herrington CONSULTING LIMITED

In partnership with:
Canterbury City Council
Engineering Services

Strategic Flood Risk Assessment
Canterbury City Council

February 2019

Canterbury City Council
Council Offices
Military Road
Canterbury
Kent
CT1 1YW

canterbury city council

This page is left intentionally blank

Strategic Flood Risk Assessment
Canterbury City Council

Contents Amendment Record

This report has been issued and amended as follows:

Issue	Revision	Description	Date	Written by	Checked by
1	0	Draft report	11 Feb 2011	SPH/TE	RB
2	1	Revised draft	22 Feb 2011	SPH/TE	RB
3	2	Final draft for consultation	25 Feb 2011	SPH/TE	RB
4	3	Final Report	25 Aug 2011	TE/SPH	PB
5	4	Report updated in line with changes to policy and historic information. Draft report submitted to CCC for review.	17 May 2016	KT/AC	DM/SMB
6	5	Update to climate change section	25 May 2016	KT	SMB
7	5	Report issued for comment.	18 Aug 2017	KT	-
8	6	Final report	23 May 2018	KT	SMB
9	7	Update to NPPF. Final report re-issued.	26 October 2018	AW	KT
10	8	Update to logo. Final report re-issued.	08 February 2019	AW	SMB

Herrington Consulting Limited
Unit 6 & 7 – Barham Business Park
Elham Valley Road
Barham
Canterbury
Kent, CT4 6DQ
Tel/Fax +44 (0)1227 833855

www.herringtonconsulting.co.uk

This page is left intentionally blank

Contents Page

Executive Summary

Canterbury is a historic city with a national and global reputation that far outweighs its size in both geography and population. The wider Canterbury District also boasts assets of great potential, including the coastal towns of Whitstable and Herne Bay, numerous villages that are often of outstanding historical quality, and a varied beautiful countryside. The District is located in the centre of the East Kent sub-region sharing boundaries with five other local authority areas and covers an area of 310 square kilometres. Parts of the District are low-lying with approximately 15%, including the town centres of the three main urban areas, lying within the Environment Agency's Zone 3a flood risk area.

Flooding can result not only in costly damage to property, but can also pose a risk to life and livelihood. It is essential therefore that future development is planned carefully, where possible away from areas that are most at risk from flooding, and ensuring that it does not exacerbate flooding elsewhere.

Herrington Consulting has been commissioned by Canterbury City Council to update the existing Strategic Flood Risk Assessment (SFRA), which was previously prepared in 2011. This study provides an analysis of the main sources of flood risk to the District, together with a detailed means of appraising development allocations and existing planning policies, against the risks posed by flooding over this coming century.

The National Planning Policy Framework (NPPF) published by the Department for Communities and Local Government in July 2018, requires Local Planning Authorities (LPA) to apply a risk-based approach to the preparation of their development plans in respect of potential flooding. In simple terms, the NPPF requires LPAs to review the variation in flood risk across their District, and to steer vulnerable development (e.g. housing) towards areas of lowest risk. Where development is to be permitted in areas that may be subject to some degree of flood risk, the NPPF requires the Council to demonstrate that there are sustainable mitigation solutions available that will ensure that the risk to property and life is minimised (throughout the lifetime of the development), should flooding occur.

The SFRA is the first step in this process and provides the building blocks upon which the Council's forward planning and development control decisions are made. One of the most pressing issues for Canterbury City Council is the fact that a large percentage of brownfield sites that have the potential for redevelopment lie within Flood Zone 3.

The primary objective of the NPPF is to steer vulnerable development towards areas of lowest flood risk and the Sequential Test provides clear guidance as to how this should be achieved. In simple terms, the Sequential Test requires that the District is delineated into areas of 'low', 'medium' and 'high' risk, i.e. Flood Zones 1, 2 and 3. It then provides a list of suitable types of land use that should be permitted within each zone, depending upon the perceived vulnerability of the community that will be present day to day within that development.

However, all the coastal settlements within the District, lying within Flood Zone 3, benefit from the protection provided by high quality flood defence infrastructure. Inland, Canterbury also benefits from various river defences and upstream flood storage. Before the completion of the SFRA in 2011, the degree of risk across these areas was generally un-quantified and therefore it was not possible for the Council to implement the primary objectives of the NPPF.

The completion of the original SFRA in 2011 provided quantifiable flood hazard information for the district. Nonetheless, since 2011, additional information on historic flooding and changes to planning policy has resulted in the requirement for the original report to be revised.

The key objectives of this revised SFRA are therefore to;

- Collate all known sources of flooding, including tidal, river, surface water (local drainage), sewers and groundwater, that may affect existing and/or future development within the District;

- To map information in relation to the risk of flooding at a scale that is appropriate to inform the planning process at both a strategic and site-based level.

Graveney, Seasalter, Reculver and the Lower Stour area comprise the majority of the low-lying area of the District and are primarily devoted to agricultural use and large parts of these areas are protected for nature conservation purposes. However, there are still parts of a number of established towns and villages that are in the floodplain. The future sustainability of these communities relies heavily upon their ability to grow, prosper and, where necessary, redevelop. For this reason, the NPPF acknowledges that in some cases it is not possible to locate all new development outside of the flood risk area.

In this situation, where the LPA has identified that there is a strong planning based argument for a development to proceed, it will be necessary for the Council to demonstrate that the Exception Test can be satisfied.

The Exception Test requires the following:

a) It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk.

b) A site-specific Flood Risk Assessment must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere and, where possible, will reduce flood risk overall.

Both elements of the test will have to be past for development to be allocated or permitted.

Effective development control policy is essential to assist the Council to manage flood risk, and to ensure a consistent approach at the planning application stage. This is essential to achieve future

sustainability within the District with respect to flood risk management. To facilitate this, the SFRA provides detailed information on flood risk throughout the District.

In parallel with development control, emergency planning is imperative to minimise the risk to life posed by flooding within the District. It is therefore recommended that the Council review their adopted flood risk response plan in light of the findings and recommendations of the SFRA.

Furthermore, the SFRA has been developed building heavily upon existing knowledge with respect to flood risk within the District. The Environment Agency regularly reviews and updates the flood zone maps and a rolling programme of detailed flood risk mapping within the South East region is currently underway. In addition, much of the major flood defence infrastructure within the District has been upgraded and improved over the last twenty years, with plans for expenditure on further improvements in the near future.

These new defences and additional information will reduce risk and improve the current knowledge of flood risk within the District. Consequently, this may influence future development control decisions and therefore the information within the SFRA will require updating.

In summary, it is imperative that the SFRA is adopted as a 'living' document and is reviewed regularly in light of emerging policy directives and an improving understanding of flood risk within the District.

1 Introduction

1.1 Overview

Herrington Consulting has been commissioned by Canterbury City Council to update the existing Strategic Flood Risk Assessment (SFRA) for the District, which was originally prepared in 2011.

The National Planning Policy Framework (NPPF) published by the Department for Communities and Local Government (DCLG) in March 2012 (updated in July 2018) requires Local Planning Authorities (LPA) to apply a risk-based approach to the preparation of their development plans in the respect of potential flooding. This district-wide appraisal of flood risk is to be delivered through the SFRA, the key requirements of which are described in paragraphs 9 and 10 of the *Planning Practice Guidance: Flood Risk and Coastal Change* (DCLG, 2014).

1.2 Key SFRA Objectives

The key objectives of the SFRA are to:

- provide sufficient data and information to enable the Council to apply the Sequential Test to land use allocations and to identify whether the application of the Exception Test is likely to be necessary;
- provide a basis on which the Council can support the appropriate policies for the management of flood risk within the adopted Local Development Documents (July 2017) and to assist in the testing of site proposals;
- inform the sustainability appraisal so that flood risk is taken into account when considering strategic land use policies;
- give guidance on the level of detail required for site-specific Flood Risk Assessments (FRAs) in particular locations;
- enable the Council to determine the acceptability of flood risk in relation to its emergency planning capability.

1.3 SFRA Format

Under the NPPF there is a requirement that, where the Local Plan has been unable to allocate all proposed development in low flood risk areas, the scope of the SFRA shall be increased in order to provide fuller information in the application of the Sequential and Exception Tests. This Level 2 SFRA is a more detailed study of the individual major flood risk areas where development may be proposed under the Local Plan. To achieve the Council's housing targets in accordance with central government requirements and the target that all development is constructed on previously developed land, it is confirmed that development is required in areas of medium to high flood risk.

A number of more detailed studies were carried out to inform the original Level 2 SFRA (2011) at urban centres where there is a risk of flooding and where development has been proposed in the Local Plan (2006). Two-dimensional (2D) hydrodynamic modelling was carried out to quantify the risk of flooding from the sea at Seasalter, Whitstable, Herne Bay, Swalecliffe, Hampton and Reculver.

A modelling study was also undertaken to quantify the risk of fluvial flooding from the River Stour, which passes through the centre of Canterbury. Since the publication of the SFRA in 2011, the Environment Agency commissioned the 'Flood Risk Mapping Study the Oyster Coast Brooks' (refer to Section 7.2) which covers the geographical areas of Whitstable, Swalecliffe and Herne Bay, as well as the River Great Stour between Wye and Fordwich. The information and outputs from these various models and studies has been used to inform this revised SFRA, in order to provide the quantitative data in relation to flood risk which is required to enable the Council to apply a risk based approach to the preparation of its development plans.

Therefore, the structure of this SFRA is a combined report comprising both the Level 1 and Level 2 requirements within a single document.

It is important to recognise that the SFRA is a 'living' document. Consequently, as new information becomes available, updates will need to be made to the SFRA and its associated flood maps. This is especially important at a time where the Environment Agency's flood and coastal erosion risk management strategy is recommending significant expenditure on flood defence infrastructure in the District over the next 20 years.

This document has therefore been prepared in the knowledge that improvement works are planned to major defences in the District within the short term. Consequently, account has been taken of these improvement works to ensure that the best and most contemporary information is used to guide the site selection and appraisal process for future developments.

2 The Study Area

2.1 Overview of the District

Canterbury is a historic city with a national and global reputation that outweighs its size both in geography and population. The wider Canterbury District also boasts assets of great potential, including the coastal towns of Whitstable and Herne Bay, numerous villages that are often of outstanding historic quality, and a varied and beautiful countryside.

The District is located in the East Kent sub-region, sharing boundaries with five other local authorities: Ashford, Swale, Shepway, Dover and Thanet. The Canterbury District sits at the centre of this sub-region and covers an area of 31,000 hectares (310 square kilometres) with a population of over 44,000. About 15% of the District is low-lying with approximately 46 square kilometres lying within the Environment Agency's Zone 3a flood risk area.

The District has a coastal frontage that extends for 21 kilometres between its western boundary at Graveney Marshes through to the Northern Seawall east of Reculver. The land at both the western and eastern boundaries of the District is low lying, but between these the coastline is undulating with clay or sandstone cliffs between the valleys at Whitstable, Swalecliffe, Hampton and Herne Bay. A total of 10.1 km of the District's coast is low lying – all of which is defended by a seawall with a shingle beach in front. The River Stour virtually bisects the District and runs through the centre of the city of Canterbury. Other important watercourses are the coastal brooks – Sarre Penn, North Stream, River Wantsum, Gorrell Stream, Swalecliffe Brook, West Brook and Plenty Brook – and the Nailbourne/Little Stour chalk stream.

The City of Canterbury has a significant retail focus and an existing role as a population and service centre, as well as a focal point for higher and further education facilities. Herne Bay is a traditional Victorian seaside resort that has suffered some economic decline of its town centre and is currently the subject of significant regeneration efforts. Whitstable is an attractive coastal town with a lively independent retail sector and strong arts culture. The desirability of the town has led to significant numbers of second home owners. The rural area of the District contains a great diversity of settlements in terms of character, size and facilities. Figure 2.1 shows the geographical extents of the District along with the main towns and villages.

The high quality landscape in the District is a distinctive and variable feature of the area. This diverse landscape gives rise to a wide range of wildlife habitats and there are four internationally designated nature conservation sites as well as fifteen national sites and numerous local nature reserves. Much of the area of flood risk in the District, from both river and coastal flooding, coincides with the location of designated wildlife habitats where no development is proposed. These designated habitats include 'The Swale' (a complex of brackish and freshwater, with floodplain grazing marsh, saltmarshes and mud-flats), 'Thanet Coast and Sandwich Bay' (including tidal river, estuaries and mud flats) and 'Stodmarsh' (including inland water bodies, marshes and fens). These are all areas where inundation or saturation by surface or ground water (be that at different

frequencies and duration) is essential to their quality and survival and must be protected at appropriate levels. However, the area of flood risk also affects large parts of the villages and urban areas due to the historical attraction of population to rivers and coastal areas. There was significant widespread inland flooding in 2000/2001. As a result of climate change, rising sea levels and increasing frequency of extreme weather patterns, flood risk will become an increasingly important issue for the District.

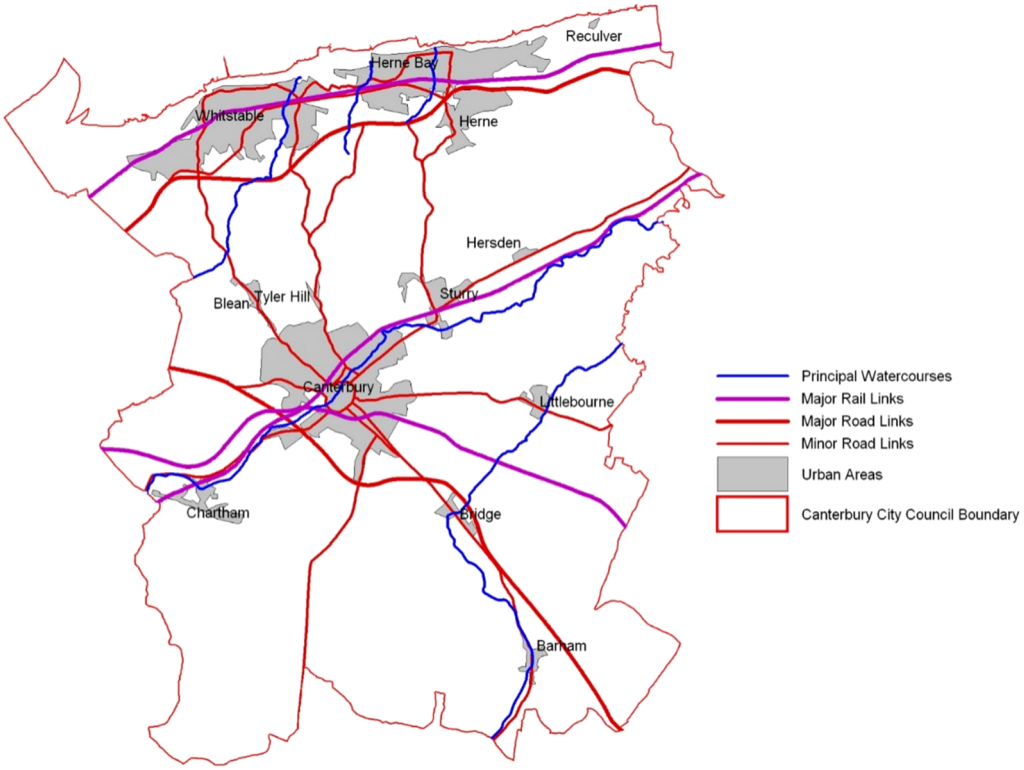


Figure 2.1 - Location plan showing the Canterbury District Boundary and the SFRA study area

2.2 Geology and Hydrogeology

In terms of the strategic appraisal of flood risk, it is important to understand the geology and hydrogeology of the District. This provides a background both for an evaluation of the potential for groundwater flooding and for an understanding of the role of infiltration drainage, either as part of a sustainable drainage system, or within the overall natural water cycle.

The bedrock across the District is broadly split into three elements. To the south of Canterbury the geology is dominated by chalk which forms the high ground of the North Downs.

The central and eastern part of the District is formed by the Thanet Sand Formation characterised by pale yellow-brown, fine-grained sand that can be clayey and glauconitic and consisting of the Oldhaven, Blackheath, Woolwich and Reading and Thanet Beds. The Thanet Sand Formation lies unconformably on the Chalk.

To the north and west between Canterbury and Whitstable and Herne Bay the bedrock geology is London Clay, part of the Thames Group. The London Clay lies unconformably on the Woolwich and Reading Beds.

The majority of the District has no recorded drift deposits. This includes large areas to the south of the District over the higher chalk bedrock and large areas to the north over the London Clay. Where there are drift deposits, these are concentrated in the valleys and lower lying areas of the District.

Within the chalk valleys superficial geology consists of clay with flints. This is a residual deposit formed by the reworking of the chalk and is typically orange brown sandy clay with nodules and pebbles of flint. Along the Stour and lower Nailbourne valleys, plus to the north east and north west of the District are superficial deposits of alluvium, characterised by soft to firm consolidated, compressible silty clay, that can contain layers of silt, sand, peat and basal gravel.

To the centre and in areas of the northern part of the District are deposits of Brickearth, which varies from silt to clay and is usually yellow-brown and massive.

To the east of Canterbury are river terrace deposits of sand and gravel. Further sand and gravel deposits are found in isolated areas east of Herne. Finally, along the northern coastline between Herne Bay and Reculver is an area of landslip deposits.

Figures 2.2 and 2.3 below show a simplification of the solid and drift geology of the Canterbury District.

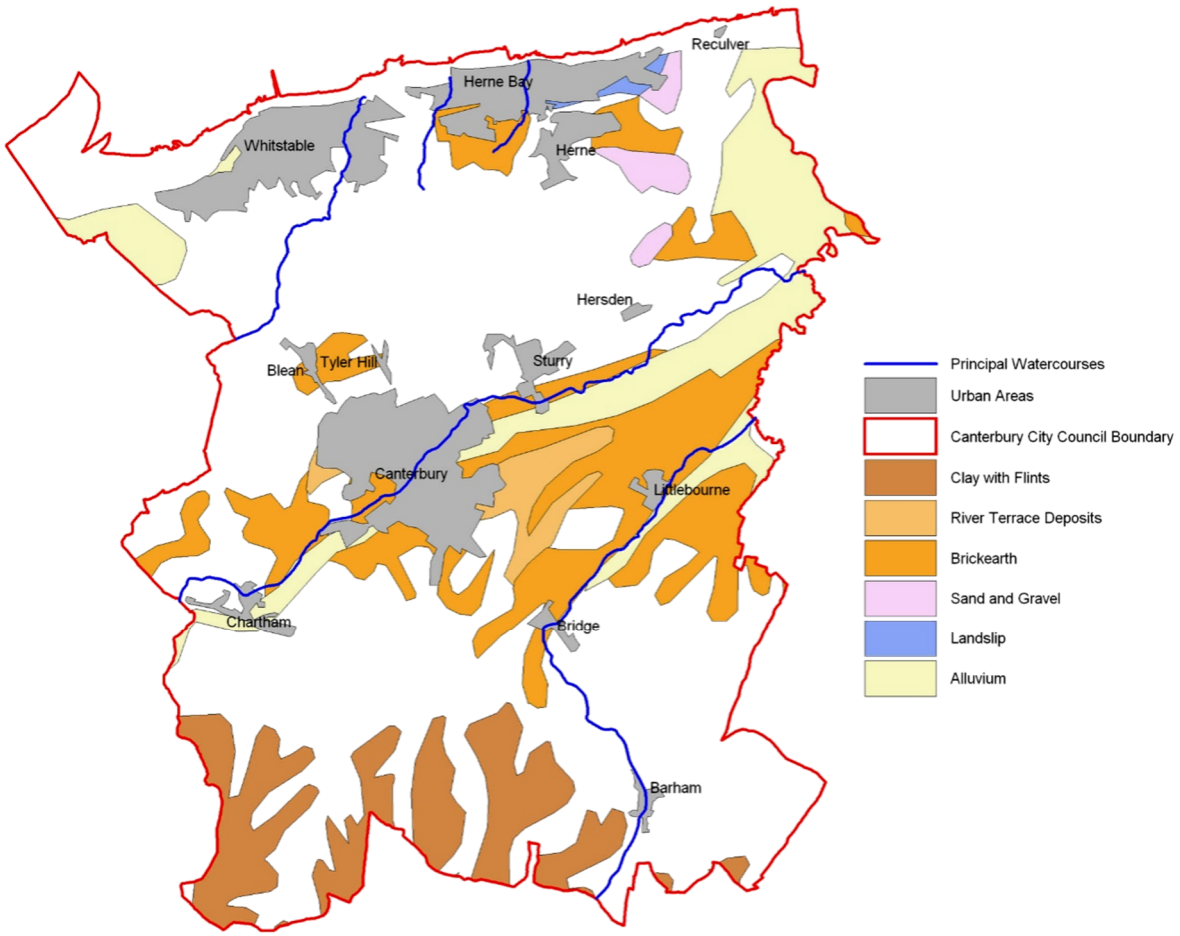


Figure 2.2 - Drift geology of the Canterbury District

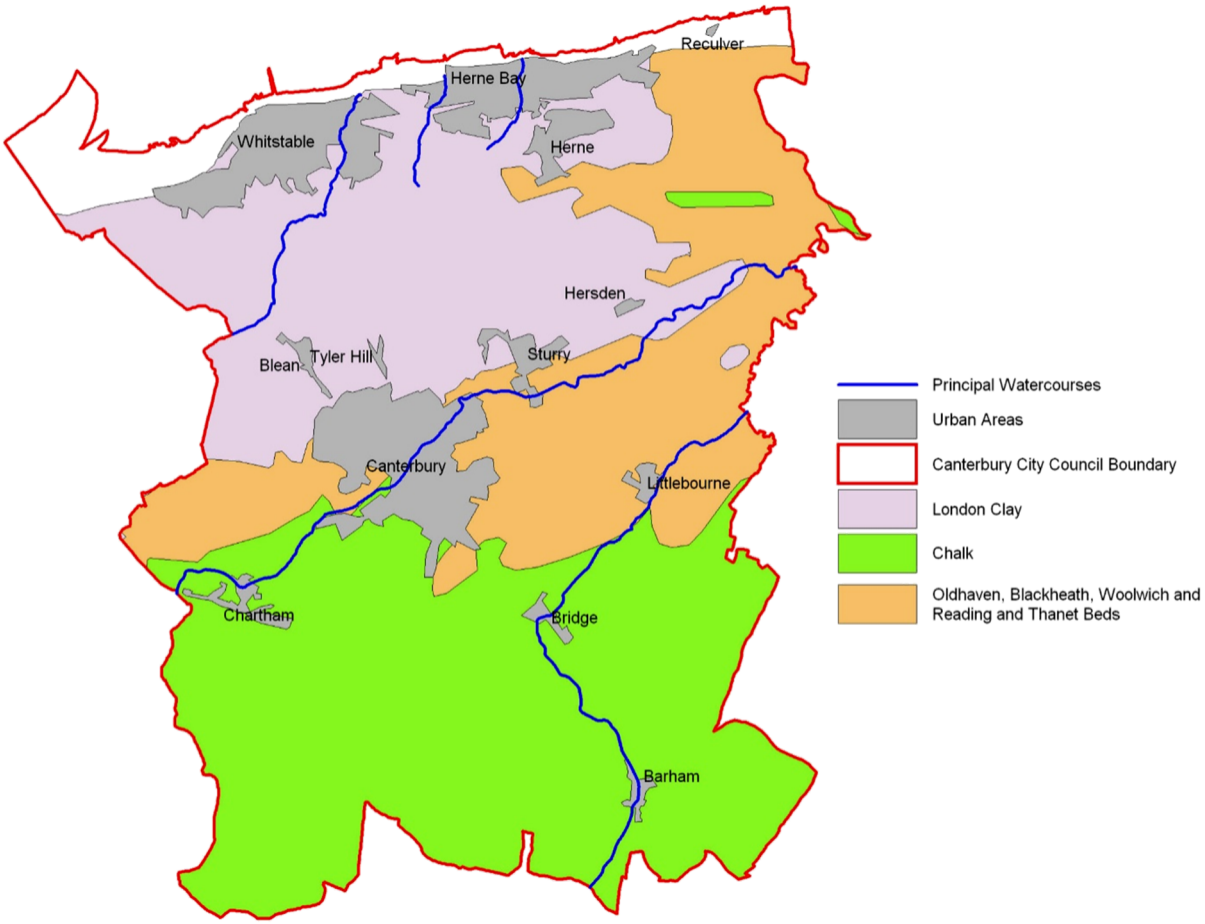


Figure 2.3 - Solid geology of the Canterbury District

The River Stour is the main hydrological feature running west to east through the District. There are no significant tributaries joining the Stour within the District, although the Nailbourne does flow into the Stour, via the Little Stour, to the east of the District boundary. Flow into the Stour from north and south is via smaller streams and via groundwater base flow. To the east the Stour valley widens to form the low lying marshy land of the Westbere, Chislet and Stodmarsh Marshes.

The chalk south of Canterbury forms a principle bedrock aquifer. Streams run northwards from this area towards the River Stour. Many of the valleys in the chalk are dry valleys whilst some have ephemeral streams that flow intermittently. There are several water extraction points along the Stour and within the chalk aquifer. A secondary aquifer is formed by the Thanet Sand Formation to the east and north east of Canterbury.

To the north of Canterbury, London Clay dominates. This stiff clay leads to low permeability with run-off flowing across the land surface through a network of ditches and streams, to several more major watercourses running south to north and discharging to the North Sea.

2.3 Soils

Soil type provides a generic description of the drainage characteristics of soils. This will dictate, for example, the susceptibility of soils to water logging or the capacity of a soil to freely drain to allow infiltration to groundwater. Generally, soil types can only be fully determined after suitable ground investigations, however, it is possible to use the mapped soil types (Soil Association) within the study area as an indicator of permeability and infiltration potential. The soil characteristic map in Figure 2.4 has been based on the soil types within the Canterbury District as mapped by the National Soil Resources Institute.

The soil types within the Canterbury District closely follow the bedrock and superficial geology. To the south of the District there are shallow lime-rich soils over the higher chalk areas. In the dry valleys where superficial deposits have been deposited the soils are clayey with impeded drainage. The soils across the central section are generally freely draining whilst to the north, overlying the London Clay, the soils are seasonally wet or have naturally high groundwater levels.

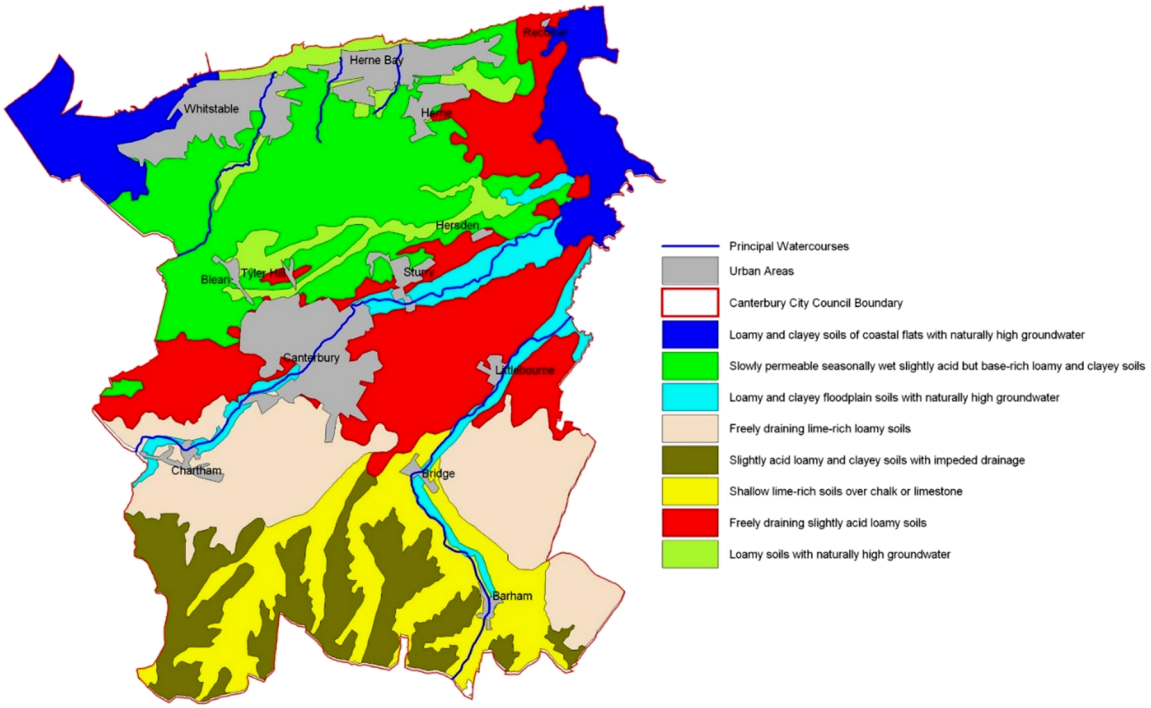


Figure 2.4 - Map showing the range of soil characteristics across the Canterbury District

2.4 Topography

The topography varies significantly across the District; areas along the north Kent coast are located below the mean high water level, whilst the North Downs located to the south of the District are elevated, approximately 155m Above Ordnance Datum (AODN). The topography south of Canterbury is characterised by chalk downland falling fairly steeply from 155m AODN in the south to between 30-40m AODN around Canterbury, Littlebourne and Chartham. This area is bisected by

several dry valleys or in the case of the Nailbourne valley an ephemeral stream that runs intermittently. Groundwater flow through the chalk is the predominant mechanism by which water flows in this area and it is characterised by springs and intermittently running streams.

A further area of high ground lies to the north of the Stour Valley with levels reaching 75-85m AODN around Blean and Tyler Hill. This ridge of high ground forms a watershed with several streams running north towards Whitstable and Herne Bay. To the south, flow is directed towards the River Stour via small streams and groundwater flow.

The north west and north east of the District is characterised by very low lying marshland at Seasalter and Chislet Marshes respectively. Land here is lower than 5m AODN and defended from inundation by sea defences along the coast. Between these two low lying areas the topography along the coastline varies with sand cliffs to the east and clay slopes interspersed with low lying areas in Herne Bay, Swalecliffe and Whitstable. The low lying areas are below 5m AODN whilst the slopes and cliffs rise to 20-35m AODN.

As well as the importance of the elevation of the land above sea level, topography is also important in assessing the risk of flooding from other sources such as overland flow and groundwater flooding. This data, in combination with the geology and soils maps can be used to gain an understanding of the potential for these mechanisms of flooding and is also useful in the determination of the appropriateness of Sustainable Drainage Systems (SuDS).

Height data from the Ordnance Survey Landform Panorama digital terrain model has been used to create Figure 2.5 below, which illustrates graphically the topographic variation across the study area. For the more detailed breach modelling and flood mapping work, which forms the basis of the flood risk and hazard analysis used in this SFRA, much higher resolution land level data derived by the use of LiDAR (Light Detection and Ranging) has been used and is discussed further in Section 9 of this report.

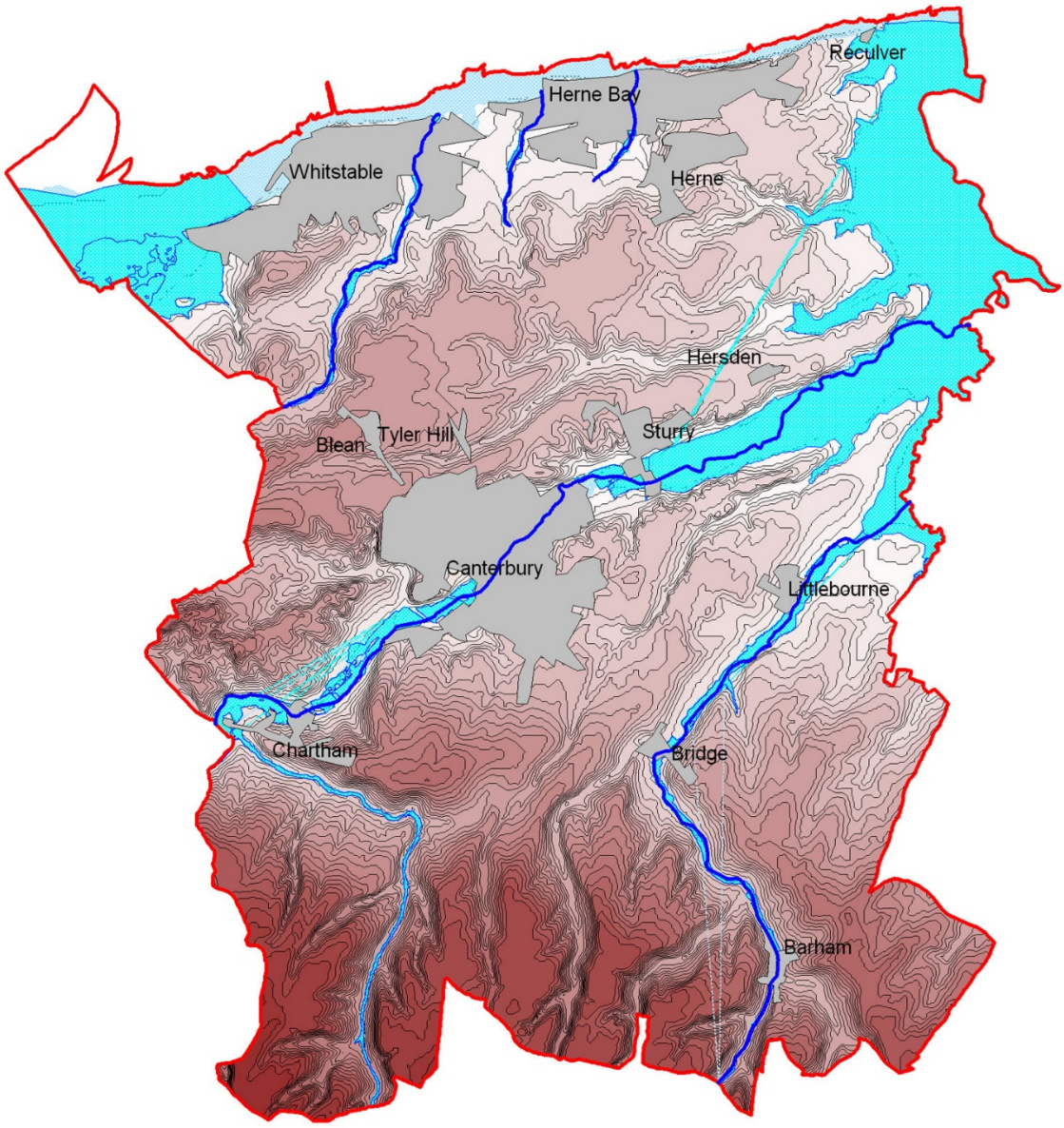


Figure 2.5 - Topography of the Canterbury District

3 SFRA Approach and Methodology

3.1 Overall Approach

The SFRA is at the core of the NPPF and supporting Planning Practice Guidance. It provides the essential information on flood risk, taking climate change into account, thereby allowing the LPA to understand risk across its District so that the Sequential Test can be properly applied. The need for LPAs to consider flood risk when preparing Local Development Documents (LDD) and to produce SFRAs is highlighted in paragraphs 10 and 11 of the *Planning Practice Guidance: Flood Risk and Coastal Change*. Paragraph 12 gives some preliminary guidance and this is developed below.

The *Planning Practice Guidance: Flood Risk and Coastal Change* promotes a two stage approach to undertaking a SFRA. The first stage (Level 1) involves discussing the scope of the SFRA with key stakeholders, in particular the Environment Agency, Internal Drainage Boards (IDBs) and sewerage undertakers. This scoping stage is recommended so that an understanding of the strategic flood risk issues that need to be assessed can be gained.

Where the Level 1 SFRA demonstrates that land in Flood Zone 1 (taking climate change into account) cannot accommodate the necessary development, then the Exception Test needs to be applied. This will involve a more detailed Level 2 SFRA that includes further data collection and analysis.

However, the town centres of the three main urban areas of the District - Canterbury, Whitstable and Herne Bay – where the majority of the District's population live and work, lie fully or partially within Flood Zone 3.

The Council had considered these issues in detail before commencing the original SFRA (2011) and had therefore already commissioned Level 2 type studies to gain a better understanding of flood risk and its consequences at the three town centres. As a result of the findings of these initial Level 2 type studies, the Council engaged with the Environment Agency to discuss the scope of the SFRA study and any detailed analysis requirements. As a consequence of these discussions, it was clear that the Level 2 information already held should be included and form an essential part of the SFRA document.

This report is a 'living' document and as such, the 2011 report recommended that the SFRA is reviewed regularly. Revisions to the SFRA should address potential key issues such as; amendments to planning policy, major flooding events, changes in the flood risk management within the district, and improvements in climate change predictions.

3.2 SFRA Aims

As identified in the original SFRA (2011), the overarching aspiration for the SFRA is to provide the end user with as much qualitative risk-based information as possible. This will assist the Council in preparing its development plans and undertaking the Sequential Test, but will also allow other users

to gain an understanding of the complex and wide-ranging flooding issues that exist within the District. Improvements and changes in the data available to achieve this have prompted the revision of the 2011 report, in line with current National and Local planning policy.

3.3 SFRA Outputs

The aim of the SFRA is to provide sufficient data and information to enable the LPA to apply the Sequential Test to land use allocations and, where necessary, the Exception Test. The NPPF also indicates that Sustainability Appraisals (SA) should be informed by the SFRA for their area. Under the Town and Country Planning (Local Development - England) Regulations 2004, a SA is required for all Local Plans. The purpose is to promote sustainable development through better integration of sustainability considerations in the preparation and adoption of plans. The Regulations stipulate that SAs for Local Plans should meet the requirements of the Strategic Environmental Assessment (SEA) Directive.

A SFRA is used as a tool by a LPA for the production of development briefs, setting constraints, identifying locations of emergency planning measures and requirements for site-specific FRAs. It is important to reiterate that the NPPF and supporting Planning Practice Guidance are not applied in isolation as part of the planning process. The formulation of Council policy and the allocation of land for future development must also meet the requirements of other planning policy.

Clearly a careful balance must be sought in these instances, and the SFRA aims to assist in this process through the provision of a clear and robust evidence base, upon which informed decisions can be made.

3.4 The Sequential Test

LPAs are encouraged to take a risk-based approach to proposals for development in or affecting flood risk areas through the application of the Sequential Test. The objectives of this test are to steer new development away from high risk areas towards those at lower risk of flooding. However, in some areas where developable land is in short supply there can be an overriding need to build in areas that are at risk of flooding. In such circumstances, the application of the Sequential Test is used to ensure that the lower risk sites are developed before the higher risk ones.

The NPPF states that the Sequential Test should be applied at all stages of the planning process and that generally the starting point is the Environment Agency's flood zone maps. These maps and the associated information are intended for guidance, and do not provide details for individual properties. They do not take into account other considerations such as existing flood defences, alternative flooding mechanisms and detailed site based surveys. They do, however, provide high level information on the type and likelihood of flood risk in any particular area of the country. The flood zones are classified as follows:

Zone 1 – Low probability of flooding – This zone is assessed as having less than a 1 in 1000 (0.1%) annual probability of river or sea flooding in any one year.

Zone 2 – Medium probability of flooding – This zone comprises land assessed as having between a 1 in 100 (1%) and 1 in 1000 (0.1%) annual probability of river flooding or between 1 in 200 and 1 in 1000 annual probability of sea flooding in any one year.

Zone 3a – High probability of flooding - This zone comprises land assessed as having a 1 in 100 (1%) or greater annual probability of river flooding or 1 in 200 (0.5%) or greater annual probability of sea flooding in any one year.

Zone 3b – The Functional Floodplain – This zone comprises land where water has to flow or be stored in times of flood and can be defined as land which would flood during an event having an annual probability of 1 in 20 (5%) or greater. This zone can also represent areas that are designed to flood in an extreme event as part of a flood alleviation or flood storage scheme.

The NPPF states that only where there are no reasonably available sites in Flood Zones 1 or 2 should decision makers consider the suitability of Flood Zone 3, taking into account the flood risk vulnerability of land uses and applying the Exception Test, if required. The NPPF adds that the Exception Test is only appropriate where there are large areas in Flood Zones 2 and 3, where the Sequential Test cannot alone deliver acceptable sites, but where some continuing development is necessary for wider sustainable development reasons, taking into account the need to avoid social or economic blight – as is the case for the town centres within the Canterbury District.

As such, it can be seen there are overriding sustainability reasons for development to be carried out in the town centres within Flood Zones 2 and 3. The Sequential Test has therefore been applied to the town centre areas and considered to be satisfied in accordance with the requirements of the NPPF and its Planning Practice Guidance. Development in these town centres should be considered against the Exception Test to determine whether development can proceed safely with the flood risk managed. Due to the high proportion of land located within Flood Zones 2, 3a and 3b within the District, a number of special cases have been identified and addressed in Section 3.6 below.

Nevertheless, the Environment Agency has a statutory responsibility and must be consulted on all development applications located within Zones 2 and 3, including areas with critical drainage problems. For all of these cases the Environment Agency will require the Council to demonstrate that there are no reasonable alternatives in lower flood risk categories available for development.

3.5 The Exception Test

If following the application of the Sequential Test it is not possible, consistent with wider sustainability objectives, for the development to be located in zones of lower probability of flooding, the Exception Test can be applied.

As part of this process it is, however, necessary to consider the type and nature of the development as not all situations require the test to be applied. Table 2 of the *Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 66)* defines the type and nature of different development classifications in the context of their flood risk vulnerability. This has been summarised in Table 3.1 below, which highlights the combinations of vulnerability and flood zone compatibility that require the Exception Test to be applied.

Flood Risk Vulnerability Classification	Zone 1	Zone 2	Zone 3a	Zone 3b
Essential infrastructure – Essential transport infrastructure, strategic utility infrastructure, including electricity generating power stations	✓	✓	e	e
High vulnerability – Emergency services, basement dwellings, caravans and mobile homes intended for permanent residential use	✓	e	×	×
More vulnerable – Hospitals, residential care homes, buildings used for dwelling houses, halls of residence, pubs, hotels, non-residential uses for health services, nurseries and education	✓	✓	e	×
Less vulnerable – Shops, offices, restaurants, general industry, agriculture, sewerage treatment plants	✓	✓	✓	×
Water compatible development – Flood control infrastructure, sewerage infrastructure, docks, marinas, ship building, water-based recreation etc.	✓	✓	✓	✓

Key:

✓ Development is appropriate
× Development should not be permitted
e Exception Test required

Table 3.1 – Flood risk vulnerability and flood zone compatibility

For the Exception Test to be passed there are two criteria that must be satisfied and these are listed below:

a) It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a Strategic Flood Risk Assessment where one has been prepared; and

b) A site-specific Flood Risk Assessment must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and where possible, will reduce flood risk overall.

The NPPF also promotes early consideration of flood risk in the formulation of Regional Spatial Strategies, Local Development Documents and proposals for development by Regional Planning Bodies, LPAs, the Environment Agency, other stakeholders and developers. This process should identify opportunities for development of infrastructure that offers wider sustainability benefits. These include dual use, i.e. flood storage and recreation, and realising cost effective solutions for the reduction and management of flood risk.

3.6 Special Cases

To date the Sequential Test has presented the Council with a significant challenge because, as discussed above, there are sustainability reasons to develop/redevelop parts of the three town centres - all located within Flood Zone 3a.

In order to address this issue, an agreement was made between Canterbury City Council and the Environment Agency with regard to the development of brownfield sites in this area. This outlines a number of requirements for planning application within areas at risk of flooding from tidal sources. A copy of this local Memorandum of Understanding (MoU) has been appended to this document (Appendix A.8).

Further to the above, following the published results of the Environment Agency's Great Stour Flood Mapping Study in 2013, it was determined that a large proportion of Canterbury City Centre was identified by the model to be located within the *functional floodplain* (Flood Zone 3b). Flood Zone 3b is classified by the extent of flooding under an extreme fluvial event with a 1 in 20 year return period.

The Environment Agency modelled flood extents for the 1 in 20 year return period event provided a starting point for consideration and discussions to identify the true extent of the functional floodplain. A review of this study, undertaken by Herrington Consulting on behalf of Canterbury City Council, identified that the flood extents predicted by the Environment Agency model for an event with a 1 in 20 year return period were not wholly congruent with historic evidence recorded by Canterbury Council Engineers. The report concluded that the strategic nature of the Environment Agency model resulted in an overestimation of the extent of flooding under lower return period events, including the 1 in 20 year flood event.

The Planning Practice Guidance that accompanies the NPPF states that "…*The identification of functional floodplain should take account of local circumstances and not be defined solely on rigid probability parameters*".

In consideration of the results of the Environment Agency model and the above statement in the NPPF practice guidance, subsequent discussions were had with the Environment Agency to better determine how the functional floodplain should be defined.

It was agreed that, due to the strategic nature of the Environment Agency model, the results for the 1 in 20 year return period event were not considered appropriate for defining the extent of the

functional floodplain at a site specific scale and instead, the results of the original fluvial model used in the 2011 SFRA should be refenced. The 2011 fluvial model comprised the reach of the River Great Stour passing through Canterbury City Centre, and this more detailed model was considered to be a more suitable model for defining the functional floodplain within Canterbury City Centre. Notwithstanding this, in determining the impact of fluvial flood events with a return period greater than the 1 in 20, including the 1 in 100 year event, the modelled flood extents from the Environment Agency's Great Stour Flood Mapping Study (2013) should be referenced.

For sites considered to be at risk of flooding from the River Great Stour which are located outside of the extents of the modelling undertaken by Herrington Consulting in 2011, the Environment Agency should be contacted to request modelled flood level data from the Great Stour Flood Mapping Study (2013). The definition of the functional floodplain within this data should be interpreted with caution and a detailed Flood Risk Assessment appraising the site specific risk of flooding under the 1 in 20 year event should accompany any planning application.

Appendix A.2 shows the modelled flood extents across Canterbury City Centre that should be used to determine whether a site is classified as being located within the Functional Floodplain.

4 Policy Framework

Positive planning has an important role in helping to deliver sustainable development and applying the Government's policy on flood risk management. It avoids, reduces and manages flood risk by taking full account in decisions on plans and applications of present and future flood risk, involving both the statistical probability of a flood occurring and the scale of its potential consequences, whether inland or on the coast. It also has a role in considering the wider implications for flood risk of development located outside flood risk areas.

4.1 National Policy

Flood and Water Management Act (FWMA) (2010)

As a response to the Pitt Review of the summer 2007 floods and the requirements of the EU Flood Directive, the Flood and Water Management Act was implemented in England and Wales in April 2010. The act outlines the responsibilities for managing flood risk and drought, with an increased focus on the risk of flooding from local sources. An important outcome of the act is that County or Unitary Authorities are now classified as *'Lead Local Flood Authorities'* and have the responsibility for managing flood risk at a local scale. Additionally, it aims to encourage the use of SuDS, and promotes resolution of sewer misconnections.

National Technical Standards for design, construction, maintenance and operation of Sustainable Drainage Systems (SuDS)

As part of the Government's continuing commitment to protect people and property from flood risk, the Department for Environment, Food and Rural Affairs (Defra) consulted on a proposal to make better use of the planning system to secure sustainable drainage systems (2014).

National Standards for design, construction, maintenance and operation of SuDS came into effect from the 6th April 2015 and relate to Schedule 3, Paragraph 5 of the Floods and Water Management Act 2010.

These (non-statutory) National Technical Standards for SuDS specify criteria to ensure sustainable drainage is included within developments of 10 dwellings or more; or equivalent non-residential, or mixed development (as set out in Article 2(1) of the Town and Country Planning (Development Management Procedure) (England) Order 2010).

These Technical Standards (S1 -14) provide additional detail and requirements not initially covered by the NPPF (see below). However, it is recognised that SuDS should be designed to ensure that the maintenance and operation requirements are economically proportionate.

National Planning Policy Framework (NPPF) (2018)

The National Planning Policy Framework (NPPF) was published on the 27th March 2012 and updated in July 2018. This Framework is a key part of the Government's reforms to make the planning system less complex and more accessible, to protect the environment and to promote

sustainable growth. The NPPF sets out the Government's planning policies for England, and is used in the preparation of local plans as well as in decision making with respect to planning. The framework is executed by means of the accompanying Planning Policy Guidance Suite (March 2014) which supersedes PPS25: Development and Flood Risk Practice Guide (2009).

Paragraphs 7 to 217 contain policy that represents the Government's view of sustainable development. In order to achieve sustainable development within different districts, local circumstances need to be taken into account. Each Local Planning Authority is required to complete a SFRA to assess the risk of flooding from all sources, following criteria set out in the NPPF. The overarching use of SFRAs is to implement the Sequential Test, and where necessary the Exception Test, when determining land use allocation (refer to Sections 3.4 and 3.5).

4.2 Regional Policy

Isle of Grain to South Foreland Shoreline Management Plan (SMP)

Whilst the SMP is not a statutory planning document, it does set policy for the management of the shoreline over the next 100 years. Consequently, the SMP is an important document when appraising the risk of coastal flooding on a regional and local scale.

The Isle of Grain to South Foreland SMP Review has been completed and was approved by the Environment Agency's Regional Director in August 2010. The SMP was adopted by the Council on 7 February 2008. The SMP has been examined as part of the SFRA process and the relevant policies are listed in Table 4.1.

Location	Policy Unit Reference	SMP Policy		
		2008 to 2028	2028 to 2058	2058 to 2108
Faversham Creek to Seasalter (Blue Anchor) *Flood frontage*	4a07	Hold the line	Hold the line for Seasalter (Sportsman to Blue Anchor) Managed realignment for the rest of the policy unit	Managed realignment
Seasalter to Whitstable Town (Golf Course) *Erosion frontage*	4a08	Hold the line	Hold the line	Hold the line
Whitstable Town to Whitstable Harbour *Flood frontage*	4a09	Hold the line	Hold the line	Hold the line
Whitstable Harbour to Swalecliffe *Erosion frontage*	4a10	Hold the line	Hold the line	Hold the line
Swaleciffe to Herne Bay Breakwater *Flood & erosion frontage*	4a11	Hold the line	Hold the line	Hold the line
Herne Bay Breakwater to Reculver Country Park *Erosion frontage*	4a12	Hold the line	Hold the line	Hold the line
Reculver Country Park *Erosion frontage*	4a13	No Active Intervention	No Active Intervention	No Active Intervention
Reculver Towers to Minnis Bay *Flood & erosion frontage*	4a14	Hold the line	Hold the line for Reculver Towers Managed realignment for the majority of the rest of the policy unit	Hold the line for Reculver Towers Managed realignment for the majority of the rest of the policy unit

Table 4.1 – Summary of SMP policies for frontages within the Canterbury District

The importance of the current defences at both Whitstable and Herne Bay is highlighted in the SMP policy statements, which state the current policy is "to maintain the existing defences to protect the significant assets, which are important to the region's economy". In the second epoch the policy changes to "upgrade the defence structures, this will maintain the character of the frontage and protect the significant built assets from sea level rise".

The SMP also contains an Action Plan, which sets out the recommended works and improvements to the coastal defences in order to meet the policy objectives. This Action Plan is summarised below for those frontages containing a flooding element. The Plan is important in that it gives a clear indication as to future maintenance and improvement where necessary of sea defences that have an impact on the SFRA, and should be taken into consideration when defining future flood risk.

For all the policy units between and including Whitstable and Herne Bay, the Action Plan states to "*undertake engineering works and maintenance activities to hold the defence line, to maintain the seawall and to maintain beach and groynes".* For the two frontages at Seasalter and Reculver, where managed realignment is proposed commencing in the second epoch, the Action Plan states to "*engage with affected parties to enable adaptation to the change in coastline"* but to "*continue maintenance to hold the defence line and maintain the seawall"* prior to managed realignment.

Stour Catchment Flood Management Plan (CFMP)

A CFMP is a high-level strategic planning tool through which the Environment Agency seeks to work with other decision-makers within a river catchment to identify and agree policies for sustainable flood risk management. The primary objectives of the CFMP are to:

- Develop complementary policies for long-term (50-100 years) management of flood risk within the catchment that take into account the likely impacts of changes in climate, land use and land management.
- To undertake a strategic assessment of current and future flood risk from all sources within the catchment and quantify the risk in economic, social and environmental terms.
- Identify opportunities and constraints within the catchment for reducing flood risk through strategic changes and identify how these benefits could be delivered.
- Identify opportunities to maintain, restore or enhance the total stock of natural and historic assets from flooding.
- Identify the relative priorities for the catchment and assign responsibility to the Environment Agency and other operating authorities, local authorities, water companies and other key stakeholders for further investigations or actions to be taken to manage and reduce flood risk within the catchment.

The Stour CFMP, relevant to the Canterbury District, was completed and published by the Environment Agency in March 2007. The CFMP has been examined as part of the SFRA process and the relevant policies and Action Plans are listed in Table 4.2.

Policy Unit	Preferred Policy	CFMP Outputs	
		Policy	Action Plan Summary
Middle Stour *Through to Shalmsford Street*	6	Take action to increase the frequency of flooding to bring benefits locally or elsewhere	High priority action to carry out Flood Risk Management (FRM) study to explore range of options and identify areas of floodplain for additional flood storage
Stour Canterbury *From Shalmsford Street through Canterbury and Fordwich*	5	Take further action to reduce flood risk (now and/or in the future)	High priority action to carry out FRM study to explore range of flood risk management options. High priority action to produce a System Asset Management Plan to determine how the assets can best be managed
Nailbourne & Little Stour *Nailbourne and Little Stour streams*	4	Take further action to sustain the current scale of flood risk into the future (responding to potential increases in flood risk)	Low priority action to carry out FRM study to explore range of flood risk management options including investigating sewer flooding and possible areas for additional flood storage
Lower Stour *From past Fordwich*	6	Take action to increase the frequency of flooding to bring benefits locally or elsewhere	Medium priority action to carry out FRM study to explore range of options and identify areas of floodplain for additional flood storage
Oyster Coast Brooks *Gorrell Stream, Swalecliffe Brook, Kite Farm Ditch, West Brook & Plenty Brook coastal streams*	5	Take further action to reduce flood risk (now and/or in the future)	Low priority action to carry out FRM study to explore range of flood risk management options. High priority action to produce a System Asset Management Plan to determine how the assets can best be managed

Table 4.2 – Summary of CFMP policies and Action Plans for Canterbury District

It should be noted that for those policy units where the preferred policy is Policy 6, this means that it is the intention to increase flood risk at specific locations only and not across the whole policy unit.

4.3 District Policy

Canterbury District Local Planning Policies

Canterbury City Council's planning policy is set out in the Canterbury District Local Plan which was published in 2017, together with the Reculver Master Plan and Herne Bay Area Action Plan, as described below.

The Local Plan recognises and supports the principle that inappropriate development in areas at known risk from flooding and coastal erosion should be discouraged. It recognises that flood risk will have a strong influence on development within the District.

Policy CC4 sets out the requirements for a Flood Risk Assessment and Drainage Impact Assessment to be submitted with planning applications. Sites which have not been previously developed within Flood Zones 2 and 3 will only be permitted where the requirements of the Sequential Test, and where required the Exception Test, have been met (Policy CC5).

However, for minor infill and previously developed land within Flood Zones 2 and 3, Policy CC6 states development will be permitted subject to the other provision of other Local Plan policies. Extensions to existing property and change of use must meet the requirements of flood risk assessment (Policy CC5) - Refer to Section 10 for further details. Reference to Proposals Map Inset 5 within the Local Plan, Policy CC7 states that development with in the *'overtopping hazard zone'* will not be permitted.

The Local Plan also includes Policy on the management of surface water, to ensure that the risk of flooding is not increased either on-site of off-site. Policy CC11 states that all development applications should include sustainable drainage and where possible seek to provide additional benefits through SuDS such as, benefits to water quality, biodiversity and amenity. (Refer to Section 10.4 for further details),

The Proposals Map (Insert 3 and 5) defines a Coastal Protection Zone within which new development will normally be refused (CC10). Policy CC8 and CC9 relate to coastal change at Seasalter and Reculver respectively. Replacement dwellings outside the urban boundary at Faversham Road, Seasalter will not be permitted, and extensions to existing dwellings will only be permitted where there is justification for exception. Whilst CCC are working with external partners to investigate and define (if necessary) a Coastal Change Management Area at Reculver, any development or management proposals in this area must be mindful of costal change, flood risk, impact on future wetland habitat, and public safety.

It should be recognised that these policies may be reviewed as part of the updates to the Local Plan.

Herne Bay Area Action Plan and Reculver Masterplan

The Canterbury District Local Development Framework to date includes the Herne Bay Area Action Plan, and numerous Supplementary Planning Documents including the Reculver Masterplan. The Herne Bay Area Action Plan, designed to focus the delivery of regeneration initiatives in the town, was adopted in April 2010. The plan recommends that developments within the town centre should be allowed to proceed, subject to individual site FRAs being produced at planning consent stage and should fully incorporate the conclusions and recommendations of the FRA.

The Reculver Masterplan has an overarching objective to develop Reculver as a high quality strategic regional hub for green tourism and education in East Kent.' This includes future aspirations for a large scale development of a saltwater marshland habitat, enabled by a strategic change in the location of sea defences.

Faversham Creek to Whitstable Harbour Coastal Defence Strategy

This Strategy Plan was completed and approved by Defra in 2004 and makes recommendations for implementing flood and coastal erosion risk management schemes along this length of coast. For the Whitstable flood frontage a number of phased capital construction schemes were proposed. The initial scheme, which comprised a major beach recharge and the construction of new groynes, was implemented in 2006 and raised the standard of protection along the full defended length to 1 in 200 years. Further beach recharges and groyne maintenance/reconstruction works are programmed for appropriate intervals throughout the century in order to continually maintain this standard.

In about 20 to 30 years' time, it is proposed to raise the rear seawall by 0.6m to allow for rising sea levels. For the whole 100 year capital and maintenance costs for the works proposed in the strategy there is a benefit cost ratio of 21:1 – clearly demonstrating the very high economic viability of the future sea defence improvement works.

Swalecliffe Coastal Defence Strategy Plan

The Strategy Plan includes the Swalecliffe and Hampton flood frontages. It was completed and submitted to the Environment Agency in March 2010 for approval. The strategy recommends continued maintenance and, where necessary, upgrading of the defences at both locations to maintain the 1 in 200 year defence standard over the next 100 years. Since 2010 the defences have been maintained and any damage rectified (e.g. groyne timber replacement). In 2015, localised improvements were undertaken at Hampton with the installation of additional floodgates along Hampton Pier Avenue.

The Hampton seawall and parts of the seawall at Swalecliffe, not already at an appropriate level, are proposed to be raised in 20 to 30 years' time to keep pace with the predicted rise in sea levels. The benefit cost ratio for the flood defence improvements recommended in the Strategy is 8:1 – indicating significant economic justification to continue maintaining and improving defences to a high standard.

Herne Bay Flood and Erosion Risk Management Strategy Plan

Preliminary work carried out for the study application and to inform the Environment Agency's Medium Term Plan indicates that some improvement works will be necessary in the short to medium term to maintain the 1 in 200 standard of the flood defences at Herne Bay over the next 100 years. An approval to carry out this strategy was received by the Environment Agency which was undertaken in 2013. The works included raising all of the Herne Bay central area defences to ensure a 1 in 200 year standard of protection is maintained. The strategy will also include raising the rear seawall by about 0.6m in about 20-30 years' time, depending upon sea level rise.

In 2015, the Environment Agency gave approval for a further more detailed study of this area, which included the towns from Hampton to Bishopstone. The aim of this study was to identify any need for improvements required to be carried out to the sea defences to the west of Herne Bay Pier and Kings Hall frontage. The works are due to be undertaken in 2016.

Reculver to Minnis Bay Coastal Defence Strategy Plan

The strategy was completed and approved by Defra in 1997. It demonstrated that it is economically beneficial for the entire defence length, including the Northern Seawall, to be maintained and improved where necessary to provide between a 1 in 50 and 1 in 100 year standard of protection over the next 100 years. As a result of these recommendations, capital works were carried out around the Reculver Towers area in 1998 to reconstruct various parts of the defences. The SMP currently recommends managed realignment in the medium term for the Northern Seawall.

Great Stour Flood Risk Mapping Study (2013)

In 2013, a Flood Risk Mapping study of the Great Stour between Wye and Fordwich was commissioned by the Environment Agency. A strategic flood model was produced for the Great Stour with the aim of updating the Flood Zone Maps and to test different options to reduce flood risk within the catchment.

Isle of Sheppey and Oyster Coast Brooks Flood Risk Mapping Study (2014)

In 2014, a Flood Risk Mapping study of four watercourses in Kent was commissioned by the Environment Agency. Three of the watercourses are located within the Canterbury District; the Swalecliffe Brook, Kite Farm Ditch and West Brook are located on the Oyster Coast between Whitstable and Herne Bay. The fourth, the Scrapsgate Drain, is located on the Isle of Sheppey at Minster. Flood models were produced for each watercourse and the peak fluvial flow and the maximum water level during the tidal cycle were run coincidently, to provide a worst case scenario. The results of this study were used to update the Environment Agency's Flood Zone Maps and to test different options to reduce flood risk within the catchment.

Council Policy Statement on Flood and Coastal Defence

In March 2001 the Council formally adopted its policy with respect to flood and coastal defence. This states that the *"Council will provide an adequate, economically, technically and environmentally sound approach to providing the flood and coastal defence service and will ensure that appropriate maintenance regimes are in place for flood and coastal defence for which the Council takes responsibility*". This policy was reinforced by the Council's Flooding Scrutiny Panel report (adopted by Council in September 2001), which contained 50 actions to reduce flood risk in the District. This report concentrated on the reduction of inland flooding from whatever source, but under Action 3 specifically stated that "this Council should continue with its proactive approach to coastal defence, both maintenance and improvement works, to ensure that the risk of flooding and erosion is kept to the very minimum".

The Flooding Scrutiny Panel report has been regularly updated. The latest update, November 2007 (see Appendix A.6), was adopted by the Council in December 2007 and contains a summary of all improvements carried out to reduce flood risk in the District and further improvements to be made.

Council Policy on Drainage Impact Assessment Requirements for New Development

The Council require a Drainage Impact Assessment (DIA) and the surface water drainage pro-forma to be submitted and approved for all new development proposals. The drainage guidance for

completing the surface water drainage pro-forma is located in Appendix A.7 and sets out all the necessary requirements to ensure that any proposed development increase the risk of flooding. Depending upon the size of the development, developers may be required to carry out, or assist in funding works aimed at reducing the risk of flooding.

5 Data Sources

5.1 Consultation and Data Collection

The following organisations have been consulted either during the development of the SFRA or for comment on the final draft.

- Canterbury City Council
- Environment Agency
- River Stour (Kent) Internal Drainage Board
- Kent County Council - Highways
- Southern Water

The data supplied for use within the SFRA has been summarised in the following Table.

Organisation	Data Supplied	Use within SFRA
Canterbury City Council	OS 10k National Grid mapping	Flood risk mapping
	Historic flood database and mapping	Historic Flooding
	Isle of Grain to South Foreland SMP Review 2010 (Halcrow)	Information on shoreline management policy
	Coastal defence asset database	Information on existing defences and their standard of service
	Coastal defence strategy plans (Whitstable, Tankerton, Swalecliffe, Herne Bay, Reculver)	Information on coastal processes and proposed defence improvements
	Flood Scrutiny Review Report and Appendices, various site specific flood reports and analyses	Information on flooding history, flood policy and post-flood improvements
Environment Agency	Flood Zone 2 and 3 extents (GIS layer)	Mapping of flood zones
	Historic flooding extents (GIS layer)	Mapping of historic flooding
	National Flood and Coastal Defence Database (NFCDD)	Information on existing defences
	LiDAR data – supplied at a resolution of 2m for the whole District	Flood risk mapping
	Extreme sea levels – taken from the JBA Extremes Sea Levels Report (Version 10)	Flood risk mapping
	River Stour Catchment Flood Management Plan	Information on fluvial processes and proposed improvement
	River Great Stour Modelling and Mapping Study Report (v2 2013)	Flood risk mapping
	Isle of Sheppey & Oyster Coast Brooks Report (v2 2014)	Flood risk mapping
Southeast Strategic Regional Coastal Monitoring Programme	Beach and structure profile data	Flood risk analysis and mapping
Southern Water	Information on historic flooding and improvements to the sewer network	Historic Flooding

Table 5.1 - Summary of data supplied

5.2 Existing Hydraulic Modelling

Since the publication of the original SFRA in 2011 there has been a number of hydraulic modelling studies undertaken for watercourses within the Canterbury District. These cover the Oyster Coast Brooks (Swalecliffe Brook, West Brook and Kite Farm Ditch) and the River Great Stour from Wye

through to Fordwich. A study was also undertaken for the Plenty Brook prior to the publication of the SFRA in 2011, although this did not include any flood mapping, nor did the study accurately quantify the extent of flooding likely to occur as a result of an extreme flood event. Since this time it is recognised that new flood models have been released and consequently, the Environment Agency should be contacted directly to obtain the outputs from the most contemporary models.

Recent changes in the guidance on climate change allowances were released in February 2016 (refer to Section 6 below) and the majority of the studies mentioned previously do not take account of these new changes. It is therefore acknowledged that some caution should be adopted when using these sources to appraise the risk of flooding. Notwithstanding this, given that this may be the best data currently available, it will still be beneficial to examine the results of these studies as a starting point when preparing a site specific Flood Risk Assessment.

In addition to this, in 2009 Herrington Consulting was commissioned as part of the original 2011 SFRA to undertake a series of detailed flood modelling studies of the key development areas within the District. The outputs from these hydrodynamic models have been used to inform this SFRA and are included in Appendix A.5. A more detailed description of the scope and methodologies employed is given in Section 9 of this report.

5.3 Flood Zone Mapping

The Environment Agency Flood Zone maps show the areas at risk of flooding from rivers and the sea and are produced initially from a national generalised and large scale computer model (JFlow). This mapping process ignores the presence of existing defences, although those defences constructed during the last 5 years are highlighted on the maps. The Environment Agency's Flood Zone mapping for the Canterbury District has been reproduced and included in Appendix A.1 of this report.

5.4 Historic and Localised Flooding

There is a detailed history of flooding within Canterbury District that has been well documented by the Council's Engineering Team and the Environment Agency. Information on actual and potential sea flood events since World War II and inland flooding over the past thirty years is held. There are particularly good records of the flooding that took place over the winters of 2000/2001, 2013/2014. The relevant details have been reproduced in a Table format in Appendix A.3, which accompanies the Historic Flood Map.

The most significant flood events that have affected the District are discussed in more detail below.

1953 North Sea Surge – During the January 1953 storm, the sea defences along most of the North Kent coast were overtopped or breached and severely damaged. Both Whitstable and Herne Bay town centres were badly flooded and at Seasalter and Reculver the sea breached the railway line hundreds of metres inland of the primary sea defences. The storm is estimated to have a return period of about 1 in 150 years (Canterbury City Council – Coastal Management Study 1993) and a still water level of 4.7m AODN was recorded at Whitstable.

The worst flooding was at Whitstable where the sea defences failed mainly due to a breach in the golf course seawall at the western end of the floodplain. There was also significant overflow and overtopping at Whitstable Harbour, at the eastern end, which quickly filled the low lying land behind it. Failure of the golf course seawall resulted in floodwater also breaching the golf course bund (secondary defence) and flooding much of the town by the "back door". Water coming through the harbour flooded the eastern part of the town, which is particularly low lying in the Gorrell area. Flooding to a depth of nearly two metres was recorded at the lowest part of the town at Cromwell Road.

The floodwater extended to the railway and passed through the bridge at Canterbury Road to flood some of the land and properties south of the railway. Seafront properties all along the Whitstable frontage were badly flooded due to a combination of overtopping and isolated pockets of overflow. Over 2,000 people became temporarily homeless as a result of the flooding, but there were no fatalities or serious injuries.

At Herne Bay during the same 1953 storm event, there was no major failure of the main seawall. The flooding resulted from significant overtopping and even some overflow of the low seawall. Flooding to a depth of about 1.2 metres was recorded at the lowest part of the town at the Beach Street car park.

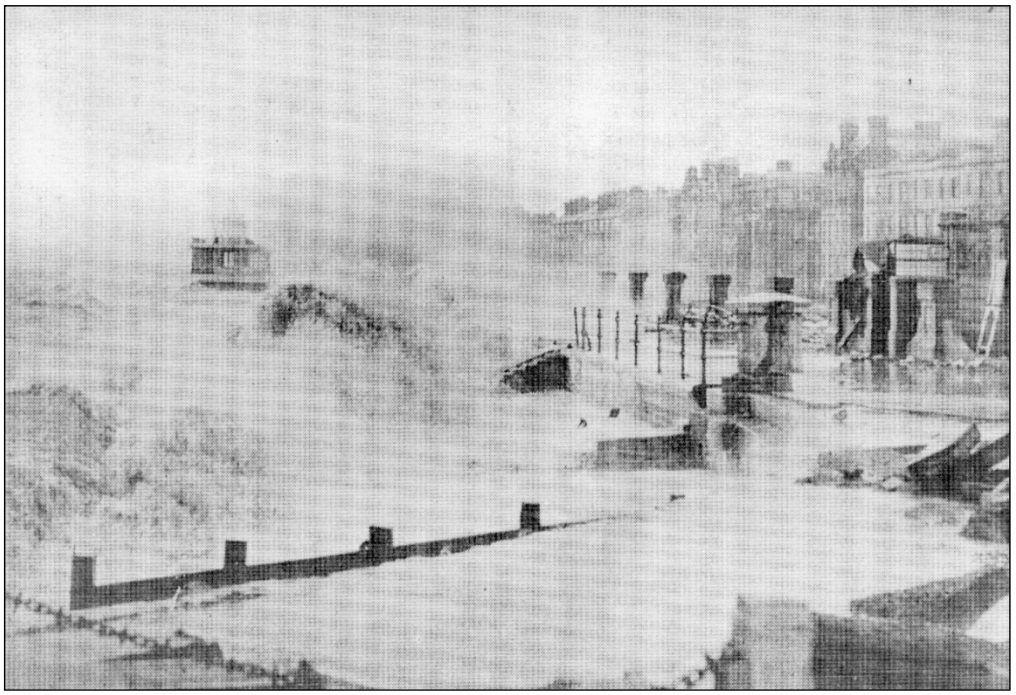


Figure 5.1 - Herne Bay Seafront during 1953 Storm

Figure 5.2 - Flooding at Whitstable, January 1953

1978 Storm – The coincidence of high tides and storm force north easterly gales in January 1978 resulted in considerable damage to property on the coast at Herne Bay, but flooding was mainly limited to property along the seafront and just inland. The storm is estimated to have been a 1 in 20/30 year return period event with a still water level of 4.1m AODN. Although the waves were bigger than in 1953, the sea level was lower. This accounted for the severity of the damage but the depth of flooding to property was only in the order of 250mm, except for basements. The number of properties flooded by this event was small.

The impact of this event was reduced because the sea defences had been raised following the 1953 floods. In addition, the seawall was not breached. Due to the orientation of its coastline in relation to the predominant direction of the 1978 storm there was little flooding at Whitstable as a result of this storm. However, significant flooding to houses along Faversham Road, Seasalter was reported and some of the properties on the beach were washed off their foundations.

Figure 5.3 - Damage at Herne Bay as a result of the 1978 Storm

1987 Hurricane – Some flooding occurred to property abutting the Great Stour through Chartham, Canterbury and Fordwich as a result of the October 1987 hurricane. The river overtopped its banks at a number of locations, however, this mainly occurred just upstream of culverts that had been almost totally blocked by fallen trees and other debris.

1996 Storm – This storm is estimated to have had a return period of 1 in 10 years, yet despite the fact that the wind was from the north-east (the worst direction), no significant flooding occurred at Herne Bay. The Neptune car park was flooded to a depth of up to 300mm in places with some water flowing from there down Market Street. There are no records of internal flooding to property during this event, although the impacts of this storm may well have been mitigated through the early deployment of sandbags. This storm occurred after the major sea defence works of 1992 at Herne Bay, which proved to be very effective as lesser storms prior to 1992 had caused property flooding on the seafront and in Market Street.

During this event flooding also occurred at a number of houses along Faversham Road in Seasalter. The seawall east of Reculver Towers also failed and only the rapid installation of emergency works prevented a full breach and extensive inland flooding.

Figure 5.4 - Failed Seawall at Reculver caused by the 1996 Storm

April 2000 Floods – On 4 April 2000, 50mm of rain fell steadily over a twelve hour period on ground that was already saturated. This resulted in widespread flooding across the District from rivers, minor watercourses, surcharged surface water sewers and from surface water run-off. Internal flooding to property was recorded at numerous locations within the District, with the worst affected area being Eddington near Herne Bay where flooding from the Plenty Brook resulted in flooding to 18 properties.

Winter 2000/2001 Floods – The winter 2000/2001 was the wettest since records began with over twice the average rainfall. There were also two days when about 50mm of rain fell over a twelve hour period (12 October 2000 and 8 February 2001) and in early November 2000 flood flows equating to a 1 in 50 year event were recorded in the Great Stour. Flooding occurred at locations throughout the District, although the sources varied considerably.

Given the extreme flood flows in the Great Stour, there were relatively few properties flooded. Those that were affected were generally as a result of overtopping of defences and not defence failure. The flooding from the Stour was partly due to the overtopping of the two storage reservoirs upstream of Ashford. These reservoirs were designed to accommodate a 1 in 100 year single storm event. However, a sequence of lesser storms occurred over a relatively short period. This did not allow the reservoirs to fully drain before the onset of the next storm, thus causing them to overflow.

Flooding directly resulting from other main rivers overtopping their banks, particularly the Little Stour, was quite high. Flooding from (at the time) non-main rivers, such as the Plenty Brook, was also a major cause of problems but the reasons for this are quite complex in a number of locations. Much flooding was as a result of surface water sewers and road drains not being able to cope with the volumes of water, particularly in rural areas where they became blocked with silt from fields.

Again, in more rural areas or on the outskirts of urban areas, unmaintained minor watercourses and significant run-off from open fields resulted in localised flooding. Springs appeared throughout the District that had not been known to flow in living memory, with some of these causing flooding to houses.

One of the most distressing aspects was flooding to properties from foul sewers either backing up or when pumping stations had failed. In what was estimated to be a 1 in 100 year event, a combination of flooding from rivers, groundwater emergence, overland flow and run-off from farmland as well as highways and sewer surcharging caused flooding to properties in all of the villages along the Nailbourne and Little Stour - at Barham, Kingston, Bishopsbourne, Bridge, Patrixbourne, Littlebourne, Ickham and Wickhambreux. Some houses at Bishopsbourne and Patrixbourne remained flooded for months. In total across the District, 290 houses were known to have been flooded internally, although there were probably more unreported cases. Many other properties were saved from internal flooding by the provision of sandbags. The Flooding Scrutiny Panel Report contained in Appendix A.6 details the event and also the various flood alleviation works carried out afterwards.

Figure 5.5 - Flooding from the Nailbourne at Barham

August 2007 Whitstable Flood – On 12th August 2007, flash flooding occurred in the low lying part of the Whitstable town centre, as a result of 50mm of rain falling in two hours. This was estimated to be in the order of a 1 in 100 year rainfall event. At least 30 and probably nearer 50 houses were flooded internally due to surcharging of the old, often combined, sewers. There were also problems

with overflowing of the Gorrell Tank (Southern Water) outfall system that is located adjacent to the harbour.

Winter 2013/2014 Floods – Following a stormy winter, where the district had experienced the biggest storm surge since 1953 in early December, England experienced the wettest January since records began in 1766. The south-east alone received 258% of its average rainfall for January. As a result, the ground became more saturated and the Nailbourne, a winterbourne that is usually dry downstream of Lyminge, began to flow.

By early February the Nailbourne was beginning to flow out of bank and flood roads and farmland. The flooding continued to intensify throughout the first part of February, exacerbated by rising groundwater levels and springs. Over-pumping of bridges occurred at Barham, Bridge, Patrixbourne and Ickham, and a pump was installed at Bishopsbourne to move water back into the river channel. In total 16 houses were flooded from the river, although most of these also had groundwater flooding and flooding from springs. A further 25 were flooded from groundwater, surface water and from foul sewers. There were also significant issues with surcharged sewers throughout the length of the Nailbourne.

Figure 5.6 – Photograph of flooding at Out Elmstead Lane, Barham January 2014.

Concurrently, the Petham Bourne began to flow, a very rare occurrence even in wet winters. This flooded roads and fields from Waltham through to its confluence with the Great Stour at Shalmsford Street. In addition, it flooded (and shut down) the Canterbury West – Ashford railway line at

Shalmsford Street. However, no houses were flooded by the Petham Bourne, or by groundwater in this area.

The Great Stour also caused problems with long term flooding of farmland particularly at Grove, where the road was closed for 3 weeks and one house was flooded. Only minor flooding to car parks occurred in the centre of Canterbury. There was significant flooding of gardens at Fordwich from December 2013 through to March 2014, but only minor internal flooding to one house. The very high sea storm surge of December 2013 did not cause any flooding to properties, but the houses along Faversham Road at Seasalter were evacuated on one night as a precaution.

5.5 Post Flood Improvements

Since the various flood events catalogued above, significant improvements have been made to the sea defences and flood alleviation systems across the District.

Since 1953 all seawalls protecting low-lying land have been raised, and where necessary reconstructed, to a level of at least 5.8m AODN (1m above the 1 in 200 year extreme sea level). All seawalls are protected against failure by a large shingle beach, stabilised by a comprehensive system of timber groynes. The shingle beach plays a significant role in reducing wave overtopping, as well as reducing the risk of the seawalls being undermined. In more recent years, major sea defence improvement works have been carried out at Whitstable (1989 and 2006), Swalecliffe (1988), Hampton (1996, 2013 and 2015), Herne Bay (1992) and Reculver (1998).

Figure 5.7 – Reduction of Overtopping due to 1990 Breakwater at Herne Bay

In response to the 2000/2001 flood events, a number of improvements were made to the Nailbourne through all of the villages. These works were mainly carried out to increase the capacity of the river channel and culverts. A new diversion channel was constructed at Littlebourne and improvements to highway drainage were carried out at a number of the villages. Improvements have also been made to the coastal brooks, including a major flood storage lake on the Plenty Brook and a new outfall to the Swalecliffe Brook. Improvements have also been made to the coastal brooks, including a major flood storage lake on the Plenty Brook and a new outfall to the Swalecliffe Brook. In general, there has been an improved awareness of the potential for flooding from the smaller watercourses in the District.

Following further flooding along the Nailbourne, Little Stour, Great Stour and Peltham Bourne, in 2014/15 Canterbury City Council have been working with the Environment Agency, Kent County Council and representatives from key parish councils to identify measures to try to reduce any future flooding.

Projects managed and funded by Canterbury City Council include:

- New floodgate at Brewery Lane ford
- Construction of a new drain from The Street at Bishopsbourne through to the Nailbourne
- Demountable flood barriers to keep the Nailbourne in its course at Derringstone
- Short length of earth bunding at The Street in Barham
- Major clearance of ditches along the route of Petham Bourne from Waltham to Shalmsford Street
- Clearance of the Blackhole Dyke upstream of Wickhambreaux
- Discussions are being held about the possibility of improving the flow of the Nailbourne by increasing capacity at the listed footbridges at The Causeway in Barham and Keepers Hill in Patrixbourne
- Penstock to control flows between the Little Sour and Blackhole Dyke (Summer 2016)

The Environment Agency's Recovery Programme – measures funded by Central Government to repair existing flood defences that were damaged in the floods.

- Reinstatement of the damaged river bund on the Nailbourne at Bridge and repairs to the bund beside the Little Stour at Littlebourne are complete
- Repairs to river walls are complete in Wickhambreaux and nearing completion in Stodmarsh and Grove
- Work on a more easily cleared weed screen at the existing culvert at Wickham Lane
- An extension of the riverside bund at Bridge, to prevent a reoccurrence of the river coming out of the bank and flowing down Brewery Lane

- A major clearance of growth, desilting of the river and removal of gravel build up, along with a small realignment of the Nailbourne at Patrixbourne
- Major cut back of trees encroaching into the river and dredging between Fordwich and Grove

Southern Water has also carried out a number of upgrades to its pumping stations reducing the risk of flooding from sewers. In 2013, on a £1 million programme to tackle the problem of high levels of groundwater flooding, repairs to the sewer network in villages along the Nailbourne river began. Engineers used remote operated CCTV cameras to extensively survey over ten kilometers of sewers and 250 manholes. A total of 3.5km sewer repairs have been completed in the following locations;

- Bridge, near Brewery Lane and Mill Lane
- Bourne Park, at Bishopsbourne
- Charlton Park
- Barham
- Other locations along the Nailbourne

Notwithstanding this, Southern Water has stated that they will continue to monitor the situation across the catchment and undertake any work, where necessary, to mitigate the risk of future drainage issues.

6 Flood Risk and Climate Change

The global climate is constantly changing, but it is widely recognised that we are now entering a period of accelerating change. Over the last few decades there have been numerous studies into the impact of potential changes in the future and there is now an increasing body of scientific evidence which supports the fact that the global climate is changing as a result of human activity. Past, present and future emissions of greenhouse gases are expected to cause significant global climate change during this century.

The nature of climate change at a regional level will vary: for the UK, projections of future climate change indicate that more frequent short-duration, high-intensity rainfall and more frequent periods of long-duration rainfall of the type responsible for the recent UK flooding could be expected.

These effects will tend to increase the size of flood zones associated with rivers, and the amount of flooding experienced from other inland sources. The rise in sea level will change the frequency of occurrence of high water levels relative to today's sea levels. It will also increase the extent of the area at risk should sea defences fail, although this increase will be comparatively small in the District due to the valley topography of the coastal floodplains. Changes in wave heights due to increased water depths, as well as possible changes in the frequency, duration and severity of storm events are also predicted.

To ensure that any recommended mitigation measures are sustainable and effective throughout the lifetime of the development, it is necessary to base the appraisal on the extreme flood level that is commensurate with the planning horizon for the proposed development. The NPPF and supporting Planning Practice Guidance Suite state that residential development should be considered for a minimum of 100 years, but that the lifetime of a non-residential development depends on the characteristics of the development. For commercial development, a 60 year design life is typically assumed, although the LPA and Environment Agency should be consulted to determine the most appropriate design life for each development.

6.1 Potential Changes in Climate

Extreme Sea Level

Global sea levels will continue to rise, depending on greenhouse gas emissions and the sensitivity of the climate system. The relative sea level rise in England also depends on the local vertical movement of the land, which is generally falling in the south-east and rising in the north and west. The accompanying Planning Practice Guidance Suite to the NPPF provides allowances for the regional rates of relative sea level rise and these are shown in Table 6.1.

Administrative Region	Net Sea Level Rise (mm/yr) Relative to 1990			
	1990 to 2025	2026 to 2055	2056 to 2085	2086 to 2115
East of England, East Midlands, London, SE England (south of Flamborough Head)	4.0	8.5	12.0	15.0
South West	3.5	8.0	11.5	14.5
NW England, NE England (north of Flamborough Head)	2.5	7.0	10.0	13.0

Table 6.1 - Recommended contingency allowances for net sea level rise

Since the completion of the numerical flood modelling undertaken as part of the 2011 SFRA (refer to Section 9), the Environment Agency has issued revised extreme sea levels for the UK coastline (Coastal flood boundary conditions for UK mainland and islands Project: SC060064/TR2: Design sea levels). These data suggest lower rates of predicted sea level rise than the values stated in the National Planning Policy Framework Technical Guidance; which were originally published in 2006 as part of the Defra report FCDPAG3 Economic Appraisal Supplementary Note to Operating Authorities – Climate Change Impacts.

For the preparation of Flood Risk Assessments for Local Plans and planning applications, the Environment Agency's guidance on climate change allowance should be followed. However, it is recognised that the numerical flood modelling undertaken for the original 2011 CCC SFRA has not been amended as part of this revision and consequently, the results of the modelling (e.g. flood depths and extents) remain unchanged from the 2011 SFRA report. The original results are, however, based on the higher values prior to the publication of the revised extreme sea levels, and as such, will provide an over-estimation of extreme sea level.

The 1 in 200 year sea levels have therefore been calculated for four time steps between current base date (2010) and the year 2110. These values are summarised in Table 6.2 below and show the difference between the values used within this SFRA and current Environment Agency guidance on climate change. From these values it can be seen that the increase in sea level due to climate change is significant and is not linear.

Year	1 in 200 year extreme water level (m AODN)	
	2011 CCC SFRA	UKCP09 Climate Change Allowance and 2011 JBA Coastal Flood Boundary Conditions*
2010	4.78	4.50
2025	4.84	4.57
2055	5.10	4.82
2085	5.46	5.18
2110	5.80	5.63

Table 6.2 - Climate change impacts on extreme sea levels

*(*These values reference the EA's revised extreme sea levels for the UK coastline. The 1 in 200 year extreme water level predictions vary significantly along the Canterbury District coastline and therefore the highest values have been quoted in Table 6.2 above; this value has been taken from an offshore point at Whitstable Bay).*

Using the revised UK Coastal Boundary Conditions (published by the Environment Agency in 2011), the extreme sea level for an extreme event with a 1 in 200 year return period for the year 2110 has been calculated as 5.63m AODN. This value is significantly lower than the 1 in 200 year (plus climate change) extreme open sea level used throughout this SFRA (5.80m AODN). Given that the extreme sea level is one of the principle boundary conditions used in the breach and wave overtopping modelling, it is evident that this reduced value will affect the outcome of the model.

In order to quantify the magnitude of change, sensitivity testing has been carried out. However, when the change in extreme sea level is contrasted against other potential variables such as, the level and condition of the beach, as well and wave overtopping rates, it is not shown to have a significant impact on the final outputs of the model.

In conclusion, whilst using the revised extreme sea levels will result in a small reduction in the predicted flood level, this change is less than the variability in flood depths experienced when testing other variables. Therefore, taking account of the precautionary approach promoted by the NPPF, the use of the predicted flood levels that are based on extreme sea level values currently adopted by the Council are considered to remain appropriate for the use in informing development in the coastal flood risk areas within the District.

Offshore Wind Speed and Extreme Wave Height

As a result of increased water depths resulting from changes in the climate, wave heights may change. The following allowances in Table 6.3 for offshore wind speed and wave height applicable around the entire English coast and are relative to a 1990 baseline. These figures include a sensitivity allowance which should be used to show that the range of impact of climate change is understood.

Parameter	1990 to 2055	2056 to 2115
Offshore wind speed allowance	+5%	+10%
Offshore wind speed sensitivity test	+10%	+10%
Extreme wave height allowance	+5%	+10%
Extreme wave height sensitive test	+10%	+10%

Table 6.3 - Recommended climate change allowance and sensitivity ranges for offshore wind speed and extreme wave height (relative to 1990)

Peak River Flow

Since the completion of this SFRA in 2011, the Environment Agency has published new guidance on the peak river flow allowances for climate change. The new figures show the anticipated changes to peak river flow by river basin district. The Canterbury District is covered by both the South East and Thames River Basin Districts, as defined by the Environment Agency River Basin maps. A copy of these maps can be found at;

https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

For each district a range of climate change allowances are provided for different time epochs over the next century, which correlate with the planning horizons for the varying classifications of development.

For each epoch there are three climate change allowances defined. These represent different levels of statistical confidence in the possible emissions scenarios on which they are calculated. The three levels of allowance are as follows:

- Central: based on the 50th percentile
- Higher Central: based on the 70th percentile
- Upper End: based on the 90th percentile

With reference to this methodology, it is recognised that although the higher percentile allowances are possible, these events are less likely to occur.

As well as encouraging sustainable development to meet the demands of a growing population, the NPPF also promotes a precautionary approach. For more vulnerable development in areas of higher risk of flooding, a higher percentile allowance is recommended in order to manage the risk of flooding over the lifetime of the proposed development. The Environment Agency has therefore provided guidance regarding the application of the climate change allowances and how they should be applied in the planning process, which can be seen in Table 6.4 below.

Flood Risk Vulnerability Classification	Zone 2	Zone 3a	Zone 3b
Essential infrastructure – Essential transport infrastructure, strategic utility infrastructure, including electricity generating power stations	↗ ↑	↗ ↑	↑
High vulnerability – Emergency services, basement dwellings caravans and mobile homes intended for permanent residential use	↗ ↑	X	X
More vulnerable – Hospitals, residential care homes, buildings used for dwelling houses, halls of residence, pubs, hotels, non-residential uses for health services, nurseries and education	→ ↗	↗ ↑	X
Less vulnerable – Shops, offices, restaurants, general industry, agriculture, sewerage treatment plants	→	→ ↗	X
Water compatible development – Flood control infrastructure, sewerage infrastructure, docks, marinas, ship building, water-based recreation etc.	No allowance	→	→

Key :

↑ Upper End

↗ Higher Central

→ Central

X Development should not be permitted

Table 6.4 – Recommended Climate Change allowance percentile based on Flood risk vulnerability and flood zone compatibility

The allowances for the Canterbury District cover both the Thames and South East river basin districts. The allowances for these are shown in Table 6.5 below.

River Basin District	Allowance category	Total potential change anticipated for epoch		
		2015 to 2039	2040 to 2069	2070 to 2115
South East	Upper End	25%	50%	105%
	Higher Central	15%	30%	45%
	Central	10%	20%	35%
Thames	Upper End	25%	35%	70%
	Higher Central	15%	25%	35%
	Central	10%	15%	25%

Table 6.5 – Recommended peak river flow allowances by river basin district (1961 to 1990 baseline)

Peak Rainfall Intensity

The recommended allowances for increase in peak rainfall intensity have also been updated since the completion of this SFRA in 2011. Although the allowance is applicable nationally, there is a range of values provided which correspond with the central and upper end percentiles (the 50th and 90th percentile respectively) over three time epochs. The recommended allowances are shown in Table 6.6 below.

Allowance Category (applicable nationwide)	Total potential change anticipated for epoch		
	2015 to 2039	2040 to 2069	2070 to 2115
Upper End	10%	20%	40%
Central	5%	10%	20%

Table 6.6 – Recommended peak rainfall intensity allowance for small and urban catchments (1961 to 1990 baseline)

All of the above recommended allowances for climate change should be used as a guideline and can be superseded if local evidence supports the use of other data or allowances. Additionally, in the instance where flood mitigation measures are not considered necessary at present, but will be required in the future (as a result of changes in climate), a "managed adaptive approach" may be adopted where development is designed to allow the incorporation of appropriate mitigation measures in the future.

6.2 Impacts of Climate Change on the SFRA Study Area

The Environment Agency Flood Zone maps are based on current day sea levels and climate conditions. For the coastal flood zones at Seasalter through to Reculver the impact of climate change will be comparatively small as the land slopes away quite steeply from the coastal floodplains; thus any rise in predicted flood levels results in a relatively small increase in the extents of the floodplain. East of Reculver, however, the impact will be more pronounced due to the relatively flat topography of the low-lying hinterland.

The reliance of the towns of Whitstable and Herne Bay on coastal flood defence infrastructure will increase over this next century and as sea levels increase, so will the consequences of the failure of these defences. It is therefore necessary to ensure that new development is designed so that these residual risks are mitigated.

The breach and wave overtopping modelling that has been undertaken as part of this SFRA has been carried out using both the current day conditions and using increased wave and water level values commensurate with the predicted 2110 climate (prior to the publication of the revised extreme sea levels). These increases have a significant impact on the outcome of the modelling.

When the dynamics of a breach are considered, the increase in sea level over the next 100 year period will result in a significantly increased volume of flow through the breach at the peak of the

event. Higher water levels will also allow larger wave heights to be sustained closer inshore in combination with the predicted increase in offshore wind speeds, it is estimated that wave overtopping could increase by a factor of between 20 and 100, depending upon location, by 2110. The impact of these climatic changes is illustrated clearly by the Hazard Maps included in Appendix A.5.

The outputs from the flood modelling for the Great Stour through Canterbury City Centre, undertaken by Herrington Consulting for the original 2011 SFRA, have not been changed in response to the latest predictions on climate change. The outputs for the design flood event (which include a 20% allowance for climate change) are considered to be superseded by the Great Stour Flood Risk Mapping Study, undertaken by the Environment Agency in 2013. The original 2013 version of the Environment Agency's flood model did not including the new allowances for climate change, however, more recently the model has been re-run to include the new increases in peak flow in the river. In accordance with the recently published guidance on the allowance for climate change (2016) the peak flow in the watercourse has been increased in the model by values varying between 10% to 105%, depending on the location and type of development. Guidelines for determining the appropriate allowance for assessing the impact of climate change on a development is outlined in Section 6.1 above.

For the preparation of Flood Risk Assessments for Local Plans and planning applications, the Environment Agency's guidance on climate change allowance should be followed and a site-specific analysis of the impact of climate change should be made.

The District has many watercourses that are particularly flashy in their response to intense rainfall and historically this has caused many problems where they flow through urbanised areas, especially where they are culverted or form part of the surface water sewerage network and have tide locked outfalls. Consequently, increases in peak rainfall intensity and peak river flow are likely to significantly increase the risk of flooding from these watercourses.

In addition to the risk of fluvial flooding, consideration should also be paid to the impact of climate change with respect pluvial flooding. By managing surface water in a sustainable manner, through the use of SuDS for example, it is possible to ensure that new development does not exacerbate flood risk on site or elsewhere within the catchment. Taking climate change into account at the planning stage will ensure that its impacts are mitigated, thus the risk of flooding can be managed throughout the lifetime of the development.

Climate change will inevitably result in an increased risk of flooding from all sources. Consequently, the potential impacts of climatic change will require careful consideration before sites for development are allocated.

7 Overview of Flood Risk

The topography and geology of the land within the boundaries of the Canterbury District are diverse and complex, as is the range of flood sources. This section of the SFRA therefore examines each source of flood risk and discusses the mechanisms by which flooding can occur.

7.1 Flooding from the Sea

The part of Canterbury District's shoreline that is low lying is approximately 10km long and is defended throughout its length. At each end of the District, these defences protect lower-lying, fertile agricultural land and important infrastructure at Graveney/Seasalter to the west and Reculver/Northern Seawall to the east. The land levels in these areas are generally at or below the Mean High Water Springs (MHWS) level of 2.7m AODN and consequently, without the protection of the existing sea defences much of this land would be inundated on a regular basis. The defences also protect the low-lying urban areas of Whitstable, Swalecliffe, Hampton and Herne Bay. At Whitstable there are locations where the land and houses are at or slightly below the MHWS level of 2.7m AODN, whilst at Herne Bay the lowest land level is around 3.3m AODN. The defences are therefore essential to protect the coastal towns from regular flooding from the sea and in some cases permanent inundation.

The whole of the District's shoreline faces north and has the potential to be affected by North Sea surges, which can raise the sea level by up to 2.5m. However, due to the relatively shallow foreshore, wave heights are generally depth limited and are therefore relatively small, even during storm surges. The predicted 1 in 200 year still water level for the current climate conditions that has been adopted by the Council is 4.81m AODN.

Given the presence of the existing sea defences, flooding from the sea can only occur as a result of either the existing defences breaching or being overtopped by wave action. Depending upon the location of the particular site with respect to the breach or overtopping event, the consequences can vary significantly. The condition of the seawall, its height, the level of the land immediately behind the seawall, the adequacy of the protecting shingle beach and its groynes, the maintenance regime and the proposals for future improvements to the sea defences will all affect the potential for a breach and the degree of overtopping. It has therefore been necessary to analyse the risk of flooding from the sea in great detail so as to be able to define as accurately as possible the risk at the six coastal floodplains – Seasalter, Whitstable, Swalecliffe, Hampton, Herne Bay and Reculver. Flood modelling has been carried out at these locations and this work is described in further detail in Section 9 of this report.

7.2 Flooding from Rivers

There are a number of watercourses within the District, which have been categorised as main rivers and as can be seen in the section on historic flooding, these have caused flooding problems in the

past. The locations of these watercourses are shown on the map in Appendix A.4 and are described as follows:

River Great Stour – The various tributaries of the Great Stour meet at Ashford, the river then flows unimpeded through rural chalk downs from south west to north east bisecting the District. It passes through the village of Chartham into Canterbury's city centre, where it is highly modified. The river splits into three channels and a complicated series of sluices, gates and mill races control river flows. Localised flood walls provide protection to some pockets of development. These structures have an important role to play in managing flood risk within the city.

Downstream of the city the river enters the tidally influenced Lower Stour at Fordwich and eventually flows into the sea near Sandwich. Upstream of Canterbury, two flood storage reservoirs, at Hothfield and Aldington, were constructed south of Ashford in the early 1990s. These, together with natural flood storage on the agricultural land between Ashford and Canterbury, provide protection against flooding to most parts of the city for events up to around 1 in 100 years. However, whilst these flood storage reservoirs provide a reasonably high standard of protection against a single larger return period event, the standard of protection against two consecutive lesser events is limited by the time taken to discharge the reservoirs. Flood modelling of the River Great Stour has been carried out throughout Canterbury's city centre (Hydraulic Modelling and Flood Risk Mapping of the Great Stour – Canterbury, Herrington Consulting, November 2008) and this work is described in further detail in Section 9 of this report.

Since the completion of the original SFRA in 2011, the Environment Agency published the Great Stour Flood Risk Mapping Study (2013). This study extends from Wye to Fordwich and comprises 1D-2D models constructed in ISIS-TUFLOW. Due to the size of the model, this reach of watercourse has been split into two smaller models which are linked. The section of the River Stour from the M20 (Ashford) to upstream of Canterbury is referred to as 'Model 1'. Upstream of Canterbury to Stodmarsh Valley is 'Model 2'.

The results of this modelling are considered to supersede the results of the flood mapping study undertaken by Herrington Consulting in 2008. However, as described in Section 3.6, the results of the Herrington Consulting flood mapping study should be used to delineate the 1 in 20 year flood extents for Canterbury City Centre (as shown in Appendix A.2). For areas outside of the City Centre, the 1 in 20 year flood extents provided by the Environment Agency should be interpreted with caution at a site specific level.

Petham Bourne – The Petham Bourne is not classified as a main river and is a tributary of the Great Stour joining it at Shalmsford Street. It is groundwater fed and flows very infrequently; 1930, 2000/2001 and 2013/2014 are the only recorded events. Its route is poorly defined in places but when it does flow there is a risk to property adjacent to it, particularly at Shalmsford Street.

Nailbourne/Little Stour – The Nailbourne is a chalk fed stream, which rises during prolonged periods of rainfall. Its source is at Lyminge and, within the District, it flows through the villages of

Barham, Kingsdown, Bishopsbourne, Bridge, Patrixbourne and Bekesbourne. The Nailbourne eventually joins the Little Stour near Littlebourne, which then flows through the villages of Wickambreux and Seaton before its confluence with the Great Stour at Stourmouth.

Flow in the Nailbourne is intermittent, locally thought to flow on average once every seven years. However, in recent years it has flowed in 2000/2001, 2003, 2010, 2013/2014, 2014/2015 and 2015/2016. The significant flooding in 2000/2001 was estimated to have a return period of between 50 and 100 years. Property close to the river in all the villages were affected to some extent. Similar impacts were seen during the winter of 2013/2014.

Considerable improvements to the river have been carried out since 2001, however, there are still a number of restrictions, such as road culverts, where localised flooding can occur upstream. It is considered that the risk of flooding to parts of the Nailbourne/Little Stour villages is in the order of 1% - 2% AEP (estimated return period between 50 and 100 years).

Sarre Penn – The Sarre Penn is sourced at Dunkirk and runs north of Canterbury at Harbledown through to Broad Oak and then parallel to the A28 to Sarre, eventually joining the River Wantsum. The Sarre Penn flows predominantly through agricultural land that is remote from developed areas, however, there are localised land drainage problems associated with this watercourse, particularly in north Canterbury and where road culverts restrict flow. Where property is located in close proximity to the Sarre Penn there may be a risk of flooding. Consequently, before further development adjacent to this watercourse the risk of flooding would need to be investigated in greater detail.

Oyster Coast Brooks – The Environment Agency, in the Stour CFPM, has grouped together the five short rivers known as Gorrell Stream, Kite Farm Ditch, Swaleciffe Brook, West Brook and Plenty Brook and refers to them as the Oyster Coast Brooks. They are all similar in that they are characterised by a clay catchment, are heavily modified, have a short and steep channel gradient and a tide-locked outfall controlled by a sluice gate. The rivers respond quickly to rainfall due to the urban area through which they mainly flow, the steepness of the catchment and the clay geology. The steep gradient means that the rivers drain into the sea very quickly so peak flows are of a short duration. However, the peak can be influenced by tide locking which makes the effects of flooding much worse. Various structures and culverts along their routes restrict flow, as does the typical narrow channel section. Significant recent development that has taken place beside these rivers has exacerbated flood risk to some degree.

In 2014, a Flood Risk Mapping study of the Oyster Coast Brooks was commissioned by the Environment Agency. Flood models were produced for three of the five watercourses with the peak fluvial flow and maximum of the tidal cycle modelled to coincide, to provide a worst case scenario. The results of this study were used to update the Environment Agency's Flood Maps and to test difference options to reduce flood risk within the catchment.

*The **Gorrell Stream*** has its source at Duncan Downs above Whitstable and flows steeply downhill into the town at St Andrews Close. It is then in a defined channel with concrete sides, with short lengths culverted, through to Belmont Road. Thereafter through to its outfall, a length of 1.1km, the stream is fully piped (1400mm diameter) and is designated as a public surface water sewer maintained by Southern Water. The Gorrell Tank, at the stream's outfall, has a capacity of 18,000 cubic metres. There is a gravity outfall into Whitstable Harbour plus a pumping station to deal with high flows discharging to a sea outfall. Because of the complex system of interconnecting sewers, the potentially high flow rate and the reliance on a pumped outfall, the lower Gorrell catchment through the town of Whitstable is particularly at risk from flash flooding, as occurred in the winter of 2000/2001 and August 2007.

*The **Kite Farm Ditch*** has its source within the Chestfield Golf Course and is mostly natural open channel, although it is culverted where it passes under the Thanet Way, railway line and various other roads. It discharges to the sea at the Swaleciffe Sea View Caravan Park via a sluice gate (operated by Canterbury City Council) which is normally left fully open, but is closed to prevent high tides causing levels in the watercourse to back-up.

The greatest risk of flooding is at the lowest section, along Colewood Road. After passing under the railway, the stream emerges briefly into an open ditch but very soon leads into a Southern Water surface water sewer. This picks up the flow from other surface water sewers and at the junction of Colewood Road and St John's Road the surface water sewer outfalls into the open channel that runs alongside the road leading to the caravan park and thence to the sea. This whole area between the railway line and the sea is virtually flat, meaning that flow rates in this part of the sewer/ditch system are always low. Consequently, high rainfall can rapidly lead to surface water sewers surcharging, which is exacerbated whenever the outfall is tide-locked. This was the cause of several houses in the area suffering internal flooding during the winter of 2000/2001.

*The **Swalecliffe Brook*** rises close to the A290 midway between Blean and the Thanet Way at Whitstable and then runs in a northerly direction for just over 8km until it reaches the sea at Long Rock, Swalecliffe. However a sequence of ditches can claim to extend the source of the Brook several kilometres further inland. Most of the Swalecliffe Brook's course is through fields and woodlands so any flooding has little impact on roads or houses. However, properties backing onto the watercourse at Chestfield and through the built-up area of Swalecliffe, north of the Herne Bay Road, are vulnerable to flooding.

The Brook is carried under the earth-bund coast protection at Long Rock in a culvert fitted with two sluice gates (both operated by Canterbury City Council). The winter of 2000/2001 showed that even with both sluices fully open, the flow in the Brook was so great that the culvert formed a constriction which prolonged the upstream flooding across the playing fields. This problem was addressed in 2002 by installing three, 900mm diameter pipes through the earth bund near the culvert, each fitted with a flap-valve on its seaward side. After the bund, the Brook enters the Long Rock Site of Special Scientific Interest.

Over the last few decades the mouth of the Swalecliffe Brook has been gradually pushed to the west as a spit of beach shingle is slowly extended by the natural east-west littoral drift. Generally there is sufficient flow in the Brook to keep the mouth clear but low summer flows mean that from time to time it is completely blocked by shingle and has to be cleared by machine. These works are undertaken by the Environment Agency.

*The **West Brook*** rises in Thornden Wood and, after just over 5 kilometres, reaches the sea at Hampton Pier Avenue. Most of its course lies through fields and woodlands but when the West Brook emerges from under the A2990 (the old Thanet Way) and the railway line, it enters the urban area of Studd Hill – Hampton, where properties adjacent to the brook are at risk of flooding. At its mouth the West Brook is carried under the concrete seawall by a short culvert, which is controlled by a sluice gate operated by Canterbury City Council. As well as some houses at Hampton, infrastructure is also vulnerable to flooding from the West Brook. A 500m section of Whitstable Road/Sea Street was inundated in April 2001 including the Sea Street / Hampton Pier Avenue junction, which caused considerable disruption to traffic. The bridge providing access into the Studd Hill Estate over the West Brook from Hampton Pier Avenue is also vulnerable.

*The **Plenty Brook*** rises on the northern edge of West Blean Woods and runs slightly east of north for some 11 kilometres until it discharges to the sea at Herne Bay, close to the Clock Tower. For the majority of its length it runs in a natural open channel but once entering a culvert to pass under the railway line it stays underground for 1.5km, all the way to its outfall.

The culvert follows the line of Cherry Gardens, Dering Road, Beach Street and finally the alleyway that runs diagonally from Mortimer Street to Central Parade. The outfall is controlled by a sluice gate operated at the Neptune car park. The culverted section is a designated Southern Water public surface water sewer and is a brick lined structure of between $2m^2$ and $3m^2$ cross sectional area.

There are a number of surface water inlets to the culvert draining parts of the built up area of Herne Bay. Consequently, when the culverted section is running at full capacity, road gullies and manhole covers can begin to surcharge causing localised flooding to roads.

Serious flooding from the Plenty Brook occurred in April 2000 and February 2001 as a result of storm events estimated to have a return period of between 10 and 20 years. These storms resulted in a large number of properties being flooded, both north and south of the railway culvert. This was mostly attributed to intense rainfall over a short time generating such a high run-off that the culvert mouth leading the Plenty Brook under the railway was unable to cope.

As a result of these events, numerous improvements have been made to the watercourse. The main ones were the construction of two new storage lagoons, one on line and one off line, at the Herne Bay Golf Club and increased capacity to existing storage reservoirs. These improvements are designed to reduce the flood risk from the river to Herne Bay and Eddington and now provide a standard of protection between 1 in 50 and 1 in 100 years.

7.3 Flooding from Surface Water Run-off and Overland Flow

Overland flooding typically occurs in natural valley bottoms as normally dry areas become covered in flowing water and in low spots where water may pond. This flooding mechanism can occur almost anywhere, but is likely to be of particular concern in any topographical low spot, or where the pathway for run-off is restricted by terrain or man-made obstructions. Parts of the District, especially at Whitstable, Herne Bay and north Canterbury are potentially vulnerable to this type of flooding. There are also a number of villages situated within valleys or at the base of hills that are also at risk and have been flooded by this mechanism in the past. In particular Littlebourne, Bridge and Bishopsbourne, although this problem can occur at many of the villages within the District, particularly affecting isolated rural communities.

Whitstable town centre lies within a valley formed by fairly steep slopes to the south, east and west. The sea borders it to the north. Although there are some individual low spots, the centre generally has a gentle incline towards the sea. Any significant overland flow would therefore disperse eventually to the sea through the town's drainage system. The slopes on the three sides are mainly developed with a surface water sewer network and hence the risk of major overland flow is reduced. There is no historical evidence of any serious flooding in the area as a direct result of overland flow. All the roads within the town centre are drained by a system of highway gullies, which drain to the public sewer network. It is accepted that parts of this system are old and in places localised ponding and blockages in gullies takes place during heavy rain. Kent Highways is aware of the problem areas and maintain the problematic parts of the system more frequently than elsewhere. Although no serious flooding has occurred in recent times as a direct result of overland flow, flood events in winter 2000/2001 and again in August 2007 did cause internal flooding. This resulted from a combination of river flooding and sewer surcharging. The topography of the town has exacerbated the problem and its effects. Those events are described elsewhere in this report.

The situation at Herne Bay is similar, with the town centre lying within a valley formed by fairly steep slopes to the east and west and gentle slopes to the south and the sea to the north. Consequently, during extreme and intense rainfall events there is potential for overland flow to be focussed on the lower-lying areas of this urban catchment. There is also a physical barrier to any overland flow draining naturally to the sea. This is the High Street, which would block the flow from the south and could potentially result in flooding to the lower land immediately to the south of it. As described elsewhere in this report, there has been surface water flooding in lower lying locations but this has been primarily as a result of the sewer network becoming surcharged.

In Canterbury the main potential problem area is the north of the city from Harbledown round to Broad Oak. The problem is exacerbated by non-functioning land drains, poorly maintained minor ditches and unchecked water flow across grassed hillsides. Particular areas where flooding as a result of overland flow has occurred are downhill from Dukes Meadow through to the cemetery, parts of St Stephens immediately below the university grounds and the northern part of Hales Place. As elsewhere, the flooding is often also due to a combination of surcharging and under-capacity

surface water sewers, which themselves lead into the very old sewer system in the older parts of the city.

In rural areas, overland flooding has occurred at Littlebourne and Bridge and has the potential to occur at Barham, Bishopsbourne, Kingston, Sturry, Herne and Petham. All of these villages have suffered some degree of flooding in recent years, often resulting from a combination of road flooding, watercourses flowing out of bank, ground water and springs, as well as water coming off fields.

It is considered that changes to farming practices may well exacerbate the potential for overland flooding in rural areas and on the outskirts of urban areas. Two particular potential causes are the grubbing up of many of the orchards traditional to Kent over the last few decades and the removal of hedgerows and ditches. It is acknowledged that orchards significantly hold up surface water naturally and their removal increases the rate of run-off from fields. The reduction in hedgerows and ditches has meant that water is not so well channelled, flow downhill increases and often this can be very silt laden, thus quickly blocking gullies and drains.

A further perceived cause of increased risk of overland flow is the ploughing of land downhill rather than parallel to the contours of the slope. Very recently, a significant increase in risk may be due to the erection of massive expanses of polytunnels over fields, particularly used for growing strawberries in this District. Unless substantial and effective drainage measures are put in place in conjunction with these practices, then considerable increased surface water run-off from these areas will occur, exacerbating flood risk to downstream areas of the catchment. This needs to be taken into consideration when planning both the erection of polytunnels and any development in their vicinity.

The Historic Flooding map included within Appendix A.3 highlights the locations where surface water flooding has been recorded. However, it should be noted that there may well be other historic flooding locations where no records are held and so those locations are not shown on the map. Ensuring that surface water run-off from new development is controlled in a sustainable manner is an essential part of the flood risk management process and consequently, the NPPF sets out clear guidelines for developers. These have been amplified as part of this SFRA to make sure that surface water management issues specific to the District are taken into account in the planning process. This is discussed in more detail in Section 11 of this report.

It is also essential that the site-specific risks of flooding as a result of surface water or overland flow are considered as part of any site-specific FRA. Such appraisals should take into account the topography and nature of the surrounding land so that potential flow paths can be established. Scheme designs should also be checked to ensure that any potential flow paths through the site are not obstructed such that they could cause water to pond.

In the Flood and Water Management Act 2010 and the Flood Risk Regulations 2009, particular concern is raised with respect to surface water flooding, and measures to prevent / reduce such flooding will be implemented. These are discussed further in Section 11 of this report.

7.4 Groundwater Flooding

Water levels below the ground rise during wet winter months, and fall again in the summer as water flows out into rivers. In very wet winters, rising water levels may lead to the flooding of normally dry land, as well as reactivating flow in 'bournes' (streams that only flow for part of the year). Where land that is prone to groundwater flooding has been built on, the effect of a flood can be very costly, and because groundwater responds slowly compared with rivers, floods can last for weeks or months. Groundwater flooding generally occurs in rural areas although it can also occur in more urbanised areas where the process known as groundwater rebound can cause localised flooding of basements. This increase in the water table level is occurring as a result of the decrease in groundwater extraction that has taken place since the decline in urban aquifer exploitation by heavy industry.

Data on groundwater flooding has been compiled by the British Geological Society (BGS) and is illustrated on mapping, which is the product of integrating several datasets: a digital model of the land surface, digital geological map data and a water level surface based on measurements of groundwater level made during a particularly wet winter. This dataset provides an indication of areas where groundwater flooding may occur, but is primarily focussed on the groundwater flooding potential of the chalk strata of southern England. Chalk shows some of the largest seasonal variations in groundwater level and so is particularly prone to groundwater flooding incidents.

Inspection of the BGS dataset shows that the Stour Valley is an area at high risk of groundwater flooding. The sandstone area to the south and east of the River Stour is classified as being at medium risk whilst the remainder of the District is located within a low risk area. The sands in the centre and north east of the District also have moderate to significant running sand potential, indicating that the lithology is suitable for fluidisation of the sand by the presence of groundwater and that groundwater can be conveyed through the sand. These characteristics mean that groundwater flooding can be of localised importance and consequently, site-specific FRAs will need to investigate any localised risks of groundwater flooding.

In the higher parts of the District the extensive fissures in the Chalk provide considerable storage for groundwater. Groundwater flooding from the chalk bournes (Petham Bourne and Nailbourne) was extensive in the winter of 2000/2001 and there have also been problems as a result of high groundwater levels along the Nailbourne in 2003, 2010, and the winters of 2013/2014 and 2014/15. This is described in more detail elsewhere in this report under historic flooding.

Specific areas of groundwater emergence are at Bishopsbourne, Patrixbourne, Duncan Downs at Whitstable and parts of the south east of the Whitstable town centre and Thurston Park area. It is possible that the problems in Whitstable are due to an underground watercourse as opposed to groundwater flows, although this has not been verified. There have also been reported groundwater

problems in the developed parts of Seasalter, again it is understood that these are more likely due to minor watercourses and drainage ditches that have been in-filled, restricting flow paths.

Although not strictly a groundwater flooding problem, there is also a need to highlight flooding problems in the villages of Chestfield and Blean. At both these villages there has been localised flooding in the past due to a combination of causes. Particularly at Chestfield but also to a lesser extent at Blean, the upper soil geology is a thick layer of stiff London Clay with only a thin band of topsoil / soft clay overlying it. During periods of prolonged winter rainfall the soil becomes saturated resulting in water lying on the surface for long periods of time. There has been considerable development in the past at both these villages and many local ditches and field drains have been filled in or inadequately piped resulting in there being nowhere for the standing water to go.

7.5 Flooding from Sewerage Infrastructure

In urban areas, rainwater is frequently drained into surface water sewers or sewers containing both surface and wastewater known as “combined sewers”. Flooding can result when the sewer is overwhelmed by heavy rainfall, becomes blocked or is of inadequate capacity, and this will continue until the water drains away. When this happens to combined sewers, there is a high risk of land and property flooding with water contaminated with raw sewage as well as pollution of rivers due to discharge from combined sewer overflows.

In the three main developed locations of Canterbury, Whitstable and Herne Bay most of the sewers in the more established areas are combined and, particularly in Canterbury city centre, very old. Flooding from sewers has occurred in all these locations. There has also been flooding from sewers (both foul and surface water) in recent years in the villages along the Nailbourne valley, at Blean, Fordwich, Chestfield, Lower Herne, Eddington, South Street (Whitstable), St Thomas Hill area (Canterbury), Seasalter Cross/Church Lane and Reculver Road in Beltinge. At Fordwich, Chestfield and Eddington extensive works by Southern Water appear to have resolved many of the surcharging problems.

Along the Nailbourne valley, the villages of Bridge, Patrixbourne and Bekesbourne have been worst affected by groundwater and infiltration into the foul sewer causing it to surcharge and the subsequent need to pump the flow from sewers into the Nailbourne. Properties immediately adjacent to the river have suffered flooding.

Southern Water undertook a detailed investigation into this problem in 2013, surveying over 10 kilometres of sewers. A total of 3.5 kilometres of sewer repairs have resulted from this investigation. Southern Water has stated that they will continue to monitor the situation and will undertake remedial work where necessary to mitigate the risk of future drainage issues.

In Whitstable, there have been three incidences of flooding from sewerage infrastructure since 2000. In each case, very heavy rainfall over a short period of time has overwhelmed the system with local drains being unable to cope and flooding to property resulting, some of which has been contaminated with effluent. On each of these occasions there have been problems with the sea

outfall pumping station at the Gorrell Tank and also high flows in the Gorrell Stream. The worst affected locations have been in the area just south of the Gorrell Tank, which is very low lying, but other parts of the town at a higher level and also some distance from the outfall, have been affected. Generally the risk of flooding from sewers in Whitstable is moderate, however, the lower parts of the town close to the seafront are at an increased risk.

In the town of Herne Bay there had been occurrences of regular surcharging of the combined sewer system and localised flooding up to the early 1990s, when a new tank sewer and pumping station was constructed. Whilst this significantly reduced the problem, there have been localised flooding incidents from the sewer system on a number of occasions since that time with a more widespread event in September 2010. It is considered that these events were largely due to a combination of human error and mechanical failures of equipment and in theory the risk of flooding from sewers in Herne Bay is low.

Despite the age of much of Canterbury's sewerage infrastructure, the instances of sewer flooding have been quite low in the city and usually combined with exceptionally high flows in the River Great Stour. Apart from some known trouble spots, which would require detailed investigation for any proposed development, the risk of flooding from sewers in the city is considered to be low.

In the village of Blean the public sewers have a limited capacity to manage heavy rainfall. For any future development, there is a need to carefully consider surface water disposal with attenuation probably required for even small sites and the possibility of the use of deep bore soakaways.

7.6 Flooding from Reservoirs and Artificial Waterways

Non-natural or artificial sources of flooding can include reservoirs, canals and lakes where water is retained above natural ground level. Operational and redundant industrial processes including mining, quarrying and sand and gravel extraction, are also important as they may increase floodwater depths and velocities in adjacent areas. The potential effects of flood risk management infrastructure and other structures also need to be considered. Reservoir or canal flooding may occur as a result of the facility being overwhelmed and/or as a result of dam or bank failure. Also, any man-made drainage system such as a drain, sewer or ditch could potentially cause flooding.

There are no potable water reservoirs within the District nor are there any artificial waterways such as canals. There are, however, a number of impounding or storage reservoirs or balancing lakes that have been constructed to reduce downstream flood risk on watercourses. When the A290 (new Thanet Way) was built in 1998/1999 balancing lagoons generally of size up to 5,000m^3 were constructed at Swalecliffe, Greenhill and Eddington to attenuate the surface water run-off from the road. At Eddington there are 26,000m^3 (Southern Water), 35,000m^3 (Environment Agency) and 10,000m^3 (privately owned) balancing lagoons to attenuate the flow of the Plenty Brook.

Following flood events in Ashford in 1985 and 1986, the Aldington and Hothfield reservoirs were constructed in 1989 and 1991 respectively. These are designed to protect approximately 300 properties downstream of Aldington and Hothfield to a 1 in 100 year design standard. Although

these reservoirs do not have a direct impact on properties within the Canterbury District, they have a strong influence on the flow within the Great Stour as far downstream as Wye.

All of the above only begin to fill at times of heavy rainfall and have restricted outlet devices, but also have bypass mechanisms to prevent excessive overtopping of their banks. They are all of fairly recent construction and designed to minimise the risk of rapid flooding to property downstream from them.

Further to the above, there is a large balancing pond/lake on the Nailbourne with dam and controlled outlet at Bourne Park (near Bishopsbourne). Its structural condition is unknown but any failure would be likely only to result in flooding to farmland with no property immediately at risk.

There are also numerous artificial lakes throughout the District but the large ones are mainly just off the Stour between Chartham and Thannington and at Fordwich and Westbere. These are all old sand/gravel workings and, as such, are excavations below surrounding ground level with no embankments or control structures apart from some minor weirs. It is not considered likely that these lakes would themselves cause flooding and they can actually help to attenuate surface water and watercourse flow. However, during exceptionally wet weather these lakes can fill to overflowing and add to any risk of flooding from groundwater and overland flow.

8 Flood Risk Management Practices

8.1 Existing Sea Flood Defence Infrastructure

Over 10km of the District's 21km coastline is low-lying, which, without the protection of the existing sea defence infrastructure, would be inundated on a regular basis. With the exception of the agricultural land at the east and west, the land behind the defences is highly developed and includes the towns of Whitstable and Herne Bay.

In order to protect these developed areas, sea defences have been constructed along the entire length of the District's low-lying frontage. These are extensive formal defences - mainly comprising a concrete seawall, fronted by a large shingle beach, kept in place by timber groynes.

Figure 8.1 - Sea defences under construction at Herne Bay in 1990

The beaches, as well as protecting the seawall against wave attack and undermining, also contribute to the overall level of protection by considerably reducing the amount of wave overtopping. The groynes are generally close spaced to ensure that a sufficient volume of beach is maintained within each groyne bay. At the majority of locations there is a relatively stable beach. The beaches are monitored at least three times every year as part of the Regional Strategic Coastal Monitoring Programme and the data analysed regularly to ensure the profile of the beach remains within the design limits.

The Council has an annual beach recycling contract to deal with any areas where the beach is eroding. It also has an adequate annual maintenance budget to repair groynes and the seawall and

to make minor improvements. Over the last twenty years, major capital projects have been carried out to bring all defences protecting developed areas up to the 1 in 200 year design standard. There is also a long-term capital programme for further improvements to the defences, which mainly comprises of raising seawalls, to sustain this standard of protection in line with projected rising sea levels.

Sections 4.3 of this report describes the four Flood and Coastal Erosion Risk Management Strategies covering the short, medium and long term proposals to maintain and improve the sea defences over time, and also the Council's approved Policy Statement on Flood and Coastal Defence. These all reiterate the need for, and the Council's commitment to, continued maintenance of the defences and planned beach replenishments where necessary. The strategy reports also highlight the need for the raising of seawalls in some locations by up to 0.7m, probably in 20 to 30 years' time. That work is included in the overall costs for schemes that are in the Environment Agency's Medium Term Plan. It should be noted that the costs for raising seawalls is relatively low and could be covered from the Council's maintenance budget if carried out in stages, should Central Government funding be limited in the future.

The coastal flood defence assets along the District's coastline are identified on the map in Appendix A.4. All relevant data, including type and construction, standard of protection, crest height, condition etc. is summarised in the accompanying Table A.4.1 also in Appendix A.4.

8.2 Existing River Flood Defence Infrastructure

With the exception of the various floodwalls and sluice gates on the Great Stour through Canterbury's city centre, there are very few physical flood defence structures on the watercourses in the District. However, many of the watercourses within the District have benefited from flood alleviation schemes and various improvement works over the last twenty years, particularly after the 2000/2001 and 2014/2015 floods. Due to the nature of these schemes it is more appropriate to describe these within the main document rather than highlighting on a map. The key information is therefore summarised in Table 8.1 below.

Watercourse	Improvement Works Undertaken
Great Stour	Construction of major flood storage reservoirs upstream of Ashford at Hothfield and Aldington in 1990 which improved the standard of protection to 1 in 100 years (single event) through Canterbury (see also Section 5.5 of this report). Minor improvements to weed screens, sluices and weirs through the city centre, particularly at Barton Mill, since 2000. Programme of river training works including dredging and bank cutting back downstream of Fordwich to improve flow. Repairs to river walls are complete in Wickhambreaux and nearing completion in Stodmarsh and Grove.
Nailbourne	Recutting of banks and watercourse bed throughout the reach from Barham to Bishopsbourne to improve flow and remove obstructions. Flood walls and new weed screens at Barham. New, improved capacity, road culverts at Barham, Kingston and Bishopsbourne. Major capital project on river at Bridge in 1995. New diversion channel, deepening of ford and other works at Patrixbourne. New floodgate at Brewery Lane ford. Construction of a new drain from The Street at Bishopsbourne through to the Nailbourne. Demountable flood barriers to keep the Nailbourne in its course at Derringstone. Short length of earth bunding at The Street in Barham. Clearance of the Blackhole Dyke upstream of Wickhambreaux. Reinstatement of the damaged river bund on the Nailbourne at Bridge. An extension of the riverside bund at Bridge, to prevent a reoccurrence of the river coming out of the bank and flowing down Brewery Lane.
Little Stour	Flood relief diversion channel from Littlebourne to Wickhambreux. Removal of obstructions and improved maintenance to channel downstream of Littlebourne. Penstock to control flows between the Little Stour and Blackhole Dyke (Summer 2016). Repairs to the bund beside the Little Stour at Littlebourne. Work on a more easily cleared weed screen at the existing culvert at Wickham Lane.
Gorrell Stream	Improved regime and additional pump by Southern Water at the Gorrell Tank outfall. New weed screen at entry to piped section. Clearing out of channel and removal of obstructions plus improvement works by EA commenced in September 2010.
Kite Farm Ditch	Re-cutting of banks and watercourse bed through majority of open section plus weed screen improvements works by EA commenced in September 2010.
Swalelciffe Brook	A second outfall structure constructed alongside existing outfall to double discharge capacity to the sea (Refer to Figure 8.2 below).
Plenty Brook	New outfall structure as part of sea defence improvements in 1990. Clearance of obstructions and minor improvements to piped section by Southern Water. New weed screen and channel improvements at Eddington. Full clearance and extension to total 26,000m^3 capacity of Southern Water holding reservoir at Eddington. Improvements to capacity of Kent Highways A299 balancing lagoons. New 35,000m^3 online balancing lagoon at Bullockstone and 10,000m^3 offline holding lagoon below Herne.

Table 8.1 - Recent Improvement Works to Rivers within the District

Figure 8.2 - Improvement to the Swalecliffe Brook Outfall

8.3 Emergency Planning and Response

The Council has defined responsibilities under the Civil Contingencies Act 2004 to assess risk, and respond appropriately in case of an emergency, including a major flooding event. The Council's primary responsibilities are:

- to assess the risk of an emergency occurring;
- to assess the risk of an emergency making it necessary or expedient for the person or body to perform any of their or its functions;
- to maintain plans for the purpose of ensuring, so far as is reasonably practicable, that if an emergency occurs the person or body is able to continue to perform its functions;
- to maintain plans for the purpose of ensuring that if an emergency occurs or is likely to occur the person or body is able to perform its functions so far as necessary or desirable for the purpose of preventing the emergency, reducing, controlling or mitigating its effects, or taking other action in connection with it.

To meet the requirements of the Civil Contingencies Act the Council has produced a Local Multi-Agency Flood Plan. The purpose of the plan is to set out all the principles that will govern the multi-agency response to a significant flood event in the Canterbury District. The plan sits underneath the Pan Kent Multi Agency Flood Plan. The SFRA provides a summary of the sources and

mechanisms of flooding within the District and may therefore be used to inform the assessment of flood risk in response to the requirements of the Act.

If flood warning systems are to have any value they must give people sufficient notice so that they can make appropriate and timely preparations and responses in order to reduce the resultant damage and distress. For Canterbury District this is achieved through District flood emergency plans. At the District level, the main emergency response is carried out by Canterbury City Council with back-up from Kent County Council's emergency planning department and the emergency services. The essence of the plans, and in particular what will actually be done and the systems that are in place to do it, is given in the Kent County Council document "Co-ordination Plan for Major Emergencies" and the Canterbury City Council documents "Major Emergency Plan" and "Flood Emergency Plan".

The Council has a duty engineer standby system set up to respond to flood warnings and flood emergencies. There are 12 engineers on the duty standby team and one of these, by rota, is always on duty such that there is cover 365 days a year and 24 hours a day. Because of the size of the team there will always be a number of engineers who are not on duty but who would also be available to respond to a call should the need arise. On top of this, there are other engineering staff, not on the duty rota, that are available to assist at relatively short notice. The majority of the duty standby team are experienced coastal engineers who have been on the team for a long time. Considerable experience of actual emergency flood conditions and actions was gained as a result of the significant flooding and numerous Severe Flood Warnings during the fluvial flood events of winter 2000/2001 and winter 2013/2014. The duty engineers receive warning information from the Council's central control, which is permanently manned by at least two persons.

When a Flood Alert is issued, the duty engineer will ensure, by visual inspection, that all appropriate floodgates in the seawalls are properly closed and, if they are not, make arrangements to have them closed. The duty engineer can monitor actual sea conditions using data from a wave and tide recorder on Herne Bay Pier, which can be obtained online in real time, and take any further action deemed appropriate. This may include upgrading the local Flood Alert to a Flood Warning.

If conditions deteriorate, the Council's Major Emergency Plan is activated. This plan sets out all the necessary actions to be taken including action by the Council's emergency response contractor, evacuation procedures and the setting up of emergency rest centres. There is a specific Sea Flood Emergency Plan, which is updated annually, with particular reference to actions needed during sea flooding. A similar system is also in place for river flooding with procedures for opening river sluice gates and monitoring river levels. There are river level sensors on both arms of the Stour through the centre of Canterbury, which will automatically give a warning to the duty engineer if the level is above the set alarm value.

8.4 Flood Warning

The Environment Agency monitors rainfall, river levels and tides, as well as employing state of the art forecasting techniques. Based on the information received from these flood warning systems, Flood Warnings are issued using a set of three codes, each indicating the level of risk with respect to flooding. The warnings issued are as follows:

The Environment Agency changed the flood symbols in November 2010 and updated the warning messages so they are easier to understand, providing more local information and giving clearer guidance about what people need to do. The updated Environment Agency flood warning service now has three types of warnings that will help prepare for flooding and take action (Table 8.2). They are:

- Flood Alert
- Flood Warning
- Severe Flood Warning

Flood warning procedures are in place for the following locations within the District.

- Coast from Kemsley to Seasalter
- Coast from Whitstable to Herne Bay
- Swalecliffe Brook
- West Brook
- The Great Stour from Shalmsford Street to Thanington including Chartham
- The Great Stour at Canterbury
- The Great Stour at Fordwich and Sturry
- The Nailbourne
- Little Stour

	What it means	When it's used	What to do
	Flooding is possible. Be prepared.	Two hours to two days in advance of flooding.	Be prepared to act on your flood plan. Prepare a flood kit of essential items. Monitor local water levels and the flood forecast on our website.
	Flooding is expected. **Immediate** action required.	Half an hour to one day in advance of flooding.	Move family, pets and valuables to a safe place. Turn off gas, electricity and water supplies if safe to do so. Put flood protection equipment in place.
	Severe flooding. **Danger to life.**	When flooding poses a significant threat to life or significant disruption to communities.	Stay in a safe place with a means of escape. Be ready should you need to evacuate from your home. Co-operate with the emergency services. Call 999 if you are in immediate danger.
Warnings no longer in force	No further flooding is currently expected in your area.	When river or sea conditions begin to return to normal.	Be careful. Flood water may still be around for several days. If you've been flooded, ring your insurance company as soon as possible.

Table 8.2 - Environment Agency Flood Symbol Guidance for Residents

Further information relating to the flood warning areas and procedures can be found on the Environment Agency's website.

9 Flood Risk Modelling

9.1 Overview

One of the primary objectives of the SFRA is to refine the quality of flood risk information available to decision makers so that planning decisions can be better informed. Without detailed analysis of flood risk, the only available information is the Environment Agency's Flood Zone mapping; however, this is far too coarse and does not recognise the presence of the existing flood defences. Consequently, as part of the SFRA, detailed numerical flood modelling has been undertaken to analyse the risk of flooding and quantify the impacts of flood events that may occur as a result of a breach or overtopping of the sea defences or banks of the River Great Stour.

In order to quantify the consequences of a flood event along the coastline and from the River Great Stour, numerical modelling was undertaken in 2008 to inform the SFRA (Hydraulic Modelling and Flood Risk Mapping of the Great Stour – Canterbury, Herrington Consulting, November 2008). The modelling methodologies are explained further in the following sections, and the results of the 1 in 100 year (including an allowance for climate change) run are plotted on the series of District wide maps, located in Appendix A.5 of this report.

Since the completion of this modelling, the Environment Agency has published the Great Stour Flood Risk Mapping Study (2013). Although the results of this modelling are considered to supersede those of the flood mapping study undertaken by Herrington Consulting previously, the mapped extents for the 1 in 20 year event should be interpreted with caution. In particular, for the City Centre, the 1 in 20 year flood extents from the Herrington Consulting study (Appendix A.2) should be used in place of the Environment Agency results. Refer to Section 3.6 for further details.

9.2 Coastal Modelling - Breach Analysis

Through discussion with the Council's Engineering Team and the Environment Agency, locations for potential breaches in the flood defences have been identified. These locations were chosen on the basis of defence type, condition, exposure and the likely consequences of a breach. All breach scenarios were run using the 1 in 200 year extreme sea levels for both current day and with an allowance for climate change for the year 2110.

At each breach location, the specific characteristics of the defence infrastructure and the immediate hinterland have been examined. This information was then used to determine the size and nature of the breach used in the model. The breach characteristics are summarised in Table 9.1 below for each location. The location of each breach is shown on the maps included in Appendix A.5 of this report.

Code (refer to App 5)	Modelled Breach Location	Description	Width (m)	Breach Invert mAODN	Time breach open (Hrs)	Defence Crest Height [2010] mAODN	Defence Crest Height [2110] mAODN
S1	Seasalter (west)	Full breach	50	3	30	6.0	6.0
S2	Seasalter (east)	Full breach	50	2	30	5.5	5.5
W1	Whitstable Tennis Courts (east)	Full Breach	20	2.9	30	5.8	6.5
W2	Whitstable Harbour (east)	Open Flood Gate	6	5	30	5.8	6.5
H1	Herne Bay Central	No breach – overtopping only	-	-	-	5.8	6.5
R0	Reculver (west of Towers)	No breach – overtopping only	-	-	-	6.4	6.4
R1	Reculver (west)	Full Breach	100	2.5	30	6.7	6.7
R2	Reculver (east)	Full Breach	100	2.5	30	6.7	6.7

Table 9.1 - Breach locations and characteristics

9.3 Wave Overtopping

As well as flooding resulting from a breach in the coastal flood defences, some of the low-lying areas of the District are also at risk from wave overtopping. During an extreme storm event the combination of high water levels and large waves can result in significant volumes of water overtopping the seawalls as waves break against and over the defences.

In order to ensure that the flood risk modelling undertaken as part of this SFRA is representative, it is therefore necessary to include the impacts of wave overtopping within the overall breach and flood propagation modelling. Analysis locations were chosen on the basis that they would be subjected to wave overtopping under extreme conditions and were generally areas where breaching of the sea defences would be unlikely because of the nature of the defences and hinterland.

Beach and structure profiles were derived using survey data taken from the Southeast Strategic Regional Coastal Monitoring Programme and from information provided by the Council's Engineering Team. The peak overtopping rate was then used to derive an input hydrograph of overtopping volume that is representative of a typical storm duration of a single tidal cycle. This was then applied along a linear boundary, equivalent to the length of frontage over which overtopping was modelled. The locations of the overtopping frontages are shown on the maps included in Appendix A.5 of this report. A summary of the overtopping boundary conditions used is given in Table 9.2 below.

Code	Modelled Overtopping Location	Description	Over-topping boundary length (m)	Time Applied (Hrs)	Over-topping Rate [2010] l/s/m	Over-topping Rate [2110] l/s/m	Defence Crest Height [2010] mAODN	Defence Crest Height [2110] mAODN
SOT1	Seasalter Overtopping (West)	Wave overtopping	5029	1 tide	8	Overflow	6.0	6.0
SOT2	Seasalter Overtopping (East)	Wave overtopping	792	1 tide	8	Overflow	5.5	5.5
WOT1	Whitstable Overtopping	Wave overtopping	1852	1 tide	1	18	5.8	6.5
WOT2	Whitstable Overtopping	Wave overtopping	511	1 tide	1	18	5.8	6.5
SCliffe WestOT	Swalecliffe Overtopping	Wave overtopping	312	1 tide	Overflow	Overflow	5.0	5.0
SCliffe EastOT	Studd Hill Overtopping	Wave overtopping	2270	1 tide	0.1	5	6.7	6.7
HampOT	Hampton Overtopping	Wave overtopping	368	1 tide	9	140	6.2	6.2
HOT	Herne Bay Overtopping	Wave overtopping	1110	1 tide	0.2	13	5.8	6.5
ROT1	Reculver (west) Overtopping	Wave overtopping	181	1 tide	18	500	6.4	6.4
ROT2	Reculver (east) Overtopping	Wave overtopping	4666	1 tide	2.3	63	6.7	6.7

Table 9.2 - Overtopping frontages and characteristics

9.4 Modelled Scenarios at the Coast

As well as identifying the location and characteristics of each breach and overtopping site, the likelihood of combined events has also been taken into consideration. Whilst a comprehensive probabilistic assessment has not been undertaken, a pragmatic and precautious approach has been adopted.

Whilst the NPPF promotes a precautionary approach to flood risk management, it is also necessary to ensure that the SFRA presents a realistic appraisal of risk and this ethos is important when considering the number of breaches and wave overtopping events that could occur concurrently.

In order to achieve the correct balance between precaution and realism, the likelihood of combined failures and overtopping events has been discussed with both Environment Agency and Council Engineers. The outcome of this process was a matrix of the individual overtopping and breach events that have then been combined to represent the impact of a storm event on each of the north Kent coast towns within the District. It has been assumed that both breach and wave overtopping events would occur concurrently and a summary table (Table A.5.1) showing the matrix of combined events for each town/frontage is included in Appendix A.5.

9.5 2D Hydrodynamic Model Set-up

The software package that has been used to undertake the breach and wave overtopping analysis was TUFLOW (version 2009-07-AF-iSP), which is a two-dimensional finite difference flood simulation model. The TUFLOW model operates within the Surface Water Modelling System (SMS v10.1.1), which is a comprehensive environment for one, two, and three-dimensional hydrodynamic modelling.

The TUFLOW model utilises a three dimensional digital elevation model (DEM) that is created from spot height data and uses this to model the propagation of floodwater across a defined landscape. The data used to create the DEM in this instance was the Environment Agency's Lidar data, which was supplied at a 2m resolution for the entire study area.

The model boundaries were set to include the entire area shown within the Environment Agency's Zone 2 flood risk area (from 2011) within the Canterbury District (coastal) boundary. To ensure that the model domain was representative, the coverage was also extended to include parts of the Swale and Thanet Districts. This allows floodwater to propagate to the physical boundaries of the floodplain rather than 'glass walling' against the District boundary line. From the DEM, a 2D grid with points every 10m was then created for use in the TUFLOW model. This resolution gives a reasonable representation of the geographical features within the model and was considered to be the optimum balance between model performance and computer processing time.

Each model was run for a minimum time of 30 hours (simulated) for frontages including breach scenarios and a minimum of 10 hours (simulated) for frontages with overtopping boundaries only.

9.6 Modelling Outputs

Flood extents maps have been produced for both the current climate, and future climate conditions, and these are included in Appendix A.5. Due to the complexity and scale of each of the modelled flood compartments, it is not possible to show the predicted depth and velocities within the SFRA at a scale that will allow this data to be interpreted at a site-specific scale. However, for each of the 10m grid cells, information on flood depth and velocity has been recorded for every 10 second interval throughout the entire 30 hour model simulation.

Consequently, in order to maximise the value of this information and facilitate the appraisal of flood risk at a strategic level, the use of hazard mapping has been adopted within the SFRA.

The Hazard Maps provide a graphical representation of the hazards associated with flooding, expressed as a function of depth and velocity. In the report 'Flood Risks to People' (R&D output FD2320/TR2) a methodology for quantifying flood hazard is set out using the following equation:

$$HR = ((v + 0.5)\, d) + DF$$

where, *HR* = flood hazard rating

d = depth of flooding (m)

v = velocity (m/sec)

DF = debris factor (as defined and evaluated in report FD2320/TR2)

The depth and velocity outputs from the breach analysis have therefore been processed for every one of the 14 modelled scenarios to give a hazard rating for each of the 10m grid cells contained within the model. The value associated with each cell is then used to assign a Hazard Rating based on the four hazard classifications shown in Table 9.3.

Hazard Rating (HR)	Degree of flood hazard	Description
< 0.75	Low	Caution – shallow flowing water or deep standing water
0.75 to 1.25	Moderate	Dangerous for some, i.e. children – deep or fast flowing water
1.25 to 2.5	Significant	Dangerous for most people – deep fast flowing water
> 2.5	Extreme	Dangerous for all – extreme danger with deep and fast flowing water

Table 9.3 - Classification of Hazard Rating Thresholds

Assessing the risk of flooding as a degree of hazard allows a simple and robust method of risk analysis across the entire district. Also, because of the way in which the hazard classifications are derived, it is possible to combine the outputs of all modelled scenarios to give a single hazard map that is representative of hazards associated with each of the modelled scenarios. Whilst this process allows the flood risk information from all scenarios to be collated into a single map, it does not result in the hazard rating being increased as a consequence of two exclusive events affecting a single site.

For instance, if a particular site has a hazard rating of 1.0 from Scenario A and 1.0 from Scenario B, the combined hazard rating is 1.0. However, if the same site were to be affected by a third scenario which resulted in a hazard rating of 1.5, the combined product of the three would be 1.5.

The Hazard Maps for both the current day and future climate change conditions are included in Appendix A.5 for all flood risk areas that have been hydraulically modelled as part of this SFRA process.

9.7 Fluvial Modelling – The River Great Stour

In conjunction with the coastal modelling that has been undertaken for the district, there has also been a requirement to identify the potential risk of flooding as a result of an extreme fluvial event in the River Great Stour, which runs through the centre of Canterbury.

A separate flood risk mapping and hydraulic modelling study was commissioned by Canterbury City Council in 2008, which identified the risk of flooding to Canterbury City from the Great Stour for a range of return periods (Hydraulic Modelling and Flood Risk Mapping of the Great Stour – Canterbury, Herrington Consulting, November 2008). The model was constructed using a 1D hydraulic model embedded within a 2D hydrodynamic model and the following return period events were tested, all of which were simulated for a period of 100 hours;

(a) 1 in 5 year flow conditions (current day)

(b) 1 in 20 year flow conditions (current day)

(c) 1 in 50 year flow conditions (current day)

(d) 1 in 100 year flow conditions (current day)

(e) 1 in 100 year flow conditions (plus climate change to 2110)

For the purposes of the SFRA, the outputs from the modelling for scenarios (d) and (e) above have been plotted on the district wide maps located in Appendix A.5., with the results delineating the flood hazard rating for the Great Stour. It should be recognised that the current flood defence infrastructure along the river was included within the model setup and therefore, these maps represent a “defended” scenario.

It is recognised that since the first publication of the SFRA in 2011, this modelling study has since been superseded by the Great Stour Flood Mapping Study (2013), undertaken by the Environment Agency. However, following discussions with the Environment Agency it was agreed with Canterbury City Council that the Herrington Consulting model should be used to determine a more realistic representation of the extent of the functional floodplain for use within site specific FRAs. This consultation process is described in more detail in Section 3.6 and the 1 in 20 year outputs can be found in Appendix A.2.

10 Guidance for Site Specific FRAs

10.1 When is a Site-specific FRA Required?

The role of the site specific FRA is to examine and quantify the risk of flooding to a particular site or development. However, the FRA also has to consider the impact that the proposed development may have on flood risk to areas outside of its own boundaries. Consequently, whilst the Flood Zone category is an important factor in triggering the requirement for a FRA, it is also necessary to consider areas of the District in which development could result in the exacerbation of flooding elsewhere.

A description of the flood zones and the specific circumstances that will require a planning application to be accompanied by a site-specific FRA are summarised below. However, for more general guidance on FRA requirements provided by Environment Agency can be accessed from the following link:

https://www.gov.uk/guidance/flood-risk-assessment-for-planning-applications

Flood Zone 1 – Low probability of flooding – This zone is assessed as having less than a 1 in 1000 probability of river or sea flooding in any one year.

> *If the site is less than 1 hectare then a site-specific FRA will only be required if it lies within an area defined by either the Critical Drainage Area or the Overtopping Hazard Zone. The exception is if the site is identified by the Council as being at risk from specific critical drainage problems, or is located within 20m of a main river.*

Flood Zone 2 – Medium probability of flooding – This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding or between 1 in 200 and 1 in 1000 probability of sea flooding in any one year.

> *A site-specific FRA will be required and this will need to be prepared in accordance with the requirements set out in paragraphs 30 - 32 and 68 of the Planning Practice Guidance: Flood Risk and Coastal Change.*

Flood Zone 3 – High probability of flooding - This zone comprises land assessed as having a 1 in 100 or greater probability of river flooding or 1 in 200 or greater annual probability of sea flooding in any one year.

> *A site-specific FRA will be required and this will need to be prepared in accordance with the requirements set out in paragraphs 30 – 32 and 68 of the Planning Practice Guidance: Flood Risk and Coastal Change. The requirement for compensatory flood storage needs to be taken into account for developments within the river flood zone.*

Overtopping Zone – As a District that has approximately 21km of shoreline, much of it developed, there is a need to consider the way in which flood risk is managed in those areas that are affected by wave overtopping. The land along the seaward side of Faversham Road, Seasalter is specifically designated as being a Wave Overtopping Zone. This is because even for storms of relatively frequent return period (1 in 10 years and above) there is a risk of flooding due to wave overtopping. For development within this wave overtopping zone, there are hazards associated with localised flooding, structural integrity of buildings and safe access and egress to the buildings. When the impact of climate change is also taken into account, the impacts of wave overtopping on development within this zone will become more severe. Consequently, it is the view of both the Council and the Environment Agency that the SFRA should put in place measures to ensure that development in these locations is appropriate.

The effects of wave overtopping are illustrated by the photograph in Figure 10.1 below, which shows wave overtopping and the onset of localised flooding at an area that is classified as a Zone 1 flood risk area. Given that many areas that are subject to wave overtopping are located within Zones 2 or 3, it is quite possible that the initial or even the total flood extent would be due to wave overtopping and thus the overtopping issues should be dealt with as part of the site-specific FRA. However, for development sites located within 30m of the landward crest of the seawall, it will be necessary for a FRA to be prepared that addresses the hazards specifically associated with wave overtopping.

A site-specific FRA will be required, and this will need to be prepared in accordance with the requirements set out in paragraphs 30 - 32 and 68 of the Planning Practice Guidance: Flood Risk and Coastal Change. In particular this will need to examine the impacts of wave overtopping on the proposed development under current and future climatic conditions.

Figure 10.1 - Wave Overtopping eastern Herne Bay

Definition of the Functional Floodplain in Locations Seaward of the Seawall

The NPPF splits Flood Zone 3 into two sub-divisions: Flood Zone 3a, defined as "*land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any one year*" and Flood Zone 3b, defined as The Functional Floodplain or "*land which would flood with an annual probability of 1 in 20 (5%) or greater in any year, or is designed to flood in an extreme (0.1%) flood, or at another probability to be agreed between the LPA and the Environment Agency, including water conveyance routes*".

There are many locations within the District where there are areas of Flood Zone 3 located seaward of the existing seawall. In some locations the level of the land/beach is above the predicted 1 in 20 year extreme level and could be misconstrued as being classified as Zone 3a rather than in Zone 3b. However, when the potential for beach drawdown and wave run-up is taken into consideration alongside the impacts of rising sea levels it is probable that areas of land/beach that are seaward of the seawall could be affected by wave run-up even if they were above the predicted 1 in 20 year still water level (SWL).

> *All undeveloped areas in front (seaward) of the seawall are therefore defined as being included in the Functional Floodplain (Zone 3b).*

For development that is permitted in the Functional Floodplain (Zone 3b), as set in Table 1 of the *Planning Practice Guidance: Flood Risk and Coastal Change,* the applicant will have to take the following requirements into account:

- The impacts of rising sea levels over the lifetime of the development including the increase in wave height and in other parameters consequent on the rising sea levels.

- The potential for beach drawdown.
- The degree of wave run-up that would occur for a range of wave height and water level combinations.

> ***Development in the Functional Floodplain in Locations Seaward of the Seawall***
> *A site-specific FRA will be required and this will need to be prepared in accordance with the requirements set out in paragraphs 30 – 32 and 68 of the Planning Practice Guidance: Flood Risk and Coastal Change. In particular this will need to examine the potential for beach drawdown under storm conditions and the potential for wave run-up under current and future climatic change scenarios. Flood extents and depths within the site shall be established by taking into account the dynamic nature of the land/beach in front of the seawall and the potential for wave run-up.*

The only development which will be permitted in the Functional Floodplain seaward of the seawall is that listed in Table 2 of the *Planning Practice Guidance: Flood Risk and Coastal Change* under water-compatible development, together with essential infrastructure and works of, or associated with, coast protection and flood control.

Critical Drainage Area – There are no designated Critical Drainage Areas under the Town and Country Planning (General Permitted Development) (England) Order 2015, which introduced the concept of Critical Drainage Areas as "an area within Flood Zone 1 which has critical drainage problems and which has been notified to the LPA by the Environment Agency". However, there are two specific areas where drainage and localised surface water flooding have been a problem for many years. These are at Chestfield and Blean.

At these two locations particular care needs to be taken with regard to the disposal of surface water to ensure that any flooding in the villages is not exacerbated by new development. There are also some smaller individual locations where there have been recurrent surface water flooding problems that any development would need to take account of. All of the known "drainage/flooding hotspots" are shown on the mapping in Appendix A.3.

Particularly at Reculver behind the Northern Seawall, but also throughout much of the rural area close to the Stour, there is land that is drained by man-made watercourses that discharge to the main river or the sea. This drainage network is maintained and managed by the River Stour (Kent) Internal Drainage Board (IDB). At Graveney a similar situation applies with respect to man-made watercourses maintained by the Lower Medway IDB.

Any new development that increases the rate and volume of surface water run-off from a site will have the potential to increase the burden on this heavily managed network of watercourses. If surface water run-off in these areas is not managed appropriately, then there is a risk that the capacity of the pumps and tidal outlets that are used to drain the land will be exceeded. This will

exacerbate the risk of flooding and therefore it is imperative that surface water drainage in these areas is managed responsibly.

In addition, many of the higher areas of the District fall within the upper catchment areas of the main rivers that flow through Canterbury, Whitstable and Herne Bay. These watercourses are already identified as posing a significant risk of flooding. Consequently, in order to ensure that this risk is not exacerbated by increased run-off from new development, specific policies have been developed (Policy CC11).

> *All development applications should include drainage provision. For applications for non-major development, the Council's guidance on the management of surface water run-off from new development should be followed.*

Sites larger than 1 hectare – In accordance with the NPPF and its supporting Planning Practice Guidance, planning applications for development on sites greater than 1 hectare will need to be accompanied by a site-specific FRA even if it is located outside of Flood Zones 2 or 3. This is to ensure that development will not be affected by flooding from other sources such as overland flow or groundwater flooding.

The site-specific FRA will also need to demonstrate, through the development of a Surface Water Management Strategy, that the proposals will not have an adverse impact on flood risk to areas outside of the site boundaries. This SWMS will need be required to adhere to the National Standards for the design, construction, maintenance and operation of SuDS. These Technical Standards (S1 -14) provide additional detail and requirements not initially covered by the NPPF. However, it is recognised that SuDS should be designed to ensure that the maintenance and operation requirements are economically proportionate.

> *The application will need to be accompanied by a site-specific FRA. This will need to include a Surface Water Management Strategy, undertaken in accordance with the requirements of the Lead Local Flood Authority (KCC). The SWMS will also need to demonstrate that, where possible, a sustainable drainage (SuDS) approach has been adopted.*

Development within 20m of a Main River – Applications containing culverting or obstruction to the flow of a watercourse, or works within 20m of the top of the bank of a Main River require a site-specific FRA and consent from the Environment Agency.

> *The application will need to be accompanied by a site-specific FRA. This will need to include design details of the culvert and proposed flow control structure and will require Land Drainage consent from the Environment Agency*

Development within 15m of the landward toe of a tidal defence – Applications containing works within 15m of the landward toe of one of the Environment Agency's tidal defence structures or the Council's sea and coastal defence structures require the consent of the relevant authority and such mitigating works as considered necessary by the authority.

> *Such works will require Land Drainage Act consent from the Environment Agency or Coast Protection Act consent from Canterbury City Council.*

Development within 8m, or connection to an IDB Watercourse – Applications containing culverting or obstruction to the flow of a watercourse, or works within 8m of the top of the bank of an IDB watercourse or including proposals to discharge surface water into any IDB watercourse require the consent of the relevant IDB.

> *In addition to any site-specific FRA that may be required, the applicant will need to consult with the IDB and gain consent for any works within this zone and/or connections to the IDB watercourse.*

10.2 FRA Requirements

The minimum requirements for a FRA are described in paragraphs 30 – 32 and 68 of the *Planning Practice Guidance: Flood Risk and Coastal Change*. The FRA must be appropriate to the scale, nature and location of the development, and consider all possible sources of flood risk, the effects of flood risk management infrastructure and the vulnerability of those that could occupy and use the proposed development.

One of the requirements of both the Exception Test and the Planning Practice Guidance: *Flood Risk and Coastal Change* that the FRA demonstrates that the development will be safe, without increasing flood risk elsewhere. To be classed as safe, there are a number of key requirements that need to be satisfied. These are as follows and shall be based on the flood level with an allowance for climate change being taken into consideration:

- That a safe access route to and from any residential development can be provided or in exceptional circumstances that a safe refuge above design flood level can be provided. The safe refuge shall have a means of escape by which residents can be rescued by the emergency services from a door or freely opening window of sufficient size.

- Living accommodation should be set at least 300mm above the design flood level, unless otherwise agreed by the Environment Agency or stated in the Memorandum of Understanding (MoU).

- Sleeping accommodation should be set at least 600mm above the design flood level, unless otherwise agreed by the Environment Agency or stated in the Memorandum of Understanding (MoU).

For fluvial flooding, the design flood level should be taken as the 1 in 100 year predicted flood level, for tidal and coastal flooding the 200 year return period event should be used. In both cases the impacts of climate change should be included to cover the lifetime of the building, which shall be taken as 100 years for residential and 60 years for commercial developments.

In much of the low-lying parts of the coastal areas of Seasalter, Whitstable, Swalecliffe, Hampton, Herne Bay and Reculver, when the predicted extreme sea levels shown in Table 6.2 are compared with the level of the land, there is a significant difference. However, it is generally not appropriate to use these open sea extremes to predict flood levels in locations that are protected by defences. Consequently, for all coastal flooding scenarios it is recommended that the outputs from the breach and wave overtopping modelling are used to define the design flood level at individual sites.

This information can be provided at a site-based scale and would include depth, velocity and water surface elevation. To obtain site specific outputs from the hydrodynamic model, please initially contact Canterbury City Council for further details. Where site-specific information is not readily available, and the model has to be interrogated, the cost to provide this data will be charged to the applicant.

10.3 Specific FRA Guidance

The Exception Test – As set out in Section 3.5, for the Exception Test to be passed there are two criteria that both must be satisfied. The first criteria (a) relates to the requirement to demonstrate that the development will provide wider sustainability benefits to the community that outweigh flood risk. The second criterion (b) is the requirement that a FRA can demonstrate that the development will be safe and advice on this is given under the sub-headings following this one.

Safe Access Route – With the exception of development on the fringes of the coastal floodplains, it is not possible to provide safe and dry access from a new development located within a coastal floodplain to an area located outside the flood zone. This is of particular concern for potential development of brownfield sites in the larger floodplains within the towns of Whitstable and Herne Bay.

In order to allow development which would otherwise pass all the other requirements of the NPPF, it is necessary in exceptional circumstances to accept alternative arrangements, whereby occupants can seek refuge within the building itself. This will only be acceptable if internal access within the building is available, leading to a suitably sized area that is raised at least 600mm above the predicted 1 in 200 year sea level, including an appropriate allowance for climate change. In addition, the building shall have a means of escape by which residents can be rescued by the emergency services from a door, or freely opening window, of sufficient size. Refer to Appendix A.8 for further details.

Floor Levels – Whilst the use of breach and overtopping modelling has shown that the flood level inland will be much lower than the open extreme sea level, in many cases it will not be possible to raise ground floors above the 1 in 200 year (plus climate change) flood level. Nevertheless, this can

generally be overcome by designing the building to have a floodable ground floor; either residential town house style development with garage, utility and storage areas located on the ground floor, or alternatively buildings with non-residential use, such as commercial or retail use on the ground floor. The Council's specific requirements for finished floor levels for new residential development on brownfield sites in Whitstable and Herne Bay is included within the Memorandum of Understanding, a copy of which is included within Appendix A.8.

Flood Resilient Construction – During a flood event, floodwater can find its way into properties through a variety of routes including:

- Ingress around closed doorways.
- Ingress through airbricks and up through the ground floor.
- Backflow through overloaded sewers discharging inside the property through ground floor toilets and sinks.
- Seepage through the external walls.
- Seepage through the ground and up through the ground floor.
- Ingress around cable services through external walls.

Since flood management measures only manage the risk of flooding rather than eliminate it completely, flood resilience and resistance measures may need to be incorporated into the design of the buildings. The two possible alternatives are:

Flood resistance or 'dry proofing', where flood water is prevented from entering the building. For example using flood barriers across doorways and airbricks, or raising floor levels.

Flood resilience or 'wet proofing', accepts that flood water will enter the building and allows for this situation through careful internal design for example raising electrical sockets and fitting tiled floors. The finishes and services are such that the building can quickly be returned to use after the flood. Such measures are generally only considered appropriate for some 'less vulnerable' uses and where the use of an existing building is to be changed and it can be demonstrated that no other measure is practicable.

In most cases the risk of new development being affected by flooding is very low, nevertheless, by incorporating flood resilience into the design of the building it is possible to reduce both the damage caused by a flood and the repair bill. It can also shorten the time occupants are displaced from their properties due to flood damage. Details of flood resilience and flood resistance measures can be found in the document 'Improving the Flood Performance of New Buildings; Flood Resilient Construction', which can be downloaded from the Communities and Local Government website.

Typical applications that are recommended for residential development located within a flood risk area are as follows:

- Solid concrete floors should be used instead of suspended floor construction as they can provide an effective seal against water rising up through the floor, provided they are adequately designed. Solid concrete floors generally suffer less damage than suspended floors and are less expensive and faster to restore following exposure to floodwater.

- The use of stud walls and plasterboard on the ground floor of new buildings should be avoided wherever possible as these absorb water and generally have to be removed and replaced after a flood event.

- Electricity sockets should be located at least one metre above floor level (or well above likely flood level) with distribution cables dropping down from an upper level. Service meters should also be at least one metre above floor level (or well above likely flood level) and placed in plastic housings.

- Boilers, should be mounted on a wall above the level that floodwater is likely to reach.

- The use non-return valves or 'anti-flooding devices' at the inspection chamber may be considered beneficial. These should only be installed in the sewer of a property upstream of the public sewerage system.

- Demountable defences – There is now a range of products available that can be used to protect properties from flooding and these generally take the form of plastic covers that clip in place over doors, windows and air bricks. The use of such measures should, however, be seen as a method of managing residual flood risk rather than as a primary defence.

10.4 Surface Water Management and Drainage Requirements

It is essential that the runoff from development does not increase risk of flooding either on-site, or elsewhere within the catchment. Re-development of existing sites can provide an opportunity to reduce flood risk by limiting the rate at which runoff is discharged from a site. Policy (C11) of the Local Plan (adopted in 2017) states that all applications for development should include a sustainable drainage system (SuDS). To facilitate this, all applications that are not classified as 'major development' (refer to National Technical SuDS Standards) are required to submit the Council's Drainage Pro-forma, which should be completed in accordance with the Drainage Guidance outlined in Appendix A.7.

11 Sustainable Drainage Systems (SuDS)

11.1 Overview

The NPPF requires that LPAs should promote Sustainable Drainage Systems (SuDS) and ensure that their policies encourage sustainable drainage practices in their Local Development Documents. SuDS is a term used to describe the various approaches that can be used to manage surface water drainage in a way that mimics the natural environment.

The management of surface water which is generated by rainfall falling onto a development site is considered essential in reducing future flood risk to both the site itself and to the surrounding area. Reducing the rate in which surface water runoff is discharged from urban sites is one of the most effective ways of reducing the risk of watercourses and sewers flooding.

In addition, appropriately designed SuDS can be utilised such that they not only attenuate flows but also provide a level of improvement to the quality of the water passed on, e.g. to a watercourses or into the groundwater table. This is known as Source Control and is a fundamental part of the SuDS philosophy. Furthermore, appropriately design SuDS can provide additional biodiversity benefits and can create areas for amenity which help to integrate water into the built environment.

11.2 SuDS at the Planning Stage

At the conceptual stage of the scheme design it is necessary to make an assessment of the way in which the surface water will be discharged from the site and how it will be managed, to ensure the risk of flooding will not be increased. The type of superficial and underlying geology is fundamental in the design process and the selection of the most appropriate SuDS system for a development. There are two variations in SuDS, these are:

- Infiltration SuDS; designed to discharge all, or part of the runoff directly to the ground. This type of system relies on a permeable geology.

- Attenuation SuDS; the drainage system is designed to store runoff onsite, before releasing water at a controlled rate to a watercourse or sewer. This type of system is typically used when infiltration is not a viable option.

It is recognised that large increases in impermeable surfacing can contribute to a significant increase in the volume of surface water that is discharged from a site. Similarly, the rate at which surface water is discharged from a site can also increase significantly if adequate SuDS are not incorporated into a development. One option to avoid the increase in the discharge rate is to attenuate the peak flow using a flow control device, in conjunction with onsite storage, which is designed to hold the water back until the storm event has passed. In some circumstances, where infiltration is available, it may also be possible to minimise the volume of runoff discharged from the development by discharging the runoff directly to the ground.

11.3 Application of SuDS

Part H of the Building Regulations recommends that wherever practicable, appropriate SuDS elements should be incorporated into the drainage system. It also sets out a hierarchy for surface water disposal and infiltration is the preferred method for achieving this. If this is not possible, the next favored option is to discharge runoff to a watercourse. Only if neither of these options are achievable should the site discharge rainwater to a sewer.

A range of typical SuDS features that can be used to reduce the risk of flooding and improve the environmental impact of a development are listed in Table 11.1 below. The table also lists the other potential benefits of each feature and the appropriateness for different sites.

SuDS Feature	Enhancements to Biodiversity	Improvement to Water quality	Suitability for low permeability soils ($k<10^{-6}$)	Ground-water recharge	Suitable for small / confined sites?
Wetlands	✓	✓	✓	x	x
Retention ponds	✓	✓	✓	x	x
Detention basins	✓	✓	✓	x	x
Infiltration basins	✓	✓	x	✓	x
Swales	✓	✓	✓	✓	x
Filter strips	✓	✓	✓	✓	x
Rainwater harvesting	x	✓	✓	✓	✓
Permeable paving	x	✓	✓	✓	✓
Green roofs	✓	✓	✓	x	✓

Table 11.1 – Environmental improvements available through SuDS

In addition to the SuDS features listed above, other options are available to attenuate runoff from a development site, including the use of; underground storage tanks/crates, oversized pipes and flow control devices. These alternative SuDS options are particularly relevant to smaller, confined sites where space is a major limiting factor.

A description of the key benefits of the SuDS features listed in Table 11.1 is given below. For any retention or detention system it is important that the design allows for sufficient capacity to be available at the start of any storm allowing for the possibility that the system may already be partially full from a previous storm event

Wetlands – Provide a range of habitats for plants and wildlife, as well as provide biological treatment. Linear wetlands can also provide green corridors.

Retention Ponds – Open water bodies can significantly enhance the visual amenity of a development and provide opportunities for improvements to wildlife habitats.

Detention Basins – Provide treatment by detention and can be designed as an amenity or offer new habitat for wildlife.

Infiltration Basins – Treatment is provided through detention and filtration. Basins can be any shape, curving or irregular, with scope for improved visual amenity and can have a dual-purpose e.g. sports pitches, play areas, wildlife habitat.

Swales – Generally used to convey water to storage facilities and provide treatment by filtration. Swales are designed to remain dry between rainfall events and can be planted with trees and shrubs to provide green links/corridors. The preferred design will include as much infiltration as the surrounding ground can accommodate.

Rainwater Harvesting – Provides attenuation and allows rainwater to be reused within the development, reducing the pressure on potable water supplies.

Porous and Pervious Paving/Surfacing – Often provides large areas of permeable surfacing which can promote infiltration and can provide a pollution barrier. These types of systems can either infiltrate at source, or alternatively be tanked to provide storage for surface water runoff. On sites that are suitable for infiltration, unlined systems are favoured as these systems can infiltrate large amounts of water due to the large surface area that is in contact with the ground.

Green Roofs – As well as providing improved opportunities for biodiversity, vegetated roofs can help to reduce the volume and the rate of surface water runoff discharged from the development, as well as helping to remove pollution.

From the soil and geology information provided in Section 2, it can be seen that the ground conditions across the District vary greatly. Consequently, the applicability of different types of SuDS will be dependent on the location of each development site. Where ground conditions are suitable, infiltration should be the first choice for discharging surface water, as the benefits of using infiltration as part of a sustainable drainage system include the following:

- Infiltration of good quality surface water helps to recharge the aquifer and may benefit local groundwater use or groundwater dependent ecosystems.
- In naturally permeable soil locations, infiltration may mimic the natural water cycle, otherwise lost during the development process.
- Can significantly attenuate discharge rates.

A high percentage of new development in the District is likely to be concentrated in Canterbury and the coastal towns of Whitstable and Herne Bay. In these locations it is unlikely that infiltration will be an effective method of discharging surface water, however, it should be recognised that the level of detail contained within the geological and soils maps published as part of this SFRA is not always appropriate for site-specific decision making. Consequently, it may be necessary to undertake further site specific investigation to establish the ground conditions in greater detail, before ruling out infiltration as an option.

11.4 Constraints Regarding Discharge to Ground

There are some locations within the District that are shown by the Environment Agency's Groundwater Source Protection Zone map to be located within areas where infiltration is controlled. These are primarily located to the south of Canterbury, and in areas such as Chartham and Barham.

When considering which infiltration SuDS to use in these areas it is important to understand the nature of the aquifer body and the surrounding groundwater levels at the site. The main constraints associated with infiltration in these areas include the contamination from brownfield sites and contamination from road drainage.

It is possible to check whether a site is located within a groundwater source protection zone by referencing Defra's Magic Map website. Whilst development of a site which is shown to be located within a groundwater source protection zone does not preclude the use of infiltration, the following points must be considered:

- Soakaways must not be constructed greater than 3m below the existing ground level.
- In order for water to be discharged to the ground, it must be demonstrated that an unsaturated zone (typically 1m) will be available between the discharge point and the groundwater table at all times of the year. Advice on ground water levels may be available from the Environment Agency.
- Assuming that the above can be satisfied, run-off from roofs will need to be discharged to the soakaway via sealed downpipes. This arrangement must be capable of preventing both accidental and unauthorised contamination of the roof water.
- All discharge must be into a clean and uncontaminated area of natural ground.

12 Policy Recommendations

Canterbury City Council's preferred option for reducing flood risk within its boundaries is to avoid inappropriate development in areas at highest risk within the broad character areas of the District. The planning process should be used to steer more vulnerable development to areas of lower risk and, where development is at higher risk, to ensure that new development is appropriately designed to manage residual risk throughout the lifetime of the development.

This approach fully supports the overarching objectives of the NPPF. The specific policy recommendations that are made by this SFRA to enable the Council to deliver these objectives are as follows:

- To ensure that, in general, new residential development does not take place in areas identified as 'extreme' flood hazard risk by the SFRA climate change hazard maps. Notwithstanding this, the Council will need to ensure that specific provisions are made for residential development to cater for sustainable development within Canterbury city centre and for the redevelopment of Whitstable and Herne Bay town centres. Sites will only be allocated for residential development within Flood Zone 3a where it can be shown that they meet the requirements of the Sequential Test and if necessary, both aspects of the Exception Test. Specific requirements for development in these locations is outlined in the Memorandum of Understanding which can be found in Appendix A.8.

- To ensure that replacement dwellings located within Flood Zones 2 and 3 reduce risk to residents through appropriate design.

- To ensure that flood risk is not increased within the District, any new development will need to be designed such that the peak rate of surface water run-off from the site does not exceed the existing surface water run-off rate. The proposals will also need to meet the requirements of the Council's Drainage Guidance Note and the surface water management strategy recommendations of the NPPF.

- To help reduce the rate and volume of surface water run-off from new development, and to improve the quality of the water passed on to watercourses, new development should incorporate sustainable drainage where practicable (following the principles outlined in the National Technical SuDS Standards).

- Development in some of the District's seafront areas may be located very close to the shoreline and will therefore be subjected to an increased risk of flooding and damage from severe wave overtopping, even if shown to be located outside of Flood Zones 2 and 3. Consequently, any development that is proposed to take place within 30m of the crest of the seawall will require a site-specific Flood Risk Assessment to be submitted. This should be compliant with the NPPF and should address the specific risk of wave overtopping.

- To ensure that all development in Flood Zones 2 and 3 incorporates flood resilient construction techniques. This will reduce the time and cost to recover the building to a habitable standard following a flood event. Specific details are set out in Section 10.3 of the SFRA.

- To ensure that any new development does not have an adverse impact on drinking water resources, by referencing the Groundwater Source Protection Zone maps published by the Environment Agency. The use of rainwater harvesting and grey water recycling systems are also encouraged to reduce the reliance on the District's potable water supply.

13 Conclusions

The Canterbury District is varied, from the historic city of Canterbury itself to the coastal towns of Whitstable and Herne Bay. Alongside these urban centres is the contrasting countryside and rural villages, all of which are exposed to a varying degree of flood risk. The risk of coastal flooding to the low-lying parts of the District does dominates much of this SFRA, however, it is recognised that there is also a history of fluvial and surface water flooding that should not be overlooked, particularly in view of the flood events witnessed in winter 2000/2001 and 2014/2015.

It is possible to manage the risk of flooding from all sources in a sustainable manner and this can be achieved through the implementation of the NPPF, the CCC Local Plan and ensuring site specific assessments (FRAs and DIAs) are undertaken as part of the development process. Re-development of brownfield sites should provide opportunities to reduce overall flood risk, principally through the use of sustainable drainage systems. However, a planning solution to flood risk management should be sought wherever possible, steering vulnerable development away from areas affected by flooding in accordance with the Sequential Test.

The District benefits from a comprehensive and well maintained sea defence system, which has been comprehensively upgraded over the last 25 years. There is an adopted Shoreline Management Plan in place as well as Flood and Coastal Erosion Risk Management Strategies, all of which promote and support the long-term investment and, where necessary, improvements to the flood defence infrastructure in this area. These improvements are designed to keep pace with climate change and future sea level rise. Inland there is an adopted Catchment Flood Management Plan with recommendations to, at minimum, maintain the current standard of flood defence allowing for climate change. The risk of flooding to the coastal towns along the northern coastline of the District has been recognised by Canterbury City Council for many years. In response to coastal flooding and erosion risk management strategies produced and adopted by the Council there is a long term commitment to sustaining the high standard of protection provided by the District's coastal defences.

Notwithstanding this, the NPPF requires the SFRA to adopt a precautionary approach to the appraisal of risk and this has meant that the impacts of residual risk have been examined in further detail. This process has resulted in the analysis of breach and overtopping scenarios and the production of comprehensive flood extent and hazard maps for both current day and for the year 2110, taking into account future allowances for climate change.

Detailed information on flood depth and velocity is now readily available for the densely urbanised coastal towns of Herne Bay and Whitstable. In these areas it is not always possible to locate new development away from the town centre for economic regeneration and other sustainability reasons and therefore, it is paramount to ensure that new development can be delivered safely without increasing the risk of flooding.

Additionally, since the original publication of the SFRA in 2011, a number of Flood Mapping and Modelling studies have been completed which complement the original model results. The Environment Agency has published the 'Great Stour Flood Mapping Study (2013)' and the 'Isle of Sheppey and Oyster Coast Brooks Modelling Study (2014)'. The availability of this detailed, site-specific flood data enables the risks to be better understood and through the use of appropriate design, the potential impacts of flooding can be mitigated.

This SFRA has also provided specific policy recommendations for areas that are not included within the Environment Agency's Flood Zones, such as areas known to have flood or drainage problems and locations that could potentially be at risk from wave overtopping.

For sites that are not identified through the Local Plan process and for windfall sites, the SFRA provides guidance for the completion of site-specific FRAs, as well as setting out policy recommendations to help manage the risk of flooding within the District.

Alongside the development control role of the SFRA, it should be recognised that emergency planning is imperative to minimise the risk to life posed by flooding within the District. The Council is fully cognisant of this and continues to review its civil contingency and emergency response plans, as well as drafting a new Local Multi Agency Flood Plan for the District and annually updating its in-house Flood Emergency Plan.

It is recommended that the Canterbury District SFRA is reviewed regularly and the review should address the following key questions:

- Has any major flooding been observed within the District since the previous review?
- Have any amendments to the NPPF and its accompanying Planning Practice Guidance been released since the previous review and will these impact upon the SFRA?
- Has the Environment Agency issued any amendments to their flood risk mapping and/or standing guidance since the previous policy review?
- Have any updates been made to the studies that underpin strategic flood risk management within the District, including the Catchment Flood Management Plan, the Shoreline Management Plan, and the Flood and Coastal Erosion Risk Management Strategies?
- Have there been any changes to Planning Policy that could affect the way in which flood risk is managed through the planning process?
- Has Government issued new guidance on climate change predictions?

Appendices

Appendix A.1 - Flood Zone Map (2016)

Appendix A.2 - Flood Zone 3b (Canterbury City Centre only)

Appendix A.3 - Historic Flood Map

Appendix A.4 - Existing Defence Infrastructure and Main Rivers

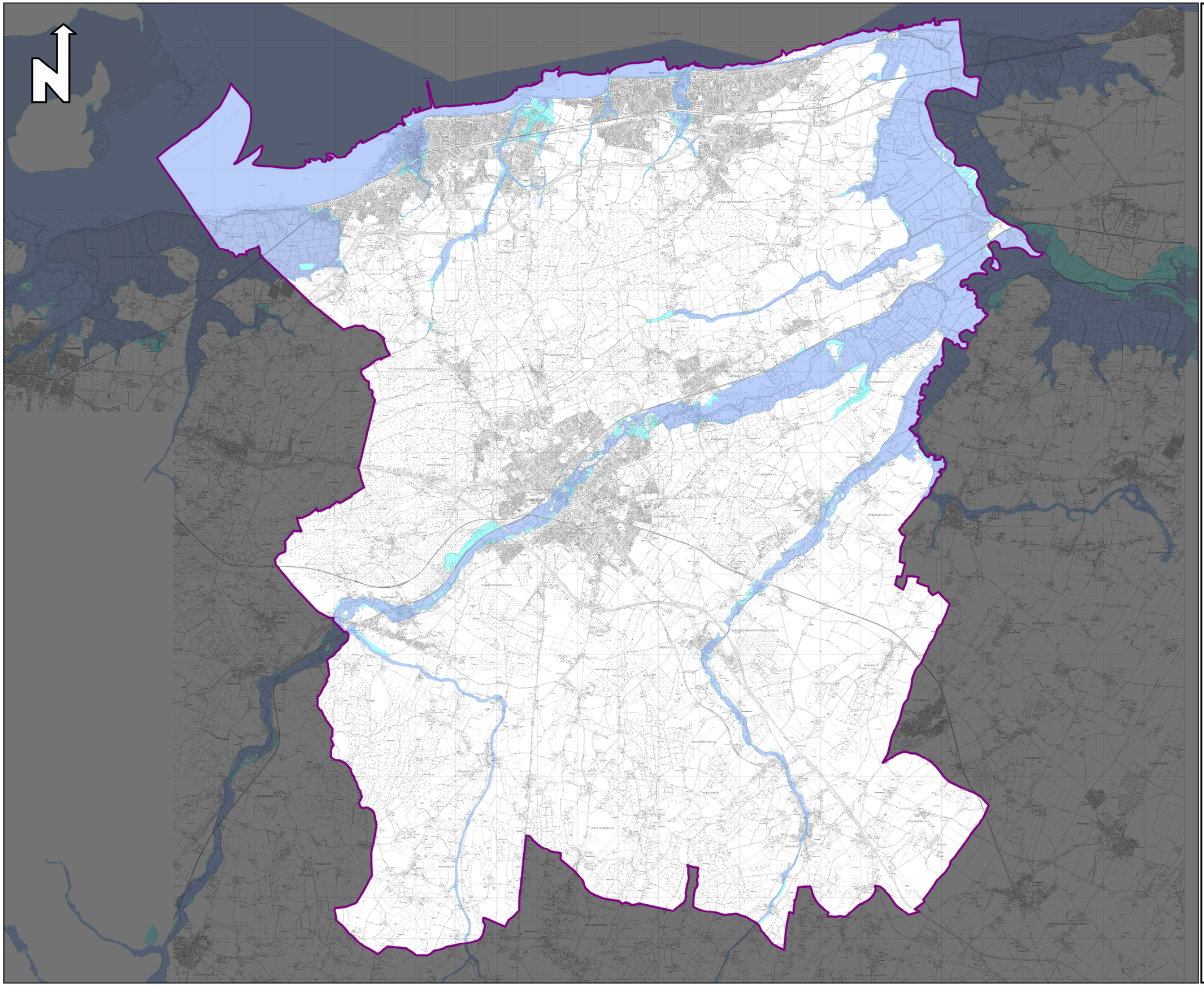
Appendix A.5 - Flood Hazard Maps

Appendix A.6 - Council Flooding Scrutiny Panel Action Plan

Appendix A.7 - Guidance on Rates of Surface Water Runoff from New Developments

Appendix A.8 - Memorandum of Understanding

Appendix A.1 – Flood Zone Map

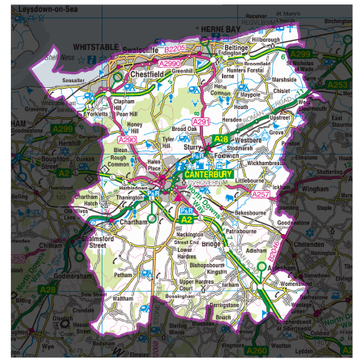


It should be noted that certain locations not shown may be at risk of flooding from other sources (piped drain systems, watermains etc.) and from other watercourses not shown in this study.

FLOOD ZONE MAPS (2018)

Appendix A.1

Canterbury City Council
Strategic Flood Risk Assessment



Flood Zone Map Legend

Flood Zone

- Flood Zone 2
- Flood Zone 3

Boundary

- Canterbury City Council Boundary

The maps shown are based on the Environment Agency Flood Zone Maps and this plan has been produced in accordance with the National Planning Policy Framework (NPPF). Because the information is indicative rather than specific, Local Planning Authorities will need to consult the Environment Agency on individual applications. Users should note that floodplain extents are mapped at 1:10,000 scale, as appropriate to the level of the investigation and are based on information available at the time of survey. Amendments will be required in future to account for information gathered subsequently e.g. changes in hydrological river response or observations following flood events. When in doubt the Environment Agency should be consulted.

Refer to Environment Agency website for periodic updates to the Flood Zone Maps.

herrington CONSULTING LIMITED
Unit 6 & 7 - Barham Business Park
Elham Valley Road
Barham
Canterbury
Kent
CT4 6DQ

www.herringtonconsulting.co.uk

tel: +44 (0)1227 833855
e-mail: enquiries@herringtonconsulting.co.uk

Client: Canterbury City Council

canterbury city council
Civic Centre
Military Road
Canterbury
Kent
CT1 1YW

Drawn: BW		Date: 29-05-2018	Original @ A3
Checked: KT		Date: 29-05-2018	
Approved: SMB		Date: 29-05-2018	
Drawing Number: Appendix A.1	Revision Number: Rev1	Sheet Number: 1 of 1	Status: FINAL

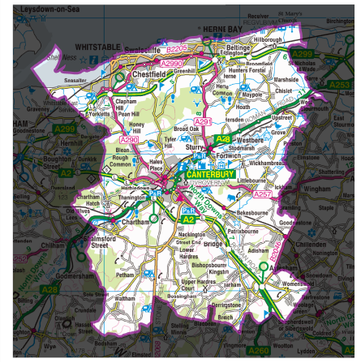
Appendix A.2 – Flood Zone 3b (Canterbury City Centre only)

It should be noted that certain locations not shown may be at risk of flooding from other sources (piped drain systems, watermains etc.) and from other watercourses not shown in this study.

FLOOD ZONE 3B
For Canterbury City Centre

Appendix A.2

Canterbury City Council
Strategic Flood Risk Assessment



Flood Zone Map Legend

Flood Zone

Flood Zone 3b [2018] for application in Canterbury City Centre

Boundary

Canterbury City Council Boundary

The extents shown are based on the results of modelling of the River Stour undertaken by Herrington Consulting Ltd. These maps have been provided in accordance with the National Planning Policy Framework (NPPF) and consultation with the Environment Agency has agreed their use to define Flood Zone 3b (Functional Floodplain) within Canterbury City Centre. Refer to Section 4.6 of the SFRA report for further details. Because the information is indicative rather than specific, Local Planning Authorities will need to consult the Environment Agency on individual applications. Users should note that floodplain extents are mappec at 1:10,000 scale, as appropriate to the level of the investigation and are based on information available at the time of survey. Amendments will be required in future to account for information gathered subsequently e.g. changes in hydrological river response or observations following flood events. When in doubt the Environment Agency should be consulted.

herrington CONSULTING LIMITED
Unit 6 &7 - Barham Business Park
Elham Valley Road
Barham
Canterbury
Kent
CT4 6DQ
www.herringtonconsulting.co.uk
tel: +44 (0)1227 833855
e-mail: enquiries@herringtonconsulting.co.uk

Client: Canterbury City Council

canterbury city council
Civic Centre
Military Road
Canterbury
Kent
CT1 1YW

Drawn:	BW	Date:	29-05-2018	Original @	A3
Checked:	KT	Date:	29-05-2018		
Approved:	SMB	Date:	29-05-2018		
Drawing Number:	Appendix A.2	Revision Number:	Rev1	Sheet Number:	1 of 1
				Status:	FINAL

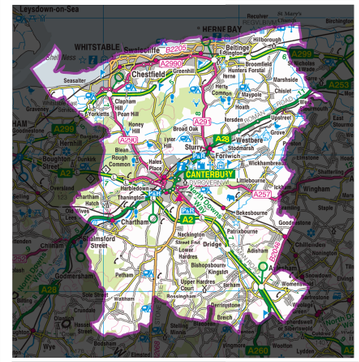
Appendix A.3 – Historic Flood Map

It should be noted that certain locations not shown may be at risk of flooding from other sources (piped drain systems, watermains etc.) and from other watercourses not shown in this study.

HISTORIC FLOOD MAP

Appendix A.3

Canterbury City Council
Strategic Flood Risk Assessment



These historic flood records are a combination of data from remote sensing, ground surveys and staff observations provided by DDC and the Environment Agency. Validated third party data and anecdotal evidence are also included. The datasets used may have been designed to be viewed at a range of map scales, and therefore this map is not intended to be viewed at a site-specific scale. These records are the best available at the time of collation, but should not be considered comprehensive. An area without a flood outline does not necessarily imply that there is no risk of flooding. Queries with regard to the recorded flood extents should be directed to the Environment Agency.

Historic Flood Map Legend

CCC Recorded Flood Events	EA Recorded Flood Events
Sea	November 2001
Fluvial	February 2001
Surface Water	November 2000
Highway	September 1968
Groundwater	November 1960
Sewer	February 1953
For individual historic flood events refer to Table A.3.1	Various (consult EA for corresponding dates)

Boundary

Canterbury City Council Boundary

herrington CONSULTING LIMITED
Unit 6 & 7 - Barham Business Park
Elham Valley Road
Barham
Canterbury
Kent
CT4 6DQ
www.herringtonconsulting.co.uk
tel: +44 (0)1227 833855
e-mail: enquiries@herringtonconsulting.co.uk

Client: Canterbury City Council

canterbury city council
Civic Centre
Military Road
Canterbury
Kent
CT1 1YW

Drawn:	BW	Date:	29-05-2018	Original @	A3
Checked:	KT	Date:	29-05-2018		
Approved:	SMB	Date:	29-05-2018		
Drawing Number:	Revision Number:	Sheet Number:	Status:		
Appendix A.3	Rev1	1 of 1	FINAL		

ID	Type of Flooding	Date Flooded	Description of Flooding
1	Sea	1996	Some overtopping occurred at the eastern end but this was minimal. One property was flooded due to seepage through the shingle full and some 2,000 tonnes of shingle were lost.
2	Fluvial	Ongoing	One property and the gardens of various other properties in Church Lane, Freemans Close and Faversham Road flood. Gardens only flood 2-3 times a year. Property floods once every 2 years. Seasalter Cross, Whitstable.
3	Fluvial	Ongoing	One property and the gardens of various other properties in Church Lane, Freemans Close and Faversham Road flood. Gardens only flood 2-3 times a year. Property floods once every 2 years. Seasalter Cross, Whitstable.
4	Fluvial	Ongoing	One property and the gardens of various other properties in Church Lane, Freemans Close and Faversham Road flood. Gardens only flood 2-3 times a year. Property floods once every 2 years. Seasalter Cross, Whitstable.
5	Fluvial	Ongoing	One property and the gardens of various other properties in Church Lane, Freemans Close and Faversham Road flood. Gardens only flood 2-3 times a year. Property floods once every 2 years. Seasalter Cross, Whitstable.
6	Surface Water	Ongoing	Surface water runs onto highway. Water from forecourt of Public House. A299 – Wraik Hill.
7	Fluvial	Ongoing	Flooding of Denstroude Lane due to surcharge of culvert and ditch.
8	Surface Water	Unknown	Surcharge of culvert and surface water sewers. Old Red Lion Bridge - Whitstable boundary A290.
9	Surface Water	Ongoing	Surface water runs onto highway. Water from Banks and verges, drainage is by a sewer. A299, Golden Hill, Millstrood.
10	Surface Water	Ongoing	Continuous flooding of gardens during wet winters. Caused by water running off the Sir William Nottidge School playing fields. Linden Avenue Whitstable.
11	Highway	Ongoing	Sunken road floods, A299 service road.
12	Fluvial	2000	Repeated flooding of property from the Swalecliffe Brook. The property is very Vulnerable, a rise in water level posing a serious threat to 56 Herne Bay Road.

ID	Type of Flooding	Date Flooded	Description of Flooding
13	Fluvial	Ongoing	Flooding of urban development, gardens adjacent to brook and South Street Road. Gardens flood once a year, South Street every 2 years.
14	Highway	Ongoing	Dished road under railway bridge. A299 - Chestfield roundabout.
15	Fluvial	2000	Flooding of gardens caused by an inadequate culvert and ditch. Maydowns Road Chestfield.
16	Fluvial	Ongoing	Flooding of Thanet Way every four years. Caused by inadequate culverts under the Thanet Way and adjacent railway line.
17	Fluvial	Ongoing	Flooding of Colewood Road, Swalecliffe, every four years, caused by an inadequate sewer.
18	Fluvial	2000	Flooding of land around the caravans at Sea View Caravan camp, Colewood Road, Whitstable. Occurs when peak flows in the watercourse coincide with the outfall being tide locked.
19	Highway	Ongoing	Flooding of Daimler Avenue, Herne Bay and some urban development. Happens twice a year.
20	Highway	Ongoing	Flooding of Whitstable Road/Sea Street, Herne Bay and some urban development. Happens twice a year.
21	Fluvial	2000	Private watercourse floods Cherry Gardens.
22	Fluvial	2000	Private watercourse floods Eddington Lane.
23	Sea	1995	Prolonged NE gale/gale force winds, large hole in the Northern Sea Wall near Reculver Towers. Further severe damage to a 150m length of the sea wall due to severe undercutting. Access road to oyster farm and to the rest of wall in jeopardy of collapse.
24	Fluvial	Ongoing	Flooding of haunches, springs, inadequate ditch.
25	Fluvial	Ongoing	Flooding of haunches, springs, inadequate ditch. Marley Lane, Chislet.
26	Fluvial	Ongoing	Flooding of haunches due to an inadequate ditch, Marley Lane, Hoath.

ID	Type of Flooding	Date Flooded	Description of Flooding
27	Fluvial	Ongoing	Discharge from banks, inadequate ditch aggravated by springs. C198 Hoath Road and Tile Kiln Farm.
28	Groundwater	Ongoing	Road flooding due to springs - no proper drainage. Bredland Lane, Westbere.
29	Highway	Ongoing	Road flooding from land and properties. Unclassified road, Westbere.
30	Highway	Ongoing	Flooding of bridge due to undersized bridge portal. C205 Stodmarsh.
31	Highway	Ongoing	Level road, with rises either side, floods, no point to discharge. C203, Grove Road, Sandpits.
32	Fluvial	Ongoing	Road flooding, caused by Nailbourne, here in ownership of Church Commissioners. C204 & unclassified roads at Ickham.
33	Fluvial	2000	Roads flood due to Nailbourne, intermittent watercourse at Old Palace Road, Patrixbourne.
34	Fluvial	2000	Road flooding at the ford and small bridge, caused by Nailbourne in heavy spate. Shepherds Close Road & C203 Patrixbourne.
35	Fluvial	2000	Road flooding at the ford and small bridge, caused by Nailbourne in heavy spate. Shepherds Close Road & C203 Patrixbourne.
36	Fluvial	2000	Road flooding due to Nailbourne in heavy flood. Mill Lane & Bridge House, Bridge.
37	Highway	Ongoing	Road flooding due to natural discharge and raising of road. C206, Adisham Downs.
38	Highway	2000	Road flooding, Rose Lane, Bishopsbourne.
39	Fluvial	2000	Road flooding from Nailbourne, B2065 Black Robin Lane to Brickbat, Barham.
40	Highway	2000	Road flooding, B2065 Out Elmsted Lane, Barham.
41	Fluvial	2000	Road flooding C195, The Street, Barham. From Nailbourne.
42	Fluvial	2000	Road flooding from Nailbourne. Temporary bridge erected after depth exceeded 6 inches.

ID	Type of Flooding	Date Flooded	Description of Flooding
43	Fluvial	2000	Road flooding from Nailbourne. South Barham Road at Barham and Derringstone.
44	Fluvial	2000	Road flooding from Nailbourne. South Barham Road at Barham and Derringstone.
45	Highway	2000	Flooding of an unclassified road at Woolage Green.
46	Fluvial	2000	Road flooding due to Nailbourne where it flows through an inadequate culvert.
47	Fluvial	2000	Nailbourne, intermittent river flooding road. Surcharge from springs. Little Buckett, Bodsham.
48	Fluvial	2000	Road flooding from intermittent underground river - Nailbourne. Yockletts Farm, Ansdore Road.
49	Fluvial	2000	Road flooding from intermittent underground river - Nailbourne. Ansdore Road.
50	Fluvial	2000	Road flooding from Nailbourne, intermittent river, surcharge from springs. Church Lane, Petham.
51	Fluvial	2000	Road flooding from Nailbourne, Intermittent underground river. Garlinge Green Road.
52	Fluvial	2000	Road flooding from Nailbourne, intermittent underground river. Kenfield Road, Garlinge Green.
53	Fluvial	2000	Road flooding due to intermittent underground stream, Nailbourne. Watery Lane.
54	Fluvial	2000	Road flooding due to intermittent underground stream, Nailbourne. Petham Road, Swarling Manor and Watery Lane.
55	Fluvial	2000	Road flooding due to intermittent underground stream, Nailbourne. Petham Road, Swarling Manor and Watery Lane.
56	Fluvial	2000	Road flooding from Nailbourne, Mystole Road, Chartham. Intermittent underground river.
57	Sewer	2000	River Stour in flood causes surcharging of sewer, Shalmsford Street, Chartham.
58	Fluvial	2000	Riverside, Chartham floods when River Stour is in flood.
59	Fluvial	2000	Road floods, unclassified road called Tonford Lane, Thanington.
60	Fluvial	2000	Road floods, unclassified road called Hassell Reach, Thanington.

ID	Type of Flooding	Date Flooded	Description of Flooding
61	Groundwater	2000	Springs cause road flooding. Primrose Lane, Chartham Hatch.
62	Groundwater	2000	Flooding of C2020, Danstead Lane, Chatham Hatch, due to springs and runoff from orchards.
63	Surface Water	2000	Water run-off from adjacent fields captured by retaining wall in gardens.
64	Surface Water	Ongoing	Severe external flooding from steep meadow. Vestigial ditch unable to intercept. Some internal flooding possible but no actual records.
65	Sewer	Ongoing	Severe flooding/waterlogging of cemetery mainly due to under-capacity/defective surface water sewer. Collapsed length now repaired. Southern Water aware of capacity problem - upgrade not believed to be imminent.
66	Surface Water	2000	Water flowing down Salisbury Road from blocked culvert.
67	Highway	2000	Deep water flooding to road and properties due to blocked drainage channel.
68	Sewer	2000	External flooding due to blocked surface water sewer.
69	Fluvial	2000	Flooding of caravan park due to neglected ditches.
70	Fluvial	2000	Very severe external flooding due to blocked culvert.
71	Surface Water	2000	Severe garden flooding due to absence of land drainage. Alleviated by installing gully in garden, culverted under road into ditch.
72	Surface Water	2000	Severe flooding to farm due to inability of ditch to discharge under the Thanet Way.
73	Highway	2000	Road flooding due to blocked culvert under Thanet Way.
74	Highway	2000	Road flooding due to inadequate ditch/culvert system.
75	Surface Water	2000	Garden flooding due to neglected private ditch.
76	Highway	Ongoing	Road flooding due to inadequate ditch/culvert system.

ID	Type of Flooding	Date Flooded	Description of Flooding
77	Surface Water	Ongoing	Flooding due to surface water runoff.
78	Fluvial	2000	Culvert blockage.
79	Highway	2000	External flooding due to inadequate highway drainage/vestigial ditch system. Highway drainage since improved.
80	Sewer	2000	Foul water blockage/backing up. Surface water sewer under capacity.
81	Highway	2000	Highway flooding possibly due to neglected ditch system. Since remedied.
82	Surface Water	2000	External flooding due to blocked allotment ditch. Since cleared.
83	Surface Water	2000	Culvert blocked, properties flooded.
84	Surface Water	2007 2000	Deep flooding to car park and surrounding streets. Numerous properties internally flooded. Flash flood exacerbated by problems at pumping station.
85	Highway	2000	External flooding due to inadequate road drainage.
86	Highway	2000	Road gully blocked. Water on road threatening properties.
87	Fluvial	2000	Minor stream fluvial flood.
88	Surface Water	2000	Severe external flooding from blocked surface water sewer taking flow from Reed Pond, to rear of properties.
89	Surface Water	2000	Water runoff from adjacent fields, internal flooding to ground floor flats. Subsequent land drainage works to divert flows are proving effective.
90	Surface Water	2000	Culvert blocked water flowing down to Salisbury and Beaconfield Rds.
91	Sewer	2000	Internal foul flooding due to under-capacity foul water sewer. Non-return valves now fitted to alleviate issue.
92	Surface Water	2000	Property flooded water coming from next door's garden.

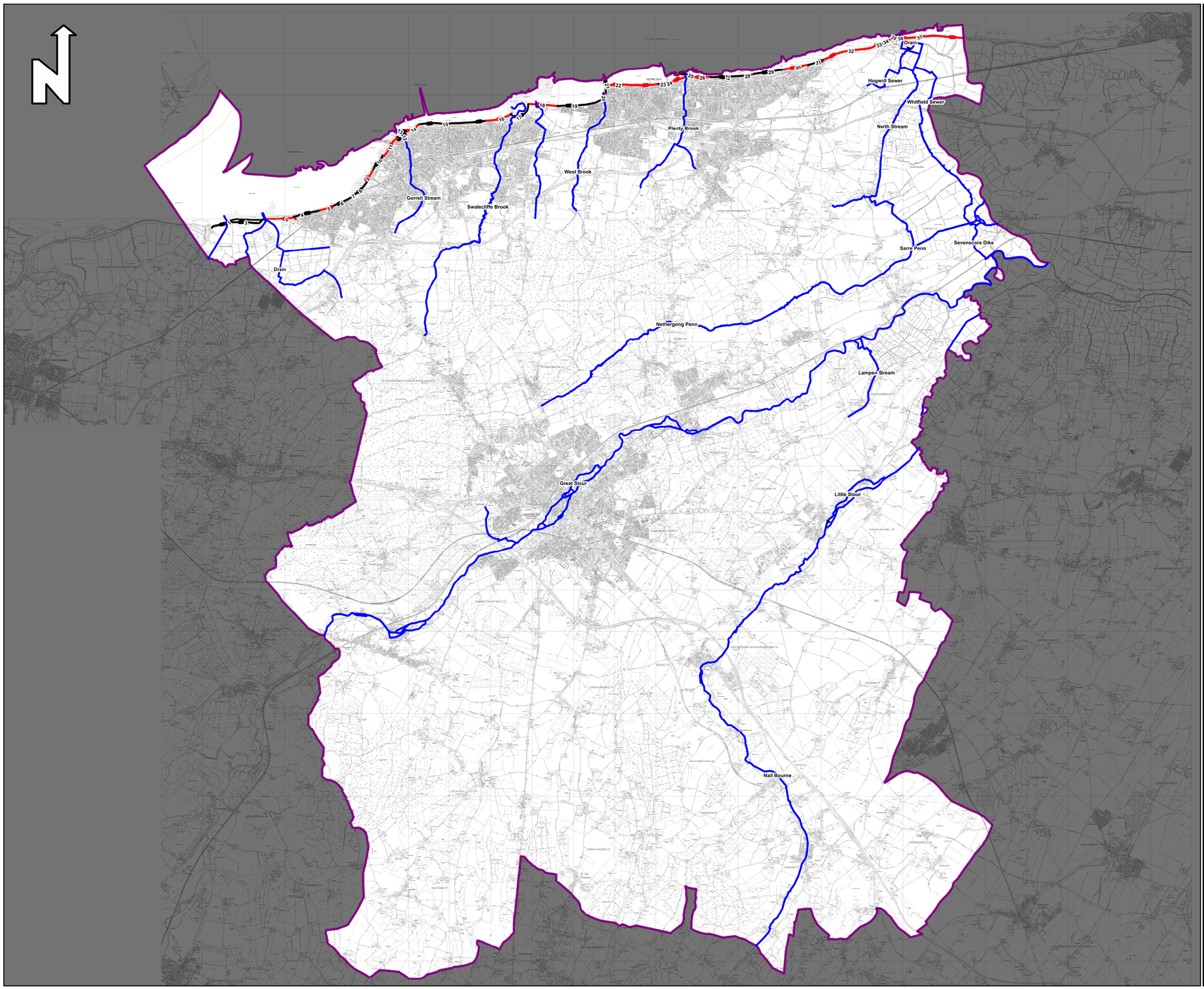
ID	Type of Flooding	Date Flooded	Description of Flooding
93	Surface Water	2000	Water entering gardens from stream uphill. Flooding also from blocked surface water sewer behind properties on St Thomas' Hill.
94	Surface Water	2000	Gardens flooded by water runoff from adjacent allotments.
95	Surface Water	2000	External flooding from playing fields probably due to poorly maintained ditch. Ditch now cleared, school aware of responsibility.
96	Surface Water	2000	Surface water runoff and drainage under capacity.
97	Surface Water	2000	External flooding due to inadequate land drainage system.
98	Fluvial	2000	External/internal flooding to several properties due to surcharged surface water sewer.
99	Highway	2007	Surface water from road flooding driveways.
100	Fluvial	2007	Flooding from suspected pump failure at Gorrell Tank.
101	Highway	April 2000	Highway flooding.
102	Surface Water	9th February 2001	Surface water flooding.
103	Surface Water	9th February 2001	Surface water flooding.
104	Surface Water	23rd March 2001	Surface water - unknown address.
105	Surface Water	8th February 2001	Surface water Canterbury Hill/Tyler Hill.
106	Surface Water	4th April 2000	Surface water flooding in the surrounding area.
107	Fluvial	Ongoing	Blean Common - flooding from ditches and culverts.
108	Sewer	2011	Badgers Close - surcharging drains.

ID	Type of Flooding	Date Flooded	Description of Flooding
109	Surface Water	Ongoing	Honey Hill - surface water runoff from fields.
110	Highway	Ongoing	Blean Hill - blocked road gullies.
111	Highway	Ongoing	Tile Kiln Hill - surface water runoff from fields.
112	Surface Water	2001	Maydowns Rd - garden and sun lounge completely flooded.
113	Surface Water	4th April 2000	Chestfield Rd - Extensive external flooding.
114	Highway	8th February 2001	Chestfield Rd closed by police due to flooding.
115	Highway	2001	Molehill Rd/Birkdale Close. Flooding in junction 3ft deep.
116	Fluvial	Ongoing	Molehill Rd - ditches/culverts vulnerable to blocking/overflowing.
117	Surface Water	2001	Little Paddocks - floodwater 2” below airbricks.
118	Surface Water	November 2000	Cherry Orchard - unspecified flooding.
119	Surface Water	2001	Highgate Lodge, The Ridgeway. Internal flooding to 9” depth.
120	Sewer	2000/2001	Foul flooding from drain and from sewage backing up. New large holding tank constructed by Southern Water to alleviate issue.
121	Fluvial	2014	Possible river overtopping.
122	Groundwater	2014	Groundwater flooding in cellar.
123	Surface Water	2014	Surface water flooding from the green.
124	Groundwater	February 2014	Accompanied by river flooding at times.
125	Fluvial	February 2014	Accompanied by groundwater flooding.

ID	Type of Flooding	Date Flooded	Description of Flooding
126	Sewer	2014	Foul sewer surcharge.
127	Surface Water	2014	Run-off down Brewery Lane.
128	Groundwater	2014	Groundwater emergence made worse by run-off down Brewery Lane.
129	Groundwater	2014	Groundwater flooding.
130	Sewer	2014	Sewer overflow with runoff and groundwater flooding.
131	Groundwater	2014	Made worse by run-off from the Nailbourne.
132	Groundwater	2014	Groundwater in cellar, affected also by fluvial flooding.
133	Fluvial	2014	Possible fluvial flooding.
134	Surface Water	October 2013	Run-off from fields behind.
135	Surface Water	January 2014	Sandbags requested.
136	Fluvial	January 2015	Nearby ditch overflowing. Sandbags requested.
137	Surface Water	August 2015	Internal flooding following heavy rainfall. Probably due to blocked gully. Sandbags sent.
138	Fluvial	December 2013	Floodwater approaching property. Flood Alert issued. Sandbags requested.
139	Surface Water	July 2012	Internal flooding - likely due to surcharged road gullies.
140	Fluvial	January 2014	Caused by localised ditch blockage. Has been cleared since.
141	Surface Water	August 2011	Flooding from rainfall, sandbags requested.
142	Fluvial	January 2014	Approximately 400 sandbags delivered. Not believed to cause internal flooding.
143	Highway	September 2012	Lots of water in the road so probably problems with road gullies.

ID	Type of Flooding	Date Flooded	Description of Flooding
144	Highway	October 2013	Potential blocked road gullies.
145	Highway	August 2015	Highway flooding.
146	Fluvial	December 2013	Sandbags sent.
147	Highway	January 2015	Flooding in the highway.
148	Surface Water	December 2013	Sandbags delivered to reports of floodwater in a garden progressing towards house.
149	Fluvial	December 2013	Water in garden approaching house. Sandbags delivered.
150	Fluvial	September 2015	Internal flooding reported.
151	Surface Water	August 2015	Sandbags sent following heavy rain.
152	Surface Water	August 2015	Sandbags sent following heavy rainfall.

Appendix A.4 – Existing Defence Infrastructure and Main Rivers

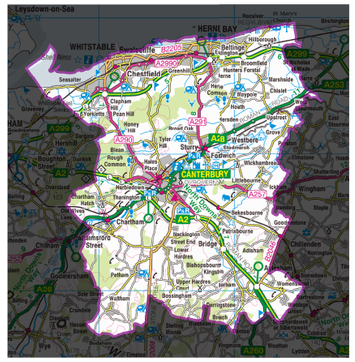


It should be noted that certain locations not shown may be at risk of flooding from other sources (piped drain systems, watermains etc.) and from other watercourses not shown in this study.

EXISTING DEFENCE INFRASTRUCTURE & WATERCOURSES

Appendix A.4

Canterbury City Council
Strategic Flood Risk Assessment



Defence and Watercourse Legend

Watercourses

Watercourses

Defence Infrastructure

Defence

Lengths

**For individual Defence Infrastucture details refer to Table A.4.1*

Boundary

Canterbury City Council Boundary

herrington CONSULTING LIMITED

Unit 6 &7 - Barham Business Park
Elham Valley Road
Barham
Canterbury
Kent
CT4 6DQ

www.herringtonconsulting.co.uk

tel: +44 (0)1227 833855
e-mail: tnquiries@herringtonconsulting.co.uk

Client: Canterbury City Council

canterbury city council

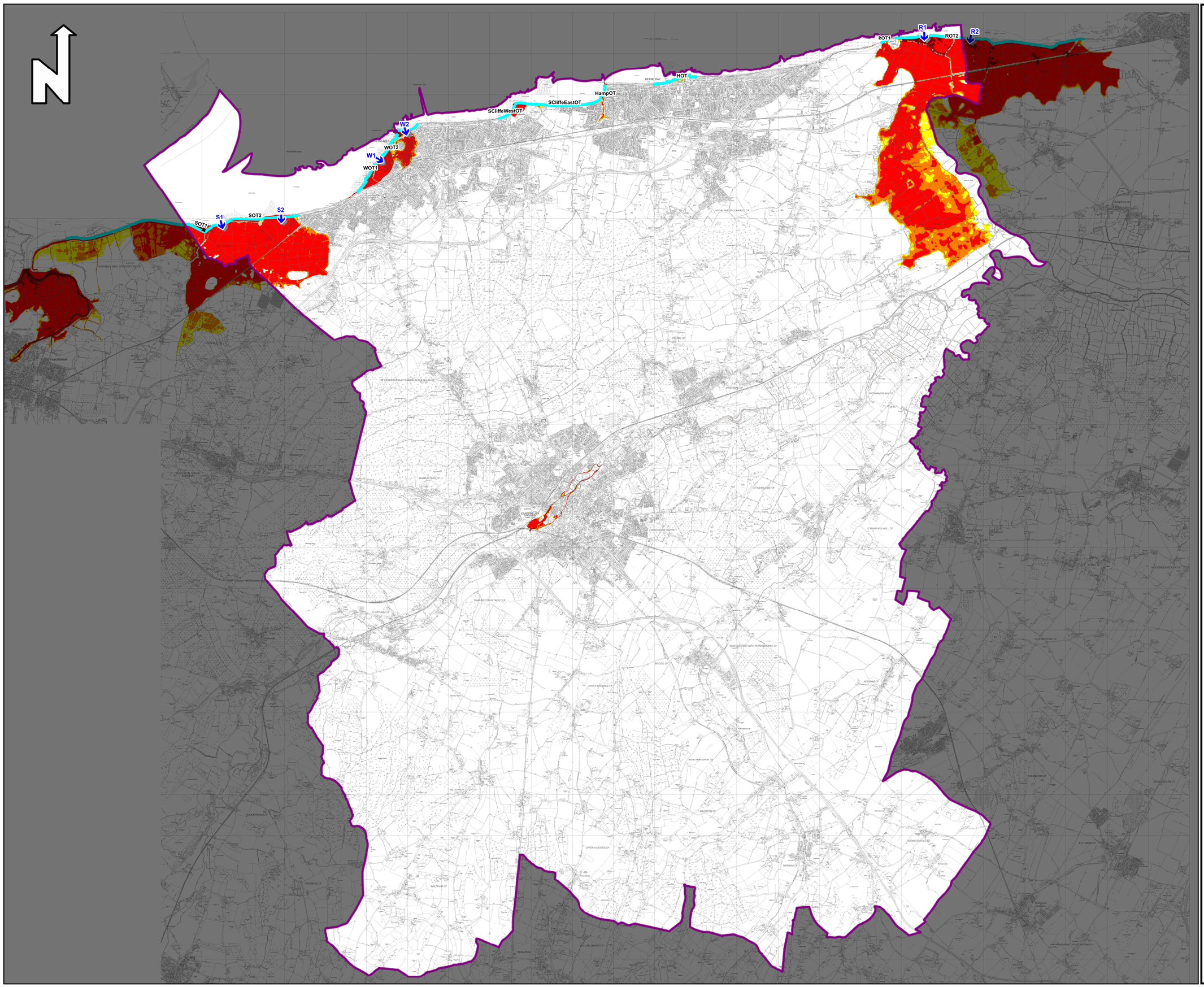
Civic Centre
Military Road
Canterbury
Kent
CT1 1YW

Drawn:	BW	Date:	29-05-2018	Original @	A3
Checked:	KT	Date:	29-05-2018		
Approved:	SMB	Date:	29-05-2018		
Drawing Number:	Revision Number:	Sheet Number:	Status:		
Appendix A.4	Rev1	1 of 1	Final		

ID	Location	Owner	Type of Defence	Length (m)	Current S.o.P.	Beach Level (m AOD)	Front seawall level (m AOD)	Rear seawall Level (m AOD)	Condition
1	Sportsman to Red Sluice	EA	Concrete Seawall	1343	1:100	3.8	6.5	N/A	Fair to good
2	Red Sluice to Blue Anchor	EA	Clay bund	761	1:50	4.0	N/A	5.3	Fair
3	Faversham Road	EA	Clay Bund	790	1:50	N/A	N/A	5.3	Fair
4	Preston Parade West	CCC	Concrete seawall	621	1:200	4.0	5.2	N/A	Very good
5	Preston Parade East	CCC	Concrete seawall	387	1:200	4.0	5.2	N/A	Very good
6	Admiralty Walk	CCC	Concrete seawall	455	1:200	4.0	5.1	N/A	Very good
7	Whitstable	Railtrack	Concrete revetment	149	1:200	4.0	3.3	N/A	Fair
8	Golf Club wall	CCC	Concrete seawall & rear wall	421	1:200	4.0	4.9	5.6	Very good
9	West Beach	CCC	Concrete seawall & rear wall	408	1:200	4.7	4.9	5.8	Very good
10	Whitstable Central Area West	CCC	Concrete seawall & rear wall	439	1:200	4.7	4.9	5.8	Very good
11	Whitstable Central Area East	CCC	Concrete seawall and rear wll	626	1:200	4.7	4.9	5.8	Very good
12	Whitstable Harbour	CCC	Concrete seawall / various buildings	482	1:200	4.7	4.8	5.8	Fair to good
13	Harbour Beach	CCC	Concrete seawall & rear wall	280	1:200	4.7	4.3	5.8	Very good
14	Beach Walk	CCC	Concrete seawall	366	1:200	4.7	5.2	N/A	Very good
15	Tankerton Beach West	CCC	Concrete seawall	1610	1:200	4.7	5.9	N/A	Very good
16	Tankerton Beach East	CCC	Concrete seawall	695	1:200	4.7	5	N/A	Very good
17	Longrock	CCC	Clay bund	639	1:100	4.2	5.2	N/A	Very good
18	Swalecliffe	CCC	Concrete seawall & rear wall	711	1:200	4.8	5.1	6.7	Very good
19	Studd Hill	CCC	Concrete seawall & rear wall	1063	1:100	4.0	5.7	6.3	Fair
20	Hampton Bay	CCC	Concrete seawall & rear wall	235	1:100	3.25	4.8	6	Fair
21	Hampton Pier	CCC	Concrete seawall & rock armour	380	1:100	4.3	4.85	5.3	Good
22	Westcliff	CCC	Concrete seawall + KCC rear wall	1273	1:100	5.0	5.45	6.9	Good
23	Lane End	CCC	Concrete seawall	265	1:100	4.6	4.8	5.7	Very good
24	Herne Bay Central	CCC	Concrete seawall & apron + rear wall	549	1:200	4.6	5.1	5.9	Very good
25	Herne Bay Breakwater	CCC	Rock Armour	595	1:200	N/A	N/A	3.8	Good
26	Coopers Hill	CCC	Concrete seawall & apron + rear wall	489	1:100	2.7	4.9	6	Good
27	East Cliff I	CCC	Concrete seawall + rear wall	865	1:100	3.5	4.1	6.5	Good
28	Queens Avenue	CCC	Concrete seawall & apron + rear wall	226	1:100	3.4	4.8	6	Good

ID	Location	Owner	Type of Defence	Length (m)	Current S.o.P.	Beach Level (m AOD)	Front seawall level (m AOD)	Rear seawall Level (m AOD)	Condition
29	East Cliff II	CCC	Concrete seawall & apron + rear wall	686	1:100	4.1	4.85	6.7	Good
30	Hillborough Cliff	CCC	Concrete seawall & apron + rear wall	658	1:100	4.1	4.85	6.3	Good
31	East Cliff III	CCC	Rock Revetment	372	1:100	N/A	6	N/A	Fair
32	Reculver Country Park	CCC	Undefended	1427	N/A	N/A	N/A	N/A	N/A
33	Reculver west wall	CCC	Concrete seawall & apron + rear wall	218	1:100	N/A	5.4	6.4	Good
34	Reculver rock revetment	EA	Concrete seawall & rock revetment	205	1:100	N/A	5.4	6.4	Very good
35	Reculver Towers	EH	Blockwork apron & toe rock	210	1:100	N/A	6	N/A	Fair to good
36	Reculver east wall	CCC/EA	Concrete seawall & rock revetment	126	1:100	N/A	6.9	N/A	Very good
37	Northern seawall	EA	Concrete seawall & apron + upstand wall	4539	1:100	4.5	6.7	N/A	Good

Appendix A.5 – Flood Hazard Maps



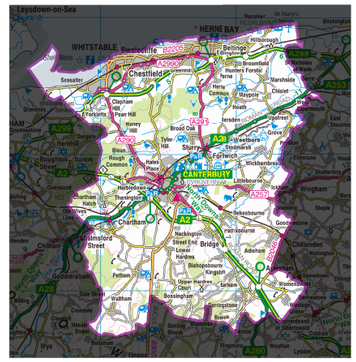
It should be noted that certain locations not shown may be at risk of flooding from other sources (piped drain systems, watermains etc.) and from other watercourses not shown in this study.

HAZARD MAPPING [2010]

Appendix A.5

Delineated results for the modelled Coastline
[1 in 200 year Tidal Event]
and the Great Stour through Canterbury City
[1 in 100 year Fluvial Event]

Canterbury City Council
Strategic Flood Risk Assessment



Hazard Map Legend

Hazard Rating

- Low [0.5 - 0.75]
- Moderate [0.76 - 1.25]
- Significant [1.26 - 2.5]
- Extreme [>2.5]

** Hazard rating calculated in accordance with criteria set out in 'Flood Risk to People' [R&D Output FD2320/TR2]*

- Canterbury City Council Boundary

Modelled Breach & Wave Overtopping Locations

- Modelled Breach Location
- Modelled Wave Overtopping Location

Refer to Table A.5.1 for Modelled Breach & Wave Overtopping Locations and Descriptions

Refer to Table A.5.2 for Modelled Breach & Wave Overtopping Scenarios

herrington CONSULTING LIMITED
Unit 6 &7 - Barham Business Park
Elham Valley Road
Barham
Canterbury
Kent
CT4 6DQ
www.herringtonconsulting.co.uk
tel: +44 (0)1227 833855
e-mail: enquiries@herringtonconsulting.co.uk

Client: Canterbury City Council

canterbury city council
Civic Centre
Military Road
Canterbury
Kent
CT1 1YW

Drawn:	BW		Date: 29-05-2018		Original @ A3
Checked:	KT		Date: 29-05-2018		
Approved:	SMB		Date: 29-05-2018		
Drawing Number: Appendix A.5 [2010]		Revision Number: Rev1		Sheet Number: 1 of 1	Status: FINAL

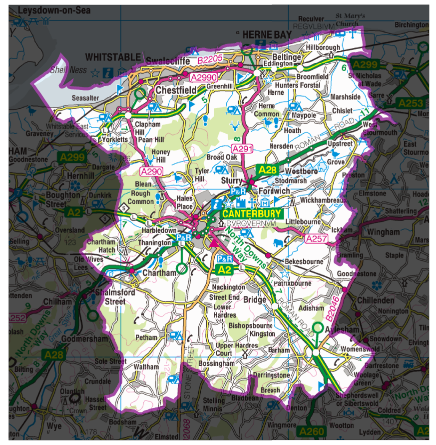
It should be noted that certain locations not shown may be at risk of flooding from other sources (piped drain systems, watermains etc.) and from other watercourses not shown in this study.

HAZARD MAPPING [2110]

Appendix A.5

Delineated results for the modelled Coastline [1 in 200 year Tidal Event] and the Great Stour through Canterbury City [1 in 100 year Fluvial Event]

Canterbury City Council
Strategic Flood Risk Assessment



Hazard Map Legend

Hazard Rating

- Low [0.5 - 0.75]
- Moderate [0.76 - 1.25]
- Significant [1.26 - 2.5]
- Extreme [>2.5]

** Hazard rating calculated in accordance with criteria set out in 'Flood Risk to People' [R&D Output FD2320/TR2]*

Modelled Breach & Wave Overtopping Locations

- Modelled Breach Location
- Modelled Wave Overtopping Location

** Refer to Table A.5.1 for Modelled Breach & Wave Overtopping Locations and Descriptions*

**Refer to Table A.5.2 for Modelled Breach & Wave Overtopping Scenarios*

Canterbury City Council Boundary

herrington CONSULTING LIMITED
Unit 6 & 7 - Barham Business Park
Elham Valley Road
Barham
Canterbury
Kent
CT4 6DQ
www.herringtonconsulting.co.uk
tel: +44 (0)1227 833855
e-mail: enquiries@herringtonconsulting.co.uk

Client: Canterbury City Council

canterbury city council
Civic Centre
Military Road
Canterbury
Kent
CT1 1YW

Drawn: BW	Date: 29-05-2018		Original @ A3
Checked: KT	Date: 29-05-2018		
Approved: SMB	Date: 29-05-2018		
Drawing Number: Appendix A.5 [2110]	Revision Number: Rev1	Sheet Number: 1 of 1	Status: FINAL

Code (refer to App 5)	Modelled Breach Location	Description	Width (m)	Breach Invert mAOD	Time breach open (Hrs)	Defence Crest Height [2010] mAOD	Defence Crest Height [2110] mAOD
S1	Seasalter (west)	Full breach	50	3	30	6.0	6.0
S2	Seasalter (east)	Full breach	50	2	30	5.5	5.5
W1	Whitstable Tennis Courts (east)	Full Breach	20	2.9	30	5.8	6.5
W2	Whitstable Harbour (east)	Open Flood Gate	6	5	30	5.8	6.5
H1	Herne Bay Central	No breach – overtopping only	-	-	-	5.8	6.5
R0	Reculver (west of Towers)	No breach – overtopping only	-	-	-	6.4	6.4
R1	Reculver (west)	Full Breach	100	2.5	30	6.7	6.7
R2	Reculver (east)	Full Breach	100	2.5	30	6.7	6.7

Modelled Breach Locations

Code (refer to App 5)	Modelled Overtopping Location	Description	Over-topping boundary length (m)	Time Applied (Hrs)	Over-topping Rate [2010] l/s/m	Over-topping Rate [2115] l/s/m	Defence Crest Height [2010] mAOD	Defence Crest Height [2110] mAOD
SOT1	Seasalter Overtopping (West)	Wave overtopping	5029	1 tide	8	Overflow	6.0	6.0
SOT2	Seasalter Overtopping (East)	Wave overtopping	792	1 tide	8	Overflow	5.5	5.5
WOT1	Whitstable Overtopping	Wave overtopping	1852	1 tide	1	18	5.8	6.5
WOT2	Whitstable Overtopping	Wave overtopping	511	1 tide	1	18	5.8	6.5
SCliffe WestOT	Swalecliffe Overtopping	Wave overtopping	312	1 tide	Overflow	Overflow	5.0	5.0
SCliffe EastOT	Studd Hill Overtopping	Wave overtopping	2270	1 tide	0.1	5	6.7	6.7
HampOT	Hampton Overtopping	Wave overtopping	368	1 tide	9	140	6.2	6.2
HOT	Herne Bay Overtopping	Wave overtopping	1110	1 tide	0.2	13	5.8	6.5
ROT1	Reculver (west) Overtopping	Wave overtopping	181	1 tide	18	500	6.4	6.4
ROT2	Reculver (east) Overtopping	Wave overtopping	4666	1 tide	2.3	63	6.7	6.7

Modelled Overtopping Locations

Modelled Location (see Appendix 5)	***Modelled Scenario***						
	Seasalter	**Whitstable**	**Swalecliffe**	**Studd Hill**	**Hampton**	**Herne Bay**	**Reculver**
S1 (Breach)	✓						
S2 (Breach)	✓						
SOT1 (Overtopping)	✓						
SOT2 (Overtopping)	✓						
W1 (Breach)		✓					
W2 (Breach)		✓					
WOT1 (Overtopping)		✓					
WOT2 (Overtopping)		✓					
SCliffeWestOT (Overtopping)			✓				
SCliffeEastOT (Overtopping)				✓			
HampOT (Overtopping))					✓		
HOT (Overtopping)						✓	
R1 (Breach)							✓
R2 (Breach)							✓
ROT1 (Overtopping)							✓
ROT2 (Overtopping)							✓

Appendix A.6 – Council Flood Scrutiny Panel Action Plan

CANTERBURY CITY COUNCIL

FLOODING SCRUTINY PANEL

ACTION PLAN

UPDATE ON SITUATION AS AT NOVEMBER 2007

Update 2 Revision 1

16/11/2007

PREFACE

This is the second update on the present situation with respect to the work of the City Council's Flooding Scrutiny Panel ("the Panel"). It comes six years after the completion of the Panel's investigations and the issue of the original report. The first update reported on the progress with respect to the Actions that were proposed in the short term. This second update aims to cover the medium and long term Actions to see how much has actually been accomplished and where we have so far failed or made little improvement. It is particularly relevant coming after the recent 21st August 2007 severe rainfall flooding in Whitstable and the coastal storm of 9 November 2007.

As for the first update this latest report expands upon the original Action Plan by adding another paragraph "Current Situation" to each of the 50 ACTIONS. These additions summarise what has happened in the intervening period, the improvements made and, where relevant, problems still to be overcome. **In order to easily find these additions the current situation at this second update for each Action point is in coloured typeface. Where it is considered that good progress has been made the situation is in purple. Where progress is considered to be poor or it has not really been possible to do much the situation is in orange.**

Assessing the situation with respect to the Actions it is noted that progress on "things" has been very good. Nearly all the flood alleviation projects have been carried out and are working well. This includes minor to major works by all the agencies, improvements in maintenance regimes and flood reduction measures in development control conditions.

However, progress on "people issues" has not been so good and in one or two cases the situation is actually worse than at the time the Panel sat. There is still confusion by the public as to responsibilities, who to call and what flood warnings mean. For various reasons the very good coordination/cooperation between the agencies, that had built up towards the end of the 2001 flooding, has deteriorated.

The final draft of the Action Plan outlining the work of the Panel was produced on 13 September 2001. It contained the main findings and recommendations of the Panel. The recommendations were submitted to the Council's Development and Planning Committee on 25 September 2001 and were fully approved. Where actions by other agencies are mentioned the information is based on what is understood to be the present position but cannot obviously commit those agencies to what is stated.

The original Action Plan formed a part of the main report of the Panel, which was issued at the same time – 13/09/2001. It was intended to be a "stand alone document" that summarised the main conclusions, recommendations and actions required as a result of the Panel's investigations. It was derived from the evidence given by the public and all involved agencies. Full information on and background to the various Actions proposed, together with more detail on the measures planned to be put into practice, are contained in the various sections of the main report. The original Action Plan was discussed at all the four Area Members Panels and their comments were included.

It should be noted that the numbering of the Actions in no way signifies order of importance or priority. The numbering is based on the sequence of the sections of the report. In order to keep this update as concise as possible the Introduction (Section 1) of the original Action Plan has been omitted but copies are available separately if required. Brief summaries of what the other sections of the main report contained were also included in the original Action Plan. These have also been omitted here but can be made available.

ACTION 1 (future weather conditions)

Conclusion The period April 2000 to March 2001 was the wettest on record with nearly double the average amount of rain falling. It was inevitable that such prolonged and intense rainfall would lead to significant flooding in the district. However, the experts predict that there is a likelihood of increased storminess in future and that rainfall in the winter could significantly increase thus making the events of last year a more regular occurrence.

Recommendation Notwithstanding that the rainfall over the last year was exceptionally high, this Council should investigate and put in hand all practicable measures to reduce the extent and frequency of flooding in the future. The situation at the Nailbourne/Little Stour requires particular attention.

Action The various actions set out elsewhere in this report, many of which have already commenced, are aimed at carrying out this recommendation. Close contact is being maintained with the Little Stour and Nailbourne River Management Group to try to progress action.

Current Situation **The continuation of the work to reduce flooding was again proved necessary by the abnormal rainfall on 21 October 2001. For the fourth time in eighteen months two inches of rain fell in less than a day. The intensity of rain on that day was actually the worst we had encountered in recent years and was equivalent to a 1 in 15 year event. Since that time rainfall has generally been just below average for the period 2002 to 2006,with the exception of Christmas to New Year 2002 when there was a prolonged wet period and there were signs in early 2003 of the Nailbourne flowing again. There have, however, been isolated short periods of very heavy rain particularly in summer 2004 and summer 2006. There were a small number of individual locations of flooding but no houses were flooded at any of the main trouble spots. It was noticeable that the number of calls for assistance was considerably down on what we had previously experienced thus showing that the measures put in place had had some real effect.**

This was the situation until summer 2007. In May, June and July 2007 the monthly rainfall was twice the average with a number of high intensity storms of 10-15mm of rain falling in a short period, often quite localised. This continued into August with the worst on the evening of 2 August 2007at Sturry, when there was some internal flooding to five houses, and on the morning of 21 August 2007 when there was severe flooding at Whitstable. On that day 50mm of rain fell in two hours, which is above the average for the whole of August, and a total of 60mm fell in under five hours. The previous four serious flood events in the district (4 April 2000, 12 October 2000, 8 February 2001, 21 October 2001) all had rainfall of just under 50mm but over at least a 12 hour period. This clearly indicates the intensity of rain on 21 August, which was equivalent to a 1 in 50 to 1 in 100 year return period rainfall event.

ACTION 2 (investigate tide locked outfalls)

Conclusion As well as the long-term rainfall there were three days over the last year when very large amounts of rain fell during one day and it would be expected that some localised flooding would result. On two occasions this was coincidental with North Sea surge tides resulting in the outlets to coastal watercourses becoming tide locked. This caused significant flooding along the coastal strip.

Recommendation Along the coast, where tide locking of outfalls can happen and there have been a number of incidents of flooding in recent times, there is a special need to investigate and implement all reasonable measures to alleviate flooding in the future. Particular attention should be paid to the Gorrel Stream, Swalecliffe Brook, Westbrook and Plenty Brook catchments.

Action The various actions set out elsewhere in this report, particularly with respect to operations at sea outfalls, are aimed at carrying out this recommendation. An inter-agency working group has been specifically set up to try to progress solutions.

Current Situation **There are five main outfalls that can become tide locked – Gorrell Stream, Swalecliffe Brook, Kite Farm Ditch, Westbrook and Plenty Brook. A more regular checking and maintenance regime has been set up by the City Council for both the mechanics and electrics for the four latter, which are under our control. More regular maintenance at the Gorrell Tank for the pumps and non-return valves has also been put in place by Southern Water for the Gorrell Stream outfall. Some basic modelling has been**

carried out to determine the effects of tide locking and this information has helped in setting out new procedures in the Council's "Flood Emergency Handbook" for the best time to open or close the sluice gates. Major improvements have been made at some of the outfalls as described in the various Actions elsewhere in this report. There is little else that can be done when high sea levels (storm surges) coincide with heavy rainfall but such events should normally have a reasonable amount of advance warning.

ACTION 3 (continue with coastal defence works)

Conclusion This report concentrates on the causes and possible solutions regarding the inland flooding that happened over the last year. It is essential that we also continue to be very active in dealing with the risk of sea flooding which could affect a large part of the urban area along the coast.

Recommendation This Council should continue with its proactive approach to coastal defence, both maintenance and improvement works, to ensure that the risk of sea flooding and coastal erosion is kept to the very minimum.

Action Coastal defence work, both revenue and capital, is continuing with the aim of ensuring that we retain a high standard of protection against the sea. The service is funded mainly through central government grant aid for capital works and through a special allowance for the Standard Spending Assessment for revenue expenditure, which means that the vast majority of the cost is covered by central government.

Current Situation **Significant capital improvements have been undertaken to coastal defences including the final stage of works at Tankerton and comprehensive sea defence works from Seasalter to Whitstable. Works to the value of about £10 million have been carried out all of which has been grant aided by Defra. As well as this the important, and Defra funded, coastal monitoring and Shoreline Management Plan are well under way. Coastal maintenance has continued and generally the defences throughout are in good condition. This was proved on 9th November with a sea surge of over one metre and gale force northerly winds. There was no flooding to any properties and damage was minimal.**

ACTION 4 (blocked gullies and road drains)

Conclusion The capacity of and blockages in highway gullies, drains and culverts was a possible contributing factor to flooding at a number of locations. Backing up of highway drains near their outfalls to watercourses also caused problems. There is a need to ensure that gullies are regularly cleaned out particularly at trouble spots. Highway drains that regularly overflow need to be remedied.

Recommendation The frequency of clearance of gullies and highway drains should be improved by targeting known flood prone locations for more regular action. A programme of improvements to highway drainage should be compiled with particular reference to areas that flooded over the last year. Locations for the fitting of non return valves should be investigated and flap valves properly maintained to reduce backing up of flood water. Additional funding needs to be made available by Kent County Council to facilitate these improvements.

Action The Kent Highways sub-contractor responsible for gully and drain clearance has been changed resulting in improvements to efficiency. All known flood locations are now targeted by Kent Highways for more regular clearance and a system of priorities has been drawn up. Non return valves and flap valves will be fitted to gully outfall pipes where considered beneficial, subject to funding. A programme of highway drainage improvements has been submitted to the County Council. Kent County Council are aware of the financial implications that the necessary improvements to the maintenance regime would mean.

Current Situation **Kent Highways considers that the efficiency of gully and highway drain clearance has improved under the new sub-contractor and overall the situation throughout the district is better than it was in 2000/2001. However, nearly all the properties flooded in October 2001 were from surface water off the highway and Littlebourne was particularly badly hit. Two sets of drainage improvement works were brought forward by KCC there and have been completed. Major drainage improvement works at Ickham, Bridge and A291 Busheyfields plus a number of smaller improvement works have been carried out. At sixteen**

problematic locations non return valves have now been fitted to highway drains to prevent river water backing up and flooding roads. All road gullies should be cleaned out at least once every year on main roads and every two years on side roads. Known trouble spots are more regularly cleared.
However, there is still a perception that many gullies are not regularly cleaned out, particularly in the older urban areas, and that the overall highway drainage system is poor and it does not take much rainfall for minor flooding of roads to occur. It would appear that in many locations the highway drainage system cannot cope with heavy rain and this is now one of the major causes of flooding. Kent Highways should be requested to carry out a total re-examination of their highway drainage performance, including frequency of gully clearing, and report on their findings and proposed improvements.

ACTION 5 (roadside ditch maintenance)
Conclusion Roadside ditches, including piped lengths at road/drive crossings are an important part of the highway drainage system and it appears that over the years many have been filled in, fallen into disuse or become totally blocked. It is realised that a lot of these ditches could be the responsibility of the adjacent riparian owner and not necessarily Kent Highways. However, lack of maintenance of the ditches clearly contributed to localised flooding and action needs to be taken to remedy the situation to prevent regular flooding. The sizing of many pipes at private drive crossings appears to be too small.
Recommendation Kent Highways should ascertain ownership of the roadside ditches wherever possible and liaise with the landowner about getting them cleared and maintaining them. Particular emphasis should be placed on ditches at known flood locations. Where the owner is not known or where the ditch is within the highway land, Kent Highways should carry out the work. All critical ditch clearances should be completed before next winter. The effect of undersized pipes at drive crossings should be investigated and action taken if required.
Action Clearance of the most critical roadside ditches has been carried out in conjunction with the City Council's own work on watercourse maintenance. A programme of clearance of other ditches is being drawn up but there is only minimal funding by the County Council for this. The situation with piped crossings will be investigated by Kent Highways and CCC Engineering.
Current Situation **Minor improvements have been made at a number of locations, including the particular problem areas at Broad Oak, Chestfield, South Street and Blean, by both Kent Highways and the City Council. Regular clearance of the known problem roadside ditches continues by the City Council and Kent Highways and they are now in a better condition than in 2000/2001 - but a number of roadside ditches remain in poor condition. Overall there is still room for improvement and better funding by Kent County Council for this important but somewhat neglected part of the whole drainage system.**

ACTION 6 (repair of flood damaged roads)
Conclusion Many roads in the rural area have been badly damaged by heavy rain and flooding. This is particularly so in the southern part of the district. In some places the roads are now barely fit for the purpose and the temporary patching carried out is unlikely to last next winter.
Recommendation Action is needed by Kent Highways to ensure that all roads are repaired to an adequate and safe standard. The work must be completed before the advent of the winter rain and frost. Additional funding needs to be made available by Kent County Council to facilitate this work.
Action Work on the structural repairs to the roads is well under way by Kent Highways and the worst affected are being targeted. All roads will, at the minimum, be patched to meet safety requirements but there is insufficient funding available to carry out the required major repairs to all of the damaged roads. Central government has made available some additional funding for this type of work as a result of the flooding nationally and Kent County Council has lodged its bid of £8.5 million. In advance of any funding from central government KCC have deferred £1.5 million of road schemes to start the repair to affected roads. Canterbury's share of this is £118,000 with a further £192,000 likely to be made available shortly.
Current Situation **Kent Highways confirm that all roads damaged in the 2000/2001 floods have been fully repaired. Any damage to roads from later flooding has been relatively minor**

and repairs carried out quickly. Repair to highway and footway damage as a result of the flooding at Sturry and Whitstable in 2007 is in hand and Kent Highways aim to complete all necessary work shortly.

ACTION 7 (maintenance of ordinary watercourses)

Conclusion Ordinary watercourses in the form of land drainage ditches, streams and dykes were considered to be one of the major causes of flooding in the district. There is a need to ensure that all forms of watercourses, including piped lengths, are kept clear and free flowing at all times. Maintenance in the form of ditch clearance, desilting, cutting of excessive vegetation, removal of obstructions etc must be regularly carried out.

Recommendation All persons and bodies responsible for keeping watercourses clear must ensure that they carry out their maintenance preferably with a preventative rather than reactive regime. This would include landowners, City Council, Kent Highways, Internal Drainage Boards plus Southern Water and Environment Agency where relevant. Watercourses that are known to have flooded should be prioritised. The City Council should investigate ownership of all watercourses that cause problems to ensure that the riparian owners are aware of the situation and do carry out their maintenance. Where owners cannot readily be traced or when they refuse to carry out maintenance, the City Council should consider doing the work and recharging the cost. For its own watercourses or when action is for its tenants or clearly beneficial to the public at large, the City Council should set up a preventative maintenance regime for critical watercourses.

Action City Council engineers have traced most of the owners of critical watercourses that need maintenance. A database of these is being set up. Many critical watercourses have been substantially cleared over the last year by the City Council. City Council engineers have drawn up a preventative maintenance schedule for all watercourses known to flood regularly and this is now operational with clearances being carried out in September once vegetation dies down. Where necessary City Council engineers have contacted other agencies reminding them of the need to keep watercourses in good condition. Publicity is being carried out to alert riparian owners to their responsibilities by both the City Council and the Environment Agency. Local community associations and parish councils are assisting with this.

Current Situation **Many riparian owners have been traced and some have cleared their own ditches and watercourses – generally parish councils have been helpful with this. A City Council programme of maintenance is now running for the regular clearing of all the major watercourses known to flood in the urban area. In the rural area some maintenance works have been carried out but this is prioritised to those watercourses close to houses. The City Council has also carried out minor improvement projects at problematic locations. Persuading riparian owners to do their duty is still difficult and time consuming and some formal notices under the Land Drainage Act have been served. Publicity about how the public can assist and what the duties of riparian owners are has been effected through District Life and via some parish councils.**

However, over the last couple of years there has been a gradual reduction in maintenance by riparian owners and a risk that the situation is gradually reverting to the conditions prior to the 2000 flooding. The City Council has had to maintain some obviously private watercourses where ownership cannot easily be found/is disputed. Another high profile publicity campaign is needed.

ACTION 8 (railway culverts)

Conclusion There are a large number of culverts beneath railways in the district and there are also watercourses on railway land. Some of these have been noted to be in need of maintenance and partial blockages have been recorded. This situation has possibly exacerbated flooding of both main rivers and ordinary watercourses. It should be noted that, because of safety and strict railway operating regulations, it is not possible for the City Council or its contractor to enter railway land to carry out even emergency work.

Recommendation Railtrack must inspect all culverts and watercourses on their land and ensure that they are clear and free flowing. Because they alone can do the work, even in an emergency, Railtrack should put into operation a planned system of maintenance and make sure all blockages

are cleared before the coming winter.

Action City Council engineers are aware of those railway culverts and watercourses that have caused problems during recent flood events. They have been in contact with Railtrack and pointed out the problem. Railtrack has carried out inspections of a number of its culverts and has carried out some clearance works. It will be commencing remaining clearance and repair works shortly.

Current Situation **Railtrack (now Network Rail) carried out clearance of all the main problem locations as notified to them by the City Council. They have been prepared to action any new problems when requested reasonably quickly as they did recently for a site at Sturry.**

However, Network Rail's inspection regime is not known and they should be asked to confirm that they do inspect and maintain regularly.

ACTION 9 (springs and high ground water levels)

Conclusion Some properties have been flooded from springs or exceptionally high ground water levels. Sources have been both in surrounding land and under houses themselves. Residents have asked the City Council for assistance to try to solve the problem.

Recommendation Where the source is in adjacent land the City Council should offer advice regarding possible works that could be done by the householder to divert the water away from the house. If this is not possible then sandbags or similar should be provided to try to prevent the water entering the property. For sources under the building itself it should be recognised that there is nothing the City Council can do to help and it is suggested that householders should engage specialist consultants for advice, possibly through their insurance company.

Action Where requested, City Council engineers have and will continue to visit the site and offer advice to householders. Some sandbags have also been provided for semi-permanent protection.

Current Situation **Nothing more has been done on this subject except to try to give guidance to any residents requesting advice. The drier winters since 2001 have meant that springs have not been much of a problem but it must be admitted that should wet weather, and the springs, reappear there is virtually nothing that the Council can do to alleviate the situation apart from supplying sandbags if these will do any good. There were no reported major problems with springs during the wet summer 2007 but should the wet weather continue into winter the springs are likely to reappear.**

ACTION 10 (surface water flooding from higher land)

Conclusion Many properties have been flooded by surface water flowing directly off adjacent higher land, often farmland or open space. It should be noted that, unless there is a ditch that has not been maintained or significant change to the upper land causing the problem, under law this is counted as a natural phenomenon. In some cases the City Council could be involved as landowner. The City Council has been approached by many residents asking for assistance.

Recommendation The City Council should offer advice and try to mediate between land owners to try to solve the flooding problem. If the upper land is City Council owned, village green or of unknown ownership then the City Council should investigate a permanent solution such as installing a land drain. If the lower land has City Council property on it or if it would benefit the public at large, a permanent solution such as a new land drain should also be investigated.

Action City Council engineers have responded to numerous requests for help by the public on this and similar land drainage issues. There is still a long backlog of site visits to be carried out as priority has been given to locations where houses have actually been flooded. Staffing availability means that not all problems will have been addressed before next winter. Minor land drainage improvement works have been implemented and some further works are planned but there are insufficient funds available to tackle the bigger problems.

Current Situation **Minor land drainage improvements by the City Council to try to alleviate the worst of the problems have been gradually carried out over the last few years and this continues under the Council's land drainage budget. There still remains a number of minor works to be carried out but the worst of the known ones have been completed. Priority has**

been given to where a number of houses may be affected. A lot of staff time has been spent in trying to mediate between neighbours and get them to agree to positive action. See also Action 14 regarding agricultural land.

ACTION 11 (weedscreens, sluices and floodgates)

Conclusion Blocked weedscreens and sluice gates not fully open or jammed with debris were the cause of a number of flooding incidents on all types of watercourses. Despite efforts by the relevant agencies these were often cleared too late or it was impossible to clear them because of danger to operatives. The public were unclear as to whom they should contact if they noted a problem. Despite the fact that this had not happened, the public were concerned that floodgates at outfalls had been left closed thus making flooding worse.

Recommendation Improvements to procedures are required to ensure that weedscreens and sluices are visited at an early stage of a potential flood event and cleared where necessary. Some weedscreens need to be redesigned and rebuilt to improve their performance and to allow safe access for operatives to clear them at the peak of the flood. The public need to be better informed of who to contact and agencies should be prepared to coordinate action. Better publicity is required to inform the public of working practices and it is suggested that notices are set beside all these structures to notify the public who to contact.

Action Environment Agency, Southern Water, Inland Drainage Board, Kent Highways and the City Council itself are all involved. These agencies have been asked to re-examine their procedures as recommended. City Council engineers confirm that their procedures do call for inspections of their sluice gates on issue of a Flood Watch. Most of the major weedscreens have been significantly improved recently and there are proposals to improve the others shortly. Publicity and better response to the public needs is being discussed with the Environment Agency and others.

Current Situation **Improved procedures for ensuring that weedscreens, sluice gates etc are checked and cleared regularly and at times of heavy rainfall have been brought into operation by all the agencies involved. No known flooding to property has occurred due to weedscreens being blocked. City Council staff continue to inspect all sluice gates when there is a Flood Watch and the procedure is written into the "Flood Emergency Handbook". All but one of the major weedscreens that previously gave problems have now been improved (Valley Road Barham, Plenty Brook Eddington, Swalecliffe Brook outfall). The weedscreen on the Gorrell at Millstrood Road will be renewed towards the end of this year as part of other works there. Many of the weedscreens on smaller watercourses have also been improved/renewed.**

ACTION 12 (dredging of main rivers and bank repairs)

Conclusion Improvements need to be made to main rivers to bring them back to the capacity that they once had. Many long time residents complained that the maintenance of rivers, such as dredging and bank repair, has reduced considerably over the last ten years and this could have been the cause of much flooding. A further point that had been made by many of the public and other bodies was that too much emphasis was now being placed on environmental reasons for not doing work and too little on the repercussions and resulting flooding.

Recommendation The Environment Agency should revert to earlier practices in that all critical sections of main rivers should be dredged regularly and the banks should be maintained in a stable state. The rivers should be widened and deepened where necessary to bring them back to their original channel size. Locations where banks have settled or been penetrated should be reinstated. Whilst environmental aspects of the work should always be considered this should not necessarily over-rule the need to prevent flooding.

Action The Environment Agency has reported that some dredging and desilting of a number of lengths of main rivers has now been carried out including the Westbrook, Swalecliffe Brook and parts of the Nailbourne/Little Stour. The work on the Great Stour and remainder of the Nailbourne and Little Stour is programmed for October/November. Critical bank repairs are also programmed for that time. There are no proposals for any extensive re-cutting of existing channels. Maintenance regimes are being re-examined but there are significant funding problems. The Environment Agency has to abide by the strict environmental protection legislation in doing its work.

Current Situation **The Environment Agency now has an annual dredging/desilting contract for the Stour and the majority of the length downstream of Fordwich has been dredged at least once. Occasional dredging/desilting at the Little Stour, Swalecliffe Brook and Westbrook has also been carried out on an as and when needed basis by EA. The critical bank repairs noted after the 2000/2001have mainly been carried out although it is considered some action is still needed on parts of the Stour embankment near Grove. Bank improvements have been carried out at Fordwich.**
However, no extensive re-cutting of existing channels has been carried out and the EA considered that action and funding for such work would need to await completion of the Stour Catchment Flood Management Plan (CFMP) and possibly an Environmental Impact Assessment. The CFMP has been completed and policies set for the various sections of the Stour and for the other main rivers. These policies, however, cannot be instigated without more detailed strategy plans and instigation of capital projects, which will not be ready for some time. It is considered that many of the main restriction in the channel could be removed at relatively low expense under maintenance and therefore could go ahead now. See also Action 13 below.

ACTION 13 (weedcutting and removal of debris at main rivers)
Conclusion Debris in main rivers needs to be removed quickly to prevent a build up of material behind it and consequential flooding. Some parts of rivers at or just downstream of flood prone locations had been observed to be clogged with weeds for a long time. The debris, arisings from dredging and cut vegetation is usually left on the river bank and quite often it quickly finds its way back into the river due to vandalism or after heavy rain.
Recommendation The Environment Agency should ensure that they have practices in place for rapid response and removal off site when there are reports of debris in rivers. Weedcutting must be regularly carried out and actual removal of roots should be considered at particularly densely weeded locations. Particularly in residential areas, material should be taken away. At other critical areas it should be placed well away from the river banks.
Action The Environment Agency confirms that weedcutting is carried out annually and can be done more regularly if required. At certain locations reed pulling will take place this year to clear very congested areas. There are no proposals to take dredgings and weedcuttings off site except in exceptional circumstances because of the very high tipping charge costs. Weedcutting and reed pulling has now been carried out on the Swalecliffe Brook, Westbrook and parts of the Nailbourne and Little Stour. Work on the Stour and second cut along the Nailbourne/Little Stour will take place in October/November.
Current Situation **Weedcutting, reed pulling and removal of general debris is carried out along all the main rivers by the Environment Agency. On the Stour this is understood to be at least once a year but at other rivers it appears to be much less frequent. There is significant concern that environmental reasons have meant that this operation is both less frequent and less extensive than it should be to maintain an adequate flow channel. This is particularly relevant on the Little Stour and on the Great Stour downstream of Fordwich. There is a narrowing of the channel on both these rivers due to vegetation and trees growing in what was once the river channel causing silt and mud to build up behind. The gradual reduction of flow capacity at these locations is considered to be a serious problem. The Environment Agency is aware of this and should be requested to action the situation which has built up over many years and is slowly reducing the capacity of the rivers. See also Action 12 above.**

ACTION 14 (agricultural practices and land drainage)
Conclusion Many people considered that changes to farming practices had exacerbated the flooding problems in rural areas and on the outskirts of urban areas. Two particular potential causes were the grubbing up of many of the orchards traditional to Kent and removal of hedgerows and ditches. It was acknowledged that orchards would significantly hold up surface water naturally and their removal had increased the rate of run off from fields. The reduction in hedgerows and ditches had meant that water was not so well channelled, flow downhill was increased and often this was

very silt laden thus quickly blocking gullies and drains. A further perceived cause of problems was the ploughing of land downhill rather than across the slope.

Recommendation The relevant ministry should be contacted to see whether there is any possibility of grant being made available to return fields to orchards or any other way to improve the situation. The NFU should be involved in these proceedings. It was understood from the NFU that there is some form of grant for replanting hedgerows and it is essential that this is well publicised. The reinstatement of ancient evaporation ditches should be considered. City Council and Kent Highways should liaise with farmers to try to reinstate or improve ditches to reduce flow at critical locations and remove the silt and mud flowing onto highways. The NFU has advised that there can be practical difficulties with ploughing across the slope but that it would ensure that farmers are made aware of the comments.

Action The City Council with the help of parish councils has had discussions with some farmers and minor improvements agreed but widespread contact via NFU has not yet been carried out. The City Council and Kent Highways have carried out minor works at some critical locations to construct or improve catchpits to reduce the silt getting into highway drains.

Current Situation **Some further meetings and discussions with individual farmers have taken place and minor improvements to reduce extreme run off have been undertaken by them. However, the problem as a whole remains for the most part and very little has been done. The very important issue of agricultural land and its relationship to flooding is a national issue that Defra are aware of but have not seriously actioned. There is increasing concern about the large number of polytunnels that have been erected in the last few years and the significant rainfall run off that they cause compared with traditional arable land. Some farmers have been considerate in installing additional land drainage and keeping the polytunnels away from houses. It is considered that parish councils could use their influence and knowledge to help with this subject.**

ACTION 15 (sewage pumping station failures)

Conclusion A large number of houses throughout the district had been flooded with sewage either directly or mixed with other flood water. Reports had been received of many failures of sewage pumping stations, which Southern Water state was mainly due to inundations by flood water. Numerous incidences of surcharging of the foul sewers also occurred. Many pumping stations had apparently failed due to inundation on a number of occasions resulting in the system becoming surcharged with surface water and backing up into houses. These problems were quite widespread and not just limited to the severely flooded areas. Particular problem locations reported over the last year had been at: Herne, Blean, Howfield Lane Canterbury, Fordwich, Eddington, Sturry, Marshside, Seasalter, Hoath, South Street Whitstable, St Stephens Canterbury, Waltham, Petham, Chartham, Thanington, Shalmsford Street, Pean Hill and all villages beside the Nailbourne/Little Stour. The public had also complained that systems often broke down after any spell of heavy rain and not just during the flooding recently experienced.

Recommendation Southern Water should carry out an investigation of all the reported problem areas with a view to preventing future reoccurrence. More preventative rather than reactive maintenance to pumping stations should be carried out and possibly flood boards should be considered at doorways to pumping stations in problem areas. Sources of infiltration should be found and stopped . There should be a better system of stand by pumps and emergency generators at critical pumping stations to reduce downtime and resulting sewage flooding. There appeared to be a need for a comprehensive review of the sewerage infrastructure and major improvements to reduce both the extent of flooding from sewers and the regular failures reported at some positions.

Action Southern Water has confirmed that it is currently carrying out investigations at all known sewage flooding locations and will make improvements if these are considered to be essential and within their current financial programme. Some improvements at regular problem locations such as Howfield Lane and Seasalter were already under way. Other minor works have now been carried out as a result of the investigations. Southern Water consider that their current maintenance system is adequate and there are no plans for extensive changes. There are not sufficient funds for major infrastructure improvements in the Canterbury district in response to flooding at the present time.

Current Situation **Southern Water has investigated all the reported pumping stations that**

had problems. Where there were any faults these have now been corrected and at some pumping stations significant improvements have been carried out or are in the current five year capital programme. Southern Water still maintains that many of the problems were not failures of pumping stations, as they were still working to design capacity during the floods, but that the pumping stations were overwhelmed by surface water ingress. This is a further outcome of the poor overall state of the infrastructure – see Action 17.

ACTION 16 (pumping effluent into watercourses)

Conclusion Sewage, both effluent and solids, had been pumped into watercourses at a number of locations, the worst and most continuous being along the Nailbourne and Little Stour but discharging into the Petham Bourne and Plenty Brook is also known to have occurred. This had been carried out by Southern Water as the foul sewerage system had become inundated by flood water from the rivers or it was incapable of handling the combined system during storms. Checks by the Environment Agency had revealed that the concentration of effluent in the rivers was actually quite low being 95% clean water. The Panel expressed its disquiet that in the 21st century raw sewage, including all the detritus, was allowed to be pumped into watercourses passing by people's homes and it appeared that nothing could be done about it.

Recommendation There appears to be the need for stricter enforcement by the Environment Agency to prevent the pumping of sewage into watercourses. OFWAT should also consider using any of their powers to stop this. At the very minimum Southern Water should take measures to ensure that, if this situation is unavoidable because of very high surface water flows, all solids should first be properly screened off so that only the liquid effluent enters the watercourse.

Action Southern Water has stated that it was the exceptional rainfall and the swollen rivers that caused this problem and major improvements are not under consideration at this time. They would be carrying out any required repairs to damaged or blocked pipelines as a matter of urgency but no additional action is proposed as the company considers the sewer system is adequate for normal operation.

Current Situation **The Southern Water response on this item in general remains as previously in that the company considers that the sewer system is adequate for normal operation and should not be expected to cope with abnormal rainfall. Repairs to damaged and leaking pipework have been carried out and at some particular problem locations further work was done including increasing pumping capacity and relining of sewers – details in the relevant Actions elsewhere in this report. Apart from one problem at Eddington in 2003, no known reoccurrence of this has happened.**

ACTION 17 (public surface water sewers)

Conclusion Flooding of houses at a number of locations had been reported by the public as being due to backing up or overflowing of main surface water sewers under the responsibility of Southern Water. Reports by the public of gullies being blocked and causing flooding sometimes turned out to be that the public surface water sewer was full. It would appear that some surface water sewers did not have the capacity to take heavy rainfall or were at least partially blocked.

Recommendation All surface water sewers at known trouble spots should be surveyed by Southern Water and any debris within them removed. A system of preventative checks of the critical sewers should be carried out before each winter to ensure that they are clear and free flowing. Capacity checks should be carried out on those sewers known to flood regularly. There appeared to be a need for a comprehensive review of the public surface water sewer infrastructure and major improvements to reduce both the extent and frequency of flooding.

Action Southern Water has carried out cctv surveys of some of the critical sewers and some others are proposed. Any debris found has been removed. They are also carrying out high pressure jetting to cleanse the pipelines. As for the foul water sewers there are no major infrastructure improvements planned at this time and the company states that the surface water sewers are generally adequate.

Current Situation **There has been a marked improvement in action by Southern Water on inspection and clearance of potentially blocked surface water sewers. All known major trouble spots have now been dealt with by the company – details in the relevant Actions**

elsewhere in this report.
However, there are clearly locations where the surface water sewers, including highway drains, have a capacity significantly under what is required during very heavy rain and flooding results from this. No action has been taken to carry out any major improvement works to the infrastructure. The situation is ably demonstrated by the flooding in Whitstable on 21 August where the infrastructure was clearly unable to cope – similar situations would be likely to occur in the older parts of Herne Bay and Canterbury if very heavy rain occurred.

5. SPECIFIC PROBLEM AREAS AND PROPOSED IMPROVEMENTS

There are a number of specific problem areas where significant flooding occurred. Particular or site specific courses of action may be needed over and above the general problems and recommendations set out in the previous section. Details for these locations are included in this section. Absence of a reference to a particular area or problem does not mean that it will be ignored or not actioned but clearly the amount of properties at the following locations that were flooded means that they should be prioritised.

ACTION 18 (Plenty Brook)
Conclusion There is a very serious flooding problem from the Plenty Brook both sides of the railway at Eddington and Cherry Gardens, Herne Bay. 45 houses were badly flooded in February 2001 and of those at Eddington were also flooded in April 2000. Many other houses in the area only just escaped flooding. In October 2000 the same houses in the area were again close to being flooded. The situation is complex involving the Southern Water main culvert under Herne Bay and the reservoir south of the old Thanet Way, the new A299 balancing lagoons and the watercourse itself. The public also see recent large housing developments in the area as being a contributory factor to the flooding.
Recommendation Urgent action is required to alleviate the situation. It is noted that the recent installation of an improved weedscreen and the removal of the tidal flap valve, both of which were previously prone to jamming, should ease matters. However, further measures are considered necessary to reduce possible flooding. In the long term the whole catchment should be investigated, together with possible major infrastructure improvements, particularly regarding future development.
Action The coastal inter-agency working group is treating this as a top priority. An independent consultant has been appointed and has examined all factors, particularly the inter-relationship between the KCC A299 lagoons and the Southern Water attenuation reservoir. The consultant's findings have been considered by the agencies involved to determine the best course of action. An extension to the reservoir and some improvements to the KCC lagoons are being evaluated and, subject to the approval of the Southern Water board, should go ahead shortly. The culvert itself has been fully inspected by Southern Water and no obstructions have been found. The vegetation growth and silt, that is reducing the capacity of the existing reservoir, is currently being removed by Southern Water. The City Council has and will continue to clear growth and debris from the brook at Eddington and a further clearance will take place at the end of September. The City Council will formally approach central government in October for funding to carry out the detailed catchment study. The drainage attenuation ponds and tanks at the recently built developments in the vicinity have been inspected and it is confirmed that they are working properly. The new planning guidance note requiring a drainage impact study will result in strict regulation of surface water flow from any further new developments.
Current Situation **A number of short and medium term improvements have been made to the Plenty Brook over the last few years. These have included - complete inspection and removal of any obstructions in the main culvert under Herne Bay by Southern Water, including the removal of a faulty flap valve; the construction by Southern Water of a new overflow holding reservoir, to improve the capacity of the existing by 30%, beside the old Thanet Way; Kent Highways has improved the holding capacity and the overflow arrangements of the A299 drainage lagoons; the City Council has totally cleared through the brook and constructed an improved weedscreen at the culvert to the railway embankment.**

As well as these improvements there is now regular maintenance and removal of growth/debris in the brook by the City Council (on behalf of the Environment Agency) and Southern Water has completely cleared its reservoir of silt and vegetation – although it is now becoming overgrown and further action is needed. The major project that will bring significant improvements is the construction by the Mill Lane developer (as part of the development requirements) of a 35,000 m^3 holding lagoon on the Plenty Brook between the A299 and the Herne Bay Golf Course. This has just been completed. There is also a 10,000 m^3 lagoon on the Herne Drain watercourse that feeds into the Plenty Brook at the Herne Bay Golf Course. This has also just been finished.

ACTION 19 (Eddington Sewerage)

Conclusion Widespread problems with the foul sewerage system throughout the district have been noted in this report. Inundation of the system by flood water and failure of pumping stations has been of great concern in many areas. However, the circumstances at Eddington are considered to be particularly critical. Whenever there is heavy rainfall there is backing up of sewers, people cannot use their lavatories, often sewage in gardens and some reports of flooding in houses. As a result of these sewerage failures there is often detritus littering the Plenty Brook. The main problem is adjacent to the Eddington Pumping Station but other areas of Herne Bay and at Herne village are also affected.

Recommendation Even though the over flow from the combined sewer has been consented by the Environment Agency, Southern Water need to fully investigate the situation and carry out works to improve the infrastructure. It is suggested that major improvements to the pumping capacity are needed to cope with the surface water inflow during heavy rain. Other options that should be considered would be methods to separate out some of the surface water that gets in. An immediate measure must be improvements to screening at the Eddington Pumping Station to stop detritus getting into the Plenty Brook.

Action Southern Water has reported that a consultant has been appointed to look into the total question. Ways to improve the situation in the immediate vicinity to the pumping station are a priority. Some improvements to the operational methods at the pumping station are currently being tested.

Current Situation **The Southern Water consultant proposed a number of local improvements and these were all undertaken by the company. In order to prevent solids being deposit along the brook the screen within the pumping station has been modified and its operation and clearing system improved. All pumps have been fully overhauled and systems put in place to reduce possibilities of breakdown. An additional standby pump has also been installed. The operation of the storm pumps has been changed so that in wet weather they come on stream earlier to make use of the full capacity of the pumping main. These changes were completed in late 2001. There was a minor problem during very wet weather in 2003 and the pumping electronics modified as a result but since that time no known problems have occurred. Southern Water has no plans to make major improvements to the system at this time. See also Action 15.**

ACTION 20 (Swalecliffe and Chestfield)

Conclusion At Swalecliffe and Chestfield there is an ongoing flooding problem that was particularly bad during the April 2000, October 2000 and February 2001 storms. Flooding is from a number of sources - mainly the Swalecliffe Brook, Kite Farm Ditch and watercourses that feed into them. Flooding to some degree has been a regular occurrence since December 1999. A total of 40 houses have been flooded, some more than once, and major roads in the area have been impassable. It is perceived by many long time residents that the new A299 has had a major impact on the land drainage pattern.

Recommendation Improvements are required at a number of locations to ease the situation. The effects of the A299 need to be investigated and corrected where necessary. The regular flooding at Molehill Road and Radfall Road, which cuts off the community, must be solved. A solution to the tide locking problems is needed and the possibility of a new outfall should be

considered. The whole catchment and longer term options should be studied especially with reference to any future development.

Action A number of minor improvements have already been carried out and more significant works are now under way or programmed for the near future. These are detailed in the main report and can be summarised as: works completed or under way - City Council removed shingle and debris at Kite Farm Ditch outfall and large amounts at Swalecliffe Brook outfall, cleared and improved watercourses at Chestfield particularly along Molehill Road, on behalf of KCC carried out drainage works at Radfall Road and new culverts at Molehill Road; Kent Highways cleared blockages in A299 drainage and at the outfall lagoon; Environment Agency completed weedcutting, removal of debris and some dredging in the Swalecliffe Brook; Southern Water commenced inspection and removal of any debris in the public sewer part of the Kite Farm Ditch and paid for new improved weedscreen at the Kite Farm outfall (work done by CCC). Works planned for the near future are - City Council construct additional outfall works at Swalecliffe plus new weedscreen (contract about to go out to tender), minor improvements to the Kite Farm Ditch at Maydowns Road (work to be done by end September); KCC construct new balancing lagoon at Molehill Road to attenuate the flow from land drainage in that area (planning approval just received subject to landscaping being agreed). Along with land drainage works to the Chestfield Golf course the Club are currently constructing two balancing lagoons on the course which should further help the drainage situation adjacent to the new A299. The City Council and Environment Agency are proposing to carry out a joint catchment study of the area subject to central government funding approval.

Current Situation **The following major works that were promised have all been completed and are working well: A new balancing lagoon at Molehill Road has been built by Kent Highways to restrict the flow of water from the A299 drainage into the Molehill Road ditch and the rest of the Chestfield watercourse system; other drainage improvements were also carried out by Kent Highways in the area; the Golf Club has improved their land drainage and built a small balancing lagoon on the golf course; the City Council constructed a second outfall for the Swalecliffe Brook at Long Rock together with improved weedscreen – this almost doubled the flow capacity there; the Kite Farm ditch has been improved and regraded by the City Council and the culverts under the old Thanet Way have been completely cleared; Southern Water carried out jetting through and clearance of the sewer system at Colewood Road; the ditch system near the Kite Farm sea outfall together with the weedscreen have been improved by the City Council; most of the smaller watercourses through Chestfield have been fully cleared and minor improvements made by both the riparian owners and the City Council. The City Council continues to regularly clear the Molehill Road and other problematic ditch systems in the area. The Environment Agency completed weedcutting and minor desilting works in the Swalecliffe Brook and have returned to remove other debris on occasions. Improved drainage at the Radfall Road flyover has been completed but the proposed new outfall works continue to be held up as permission is still withheld by the landowner. It should be noted that there was no known flooding to property at Chestfield despite the heavy rain of 21 August 2007 although there were flooding problems under the Radfall Road flyover.**

ACTION 21 (Greenhill and Hampton)

Conclusion There was significant flooding in February 2001 at both Hampton and Greenhill, Herne Bay from the Westbrook and the Greenhill Ditch which runs into it. In total 25 properties were flooded plus a school and a number of business premises. The coastal road at Sea Street was impassable for some time. The main locations were Aldridge Road and Fife Road at Greenhill and Studd Cottages at Herne Bay. These locations all have a history of flooding. Causes of flooding at Hampton are related to the tide locking of the river but the various restrictions by bridges and the condition of the river itself are considered significant. At Greenhill there are a number of possible factors contributing to flooding.

Recommendation The Westbrook has a number of places where the width is restricted or banks have partially fallen in and is in need of dredging. Environment Agency should carry out maintenance works before the winter. Possible improvements to flow at culverts and bridges should

be investigated. An off stream attenuation lake to hold back some of the flow should be considered in the long term. Improvements to the downstream end of the Westbrook will also assist the Greenhill Ditch. The various agencies involved with the Greenhill Ditch, much of which is piped, need to get together to resolve the problems and make improvements.

Action Environment Agency has completed weedcutting and desilting of the Westbrook together with removal of accumulated debris. Repairs to the banks are also under way. For the piped section of the Greenhill Ditch, Southern Water has jetted the system at the problem area and removed some obstructions but recent road flooding shows there still to be a problem with the pipework. Southern Water are being pressed to carry out a full cctv survey and a capacity check on the public sewer network. Railtrack have cleared debris from the culvert under the railway. The City Council has cleared the large amount of debris in the private section of the watercourse and has contacted the owner pointing out his maintenance duties. The City Council has, at the cost of the landowner, removed the disused private bridge that caused a restriction to the flow. The Environment Agency will carry out a catchment study but this is not programmed for some time.

Current Situation **The Environment Agency completed all the planned works to the Westbrook - comprising weedcutting, desilting, bank repairs, removal of debris and cutting back of trees encroaching on the river. Southern Water carried out a detailed cctv survey of the surface water drainage system at Greenhill and found major blockages by tree roots in the pipeline. These blockages were removed and the pipeline fully jetted. The City Council has quite regularly removed debris thrown into the Greenhill Ditch open watercourse and carried out general maintenance. Regular maintenance of the Rowland Drive watercourse is carried out. There is still difficulty in getting action from riparian owners and the problem of discarding debris, particularly garden rubbish, in this area continues.**

ACTION 22 (Whitstable)

Conclusion Flooding was not so widespread in Whitstable as in other urban areas but still at least 20 houses were flooded. The worst hit areas were all along the Gorrel Stream which is the main watercourse draining the town. Part of the City Council estate at St Andrews Close was badly flooded in February 2001 by both surface and foul water. The main reason was probably that the adjacent watercourse was blocked by illegal dumping of rubbish. In October 2000 there was flooding to many properties in the Westgate Terrace area when the pumps at the outfall at Gorrel Tank failed. This part of the Gorrel Stream is designated as a public surface water sewer maintained by Southern Water.

Recommendation At St Andrews Close the City Council should contact the riparian owner of the watercourse to ensure that he keeps it clear and free flowing. Until a satisfactory maintenance regime is set up by the owner the City Council should protect its tenants by carrying out preventative maintenance to try to ensure the stream remains clear. A publicity campaign is needed to advise tenants not to dump rubbish. At the Gorrel Tank Southern Water should investigate and carry out improvements to the pumping system to try to ensure that this major pumping station does not break down again.

Action City Council engineers have contacted the riparian owner at St Andrews Close and are awaiting a response. In the meantime regular maintenance of the watercourse is taking place and it will be cleared again at end September. Southern Water have advised that improvements have been made to the pumps and the control systems at Gorrel Tank. A secondary back up system has also been installed.

Current Situation **A new weedscreen by the City Council and extra maintenance has significantly improved the situation at St Andrews Close and there was no flooding there even during the 21 August 2007 event. The occasional major clearance and more regular general maintenance visits to the Gorrell at Millstrood Road has improved the situation but fly tipping remains a serious problem. Works to the outfall there plus new weedscreen and regrading of the stream are about to commence. At the Gorrell Tank Southern Water increased to three the number of pumps that would be operational during heavy rain.**
Despite the above and other general improvements there was flooding to about 50 houses at Whitstable as a result of the very heavy rain on 21 August 2007. It is considered that the intensity of rainfall over a very short period caused the flooding but the low capacity of the

highway drainage system and that of the public sewers may well have exacerbated the problem. The amount of silt within the Gorrell tank structure and the lack of urgency by Southern Water to remove it remains a matter that needs to be resolved.

ACTION 23 (Stour Canterbury to Fordwich)

Conclusion In the urban area there was no major overtopping or bursting of its banks by the Stour. There were some localised problems where flooding directly and indirectly came from the river. These were at Thanington, St Peters Canterbury, Broad Oak Road/St Stephens Canterbury, Sturry and Fordwich. In total 20 houses were flooded. At Fordwich there is a related land drainage problem which also caused some flooding. Backing up of surface water drains that outfall into the river at a number of these locations may well have made the situation worse.

Recommendation The Environment Agency should ascertain the various possible reasons for flooding and carry out improvement works. Non return valves should be fitted to outfall pipes. The banks of the river should be surveyed to find any low spots where attention would reduce the possibility of flooding. Dredging of the river should be carried out where necessary to improve the flow. Canterbury City Council should examine the land drainage problems at Fordwich.

Action The Environment Agency has agreed to remove the shoals in the river at St Stephens and the work will be carried out in October. The situation with the river banks there will also be checked at that time. The City Council will survey the banks in the St Peters area to see if any raising can be carried out - survey planned for September. Southern Water has agreed to fit flap valves to outfalls - work to be carried out shortly. At Fordwich the Environment Agency will carry out works in October/November to ensure that the river walls and banks are continuous and at the correct level. The damaged expansion joints will also be renewed. The City Council, with the landowner, is looking into the land drainage problems there and the situation will be advised to residents shortly. An action group, Floodlinks, has been set up by affected residents and parish councils at Fordwich/Sturry and the City Council is liaising with that group in order to try to solve some of the issues.

Current Situation **The removal of shoals in the river and the minor raising of banks at locations downstream of Kingsmead has been carried out by the Environment Agency. Non return valves have been fitted at some but not all the outfall locations by Southern Water. At St Peters the fitting of non return valves to highway drains has been completed by Kent Highways. The City Council has installed/raised some floodboards at St Peters. At Fordwich the Environment Agency has completed maintenance works to river walls and banks to restore them back to their original level. Clearance and minor improvements to ditch systems has been carried out by the riparian owners and the City Council at Fordwich and Whitehall Road. The City Council has completely refurbished all river sluice gates through Canterbury to ensure easy operation during high river flows. The private sluice gates at Barton Mill, which have caused some backing up of the river, are now being removed in conjunction with the development there. Concerns have been raised about the general condition of the Stour through Canterbury and EA have recently carried out cutting back of vegetation and debris clearance.**

ACTION 24 (Herne Bay & District)

Conclusion In the centre of Herne Bay and the surrounding communities of Herne, Broomfield and Beltinge there were quite a large number of flooding incidents from a variety of sources. It is estimated that at least 15 houses were flooded internally, at about ten different places, over the April 2000, October 2000 and February 2001 storms in this area. The probable causes were foul sewers backing up, minor streams being blocked, problems with highway and public surface water sewers, possible land drainage changes due to the new A299 and water flowing off fields.

Recommendation City Council engineers should investigate all these problem areas and ensure that the responsible agency is aware and is looking into possible solutions. Where no other agency is involved the City Council should consider what action it can take to assist.

Action Some of the issues have been followed up and other agencies are also investigating but most of the problems have yet been looked into in detail. Sewage flooding at Herne has happened again recently and Southern Water are being pressed to solve this problem.

Current Situation **A number of the flooding and land drainage problems have been resolved but there remain some still to be fully dealt with – but these have no solution without very expensive capital works (Southern Water). The sewage flooding problem at Herne appears to have been solved by Southern Water by the installation of non return valves. Some minor improvements to surface water flooding at Reculver Road and Beltinge have been made by Southern Water. The City Council has carried out land drainage improvements at Canterbury Road, Lower Herne and Eddington as well as a continuing maintenance programme for other problematic minor watercourses. See also Action 15 with respect to sewage pumping stations.**

ACTION 25 (North Canterbury)

Conclusion There has been a land drainage problem in existence for a long time at north Canterbury from Harbledown right through to Broad Oak. This is allied to the catchment of the Sarre Penn watercourse. Many land drains and watercourses are not functioning properly and water flows unchecked from the hillsides above into residential areas. In the past there have been minor landslides and failures of retaining walls. Although there was considerable flooding of a large area a number of times over the last year the number of houses reported flooded internally was 5. Except for at the Cherry Gardens locality where the condition or capacity of the Southern Water foul and surface water sewers have added to the problem, there are no other agencies involved.

Recommendation The City Council should carry out an in depth study to ascertain the problems and options for improvement. All incidents reported should be followed up to try to instigate short term measures that may help. Landowners should be contacted and made aware of the problems and their responsibilities where relevant.

Action The City Council will shortly be applying to central government for funding of a detailed study here. Some problems have been investigated but because of priorities there are many still to be checked up on.

Current Situation **Defra grant aid was received for a land drainage study here and at some other locations within the district. The study has been completed and the consultants made a number of recommendations. The short term recommendations, which included a number of minor improvements to watercourses, have been completed. Some improvements have been made by Southern Water to the foul and surface water sewer systems at Cherry Gardens. The City Council has recently carried out minor improvements to the watercourses at Hillside Avenue and Longmeadow Way.**

However, the more comprehensive land drainage improvements suggested in the study still need to be carried out. This work is dependent upon funding from the land drainage revenue account and the call on that money from higher priority items elsewhere in the district.

ACTION 26 (Great Stour)

Conclusion Considering the large developed floodplain of the Great Stour and its massive catchment, there was not widespread flooding from it. Houses as Shalmsford Street and Chartham were very close to being flooded in November 2000 and February 2001. Some houses were flooded at Canterbury and Fordwich directly or indirectly (see elsewhere in this report) from the Stour. However, the main problems were at its confluence with the Little Stour where large tracts of land at Grove were under water for many weeks around February 2001. It is concluded that the holding reservoirs at Aldington and Ashford worked well and the Environment Agency are praised in this respect.

Recommendation Improvements and raising of the banks of the Stour need to be made in the vicinity of Grove to prevent overflow and flooding of the low lying land. Significant dredging of the river bed is urgently needed at Plucks Gutter and further downstream and more frequent maintenance should be planned in future. The pumping capacity at Stourmouth, where the Little Stour is pumped into the main river, should be investigated with a view to increasing flow rate. The whole catchment including the Little Stour and Nailbourne should be studied and the resulting long term improvements put into Environment Agency's capital programme for action as soon as possible.

Action The Environment Agency has confirmed a programme for dredging 3 km of the Stour downstream of Plucks Gutter commencing in October. Due to insufficient funds the next stage of dredging will not start until autumn 2002. The environmental problems in repairing the banks at Grove Ferry have been solved and the work will be carried out in October. Other major improvements to the Stour including possible increased pumping at Stourmouth will be examined as part of the in depth catchment strategy study which is about to commence. The Agency has been requested to urgently repair and bring into use the two (out of six) damaged gates at Stonar Cut and to look into reinstating the original width of the river in the Grove area.

Current Situation **The Environment Agency now has in place, and funds available, a programme for capital dredging of the Stour from Sandwich back to Fordwich with an annual rate of about 3 km per year. The first length from Sandwich towards Plucks Gutter was completed in 2001. Since that time the dredging has been fairly regular although perceived environmental impacts have caused delays. The gates at Stonar that all needed repair and partial refurbishment have all been repaired/renewed.**

Repair/raising of the banks and some reinstatement of river width at Grove Ferry did not go ahead because of the need for a full environmental impact study and much of the work is even now still outstanding. The question of the possibility of additional pumps at Stourmouth (to pump up the Little Stour) was to be examined as part of the Stour Catchment Flood Management Plan, but the plan did not examine matters in that sort of detail. The CFMP has now been completed but there is no detailed action plan with it and further studies will be needed before any significant capital work on the Stour will be allowed to go ahead.

ACTION 27 (Little Stour & Lower Nailbourne)

Conclusion Serious flooding occurred in the parishes of Bridge, Patrixbourne & Bekesbourne, Littlebourne, Ickham and Wickhambreux due to the Little Stour and Lower Nailbourne main river bursting its banks. A total of 60 houses were flooded. Some of these properties were affected continually from November 2000 to April 2001 with the flooding peaking in February 2001. Not all houses were flooded directly from the river as a number of these were flooded as a result of run off from fields and roads where the outfalls to the river also backed up. In February 2001, particularly at Bridge, some houses were flooded due to foul sewers backing up. Restrictions in the river that reduced its flow at highway culverts, water mills, numerous obstructions constructed both privately and as a result of nature all contributed to the problem. The outfall with the Great Stour (see Action 26) was also a major factor.

Recommendation The whole of the Nailbourne and Little Stour should be investigated as one entity as the problems and potential solutions affect the full length. This includes Elham and Lyminge which, although outside the City Council's area, are equally affected. A survey of the river should be undertaken to determine all restrictions and to be the basis of action to remove them where practicable. Care must be taken to ensure that any works do not make the situation worse downstream. The Environment Agency should increase the scope of annual maintenance to the river to ensure that it is in its optimum condition. The work of weedcutting and removal, dredging and bank remedials must be carried out before this winter. Other sources of flooding in the area should be investigated and actioned where possible. Means of keeping the source aquifer at a lower level before winter should be assessed. A detailed study of the entire catchment should be carried out to determine long term solutions.

Action The parishes affected along the entire length of the river have set up the Little Stour and Nailbourne River Management Group to co-ordinate action and are working with the Environment Agency and City Council. This has proved to be a very beneficial partnership which has been instrumental in getting many projects under way. The City Council has completed a survey of the Nailbourne and issued a report detailing maintenance work required. The Environment Agency has surveyed the Little Stour and has began to action some of the issues. The Environment Agency will carry out some limited dredging of shoals and bank repairs (including at Scoutlands) in September. Some weedcutting and reed pulling has been completed and a further programme of work for the full length of the river will commence in October. The Environment Agency is looking into possible flow improvement works at the water mills. The City Council has completed the high

flow by-pass channel at Patrixbourne. The proposed by-pass channel from Littlebourne through to Seaton has been drawn up and set out on site. Subject to satisfactory agreements with landowners and some other legal requirements, Environment Agency considers the channel could be completed (excluding road crossings) by December. The Environment Agency has been asked to check on the feasibility of pumping at the source of the Nailbourne during the summer - no response on this has yet been received. The City Council and Kent Highways have carried out minor local drainage improvements at Bridge and Littlebourne. Kent Highways will carry out drainage improvement works at Ickham in September to provide an outfall for the pond.

Current Situation **The Little Stour and Nailbourne River Management Group continued to meet regularly and close liaison was being maintained with the City Council. In the last two years meetings have been very few and possibly a meeting should be arranged shortly to discuss any potential problems. The Group has, on the whole, been a great success. At various locations along the length of the river the Environment Agency had carried out dredging, mainly at the location of shoals. EA has carried out weedcutting and reed pulling at intervals. The major improvement to the river, comprising a new high flow diversion channel from Littlebourne to Seaton, was completed some time ago together with fords/drainage culverts at road crossings carried out by Kent Highways and the City Council. This should noticeably reduce flooding to the villages along this length. A number of local highway drainage improvements at Bridge, Littlebourne and Ickham by Kent Highways have been carried out. The joint project for improvements at Patrixbourne has been completed. This comprised a high flow diversion channel, clearance of material under bridges, dredging and some widening of the river and lowering of the ford. The City Council has also carried out a number of land drainage improvements, particularly at Littlebourne.**

However, it is considered that both the Lower Nailbourne and Little Stour are now again in a poor state with narrowing of the channel due to vegetation growth, various obstructions to flow, shoals of silt reappearing and still the need for an entire dredge of the river as originally requested. At Littlebourne there has been near flooding recently due to the poor drainage along Nargate Street – Kent Highways are looking into this.

ACTION 28 (Upper Nailbourne)

Conclusion The Upper Nailbourne from its source to Bridge is not a designated main river and does not come under the auspices of the Environment Agency. The villages of Barham, Kingston and Bishopsbourne suffered from flooding just as badly as down river and a total of 40 houses were flooded from the river overtopping its banks and other related causes. Flooding due to run off from fields and from natural springs was particularly bad in this area. The main problems are identical to those for the main river (see Action 27) with respect to restrictions and lack of maintenance reducing the flow.

Recommendation The main recommendations are as for the rest of the river (see Action 27) and must be carried out in conjunction with them. The City Council should co-ordinate action and organise an inspection and detailed survey of the Nailbourne to assess restrictions and possible improvements in conjunction with the parish councils, riparian owners and Kent Highways and Bridges. Possible local drainage improvements should be investigated by the City Council to try to reduce flooding from other sources. After the surveys the riparian owners should be requested to undertake urgent maintenance to the river in the form of removal of vegetation, trimming of tree branches, removal of debris, repair of fallen in banks and dismantling of any unapproved structures restricting the flow .

Action The main actions follow those of Action 27 for the lower part of the river. Both the inspection and detailed survey/analysis of the river has been completed by City Council engineers and the report issued. The new culvert at Black Robin Kingston, currently being installed by Kent County Council, will have some four times the capacity of the original structure. The actual maintenance by the riparian owners is now well under way and considerable improvements have been made along a number of lengths of the river through the villages. All bridges and culverts have been cleaned out by Kent County Council. KCC Bridges have surveyed and reported on all the structures and, together with the City Council, will shortly issue a report on the short and long term

works proposed. It is likely that improvements to the culvert at Frog Lane Bishopsbourne will be the first priority and that the culvert at Valley Road Barham will also be proposed for improvement in the future. Other improvement works by the City Council, either under way or soon to commence, are channel deepening and improvements downstream of Bishopsbourne, flood wall at Barham plus a number of local drainage improvements in conjunction with Kent Highways.

Current Information **Considerable improvements have been made to the river by the riparian owners and the City Council in clearing the river and improving the channel. Regular inspections are made by the City Council and minor works and clearance carried out to maintain an effective channel. All bridges and culverts, both KCC and private, have been cleared out and are now regularly checked by Kent Highways. Kent Highways has enlarged the problematic Frog Lane culvert at Bishopsbourne. The Black Robin culvert and the adjacent river improvements have been completed. The City Council has carried out a number of small and medium sized improvements to the river at Barham, Kingston and Bishopsbourne. For some of these the Parish Council and Kent Highways have contributed to the cost.**

ACTION 29 (Nailbourne Sewerage)

Conclusion Inundation of the foul sewerage system by flood water causing failure of pumping stations and pumping raw sewage into the river has been a major concern to residents as it continued over such a long period at nearly all the villages along the Nailbourne and Little Stour. Particularly in February 2001 there were a number of houses that had previously escaped problems that were flooded from the sewers. Residents advised that even prior to last year there had been indications of infiltration of ground water into the pipelines and that they considered the system was becoming worn and running at over capacity.

Recommendation Southern Water need to fully investigate the situation and carry out works to improve the infrastructure. A cctv survey of the whole system should be carried out and leaking pipelines replaced or relined. A review of the system's capacity is needed to ascertain any upgrading works to both pumping stations and sewerage.

Action Southern Water has carried out some localised inspections and repairs to damaged pipework and is considering carrying out cctv surveys in all villages to check for cracks and significant displacement of pipes. Since the flooding ceased there have been further reports of failures of the system and a list of known problems is being compiled by the River Management Group for Southern Water's action. There are no proposals at this time by Southern Water for major improvements to the system as the company considers the system has the capacity for normal operation.

Current Situation **Southern Water completed all their investigations into known and reported leaking and damaged pipe locations in 2003. A full cctv survey of the pipeline was also carried out to determine overall condition. Where any problems had been found, repairs were carried out. Southern Water has reiterated that it considers the Nailbourne and Little Stour sewerage system is in adequate condition and no major improvements are proposed. The company states it will continue to react as quickly as possible to any pumping station problems and that it has an action plan, based on the lessons learnt from earlier years, to quickly bring into operation additional pumps and equipment should there be future significant flooding of the Nailbourne.**

ACTION 30 (Rural Area)

Conclusion The rest of the rural area also suffered from some severe flooding. Conditions in the villages along the Petham Bourne were particularly bad although it was noticeable that people coped very well with little assistance being asked for. It is estimated that about 20 houses were flooded in but the number could quite well be many more. The flow in the Petham Bourne was the worst in living memory and was the cause of half of the incidents of flooded homes in the general rural area. The others were at isolated locations due mainly to water flooding off fields and natural springs but blocked watercourses were also to blame. Failure and inundation of sewage pumping stations was another factor in the flooding.

Recommendations City Council engineers should investigate all these problem areas and

consider what action can be taken to assist. Where relevant Southern Water should carry out their own investigations.

Action Some of the issues have been followed up and other agencies are also investigating but most of the problems have not yet been looked into in detail due to other priorities. The City Council accepts that further investigations should be commenced as early as possible.

Current Situation **Further individual land drainage and flooding problem locations in the general rural area have been followed up and some action taken and/or advice given. Whenever a problem is notified a follow up site visit is made and if possible, and within budget, improvements are made.**

However, many residents expect the Council to be able to solve everything, often when it is a different agency who may be responsible. In many cases the work to completely solve the problem is not economically viable and often the more urban areas have to take priority because of the number of properties that are affected there.

6. EFFECTIVENESS OF FLOOD WARNINGS

This section of the report covers a description of the general situation with respect to Flood Warnings, the Flood Warnings that were issued last year and some suggestions as to how Flood Warnings could be improved.

ACTION 31 (dissemination of flood warnings)

Conclusion There is a need for better dissemination of flood warnings to ensure that all residents living in the flood plains of rivers are able to receive and are aware of flood warnings as quickly as possible after they come into force. There is a particular problem in this district with respect to locations prone to flooding from watercourses near main rivers but outside the main river flood plain. These residents should also be able to receive flood warnings as experience has shown that flooding there is coincident with flooding at nearby main rivers.

Recommendation The Environment Agency should extend the AVM system to include all locations known to be prone to flooding regardless of whether or not they are within the main river flood plain. Improvements in dissemination of flood warnings to all known potential flooding locations should be made by setting up flood warden systems via parish councils and residents associations. City Council engineers should liaise with Environment Agency to assist with these improvements.

Action Discussions have been held with Environment Agency, who agree in principle to the proposals, but the AVM system for this area is already overfull and EA's procedures state that priority must be given to those in the sea and main river flood plains. The City Council is compiling a list of streets that should be included with the relevant main river flood warning and the information compiled to date has been passed to the Agency. Parish councils and residents associations should approach the Environment Agency who will advise on the best method for setting up flood wardens. The City Council will assist in bringing together the various parties involved.

Current Situation **The Environment Agency has made a number of improvements to the flood warning system over the last few years and it is now much wider than in 2000. Particular attention has been made to the dissemination of warnings by various means including via radio, television, internet and "Floodline". The newer "Flood Watch" warning is catchment based and should alert people to potential problems even though they are not within the river floodplain. The AVM (now called "floodline warnings direct") has been considerably extended. Along the Nailbouurne, Little Stour and at Fordwich there are systems of flood wardens and flood contact persons.**

ACTION 32 (Nailbourne and Plenty Brook flood warnings)

Conclusion There is significant concern that two of the most seriously flooded locations, Plenty Brook and Nailbourne/Little Stour, do not receive flood warnings.

Recommendation For the Plenty Brook it is proposed that Environment Agency include this watercourse on the warning issued for the Westbrook as both tend to react similarly after heavy rainfall. Residents along the Plenty Brook should also be included on the AVM system. For the

Nailbourne/Little Stour the Environment Agency are requested to examine methods to provide a flood warning system and it is suggested that this is based on the level of the aquifer at the source of the watercourse.

Action The Environment Agency states that the flood warning rules do not allow them to include the Plenty Brook with the Westbrook flood warnings but will look into possible changes. The City Council has provided a list of potential flooding locations along the Plenty Brook for the AVM and the EA will contact these addresses to see whether they wish to be included. The Environment Agency will set up by the end of September an advance warning system for the Nailbourne/Little Stour. This will be direct to the City Council and parish council representatives, who will disseminate the warning. A more formal flood warning system is planned for autumn 2002.

Current Situation **There is now a full flood warning system introduced by the Environment Agency for the Nailbourne and Little Stour in the same format as for all other main rivers. The Plenty Brook has now been added to the alert for the Westbrook and flood warning information can be found under "The Plenty, Swalecliffe and West Brooks". All these areas can receive automatic telephone warnings from the Environment Agency through the AVM system and it is understood that the take up by the public is higher than the national average.**

However, the Gorrell Stream, although now a designated main river, is not covered under the flood warning system and it is suggested that the Environment Agency should add it to the above list of coastal brooks for warnings.

ACTION 33 (improvements to flood warnings)

Conclusion During some of the last year's flooding events the coastal river flood warnings arrived too late to allow effective action. It is considered that some warnings contain inappropriate statements or give the wrong impression as to what may happen.

Recommendation The Environment Agency is asked to re-examine its processes to try to improve the lead time on flood warnings for coastal rivers and particularly the situation when they are tide locked. The Environment Agency should reassess the wording contained in the flood warnings so that it reflects a more likely scenario based on the experience of events over the last year.

Action The Environment Agency is currently setting up a number of extra telemetry stations which will aid more accurate forecasting. The City Council has provided information on actual rainfall and tides during recent flood events to assist. The Environment Agency is currently reviewing the text of flood warning messages with a view to making the wording more consistent with what does happen.

Current Situation **Some additional telemetry stations have been set up by the Environment Agency on the Swalecliffe Brook and Nailbourne. These should result in improved lead times on some flood warnings. There has been little or no change in the wording of flood warnings to more accurately describe the likely flooding scenario. City Council engineers have been in contact with EA about this but the national procedures (and type of wording) on the warnings do not allow for local changes to wording. This tends to mean that the coastal warnings for our area can be overly severe whilst the river warnings may not be severe enough and come when a flood is already taking place. The flood warnings are still very much centred on sea and the larger main rivers (The Stour) and do not cater for overland and flash flooding events – such as at Whitstable on 21 August 2007. This needs to be discussed with EA to see whether improvements can be made but national protocol on flood warnings makes any changes very unlikely. It is possible that Defra may now require EA to be more involved with flood warnings for heavy rainfall/flash flooding events but this will take some time before it could be set up.**

7. FLOOD EMERGENCY PLANNING AND RESPONSE

Under this section the various emergency plans are described, particularly the City Council's "Major Emergency Plan" and "Flood Emergency Plan". The roles during flooding of the other agencies, including the Police and Fire Services, are summarised. The actual action and response during

emergencies and the resources available, such as sandbags, is included. A number of improvements to the systems are proposed.

ACTION 34 (major emergency plan)

Conclusion The City Council has a Major Emergency Plan which is generic and set up for all the types of emergencies that a local authority is likely to be called upon to deal with. Whilst the plan obviously covers flood emergencies its aim is the overall management of emergencies, ensuring close liaison with the emergency services and other agencies, evacuation and the setting up of temporary shelter. Reports have been received, particularly on the events of February 2001, that there have been breakdowns in communication between agencies. There also appeared to be problems between the site of the emergency and the control centre. With respect to evacuation of flooded homes (specially occupied by the elderly), transportation and setting up the emergency rest centres was clearly a problem at times and it took much longer than it should have done.

Recommendation The City Council together with the KCC Emergency Planning Officer should reassess systems of communication and make refinements wherever necessary. The City Council should send experienced officers to major sites to act as coordinators on the ground and with the control centre. Arrangements for evacuation and transport, bearing in mind the needs of the elderly, need to be improved. Methods must be in place to ensure that regional control centres are fully aware of local problems and will take action to draft in additional resources from elsewhere when necessary.

Action The City Council has just redrafted its Major Emergency Plan which takes account of many of the lessons learnt during the last year's flooding. The system of evacuation and transport has been further re-examined to ensure that the Plan is clear on how this should take place. The draft Plan is now being worked to pending formal issue. A system of "Forward Control Officers" has been included and they will be responsible for ensuring that full situation reports are regularly sent to the control room from the site of flooding. The KCC Emergency Planning Officer has reviewed all downward and upward systems of communication to ensure that all levels have sufficient information to make informed decisions on resource allocations.

Current Situation **The City Council's new Major Emergency Plan was issued in 2002 and regularly updated since then. It includes improvements based on the lessons learnt from the 2000/2001 flooding. Inter departmental discussions have also taken place to try to ensure that there is improved communication, especially at the site of the incident, with respect to evacuation and the setting up of emergency rest centres. Actual events such as Tenterden Drive have proved that on the whole the system now works much better. Some problems were encountered during the flash flooding at Whitstable on 21 August 2007, mainly due to poor communication with the contact centre. These problems have been examined and proposals made to rectify them. The sea flood emergency of 9 November 2007 took the proposed amendments into account and the system ran well.**

ACTION 35 (flood emergency plan)

Conclusion The actions, responsibilities and work required to deal with and try to alleviate the effects of flooding are set out in the "Flood Emergency Plan". This document is updated annually in September. It is basically a handbook of actions to be taken by the City Council's engineering staff from when the lowest level of Flood Warning is issued up to dealing with actual flooding. The plan was originally set up for sea flooding response but in recent years has been extended to include some guidelines for action on river and other types of flooding. The plan lacks detail on the complex issues of inland flooding and the actions to be taken are very much left to the individual engineer. This can lead to confusion, especially in the minds of the public, as to what will and will not be done. It is considered that, particularly with the Nailbourne flooding, the plan could possibly have gone into action quicker. There were also complaints that at times resources to back up the plan were scarce although attendance by an engineer to a problem area was usually quite rapid.

Recommendation Lessons should have been learnt from the events over the last year and it is considered that improvements could be made to the Flood Emergency Plan to include further operational activities and knowledge that could lead to improved efficiency and possibly a quicker response. These improvements should be brought in before next winter subject to any necessary

City Council financial and policy approvals.

Action The following improvements to the Flood Emergency Plan are being investigated:

1) List all known serious flood locations and indicate known actions that can be taken to reduce the impact of flooding;
2) Utilise the experience of engineers at certain locations and include this in the plan so that they are sent, whenever possible, to that location;
3) List approximate number of sandbags that will probably be required at each site particularly with respect to large numbers used at strategic locations;
4) Include a list of local representatives names and telephone numbers, such as parish councils, who are able to assist at short notice;
5) Ensure that policies relating to flooding, such as the sandbag policy, are clearly set down so that all who are involved in the emergency are fully aware of the agreed approach;
6) Include a brief summary of what Environment Agency and other agencies do to ensure there is no duplication of effort;
7) List roads that are known to flood, actions that might be needed and possible diversion routes so that time is not wasted getting to other flooded sites;
8) Ensure that the plan is fully integrated with the Kent Highways emergency plan for flood events.

Some of these have already been included in the September 2001 issue and others will be included in an October revision once all details have been received/agreed.

Current Situation **The current version of the City Council's Flood Emergency Plan includes details of the Action items listed under this heading. This information is included in the document itself or relevant details/maps/lists are held in the Emergency Room. In view of the local Kent Highways now being a separate organisation there is a need to check the compatibility of the two emergency plans to ensure they work together. This is being done as part of the actions agreed after the Whitstable flooding. Further work is needed with respect to diversion routes for roads known to flood. This will be done in conjunction with Kent Highways.**

ACTION 36 (public awareness and contact)

Conclusion There were a number of comments made by the public that there was a lack of co-ordination between agencies and a "not our responsibility" reaction. The public also considered that they were not kept informed of events, were not aware of what the procedures were and did not know who to contact. There were problems at times getting through to the City Council particularly after normal working hours. Difficulties were also experienced in contacting the Environment Agency and the Southern Water's system for answering calls from the public meant that sometimes people had to wait a long time to get through.

Recommendation Communications between the agencies need to improve to ensure that a problem is being properly investigated. If it turns out that the problem is the responsibility of another agency or can better be dealt with by them then systems must be in place so that the person on site knows who to contact and that the action is followed up. The agencies involved should consider setting up a "one stop shop" so that the public are dealt with at their first contact point. Inter agency lines of communications should be set up so that the problem can quickly be passed from the receiving agency to the one who will deal with it. Improved procedures should be set up for keeping the public informed and so they know who normally deals with what. The City Council needs to review its out of office hours call system to be able to cope with and action large amounts of calls. Use should be made of parish councils and community associations to get messages quickly to local residents.

Actions The City Council, Environment Agency and Southern Water have jointly reviewing communication procedures and better direct contact routes have been set up. In emergencies the City Council will try to adopt the "one stop shop" approach but this may require additional staff resources. Other agencies are being asked to do similar in which case there should be little overall increase in workload. During an emergency, when the emergency centre is set up, there are now considered to be sufficient phone lines, and experienced personnel to answer them, at the City Council. The system for calls when the emergency centre is not set up is being reviewed. Direct lines of contact between City Council engineers and appointed representatives of parish council and

community associations in flood prone areas are beginning to be set up.

Current Situation **As far as is practicable the City Council is now using a "one stop shop" approach when answering calls from the public about "flooding" by making use of the contact centre facilities. There were problems with this during the Whitstable flooding but these are being resolved and a system set up to ensure there is good two way contact between the emergency room staff and the contact centre. The other agencies have also improved their call centres and response mechanisms to the public.**

Despite these improvements the public still have difficulty at times in knowing who to contact and do get passed from one agency to another. There is also the strong perception that the Environment Agency "Floodline" will solve all the problems. Floodline is merely an information service on the levels and extent of flood warnings in force and does not take any action. Further discussion between agencies and better public information is needed to ease this problem.

ACTION 37 (sandbags)

Conclusion Sandbags were a major source of "dispute" between the public and the City Council during the flooding. The City Council's current policy is that sandbags will not normally be delivered to individual properties and they will only be deployed in strategic areas after an engineer has assessed the situation. In the event the City Council delivered about 35,000 sandbags, virtually on demand in the end. This relaxation of the policy probably saved a very large number of homes from flooding. It is known that some houses did not get sandbags or more often they arrived too late but the widespread nature and scale of the flooding made this almost inevitable. The later retrieval of sandbags also, surprisingly, led to some complaints and it is noted that the cost of retrieval is almost as much as the supply. The situation at other local authorities in Kent has been looked into and the policies vary from nil supply to supply on demand with some limitations.

Recommendation A total review of the sandbag policy should be made by the City Council and it should allow supply to all reasonable requests subject to availability, priority and the engineer's knowledge of the location. Unlimited supply without question to all who ask for sandbags should not be agreed. The supply of sandbags to individuals should be on the understanding that they then keep them for possible future use. The setting up of local area sandbag stores at critical points, with possible distribution by appointed people, should also be investigated.

Action City Council engineers have drawn up a revised sandbag policy in line with the recommendations of the Panel. Local area stores have already been set up at a most locations and the remainder will be completed in September. A list of local representatives to assist in distribution from these stores is being drawn up. The new policy, which is subject to Committee approval, will make it clear that sandbags when delivered will become the property of the householder and advice on storage will be given.

Current Situation **The new sandbag policy has been agreed by Council and has been in operation since October 2001. It has been quite well advertised so that the public should know what to expect, although there is still some opposition when people are told that the sandbags have become their property and often we have ended up taking them away. There also seems to be an impression now that sandbags will be delivered to all the public who call for them and they will get there on time – clearly this is not possible and the wording of the advertised policy may need to make this clearer. Coastal sandbag stores have been set up at Whitstable, Swalecliffe and Herne Bay. Along the Nailbourne/Little Stour every parish now has its own local sandbag store for immediate use by residents. Serco have set up a system by which their larger lorries transport the sandbags from stores to the general area and local distribution is by a fleet of smaller trucks. The Council has advertised empty sandbags for sale to residents at cost price and the take up has been high.**

ACTION 38 (the emergency services)

Conclusion The City Council and the public were appreciative of the work of the Police and Fire Brigade during the flooding. On the whole they had responded quickly and done their best to alleviate the situation. The Fire Brigade confirmed that, subject to other emergencies, they would assist householders in the pumping of flood water from their property but their pumps are not large

enough to move any appreciable amount of flood water. Some improvements in communication with the Fire Brigade were suggested to exchange information on properties being flooded. The Police confirmed that their main duties during flooding are to warn residents, assist with their evacuation and protect empty property.

Recommendation There was some concern by the Panel that other, higher profile parts of the county, might have had call on reserves within the emergency services that should have better been deployed in this district. The emergency services and the KCC Emergency Planning Officer were requested to therefore examine procedures to ensure that this would not be the case in future.

Action The KCC Emergency Planning Officer has checked on the position with respect to strategic control of emergencies affecting the whole county and he confirms that resource allocation will be based on "the greatest need".

Current Situation **The flooding in Whitstable on 21 August 2007 and the sea flood emergency of 9 November 2007 tested the response of the emergency services, which was generally seen to be very good. There were a number of lessons learnt from Whitstable that were put into practice for the sea flood emergency. The main difference was that for the sea flood emergency the police and fire services attended at the Council emergency room and ran their operations from there. This worked very well and will be the system for future similar emergencies.**

ACTION 39 (road closures during flooding)

Conclusion There were perceived problems during flood events with the time it took to close flooded roads and sometimes that the signing was inadequate. Roads that were closed were still used by large vehicles which often exacerbated flooding and little action was taken by the Police or the highway authority to prevent this. On partially flooded roads that did remain open speeding vehicles caused bow waves that flooded some properties.

Recommendation Kent Highways and the Police should liaise to ensure that there are sufficient "Road Closed" and "Flood" signs held at suitable locations to allow speedy road closures when necessary. Manpower resources should be checked to ensure there are sufficient persons available in an emergency to effect road closures. The possibility of other responsible persons being allowed to close roads, e.g. parish councils, should be checked. For closures that are likely to last some time, heavy barriers should be installed to physically stop vehicles entering. Ways to ensure vehicles drive slowly along partially flooded roads should be examined.

Action The number of signs readily available for road closures during flooding has been significantly increased since early flooding events and is now considered to be adequate. Joint Police and Kent Highways systems have been re-examined to try to ensure that, within operational limits, sufficient manpower will be available for road closures to be carried out within a reasonable time. Subject to certain provisos it is confirmed that parish councils can carry out road closures in an emergency and City Council staff will liaise on this. The means for physically closing roads when necessary will be examined by Kent Highways. The Environment Agency is nationally looking into the "bow-wave" problem and its report is awaited.

Current Situation **It has been confirmed with Kent Highways that parish councils can be allowed to close roads that are badly flooded. This is with the prior permission of the Highway Manager's staff. Road closure signs were made available in 2002 to the parishes for storage in their sandbag stores.**

However, the flooding in Whitstable in 2007 showed that there is still a problem in getting roads closed quickly and that even when signage is in place there is a tendency for the public to ignore it. Flooding of houses as a result of "bow waves" from vehicles is still happening. Kent Highways and the Police should be requested to re-examine the emergency road closure procedures to see whether the closures can be put into operation more quickly and effectively. As far as can be ascertained there has been nothing published by EA about the problem of vehicles driving through flooded roads.

8. LEGAL SITUATION AND ROLES & FUNDING OF THE AGENCIES

This section deals with the legal situation with respect to the powers and duties of the various

agencies involved together with the requirements placed on riparian owners of watercourses. It also includes an explanation of the roles and responsibilities of these agencies and an indication of their basis of funding.

ACTION 40 (riparian owners)

Conclusion It was found that many property owners living beside watercourses were unaware that they had riparian responsibilities to keep the watercourse clear and free flowing and that it is a legal duty. The requirements are set out in the Land Drainage Act. A considerable amount of the riparian watercourses from rivers such as the Upper Nailbourne to minor ditches were found to be in a very poor state of maintenance. There is clearly a need to ensure that riparian owners are made aware of their responsibilities and do carry them out. The filling in, piping or obstructing of watercourses is theoretically an offence unless the relevant authority has given consent.

Recommendation A publicity campaign is needed before next winter to ensure that all riparian owners are aware of their responsibilities. The relevant authority should check all critical watercourses and those known to flood in order to make sure maintenance work by the owner, where necessary, is carried out. An owners guide to the legal requirements should be made available. The legal powers of the agencies to force the work should only be used as a last resort.

Action There are so many ordinary watercourses in the district that City Council engineers do not have the resources to check them all and have to rely on the public to advise of a problem. A programme has been drawn up to inspect the critical watercourses and those known to flood regularly and a list of known owners is being compiled. The Environment Agency has produced a booklet on this subject and this can be made available free to the public. Publicity about this problem will be put into the next issue of the Council Newspaper.

Current Situation **All watercourses known to cause problems in the past, whether private or public, are inspected by Council engineers at least annually and whenever there is a flood warning in place. Other watercourses are inspected should a problem be notified and where relevant the riparian owner advised what to do.**

However, many riparian owners still do not accept what they need to do and appear unaware of their responsibilities. There has been little further progress to advertise riparian owner responsibility apart from an article some time back in District Life. Ways to improve publicity/action by riparian owners need to be considered.

ACTION 41 (responsibilities of the various agencies)

Conclusion The situation with regard to watercourses and sewers in this country is complex and the public clearly finds it difficult to know who does what and who to contact. In broad terms main (known as public) foul and surface water sewers are the responsibility of Southern Water, road gullies and drains come under Kent Highways and the City Council acts as agent, main rivers are the responsibility of Environment Agency, watercourses in the rural area in the basin of the Stour are looked after by the Internal Drainage Board and the riparian owners should look after all other watercourses with assistance from the City Council. The powers of the Environment Agency, IDB and City Council are permissive which means that they can carry out works if they choose but they do not have to. These powers do not take away the duties of the riparian owners (see Action 40) to act.

Recommendation Publicity, as to who does what, is required so that the public know who to contact if they have a problem and in an emergency. The agencies need to get together to formulate the best approach to this. The “one stop shop” approach should be considered.

Action The inter-agency working group will look into possible ways of improving the situation. An item about this has been included in the next issue of the Council Newspaper.

Current Situation **Of all the actions in this report this one has made the least progress and the situation could actually be considered to be worse than it was after the 2000/2001 floods. There has been little progress to better inform the public on which of the agencies does what, although the Environment Agency has included some information in its “flooding” leaflets and on its website. Clearly the public do not know who best to contact and they are often told that “it’s not us try them”. The public are confused about the EA “Floodline” and it’s purpose – actually only to give out information on flood warnings with respect to the sea**

and main rivers. All agencies (including the City Council) now deal through call centres – EA in Northern Ireland, Southern Water at Worthing, Kent Highways at Maidstone. This results in sometimes a total lack of knowledge of the area and at best little knowledge of specific problems. Co-operation and contact between the agencies has worsened due to a number of staffing reorganisations in EA and loss of knowledgeable local staff. Similarly most of Southern Water work is now carried out by consultants and local staff have been moved elsewhere. The termination of the Kent Highways agency has particularly caused problems reducing by two thirds the number of engineering staff available to deal with an emergency at Canterbury and considerably slowing response.

ACTION 42 (Plenty Brook & Upper Nailbourne)

Conclusion The Plenty Brook and Upper Nailbourne (upstream of Bridge) are classified as ordinary watercourses even though their flows are greater than some main rivers in the district. They are major surface water routes and have comparatively large catchments. They should be main rivers maintained by the Environment Agency who has the funding, staffing and expertise to look after them. The fact that they are not main rivers is only because they were not so designated in the past and included on the main river maps.

Recommendation The Environment Agency should take over these two rivers and carry out the necessary formalities with the relevant government department to "enmain" them.

Action The City Council has written to the Environment Agency on this matter and the Agency is considering it. It is understood though that the Environment Agency will expect quite a considerable sum of money to take over the two rivers.

Current Situation **These two watercourses plus the Gorrell Stream and the Kite Farm Ditch were enmained on 1 April 2006 and from that date come under the management of the Environment Agency. However, under an agency arrangement the City Council continues to maintain the rivers and the Environment Agency reimburses the cost. This is considered to be best practice as the rivers come under the overall supervisory powers of EA but the local knowledge of City Council staff is used to best maintain them. There is a possibility that this arrangement may have to cease from 1 April 2008 due to EU procurement rules and City Council involvement would then cease – this is considered to be a backward step.**

ACTION 43 (Environment Agency and IDB financing)

Conclusion Funding for the Environment Agency's flood defence works comes from a levy to the county council plus central government grant for capital works. The levy is fixed by the Kent Flood Defence Committee and becomes part of the community charge that goes to Kent County Council. It is understood that the Environment Agency also received additional funding from central government this year to deal with the effects of last year's flooding. It is estimated that this Council's charge payers contributed about £800,000 to the Environment Agency for flood defence this year. From information available the Panel were of the opinion that well under that amount was actually spent in this district. Funding for the River Stour Internal Drainage Board comes from various levies of which the City Council paid about £70,000 this year. There was no reported serious flooding to property from IDB watercourses which are all in the rural area.

Recommendation If the Environment Agency is to make significant improvements to reduce the impact of flooding from main rivers and is to take over responsibility for the Plenty Brook and Upper Nailbourne, it will need to considerably increase its expenditure in this district. More of the current budget should be spent here in line with what is actually paid in. The total budget itself should also be increased to allow for improved flood defence measures. The IDB should prioritise its expenditure to those watercourses that will help to alleviate flooding to peoples homes.

Action The Environment Agency and IDB are aware of these recommendations as is the Kent Flood Defence Committee.

Current Situation **Since 2000 there have been a number of reviews of flooding and flood defence expenditure by central government. The Making Space for Water initiative has set out the government view for the next decade on how and where the money should best be spent by the Environment Agency. However, there have been a number of cut backs to spending, including in 2007. This has meant that maintenance has not been increased and**

there has been a slow down in capital expenditure. As a result of the summer 2007 flooding at a number of locations in England there has been a promise of a further £200 million but there are doubts that much of this may not go to new flood defence schemes. There is also the concern that the Environment Agency is overly reliant on consultants and their fees appear to take an overly large proportion of the available money.

ACTION 44 (City Council financing)

Conclusion The City Council revenue budget for land drainage works and for flood relief was increased from £10,000 to £50,000 for this financial year. Most of the minor remedial and maintenance works under the various Actions this year can be financed from this budget provided that there are no further significant flood events. The staffing budget will, however, be vastly overspent because of the time being taken to follow up all the problems. This will have to be at the expense of other Council services. If improvements to maintenance and systems are to continue as for this year then at least the current level of revenue funding will be required in the future. There are insufficient funds to carry out any major improvement works although there are a number of locations that would clearly benefit.

Recommendation The City Council has to weigh up the need to improve the service with respect to land drainage, flood alleviation and flood emergency response against the requirements of its other services regarding financing. It is considered that the public clearly expect an improved service. Means of obtaining external funding should be examined in order to progress major improvements. Possible partnerships with the other agencies should also be investigated.

Action Some partnership arrangements have been formed for a number of the works currently in hand. These have been with Southern Water, the Environment Agency and KCC. An application will shortly be made to the Department of the Environment, Food and Rural Affairs for funding for studies at Plenty Brook, Upper Nailbourne, Kite Farm Ditch, North Canterbury and Fordwich. These studies may lead to major improvement works which would then also be eligible for central government funding.

Current Situation **The Council has been very successful in obtaining finance from government (Defra) for major capital schemes at the coast, as well as for study work on the inland watercourses. The revenue budget for general maintenance work and minor improvements has been reduced but only by the amount that was previously spent on the critical ordinary watercourses (Plenty Brook, Nailbourne etc) and is now directly financed by the Environment Agency. It is considered that, bearing in mind the financial need of all the other council services, this revenue sum is adequate provided that there is not a repetition of the 2000/2001 conditions. Financing of medium size land drainage and watercourse improvements by the private sector using Section 106 agreements under PPG25 has been very successful.**

9. PLANNING POLICIES AND DEVELOPMENT CONTROL

The City Council's policies relating to planning and development control are outlined in this section with particular reference to flooding. It also includes recent initiatives to improve the situation such as the City Council's new drainage guidelines and central government's PPG 25 (development and flood risk).

ACTION 45 (current developments)

Conclusion There has been considerable publicity about the effect of new developments and their possible contribution to the flooding. Particular comment has been made about the large developments along the route of the old Thanet Way. Many members of the public are also blaming these developments for the flooding. There has also been comment that these developments have gone ahead despite Environment Agency advice to the contrary. It is noted that some of the recent developments were approved on appeal against the wishes of the City Council. It is also noted that the Environment Agency has confirmed that the City Council has always abided by its requirements. All the recent developments have had strict drainage restrictions applied such that the outflow of surface water from them is no more than the original agricultural land on which they stand. This is

normally done by large attenuation lakes or underground tanks.

Recommendation The public needs assurance that the new developments are not making things worse in their area. New residents need to be sure that there will not be flooding to their new homes. Public perception is not helped by the poor state of some sites during building and the actions of some of the contractors in dealing with water before permanent works are built. Tighter control during construction is considered necessary.

Action The new guidance note with respect to the requirement for a drainage impact assessment and other drainage measures is now being used for all relevant new development applications. It includes means of ensuring stricter enforcement of requirements during construction.

Current Situation **The new "Drainage Impact Assessment for Development – Guidance Note" has been approved by Council and further improvements have been made to it over time. It is working well and developers are prepared to abide by its conditions although it can be difficult to get all the information from them at an early stage. The drainage requirements, particularly with respect to attenuation of storm water, are made a condition of planning consent. It is considered that its implementation should go a long way to reduce any possible increase in flooding as a result of new developments. In some cases the drainage requirements have actually reduced local flooding. One problem that has arisen is that Southern Water is not prepared to adopt some of the attenuation structures that now become necessary and there could therefore be long term maintenance problems.**

ACTION 46 (sewerage to new developments)

Conclusion Some press reports and many members of the public have called for an embargo on new development until the sewerage system is upgraded by Southern Water. Advice from Southern Water is that everyone has a legal right to a connection to the public sewerage system but to minimise the risk of problems the company can require attenuation or connection at a point where there is sufficient capacity. One of the problems is that during very heavy rain, surface water gets into the system and inundates it thus causing flooding. It is understood that the volume of this surface water is so great compared with the normal foul water flow that additional connections make little difference.

Recommendation As stated elsewhere in this report Southern Water need to improve the infrastructure to ensure that it can cope with the surface water infiltration or take measures to separate out the surface water.

Action Southern Water are fully aware of the problem and have appointed consultants to investigate the major problem areas.

Current Situation **As stated elsewhere, Southern Water are not in a position to make major improvements to the infrastructure which would generally solve this problem. Their consultants have reported on the situation and some improvements, as set out under the individual actions in this report, have been made. Where there are foul sewer capacity problems for new developments various individual solutions have been made including: site storage of sewage with disposal at off peak times: removal of surface water from the system thus allowing new foul flow without increasing the current load; restricting numbers of houses to that which the system can take. Development control committee insist that no new development can be approved without confirmation from Southern Water that there is sufficient capacity in the public sewers.**

ACTION 47 (new developments)

Conclusion There are a number of new developments that are proposed and have already received outline planning permission. Most of these are under way on site or will start shortly. There are great concerns about the impact of these and the effects they may have on flooding. A number of the developments are along the coastal strip where significant flooding occurred over the last year.

Recommendation It is essential that strict requirements are placed on these developments to ensure that they do not make flooding any worse and that they do not flood themselves. Where possible the development should include proposals that aim to improve the overall situation. The new PPG 25 (development and flood risk) guidance should be used wherever possible to

encourage developers to reduce flood risk. The requirements of the Environment Agency and Southern Water must be fully complied with.

Action The City Council's drainage guidance notes, that are now being applied to the majority of new planning applications, contain very strict requirements with respect to the need for a drainage impact assessment, on site storage of surface water for a 1 in 100 year storm, use of more sustainable drainage systems, independent certification of proposals and supervision during construction. There are also proposals that the developer may be required to take measures to reduce flooding outside the site.

Current Situation **All new developments have been required to abide by the requirements of the Drainage Impact Guidance Note. Very close liaison is now being maintained between planners and engineers to try to ensure that no development will exacerbate any current flooding problems. Both the Environment Agency and Southern Water are also, within the limits of their powers, assisting. At some locations specific methods of surface water disposal are being made a requirement on the development proceeding. At most developments surface water attenuation equal to or to less than the greenfield run off is a requirement. The attenuation figure we require (4 l/sec/ha) is stricter than the government guidelines and most other authorities in Kent. Area flood reduction measures, or provision of funding towards them, have also been a requirement of a number of major developments to the benefit of the local community. Examples are the Plenty Brook storage lagoons, contribution to new drainage at South Street and for work to the Gorrell Stream.**

ACTION 48 (future developments)

Conclusion When considering the allocation of land for future developments the City Council should pay particular heed to what has happened over the past year. New development must not be at risk itself from flooding and it must not exacerbate flooding elsewhere. The impact of the development area on its surroundings and possibly the whole catchment should be assessed.

Recommendation New development should not be in the river or sea flood plains and a drainage impact assessment should be carried out for all large sites and those in or adjacent to flood prone areas. Infill development and redevelopment, especially within a flood plain, should be carefully considered using a risk based approach. The possibility should be considered of major infrastructure improvements or flood defences being constructed as part of large developments.

Action The new Local Plan is currently being compiled and flooding is one of the major factors under consideration in its review. Policies in line with these recommendations are being considered for inclusion.

Current Situation **All the requirements following on from the Panel's work, with respect to flooding and new development, have been included in the Canterbury District Local Plan First Review (July 2006). Policies C31, C32, C33, C34 & C37 refer.**

10. ASSISTANCE AND ADVICE TO THE PUBLIC

ACTION 49 (self help)

Conclusion The public need to be better informed of what measures they can take to help themselves during flooding and what precautions they should take if they are in a high risk area. There is a health risk when sewers have overflowed and information on this is needed. Many homes were flooded through air bricks and this could have been avoided. Sometimes sandbags were late in arriving but other measures could have been put in place to ease the situation.

Recommendation The City Council and the Environment Agency should produce advice leaflets on the various self help topics with respect to flooding. This should be well publicised particularly targeting vulnerable areas. The availability of prefabricated products to prevent water coming in through doorways and air bricks should be investigated. Public health advice is particularly important. Parish councils and community associations should involve themselves and help to disseminate information. Temporary "sandbags", that are quite effective, can easily be made from various materials such as strong polythene bags and soil. People should be made more aware of this. Procedures should be in place to ensure that vulnerable people such as the elderly are not forgotten.

Action The Environment Agency produces a leaflet on things to be done to prepare for possible flooding, how to reduce the effects of flooding and actions to be taken when flooding is occurring. This can be obtained free from the Agency. The City Council has produced a leaflet on health advice for flooded homes which can be made available on request. City Council engineers have information on a number of proprietary products, and their suppliers, that can be fitted quite quickly in advance of flooding to doors and air bricks. It is understood that the Environment Agency has examined these products in some detail and can advise on the most effective ones. The Environment Agency has arranged a publicity week on all flooding issues including self help towards the end of September. The City Council has a full page item on flooding and self help in the October issue of the Council's newspaper. The Council website will shortly contain much of this information.

Current Situation **The Environment Agency has continued to be very proactive with respect to information to the public regarding self help and various measures that can be taken to protect one's own property. This is usually reinforced every year during autumn but does tend to concentrate on action in sea and main river flood plains and when a flood warning has been issued. It is suggested that information leaflets on dealing with flash flooding would be helpful.**

The Council did have useful information on its website about self-help and various proprietary products up to about a year ago. However, this seems to have disappeared with the change to the website format. Clearly this needs to be reintroduced in a place that can easily be found together with information in the next Council newspaper similar to what was issued in October 2001. On the whole there is a clearly need for improvement in getting the message across to the public.

ACTION 50 (assistance after flooding)

Conclusion There were complaints from many people that they were given no help by the authorities after the flooding to clear up and put their homes back in order. There also appeared to be lack of advice on what to do and who to contact. Many residents felt that their plight had been totally ignored.

Recommendation For homes flooded from sewers, Southern Water do have a free basic clean up service but this needs to be better advertised. The City Council should decide what level of assistance it is prepared to give to flooded householders and this should also be advertised. It is suggested that as soon as possible after flooding an officer should call at each property with a leaflet containing advice on what to do and letting the occupier know of any help that the Council can give.

Action A decision needs to be made on the level of City Council assistance and how to carry this out and no action has yet been taken on this.

Current Situation **There is still no formal agreement as to the degree of assistance that will be given to the public after a flood event. After the 21 August 2007 floods at Whitstable a flyer was drawn up and hand delivered within two days to all who might need assistance setting down what the Council would do. This appears to have been well received by the public.**

However, this was an officer decision made at that time and there is a need for the Council to formally decide what if any assistance will be given.

Appendix A.7 – Guidance on Rates of Surface Water Runoff from New Developments

Guidance Note – Canterbury City Council
Surface Water Drainage Pro-forma

New development within the Canterbury District has the potential to increase the rate at which surface water runoff is discharged from a site and if unmanaged, this can increase the risk of flooding. In general, this risk can be mitigated by ensuring that the rate of discharge is not increased by the development through the use of Sustainable Drainage systems (SuDS). This Guidance Note is designed to assist developers to complete the **Surface Water Drainage Pro-forma.** Canterbury City Council requires all developers to complete this pro-forma for ALL developments that are not classified as 'small scale'.

Whilst this document is meant to provide general drainage guidance to developments across the entire of Canterbury District, it is recognised that there may be specific locations that are more sensitive to flooding and therefore, Canterbury City Council reserve the right to alter or introduce additional requirements to ensure that developments do not increase the risk of flooding.

In accordance with the National Planning Policy Framework (NPPF) 2018 and Non-statutory Technical Standards for SuDS (NTSS), it is preferable to provide a drainage solution which replicates surface water runoff under greenfield conditions. The estimated peak runoff rate from a development site in its greenfield condition is referred to as the 'greenfield runoff rate', and the return period of the rainfall event will dictate the greenfield runoff rate for that specific return period. The greenfield runoff rate is dependent on several key site characteristics; including underlying ground conditions and the topography of the site.

Given that the topography and geology of the Canterbury District varies widely, it is considered inappropriate to request that developers restrict the runoff rates from sites to a specific *single* limiting discharge rate. On this basis, the District has been sub-divided into four "Drainage Zones" and a map delineating each of the identified Drainage Zones is appended to this document.

SECTION 1 - Climate Change

Section 1.1 – Impact of Climate Change

The global climate is constantly changing, but it is widely recognised that we are now entering a period of accelerating change. The nature of climate change at a regional level will vary: for the UK, projections of future climate change indicate that more frequent short-duration, high-intensity rainfall and more frequent periods of long-duration rainfall of the type responsible for the recent UK flooding could be expected.

To ensure that any recommended mitigation measures are sustainable and effective throughout the lifetime of the development, it is necessary to base the appraisal on the extreme flood level that is commensurate with the planning horizon for the proposed development. The National Planning Policy Framework (NPPF) and supporting Planning Practice Guidance (NPPG) state that residential development should be considered for a minimum of 100 years, but that the lifetime of a non-residential development depends on the characteristics of the development.

The recommended allowances for increases in peak rainfall intensity are applicable nationally and a range of climate change allowances are provided for the different time epochs over the next century. These time epochs correlate with the planning horizons for the varying classifications of development.

For each time epoch, values have been provided which correspond with different levels of statistical confidence in the possible emissions scenarios on which they are calculated. The Environment Agency's recommended allowances, as of July 2018, are shown in Table 1 below.

Allowance Category (applicable nationwide)	Total potential change anticipated for each epoch		
	2015 to 2039	2040 to 2069	2070 to 2115
Upper End	+10%	+20%	+40%
Central	+5%	+10%	+20%

Table 1 – Recommended peak rainfall intensity allowance for small and urban catchments (1961 to 1990 baseline)

These climatic changes can have an impact on the way in which development affects flood risk and are primarily linked to the surface water discharged from the site. As such, any potential increase in future rainfall needs to be taken into consideration when designing surface water drainage systems.

Section 1.2 - Which Climate Change Values Should I Use?

When designing surface water drainage systems a 'central' allowance should typically be applied. In most instances, for either commercial or residential development, the development lifetime will fall within the 2070 to 2115 epoch and therefore, any references to climate change within this document assume a 20% increase in peak rainfall intensity will be incorporated in the design of surface water drainage system.

The upper end allowance should also be considered in order to test the sensitivity of a drainage system to increases in peak rainfall intensity. An increase of 40% should be considered to represent an exceedance event (sensitivity testing). This is discussed further in Section 8 – Sensitivity Testing.

In circumstances where it can be demonstrated that the lifetime of the proposed development will be lower, then the corresponding allowances stated in Table 1 can be used to complete the Surface Water Drainage Pro-forma.

SECTION 2 - 'Small Scale Development'

For certain types of development, the requirement to restrict to the limiting discharge is not considered appropriate; either due to the nature of the development proposals (i.e. no external alterations), or due to the scale of the development being so small that the impact is considered negligible. For such 'small scale development', it is not reasonably practicable to require the limiting discharge to be adhered to. The definition of 'small scale development' has been based on the definition of 'minor development' taken from the National Planning Practice Guidance (NPPG) accompanying the National Planning Policy Framework (NPPF).

- Minor non-residential extensions: industrial/commercial/leisure, extensions etc. with a footprint less than 25 square metres.
- Householder development: e.g. sheds, garages, games rooms etc. within the curtilage of the existing dwelling, in addition to physical extensions to the existing dwelling itself, that have a footprint less than 30 square meters.
- Change of use/alterations to an existing development: development that does not increase the size of buildings e.g. alterations to external appearance. This includes any proposed development that would create a separate dwelling within the curtilage of the existing dwelling e.g. subdivision of houses into flats.

If the proposed development meets the criteria outlined above and is classified as small scale development, the developer is not required to complete the Surface Water Drainage Pro-forma.*

** Nevertheless, small scale development should aim to provide a betterment in respect to the risk of flooding from surface water. Priority should therefore be given to the use of SuDS (where practicable) in accordance with the CIRIA SuDS Manual (C753) and the NPPF (2018).*

SECTION 3 – Brownfield Development Sites

For brownfield sites, all developments must make best endeavours to reduce the post development discharge rates to greenfield rates, under all return period rainfall events. Only if it can be demonstrated that it is not possible to achieve the greenfield runoff rate(s), can the rate of surface water discharged from a brownfield development be higher than greenfield runoff rates. In this case the proposals must never exceed 50% of the existing discharge rate for the site, including the appropriate allowance for climate change.

Exemption: The 50% reduction requirement may not apply if you are building over an area which consists 100% existing impermeable hardstanding, and there is no opportunity to incorporate SuDS into the scheme. The Applicant will, however, still be required to confirm that there will be no increase in the existing discharge rate to receiving sewers, or watercourses as outlined below. Canterbury City Council may request further information to confirm whether this exemption is applicable on a site by site basis.

Section 3.1 - Calculating the Existing Discharge Rates:

Brownfield sites often have existing drainage infrastructure which can increase, or restrict the rate at which surface water runoff is discharged from a site. Consequently, any existing drainage infrastructure at a site should be considered when calculating the rate at which runoff is discharged to any receiving waterbodies or sewers.

If existing drainage features such as; SuDS, storage systems, soakaways, are present onsite, these should also be taken into consideration when calculating the rate and volume of runoff exiting the pre-developed, brownfield site.

There are two approaches acceptable to CCC for calculating the rate of existing discharge from brownfield sites and these are outlined below:

Option 1 - Preferred Option

If the existing drainage system has been surveyed, or it can be clearly demonstrated that runoff from the existing impermeable surfaces is drained directly to a waterbody or sewer, an assessment of the existing discharge rate should be made based on the capacity and details of the existing drainage system. In this case, any runoff which is not drained directly to the sewer or waterbody should not be included within the pre-development discharge rate calculations. If this option is considered, evidence should be provided within the application which confirms the existing drainage at the site (i.e. photographs of sewer connections, CCTV drainage surveys, existing drainage plans, infiltration test results (if existing soakaways are present), etc.)

Option 2 - Alternative Option

If the existing drainage system is unknown and there is no evidence of an existing drainage connection between the site and a waterbody or sewer, it should be assumed that the pre-developed brownfield discharge rate (to any waterbody or sewer) is no greater than the greenfield runoff rate for the site.

If the development site is classified as brownfield, Sections 1, 2 and 4 of the Surface Water Drainage Pro-forma are required to be completed.

SECTION 4 – Greenfield Sites

The overarching objective of managing surface water runoff discharged from a development site is to reduce the rate of discharge to the corresponding greenfield runoff rate, in order to better replicate pre-developed conditions. By limiting the discharge rate of surface water runoff from the proposed development, it is possible to reduce the risk of flooding to the area surrounding the site. Consequently, it should be clearly demonstrated that the peak rate of runoff from any proposed development site would not increase the risk of flooding both onsite and elsewhere.

Due to varying characteristics across the district, the requirements for limiting the rate of discharge from a development site have been specified for a number of 'Drainage Zones'. The coverage of each Drainage Zone is shown in the map appended to the end of this guidance document.

Section 4.1 - Drainage Zone 1

Due to the impermeable geological make-up of the northern half of the Canterbury District, the calculated greenfield runoff rates are generally very high. The impermeable nature of the ground in this location means that infiltration rates are often insufficient for the use of infiltration SuDS to be used effectively. As such, surface water runoff is typically discharged either into watercourses, or alternatively into the public sewer network. For this very reason, the burden on the public sewer network is high, an issue which is reflected in the historic sewer flooding records for these areas.

Although it is recognised that greenfield runoff rates will be high across the entire northern half of the District, there are a number of key urban towns (e.g. Whitstable and Herne Bay), which are particularly susceptible to surface water and sewer flooding.

Consequently, the limiting discharge rate for sites located within **Drainage Zone 1** has been set to a specific rate of **4 l/s/ha**, which must be achieved for all return period events.

Section 4.2 - Drainage Zones 2, 3 and 4

For the remainder of the district, surface water runoff from a new development should be **restricted to the corresponding greenfield runoff rate**. There are a number of methods by which greenfield runoff rates can be calculated. These are detailed below and provide the developer with the opportunity to undertake bespoke hydrological analysis (to determine a greenfield runoff rates based on site-specific ground conditions), or to use a pre-calculated runoff rate based on the characteristics of each Zone. In either case, it will be the developers' responsibility to provide evidence to demonstrate that the limiting discharge has been derived in accordance with current best practice guidance.

Method 1 – Calculate the site-specific greenfield runoff rates for the development site.

The developer should specify within the Surface Water Drainage Pro-forma the hydrological method used to calculate the *site-specific* greenfield runoff rates for the development site. In certain circumstances, it may be possible to discharge at the greenfield runoff rates for all return periods, i.e. the rate of runoff from the developed site should replicate the current day rainfall runoff for each specified return period.

The greenfield runoff rates calculated should be based on current day conditions, and should **not** include an allowance for climate change.

HR Wallingford have produced an online tool for assisting developers and consultants with undertaking greenfield runoff rate calculations, this can be accessed from the following link: http://www.uksuds.com/drainage-calculation-tools/greenfield-runoff-rate-estimation

Method 2 – Where the applicant does not have access to the relevant hydrological software and is therefore unable to calculate the site-specific greenfield runoff rates.

The greenfield runoff rate (Qbar) has been calculated for each for each Drainage Zone using IoH Report 124 methodology (refer to Table 3 below). If Method 2 is adopted by the developer, the limiting discharge rates specified in Table 3 below should be applied for all return period events, *including an allowance for climate change*.

Drainage Zone	Limiting Discharge Rate (l/s/ha)
Zone 2	4.0
Zone 3	0.4*
Zone 4	0.5*

Table 3 – Limiting Discharge Rate for each zone derived using IoH Report 124 methodology.

**From Table 3 above it can be seen that the limiting discharge rate for Drainage Zones 3 and 4 are particularly low, primarily as the southern half of the District is underlain by geology which is more likely to have an infiltration rate which is considered suitable for infiltration SuDS to be effectively, e.g. soakaways, permeable surfacing.*

In locations where the infiltration rate is found to be unsuitable for infiltration SuDS (as demonstrated by the results of infiltration testing), it will be necessary to discharge the runoff from the development into either a watercourse, or the public sewer network. Under these circumstances, it may be necessary to recalculate the greenfield runoff rates from the development site using Method 1 (outlined above). The implications of blockage should also be considered if extremely low discharge rates are specified (refer to Section 8).

If the development site is classified as greenfield, Sections 1, 3 and 4 of the Surface Water Drainage Pro-forma are required to be completed.

SECTION 5 – Method of Discharge

The drainage hierarchy identifies that the preferred option for discharging surface water runoff from the site is to **infiltrate** water into the ground, as this deals with the water at source and serves to replenish groundwater. If this option is not viable, then the next preferred option is for the runoff to be discharged into a **watercourse**. Only if neither of these options are possible should the water be conducted into the **public sewer system**.

The following sections provide some additional information to assist developers in the completion of the Surface Water Drainage Pro-forma.

Section 5.1 – Discharge via Infiltration

Where infiltration is the primary route of discharge from a development site, soakage rates should be confirmed by undertaking infiltration testing (in accordance with BRE Digest 365). Results should be submitted for each test to confirm viability of infiltration.

For brownfield sites, discharging surface water runoff via infiltration should be considered above any other method of discharge, even if the existing site currently discharges to a watercourse, or to a public sewer.

If surface water runoff from the proposed development cannot be discharged via infiltration, it will be necessary to provide evidence to justify why this is the case. This information should take into consideration any specific site constraints, or restrictions which could include, but are not limited to the following:

- Poor ground conditions / limited infiltration rate
- High groundwater levels (within 1m of the base of the soakaway)
- Contaminated ground (a contamination report should be provided to support any assumptions)
- Environment Agency's Source Protection Zones (specify which SPZ the site is located in)

In all instances, where infiltration is proposed, details of the proposed SuDS should be provided (e.g. soakaway calculations, permeable paving details, etc.)

Section 5.2 – Discharge to a Watercourse/Waterbody

In accordance with the drainage hierarchy, if it has been demonstrated that the proposed development cannot discharge surface water runoff via infiltration, then the next preferred option is to discharge surface water to a watercourse/waterbody. When considering this option, the topography of the site should be analysed to ensure that this option is viable and to confirm that the outfall will not become blocked by high water levels in the watercourse.

If discharging to a watercourse/waterbody, a location plan delineating the proximity of the site to the watercourse/waterbody and details of the proposed outfall location will be required to be provided.

For brownfield developments, if an existing connection to a watercourse is to be maintained, details of this outfall and its location should be provided. However, it should be recognised that the presence of an existing connection to a watercourse does not automatically set a precedent and it must be demonstrated why infiltration cannot be utilised.

For all developments, consideration needs to be given to the classification of the watercourse (e.g. EA Main River/ IDB maintained watercourse / ordinary watercourse / privately owned), as at the detailed design stage it will be necessary to apply for consent to discharge into the watercourse from the relevant organisation responsible for the watercourse (e.g. EA/IDB/LLFA). Contact details for the EA, IDB and LLFA are provided below:

Environment Agency:	enquiries@environment-agency.gov.uk
River Stour Internal Drainage Board:	enquiries@riverstouridb.org.uk
Lead Local Flood Authority (Kent County Council):	SuDS@kent.gov.uk

It is also recognised that any new outfalls to the River Stour must include a non-return valve (flap valve) on the outlet into the river. Furthermore, details of any proposed flow control devices and / or attenuation features (e.g. cellular storage crates, detention basins etc.) should also be provided.

If the proposed development cannot discharge into a watercourse/waterbody, it will be necessary to provide justification to demonstrate why this option is not viable (e.g. the absence of a waterbody in close proximity to the site).

Unrestricted discharge into the River Stour will not be permitted, unless it is confirmed with the River Stour Internal Drainage Board, Environment Agency, and Lead Local Flood Authority that there are no alternative more preferable solutions available. If this approach is adopted, unattenuated discharge must be agreed prior to submission of a planning application. For sites on upland areas and for sites which are indirectly connected to the River Great Stour (i.e. via a public sewer), the LPA, EA, IDB & LLFA, would always request attenuation is provided where infiltration is unviable.

For all developments discharging to watercourses the following limitations will apply:

- There is a requirement to manage the first 5mm of rainfall (typically termed the ‘first flush’). This should ideally be achieved through the use of open vegetated storage, or infiltration.
- A Flood Risk Activity Permit (FRAP) will be required for all outfall structures into a ‘main river’.

- Sufficient pollution treatment should be provided in accordance with the latest EA pollution prevention guidance.

Section 5.3 – Discharge to a Sewer

In accordance with the drainage hierarchy, if it can be demonstrated that the proposed development cannot discharge via infiltration, and that discharging to a watercourse is not possible, then discharging to the public sewer is likely to acceptable. However, this option should be considered as a final option for discharging surface water runoff from the development site and discharge to a dedicated public sewer would be the preferred approach.

When considering this option, the topography of the site should be analysed to confirm whether the site can drain via gravity, or alternatively specify whether a pumped system may be required. Gravity systems are always favoured over pumped systems, which rely upon ongoing maintenance to prevent failure. If a pump system is to be used, evidence is required to be submitted to demonstrate why the site cannot be drained by gravity and what mechanisms will be put in place to prevent flooding should the pump system fail (e.g. back-up pumps, alternative battery power supply etc.).

For all developments, there is a requirement to consider the classification of the public sewer (e.g. surface water/ foul/ combined/ other). Discharging surface water to a foul sewer will only be acceptable if it can be demonstrated that there are no surface water or combined sewers available to connect to. Ideally dialogue should be had with the sewerage undertaker (Southern Water) to confirm that discharge to the foul sewer system is acceptable.

If discharging to the public sewer, an annotated site location plan should be submitted delineating the location of the proposed connection(s). Southern Water should also be contacted to ascertain the location of their public sewer assets within close proximity to the site. A copy of the asset location plan should be submitted in support of the Surface Water Drainage Pro-forma.

If an existing connection to a public sewer is to be maintained, details of this outfall and its location should also be provided. However, it should be recognised that the presence of an existing connection to a sewer does not automatically set a precedence and it must be demonstrated why infiltration and/or a connection to a watercourse cannot be specified. Furthermore, details of any proposed flow control devices and/or attenuation features (i.e. cellular storage crates, detention basins etc.) should also be provided for the LPA to review.

Southern Water should be contacted prior to any new connection being made to the public sewer system. Similarly, if any new development is proposed to discharge to the public sewer at a higher rate than the existing site, the sewerage undertake should be consulted to agree the limiting discharge rate which will be considered acceptable.

If existing sewers have insufficient capacity to accommodate surface water runoff discharged from the development, the LPA may impose a Grampian planning condition to ensure construction does not commence until the upgrades to the sewer system have been completed. The LPA may object to proposals where the details of the proposed drainage solution, and the timescales involved in upgrading sewers to accommodate the development, are not provided. It is recommended that the capacity of the existing sewer system is assessed prior to submission of a planning application.

SECTION 6 – Post-development Runoff Rate and Volume

The rate of runoff from the proposed development should meet the requirements outlined within this guidance document. The Surface Water Drainage Pro-forma requires the limiting discharge rate (or the greenfield runoff rates) to be clearly stated; this is the *maximum* allowable rate of discharge from the site.

The rate of runoff from the proposed development for the 1 in 1 year return period, and the 1 in 100 year return period event (including an appropriate allowance for climate change – refer to Section 1.2) should be provided. Additional runoff rates for other return periods can also be supplied, however, these should not replace the 1:1 and 1:100+cc rates. These values should account for any attenuation provided and should show the details of how the rate has/can be restricted (e.g. a flow control device). Relevant calculation sheets should be provided as supporting evidence.

In certain circumstances, it is recognised that it may not be reasonably practicable to achieve the limiting discharge rate, and therefore a number of exceptions have been outlined in Section 7 below. The post-development discharge rate stated within the pro-forma for the 1 in 1 year event, and 1 in100 year event (including an allowance for climate change) should therefore state the **peak** rate of discharge from the site. This value should recognise the exceptions outlined below.

Where the proposed development may increase the volume of water discharged off site which could impose a greater risk of flooding, additional volume control should be considered. The LPA may also request post development discharge rates to be reduced further, (e.g. to Qbar) to ensure long term storage for stormwater is provided.

SECTION 7 – Exceptions

The overarching objective of managing surface water runoff is to promote sustainable development by ensuring that the risk of flooding from surface water is not increased. However, it is recognised that the requirement to restrict the rate of discharge should not be overly prescriptive and prohibit development unnecessarily. A number of exceptions have therefore been identified which *apply to both greenfield and brownfield sites*:

Section 7.1 - Small Sites

Whilst the limiting discharge rates set out above are aspirational, it is acknowledged that on some sites such as particularly small developments, it is not viable to attenuate to the limiting discharge rate. One reason may be due to limited space on site which could prevent the required storage from being provided. Although valid for existing development, this should not automatically be deemed as a reason why the limiting discharge cannot be achieved for proposed developments. If limited space is to be used as a justification for not attenuating to the specified rate, then the developer will be required to demonstrate that no viable alternative solutions are available. In this circumstance, the LPA should be consulted.

Section 7.2 - Reducing the Risk of Blockage in Flow Control Devices

In some situations, it may not be possible to restrict to the required limiting discharge rate. For example, if the attenuated flow rate is too low, this could result in blockages in flow control device. Consequently, in circumstances where it can be demonstrated that it is not possible to achieve the limiting discharge rate, an alternative discharge

rate of 2.0l/s may be considered acceptable. However, higher discharge rates will only be considered acceptable if justification can be provided to CCC to demonstrate that the risk of blockage is considered to be too high.

SECTION 8 – Sensitivity Testing

Section 8.1 – Exceedance Event

The Surface Water Drainage Pro-forma facilitates the design of surface water drainage systems for new development, ensuring the runoff from a site is limited for the lifetime of the development. Typically, the design event is classified as a rainfall event with a 1 in 100 year return period, including a 20% increase in peak rainfall intensity to account for the impacts of climate change. However, in accordance with the precautionary principle promoted by the NPPF, it is also necessary to consider the impact of an event which exceeds the design event.

Evaluating the response of the proposed drainage system under an event greater than the 1 in 100 year event (which includes a 20% allowance in climate change) will help to assess the sensitivity of the system to changes in peak rainfall intensity, and represents any uncertainty in calculating the rainfall hydrograph or climate change allowance.

Based on the EA's climate change guidance an Upper End climate change allowance of 40% should be used to test the proposed drainage system. This climate change scenario represents the 90th percentile (refer to Section 1). Although it is more improbable, a 40% increase in peak rainfall intensity is still possible.

It is therefore a requirement for the developer to consider both the impact on-site and off-site, as a result of an exceedance event. The peak rate of discharge from the proposed drainage system and the volume of additional flood water should be discussed within the Surface Water Drainage Pro-forma for the 1 in 100 year return period rainfall event, including a **40% increase** in peak rainfall intensity. Where applicable, this should include flow route diagrams and areas where flood water could pond.

Section 8.2 – Blockage Event

It is also necessary to consider the implications of a failure of the proposed drainage system. This is of particular importance for development sites where the proposed method of discharge is to a watercourse, which could exhibit high water levels. High water levels could prevent the site from discharging surface water as the outfall could become submerged. Consequently, it is necessary for the developer to quantify the impact that a 100% blockage scenario could have.

Section 8.3 – Evaluating the Impacts of a Sensitivity Scenario

Sensitivity testing does not require the developer to design the drainage system to accommodate the 40% climate change allowance scenario, or a 100% blockage scenario, instead the relevant section on the Surface Water Drainage Pro-forma is designed to appraise the sensitivity of the proposed drainage system, to ensure that there is no undue risk to life resulting from a residual risk scenario.

The following points are a guide to enable the developer to consider the impacts on the drainage system, based on the sensitivity tests described above:

On-site impacts: If water is shown to surcharge from the proposed drainage system under either; a 100% blockage, or an exceedance event: *What is the expected depth and velocity of flooding across the site? Can you describe the overland flow route of water leaving the drainage system, based on the topography of the site? What is the risk of internal flooding?*

Off-site impacts: If water is expected to flow off-site during either; a 100% blockage, or an exceedance event: *Can you describe the overland flow route of water leaving the site, based on the topography of the site? What is the risk of flooding off-site? e.g. to nearby properties, pedestrian/vehicular access routes etc.*

For ALL developments, Sections 4 of the Surface Water Drainage Pro-forma is required to be completed

Appendix A.8 – Memorandum of Understanding

MEMORANDUM OF UNDERSTANDING BETWEEN CANTERBURY CITY COUNCIL AND THE ENVIRONMENT AGENCY (KENT AREA OFFICE)

MAY 2016 [Draft]

DEVELOPMENT CONTROL AND TIDAL FLOODING IN HERNE BAY AND WHITSTABLE

1. This local Memorandum of Understanding has been agreed between Canterbury City Council and the Environment Agency.

2. The purpose of this local Memorandum of Understanding is to facilitate the consideration of development proposals in tidal flood risk areas in Whitstable and Herne Bay. This document takes account of the National Planning Policy Framework (NPPF) and its accompanying Planning Practice Guidance – *Flood Risk and Coastal Change*, Environment Agency policy and practice on development in tidal flood risk areas and Flood Risk Standing Advice issued by the Environment Agency. The document also takes into account relevant policies in the Canterbury District Local Plan and the information and guidance in the Canterbury Strategic Flood Risk Assessment 2016 (SFRA) together with the modelling carried out for the SFRA.

3. This document applies only to Brownfield sites deemed to be defended to an appropriate standard.

4. All developers/applicants must supply details of levels, both existing ground levels and proposed floor levels, in metres Above Ordnance Datum (AOD) to the City Council before any proposals will be considered. A site specific Flood Risk Assessment (FRA) appropriate to the site shall be provided in accordance with the requirements of the NPPF, before any planning application is registered.

5. In dealing with enquiries from prospective developers and in considering planning applications within tidal flood risk areas of Whitstable and Herne Bay the minimum floor levels set out in Table 1 (below) shall apply. The floor levels are based on the modelled flood water level in the 1 in 200 year return period event in one hundred year's time, allowing for the current climate change sea level rise predictions as set out in the NPPF. To allow a safety factor, for general living accommodation the floor level is 300mm above the flood level and for sleeping accommodation 600mm above flood level.

Location of development site	Living accommodation floor level (m AOD)	Sleeping accommodation floor level (m AOD)
Whitstable		
Seafront	5.7	6.0
North of railway line	5.3	5.6
South of railway line	5.3	5.6
Herne Bay		
Seafront	5.4	5.7
North of High Street	5.2	5.5
South of High Street	5.0	5.3

Table 1 – Minimum floor levels

6. Seafront development sites shall be when any part of the site is within 30m of the seawall. The flood level could be elevated at these locations due to the high risk of significant overtopping at extreme flood events.

7. If the ground level of the development is below the minimum floor levels set out in the table above, that ground floor level shall only comprise garage, store, utility and similar. It may also be possible to include kitchen area subject to agreement.

8. All developments in the tidal flood risk areas shall also include the following requirements, which shall be set out and detailed in the site specific FRA:

    a) For development on the fringes of the tidal floodplain a safe and dry access route shall be available from a new development within the tidal floodplain to an area outside the flood zone. Where this is not feasible alternative arrangements shall be made whereby occupants can seek refuge within the building itself. This will only be acceptable if access can easily be gained internally within the building to a suitably sized area that is raised at least 600mm above the 1 in 200 year predicted sea level including for climate change, and shall have a means of escape by which residents can be rescued by the emergency services from a door or freely opening window of sufficient size.

    b) The developer shall ensure that all occupants are advised to sign up to the flood messages from the Environment Agency's "Flood Warning Direct" service. A flood plan shall be prepared for the building and copies made available to all occupants.

    c) Flood resilient materials and methods shall be used for all construction below the 600mm level above the 1 in 200 year predicted sea level including for climate change. This shall be in accordance with the guidance set out in the Environment Agency publication

https://www.gov.uk/guidance/flood-risk-assessment-in-flood-zones-2-and-3#extra-flood-resistance-and-resilience-measures

d) The fact that the development could be flooded should be recorded in Land Search so that all future occupiers can be made aware of the flood risk. The requirements with respect to living and sleeping accommodation with respect to the various floors of the building shall also be recorded in Land Search.

9. In any cases of doubt, the City Council will consult the Environment Agency's Kent Area Office.

10. This local Memorandum of Understanding will be reviewed as and when required.

11. The City Council will send the Environment Agency copies of decision notices for planning applications.

Signed on behalf of the City Council

Title: Engineering Manager

Date: 8th July 2016