Planning Policies to Influence Development	-	-	-	-	-	-	-	-		
			Community awareness		Social Change, Education and Awareness	-	-	-	-	-	-	-	-		

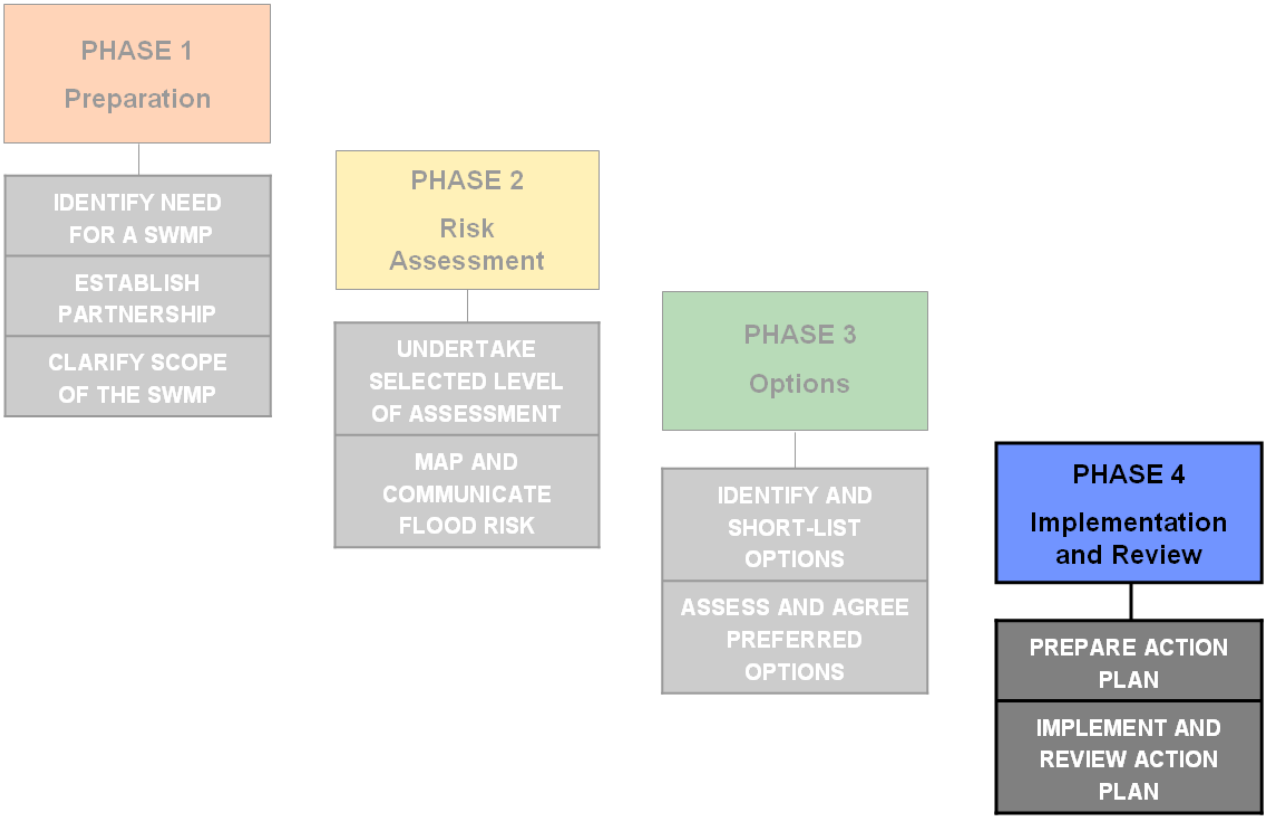
ROC 8	Great Stambridge	Further Investigate Flooding Mechanisms	Investigate the channel alignment and its association with flooding	✓	Investigation	-	-	-	-	-	-	-	-	N/A	15
		Planning Policy	To ensure retention of surface water generated by new development.		Planning Policies to Influence Development	-	-	-	-	-	-	-	-		
		Community Awareness / Resilience	Community awareness	×	Social Change, Education and Awareness	-	-	-	-	-	-	-	-		
ROC 9	Little - Great Wakering	Other or Combination	Investigation of flood risk	✓	Investigation	-	-	-	-	-	-	-	-	N/A	N/A
			Community awareness through CDA		Social Change, Education and Awareness	-	-	-	-	-	-	-	-		

Note: This table has been produced to assist with the preliminary cost estimates as part of the South Essex SWMP. All dimensions and costs are indicative and should only be used for preliminary estimates due to the generalised nature of the information used to compile it. An estimated cost for the preferred flood mitigation option for each identified CDA has been calculated based on standard unit costs. No monetised damages have been calculated, and flood mitigation costs have been determined using engineering judgement, but have not undergone detailed analysis. The following standard assumptions have been applied:

- The costs are the capital costs for implementation of the scheme only.
- Costs do not include provisions for consultancy, design, supervision, planning process, permits, environmental assessment or optimum bias.
- No provision is made for weather (e.g. winter working).
- No provision is made for access constraints
- Where required, it will be stated if costs include approximate land acquisition components.
- No operational or maintenance costs are included.
- No provision is made for disposal of materials (e.g. for flood storage or soakaway clearance).

As a result, costs have been provided as cost bands, reflecting the strategic nature of the SWMP study and options identification.

Phase IV: Implementation and Review



Part A: Study Wide

14. Implementation & Review

14.1 Action Plan

The purpose of Phase 4 of the SWMP is to clearly identify actions and responsibilities for the ongoing management of surface water flood risk throughout South Essex that have been identified through the work undertaken in Phases 1 to 3. These build on the recommendations identified throughout the SWMP and options developed through Phase 3.

A draft Action Plan has been created for Essex County Council (Appendix F1), Basildon Borough Council (Appendix F2), Castle Point Borough Council (Appendix F3) and Rochford District Council (Appendix F4). The draft Action Plan is a simple summary spreadsheet that has been formulated by reviewing the previous phases of the SWMP in order to create a useful set of actions relating to the management and investigation of surface water flooding going forward.

It is the intention that the draft Action Plan is a live document, maintained and regularly updated by each of the Councils, as actions are progressed and investigated, and as such has been issued as a draft Action Plan. It should be understood that following further detailed investigation the preferred option in each CDA (and even in some cases the need for any action other than basic investigation in a particular CDA) may be discounted. Likewise new actions may be identified, or may be required by changes in legislation and guidance over time.

The Action Plan identifies:

- Actions to help manage flood risk and to meet the requirements under the Flood and Water Management Act 2010 and Flood Risk Regulations 2009;
- Future studies and consultations for investigation and confirming the level of flood risk within each Council;
- An estimation of costs for investigations and optioneering works – including possible sources of funding – for the CDAs within each Council, as identified in Phase 3 of the SWMP;
- The partners or stakeholders responsible for implementing and supporting the actions;
- An indication of when the actions should be undertaken, reviewed and updated (these should be confirmed upon adoption of the draft Action Plan);
- An indication of the priority of the actions – high, medium or low to aid prioritisation of the actions; and,
- Linkage between actions.

Actions within the Action Plan have been categorised according to different actions types as summarised in Table 14-1.

Table 14-1 -Types of Action within the Action Plan

Definition	Description
FWMA 2010 / Flood Risk Regulations 2009	Duties and actions required under the Flood Risk Regulations and FWMA - Refer to Appendix A of the LGG 'Preliminary Framework to assist the development of the Local Strategy for Flood Risk Management' (February 2011) for minimum requirements.
Policy Action	Spatial planning or development control actions.
Communication / Partnerships	Actions to communicate risk internally or externally to LLFA or create / improve flood risk related partnerships.
Financial / Resourcing	Actions to secure funding internally / externally to support works or additional resources to deliver actions.
Investigation / Feasibility / Design	Further investigation / feasibility study / Design of mitigation.
Flooding Mitigation Action	Maintenance or capital works undertaken to mitigate flood risk.

As part of the preparation of the draft Action Plan and the SWMP, the requirement for a Strategic Environmental Assessment (SEA), an Appropriate Assessment (required by the Habitats Directive) or an Article 4.7 assessment (under the Water Framework Directive) was considered.

Liaison with the Environment Agency in relation to other SWMPs undertaken nationally suggested that the SWMP alone does not require any of the environmental assessments described above. However, it is possible that any actions which are taken forward will require such assessments and it is envisaged that the requirement for this will form part of feasibility studies for individual schemes.

14.2 Essex County Council Actions

Essex County Council, as LLFA, will undertake a number of generic actions across the South Essex study area (Appendix F1). Table 14-2 details the actions that will be covered by Essex County Council. These actions should be incorporated into the Essex Partnership for Flood Management's Annual Action Plan and progress against them should be reviewed by this body. Any alterations to them should by agreed by the partnership.

Table 14-2: Actions Taking place across Essex County Council

	Recommendation	Action Type	Timeframe	Responsibility[19]
1	Establish a Flood Risk Management Group to take forward FWMA and SWMP actions and Local Flood Risk Management.	FWMA 2010 / FRR 2009	Short	ECC
2	Land management – Meet with farmers to discuss farming practices and potential changes that could bring benefits to the management of surface water runoff.	Communication / Partnership	Short	ECC
3	Improved Weather Warning – Extreme Rainfall Alert – Examine the suitability and potential to adopt the Extreme Weather Alert and the incorporation of this into the emergency response plan	Investigation / Feasibility / Design	Short	ECC
4	Improved Weather Warning – Adopt the Extreme Rainfall Alert provided by the Flood Forecasting Centre	Flood Mitigation Action	Medium	ECC
5	Review and update the South Essex SWMP Action Plan annually for ongoing and future flood management options.	FWMA 2010 / FRR 2009	Short	ECC

Table 14-3: Actions to be undertaken by Essex County Council in South Essex

	Recommendation	Action Type	Timeframe	Responsibility	Action Plan ID
Standardised Flood Incident Log					
1	Actively engage political stakeholders as appropriate within the formal political structures and communication protocols	Communication / Partnership	Short	ECC	1
Community Awareness					
2	Actively engage political stakeholders as appropriate within the formal political structures and communication protocols	Communication / Partnership	Short	ECC	3
3	Raise community awareness – identify areas where Community Flood Plans may be effective and consider opportunities to develop these, in conjunction with the local community	Communication / Partnership	Short	ECC, BBC, CPBC, RDC	4
Emergency Planning Response					
4	Develop emergency response strategy –focused on PSWFH where the risk of surface water flooding is greatest.	Communication / Partnership	Short	ECC, BBC, CPBC, RDC	20

[19] Abbreviations for Organisations: BBC = Basildon Borough Council; CPBC = Castle Point Borough Council; RDC = Rochford District Council; ECC = Essex County Council; EA = Environment Agency; AWS = Anglian Water Services; NR = Network Rail; Com = Communities / General Public; All = All third parties involved in local flood risk management

	Recommendation	Action Type	Timeframe	Responsibility	Action Plan ID
Maintenance and Inspection of Watercourse					
5	Ongoing improvements to the maintenance of the drainage network – targeted maintenance of the drainage network	Flood Mitigation Action	Medium	ECC	6
6	Identify rights of ownership for drainage ditches	Policy Action	Medium	ECC, BBC, CPBC, RDC	7
Improve Knowledge of area					
7	Formalise washlands, flood storage areas and detention basins to ensure their integrity is not negatively influenced by new development and develop a management plan for ongoing maintenance of their storage function	Policy Action	Medium	ECC	10
8	Work with AWS to identify where sewer flooding influences surface water flooding	FWMA 2010 / FRR 2009	Short	ECC, AWS	2
9	Identify rights of ownership for drainage ditches	Policy Action	Medium	ECC, BBC, CPBC, RDC	7
FDGiA funding					
10	Priority capital schemes will be put forwarded for FDGiA funding.	Flood Mitigation Action	Short	ECC	21
Development and Adoption of SuDS Design Guide					
11	Land management - Increase urban vegetation coverage by planting of trees and bushes along streets and in car parks	Flood Mitigation Action	Medium	ECC	5
12	Planning Policy – Runoff Rates from New Development, Information on SuDS, Use of SuDS, Paved driveways,	Policy Action	Short	ECC	8, 9, 11, 12, 13
13	Water Conservation – incentive scheme for rainwater harvesting or water butts, installing rainwater harvesting on new or regenerated development areas, retrofitting rainwater harvesting systems on council owned buildings, installing water butts in all new residential developments, retrofitting water butts on all existing development, promotion of water butts across the study area.	Policy Action	Short	ECC	14, 15, 16, 17, 18, 19

Part B: Council Action Plans

15. Basildon Borough Council Action Plan

15.1 Summary of Key Actions

The key (high priority) actions for Basildon Borough Council over the short- to medium-term, largely relate to providing assistance to Essex County Council as LLFA in order to meet their requirements under the FWMA 2010 and Flood Risk Regulations 2009, and general actions and investigations that apply to the wider Council. These include actions and investigations indentified in the CDAs and consultation with professional and political stakeholders and the public.

Proposed actions have been classified into the following timeframes:

- Short term – Actions to be undertaken within a year of the SWMP being adopted;
- Medium term – Actions to be undertaken within a year to five years after the SWMP is adopted; and
- Long term – Actions to be undertaken beyond five years after the SWMP is adopted.

The preferred options and 'quick wins' identified for each CDA have been included in the draft Action Plan. All actions included within Table 15-1 below have been identified as 'High Priority' actions. The reader is referred to the draft Action Plan in Appendix F2 for all actions identified within Basildon Borough Council.

It should be noted that Basildon Borough Council is identified as the 'lead organisation' for the majority of the actions identified within the draft Action Plan. It is envisaged that though many of the actions should be taken forward in collaboration with third-parties such as Essex County Council (as LLFA), Anglian Water, or the Environment Agency, for example, and could be partly or fully funded by these parties, the initial emphasis is likely to come from the Council as the 'lead' organisation. It will therefore be essential that responsibility and funding opportunities for any potential actions are identified at the earliest opportunity.

Table 15-1- High Priority Actions for Basildon Borough Council

	Recommendation	Action Type	Timeframe	Responsibility[20]	Action Plan ID
11	Further investigation and feasibility analysis of the preferred (P) and other potential options (O) within BAS 1: • Flood Storage: Detention Basin in Lake Meadows (P) • Swales: Rochford Crescent (P) • Source Control/Attenuation: The Pantiles (P) • Rainwater Harvesting: Lake Meadows Swimming Pool (O)	Investigation / Feasibility / Design	Short	BBC	Action BAS 1
12	Further investigation and feasibility analysis of preferred (P) and other potential options (O) within BAS 3: • Flood Storage: Detention basin within Mayflower School and the land at Hollyford (P) • Preferential Overland Flow Path: Stock Road (O)	Investigation / Feasibility / Design	Short	BBC	Action BAS 7
13	Further investigation and feasibility analysis of preferred (P) and other potential options (O) within BAS 4: • Flood Storage – Bund: Mill Meadows (P) • Increase Conveyance: Sunnymede Ordinary Watercourse (P) • Flood Storage: Two stage channel Outwood Common (O)	Investigation / Feasibility / Design	Short	BBC	Action BAS 10
14	Further investigation and feasibility analysis of the preferred (P) and other potential options (O) within BAS 8: • Flood Storage – Bund: Paddocks recreation ground (P) • Potential / Designated overland flow route: High Road (P) • Source Control/Attenuation: Laindon Centre (P)	Investigation / Feasibility / Design	Short	BBC	Action BAS 14
15	Further investigation and feasibility analysis of the preferred (P) and other potential options (O) within BAS 12: • Diversion of flows: Kingswood Washland (P) • Swales: Tinkler Side (P) • Source Control: Basildon Shopping Centre (O) • Resilience: Basildon Community Hospital (O)	Investigation / Feasibility / Design	Short	BBC	Action BAS 18

[20] Abbreviations for Organisations: BBC = Basildon Borough Council; CPBC = Castle Point Borough Council; RDC = Rochford District Council; ECC = Essex County Council; EA = Environment Agency; AWS = Anglian Water Services; NR = Network Rail; Com = Communities / General Public; All = All third parties involved in local flood risk management

	Recommendation	Action Type	Timeframe	Responsibility[20]	Action Plan ID
16	Further investigation and feasibility analysis of the preferred (P) and other potential options (O) within BAS 14: • Detention Basin: Barstable School (P) • Source Control: Barstable School (O)	Investigation / Feasibility / Design	Short	BBC	Action BAS 23
17	Further investigation and feasibility analysis of the preferred (P) and other potential options (O) within BAS 15: • Detention Basin: Briscoe and Felmore School (P) • Further Investigation: Drainage Network across CDA (P) • Source Control: Briscoe and Felmore School (O) • Resilience: Briscoe and Felmore School (O)	Investigation / Feasibility / Design	Short	BBC	Action BAS 26
18	Further investigation into the flooding mechanisms within BAS 16, mainly the interaction between the ordinary watercourses, main rivers and drainage ditches.	Investigation / Feasibility / Design	Short	BBC, ECC, AWS, EA	Action BAS 31
19	Further investigation of the network rails drainage network across the railway embankment in BAS 17.	Investigation / Feasibility / Design	Short	BBC, ECC, AWS, NR	Action BAS 32
20	Further investigation and feasibility analysis of flood storage areas in the Elder Avenue Recreation Ground and the Kingsley Meadows Recreation Ground within BAS 21.	Investigation / Feasibility / Design	Short	BBC	Action BAS 33
21	Further investigation and feasibility analysis of flooding mechanisms, preferred (P) and other potential options (O) within BAS 22: • Flood Storage: Main river (O) • Further Investigation: Land Drainage Capacity (P)	Investigation / Feasibility / Design	Short	BCC, EA, AWS	Action BAS 36

15.2 Review Timeframe and Responsibilities

The draft Action Plan identifies the relevant internal departments and external partnerships that should be consulted and asked to participate when addressing an action, though these should be checked and confirmed by Basildon Borough Council as the first stage in taking forward their Action Plan recommendations. After an action has been addressed, it is recommended that the responsible department (responsible for completing the action) review the Action Plan and update it to reflect any issues (communication or stakeholder participation) which arose during the completion of an action and whether or not additional actions are required.

It is recommended that the Action Plan is reviewed and updated on an annual basis to reflect any works undertaken by the Council and other stakeholders.

15.3 Ongoing Monitoring

The partnership arrangements established as part of the South Essex SWMP process (e.g. the SWMP working group of Basildon Borough Council, Castle Point Borough Council, Rochford District Council, Essex County Council, Environment Agency, and Anglian Water working in collaboration) should continue beyond the completion of the SWMP in order to discuss the implementation of the proposed actions, review opportunities for operational efficiency and to review any legislative changes.

The draft Action Plan should be reviewed and updated once annually as a minimum, but there may be circumstances which might trigger a review and/or an update of the Action Plan in the interim, for example:

- occurrence of a surface water flood event;
- additional data or modelling becoming available, which may alter the understanding of risk within the study area;
- if the outcome of an investment decision 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.

15.4 Updating SWMP Reports and Figures

In recognition that the SWMP will be updated in the future, the report has been structured in chapters according to the SWMP guidance provided by Defra, and split between with a part B of each chapter relevant to each partner Council. By structuring the report in this way, it is possible to undertake further analyses on a particular source of flooding and only have to supersede the relevant chapter, whilst keeping the remaining chapters unaffected.

In keeping with this principle, the following tasks should be undertaken when updating SWMP reports and figures:

- undertake further analyses as required after SWMP review;
- document all new technical analyses by rewriting and replacing relevant chapter(s) and appendices;
- amend and replace relevant SWMP Maps; and,
- reissue to departments within Basildon Borough Council and other stakeholders.

16. Castle Point Borough Council Action Plan

16.1 Summary of Key Actions

The key (high priority) actions for Castle Point Borough Council over the short- to medium-term, largely relate to providing assistance to Essex County Council as LLFA in order to meet their requirements under the FWMA 2010 and Flood Risk Regulations 2009, and general actions and investigations that apply to the wider Council. These include actions and investigations indentified in the CDAs and consultation with professional and political stakeholders and the public.

Proposed actions have been classified into the following timeframes:

- Short term - Actions to be undertaken within a year of the SWMP being adopted;
- Medium term - Actions to be undertaken within a year to five years after the SWMP is adopted; and
- Long term - Actions to be undertaken beyond five years after the SWMP is adopted.

The preferred options and 'quick wins' identified for each CDA have been included in the draft Action Plan. All actions included within Table 16-1 below have been identified as 'High Priority' actions. The reader is referred to the draft Action Plan in Appendix F3 for all actions identified within Castle Point Borough Council

It should be noted that Castle Point Borough Council is identified as the 'lead organisation' for the majority of the actions identified within the draft Action Plan. It is envisaged that though many of the actions should be taken forward in collaboration with third-parties such as Essex County Council (as LLFA), Anglian Water, or the Environment Agency, for example, and could be partly or fully funded by these parties, the initial emphasis is likely to come from the Council as the 'lead' organisation. It will therefore be essential that responsibility and funding opportunities for any potential actions are identified at the earliest opportunity.

Table 16-1- High Priority Actions for Castle Point Borough Council

	Recommendation	Action Type	Timeframe	Responsibility[21]	Action Plan ID
11	Further investigation and feasibility analysis of the preferred (P) and other potential options (O) within CAS 1: • Flood Storage: Benfleet Marsh (P) • Flood Storage – Bund: Boyce Hill Golf Course (P) • Preferential Overland Flow Path: Grove Road (O)	Investigation / Feasibility / Design	Short	CPBC	Action CAS 1
12	Further investigation and feasibility analysis of the preferred (P) and other potential options (O) within CAS 2: • Flood Storage: Robert Drake School, Tarpots Recreation Ground, Montgomery School, Glennwood School (P) • Flow Restriction / Flood Storage: Coombe Wood (P) • Increase Conveyance – A130 Embankment (near Hornbeams) (P) • Source Control: Rainwater harvesting across public buildings (O)	Investigation / Feasibility / Design	Short	CPBC	Action CAS 5
13	Further investigation and feasibility analysis of the preferred (P) and other potential options (O) within CAS 3: • Online Storage: Prittle Brook through West Wood (P) • Flood Storage: Cedar Hall School (P) • Source Control: Rainwater harvesting in residential buildings at head of catchment (O)	Investigation / Feasibility / Design	Short	CPBC	Action CAS 12
14	Further investigation and feasibility analysis of the preferred (P) and other potential options (O) within CAS 4: • Flood Storage: Hadleigh Infant School, The Crescent Recreation Ground (P) • Resilience Measures: Buildings identified at high risk (O) • Increase Sewer Capacity: The Avenue, The Crescent and Estate Road (O)	Investigation / Feasibility / Design	Short	CPBC	Action CAS 16

[21] Abbreviations for Organisations: BBC = Basildon Borough Council; CPBC = Castle Point Borough Council; RDC = Rochford District Council; ECC = Essex County Council; EA = Environment Agency; AWS = Anglian Water Services; NR = Network Rail; Com = Communities / General Public; All = All third parties involved in local flood risk management

16.2 Review Timeframe and Responsibilities

The draft Action Plan identifies the relevant internal departments and external partnerships that should be consulted and asked to participate when addressing an action, though these should be checked and confirmed by Castle Point Borough Council as the first stage in taking forward their Action Plan recommendations. After an action has been addressed, it is recommended that the responsible department (responsible for completing the action) review the Action Plan and update it to reflect any issues (communication or stakeholder participation) which arose during the completion of an action and whether or not additional actions are required.

It is recommended that the Action Plan is reviewed and updated on an annual basis to reflect any works undertaken by the Council and other stakeholders.

16.3 Ongoing Monitoring

The partnership arrangements established as part of the South Essex SWMP process (e.g. the SWMP working group of Basildon Borough Council, Castle Point Borough Council, Rochford District Council, Essex County Council, Environment Agency, and Anglian Water working in collaboration) should continue beyond the completion of the SWMP in order to discuss the implementation of the proposed actions, review opportunities for operational efficiency and to review any legislative changes.

The draft Action Plan should be reviewed and updated once annually as a minimum, but there may be circumstances which might trigger a review and/or an update of the Action Plan in the interim, for example:

- occurrence of a surface water flood event;
- additional data or modelling becoming available, which may alter the understanding of risk within the study area;
- if the outcome of an investment decision 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.

16.4 Updating SWMP Reports and Figures

In recognition that the SWMP will be updated in the future, the report has been structured in chapters according to the SWMP guidance provided by Defra, and split between with a part B of each chapter relevant to each partner Council. By structuring the report in this way, it is possible to undertake further analyses on a particular source of flooding and only have to supersede the relevant chapter, whilst keeping the remaining chapters unaffected.

In keeping with this principle, the following tasks should be undertaken when updating SWMP reports and figures:

- undertake further analyses as required after SWMP review;
- document all new technical analyses by rewriting and replacing relevant chapter(s) and appendices;
- amend and replace relevant SWMP Maps; and,
- reissue to departments within the Castle Point Borough Council and other stakeholders.

17. Rochford District Council Action Plan

17.1 Summary of Key Actions

The key (high priority) actions for Rochford District Council over the short- to medium-term, largely relate to providing assistance to Essex County Council as LLFA in order to meet their requirements under the FWMA 2010 and Flood Risk Regulations 2009, and general actions and investigations that apply to the wider Council. These include actions and investigations indentified in the CDAs and consultation with professional and political stakeholders and the public.

Proposed actions have been classified into the following timeframes:

- Short term - Actions to be undertaken within a year of the SWMP being adopted;
- Medium term - Actions to be undertaken within a year to five years after the SWMP is adopted; and
- Long term - Actions to be undertaken beyond five years after the SWMP is adopted.

The preferred options and 'quick wins' identified for each CDA have been included in the draft Action Plan. All actions included within Table 17-1 below have been identified as 'High Priority' actions. The reader is referred to the draft Action Plan in Appendix F4 for all actions identified within Rochford District Council

It should be noted that Rochford District Council is identified as the 'lead organisation' for the majority of the actions identified within the draft Action Plan. It is envisaged that though many of the actions should be taken forward in collaboration with third-parties such as Essex County Council (as LLFA), Anglian Water, or the Environment Agency, for example, and could be partly or fully funded by these parties, the initial emphasis is likely to come from the Council as the 'lead' organisation. It will therefore be essential that responsibility and funding opportunities for any potential actions are identified at the earliest opportunity.

Table 17-1- High Priority Actions for Rochford District Council

	Recommendation	Action Type	Timeframe	Responsibility[22]	Action Plan ID
11	Further investigation and feasibility analysis of the preferred (P) and other potential options (O) within ROC 1: • Flood Storage: Sweyne Park, Sweyne Park School (P) • Online Storage: Rawreth Brook through Sweyne Park (P) • Further Investigation: Ordinary Watercourse from Heron Close towards the A129 (P) • Resilience: Sweyne Park School (O) • Source Controls: Water Butts to residential buildings at the head of the catchment (O)	Investigation / Feasibility / Design	Short	RDC	Action ROC 1
12	Further investigation into the causes of flooding and feasibility analysis of preferred (P) and other potential options (O) within ROC 2: • Resilience measures: Vulnerable buildings (P)	Investigation / Feasibility / Design	Short	RDC	Action ROC 8
13	Further investigation and feasibility analysis of preferred (P) and other potential options (O) within ROC 4: • Flood Storage: Greensward Academy, Plumberow Primary School (P) • Flow Restriction – Bunds: Eastern Boundary of Marylands Wood (P) • Further Investigation: Sewer network across CDA (O)	Investigation / Feasibility / Design	Short	RDC, AWS	Action ROC10
14	Further investigation and feasibility analysis of the preferred (P) and other potential options (O) within ROC 6: • Flood Storage: South of Napier Road and Grove Nature Reserve (P) • Further Investigation: Sewer network on Thorington Road, The Chase, Napier Road (P) • Preferential Flow Path: Albert Road, Bull Lane and The Chase (O)	Investigation / Feasibility / Design	Short	RDC, AWS	Action ROC 15

[22] Abbreviations for Organisations: BBC = Basildon Borough Council; CPBC = Castle Point Borough Council; RDC = Rochford District Council; ECC = Essex County Council; EA = Environment Agency; AWS = Anglian Water Services; NR = Network Rail; Com = Communities / General Public; All = All third parties involved in local flood risk management

	Recommendation	Action Type	Timeframe	Responsibility[22]	Action Plan ID
15	Further investigation and feasibility analysis of the preferred (P) and other potential options (O) within ROC 7: • Flood Storage: Spencer's Park and carparks off Union Lane and Pollards Close (P) • Flow Restriction – Bund: north of Rochford Garden Way (P) • Further Investigation: Capacity of the railway embankment culvert (P) • Source Controls – Rainwater Harvesting: Residential buildings of Pollards Close, Union Lane and Ashingdon Road (O) • Infrastructure Resilience: Rochford Fire Station (O)	Investigation / Feasibility / Design	Short	RDC	Action ROC 19
16	Further investigation into the causes of flooding and feasibility analysis of the preferred (P) and other potential options (O) within ROC 8: • Investigate the cause of flooding in relation to Bartonhall Creek (P) • Flood Resilience: To buildings identified as being at high risk (O)	Investigation / Feasibility / Design	Short	RDC	Action ROC 26
17	Further investigation into the causes of flooding and feasibility analysis of the preferred (P) and other potential options (O) within ROC 9: • Flood Storage: Utilise open space behind Cronje Cottage (O)	Investigation / Feasibility / Design	Short	RDC	Action ROC 28

17.2 Review Timeframe and Responsibilities

The draft Action Plan identifies the relevant internal departments and external partnerships that should be consulted and asked to participate when addressing an action, though these should be checked and confirmed by Rochford District Council as the first stage in taking forward their Action Plan recommendations. After an action has been addressed, it is recommended that the responsible department (responsible for completing the action) review the Action Plan and update it to reflect any issues (communication or stakeholder participation) which arose during the completion of an action and whether or not additional actions are required.

It is recommended that the Action Plan is reviewed and updated on an annual basis to reflect any works undertaken by the Council and other stakeholders.

17.3 Ongoing Monitoring

The partnership arrangements established as part of the South Essex SWMP process (e.g. the SWMP working group of Basildon Borough Council, Castle Point Borough Council, Rochford District Council, Essex County Council, Environment Agency, and Anglian Water working in collaboration) should continue beyond the completion of the SWMP in order to discuss the implementation of the proposed actions, review opportunities for operational efficiency and to review any legislative changes.

The draft Action Plan should be reviewed and updated once annually as a minimum, but there may be circumstances which might trigger a review and/or an update of the Action Plan in the interim, for example:

- occurrence of a surface water flood event;
- additional data or modelling becoming available, which may alter the understanding of risk within the study area;
- if the outcome of an investment decision 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.

17.4 Updating SWMP Reports and Figures

In recognition that the SWMP will be updated in the future, the report has been structured in chapters according to the SWMP guidance provided by Defra, and for each Council. By structuring the report in this way, it is possible to undertake further analyses on a particular source of flooding and only have to supersede the relevant chapter, whilst keeping the remaining chapters unaffected.

In keeping with this principle, the following tasks should be undertaken when updating SWMP reports and figures:

- undertake further analyses as required after SWMP review;
- document all new technical analyses by rewriting and replacing relevant chapter(s) and appendices;
- amend and replace relevant SWMP Maps; and,
- reissue to departments within the Rochford District Council and other stakeholders.

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The methodology adopted and the sources of information used by URS Scott Wilson in providing its services are outlined in this Report. The work described in this Report was undertaken between June 2010 and March 2012 and is based on the conditions encountered and the information available during the said period of time. The scope of this Report and the services are accordingly factually limited by these circumstances.

Where assessments of works or costs identified in this Report are made, such assessments are based upon the information available at the time and where appropriate are subject to further investigations or information which may become available.

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Figure D 31 – ROC7: Ashingdon / Rochford Flood Depth 1 in 100 year Rainfall Event

Figure D 32 – ROC7: Ashingdon / Rochford Flood Hazard 1 in 100 year Rainfall Event

Figure D 33 – ROC8: Great Stambridge Flood Depth 1 in 100 year Rainfall Event

Figure D 34 – ROC8: Great Stambridge Flood Hazard 1 in 100 year Rainfall Event

Figure D 35 – ROC9: Little Great Wakering 1 in 200 year Environment Agency Flood Map for Surface Water

Appendix E – Options Assessment Details

Appendix E1 – Basildon Borough Council

Appendix E2 – Castle Point Borough Council

Appendix E3 – Rochford District Council

Appendix F – Draft Action Plan

Appendix F1 – Essex County Council

Appendix F2 – Basildon Borough Council

Appendix F3 – Castle Point Borough Council

Appendix F4 – Rochford District Council