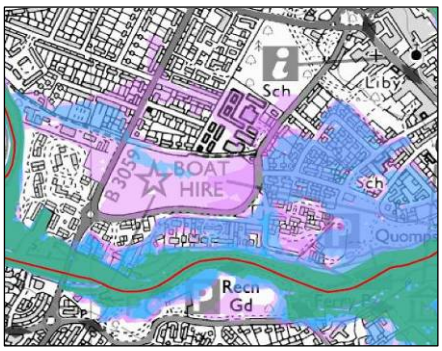
Christchurch Borough Council

Strategic Flood Risk Assessment

Level 2 SFRA – Main Report (Volume I)

May 2009

Halcrow Group Limited



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Strategic Flood Risk Assessment

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May 2009

Contents Amendment Record

This report has been issued and amended as follows:

Issue	Revision	Description	Date	Signed
1	0	Draft	26 Jan 09	C Wood
2	1	Draft	30 April 09	C Grice
3	2	Final draft	15 May 09	C Weeks
				P Crozier
				D Wilson
				PS Rayner

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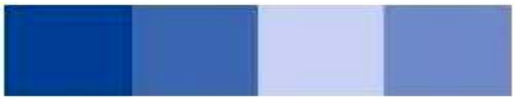
Appendices



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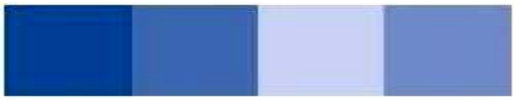

1 Introduction

1.1 Background

In June 2008, Christchurch Borough Council (CBC) commissioned Halcrow to produce a Level 2 Strategic Flood Risk Assessment (SFRA) for all populated areas at risk of flooding and locations being considered for future development (identified by Level 1 SFRA).

This Level 2 SFRA is in accordance with Planning Policy Statement 25: Development and Flood Risk (PPS25) and its accompanying practice guide. The areas investigated are shown in Figure 1.1.

1.2 Outline approach

This Level 2 SFRA refines and builds upon the recent Level 1 SFRA (February 2008), providing more detailed information on all forms of flood risk: fluvial (rivers), tidal, surface water, groundwater, sewer and from impounded water bodies (reservoirs), both now and in the future given the likely impacts of climate change.

A series of detailed hydraulic models have been developed for flood risk areas that had only previously been modelled by the Environment Agency using a national generalised computer model (see ***Section 1.4***). Where appropriate, 2-D modelling software (TUFLOW) has been used to produce peak flood extents, depths and flow velocities and this information has been used to produce flood hazard classifications and animations to illustrate the rate of onset of flooding.

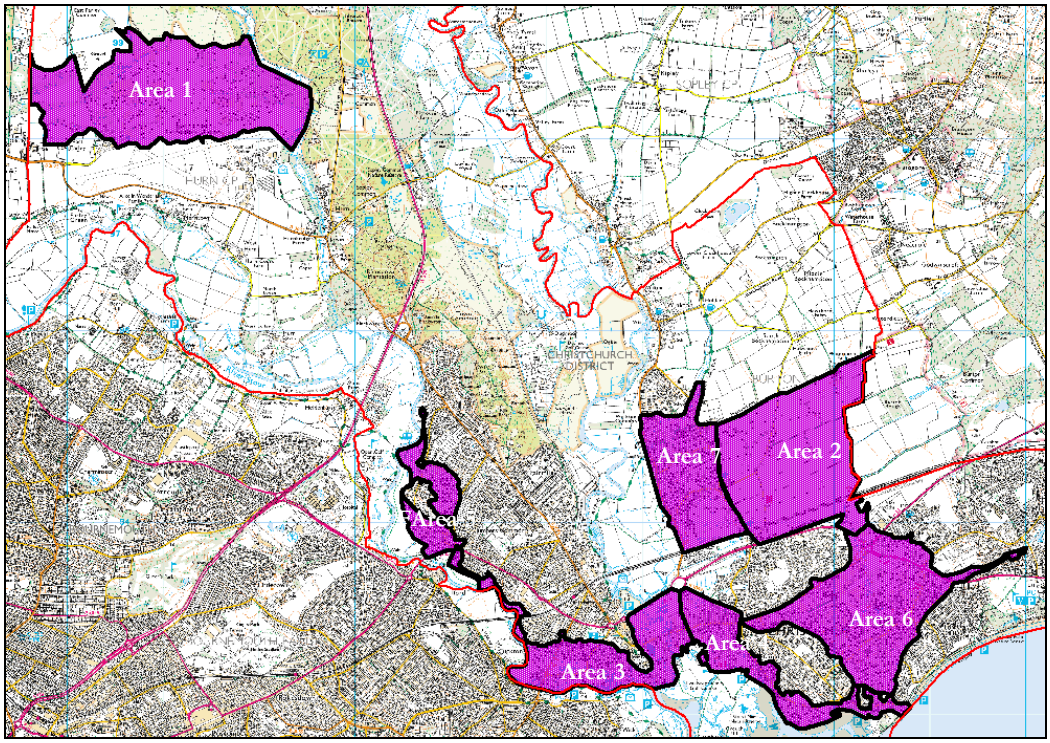

Figure 1.1 Level 2 SFRA areas

The refined assessment of flood risk has then been used to inform appropriate flood risk management policies for the areas being considered for future development. Based on this level of flood risk detail, a policy matrix is presented for the lifetime of proposed developments (to 2086 for non-residential and 2126 for residential developments).

The Environment Agency's Development Control and Flood Risk Mapping team have been consulted at all stages of the assessment, and both modelling and mapping methodologies are consistent with the Environment Agency requirements for Level 2 SFRAs.

The Level 2 SFRA is presented as a series of documents: Executive Summary, Main Report (***Volume I***), Flood Maps (***Volume II***) and Modelling Report (***Volume III***).

1.3 Purpose of the Level 2 SFRA

PPS25 sets out government planning policy on development and flood risk, and aims to:

- ensure that flood risk is taken into account at all stages of the planning process
- avoid inappropriate development in areas at risk of flooding
- direct development away from the areas of highest risk.

Where new development is necessary in such areas, under exceptional circumstances, the policy aims to make the development 'safe' through application of the Exception Test (refer to Section 2.5) without increasing flood risk elsewhere and, where possible, reducing flood risk overall.

The Level 1 SFRA (February 2008) mapped all sources of flood risk and thereby provided the evidence base to inform a risk-based sequential approach to flood risk (the Sequential Test). This approach helps ensure that development is located in areas of lowest possible risk of flooding.

The Draft South West Regional Spatial Strategy (RSS) published in June 2006 sets out the requirements for housing and employment within Christchurch Borough Council (CBC) over its 20 year period to 2026. In particular, Policy SR29 sets a borough wide housing requirement of between 2,700 and 3,000 houses, plus some 600 houses specifically as an urban extension to the north of Christchurch, referred to as Area of Search M in the Draft RSS. These figures have not been revised by the Secretary of State's Proposed Modifications (July 2008) and are not anticipated to change on final adoption of the Strategy.

Accordingly, there is a need for CBC to allocate significant land for housing (as well as complimentary employment and other land) and planners are currently identifying suitable sites to meet this requirement. This Level 2 SFRA is intended to help with this process, and to form part of the evidence base to ensure that the most appropriate land is allocated for development.

Seven flood risk areas were identified by CBC as requiring a Level 2 SFRA. These areas are detailed in Table 1.1 and illustrated in Figure 1.1. A Level 2 SFRA is necessary as CBC is considering these areas for future development, and is therefore required to carry out the Exception Test in accordance with Table D3 of PPS25.

Specifically, this Level 2 SFRA will demonstrate whether or not the flood risk to and from any development will be 'acceptably safe' throughout the lifetime of the proposed

developments, taking account of climate change. For a development to be classed as 'acceptably safe' the site should be classed as 'very low hazard' as defined by Defra (2005) R&D Technical report, FD2320/TR2.

Table 1.1 Areas requiring Level 2 SFRA

Site	Local town/ area	Watercourse	Culverted sections	Flood defences
1	Bournemouth International airport	Two minor watercourses at the airport	Culverted sections on both streams	None
2	RSS area of search M – currently greenbelt north of Christchurch and east of Burton	River Mude	None	None
3	Christchurch town centre	Rivers Avon and Stour	None	Sections of defence along the Rivers Avon and Stour
4	Stanpit, Mudeford and Purewell	Tidal	None	Seawalls, revetments and embankments
5	West Christchurch (Iford / River Way area)	River Stour	None	Defences along the River Stour
6	Somerford and Mudeford	River Mude and Bure Brook	Culverted sections on both the River Mude and Bure Brook	None
7	Burton	Burton Brook and Clockhouse stream	Culverted sections on the Burton Brook	None

1.4 SFRA Level 2 Aims and Objectives

The main aim of the Level 2 SFRA is to develop detailed hydraulic models to provide an improved assessment of fluvial and tidal flood risk. The objectives agreed with CBC and the Environment Agency are:

- Prepare flood zone, depth and velocity maps that represent the 'defended' and 'undefended' conditions for all areas, and for current and climate change scenarios (to 2086 and 2126) where applicable (see ***Table 1.2*** for a summary of the results available by area). Current and climate change SFRA Flood Zones shown in the Level 1 SFRA (Volume II) have been updated in the Level 2 SFRA based on detailed modelling.
- Provide animations to show the rate of onset of flooding for the following events:
  - 1 in 100 (fluvial)/200 (tidal) and 1 in 1000-year (SFRA Flood Zone 2 and 3a, respectively) for the town centre (defended scenario)
  - 1 in 100 and 1 in 1000-year (SFRA Flood Zone 2 and 3a, respectively) for Bournemouth airport
  - 1 in 100 (fluvial)/200 (tidal) and 1 in 1000-year (SFRA Flood Zone 2 and 3a, respectively) for Stanpit, Mudeford and Purewell (defended scenario)
- Prepare hazard mapping (see ***Section 3.4***) for the following design events (all defended scenarios):
  - 1 in 100 (fluvial)/200 (tidal) year present day (SFRA Flood Zone 3a)
  - 1 in 100 (fluvial)/200 (tidal) year, with climate change to 2086 (SFRA Flood Zone 3a with climate change to 2086)
  - 1 in 100 (fluvial)/200 (tidal) year, with climate change to 2126 (SFRA Flood Zone 3a with climate change to 2126)

- 1 in 1000 year present day (SFRA Flood Zone 2)
- 1 in 1000 year, with climate change to 2086
  (SFRA Flood Zone 2 with climate change to 2086)
- 1 in 1000 year, with climate change to 2126
  (SFRA Flood Zone 2 with climate change to 2126)

- Help inform CBC's flood risk management policy
- Run workshops to support CBC in their use of the Level 2 SFRA

This Level 2 SFRA provides the necessary information to inform application of the Exception Test to development proposals for the Christchurch area, as described in PPS25 (Annex D). The Level 1 and 2 SFRAs together form part of the evidence base for the Local Development Framework (LDF) and inform decisions regarding land allocation and policies. This SFRA allows CBC to:

- prepare appropriate policies for the management of flood risk;
- inform the sustainability appraisal so that flood risk is taken account of, both when considering options and in the preparation of strategic land use policies;
- identify the level of detail required for site-specific Flood Risk Assessments (FRAs);
- provide information to developers on flood risk and flood management issues for use in detailed site specific Flood Risk Assessments;
- help inform the acceptability of flood risk in relation to emergency planning capability and by considering the beneficial effects of flood risk management infrastructure in generally reducing the extent and severity of flooding.

Table 1.2 Summary of modelling results available for each area

Scenario modelled	Area						
	1	2	3	4	5	6	7
Flood zones, undefended	✓	✓	✓	✓	✓	✓	✓
Flood zones, defended	×	×	✓	✓	✓	×	×
Flood zones with climate change, undefended	✓	✓	✓	✓	✓	✓	✓
Flood zones with climate change, defended	×	×	✓	✓	✓	×	×
Flood depths, undefended	✓	✓	✓	✓	✓	×	✓
Flood depths, defended	×	×	✓	✓	✓	×	×
Flood depths with climate change, undefended	✓	✓	✓	✓	✓	×	✓
Flood depths with climate change, defended	×	×	✓	✓	✓	×	×
Flood velocities, undefended	✓	✓	✓	✓	✓	×	✓
Flood velocities, defended	×	×	✓	✓	✓	×	×
Flood velocities with climate change, undefended	✓	✓	✓	✓	✓	×	✓
Flood velocities with climate change, defended	×	×	✓	✓	✓	×	×

Defended model results are not available for areas without defences. Depth and velocities are not available for Area 6 because the development of TUFLOW models for this area is inappropriate due to inaccuracies with the ground data (LiDAR).

1.5 Hydrology and current knowledge of flood risk within Christchurch Borough

Christchurch encompasses the lower reaches of the Hampshire Avon and the Stour catchments. The River Stour flows along the western boundary of the borough, being joined by the Moors river close to Blackwater Hill. The River Avon enters the borough from the north and flows in a southerly direction past Winkton and Burton to eventually join the River Stour.

These major rivers join just south of Christchurch town centre, before flowing into Christchurch Harbour, a short distance downstream. Within the eastern part of the borough lies the Bure Brook and the River Mude, both of which flow directly into Christchurch harbour.

Prior to undertaking this Level 2 SFRA known information about the fluvial and tidal flood risks within Christchurch could be sourced from either the Level 1 SFRA or the Environment Agency Flood Map (http://www.environment-agency.gov.uk). This Level 2 SFRA refines current knowledge about fluvial and tidal flood risks within Christchurch and represents the latest understanding of these risks.

1.6 Future SFRA updates

Over coming years, further refinements may be undertaken (as part of the Environment Agency's flood risk mapping program), and any updates to Flood Zones 2 and 3a will be reflected in the latest Environment Agency Flood Map (updated quarterly). As such, it is recommended that CBC remain abreast of any further refinements to these flood zones although significant changes are not anticipated.

Generally, it is recommended that the fluvial and tidal models should be reviewed every five years, but even then only minor revisions are envisaged, e.g. possibly to incorporate more recent data or to follow updates to climate change guidance (due to be published by UKCIP in 2009).

2 Planning context

2.1 Overview

National planning policy relating to flooding is set out in PPS25: Development and Flood Risk. This is referred to throughout this SFRA where appropriate and forms the main policy context. The practice guide to PPS25 explains how to implement the aspirations contained in PPS25 to deliver appropriate sustainable development in the right place while taking full account of flood risk. Specific elements of PPS25 are set out in detail in this Chapter, in particular the Sequential Test and the Exception Test. More specifically, at the regional level the planning policy context is set by the Draft South West Regional Spatial Strategy (section 1 of this SFRA refers to the development targets set by the RSS).

2.2 The SFRA in the planning context

This Level 2 SFRA will be used by Christchurch Borough Council in the application of the Sequential Test and the Exception Test as set out in PPS25, Annex D. The Sequential Test steers development to areas of lowest flood risk, and the Exception Test must be applied if it is necessary to consider allocating development sites in flood risk areas (as indicated in Table D3 of PPS25).

Flood zones (as mapped in the level 1 SFRA) only show the extent of flooding and not the variation in flood hazard. In order to apply the Exception Test it is necessary to consider the actual flood risk to the site, in terms of the frequency, impact, speed of onset, depth and velocity of flooding. This Level 2 SFRA provides this detailed flood risk information, and thereby identifies lower risk areas within a flood zone, to inform suitable site layout so that flood risk can be mitigated and developments made safe.

This Level 2 SFRA takes into account both undefended and defended conditions for each flood risk area benefiting from defences. This means that the actual protection provided by existing flood defences can be considered for potential development areas. An appraisal of the condition of defences has also been made based on available information. However, any appraisal of the potential for flood defence failure, such as breach of the defences, is outside the scope of this study.

2.3 Planning horizons

The minimum design life for non-residential development is taken as 60 years (although at application stage, the LPA or applicant may need to specify an alternative lifetime for specific developments). The design life for a residential development should be taken as a minimum of 100 years.

The emerging Local Development Framework for Christchurch is expected to run until 2026. To correspond with this planning horizon, the impact of climate change on the risk of fluvial and tidal flooding has been assessed for 60 and 100 years beyond 2026, i.e. in year 2086 and year 2126 (using the assumptions of a 20% increase in peak river flows and sea level rise, as detailed

in Annex B of PPS25). This approach ensures that CBC is planning in line with the LDF and beyond the life of the RSS.

2.4 Future development within Christchurch

Many of the sites being considered by CBC for housing development are within Flood Zones 2 and 3. For this reason, CBC will carry out sequential testing of potential housing sites following production of their Strategic Housing Land Availability Assessment (SHLAA, due for publication in July 2009) to identify appropriate development sites that will be informed by this Level 2 SFRA.

Findings of the Employment Land Review show that CBC needs to retain the vast majority of its existing employment land, but that there may be scope to possibly redevelop some of the older employment areas more intensively, thereby freeing up some land for housing.

2.5 Sequential Test

The Sequential Test is used to direct all new development (through the site allocation process) to locations at least risk of flooding, giving highest priority to Flood Zone 1. Before the sites being considered in this SFRA can be allocated for development CBC must complete the Sequential Test to determine whether these sites are appropriate as strategic allocations given the flood risks associated with them. The output from the Strategic Housing Land Availability Assessment (SHLAA) will be critical evidence in this process. If these sites do not pass the Sequential Test they should not be allocated and alternative sites should be brought forward. Where the Sequential Test alone cannot deliver acceptable sites, the Exception Test will need to be applied.

The Environment Agency (2009) recommends that the following approach is used by local planning authorities to apply the Sequential Test to planning applications located in Flood Zones 2 or 3. The same approach should also be used for the LDF site selection process, which is undertaken at the at the larger borough scale. A pro forma template, based on the process below, is provided in Appendix A. There are three stages, as follows:

Stage 1 – Strategic application & development vulnerability

The Sequential Test can be considered adequately demonstrated if **both** of the following criteria are met:

- The Sequential Test has already been carried out for the site (for the same development type) at the strategic level (development plan) in line with paragraphs D5 and D6 of PPS25; and
- The development vulnerability is appropriate to the Flood Zone (see table D1 of PPS25)

1.A. Has the Sequential Test already been carried out for this development at the development plan level? If yes, reference should be provided to the site allocation and Development Plan Document (DPD) in question.

1.B. B Is the flood risk vulnerability classification of the proposal appropriate to the Flood Zone in which the site is located according to Tables D1 and D3 of PPS25? The vulnerability of the development should be clearly stated.

Where the SHLAA has demonstrated that there are adequate available sites to meet the RSS allocation, there is an assumption that the Sequential Test will not be met.

Finish here if the answer is 'Yes' to both questions 1.A. and 1.B

Only complete Stages 2 and 3 if the answer to either questions 1.A and 1.B is 'No'.

Stage 2 – Defining the evidence base

2.A. State the geographical area over which the test is to be applied.

2.B. If greater or less than the borough boundary justify why the geographical area for applying the test has been chosen.

Identify the geographical area of search over which the test is to be applied – this will usually be over the whole of the borough but may be reduced where justified by the functional arrangements of the development (e.g. catchment area for a school or doctors surgery) or relevant objectives in the RSS of LDF. Equally, in some circumstances it may be appropriate to expand the search area beyond the borough for uses that have a sub-regional, regional or national market.

2.C. Identify the source of reasonable available sites, either:

- Background / evidence base documents (state which), or if not available
- Other sites known to CBC that meet the functional requirements of the application

Identify the source of 'reasonably available' alternative sites – these sites will usually be drawn from the evidence base / background documents that have been produced to inform the emerging LDF. For example, an important source of information from housing sites and employment land will be provided by the Strategic Housing Land Availability Assessment (SHLAA, due for publication July 2009) and the Employment Land Review (ELR).

Until the SHLAA is complete, or in the absence of background documents, 'reasonably available' sites would include any sites that are known to the CBC and that meet the functional requirements of the application in question, and where necessary, meet the LDF Policy criterion for windfall development (see below)

Windfall sites

Windfall sites are those which have not been specifically identified as available in the Development Planning Process. They comprise previously-developed sites that have unexpectedly become available. Government policy in PPS3 para. 59 advises that LPAs should not normally rely on windfall sites to meet housing needs.

The Environment Agency recommend that the acceptability of windfall applications in flood risk areas should be considered at the strategic level through a policy setting out broad locations and quantities of windfall development that would be acceptable or not in Sequential Test terms. Evidence on this position should be provided as support to the soundness of the Core Strategy. Guidance on determining the housing potential of windfall (where justified) for broad locations can be found in paras 50-52 of Strategic Housing Land Availability Assessments, Practice Guide to PPS3.

In the absence of flood risk windfall policy, it may be possible (where data is sufficiently robust) for the LPA to apply the Sequential Test taking into account historic windfall rates and their distribution across the district relative to Flood Zones. Where historic and future trends evidence indicate that housing need in the district through windfall can be met largely/entirely by development outside high flood risk areas, this may provide grounds for factoring this into the consideration of 'reasonably available' alternative sites at the planning application stage.

2.D. State the method used for comparing the flood risk between sites, whether it is this SFRA or an alternative (e.g. Environment Agency flood map, site specific flood risk assessment) as new information becomes available.

Stage 3 – Applying the Sequential Test

Compare the reasonably available sites identified under stage 2 with the application site. Sites should be compared in relation to flood risk; development plan status; capacity; and constraints to delivery including availability, policy restrictions, physical problems or limitations, potential impacts of the development, and future environmental conditions that would be experienced by the inhabitants of the development.

3.A State the name and location of the reasonably available site options being compared to the application site

3.B Indicate whether flood risk on the reasonable available options is higher or lower than the application site. State the Flood Zone or SFRA classification for each site.

3.C. State whether the reasonably available options being considered are allocated in the Development Plan. Confirm the status of the plan.

3.D. State the approximate capacity of each reasonably available site being considered. This should be based on:

- the density policy within a LDD
- the current Strategic Housing Land Availability Assessment for the borough
- past performance

3.E. Detail any constraints to the delivery of identified reasonably available options; for example, availability within a given time period or lack of appropriate infrastructure i.e. flood defences which protect the site through its design lifetime. This part of the test should include recommendations on how these constraints should be overcome and when.

Sequential Test conclusion

Are there any reasonably available sites in areas with a lower probability of flooding, that would be appropriate to the type of development or land use proposed?

Next step

Exception Test – Where necessary, the Exception Test should now be applied in the circumstances set out by table D.1 and D.3 of PPS25.

Applying the sequential approach at the site level – In addition to the formal Sequential Test, PPS25 sets out the requirements for developers to apply the sequential approach (see para. 14 and D8) to locating development within the site.

The following questions should be considered:

- Can risk be avoided through substituting less vulnerable uses or by amending the site lay-out?
- Has the applicant demonstrated that less vulnerable uses for the site have been considered and reasonably discounted?
- Can density be varied to reduce the number or vulnerability or units located in higher risk parts of the site?

2.6 Exception Test

The Exception Test should be applied by decision-makers only after the Sequential Test has been applied and in the circumstances shown in Table D.1 of PPS25 when 'more vulnerable' development and 'essential infrastructure' cannot be located in Zones 1 or 2 and 'highly vulnerable' development cannot be located in Zone 1.

The principal purpose of a Level 2 SFRA is to facilitate the application of the Exception Test. The test is applied when there are an insufficient number of suitably available sites for development within zones of lower flood risk or due to possible increases in flood risk arising from climate change.

For the Exception Test to be passed:

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

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

c) A flood risk assessment must demonstrate that the development will be safe, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall. The Emergency Services (Fire & Rescue) will need to be formally consulted for their consideration on whether they will be able to rescue people from the development for all flood events up to an annual probability of 0.1%. CBC should also consult their Emergency Response Office to confirm that systems will be available to assist people displaced during a major flood event.

The PPS25 Practice Guide (Sections 4.47-4.61) provides further guidance on ensuring that a development is safe), and as part of this advises that in some 'exceptional cases' developments or redevelopments might be acceptable if the building remains safe, but safe access cannot be guaranteed during a flood (section 4.58).

Where safe access to a site cannot be guaranteed during a flood, the site should only be considered as a last resort once CBC are convinced that the need for development overrides the flood risk. An 'exceptional case' could be where the development is on a dry island (the site is in Flood Zone 1) and can provide a safe refuge or where a site is defended (from fluvial and/or tidal flooding) with residents living on the first floor and above (the ground floor is only used for car parking).

It is likely that CBC will need to apply the Exception Test as several potential development sites fall within Flood Zone 3a, although this is not possible to determine until the Sequential Test process is complete. CBC shall then demonstrate in a transparent means that the positive contribution to the community of development on the site is so great that they firmly outweigh the concerns about the risk of flooding and safety.

3 Flood risks – coastal & fluvial

3.1 Overview

The aim of the hydraulic modelling undertaken is to improve the flood zone information for the seven areas being considered for future development and to assess the flood hazard posed. This chapter details the coastal and fluvial flood risks to each of these sites, and also considers the impact of flood risks on the Draft RSS proposals and old refuse tips.

3.2 SFRA flood zones

Detailed hydraulic modelling has been undertaken to refine the assessment of the fluvial and tidal flood risks within Christchurch as presented in the Level 1 SFRA. Technical details of this assessment are presented as a separate modelling report (***Volume III***).

The SFRA flood zones (Figure 3.1) are defined as:

- Flood Zone 1 (Low probability) – This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).
- Flood Zone 2 (Medium probability) – This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% – 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% – 0.1%) in any year.

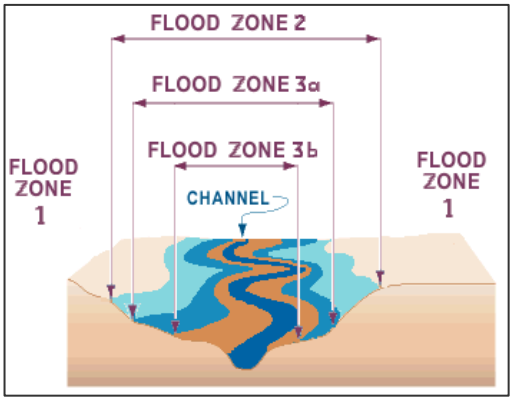

Figure 3.1 Flood Zone classification

- Flood Zone 3a (High probability) – This zone comprises 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 year.
- Flood Zone 3b (Functional Floodplain) – This zone comprises land where water has to flow or be stored in times of flood (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, including water conveyance routes). In areas where the 1 in 25 year (4%) flood event has been modelled previously (but not the 1 in 20 year event), this flood limit was taken to represent Flood Zone 3b as agreed between CBC and the Environment Agency

It should be noted, however, that flooding from sources including sewers, surface water, groundwater and impounded water bodies (reservoirs), can occur in any zone.

The impact of climate change on each of these flood zones has been assessed to 2086 and 2126 (***see Section 2.3***). The assumptions used to model the impacts of climate change are based on the following predictions as advised by Annex B of PPS25:

- Fluvial flood flows increased by 20% from 2025

- Sea levels to increase from a baseline of 1.2mAOD (representative of the mean spring tide cycle extracted from data measured at Priory Quay in 2005, Capita Symonds, 2006) to 1.87mAOD (+0.67m) in year 2086 and 2.45mAOD (+1.25m) in year 2126

- Where flood risk is dominated by high tide sand surge sea levels the following increases were applied to baseline sea levels. The baseline levels represent the current extreme still water tide level during an event with an annual probability of 0.5% or 0.1%, respectively, from the Report on Regional Extreme tide levels by Posford Haskoning (for the Environment Agency), February 2003:

    - 0.5%AEP: from a baseline of 1.99mAOD to 2.66mAOD (+0.67m) in year 2086 and 3.24mAOD (+1.25m) in year 2126.
    - 0.1%AEP: from a baseline of 2.17mAOD to 2.84mAOD (+0.67m) in year 2086 and 3.42mAOD (+1.25m) in year 2126

Given the uncertainties about climate change impacts on wind speed and wave heights an additional precautionary allowance of 0.1m (to the years 2086 and 2126) has also been added to the sea level rise assumed above. This allowance has been made following discussions with CBC and the Environment Agency, and is approximately 15% and 8% of the sea level rise assumed to 2086 and 2126, respectively (in accordance with guidance contained in PPS25).

In assessing the impacts of climate change on tidal flooding, only defended (not undefended) model runs have been considered (as agreed with the Environment Agency), since by 2086 and 2126 it is assumed that existing defences will be overtopped.

There are presently no gauges on either of the two streams at the airport, Burton Brook or the Clockhouse stream, therefore it is recommended that consideration is given to the installation of gauges on these watercourses to improve the quality of the data available for future reviews of the SFRA.

The SFRA flood zones, depths and velocities (refer to ***Section 3.3***) have been mapped and provided as GIS files and in some cases hard copy maps as detailed in Appendix B. All maps are A1 size and are provided at the 1:25,000 scale, except for the airport and coastal area only maps (Map 5, and Map Set 12) which are provided at the 1:10,000 scale.

3.3 Flood depths and velocities

Within a Flood Zone the depth and velocity of flood water can vary significantly. As a result, the modelled depths and velocities for each flood zone have been mapped separately (***Appendix B***) to help inform the safest locations within the seven areas. However, it is often the different combinations of depths and velocities that are critical, such that:

'six inches (0.15m) *of fast flowing water can knock someone off their feet and two feet* (0.61m) *of water is enough to float a car'* (Pitt Review, 2008)

The following section therefore considers the combination of depths and velocities together with an appropriate debris factor in order to provide useful guidance of the dangers to people likely to be caused by individual flood events.

3.4 Flood Hazard

In addition to TUFLOW model output of flood depth and velocity, flood hazard can also be calculated. The output includes a grid of Flood Hazard derived from the flood depth and velocity outputs and a debris factor. The methodology for these calculations is given below.

Flood Hazard is calculated using the following equation from Defra (2006) R&D outputs: Flood Risks to People Phase Two Draft (FD2321/TR2).

Hazard = d x (v + 0.5) + DF where **d** = depth (m)
v = velocity (m/s)
DF = Debris Factor

A conservative DF of 1.0 for urban areas has been applied to this study, as advised by Defra (2006). The value obtained for the Hazard is then used to assign a hazard category. Based on the value of the Hazard for a given area, a Hazard Classification is then assigned. The Flood Hazard classifications are as shown in ***Table 3.1*** and are divided into four categories. The Environment Agency (Development control) have advised that where the flood hazard for a site (for the lifetime of the development), is not classified as 'low' they will look to object to the development.

Table 3.1 Flood Hazard Classification (Source: Supplementary note on flood hazard ratings and thresholds for development and planning control purpose – Clarification of Table 13.1 of FD2320/TR2 and Figure 3.2 of FD2321/TR1, May 2008)

Flood Hazard Rating	Degree of flood hazard	Description
< 0.75	Low	Caution – flood zone with shallow flowing water or deep standing water
0.75 – 1.25	Moderate	Danger for some – Flood Zone with deep or fast flowing water that presents a hazard for some people (i.e. children, the elderly and the infirm)
1.25 – 2.0	Significant	Danger for most – Flood Zone with deep or fast flowing water that presents a hazard for most people
> 2.0	Extreme	Flood Zone with deep or fast flowing water that presents a hazard for all people.

3.5 Flood risks to the seven areas being considered for future development

This section details the current flood risks to the seven areas being considered for future development. When allocating sites for future development the potential impacts of climate change on the Flood Zones should also be considered (refer to ***Volume II, Maps 2a*** & ***2b***)

Bournemouth airport

The model results (Figure 3.2) show that a significant area of Aviation Park West and a limited area of Aviation Park East (along the southernmost stream) is situated within Flood Zone 3b. Flood Zone 3a spans a larger area of Aviation Park West, while Flood Zone 2 affects much of Aviation Park West and part of Aviation Park East. The remainder of the site is classified as Flood Zone 1.

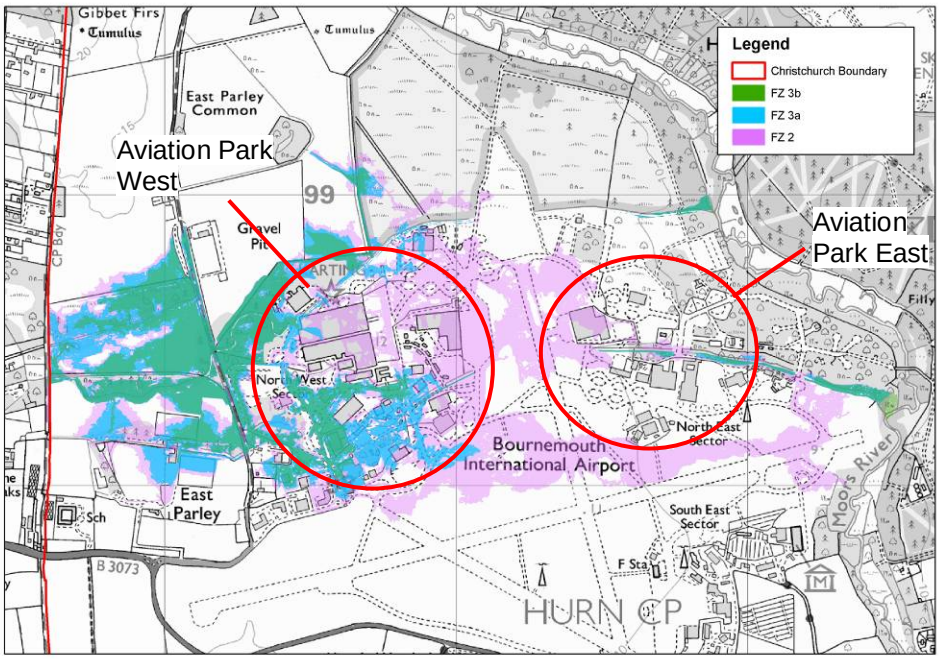

Figure 3.2 Current SFRA flood zones at Bournemouth airport

Roeshot Hill area of search

The majority of the Roeshot Hill area of search lies within Flood Zone 1. However, to the north of the railway line in the east (along the River Mude) there are limited areas of Flood Zones 2, 3a and 3b (Figure 3.3).

Small areas of Flood Zone 2 are also identified in the north along Hawthorne Road and Preston Road.

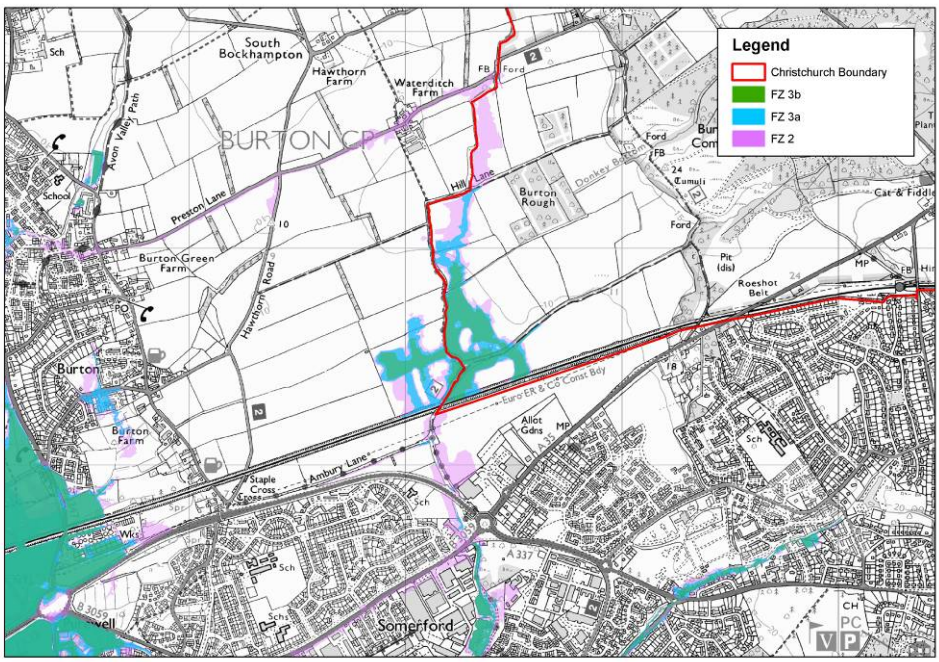

Figure 3.3 Current SFRA flood zones for the Roeshot Hill area of search

Town Centre

Significant areas of the town centre are at risk of flooding from both the Rivers Avon and Stour (Figure 3.4). Locations along the banks of both of these rivers lie within Flood Zone 3b, which can only be developed for 'water compatible' uses in accordance with Table D.3 of PPS25. The Quomps and parts of Tuckton and Purewell are situated within Flood Zone 3a. Much of the remaining areas being assessed within Area 3 lies within Flood Zone 2, with limited areas of Flood Zone 1.

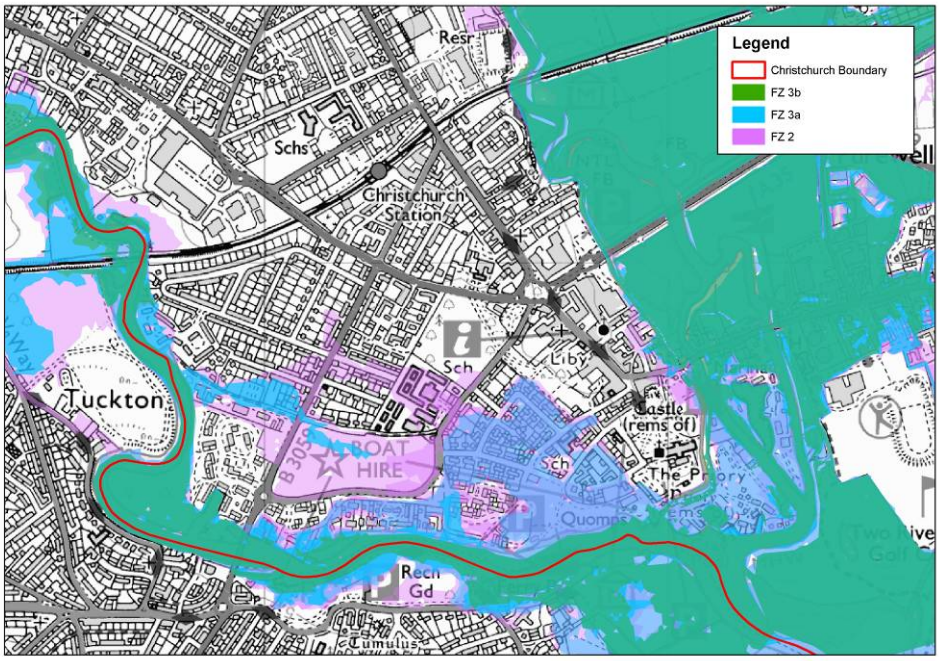

Figure 3.4 Current SFRA flood zones for the Town centre (note: maps show flood risks in the absence of any defences)

Stanpit, Mudeford and Purewell

Purewell and Stanpit are at risk of flooding from both the River Avon and the sea (Figure 3.5). Mudeford is at risk of flooding from the sea, the River Mude and Bure Brook (see Area 6 for the assessment of the fluvial flood risks in Mudeford). Part of Purewell lies within Flood Zone 3b. Areas along the coastline and part of Purewell are identified as Flood Zone 3a, with areas further inland classified as Flood Zone 2.

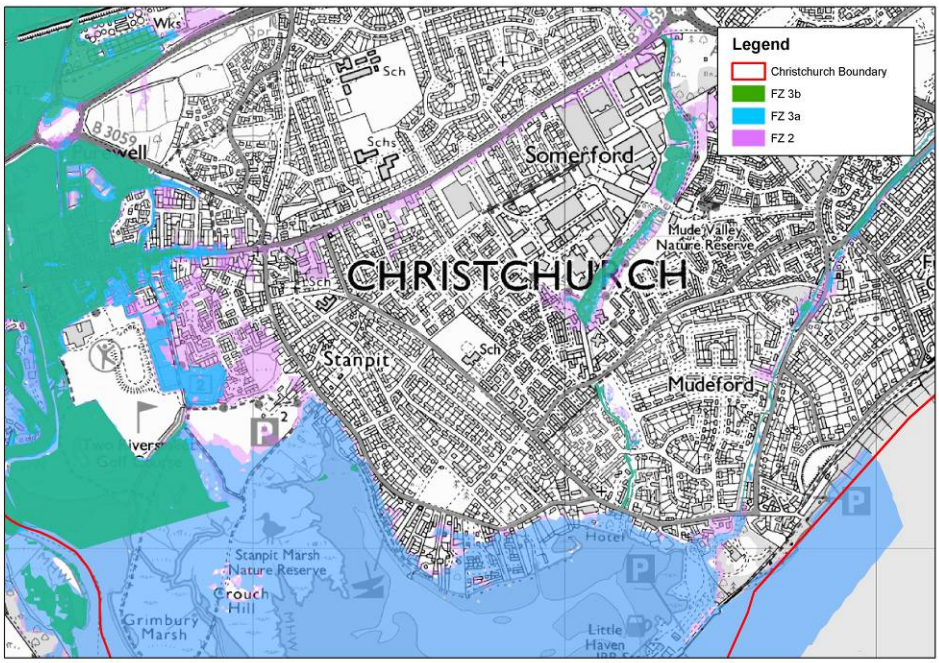

Figure 3.5 Current SFRA flood zones for Stanpit, Mudeford and Purewell (note: maps show flood risks in the absence of any defences)

West Christchurch

West Christchurch is at risk of flooding from the River Stour. The banks of the River Stour are classified as Flood Zone 3b, which includes the caravan park (Figure 3.6).

Limited areas of adjacent land are classified as Flood Zone 3a, with larger areas of western Jumpers identified as lying within Flood Zone 2.

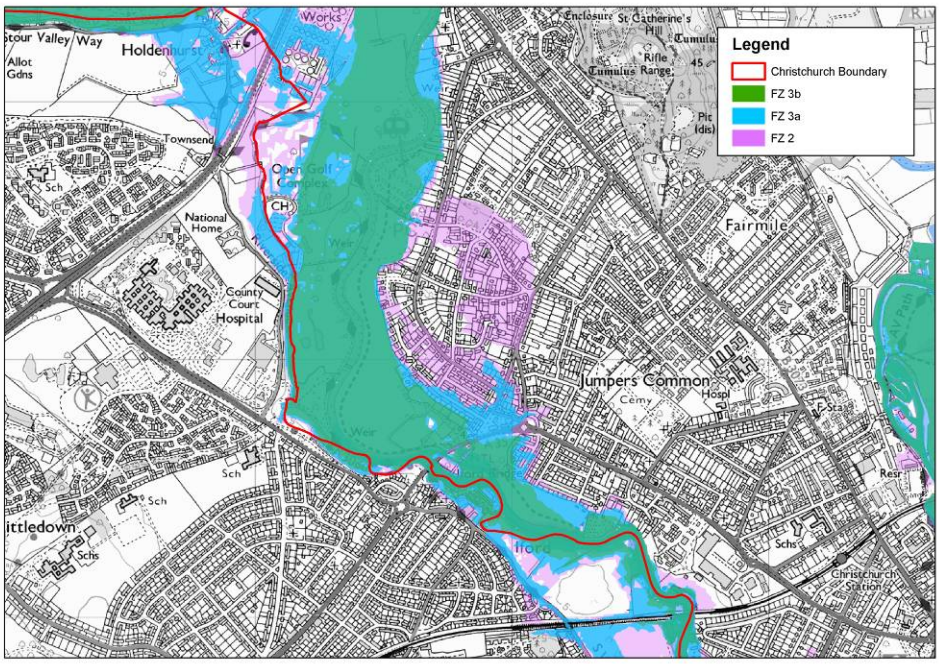

Figure 3.6 Current SFRA flood zones for West Christchurch (note: maps show flood risks in the absence of any defences)

River Mude and Bure Brook

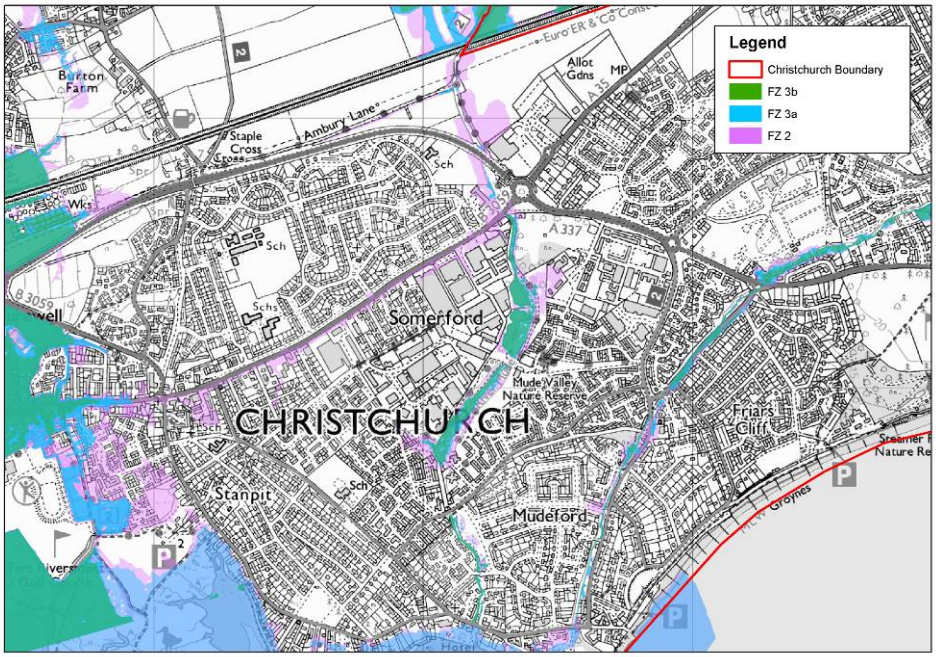

Figure 3.7 Current SFRA flood zones for River Mude and Bure Brook (note: maps show flood risks in the absence of any defences)

The majority of Area 6 lies within Flood Zone 1, but limited areas along the River Mude and the Bure Brook are situated within Flood Zones 3b, 3a and 2. To the north of Area 6 the B3059 Somerford Road is also identified as a flood flow route during a 1 in a 1000 year flood event and is therefore classified as Flood Zone 2.

Burton

Parts of Burton are at risk of flooding from the Clockhouse stream (north Burton) and the Burton Brook (south Burton). The area of undeveloped land to the south and west of Burton is at risk of flooding from the River Avon.

Model results identify locations along the Clockhouse stream and to the south and west of Burton to be within Flood Zone 3b. Note that areas to the north-west of Burton along the River Avon (e.g. Wickton Common) are also at risk of flooding from the River Avon but that the flood risk to these areas has not been modelled/mapped in this SFRA. In addition, there are small areas identified as both Flood Zones 3a and 2 along both the Clockhouse stream and the Burton Brook (Figure 3.8)

Within all seven areas considered in this SFRA the effect of climate change to 2086 and 2126 is that generally the area at risk of flooding is increased. Maps 2a and 3b show the extents of the flood zones in 2086 and 2126.

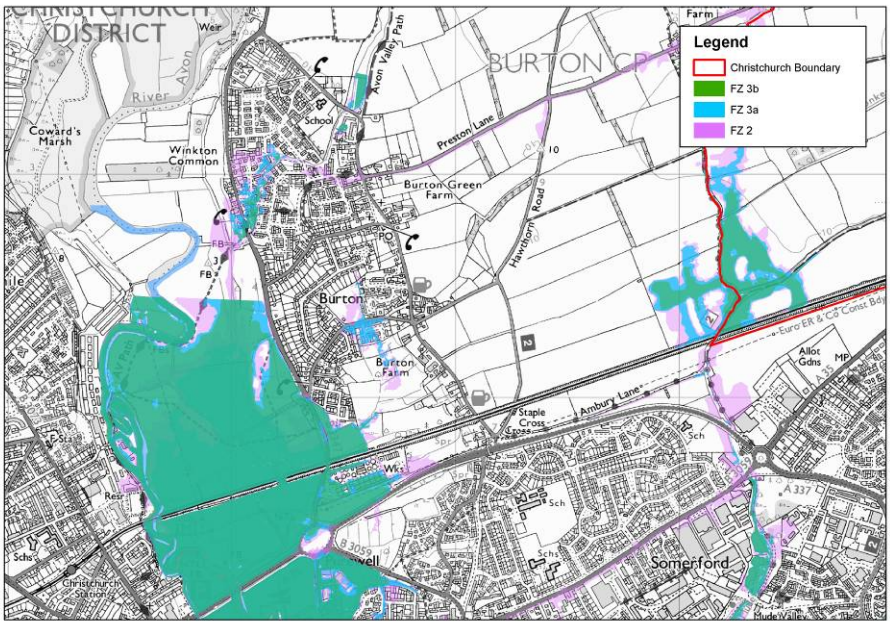

Figure 3.8 Current SFRA flood zones for Burton

3.6 Rate of flooding onset

As part of the Level 2 SFRA, six animations have been provided on DVD to illustrate the rate of the onset of flooding for each of the following events (all defended scenarios)

- 1 in 100 (fluvial)/200 (tidal) year present day (SFRA Flood Zone 3a)
- 1 in 100 (fluvial)/200 (tidal) year, with climate change to 2086 (SFRA Flood Zone 3a with climate change to 2086)
- 1 in 100 (fluvial)/200 (tidal) year, with climate change to 2126 (SFRA Flood Zone 3a with climate change to 2126)
- 1 in 1000 year present day (SFRA Flood Zone 2)
- 1 in 1000 year, with climate change to 2086 (SFRA Flood Zone 2 with climate change to 2086)
- 1 in 1000 year, with climate change to 2126 (SFRA Flood Zone 2 with climate change to 2126)

These animations have been produced using ISIS Mapper. CBC have been provided with the software and guidance (see ***Volume III***) to allow further animations to be produced when required.

3.7 Combined probabilities

Large areas of Christchurch are influenced by tidal flood levels, or periods of tide-lock when flows can not be discharged due to high sea levels. Significant effects are possible up to Iford Bridge on the River Stour (Environment Agency, 2007) and the main A35 crossing of the River Avon, though some tidal influence can continue as far upstream as the village of Burton (Environment Agency, draft b).

For this SFRA, the Rivers Avon, Stour, tidal flooding and flooding from the other watercourses have all been modelled separately, with no account being taken of flood volumes in the harbour. It is possible, due to the narrow throat of the harbour, that a combined event could cause higher levels than currently modelled due to high water

volumes. The Environment Agency are hoping to investigate the effect of joint probability flood events in 2009/2010 or 2010/2011.

Joint probability extremes can be assessed by analysis of data records to determine the correlation between tidal and fluvial flood events that resulted in the highest water levels at different locations. In this way a correlation factor can be determined, such that:

$R_{combined} = CF \times R_{tidal} \times R_{fluvial}$ where R is the return period and CF the correlation factor.

For Christchurch it has previously been established that sea levels and river flows are highly correlated (Defra/EA, 2005a), and based on Defra/EA (2005b) research Table 3.2 details a sample of the fluvial/tidal return period events which can be combined to give a 1 in a 100 year joint event.

Table 3.2 Tidal and fluvial return periods which when combined produce a joint exceedence return period of 100 years

Source: Defra/EA, 2005b

Joint Exceedence return period of 100 years	
Tidal return period (years)	**Fluvial return period (years)**
1	97
2	48
5	19
20	6
100	1

To establish the 'worst case' for a joint probability event (e.g. 100 year) each combination of tidal and fluvial return period events needs to be modelled. Results suggest that higher magnitude tidal events are most likely to be critical for areas along the coast, with higher magnitude fluvial events most critical further inland. However, there are likely to be intermediate locations where other combinations of tidal/fluvial return periods are critical.

3.8 Residual risk: blockage/collapse of culverts

At the airport and on the Burton Brook there is a residual risk associated with the blockage/collapse of culverts which would affect the volume of water being passed along these watercourses.

Appendix C details the silt build up within each of the culverts, as assessed during the site survey. This shows that structure numbers 13a, 14 and 20 (refer to Appendix C; Figure 3.9) at Bournemouth airport are partially blocked and need to be cleared in order for them to operate effectively during a flood event.

Figure 3.9 Structure 20 at Bournemouth airport *– 100mm of silt and right hand pipe is partially blocked*

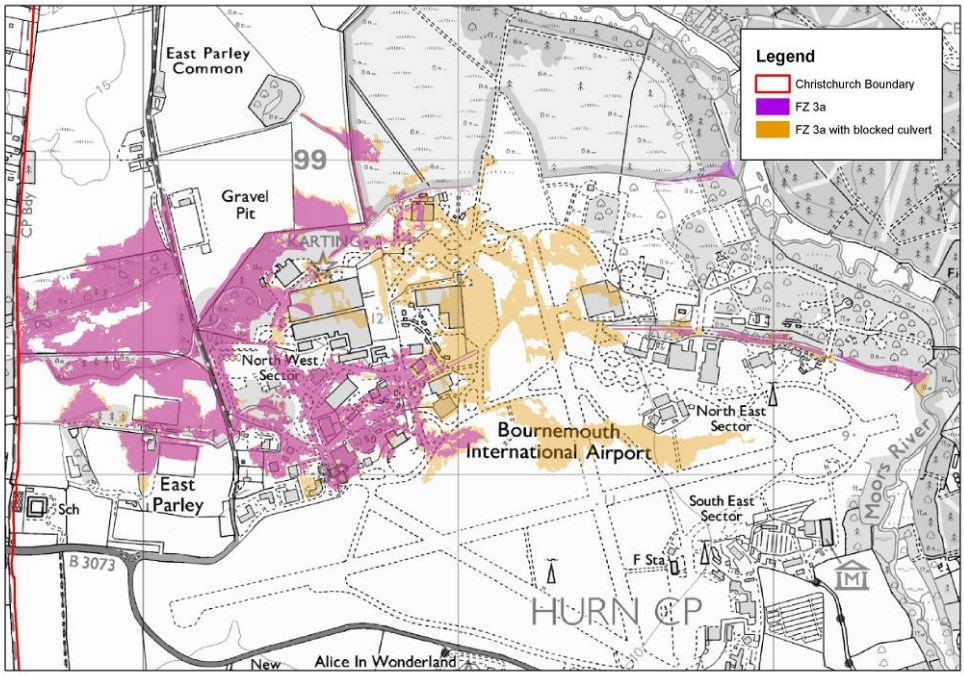

Figure 3.10 Comparison of Flood Zone 3a at Bournemouth airport with and without a 50% reduction in culvert capacity

For the airport, the residual risk associated with blockage of the culverts has been assessed for the 100 year return period (i.e. SFRA Flood Zone 3a) where the capacity of all culverts at the airport is reduced by 50% (i.e. SFRA Flood Zone 3a). Results of this blockage assessment have been mapped and are shown in ***Volume II Map 5a***. Figure 3.10 compares Flood Zones 3a with and without a 50% reduction of culvert capacity of all of the culverts at the airport. This shows that the area at risk of flooding during a 1 in a 100 year flood event is significantly increased when the capacity of the culverts is reduced. It is important that these culverts are maintained otherwise the potential impact of blockages should be considered when assessing sites for development.

3.9 Implications for Flood Zones on proposals

Policy SR29 of the Draft Regional Spatial Strategy states that development should focus on the intensification of Christchurch's urban areas through the re-use of previously developed land, but that this should be complemented by the provision of urban extensions closely related to local centres in an area to the north of Christchurch's urban area within the borough (Area of Search M). This area should accommodate about 600 dwellings.

Figure 3.11 illustrates some example sites which as part of the urban extension could theoretically be developed for housing development in line with Policy SR29. None of these sites are affected by known local drainage issues (***Section 4.1***), but the risk of fluvial flooding varies between the sites (see ***Table 3.3***).

Based on the risk of fluvial flooding the site south of Burton is least favoured together with parts of the sites situated in Flood Zones 2 and 3a along the River Mude. It should be possible to locate all development within Flood Zone 1, or if necessary, Flood Zone 2.

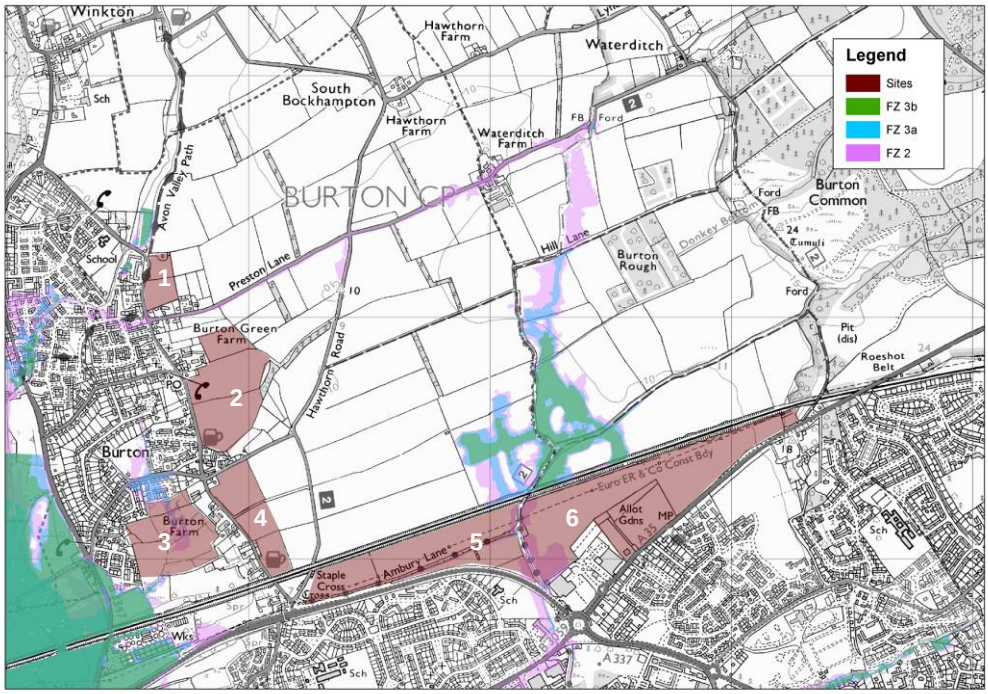

Figure 3.11 Some example sites which could theoretically provide housing within RSS proposed area of search M *(refer to Table 3.1 for details of sites)*

Table 3.3 Flood risk (in 2126) to example sites in the RSS proposed area of search M

Site	Name of site	Fluvial flood risks in 2126
1	North-east of Burton	Flood Zone 1
2	East of Burton	Flood Zone 1
3	South of Burton	Flood Zones 1, 2 and 3a
4	South east of Burton	Flood Zone 1
5	Roeshot west	Flood Zones 1 and 2, with only a very small area of Flood Zone 3a where development could be avoided
6	Roeshot east	

3.10 Flood risks to old refuse tips

Several sites within Christchurch and Bournemouth alongside the River Stour have in the past been used for landfill. The location of these sites is illustrated in Figure 3.12. Some of these sites are currently at risk of fluvial and/or tidal flooding, and in the future it is likely that these risks will increase (***Appendix D***).

Landfill sites are classified as 'more vulnerable' development types (see Table D.2 of PPS25) and therefore the allocation of new landfill sites is compatible with the flood risk in Flood Zone 2 or 3a, when the Exception Test is passed, but not Flood Zone 3b. This is because landfill sites can pose a pollution threat, potentially degrading water quality and impacting environmentally designated sites (e.g. Christchurch Harbour SSSI).

The contents of these landfill sites, their age and current condition requires further investigation to help inform the pollution risks they pose. In some older landfills with no

membrane between the waste and the underlying geology there is the risk that leachate is free to egress the waste directly into the groundwater.

More modern landfills have some form of membrane separating the waste from the surrounding ground to prevent leachate mixing with groundwater although there is still a risk that leachates can mix with floodwaters during a flood event. The risk of pollution from leachates is indicated by the flood zone in which the landfill sites lies (Appendix D; FZ3b = 1 in 20 years, FZ3a = 1 in 100 years, FZ2 = 1 in 1000 years).

The cost of defending all old landfill sites at risk of flooding as a precautionary measure would be prohibitively expensive. CBC may wish to monitor the integrity of these sites during and after flood events to ensure that unacceptable levels of pollutants are not released.

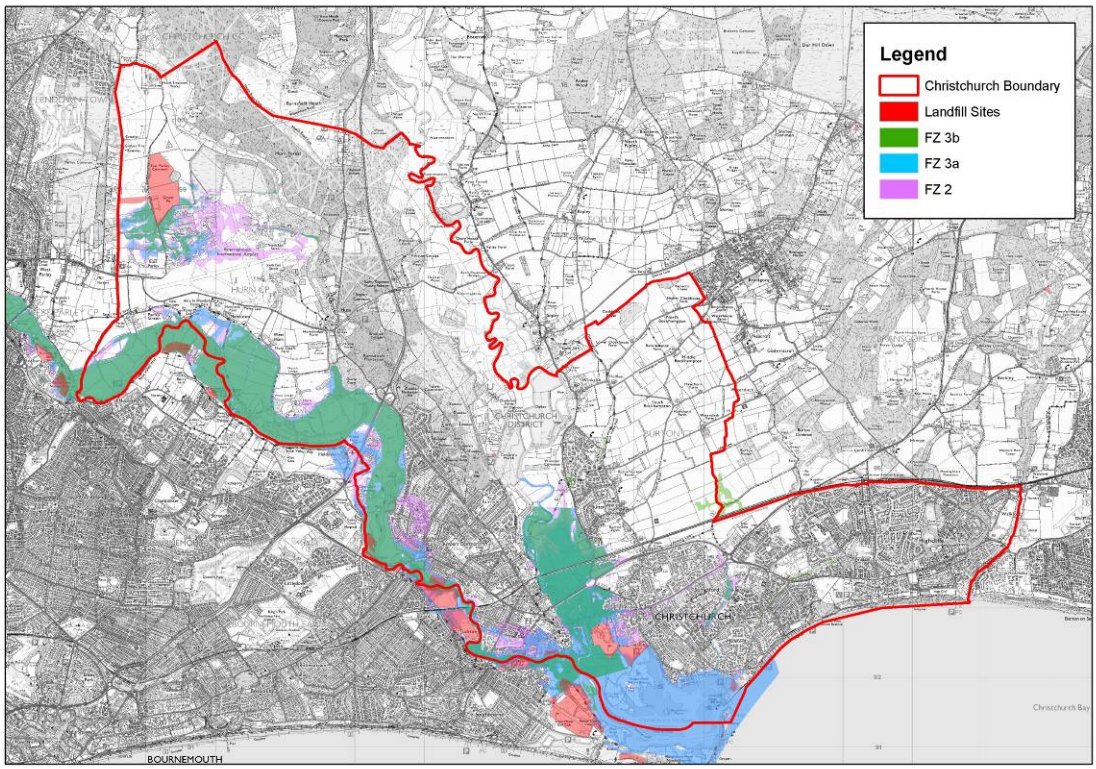

Figure 3.12 Location of landfill sites within Christchurch and surrounding areas

The landfill sites within the seven areas assessed by this study are summarised in Table 3.4 and Figures 3.13 and 3.14. It is recommended that these old landfill sites are avoided when allocating sites due to potential contaminants.

Table 3.4 Old landfill sites situated within the areas being considered for future development

Area	Landfill site	Flood Zone		
		Current	In 2086	In 2126
1	None*	-	-	-
2	None	-	-	-
3	Stanpit Marsh	Mainly FZ1, small areas of FZ2 and FZ3a	Mainly FZ1, areas of FZ2 and FZ3a	Mainly FZ1, some areas of FZ2, FZ3b and FZ3a
	Christchurch Quay	FZ3a	FZ3b	FZ3b
	Willow Way	FZ3a	Mainly FZ3b small area FZ3a	Mainly FZ3b small area 3a
4	Stanpit Marsh	Mainly FZ1, small areas of FZ2 and FZ3a	Mainly FZ1, areas of FZ2 and FZ3a	Mainly FZ1, some areas of FZ2, FZ3b and FZ3a
	Mudeford Quay	FZ3a	FZ3a	FZ3a
5	None	-	-	-
6	None	-	-	-
7	None	-	-	-

* Parley Court Farm landfill site is adjacent to the airport site, but it is assumed that any development will not encroach onto this old landfill site

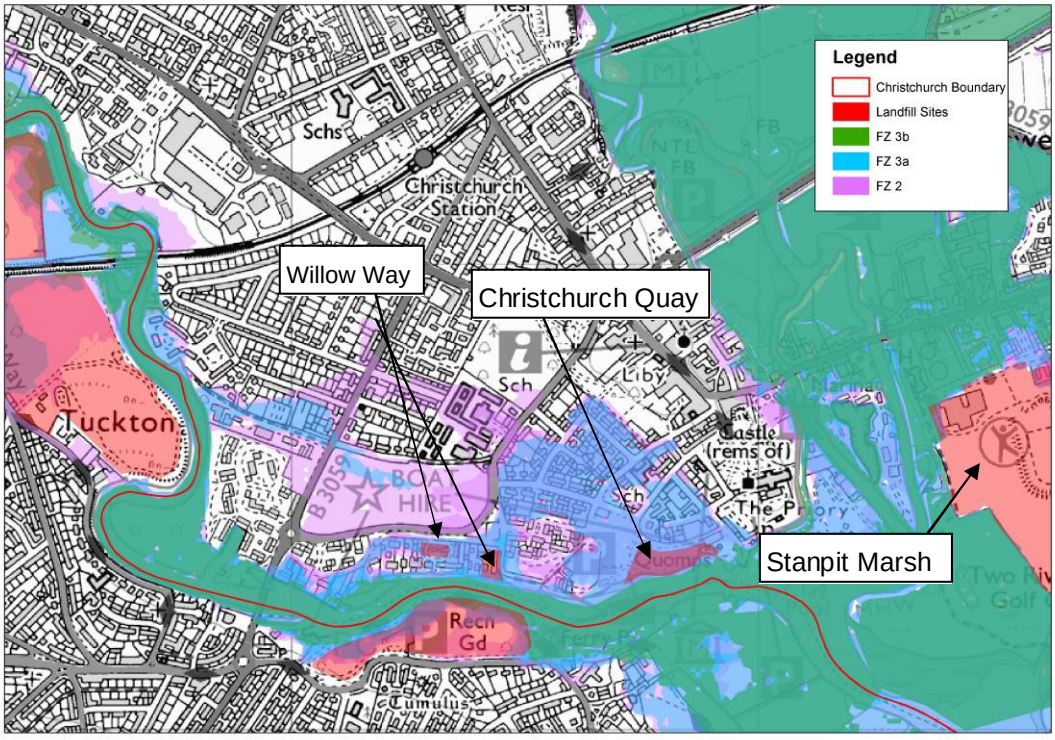

Figure 3.13 Landfill sites within Area 3

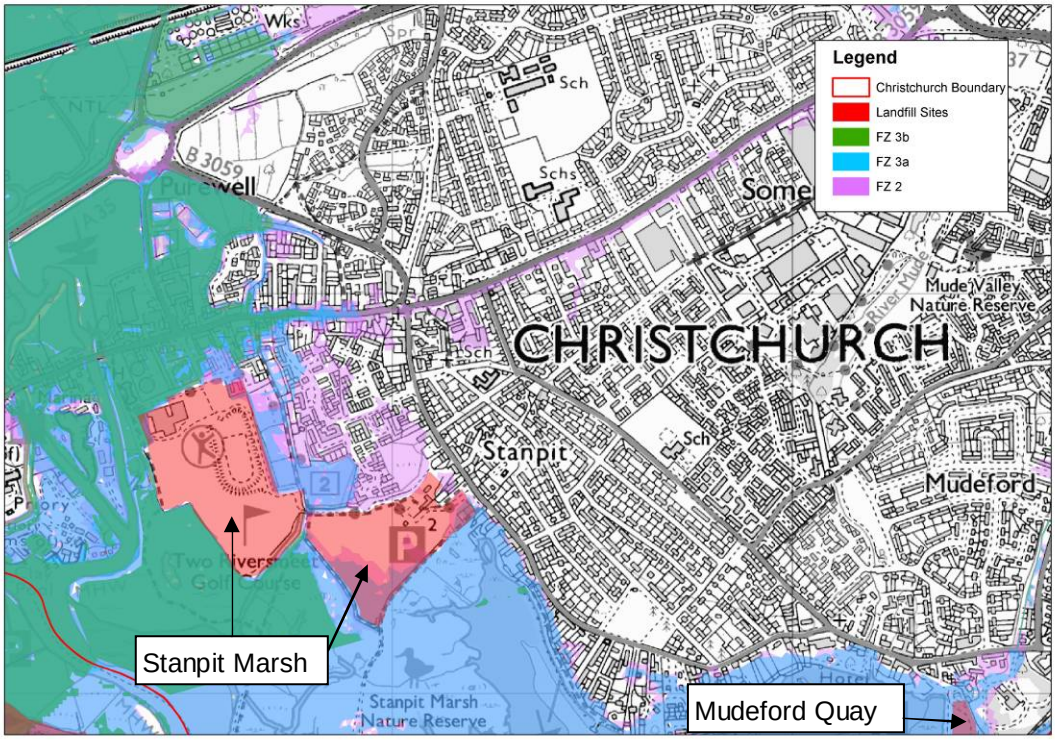

Figure 3.14 Landfill sites within Area 4

4 Flood risks – other sources of flooding

4.1 *Surface water flood risk* – *based on available information*

As part of the Level 1 SFRA (February, 2008) a series of consultations were undertaken to identify known local drainage issues (surface water flooding). These incidents have been added to the current Level 2 SFRA maps (***Volume II, Maps 1*** and ***3***).

Details of sites affected by surface water flooding can be obtained by referring to the supporting GIS database. In response to the recommendation made in the Level 1 SFRA to collate information regarding flood incidents in GIS format, CBC now record all incidents on MapInfo GIS. Flood incidents are also now recorded on Dorset Explorer by the Wessex Area Local Resilience Forum. Dorset Explorer is a GIS based website for online flood mapping and incident recording.

Recommendation: Updated surface water flooding records should be obtained after any significant flooding incidents, to ensure that the best available information is used to inform site allocations and windfall sites.

It is reiterated in this Level 2 SFRA that the surface water flooding records collated are not considered an exhaustive assessment of surface water flooding since these data are based on historical events rather than predictive modelling. This means that very rare events will not be represented and, hence, the full extent of surface water flooding mechanisms is unlikely to have been captured.

4.2 *Surface Water Management Plans (SWMPs)*

Intense rainfall events can occur anywhere as was highlighted by the summer 2007 floods which affected areas of Northern Ireland, north east England, the Midlands and Wales. The occurrence of such events needs all stakeholders to work in partnership to improve understanding and the management of flood risk in urban areas so that they are better prepared for future events.

The Pitt Review Recommendation 18: "Local Surface Water Management Plans, as set out in PPS25 and coordinated by local authorities, should provide the basis for managing all local flood risk."

PPS25: "Surface Water Management Plans (SWMPs) are referred to in Planning Policy Statement 25 (PPS25) as a tool to manage surface water flood risk on a local basis by improving and optimising coordination between relevant stakeholders. SWMPs will build on SFRAs and provide the vehicle for local organisations to develop a shared understanding of local flood risk, including setting out priorities for action, maintenance needs and links into local development frameworks and emergency plans."

Source: Defra (2009) Surface Water Management Plan guidance

A SWMP is a framework through which key local partners with responsibility for surface water in their area work together to understand the causes of surface water flooding and agree the most cost effective way of managing surface water flood risk. The purpose is to make sustainable urban surface water management decisions that are evidence based, risk based, future proofed and inclusive of stakeholder views and preferences (Defra, 2009). The Pitt Review (2008) recommends SWMPs be adopted where surface water flood risk is high.

Recommendation: Within Christchurch Borough the recorded incidents of surface water flooding are limited in both number and extent (***Volume II, Map 1***), and there is currently no requirement for Christchurch BC or other stakeholders to undertake a SWMP for Christchurch (Defra, 2009). However, on a local scale the need for a SWMP at Bournemouth airport should be considered by CBC in discussion with the Environment Agency, given the identified fluvial flood risks and the potential for surface water flooding in this area. Also, Wessex Water have an existing urban surface water drainage network along the River Stour which suggests there have been problems of surface water flooding in the past and surface water management within this area may need to be reviewed in the future. The need for SWMPs should be reconsidered in five years taking into account new home building and redevelopment since this can present a challenge to existing drainage systems.

4.3 Water Cycle Strategies (WCS)

The Environment Agency encourages the use of WCS to address a range of water and environmental planning issues, including flood risk management, water resources and waste water planning processes, in areas where significant development is planned.

Recommendation: No strategy is currently required for Christchurch since there is no requirement for a SWMP and the environmental capacity of the water cycle to cope with the proposed development is not in doubt. Bournemouth & West Hants Water and Wessex Water have already confirmed to CBC that they will be able to meet the water supply and sewerage requirements of additional development as detailed in the draft RSS.

5 Advice for site specific flood risk assessments

5.1 Overview

This chapter provides guidance for development control and potential developers for site specific flood risk assessments. The following recommendations are in accordance with PPS25 and the broad objectives of the Hampshire Avon and River Stour CFMPs and the Poole and Christchurch Bays SMP Policy Units for Christchurch.

5.2 Sequential testing using the SFRA

Future development within all areas will require application of the sequential approach at the site level (sequential design) to ensure that the more vulnerable development (e.g. residential housing) is located within an area of the site at least risk of flooding (i.e. Flood Zone 1).

Areas at higher risk of flooding should ideally be set-aside as open space for amenity and potential environmental enhancements to satisfy requirements of the Sequential Test (see Table D.3. of PPS25 for other uses). For the more vulnerable use it is necessary to ensure that the requirements of the Exception Test are satisfied. The Exception Test will need to demonstrate that the development will provide wider sustainability benefits and will not increase flood risk at the site or downstream (see ***Section 2.5***)

The vulnerability from other sources of flooding should be considered as well as the effect of the new development on surface water runoff.

5.3 Using SFRA results to inform flood risk assessments for development at each of the sites considered in this SFRA

This SFRA provides an assessment of flood risk at a level appropriate to inform CBC's planning decisions. Site specific flood risk assessments need to be prepared for specific development sites by prospective developers. The following reflects the minimum requirements under PPS25 for a Flood Risk Assessment (reference should also be made to Tables D.1-D.3 in PPS25) on the basis of the fluvial/tidal flood risk identified for the site for the lifetime of the proposed development (see ***Volume II, Maps 2a*** and ***2b***).

Sites in Flood Zone 1

The majority of the sites being considered by CBC for future development as part of the 2008 Strategic Housing Land Availability Assessment lie within Flood Zone 1. This section details the requirements for development in Flood Zone 1. To prevent a piecemeal approach, if large sites are split into units less than 1 Ha a Flood Risk Assessment will still be required.

- In accordance with Table D3 of PPS25, any type of development can be located in Low Probability Flood Zone 1.
- The vulnerability of the development from other sources of flooding should be considered as well as the effect of the new development on surface water runoff.
- Floor levels should be situated above the 100 year (fluvial) and 200 year (tidal) plus climate change predicted maximum level plus a minimum freeboard of 600mm.
- The proposed development should be set-back from the watercourse with a minimum 8m wide undeveloped buffer zone, to allow appropriate access for routine maintenance and emergency clearance.

- Where the site forms part of a dry island surrounded by ground which is now or will be subject to classification as Flood Zone 3 consideration will need to be given to how safe access will be achieved in accordance with FD2320.
- The potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water runoff, with appropriate mitigating action, should be incorporated in a Flood Risk Assessment (FRA) for the site.

  This should take the form of a Drainage Impact Assessment (DIA), required to demonstrate that runoff from the site is the same as in the predevelopment case, thereby ensuring flood risk is not increased (though wherever possible, betterment should be achieved). This will involve the use of SUDS techniques which should take into account the local geological and groundwater conditions. Where possible these should be strategic SUDS. Space should also be set-aside for SUDS at the master planning stage.

Sites in Flood Zone 2

All seven areas assessed by this study are intersected by Flood Zone 2 to a greater or lesser extent. Where possible alternative sites in Flood Zone 1 should be considered in preference to those in Flood Zone 2 as part of the Sequential Test process. This section details the requirements for development in Flood Zone 2.

- In accordance with Table D3 of PPS25, land use within Medium Probability Flood Zone 2 should be restricted to the 'essential infrastructure', 'water compatible', 'less vulnerable' and 'more vulnerable' categories. Only if the Sequential Test process has been carried out and passed can development occur in Flood Zone 2.
- 'Highly vulnerable' uses in Flood Zone 2 will have to pass the Exception Test.
- A FRA will be required, which should confirm flood extents and levels within the site.
- The development should not increase flood risk elsewhere, and opportunity should be taken to decrease overall flood risk.
- Floor levels should be situated above the 100 year (fluvial) and 200 year (tidal) plus climate change predicted maximum level plus a minimum freeboard of 600mm.
- Dry pedestrian access to and from the development should be possible above the 1 in 100 year (fluvial) and 200 year (tidal) plus climate change flood level.
- The development should be safe, meaning that: people (including those with restricted mobility) should be able to remain safe inside the new development up to a 1 in 1000 year event; and rescue and evacuation of people from a development (including those with restricted mobility) to a place of safety is practicable up to a 1 in 1000 year event.
- If the land use of the development proposed is 'highly vulnerable', consideration should be given to the incorporation of flood resistance and resilience measures
- The proposed development should be set-back from the watercourse with a minimum 8m wide undeveloped buffer zone, to allow appropriate access for routine maintenance and emergency clearance.
- SUDS should be implemented to ensure that runoff from the site (post development) is reduced. Space should be set-aside for SUDS at the master planning stage.
- The vulnerability of the development from other sources of flooding should be considered as well as the effect of the new development on surface water runoff.

- Residents should be made aware that they live in a flood risk area. The Environment Agency plan to make their flood warning service 'opt-out' instead of 'opt-in', but until such time residents should be encouraged to sign up to Floodline Warnings Direct, should a Flood Warning system exist (as indicated by the Level 1 SFRA).
- Car parking needs to be safe, especially in terms of flood warning and overnight parking areas.

Sites in Flood Zone 3a

Flood Zone 3a encroaches on all seven areas assessed by the Level 2 SFRA and in some cases (e.g. Area 3) the areas affected are large. Wherever possible, development in Flood Zone 3a should be avoided, unless it can be clearly demonstrated that the overall level of flood risk in an area will be reduced to an acceptable level as a result of the development. This section details the requirements for development in Flood Zone 3a.

- Only if the Sequential Test process has been carried out and passed can development occur in Flood Zone 3a
- Land use with High Probability Flood Zone 3a should be restricted to the 'less vulnerable' and 'water compatible' uses.
- 'Essential Infrastructure' and 'More vulnerable' uses in Flood Zone 3a will have to pass the Exception Test.
- An FRA should be prepared for the site, which should confirm flood extents and levels.
- Properties situated within close proximity to formal defences or water retaining structures (reservoirs) will require a detailed breach and overtopping assessment to ensure that the potential risk to life can be safely managed throughout the lifetime of the development. The nature of any breach failure analysis should be agreed with the Environment Agency.
- The development should not increase flood risk elsewhere, and opportunities should be taken to decrease overall flood risk.
- Floor levels should be situated above the 100 year (fluvial) and 200 year (tidal) plus climate change predicted maximum level plus a minimum freeboard of 600mm.
- Dry pedestrian access to and from the development should be possible above the 1 in 100 year (fluvial) and 200 year (tidal) plus climate change flood level.
- The development should be safe, meaning that: people (including those with restricted mobility) should be able to remain safe inside the new development up to a 1 in 1000 year event; and rescue and evacuation of people from a development (including those with restricted mobility) to a place of safety is practicable up to a 1 in 1000 year event.
- If the land use of the development proposed is 'more vulnerable' or 'essential infrastructure', consideration should be given to the incorporation of flood resistance and resilience measures.
- Basements should not be used for habitable purposes. Where basements are permitted for commercial use, it is necessary to ensure that the basement access points and any venting are situated 600 mm above the 1 in 100 year (fluvial) and 1 in 200 year (tidal) flood level plus climate change for the life of the development. Near the coast an allowance for wave action should also be considered.

- An evacuation plan should be prepared in consultation with CBC's Emergency Planning team.
- Residents should be made aware that they live in a flood risk area. The Environment Agency plan to make their flood warning service 'opt-out' instead of 'opt-in', but until such time residents should be encouraged to sign up to Floodline Warnings Direct, should a Flood Warning system exist (as indicated by the Level 1 SFRA).
- The proposed development should be set-back from the watercourse with a minimum 8m wide undeveloped buffer zone, to allow appropriate access for routine maintenance and emergency clearance, if appropriate.
- SUDS should be implemented to ensure that runoff from the site (post development) is reduced. Space should be set-aside for SUDS at the master planning stage.
- The vulnerability of the development from other sources of flooding should be considered as well as the effect of the new development on surface water runoff.

Sites in Flood Zone 3b

Flood Zone 3b is identified in all seven areas assessed by the study. This section should be used to understand the requirements of development in this high probability Flood Zone.

- Development in High Probability Flood Zone 3b should be restricted to 'water-compatible uses' only.
- PPS25 dictates that 'essential infrastructure' can be located in Flood Zone 3b if the Exception test is passed. However, appropriate judgement should be exercised when attempting the Exception Test for essential infrastructure in Flood Zone 3b. Essential infrastructure includes: essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk; and strategic utility infrastructure, including electricity generating power stations and grid and primary substations.

  Essential transport infrastructure may be appropriate if designed in such a way that flood flow routes and flood storage areas are not affected (e.g. designing a bridge to cross the flood risk area). However, utility infrastructure may be less appropriate due to the potential consequences that may occur should the utility site become flooded (as demonstrated by the flooding of Mythe Treatment Works and near-flooding of the power station in Gloucestershire during the summer 2007 flood events).
- 'Essential infrastructure' in this zone must be designed and constructed to remain operational in times of flood and not impede water flow.

5.4 Site specific risk, location of uses within the site, access points, levels, safe design

Site specific risks and recommendations are considered in the Policy matrix in Table 7.1, and generic recommendations regarding the use of SUDS, appropriate flood avoidance, site layout, resistance and resilience measures are detailed in Sections 7.10 and 7.11. The requirements for access points, levels and safe design are dependent on flood risks at the site as detailed above (refer to ***Volume II Maps 2a and 2b*** and ***Section 5.3***)

6 Flood defences

6.1 Overview

Several areas of Christchurch are protected from flooding by raised defences. This chapter identifies these defences, assesses the condition of any key defences, details current policy and any existing proposals for their maintenance and upgrade. The final section briefly considers the potential implications of failure.

6.2 Flood defences – asset details, responsibilities, etc.

Nearly all the raised defences within Christchurch are located on either the Rivers Stour or Avon. Figure 6.1 illustrates the location of all fluvial and tidal defences within the borough as advised by the Environment Agency (from their National Flood and Coastal Defence Database, NFCDD) and CBC. Details of the defences including the maintainer are provided in Appendix E.

The majority of the defences within Christchurch are designed to provide a 1 in 100-year standard of protection (SoP), although there are a limited number where the SoP is lower or higher as detailed below:

- Raised embankments on the River Stour near Holdenhurst (close to the borough boundary) – SoP of 1 in 65-year
- Private raised defence (defence number 1358) on the River Avon near the roundabout between the B3347 and the A35 – SoP less than 1 in 20-year.
- Small private defences on River Mude and Bure Brook – SoP less than 1 in 20-year.
- Coastal defence at Mudeford Quay maintained by CBC – SoP less than 1 in 200-year.

However, a defences SoP is indicative and modelling often demonstrates a higher SoP for some defences. There is a small section of defence on the River Stour adjacent to Grove Farm Caravan Park to the west of Jumpers Common where NFCDD reports the SoP to be 1 in 50-year, but this defence was not shown to be overtopped by detailed modelling. Also the SoP detailed for the Quomps defences on NFCDD is 1 in 100 year, but modelling has shown the SoP provided by this defence to be approximately 1 in 200 year.

6.3 Condition assessment of key flood defences

The SoP provided by a defence can be reduced if a defence is in a poor condition. A flood defence condition assessment has been undertaken using the information provided by the Environment Agency (in their NFCDD information advised by specialists) and a limited site inspection on the 14 January 2009 of critical areas.

The key flood defences within Christchurch are in four areas, one area on the River Avon and three on the River Stour (***Table 6.1*** and ***Figure 6.2***). The findings of the site inspection are detailed in ***Appendix F***. For reporting purposes there is one template for each of the three areas on the Stour and four templates for the area on the Avon, as shown in the Table 6.1 below. The assessment findings are qualified in parts by the lack of access for inspection, especially on the island and upstream of Bridge Street on the Avon.

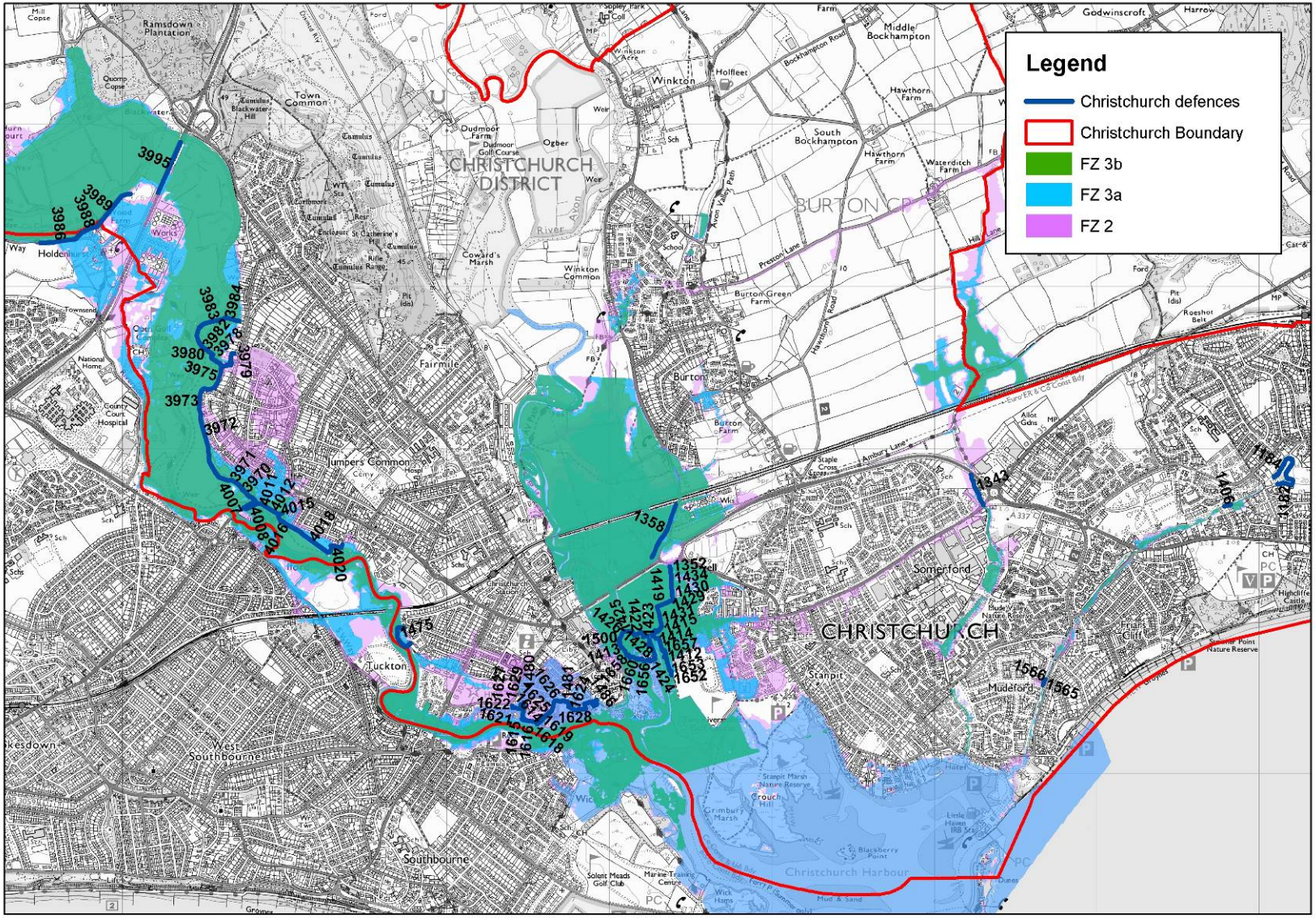

Figure 6.1 Flood defences within Christchurch (numbers indicate NFCDD ID no. details of each defence are provided in Appendix E)

Table 6.1 Key groups of flood defences within Christchurch

River	Area	Protection
Avon	Civic Offices reach, d/s Bridge Street (***Figure 6.2a***)	Fluvial/tidal
Avon	Bridge Street u/s to A35 road embankment (***Figure 6.2a***)	Fluvial/tidal
Avon	The island north (u/s) of Bridge Street (***Figure 6.2a***)	Fluvial/tidal
Avon	The island south (d/s) of Bridge Street (***Figure 6.2a***)	Fluvial/tidal
Stour	Old Pontins site and the Quomps, d/s B3059 (***Figure 6.2b***)	Tidal
Stour	Homelands area, d/s railway line (***Figure 6.2c***)	Fluvial
Stour	Jumpers Common and Iford area, u/s and d/s A35 (***Figure 6.2d***)	Fluvial

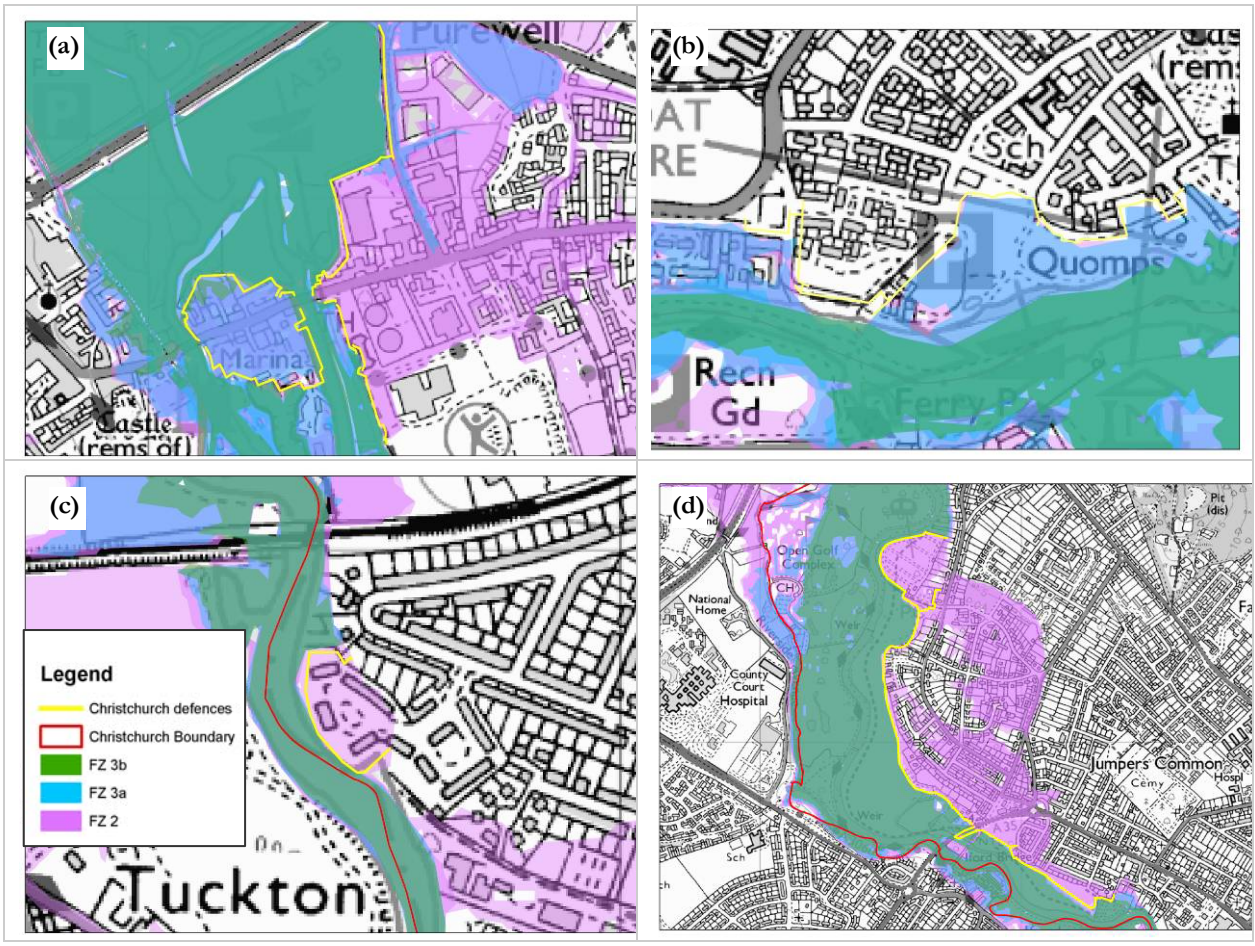

Figure 6.2 Key groups of flood defences within Christchurch *(only fluvial flood zones are illustrated, except for the Old Pontins site and the Quomps (figure b) with the tidal flood zones are also shown)*

Most of the defences were constructed under two schemes: the Lower Avon Flood Defence Scheme (inaugurated in September 1998); and the Lower Stour Flood Defence Scheme (inaugurated in October 1993).

Some of the defences on the island south of Bridge Street, particularly those in the marina area, look to be newer than this but this is not confirmed. Similarly, the defences to the Homelands area look new, the Jumpers Common Flood Embankment was reconstructed in 2004/5, and the Grove Farm Caravan Park Flood Wall has been constructed recently.

The conclusion is that all the defences are less than 20 years old.

The defences are predominantly a mix of flood walls, mostly reinforced concrete with brick or stone cladding, and earth embankments. There are some sections of steel sheet piled walls on the Avon, upstream of Bridge Street and in the marina area of the island. Also, there are some floodgates on the Avon and Stour, some ramped vehicular accesses on both rivers, and a number of gated drainage outfalls on both rivers.

The defences are owned by the Environment Agency, except for some short sections upstream of Bridge Street and in the marina area of the island on the Avon.

The overall condition of the defences is good to very good, which reflects their age and location. A few minor concerns are detailed in ***Appendix F***, mostly relating to two low spots in the defences on the Avon, and also the need for some maintenance to the earth embankments.

6.4 Current policy for flood defences – as set by the EA strategically

The need for defences within Christchurch will increase in the future with increased fluvial flood risks, rising sea levels and a potential increase in storm surge frequency and magnitude. The Environment Agency advocates a strategic approach to flood risk management on a 'whole catchment' basis, and have adopted the CFMP (Hampshire Avon and Dorset Stour CFMPs; Environment Agency, draft a, draft b) policy to 'take further action to reduce flood risk (now and/or in the future)' on the lower reaches of the Avon and Stour within Christchurch.

Along the coast, the Poole and Christchurch Bays SMP policy varies, but in Stanpit and Mudeford the policy is largely to 'hold the existing defence line' (***Figure 6.3***) where properties are at risk of flooding (Environment Agency, 1999, under review). The 'managed realignment' policy which has been adopted for Stanpit Marsh will 'do nothing' in the short term and pursue 'selective retreat' in the longer term. The 'mixed management types' policy adopted for Christchurch Bay will selectively 'hold the line' where appropriate, likely where the urban infrastructure is threatened.

The implementation of these policies allows the standard of protection currently provided to existing properties to be continued.

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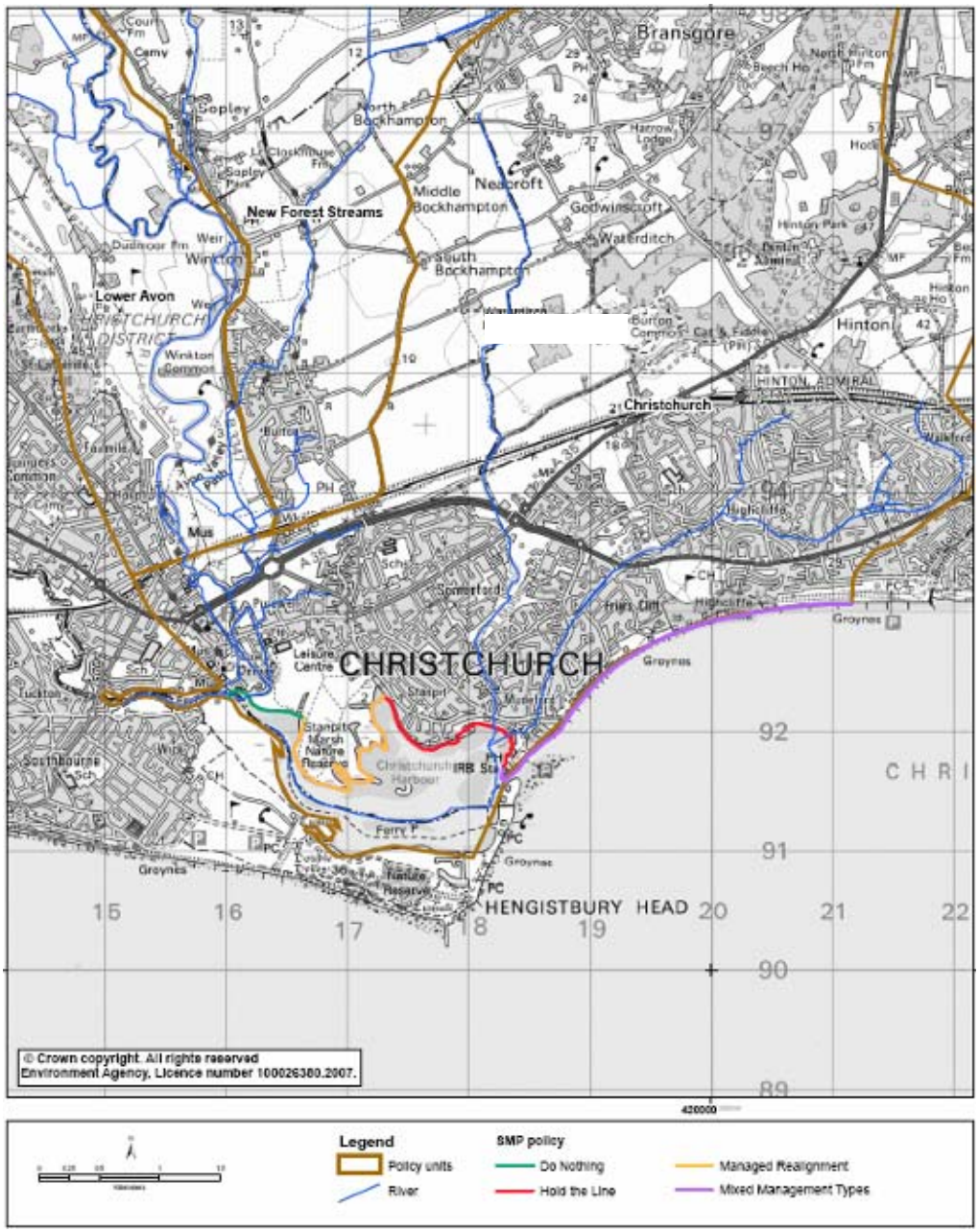

Figure 6.3 Summary of the SMP policies along the Christchurch coastline (Environment Agency, draft b)

6.5 Any existing proposals to improve protection and opportunities for upgrade

The Environment Agency's policy for fluvial defences within Christchurch is to take further action to reduce flood risk (now and/or in the future; Section 6.4), but there are currently no plans to improve on the 1 in 100 year SoP currently provided by these existing defences.

The Poole and Christchurch Bays SMP indicates that the policy for tidal defences in Stanpit and Mudeford is largely to 'hold the existing defence line' where properties are at risk of flooding. The Environment Agency also accepts that these tidal defences can be upgraded and will not object to others undertaking the works, but may not upgrade the defences themselves. At present, there are no proposals for such works and it is not known (by the Environment Agency) if the defences in Stanpit and Mudeford will eventually be upgraded.

The Environment Agency consider defences for existing developments, not future needs.

6.6 *Implications of failure, e.g. breach, overtopping*

A significant risk within Christchurch is the reliance on raised defences and as sea levels continue to rise any breach or overtopping of defences could be very severe and have a major impact. The areas at greatest risk of breach or overtopping are the town centre and West Christchurch (also see ***Section 7.5***), and in particular the sites located close behind the flood defences.

The areas behind a defence are protected from flooding (up to a standard of protection) by the defence, but undefended model flood limits show the areas at risk of flooding if the defences are removed, and hence indicates the areas at risk of flooding if the defence should fail. Figure 6.4 compares the undefended model runs for the present day, and in 2086 and 2126 with climate change. This figure indicates that if existing defences are raised and widened (to maintain current standards of protection with climate change), the areas at risk of flooding as a result of defence failure (i.e. overtopping or breaching) will progressively increase. However, this figure is only indicative of the effect of defence failure, and breach and/or overtopping scenarios are recommended to better understand risks to any existing or future development.

Low lying areas around the perimeter of Christchurch Harbour are significantly developed with residential property, much of which is located in the 1 in 200 year tidal flood zone (New Forest District Council, draft). As a result, a number of tidal flood defences have been constructed which mainly consist of seawalls, but also revetments and embankments.

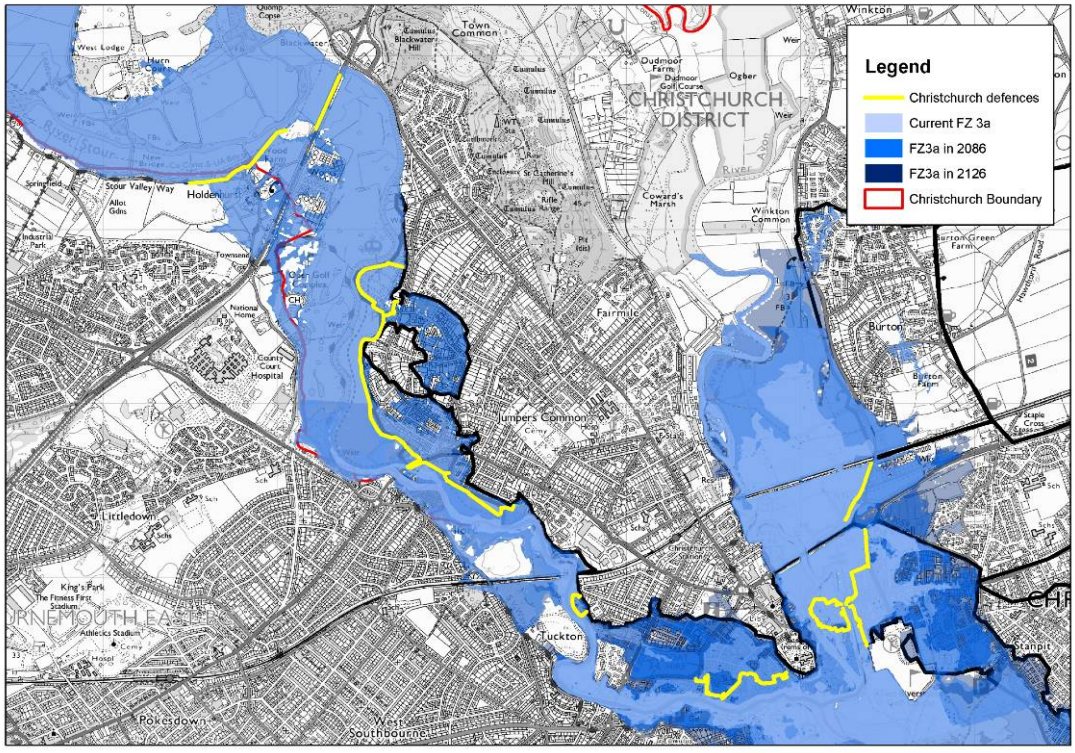

Figure 6.4 Areas at risk of flooding in a 1 in 100 year flood event without defences (a) present day, (b) in 2086 and (c) 2126

New Forest District Council have undertaken a study of the extent of flooding that is likely to occur in the event of defence failure using extreme tide level data (Posford Haskoning, 2003) for a range of return periods and projecting these water levels onto the land to identify the properties at risk of flooding (using LiDAR to take into account the ground elevation plus a threshold level of 0.15m for each property). The Environment Agency have advised that the flood limits derived using this method are generally more conservative than those derived using more detailed (e.g. ISIS or TUFLOW) modelling. The extent of the inundation due to a breach is also dependent upon the extent of the breach.

This New Forest study shows that future rises in tide levels will increase the areas and properties at risk of flooding, and that if tidal defences are not raised this will result in a steady reduction in their SoP. The cost/benefit of various defence improvement options has also been considered by this study.

Halcrow (2006) undertook an inception study to establish the further work required to determine the impact of a breach of the defences at Double Dykes on Hengistbury Head. The Poole and Christchurch Harbour SMP review will consider the risk of breach in more detail and if appropriate specify what work is required.

7 Flood risk management policy – area specific

7.1 Overview

This chapter provides recommendations for flood risk management policies within the seven areas being considered for future development. These policies are specific to an area (as detailed), and others that are more generic recommendations that apply to all areas are detailed in the next chapter.

7.2 The Local Development Framework

Christchurch Borough Council (CBC) is currently in the process of preparing its Local Development Framework. Its production is at an early stage, with a Local Development Scheme (Revision 3) having been published in March 2007, and the Core Strategy DPD not due for adoption until 2011.

7.3 Planning policy implications

The complex range of issues that result from this Level 2 SFRA have wide ranging implications for future planning in Christchurch. The emerging Local Development Framework will require detailed policies to ensure development takes place in safe and sustainable locations, while making the best use of the borough's scarce developable land.

Policies are likely to be too detailed for inclusion in the Core Strategy alone and the Council will need to give consideration to preparing a Supplementary Planning Document on the subject of flood risk. Such a document could provide clarity on a range of issues as covered by this report and set out below. Ideally the Supplementary Planning Document on flood risk should be produced in tandem with the Core Strategy as will form part of the evidence base which will demonstrate that the Core Strategy is sound. The Core Strategy should provide the strategic policy basis for directing development away from areas at risk of flooding and ensuring that where development is at risk, it incorporates appropriate flood resistance and resilience measures. The SPD should provide additional detail to clarify how the LPA and developers should deliver the Core Strategy policies . It is advised that any site specific allocation identified in the Local Development Framework, which wholly or partly lies within future flood risk areas identified in this report are scheduled for delivery after the SPD on flood risk has been published. This will allow site-specific and/or area-wide flood mitigation measures to be assessed as part of the planning process.

Possible layout for a Supplementary Planning Document dealing with flood risk

Background & Context

- background (UK flooding), PPS25.
- current situation in Christchurch, Environment Agency flood zones and current practice
- Sequential Test, available developable land in Christchurch, the Strategic Housing Land Availability Study, Employment Land Review.
- Exception Test, principles of safe development in flood zones, access, egress, emergency services.

SFRA Flood Zones

- explanation of SFRA zones, probabilities, risk / hazard
- flood risk in relation to proposals
- surface water flooding

Flood policy

- Core Strategy policy
- location specific development policies
- policies for defended and undefended areas
- possible non-development zones (in areas of greatest risk, beyond mitigation)
- time-limited consents for commercial development
- developable zones where mitigation may be appropriate (for allocations)
- areas where the Council will or will not consider windfall applications
- developer contributions for flood defences
- SUDS (strategic and local, appropriate locations and types)
- appropriate flood avoidance, resistance and resilience measures (appropriate locations/types), design
- other flood mitigation, e.g. flood storage areas (appropriate locations and types), new technologies
- substitution of uses (more vulnerable for less vulnerable in high risk zones)

Advice for site specific FRAs

- sequential testing using the SFRA
- using SFRA results to inform FRAs
- site specific risk, location of uses within the site, access points, levels, safe design

7.4 Location specific development policies

Each of the seven areas being investigated in this Level 2 SFRA span Flood Zones 1, 2, 3a and 3b (see Section 3.1), but within these Flood Zones the flood hazard varies due to differences in flood depth and velocity. As a result, the location specific development policies detailed in Table 7.1 are recommended for these areas. These location specific policies are in addition to those borough wide policies advised as part of the ***Level 1 SFRA*** (***Section 10.5***). However, the policy recommendations in the Level 1 SFRA for safe access and egress require revision in line with the updated PPS25 Practice Guide (June 2008). This updated recommendation is contained within Section 8.6 of this report.

In allocating sites for development CBC is required to adopt the climate change fluvial and tidal flood zone maps for the lifetime of the proposed development, as detailed below, in addition to any other sources of flooding (surface water, groundwater and sewer), as identified on ***Volume II, Map 1***:

- ***Volume II, Map 2a*** (undefended flood zones with climate change to 2086) to be used for commercial development, since commercial development can be considered to have a lifetime of 60 years (or alternative period if considered more appropriate).
- ***Volume II, Map 2b*** (undefended flood zones with climate change to 2126) to be used for residential development, since residential development can be considered to have a lifetime of 100 years.

When considering the layout of new developments information about flood depths (***Maps 6a*** to ***8c***, and ***12a*** to ***12d***) and velocities (***Maps 13a*** to ***15c***, and ***19a*** to ***19d***) should be used to minimise any flood risk or ensure the level of risk is appropriate to the type of development being proposed.

Although defences are modelled for the coastal model runs (***Maps Sets 12*** and ***19***) it has been shown that these will be overtopped and therefore these scenarios also represent the undefended situation.

For any sites situated behind defences the defended flood zones with climate change to 2086 (***Map 4a***) and 2126 (***Map 4b***) should also be considered, together with information about flood depths (***Maps 9a*** to ***12d***) and velocities (***Maps 16a*** to ***19d***).

Table 7.1 Policy matrix for the lifetime of proposed developments *(to 2086 for non-residential and 2126 for residential developments)*

Site	Site description and potential for development	Flood depth assessment	Flood velocity assessment	Flood hazard assessment	Recommendations
1 – Bournemouth airport	Continued use as operational airport and employment land	In 2086 - FZ3a (Map 7b) Flooding is deepest in west with peak of 1m. The depth is generally low (0 – 0.6m) in the east	In 2086 - FZ3a (Map 14b) Velocities are negligible (<0.05m/s)	In 2086 - FZ3a Hazard is mainly cautionary however it is dangerous for most in a small area in the north west region	➢ Large areas of this site are at risk of flooding, but flood depths and velocities vary across the site and so development should be directed to the areas of lowest risk (in the east), unless flood risks in the west of the site can be mitigated (*refer to* ***Section 8.7***). Follow guidance in ***Section 5.3*** for development within each of the flood zones. ➢ Culverts at the airport need to be maintained. At the present there are three structures that were observed to be partially blocked during the site survey (*refer to* ***Section 3.8***).
2 – Roeshot Hill area of search	Currently greenbelt. Partial development for housing; most likely south of the railway and possibly along the east edge of Burton. Remaining land to continue use for agriculture within green belt.	In 2126 – FZ2 (Map 8c) Flooding only at region edge and is <0.4 m except for where it peaks at approx 0.7m In 2126 – FZ3a (Map 8b) Depth is shallow (<0.25m) and only in the south east area	In 2126 – FZ2 (Map 15c) Velocities are low (<0.2m/s) except at boundary (<0.8m/s) In 2126 – FZ3a (Map 15b) Velocities are low (<0.2m/s) except at boundary (<0.8m/s)	In 2126 – FZ2 North and Eastern boundaries are cautionary. In 2126 – FZ3a North and Eastern boundaries are cautionary	➢ Much of this site lies within Flood Zone 1. Therefore it is recommended that any future development sites are allocated within Flood Zone 1 (*refer to* ***Section 3.9*** *for details of flood risks to the sites being considered across this RSS area of search*). Follow guidance in ***Section 5.3*** for development in Flood Zone 1.
3 – Town centre	Medium to high density urban area; housing, commercial and leisure uses. Continuing pressure for development. Large green spaces likely to continue to be protected.	In 2086 - FZ3a (Map 7b) Only dry areas in west flooding (mainly 0.5 to 3.5m) In 2126 – FZ2 (Map 8c) One dry and one shallow area in west, otherwise 1.5 to 5m In 2126 – FZ3a (Map 8b) The same as 2126 – FZ2 but approx 0.25 m shallower	In 2086 - FZ3a (Map 14b) Always approx 0.25 m/s slower than 2126 – FZ3a In 2126 – FZ2 (Map 15c) Always approx 0.25 m/s faster than 2126 – FZ3a In 2126 – FZ3a (Map 15b) Velocities high along southern edge and in north (1 to 2m/s)	In 2086 - FZ3a Mostly 1.25 – 2.5 In 2126 – FZ2 Dangerous for all along river course and northern area, otherwise mainly dangerous for most. In 2126 – FZ3a Mostly 1.25 – 2.5	➢ Large areas of this site are at risk of flooding, but flood depths and velocities vary across the site and so development should be directed to the areas of lowest risk (in the north). Follow guidance in ***Section 5.3*** for development within each of the flood zones. ➢ Fluvial defences lower the risk of flooding within this area. Any sites behind a defence that is being considered for residential development will require a breach and overtopping assessment to allow any development to be designed appropriately (*refer to* ***Section 7.5***) ➢ Old landfill sites (*refer to* ***Section 3.10***) should be avoided due to the risk of potential contaminants.
4 – Stanpit, Mudeford, Purewell	Low to medium density residential area. Moderate pressure for intensification (infill residential development). Large green spaces likely to continue to be protected.	In 2126 – FZ2 (Map 8c) Area completely flooded (0.6 to 2 m) In 2126 – FZ3a (Map 8b) Area completely flooded (0.5 to 1.9 m)	In 2126 – FZ2 (Map 15c) Velocities are negligible (<0.13m/s) In 2126 – FZ3a (Map 15b) Velocities are negligible (<0.06m/s)	In 2126 – FZ2 Dangerous for most In 2126 – FZ3a Mainly dangerous for most however in some northern regions only cautionary	➢ Large areas of this site are at risk of flooding, but flood depths and velocities vary across the site and so development should be directed to the areas of lowest risk (in the east). Follow guidance in ***Section 5.3*** for development within each of the flood zones. ➢ Fluvial defences lower the risk of flooding to the north of this area (Purewell). Any sites behind a defence that is being considered for residential development will require a breach and overtopping assessment to allow any development to be designed appropriately (*refer to* ***Section 7.5***) ➢ Old landfill sites (*refer to* ***Section 3.10***) should be avoided due to the risk of potential contaminants.
5 – West Christchurch	Medium to low density residential area. Continuing pressure for intensification (infill residential development). Large green spaces likely to continue to be protected.	In 2126 – FZ2 (Map 8c) Shallow (0.2 to 2 m), although higher along western edge In 2126 – FZ3a (Map 8b) Mainly shallow (<0.5m) deeper areas in the west (1 to 1.5 m)	In 2126 – FZ2 (Map 15c) Velocities low (<0.5m/s) except for middle region (0.7 to 1.5m/s) In 2126 – FZ3a (Map 15b) Slow velocities (<0.5 m/s)	In 2126 – FZ2 Mainly dangerous for most, some areas dangerous for all. In 2126 – FZ3a Mainly dangerous for most, some areas dangerous for all.	➢ Large areas of this site are at risk of flooding, but flood depths and velocities vary across the site and so development should be directed to the areas of lowest risk (in the east). Follow guidance in ***Section 5.3*** for development within each of the flood zones. ➢ Fluvial defences lower the risk of flooding to the west of this area (west of Jumpers Common). Any sites behind a defence that is being considered for residential development will require a breach and overtopping assessment to allow any development to be designed appropriately (*refer to* ***Section 7.5***)
6 – River Mude & Bure Brook	Primarily green spaces and wildlife corridors within medium density residential area. Mild pressure for intensification (infill residential development). Large green spaces likely to continue to be protected.	In 2126 – FZ2 (Map 8c) Shallow flooding only, along north western edge. In 2126 – FZ3a (Map 8b) Small area of shallow flooding in north (<0.4m)	In 2126 – FZ2 (Map 15c) Velocities low (0.5m/s) In 2126 – FZ3a (Map 15b) Velocities are negligible (<0.13)	In 2126 – FZ2 Cautionary along North western boundary In 2126 – FZ3a Cautionary along North western boundary	➢ Much of this site lies within Flood Zone 1. Therefore it is recommended that any future development sites are allocated within Flood Zone 1 (*refer to* ***Section 3.9*** *for details of flood risks to the sites being considered across this RSS area of search*). Follow guidance in ***Section 5.3*** for development in Flood Zone 1. ➢ Culverts on the River Mude and Bure Brook need to be maintained (*refer to* ***Section 3.8***).
7 - Burton	Medium density residential area and some green spaces. Moderate pressure for intensification (infill residential development). Large green spaces likely to continue to be protected.	In 2126 – FZ2 (Map 8c) Deepest at western edge and northern tip (0.6 to 1.6m) other wise <0.5m In 2126 – FZ3a (Map 8b) Shallow (<0.5m) except for south-west corner (1 to 1.3m)	In 2126 – FZ2 (Map 15c) Velocities are slow (<0.30m/s) In 2126 – FZ3a (Map 15b) Velocities are negligible (<0.05m/s)	In 2126 – FZ2 North and south-west dangerous for most, a few cautionary areas. In 2126 – FZ3a North and south-west dangerous for most, a few cautionary areas.	➢ Much of this site lies within Flood Zone 1. Therefore it is recommended that any future development sites are allocated within Flood Zone 1. Follow guidance in ***Section 5.3*** for development in Flood Zone 1. ➢ Culverts on the Burton Brook need to be maintained (*refer to* ***Section 3.8***).

7.5 Policies for defended areas

Key flood defences are located within the town centre (Area 3, Figure 7.1) and west Christchurch (Area 5, Figure 7.2), as well as along Bridge Street west of Purewell (Figure 7.1). These currently provide a 1 in 100-year standard of protection to locations within these areas.

All these existing defences should be maintained to a high standard, where they currently protect development or will be relied upon to protect future development (although reliance on defences to protect new development is not supported by PPS25 or the Environment Agency), with an allowance for climate change – see ***Volume II, Maps 4a*** and ***4b***.

Areas behind flood defences, for example in west Purewell and the caravan park at Jumpers Common, are at particular risk from rapid onset of flooding, with little or no warning if defences are overtopped or breached.

Sites protected from flooding by a flood defence may be at risk of rapid inundation. Therefore, new development should be sited away from existing flood defences except in exceptional circumstances, where a flood risk assessment shows how the building and its users will be made safe.

Any area behind a defence that is being considered for residential development will require a breach and overtopping assessment to allow any development to be deigned appropriately (see ***Section 5.3***).

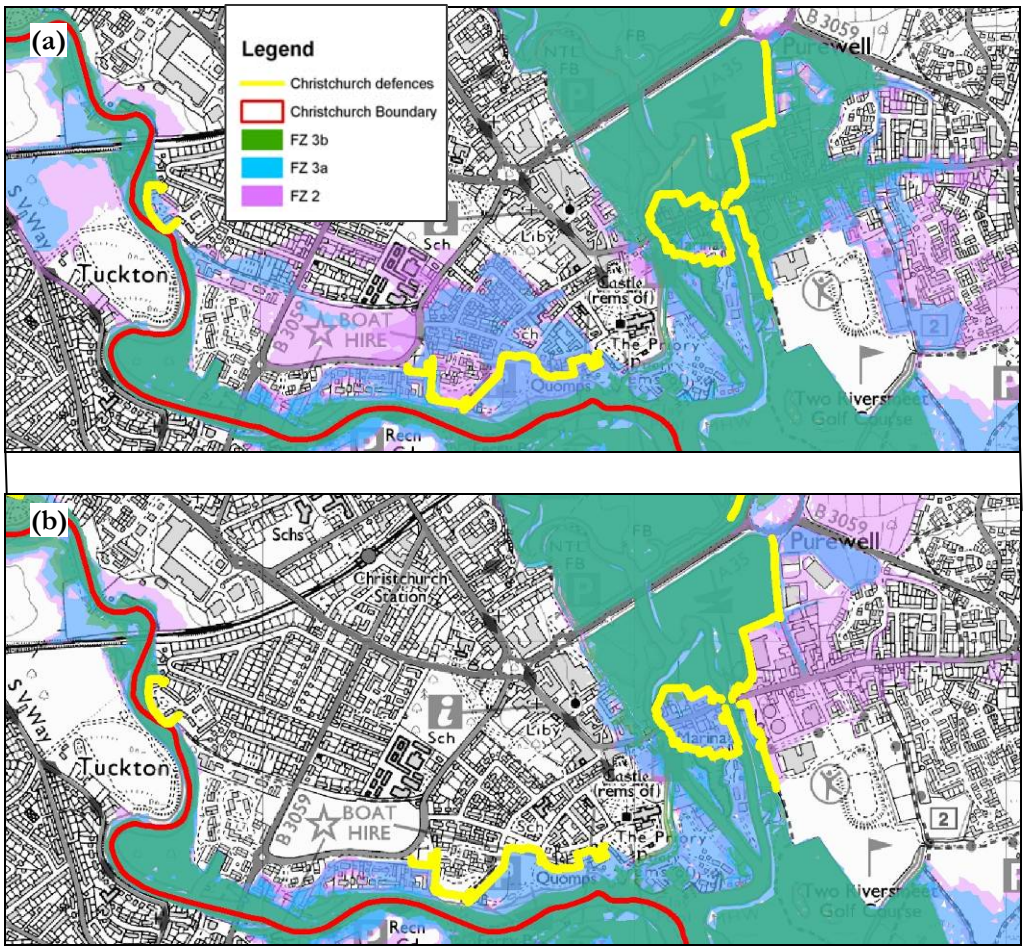

Figure 7.1: Town centre (FRA 3) (a) undefended SFRA Flood Zones (b) defended Flood Zones

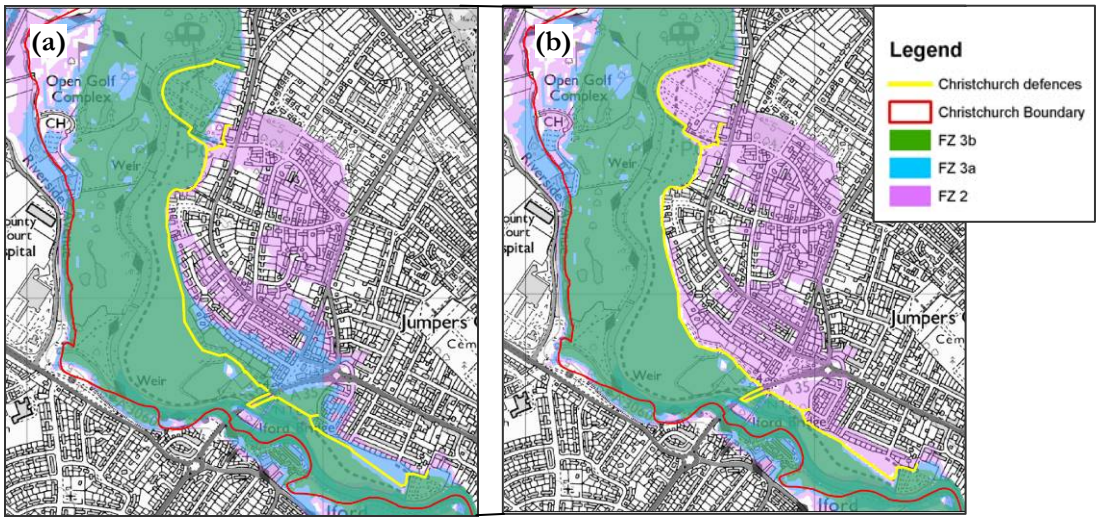

Figure 7.2: West Christchurch (FRA 5) ***(a) undefended SFRA Flood Zones (b) defended Flood Zones***

7.6 ***Possible non-development zones*** *(in areas of greatest risk, beyond mitigation)*

When development pressures means that it is necessary to consider development in areas that are at medium or high flood risk and there are no other suitable alternative sites for development after applying the Sequential Test the nature of the flood hazard should be considered (***refer to Volume II, Maps 20-25***). This will allow a sequential approach to site allocation to be adopted in each flood zone. When allocating sites for development and designing safe access and exit routes, the combinations of depth and velocity on the routes should correspond to the category of 'very low hazard – caution'. The Environment Agency have advised that they will look to object to development where the flood hazard is at least 'danger for some'. Figure 7.3 illustrates the flood hazard in 2126 for the areas being considered in this SFRA. Residential development should be avoided in all areas shown in Figure 7.3 where the flood hazard is categorised as 'danger for some' or greater.

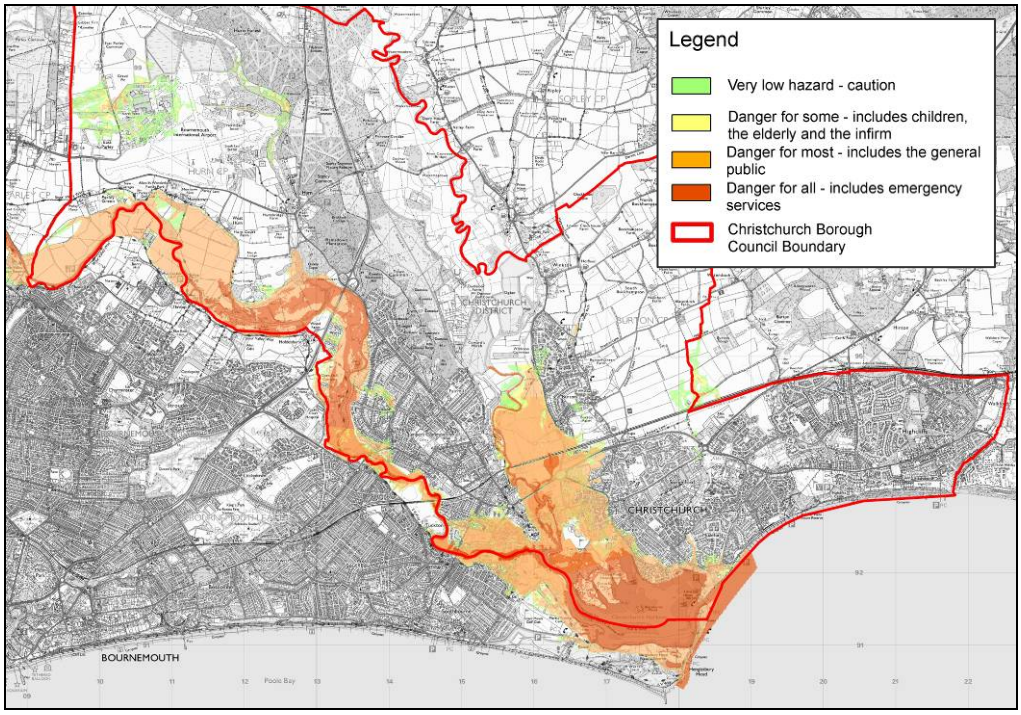

Figure 7.3 Defended hazard map with climate change in 2126 *(refer to Volume II, Map 22 for a larger version of this figure)*

8 Flood risk management policy – Borough wide

8.1 Overview

This chapter provides recommendations for flood risk management policies that are more generic recommendations that apply to all the seven areas which have been assessed. The policies that are specific to an area are detailed in the previous chapter.

8.2 Developable zones where mitigation maybe appropriate (for allocations)

Development should not be located in flood risk areas unless the Sequential Test, and where necessary, the Exception Test have shown that it is necessary. Where this is the case, a mitigation strategy to deal with the flood risk is required to ensure that any development will be safe.

Wherever possible the construction of new defences to protect new development should be avoided, since there is a residual risk that the defence may breach or be overtopped. Strategic solutions of upstream storage, the attenuation of flows or individual property protection (Section 7.9) may be appropriate mitigation measures. Possible strategic solutions to manage flood risks within each of the Areas are identified in Section 8.7.

Any development that requires the construction of new defences will need to show that other options (e.g. flood storage areas) have been considered and are not feasible, and that the defences are compatible with the long-term flood risk management policies for Christchurch as detailed in the CFMPs and the SMP (see ***Section 6.3***). Furthermore, to ensure soundness of Local Development Framework policies, CBC may be required to produce a flood management and delivery strategy setting out how an area will be adequately defended with provision for the long term maintenance of the defences. This may be required prior to adoption of the Core Strategy and the Site Specific Allocations document.

Opportunities may exist to reduce overall flood risk within a zone through the redevelopment of existing uses, through innovative design, drainage or other forms of flood mitigation. The merits of such schemes will need to be clearly demonstrated by the applicants and supported by a flood risk assessment and drainage impact assessment.

8.3 Areas where the Council will consider 'windfall' applications

'Windfall' sites are those sites which become available unexpectedly and therefore have not necessarily been considered as part of the forward planning site allocation process. CBC should consider windfall applications for sites with an equal or lower risk of flooding as those sites that have already been allocated.

For the purpose of development control, policies may need to be included for unallocated windfall sites that will set out broad locations and quantities of windfall development that will be acceptable. Windfall sites should be subject to the same consideration of flood risk as other allocated sites.

The Sequential Test should be applied to windfall sites, unless the area in which they occur has been sequentially tested on the basis of this SFRA. Where the Sequential Test has not been applied to the site or area, proposals will need to be dealt with on an individual site

basis and the developer will need to provide evidence to CBC that they have adequately considered other reasonably available sites, both allocated and unallocated.

A change of use to a higher flood risk Vulnerability Classification as set out in table D2 of PPS25 will generally not be subject to the Sequential Test however the application will still be subject to the Exception Test where applicable and in all cases a FRA will be required to demonstrate that the development is safe.

8.4 Developer contributions for flood defences

At present, each development is required to mitigate its own flood risk. Until CBC adopts policies in its LDF, there is no adopted policy that requires contributions for flood defences from developments within flood zones. Current planning practice allows CBC to consider LDF policy for developer contributions which takes the form of a 'roof tax' type charge for all developments affected by flood risk, to facilitate the pooling of funds for future defence improvements. This charge could be included within a schedule of infrastructure funded through the Government's proposed Community Infrastructure Levy. Should CBC have aspirations to regenerate areas which will be subject to increasing flood risk its LDF policy for developer contributions will need to take the form of a 'roof tax' type charge for all development affected by flood risk, to facilitate the pooling of funds for future defence improvements.

In a location where levels of development are such that it would not be possible to pool sufficient contributions to build adequate defences ahead of that development going ahead (for example, Stanpit and Mudeford), it may be necessary to produce a flood management and delivery strategy setting out how the area will be adequately defended in the future, in order to permit development to take place in the short term. A flood management and delivery strategy should identify the risks to the local authority for any shortfall in funding required to deliver the defences when required and the liability on CBC to meet those costs.

8.5 SUDS – appropriate locations and types

Current Environment Agency standing advice requires that any development larger than one hectare must ensure that the post development runoff volumes and peak flow rates (1 in 100-year with climate change) are attenuated to the Greenfield (pre-development) condition or at least to mimic the surface water flows arising from the site prior to the proposed development. As a result, SUDS can have a potential positive effect by reducing flood risk at all sites. This report recommends that SUDS should be a requirement for all new development. Space should be specifically set-aside for SUDS and used to inform the overall site layout.

Appropriate SUDS techniques will need to be established through a site specific drainage assessment which will investigate local geological and groundwater conditions (see ***Section 9*** of the ***Level 1 SFRA*** for SUDS guidance). Figure 8.1 illustrates some of the SUDS techniques that can be implemented at the local scale.

In October 2008, the Government changed the General Permitted Development Order making (inter alia) the hard surfacing of more than five square metres of residential front gardens only permitted where a permeable surface is used (CLG and Environment Agency, 2008). The purpose of this policy change is to slow any increase in the loss of natural drainage storage and the incidence of surface water flooding.

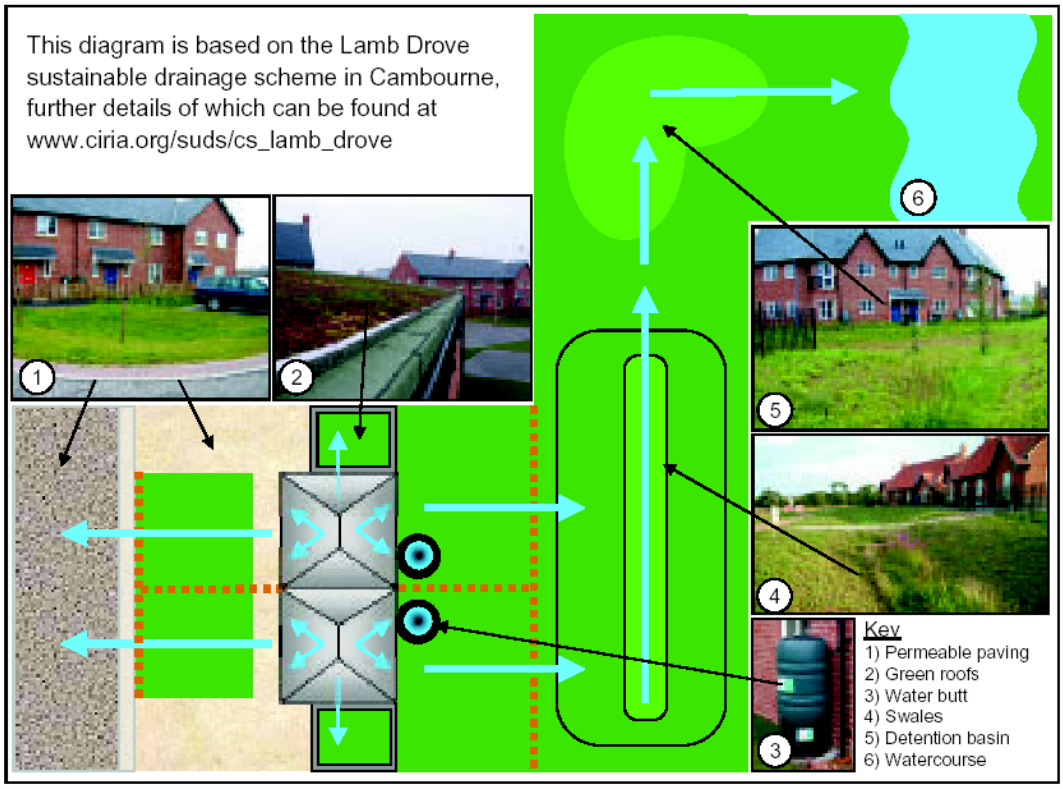

Figure 8.1 Diagram of how SUDS can be used at a local scale

(Source: The Pitt Review, 2007. Learning Lessons from the 2007 floods, Cabinet Office).

8.6 Appropriate flood avoidance, site layout, resistance and resilience measures

The best way to avoid flood risk is to locate the development outside areas of flood risk i.e. Flood Zone 1. Where there are no suitable sites in lower flood risk areas, the Sequential Approach should be applied within the development site to locate the most vulnerable elements of a development in the lowest risk areas.

Site layouts should be designed so that the most vulnerable uses are restricted to higher ground at lower risk of flooding, with more flood-compatible development (managed public parking, open space etc.) in the highest risk areas. The acceptability of parking use will be dependant on the depth and the ability to manage parking during potential flood events.

Where development is considered necessary and it is not possible to minimise flood risks to an acceptable level through the use of defence structures, flood storage areas or other alternatives, the less desirable resort is to minimise the impact of flooding through individual building design by raising finished floor levels and providing safe access routes.

Other resistance and resilience measures are likely to be considered as unacceptable on their own for new development since the hazard posed by flood waters still remains, particularly for access, egress and the supply of utilities.

Indeed, on their own these measures are unlikely to be suitable as the only mitigation measure implemented, but may be appropriate where land is being used for water-compatible or change of use to less-vulnerable building types (see Table D.2 of PPS25) where there is not an inappropriate risk to people or assets.

Further requirements to enable development may include appropriate flood warning, raised floor level and raised ground levels that allow safe access and egress, i.e. dry pedestrian egress should be possible above the 1% fluvial or 0.5% tidal flood level plus climate change. Should this not be possible an egress route which has a flood hazard rating of less than 0.75 and considered to have a low degree of flood hazard as identified in Table 13.1 of FD2320/TR2 and Figure 3.2 of FD2320/TR1 shall be provided. Emergency vehicles should be able to access the site during an extreme event (an event with an annual probability of 0.1%). Advise from the Local Authorities emergency planning officer and the emergency services should be sought on whether they will be able to provide emergency evacuation from the development during exceedance events (events in excess of a design event, i.e. with an annual probability of between 0.5% and 0.1% for tidal events or 1% and 0.1% for fluvial events).

Individual property protection can be divided into two main types (**Figure 8.2**):

- Flood resistance measures (also known as dry proofing) are those put in place to prevent flood water entering a building. These measures may be acceptable for a change of use. For new development elevating finished floor levels above future flood levels would be more appropriate.
- Flood resilience measures (also known as wet proofing) accept that water will enter the building but through careful design will minimise damage and allow the re-occupancy of the building quickly.

As resilience measures still allow water to enter a building, these should not normally be considered for new developments.

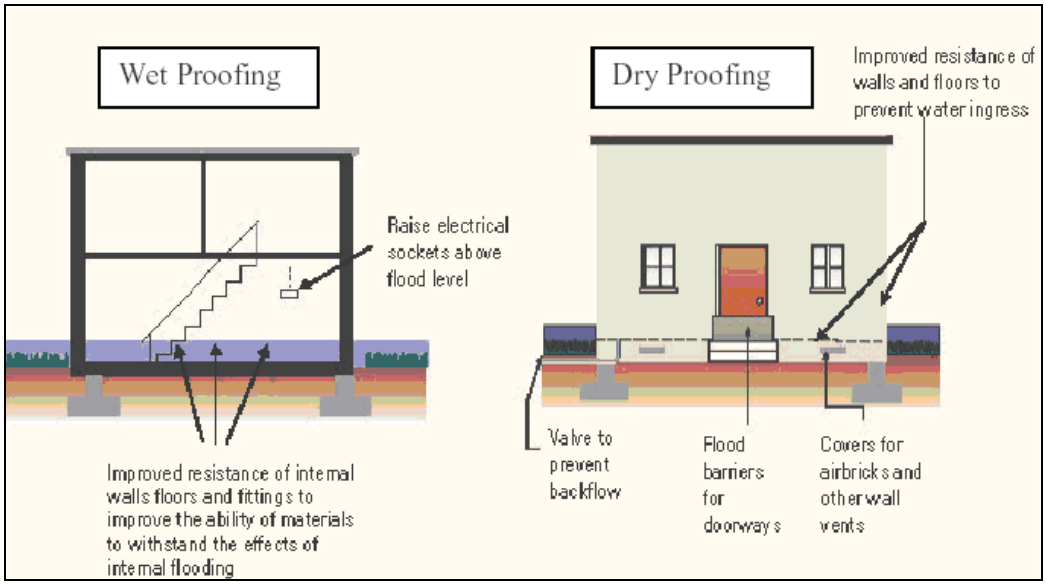

Figure 8.2 Examples of flood resistance and resilience measures
(Source: Adapted from Scottish Executive, 2004)

Making a building flood resistant aims to prevent flood water entering the building. This approach relies on flood barriers and the building structure. The flood barriers are placed across doors and air vents and may include non-return valves on drains. It is difficult to effectively block all flooding routes, e.g. where services enter the building. These types of measures are most effective for short duration flooding with simple measures estimated to

be effective for several hours and more complex measures effective for several days (Scottish Executive, 2004). However, the size and the permeable nature of part of the Avon and Stour catchments will result in an extended flooding duration throughout much of the borough.

Making a building flood resilient involves a number of measures to make the building able to cope with being inundated with flood water. Work may include the raising of the services, in particular the service meters and electrical wiring above the flood level. Some examples of flood resilience measures include:

- replacing floors with concrete;
- removing carpet and replacing with clay tiles;
- replacing open cell insulation with closed cell insulation.

Since any flood management measures only manage the risk of flooding rather than remove it, flood resistance and flood resilience may need to be incorporated into the design of buildings and other infrastructure behind flood defence systems. If a defence does fail, the area behind the defence may be rapidly inundated with high velocity flood water. As such, buildings should be structurally designed to withstand the expected water pressures, potential debris impacts and erosion which may occur during a flood event.

8.7 *Possible strategic solutions to manage flood risks*

Flood risk management requires integrated solutions to manage flood risk, addressing the issues of rainfall, runoff, rivers, coasts and flood inundation as well as the human and socio-economic issues of planning, development and management.

> "Flooding is a natural process – we can never stop it happening altogether. So tackling flooding is more than just defending against floods. It means understanding the complex causes of flooding and taking co-ordinated action on every front to reduce flood risk. This calls for long-term planning and truly 'joined-up' action from the full spectrum of partners, from policy makers to vulnerable communities. To help make this step change in the way we tackle flooding ….."
>
> Extract: Environment Agency Strategy for Flood Risk Management 2003-08

Such an integrated approach is promoted in Defra's *The Government's Water Strategy for England – Future Water*, and strategy *Making Space for Water*, DTI's *Foresight Future Flooding* project and the European Directive on the *Assessment and Management of Flood Risks.*

Structural options to manage flood risks can be summarised as:

- Increase flood storage as a strategic solution - dams, floodplain/wetland storage, floodplain restoration, temporary channel storage
- Increase flood conveyance (affects d/s) - canalisation, channel restoration, dikes and embankments, by-pass and diversion channels, structure upgrade/improvement – *environmental and sustainability concerns, operation/maintenance legacy.*
- Flood defences - flood defences along river, ring dykes for key areas, special structures, including the option to increase the standard of protection provided by existing defences.
- Flood water transfer - bypass or diversion across river/tributary catchments - *not considered a feasible option for the Avon or Stour catchments*

The scope of structural and non-structural options for flood risk management is detailed in Appendix G, and includes the structural (river engineering) options above, mainly non-structural approaches to manage flood events and losses, and urban (fabric) and rural management.

As a strategic solution, the provision of upstream flood storage, either on or off the line of a river or watercourse, can be an effective way to reduce peak flows and thereby manage flood levels. Creating wetlands and associated habitat is a major benefit of this type of solution. Flood storage areas and washlands can be effective for flood risk management.

In contrast, the impact of land management change (e.g. afforestation, grass buffers) on flood risk is proven to provide benefit at the small catchment scale, but not large scale as effects are difficult to determine - they are the result of aggregating many local-scale effects and are also dependent on individual physical catchment characteristics.

Possible strategic solutions to manage flood risk are determined from the related CFMP recommendations for the Avon and Stour catchments, and an appraisal of catchment characteristics.

Hampshire Avon Catchment Flood Management Plan (CFMP)

This CFMP recommends for Christchurch a long term reduction in flood risk to be achieved primarily through a number of measures to be determined through further flood risk, asset management and integrated urban drainage studies. This will need to look at the combined risk from the Avon, Stour, the harbour tributaries and the sea and urban drainage. The focus is likely to be on improving defences and channel/ structure conveyance and operation through critical parts of the town.

The most significant long term impact is likely to be from rising sea levels which will require defences to be maintained, in line with the Shoreline Management Plan (SMP) which is currently under revision. There is also some potential for flood storage on the upstream tributaries (policy units B Upper Avon & Wylye; and D - Nadder). In the urban areas, opportunities should be sought to implement strategic works as part of any redevelopment plans, and to enhance floodplain wetland habitats and the River Avon System SSSI.

Emergency response plans should be developed due to the complexities of the flooding mechanism and potentially very high consequences.

Dorset Stour CFMP

With flood risk forecast to become a far more significant feature for Christchurch (and Bournemouth), the recommended policy to take further action to reduce flood risk (now and/or in the future) will support further investigations to identify sustainable solutions to estimate increased flooding. The priority actions to be undertaken are:

- Develop a strategy plan for Bournemouth and Christchurch to address the possible reduction of the standard of protection of existing defences which may occur as a result of climate change.
- Further investigate the impact and performance of Iford Bridge and the railway bridge under flood conditions.

- Devise a strategy to record, identify and address the risk of surface water flooding.

The CFMPs identify the following implications for planning:

- Flooding may happen more often in the future and the long-term effectiveness of flood defences is uncertain.
- Development is a significant pressure. Development should not take place within the floodplain. Appropriate urban drainage strategies will allow urban growth within the area without having a negative effect on flood risk.
- We need to consider the effect infill development in the urban area will have on flood risk. Make sure there is no increase in run-off from new developments, including using SuDS.
- Make sure adequate foul and surface water infrastructure is available before new developments are carried out.
- Flood risk in this area is greatest from the sea.

This options appraisal has included an assessment of four sand and gravel mining sites proposed by Dorset County Council (in their 2008 discussion draft Minerals Sites Allocation Document - 'MSAD'), one on the CBC border proposed by Hampshire County Council, and the proposed area of search for housing (urban extension) north of Christchurch (RSS policy SR29).

The solutions set out below provide a "first pass" at the types of structural and non-structural options that are considered appropriate. The intention is to highlight options to be considered further as part of the planning process, e.g. it may be appropriate to reserve land areas or impose conditions on sand/gravel mining sites for future flood storage.

Table 8.1 Possible strategic solutions to manage fluvial flood risks

Area	Local town/ area	Watercourse	Possible solutions
1	Bournemouth International airport	Two minor watercourses at the airport	- daylighting culverted sections - bypass or flood relief channel - increase flood storage - increase surface water attenuation and runoff management
2	Roeshot Hill RSS area of search –currently greenbelt adjacent to Burton	River Mude	- increase flood storage - increase surface water attenuation and runoff management
3	Christchurch town centre	River Avon River Stour	- improve/extend existing defences - improve channel/ structure conveyance and operation - increase upstream flood storage, e.g. for the Avon on the Upper Avon/ Wylye/ Nadder - increase surface water attenuation and runoff management
4	Stanpit, Mudeford and Purewell	Tidal	- improve/extend existing defences
5	West Christchurch (Iford/Jumpers)	River Stour	- improve/extend existing defences - increase upstream flood storage - increase surface water attenuation and runoff management
6	Somerford and Mudeford	River Mude Bure Brook	- daylighting culverted sections - increase flood storage

			- increase surface water attenuation and runoff management
7	Burton	Burton Brook Clockhouse Stream	- daylighting culverted sections - increase flood storage - increase surface water attenuation and runoff management

The option for flood storage can provide flood relief, but not a single strategic flood alleviation solution for the Avon and Stour catchments, nor is it a practicable one. The long duration and high volume flood hydrographs cannot be attenuated easily without very large storage facilities and it is rare that this option is adopted in such areas.

For these catchments, the existing physical infrastructure (roads, towns/villages) is such that identification of acceptable sites to create flood attenuation storage would be extremely difficult, if not impossible. Additionally, due to the shape of these catchments and number of significant tributaries, such an approach can only be pursued on the basis of multiple storages on the main river and its tributaries.

Notwithstanding the above, storage is considered appropriate for the smaller tributary catchments and as local options. Not only do small to medium size flood storage areas contribute to flood attenuation (and compensatory storage for flood defences schemes), especially for low to medium order flood events, but they provide opportunity for wetland creation and other environmental enhancement.

There is potential to improve/extend the existing flood defences for greater protection.

8.8 Substitution of uses - more vulnerable for less vulnerable in high risk zones

In Christchurch there are significant development pressures, exacerbated by a lack of available land outside Flood Zones 2 and 3. As a result, some of the sites which may have to be considered for allocation are situated within Flood Zone 3 and the relocation of allocations to lower risk areas may not be achievable in all cases.

However, early findings of the Employment Land Review show that there may be scope to possibly redevelop some of the existing employment areas more intensively, thereby freeing up some land for other uses. In line with PPS25, it is recommended that where possible, sites with a greater flood risk are retained for employment uses, with sites at a lower risk of flooding considered for re-allocation as housing. This approach will however need to be guided by identified employment need and established through the Christchurch LDF.

By applying the Sequential Approach and the Sequential Test at the site level, the more vulnerable developments will be located in the lowest flood risk areas. Any FRA should show that opportunities to substitute lower vulnerability uses in higher risk areas and place housing development in lower risk areas have been taken wherever possible.

8.9 Flood warning and evacuation plans

Flood warning and evacuation plans should be used to manage residual flood risks. Key considerations to ensure that any new development is safe are:

(i) whether adequate flood warnings will be available and that people using the development will act on them;

(ii) that safe access routes located above design flood levels (i.e. 1 in 100-year fluvial or 1 in 200-year tidal flood level plus climate change) are available and that individuals will be able to use these routes unaided to retreat to safe ground beyond the flooded area; and

(iii) that emergency vehicles can access the site during an extreme flood event (1 in 1000 year) and are able to evacuate individuals to safe locations. The route shall not require people to enter into flood water which is considered to be a danger for some, which includes children, the elderly or infirm as identified in the Defra (2005) R&D Technical report, FD2320/TR2. Developers should take advice from the emergency services when producing an evacuation plan for the development as part of their FRA.

Where it is not possible to provide dry access routes, limited depths of flooding maybe appropriate, depending on the modelled flood velocities.

Following publication of this report, CBC plan to review the Major Incident Plan (MIP) for Christchurch. It is recommended that CBC and the Environment Agency incorporate the findings of this SFRA for existing and future developments into the MIP. This should specifically identify strategic evacuation routes to enable emergency services to continue work during a flood event. The flood risk to key command centres and emergency facilities should also be assessed using this SFRA.

8.10 Other policy – responsibilities for flood risk management and associated activities

The Department for the Environment, Food and Rural Affairs (Defra) has overall responsibility for flood risk management in England. Their aim is to reduce flood risk by:

- Discouraging inappropriate development in areas at risk from flooding.
- Encourage the provision of adequate and cost effective flood warning systems.
- Encourage the provision of adequate technically, environmentally and economically sound and sustainable flood defence measures.

The Government's Foresight Programme has recently produced a report called *Future Flooding,* which warns that the risk of flooding will increase between 2 and 20 fold over the next 75 years. The report produced by the Office of Science and Technology has a long-term vision for the future (2030 – 2100), helping to ensure effective strategies are developed now. Sir David King, the Chief Scientific Advisor to the Government concluded:

"*continuing with existing policies is not an option – in virtually every scenario* considered *(*for climate change*), the risks grow to unacceptable levels. Secondly, the risk needs to be tackled across a broad front. However, this is unlikely to be sufficient in itself. Hard choices need to be taken – we must either invest in more sustainable approaches to flood and coastal management or learn to live with increasing flooding".*

In response to this, Defra is leading the development of a new strategy for flood and coastal erosion for the next 20 years. This programme, called "Making Space for Water" will help define and set the agenda for the Government's future strategic approach to flood risk.

The strategic approach is being delivered through a strong and continuing commitment to Catchment Flood Management Plans and Shoreline Management Plans within a broader planning matrix which will include River Basin Management Plans prepared under the Water Framework Directive and Integrated Coastal Zone Management.

The Government's policy in flood and coastal erosion management has a key role to contribute to mitigation and adaptation to climate change. Increases in sea level and changing rivers flows (more floods / droughts) will impact on catchments and coastal areas:

- It is expected that larger numbers of people could in the future be at risk from flooding and coastal erosion, particularly from exceptional events, and if severe events occur beyond the current design standards of flood defences across the UK.
- To reduce these risks means investing significant sums each year to do so, and increased flood and coastal defence activities are part of the adaption strategy to protect the UK economy from the full effects of climate change.

The EC Water Framework Directive (WFD) (2000/60/EC) came into force in December 2000 and has set out a timetable for inclusion into the laws of Member States and then for their implementation through river basin management plans (RBMP). It requires all inland and coastal waters to reach a "good status" by 2015.

Article 4(3) of the WFD allows Member States to designate surface water bodies, which have been physically altered by human activity, as artificial or heavily modified, subject to a number of provisions. Good ecological potential is the environmental objective for these water bodies.

The EC has recently proposed a new directive on the assessment and management of flood risk (the Floods Directive). The Floods Directive aims to reduce the risk to human health, the environment and economic activity associated with floods.

The Floods Directive will require the preparation of Flood Risk Management Plans (FRMPs) that will sit alongside the River Basin Management Plans prepared under the Water Framework Directive. The FRMPs to be prepared in the future will build on Catchment Flood Management Plans and Shoreline Management Plans.

The summer floods of 2007 and 2008 highlighted a wide range of challenges that we face in relation to flooding. Sir Michael Pitt undertook a comprehensive review of the lessons to be learned. He clearly identified the need for changes to primary legislation and called for a single unifying act.

The Government's Floods and Water Bill (consultation draft published April 2009) will take forward the outcomes of the Pitt Review. The content of the Bill which is related to flooding is likely to include: measures in relation to surface water management, transposition of the Floods Directive requirements, SUDS adaption and maintenance measures, sewer micro-connections, critical infrastructure, information sharing, disaster recovery, flood event management and potential amendments to the Civil Contingencies Act.

9 Concluding remarks

This Level 2 SFRA follows PPS25 and its associated Practice Guidance (June 2008), best practice and the guidance provided at all stages by the Environment Agency and CBC planners. This Level 2 SFRA is required to assess the flood risk in greater detail than the Level 1 SFRA, because it may be necessary to allocate development or consider windfall development in areas of higher flood risk.

This Level 2 SFRA together with the Level 1 SFRA, provide the necessary information with which to apply the Exception Test to development proposals for the Christchurch area (PPS25, Annex D) and inform what could potentially be included in a Supplementary Planning Document on flood risk.

The Levels 1 and 2 SFRA together form part of the evidence base for the Local Development Framework (LDF) and are intended to inform decisions regarding land allocation and policies. The SFRA will be considered an integral part of the Sustainability Appraisal of relevant component documents of the LDF.

Seven geographical areas which may need to be considered for development have been investigated, with the final SFRA output including:

- Hydraulic models developed for areas not previously modelled
- Flood Zone, depth and velocity maps that represent the 'defended' and 'undefended' conditions for all FRA's for current and climate change (to 2086 and 2126) scenarios, where applicable.
- Animations for each area of the rate of flooding onset for the selected design events.
- Hazard mapping for SFRA Flood Zones 2 and 3a, with and without climate change (to 2086 and 2126, all defended scenarios)
- Workshops to support CBC in their use of the Level 2 SFRA

The best information is to be used to guide the site selection process for future developments. For this reason, this SFRA is a living document (reports and maps) to be updated as new information becomes available, e.g. further improvements to river models, surface water flooding incidents or revised climate change guidance.

Glossary

Breach Hazard/Analysis – Hazard attributed to flooding caused by the constructional failure of a flood defences or other structure that is acting as a flood defence.

CFMP – Catchment Flood Management Plan. A CFMP is a high-level strategic plan through which the Environment Agency seeks to work with other key-decision makers within a river catchment to identify and agree long-term policies for sustainable flood risk management.

Core Strategy - The Development Plan Document which sets the long-term vision and objectives for the area. It contains a set of strategic policies that are required to deliver the vision including the broad approach to development.

CBC – Christchurch Borough Council.

Culvert - A closed conduit used for the conveyance of surface drainage water under a roadway, railroad, canal, or other impediment

Defra - Department of Environment, Food and Rural Affairs Development

DPD - Development Plan Document. A DPD is a spatial planning document within the Council's Local Development Framework which set out policies for development and the use of land. Together with the Regional Spatial Strategy they form the development plan for the area. They are subject to independent examination.

Dry pedestrian egress - Routes to and from buildings that will remain dry and allow pedestrian/wheelchair evacuation to dry land in times of flood.

DTM – Digital Terrain Model.

Environment Agency - The leading public body for protecting and improving the environment in England and Wales.

Exception Test - If, following application of the Sequential Test, it is not possible (consistent with wider sustainability objectives) to demonstrate that there are no reasonably available sites in areas with less risk of flooding that would be appropriate to the type of development or land use proposed, the Exception Test may apply. PPS25 sets out strict requirements for the application of the Test.

Flood Defence – Natural or man-made infrastructure used to reduce the risk of flooding

Flood Risk – Flood risk is a combination of two components: the chance (or probability) of a particular flood event and the impact (or consequence) that the event would cause if it occurred

FRA – Flood Risk Assessment. Assessment of flood risk posed to a defined area (usually a new development site) as defined above.

Flood Risk Management – Flood risk management can reduce the probability of occurrence through the management of land, river systems and flood defences and reduce the impact through influencing development on flood risk areas, flood warning and emergency response.

Flood Risk Vulnerability - PPS25 provides a vulnerability classification to assess which uses of land maybe appropriate in each flood risk zone.

Flood Warning – A system maintained by the Environment Agency to enable warning messages to be sent to homeowners and businesses when floods are predicted.

Formal Flood Defence - A structure built and maintained specifically for flood defence purposes.

Flood Zones - Nationally consistent delineation of 'high' and 'medium' flood risk, published on a quarterly basis by the Environment Agency.

Functional Floodplain Zone 3b - Defined as areas at risk of flooding in the 5% AEP (1 in 20 year) design event. In any one year the chance of a 5% AEP (1 in 20 year) event occurring is 5%. In areas where the 4% (but not 5%) AEP event has been modelled previously; this was taken to represent the functional floodplain as agreed between CBC and the Environment Agency

GIS – Geographic Information System. GIS is any system which stores geographical data, such as elevations, location of buildings and extent of flood outlines.

High probability Zone 3a - Defined as areas at risk of flooding in the 1% Annual Exceedance Probability (AEP) (1 in 100 year) design event for fluvial or 0.5% AEP (1 in 200 year) for tidal. In any one year the chance of a 1% AEP (1in 100 year)event occurring is 1% and for a 0.5% AEP (1 in 200 year) event occurring is 0.5%.

Informal Flood Defence - A structure that provides a flood defence function however has not been built and/or maintained for this purpose (e.g. boundary wall).

LDD – Local Development Documents

LiDAR - Light Detection and Ranging. LiDAR is an airborne terrain mapping technique which uses a laser to measure the distance between the aircraft and the ground.

LDF - Local Development Framework. The LDF consists of a number of documents which together form the spatial strategy for development and the use of land.

Low Probability Zone 1 – The area outside Zone 2. Defined as an area with less that 0.1% AEP (1 in 1000 year) chance of flooding. In any one year the chance of a 0.1% AEP (1 in 1000 year) event occurring is less than 0.1%.

LPA – Local Planning Authority

'Making Space for Water' (Defra 2004) - The Government's new evolving strategy to manage the risks from flooding and coastal erosion by employing an integrated portfolio of approaches, so as: a) to reduce the threat to people and their property; b) to deliver the greatest environmental, social and economic benefit, consistent with the Government's sustainable development principles, c) to secure efficient and reliable funding mechanisms that deliver the levels of investment required.

Medium probability Zone 2 - Defined as an area at risk of flooding from flood events that are greater than the 0.1% AEP (1 in 1000 year), and less than the 1% AEP (1 in 100 year) fluvial or 0.5% AEP (1 in 200 year) tidal design event. The probability of flooding occurring in this area in any one year is between 1% (fluvial)/0.5% tidal) and 0.1%.

mAOD – Metres Above Ordnance Datum

PPS - Planning Policy Statements. The Government has updated its planning advice contained within Planning Policy Guidance Notes with the publication of new style Planning Policy Statements.

PPS25 - Planning Policy Statement 25: Development and Flood Risk. PPS 25 reflects the general direction set out in 'Making Space for Water'.

PPS25 Practice Guide – The Practice Guide explains how to implement PPS25's commitment to deliver appropriate sustainable development in the right places while taking full account of flood risk

Previously Developed (Brownfield) Land - Land which is or was occupied by a building (excluding those used for agriculture and forestry). It also includes land within the curtilage of the building, for example a house and its garden would be considered to be previously developed land.

Residual Risk - The risk which remains after all risk avoidance, reduction and mitigation measures have been implemented.

Return Period – The probability of a flood of a given magnitude occurring within any one year e.g. a 1% AEP (1 in 100 year) event has a probability of occurring once in 100 years, or a 1% chance in any one year. However, a 1% AEP (1 in 100 year) event could occur twice or more within 100 years, or not at all.

RSS - Regional Spatial Strategy. The RSS for Christchurch is the South West RSS, a regional planning policy providing the overarching framework for the preparation of LDFs. It provides a broad development strategy for the South West region up to 2026.

SA - Sustainability Appraisal. An SA is an appraisal of plans, strategies and proposals to test them against broad sustainability objectives.

SAAR – Standard-period Annual Average Rainfall.

Sequential Test - Informed by a SFRA, a planning authority applies the Sequential Test to demonstrate that there are no reasonably available sites in areas with less risk of flooding that would be appropriate to the type of development or land use proposed.

SFRA - Strategic Flood Risk Assessment. An SFRA is used as a tool by a planning authority to assess flood risk for spatial planning, producing development briefs, setting constraints, informing sustainability appraisals and identifying locations of emergency planning measures and requirements for flood risk assessments.

SHLAA – Strategic Housing Land Availability Assessment

SPD - Supplementary Planning Document. An SPD provides supplementary guidance to policies and proposals contained within Development Plan Documents. They do not form part of the development plan, nor are they subject to independent examination.

SoP – Standard of Protection. The return period against which a defence offers protection.

SUDS – Sustainable Urban Drainage Systems. SUDS are drainage systems which are designed to reduce the impact of urbanisation on the hydrology of a river system.

Sustainable Development – "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (The World Commission on Environment and Development, 1987)

TUFLOW – A 2D hydraulic modelling package

UK Flood Hazard – a measure of hazard of a given flood event, calculated by using the following equation from Defra's Flood Risks to People – Phase Two Document (FD2321/ TR2) (2006). Hazard is calculated as follows:

Hazard = d x (v + 0.5) + DF where: **d** = depth (m); **V** = velocity (m/s); **DF** = debris factor

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Appendix A – Sequential Test Template for Local Planning Authorities (Source: Environment Agency)

Demonstrating the flood risk (PPS25) Sequential Test for Planning Applications

This template is to be used in conjunction with the Sequential Test process set out in the Environment Agency's Flood Risk Standing Advice. Flood Risk Standing Advice for LPAs can be downloaded for use from standing advice pages on the Environment Agency website - www.environment-agency.gov.uk

Application details

Planning application reference number

Site address and development description

Date

Completed by

Stage 1 – strategic application & development vulnerability

Has the Sequential Test already been carried out for this development at development plan level? Enter Yes or No	**Provide details of site allocation and LDD below**

State the Flood Risk Vulnerability Classification in accordance with PPS25 table D2	**State the Flood Zone of development site**

Stage 2 – defining the evidence base

State the defining parameters for the geographical area over which the Sequential Test is to be applied e.g. functional requirements of the development; regeneration need *identified in the LDF;* serves a national market. Indicate if no parameters exist for example, windfall development.	State the area of search in view of identified parameters e.g. whole LPA area, specific market area, specific area of need/regeneration area or on a sub regional or national level.
Additional justification (if needed):	

Evidence base to be used as source for 'reasonably available' sites	Provide details below e.g. date, title of document and where this can be viewed
Strategic Housing Land availability Assessment	
Other housing land study	
Employment Land Review	
National Land Use Database – Previously Developed Land	
Register of Surplus Public Sector Land	
Rural Exceptions Strategy	
Regeneration strategy	
Other sites known to the LPA e.g. sites of other planning applications	
Other sources not stated	

Method used for comparing flood risk between sites	Provide details below e.g. date, title of document and where this can be viewed
Environment Agency Flood Map	
Strategic Flood Risk Assessment (if comparing flood risk within the same Flood Zone)	
Site specific Flood Risk Assessments where they are suitable for this purpose.	
Other mapping / source of flooding information not stated	

Stage 3 – applying the Sequential Test

Name and location of the reasonably available sites	**Flood Zone:** (Higher (H) Lower (L), Same(=)	**Allocated in plan with flood risk sequential test?** (Indicate the status of the plan)	**Approx Capacity[1] of site**	**Constraints to delivery[2]**
Conclusion: Are there any reasonably available sites in a lower flood risk zone or at a lower risk of flooding than the application site?				

[1] based on LDF density policies and past performance

[2] constraints to delivery include: availability, policy restrictions, physical problems or limitations, potential impacts of the development, and future environmental conditions that would be experienced by the inhabitants of the development.

Appendix B – List of maps

No.	Parameter	Layers	GIS files provided*	Hardcopy maps provided in Volume II
Map 1	**SFRA flood zones** (current undefended)	1 in 20-year undefended (SFRA Flood Zone 3b – Functional floodplain)	√	√
		1 in 100-year undefended (SFRA Flood Zone 3a – High probability)	√	
		1 in 1000-year undefended (SFRA Flood Zone 2 – Medium probability)	√	
		Localised flooding (identified in Level 1 SFRA)	√	
Map 2a	**SFRA flood zones** (climate change undefended in 2086)	1 in 20-year with climate change undefended (SFRA Flood Zone 3b – Functional floodplain with climate change in 2086)	√	√
		1 in 100-year with climate change undefended (SFRA Flood Zone 3a – High probability with climate change in 2086)	√	
		1 in 1000-year with climate change undefended (SFRA Flood Zone 2 – Medium probability with climate change in 2086)	√	
Map 2b	**SFRA flood zones** (climate change undefended in 2126)	1 in 20-year with climate change undefended (SFRA Flood Zone 3b – Functional floodplain with climate change in 2126)	√	√
		1 in 100-year with climate change undefended (SFRA Flood Zone 3a – High probability with climate change in 2126)	√	
		1 in 1000 year with climate change undefended (SFRA Flood Zone 2 – Medium probability with climate change in 2126)	√	
Map 3	**SFRA flood zones** (current defended)	1 in 20-year defended (SFRA Flood Zone 3b – Functional floodplain)	√	√
		1 in 100-year defended (SFRA Flood Zone 3a – High probability)	√	
		1 in 1000-year defended (SFRA Flood Zone 2 – Medium probability)	√	
		Localised flooding (identified in Level 1 SFRA)	√	
Map 4a	**SFRA flood zones** (climate change defended in 2086)	1 in 20-year with climate change defended (SFRA Flood Zone 3b – Functional floodplain with climate change in 2086)	√	√
		1 in 100-year with climate change defended (SFRA Flood Zone 3a – High probability with climate change in 2086)	√	
		1 in 1000-year with climate change defended (SFRA Flood Zone 2 – Medium probability with climate change in 2086)	√	
Map 4b	**SFRA flood zones** (climate change defended in 2126)	1 in 20-year with climate change defended (SFRA Flood Zone 3b – Functional floodplain with climate change in 2126)	√	√
		1 in 100-year with climate change defended (SFRA Flood Zone 3a – High probability with climate change in 2126)	√	
		1 in 1000-year with climate change defended (SFRA Flood Zone 2 – Medium probability with climate change in 2126)	√	
Map 5	**Airport – 50% reduction in culvert capacities**	1 in 100-year undefended (SFRA Flood Zone 3a with 50% reduction in culvert capacity)	√	√

No.	Parameter	Layers	GIS files provided*	Hardcopy maps provided in Volume II
Map 6a	**SFRA flood zone depth** (current undefended)	1 in 20-year undefended (SFRA Flood Zone 3b – Functional floodplain)	√	
Map 6b	**SFRA flood zone depth** (current undefended)	1 in 100-year undefended (SFRA Flood Zone 3a – High probability)	√	
Map 6c	**SFRA flood zone depth** (current undefended)	1 in 1000-year undefended (SFRA Flood Zone 2 – Medium probability)	√	
Map 7a	**SFRA flood zone depth** (climate change undefended in 2086)	1 in 20-year with climate change undefended (SFRA Flood Zone 3b – Functional floodplain with climate change in 2086)	√	
Map 7b	**SFRA flood zone depth** (climate change undefended in 2086)	1 in 100-year with climate change undefended (SFRA Flood Zone 3a – High probability with climate change in 2086)	√	
Map 7c	**SFRA flood zone depth** (climate change undefended in 2086)	1 in 1000-year with climate change undefended (SFRA Flood Zone 2 – Medium probability with climate change in 2086)	√	
Map 8a	**SFRA flood zone depth** (climate change undefended in 2126)	1 in 20-year with climate change undefended (SFRA Flood Zone 3b – Functional floodplain with climate change in 2126)	√	
Map 8b	**SFRA flood zone depth** (climate change undefended in 2126)	1 in 100-year with climate change undefended (SFRA Flood Zone 3a – High probability with climate change in 2126)	√	
Map 8c	**SFRA flood zone depth** (climate change undefended in 2126)	1 in 1000-year with climate change undefended (SFRA Flood Zone 2 – Medium probability with climate change in 2126)	√	
Map 9a	**SFRA flood zone depth** (current defended)	1 in 20-year defended (SFRA Flood Zone 3b – Functional floodplain)	√	
Map 9b	**SFRA flood zone depth** (current defended)	1 in 100-year defended (SFRA Flood Zone 3a – High probability)	√	
Map 9c	**SFRA flood zone depth** (current defended)	1 in 1000-year defended (SFRA Flood Zone 2 – Medium probability)	√	
Map 10a	**SFRA flood zone depth** (climate change defended in 2086)	1 in 20-year with climate change defended (SFRA Flood Zone 3b – Functional floodplain with climate change in 2086)	√	
Map 10b	**SFRA flood zone depth** (climate change defended in 2086)	1 in 100-year with climate change defended (SFRA Flood Zone 3a – High probability with climate change in 2086)	√	
Map 10c	**SFRA flood zone depth**	1 in 1000-year with climate change defended (SFRA Flood Zone 2 – Medium probability	√	

No.	Parameter	Layers	GIS files provided*	Hardcopy maps provided in Volume II
	(climate change defended in 2086)	with climate change in 2086)		
Map 11a	**SFRA flood zone depth** (climate change defended in 2126)	1 in 20-year with climate change defended (SFRA Flood Zone 3b – Functional floodplain with climate change in 2126)	√	√
Map 11b	**SFRA flood zone depth** (climate change defended in 2126)	1 in 100-year with climate change defended (SFRA Flood Zone 3a – High probability with climate change in 2126)	√	√
Map 11c	**SFRA flood zone depth** (climate change defended in 2126)	1 in 1000-year with climate change defended (SFRA Flood Zone 2 – Medium probability with climate change in 2126)	√	√
Map 12a	**Coastal flood zone depths** (climate change defended in 2086)	1 in 200-year coastal flood zone depths in 2086 accounting for the increase in wind speed and wave heights (defended scenario)	√	
Map 12b	**Coastal flood zone depths** (climate change defended in 2086)	1 in 1000-year coastal flood zone depths in 2086 accounting for the increase in wind speed and wave heights (defended scenario)	√	
Map 12c	**Coastal flood zone depths** (climate change defended in 2126)	1 in 200-year coastal flood zone depths in 2126 accounting for the increase in wind speed and wave heights (defended scenario)	√	√
Map 12d	**Coastal flood zone depths** (climate change defended in 2126)	1 in 1000-year coastal flood zone depths in 2126 accounting for the increase in wind speed and wave heights (defended scenario)	√	√
Map 13a	**SFRA flood zone velocity** (current undefended)	1 in 20-year undefended (SFRA Flood Zone 3b – Functional floodplain)	√	
Map 13b	**SFRA flood zone velocity** (current undefended)	1 in 100-year undefended (SFRA Flood Zone 3a – High probability)	√	
Map 13c	**SFRA flood zone velocity** (current undefended)	1 in 1000-year undefended (SFRA Flood Zone 2 – Medium probability)	√	
Map 14a	**SFRA flood zone velocity** (climate change undefended in 2086)	1 in 20-year with climate change undefended (SFRA Flood Zone 3b – Functional floodplain with climate change in 2086)	√	
Map 14b	**SFRA flood zone velocity** (climate change undefended in 2086)	1 in 100-year with climate change undefended (SFRA Flood Zone 3a – High probability with climate change in 2086)	√	
Map 14c	**SFRA flood zone velocity** (climate change undefended in 2086)	1 in 1000-year with climate change undefended (SFRA Flood Zone 2 – Medium probability with climate change in 2086)	√	
Map 15a	**SFRA flood zone velocity** (climate change undefended in 2126)	1 in 20-year with climate change undefended (SFRA Flood Zone 3b – Functional floodplain with climate change in 2126)	√	
Map 15b	**SFRA flood zone velocity** (climate change undefended in 2126)	1 in 100-year with climate change undefended (SFRA Flood Zone 3a – High probability with climate change in 2126)	√	

No.	Parameter	Layers	GIS files provided*	Hardcopy maps provided in Volume II
Map 15c	**SFRA flood zone velocity** (climate change undefended in 2126)	1 in 1000-year with climate change undefended (SFRA Flood Zone 2 – Medium probability with climate change in 2126)	√	
Map 16a	**SFRA flood zone velocity** (current defended)	1 in 20-year defended (SFRA Flood Zone 3b – Functional floodplain)	√	
Map 16b	**SFRA flood zone velocity** (current defended)	1 in 100-year defended (SFRA Flood Zone 3a – High probability)	√	
Map 16c	**SFRA flood zone velocity** (current defended)	1 in 1000-year defended (SFRA Flood Zone 2 – Medium probability)	√	
Map 17a	**SFRA flood zone velocity** (climate change defended in 2086)	1 in 20-year with climate change defended (SFRA Flood Zone 3b – Functional floodplain with climate change in 2086)	√	
Map 17b	**SFRA flood zone velocity** (climate change defended in 2086)	1 in 100-year with climate change defended (SFRA Flood Zone 3a – High probability with climate change in 2086)	√	
Map 17c	**SFRA flood zone velocity** (climate change defended in 2086)	1 in 1000-year with climate change defended (SFRA Flood Zone 2 – Medium probability with climate change in 2086)	√	
Map 18a	**SFRA flood zone velocity** (climate change defended in 2126)	1 in 20-year with climate change defended (SFRA Flood Zone 3b – Functional floodplain with climate change in 2126)	√	
Map 18b	**SFRA flood zone velocity** (climate change defended in 2126)	1 in 100-year with climate change defended (SFRA Flood Zone 3a – High probability with climate change in 2126)	√	
Map 18c	**SFRA flood zone velocity** (climate change defended in 2126)	1 in 1000-year with climate change defended (SFRA Flood Zone 2 – Medium probability with climate change in 2126)	√	
Map 19a	**Coastal flood zone velocities** (climate change defended in 2086)	1 in 200-year coastal flood zone velocities in 2086 accounting for the increase in wind speed and wave heights (defended scenario)	√	
Map 19b	**Coastal flood zone velocities** (climate change defended in 2086)	1 in 1000-year coastal flood zone velocities in 2086 accounting for the increase in wind speed and wave heights (defended scenario)	√	
Map 19c	**Coastal flood zone velocities** (climate change defended in 2126)	1 in 200-year coastal flood zone velocities in 2126 accounting for the increase in wind speed and wave heights (defended scenario)	√	
Map 19d	**Coastal flood zone velocities** (climate change defended in 2126)	1 in 1000-year coastal flood zone velocities in 2126 accounting for the increase in wind speed and wave heights (defended scenario)	√	
Map 20	**Hazard Mapping (current defended)**	1 in 100-year (fluvial)/ 1 in 200-year (tidal) defended (SFRA Flood Zone 3a – High probability)	√	√
Map 21	**Hazard Mapping (climate change defended in 2086)**	1 in 100-year (fluvial)/ 1 in 200-year (tidal) with climate change defended (SFRA Flood Zone 3a – High probability with climate change in 2086)	√	√
Map 22	**Hazard Mapping**	1 in 1000-year (fluvial)/ 1 in 200-year (tidal) with climate change defended (SFRA Flood	√	√

No.	Parameter	Layers	GIS files provided*	Hardcopy maps provided in Volume II
	(climate change defended in 2126)	Zone 3a – High probability with climate change in 2126)		
Map 23	**Hazard Mapping (current defended)**	1 in 1000-year defended (SFRA Flood Zone 2 – Medium probability)	√	√
Map 24	**Hazard Mapping (climate change defended in 2086)**	1 in 1000-year with climate change defended (SFRA Flood Zone 2 – Medium probability with climate change in 2086)	√	√
Map 25	**Hazard Mapping (climate change defended in 2126)**	1 in 1000-year with climate change defended (SFRA Flood Zone 2 – Medium probability with climate change in 2126)	√	√

*GIS files provided in both ArcView and Mapinfo formats

Appendix C – Condition of the culverts at Bournemouth airport, Burton Brook and Clockhouse stream

Table C.1 details the condition of the pipes and culverts as observed during the site survey. The Structure Reference numbers are cross-referenced with Figures C.1 and C.2 to show the locations of the pipes/culverts. Note that Table C.1 was produced at the time of the survey and should be used as a guide only.

Table C.1 Silt levels in the pipes, culverts and under bridges as observed during the site survey

Structure Ref No.	**Comments about siltation levels**
Bournemouth airport	
3	50mm of silt, but free flowing
4	No silt
6	10mm of silt, but free flowing
7	30mm of silt, but free flowing
9	50mm of silt, but free flowing
10	100mm of silt, but free flowing
13a	Left hand pipe blocked with silt/weed
14	Right hand pipe blocked with silt/weed
16	50mm silt/dirt (visible portion only)
17	50mm silt
19	No silt
20	100mm silt and right hand pipe partially blocked
Clockhouse stream (bridges only)	
26	Minor silt
30	Minor silt on inside bend
34	Minor silt
37	Up to 100mm silt across structure
Burton Brook	
42	100mm silt but free flowing
43	50mm silt but free flowing
48	No silt

Figure C.1 Cross=sections and culverts surveyed at Bournemouth Airport

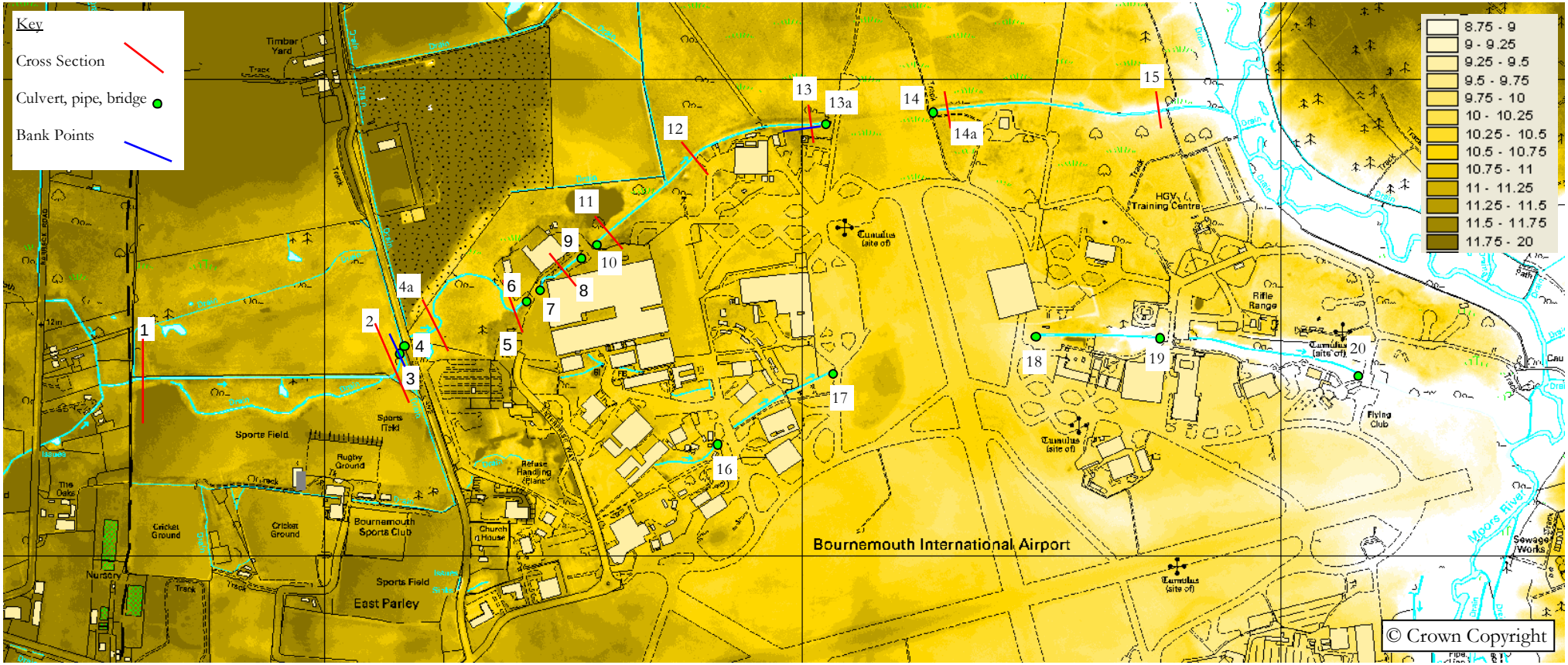
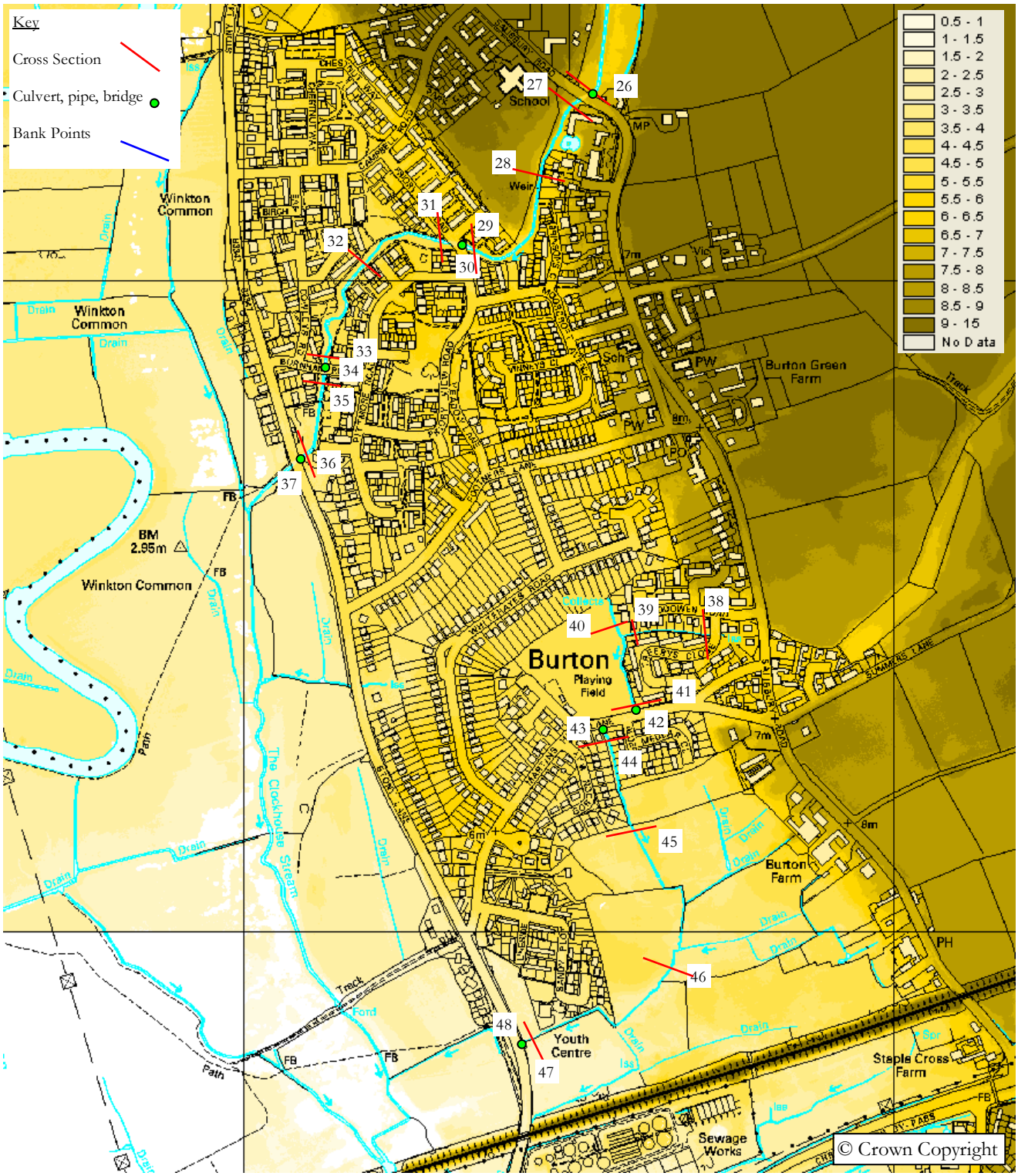


Figure C.2 Cross-sections and culverts surveyed on the Burton Brook and Clockhouse Stream



Appendix D – Flood risks to old refuse tips

The table below details the flood risks to refuse tips in Christchurch and Bournemouth (on R Stour only)

Site	LPA	Flood Zone		
		Current	In 2086	In 2126
Hatchpond, Poole	Poole	Mainly 1 small areas 2, 3a, and 3b	Mainly 1 small areas 2, 3a, and 3b	Mainly 1 small areas 2, 3a, and 3b
Manor Farm, Bournemouth	Bournemouth	Mainly 3a and 2	Mainly 3a and 2	3a, 3b and 2
New Road North of sewage works, Bournemouth	Bournemouth	Mainly 1 small areas 2, 3a, and 3b	Mainly 1 small areas 2, 3a, and 3b	Mainly 1, some areas 2, 3a, and 3b
North of Whitelegg Way, Bournemouth	Bournemouth	Mainly 3b small areas 2 and 3a	Mainly 3b small areas 2 and 3a	Mainly 3b small areas 2 and 3a
Riverside Area, Christchurch	Christchurch	3b and 1	3b, 2 and 1	3b and 1
Muscliffe Purification Works, Bournemouth	Bournemouth	3b and 1	3b and 1	3b and 1
Adjacent Muscliff Purification works, Bournemouth	Bournemouth	3b	3b	3b
Hicks Farm, Bournemouth	Bournemouth	3b and 1	3b and 1	3b and 1
Throop Mill Car Park, Bournemouth	Bournemouth	Mainly 1	Mainly 1 small areas 2, 3a and 3b	Mainly 1 small areas 2, 3a and 3b
Abbotswood, Christchurch	Christchurch	Mainly 3b, small areas 3a and 2	3b	3b
Sheepwash Recreation Ground, Christchurch	Christchurch	Mainly 3b, small areas 2, 3a and 1	3b	3b
North of Bridle Crescent, Bournemouth	Bournemouth	Mainly 1 small areas 2, 3a, and 3b	Mainly 1 small areas 2, 3a, and 3b	Mainly 1 small areas 2, 3a, and 3b
Bernards Mead, Christchurch	Christchurch	3a and 3b, small area 2	3a and 3b	Mainly 3b small area 3a
Ilford Meadows, Bournemouth	Bournemouth	Mainly 1 small areas 2, 3a, and 3b	1, 2, 3a, and 3b	1, 2, 3a, and 3b
Iford Playing Fields, Bournemouth	Bournemouth	Mainly 1, also areas of 2, 3a, and 3b	Mainly 1 and 3a also areas of 2 and 3b	Mainly 1, 3b and 3a also areas of 2
Willow Way, Christchurch	Christchurch	3a	Mainly 3b small area 3a	Mainly 3b small area 3a
North of Wick Lane, Bournemouth	Bournemouth	Mainly 3a, small areas of 2	3a and 3b	3b small areas 3a
Christchurch Quay, Christchurch	Christchurch	3a	3b	3b
Practice Driving Range, Wick, Bournemouth	Bournemouth	Mainly 3b, small area of 3a	3b	3b
Wick, Wasteland, Bournemouth	Bournemouth	Mainly 1, small areas of2 and 3a	Mainly 1, small areas of 2 and 3a	Mainly 3a small areas of 3b, 2 and 1
Solent Meads Golf Course		Mainly 1, very small area of 3a	Mainly 1, very small area of 3b and 3a	Mainly 1, very small area of 3b and 3a
East of Doubles Dyke, Hengistbury Head, Bournemouth	Bournemouth	Mainly 1, small areas 2	Mainly 1, small areas 2 and 3a	Mainly 1, small area 3a
Stanpit Marsh, Christchurch	Christchurch	Mainly 1, small areas of 2 and 3a	Mainly 1, areas of 2 and 3a	Mainly 1, some areas of 2, 3b and 3a

		Flood Zone		
Mudeford Quay, Christchurch	Christchurch	3a	3a	3a
Avon beach, Christchurch	Christchurch	1	1	Mainly 1 small area of 3a
Sunken car park, Off Avon Run Road, Mudeford, Christchurch	Christchurch	1	1	1
Plots 2 & 3, Dudmoor Farm Lane, Christchurch	Christchurch	1	1	1
Plot 7, Dudmoor Farm Lane, Christchurch	Christchurch	1	1	1
Parley Court Farm, Parley, Christchurch	Christchurch	Mainly 1 small area of3b	Mainly 1 small area of 3b	Mainly 1 small area of 3b

Appendix E – Flood defences in Christchurch

(Source: Environment Agency's NFCDD and information provided by CBC)

NFCDD_ID	Asset type	Maintainer	Type	Comment	Description	Location	Design standard	Bank
1182	raised defence (man-made)	private	fluvial	Earth embankment forms flood storage area basin.	Embankment.	Nea Meadows.	-999	left
1184	raised defence (man-made)	private	fluvial	Earth embankment/ high ground around Nea Meadows, flood storage area basin. Height varies.	Embankment.	Nea Meadows.	-999	right
1343	raised defence (man-made)	private	fluvial		Embankment	SOMERFORD ROAD TO BY-PASS	-999	left
1352	raised defence (man-made)	Environment Agency	fluvial / tidal	Design crest levels from Lower Avon ops manual	Embankment	Stony Lane, Christchurch	100	left
1358	raised defence (man-made)	private	fluvial / tidal		Earth Embankment	STONY LANE (SOUTH OF RAILWAY)	-999	left
1406	raised defence (man-made)	private	fluvial	Bank defence. Poured concrete at bottom 0.4m high, with stone wall above. Height of wall is 1.3m high, defended height is approximately 0.3m. Wall is filled with earth.	Bank defence.	U/S of Burnside.	-999	left
1412	raised defence (man-made)	local authority	fluvial / tidal		BUILDING	Civic Offices, Christchurch	100	left
1413	raised defence (man-made)	Environment Agency	fluvial / tidal	Actual UCL and DCL taken from: Operation and Maintenance Manual of the Lower Avon Flood Defence Scheme.	Masonry Wall	Bridge Place, Christchurch	100	left
1414	raised defence (man-made)	Environment Agency	fluvial / tidal		FLOOD WALL	Waterloo Boat Yard, Christchurch	100	left
1415	raised defence (man-made)	Environment Agency	fluvial / tidal	Actual UCL and DCL taken from: Operation and Maintenance Manual of the Lower Avon Flood Defence Scheme.	FLOOD WALL	Avon Wharf, Christchurch	100	right
1419	raised defence (man-made)	Environment Agency	fluvial / tidal		Flood Wall	Waterloo Bridge, Christchurch	100	left
1422	raised defence (man-made)	Environment Agency	fluvial / tidal		FLOOD WALL	Brigands Creek, Christchurch	100	right
1423	raised defence (man-made)	Environment Agency	fluvial / tidal	Actual UCL and DCL taken from: Operation and Maintenance Manual of the Lower Avon Flood Defence Scheme.	FLOOD WALL	Brigands Creek, Christchurch	100	right
1424	raised defence (man-made)	private	fluvial / tidal	House wall forms defence - other defences tie in.	BUILDING	Waterloo Bridge, Christchurch	100	left

NFCDD_ID	Asset type	Maintainer	Type	Comment	Description	Location	Design standard	Bank
1425	raised defence (man-made)	Environment Agency	fluvial / tidal	Earth bank with sheet piled cut off.Actual UCL and DCL taken from: Operation and Maintenance Manual of the Lower Avon Flood Defence Scheme.	FLOOD BANK	Brigands Creek, Christchurch	100	right
1426	raised defence (man-made)	Environment Agency	fluvial / tidal	Sheet Piled Flood wall & cut off. Top burried as part of flood bank. Actual UCL and DCL taken from: Operation and Maintenance Manual of the Lower Avon Flood Defence Scheme.	FLOOD BANK	No. 16 Bridge Street, Christchurch	100	left
1428	raised defence (man-made)	Environment Agency	fluvial / tidal	Wall runs from Goya Garage to No. 38 Bridge place. Garage demolished. Design crest levels form drawing AK1658/CS/R6/148	MASONRY WALL	Waterloo Bridge, Christchurch	100	left
1429	raised defence (man-made)	private	fluvial / tidal	Flood Defences tie into house.	BUILDING	Bridge Place, Christchurch	100	left
1430	raised defence (man-made)	Environment Agency	fluvial / tidal	Concrete capped sheet piled flood wall. Actual UCL and DCL taken from: Operation and Maintenance Manual of the Lower Avon Flood Defence Scheme. Design crest levels from Lower Avon ops manual	SHEET PILED WALL	Barlins, Christchurch	100	left
1431	raised defence (man-made)	Environment Agency	fluvial / tidal	Brick built wall. Design crest levels form drawing AK1658/CS/R6148	FLOOD WALL	38 Bridge Street, Christchurch	100	left
1434	raised defence (man-made)	Environment Agency	fluvial / tidal	Earth Embankment - Sheet Piled Cut-Off. Design crest level from Lower Avon ops manual	EMBANKMENT	Stony Lane, Christchurch	100	left
1475	raised defence (man-made)	Environment Agency	fluvial	ACTUAL ACL & DCL VALUES (FLOOD DEFENCE ASSET SURVEY, STH WESSEX AREA, 1996) DESIGN STD (POST PROJECT APPRAISAL, LOWER STOUR FAS, 1996). Design crest levels from F4151/062A/P	WALL - FLOOD - CONCRETE - MASONRY - CLAD	HOMELANDS, KINGS AVENUE	100	left
1480	raised defence (man-made)	Environment Agency	tidal	TARMAC SURFACED ROAD RAMP. Crest Level Data taken from EA Survey, 11th July 2003.	ACCESS - VEHICLE - TARMAC RAMP	Old Pontins Site, Christchurch	100	left
1481	raised defence (man-made)	Environment Agency	tidal	Tarmac Surfaced access ramp. Ties into neighbouring defences	ACCESS - VEHICLE - TARMAC - RAMP	The Quomps, Christchurch	100	left
1486	raised defence (man-made)	Environment Agency	tidal	BITMAC SURFACED RAMP - PROVIDES VEHICULAR ACCESS TO DEFENCE LEVEL. Ties directly into neighbouring defence	ACCESS - VEHICLE - TARMAC - RAMP	THE QUOMPS CHRISTCHURCH	100	left
1500	raised defence (man-made)	Environment Agency	fluvial / tidal	Actual UCL and DCL taken from: Operation and Maintenance Manual of the Lower Avon Flood Defence Scheme.	FLOOD WALL	U/S Town Bridge, Christchurch	100	left
1565	raised defence (man-made)	private	fluvial	Stone and mortar wall acting as D/S R/B wing wall to culvert and retaining/garden wall to property. Bagwork at toe. Approximately 1.4m high FI, 0.3m	Wall.	1, Bure Haven Drive.	-999	right

NFCDD_ID	Asset type	Maintainer	Type	Comment	Description	Location	Design standard	Bank
				high FO. Double thickness in one short section, U/S of this bottom section of wall is concrete bricks.				
1566	raised defence (man-made)	private	fluvial	Concrete beams laid horizontally and laid within grooves in concrete posts. Defence is 5 beams high. U/S most section has timber beams which replace bottom three concrete beams.	Wall.	1, Bure Haven Drive.	-999	right
1614	raised defence (man-made)	Environment Agency	tidal	Crest Level Data taken from EA Survey, 11th July 2003. Design crest levels from Lower Stour FAS ops manual, march 1998.	WALL - FLOOD - CONCRETE - MASONRY CLAD	CHRISTCHURCH ROWING CLUB	100	left
1615	raised defence (man-made)	Environment Agency	tidal	Crest Level Data taken from EA Survey, 11th July 2003. Design crest levels from Lower Stour ops manual, march 1998.	WALL - FLOOD - CONCRETE - MASONRY CLAD	OLD PONTINS SITE, CHRISTCHURCH	100	left
1616	raised defence (man-made)	Environment Agency	tidal	BITMAC SURFACED RAMP - PROVIDES PEDESTRIAN ACCESS OVER FLOODWALL. Ties into neighbouring defences	ACCESS - VEHICLE - TARMAC - RAMP	OLD PONTINS SITE, CHRISTCHURCH	100	left
1618	raised defence (man-made)	Environment Agency	tidal	Crest Level Data taken from EA Survey, 11th July 2003.	ACCESS - VEHICLE - TARMAC - RAMP	THE QUOMPS, CHRISTCHURCH	100	left
1619	raised defence (man-made)	Environment Agency	fluvial / tidal	Stone faced, concrete flood wall.Crest Level Data taken from EA Survey, 11th July 2003. Design crest levels from Lower Stour FAS ops manual, march 1998.	WALL - FLOOD - CONCRETE - STONE CLAD	The Quomps, Christchurch	100	left
1621	raised defence (man-made)	private	tidal	Crest Level Data taken from EA Survey, 11th July 2003. Defence ties into neighbouring defences	ACCESS - VEHICLE - TARMAC - RAMP	Old Pontins Site, Christchurch	100	left
1622	raised defence (man-made)	Environment Agency	fluvial / tidal	Crest Level Data taken from EA Survey, 11th July 2003. Design crest levels from Lower Stour FAS ops manual, march 1998.	WALL - FLOOD - CONCRETE - MASONRY CLAD	Old Pontins Site, Christchurch	100	left
1624	raised defence (man-made)	Environment Agency	tidal	Stone faced - concrete Flood Wall.Crest Level Data taken from EA Survey, 11th July 2003. Design crest levels from Lower Stour FAS ops manual, march 1998.	WALL - FLOOD - CONCRETE - STONE CLAD	The Quomps, Christchurch	100	left
1625	raised defence (man-made)	Environment Agency	tidal	Tarmac surfaced access ramp	ACCESS - VEHICLE - TARMAC - RAMP	The Quomps, Christchurch	100	left
1626	raised defence (man-made)	private	fluvial / tidal	Crest Level Data taken from EA Survey, 11th July 2003. Design crest levels from Lower Stour ops manual, march 1998.	FLOOD WALL	The Quomps, Christchurch	100	left
1627	raised defence (man-made)	Environment Agency	tidal	FLOOD WALL DEFENDING CAR PARK AREA. Design crest levels from Lower Stour FAS ops manual, march 1998.	WALL - FLOOD - CONCRETE - MASONRY CLAD	Willow Way Car Park, Christchurch	100	left
1628	raised defence	Environment Agency	tidal	Design crest levels from Lower Stour FAS ops manual, march 1998.	EMBANKMENT - FLOOD - EARTH -	The Quomps, Christchurch	100	left

NFCDD_ID	Asset type	Maintainer	Type	Comment	Description	Location	Design standard	Bank
	(man-made)				CLAY - CORE			
1629	raised defence (man-made)	Environment Agency	tidal	TARMAC SURFACED PATH OVER RAMP	ACCESS - PEDESTRIAN - TARMAC - RAMP	Willow Way Car Park, Christchurch	100	left
1652	raised defence (man-made)	Environment Agency	fluvial / tidal	Tarmac surfaced - vehicular access	ACCESS RAMP	RIBS Marine, Christchurch	100	left
1653	raised defence (man-made)	Environment Agency	fluvial / tidal	Brick clad Flood Wall. Design crest levels from Lower Avon ops manual	FLOOD WALL	D/S Civic Offices, Christchurch	100	left
1656	raised defence (man-made)	private	fluvial / tidal	Actual UCL and DCL taken from: Operation and Maintenance Manual of the Lower Avon Flood Defence Scheme.	SHEET PILED WALL	Rossiters Quay, Christchurch	100	left
1657	raised defence (man-made)	Environment Agency	fluvial / tidal	Design crest levels from Lower Avon ops manual	SHEET PILING	Avon Wharf, Christchurch	100	right
1658	raised defence (man-made)	Environment Agency	fluvial / tidal	Actual UCL and DCL taken from: Operation and Maintenance Manual of the Lower Avon Flood Defence Scheme.	MASONRY WALL	Bridge Place, Christchurch	100	left
1660	raised defence (man-made)	Environment Agency	fluvial	Actual UCL and DCL taken from: Operation and Maintenance Manual of the Lower Avon Flood Defence Scheme.	Masonry Wall	Bridge Place, Christchurch	100	left
3970	raised defence (man-made)	Environment Agency	fluvial	ACTUAL UCL & DCL VALUES (FLOOD DEFENCE ASSET SURVEY, STH WESSEX AREA, 1996)DESIGN STD (POST PROJECT APPRAISAL, LOWER STOUR FAS, 1996). Design crest levels from drawing F4151/263A/P.	WALL - FLOOD - CONCRETE - MASONRY CLAD	IFORD BOWLING CLUB FLOODWALL	100	left
3971	raised defence (man-made)	Environment Agency	fluvial	ACTUAL UCL & DCL VALUES (FLOOD DEFENCE ASSET SURVEY, STH WESSEX AREA, 1996)DESIGN STD (POST PROJECT APPRAISAL, LOWER STOUR FAS, 1996). Design crest levels from drawing F4151/263A/P.	WALL - FLOOD - CONCRETE - MASONRY CLAD	IFORD GOLF CLUB FLOODWALL	100	left
3972	raised defence (man-made)	Environment Agency	fluvial	Bank reconstructed in 2004/5.	EMBANKMENT	JUMPERS COMMON, CHRISTCHURCH	100	left
3973	raised defence (man-made)	Environment Agency	fluvial	ACTUAL UCL & DCL VALUES (FLOOD DEFENCE ASSET SURVEY, STH WESSEX AREA, 1996)DESIGN STD (POST PROJECT APPRAISAL, LOWER STOUR, 1996). Design crest levels taken from drawing F4151/352C/C	EMBANKMENT - FLOOD - EARTH - CLAY CORE	IFORD GOLF COURSE,U/S FLOOD EMBANKMENT	100	left
3975	raised defence (man-made)	Environment Agency	fluvial	ACTUAL UCL & DCL VALUES (FLOOD DEFENCE ASSET SURVEY, STH WESSEX AREA, 1996)DESIGN STD (POST PROJECT	EMBANKMENT - FLOOD - EARTH - CLAY CORE	EMBANKMENT RIVER WAY SOUTH	100	left

NFCDD_ID	Asset type	Maintainer	Type	Comment	Description	Location	Design standard	Bank
				APPRAISAL, LOWER STOUR, 1996). Design crest levels taken from F4151/352C/C/				
3978	raised defence (man-made)	Environment Agency	fluvial	ACTUAL UCL & DCL VALUES (FLOOD DEFENCE ASSET SURVEY, STH WESSEX AREA, 1996)DESIGN STD (POST PROJECT APPRAISAL, LOWER STOUR, 1996)	EMBANKMENT - FLOOD - EARTH - CLAY CORE	EMBANKMENT STOUR WAY	50	left
3979	raised defence (man-made)	Environment Agency	fluvial	BRICK BUILT FLOOD WALL	WALL - FLOOD - CONCRETE - MASONRY CLAD	Stour Way, Christchurch	100	left
3980	raised defence (man-made)	Environment Agency	fluvial	Brick Built Flood Wall	WALL - FLOOD - CONCRETE - MASONRY CLAD	STOUR WAY - CHRISTCHURCH	100	left
3982	raised defence (man-made)	Environment Agency	fluvial	Recently constructed. Brick faced flood wall	WALL - FLOOD - CONCRETE - MASONRY CLAD	Grove Farm Caravan Park	50	left
3983	raised defence (man-made)	Environment Agency	fluvial	ACTUAL UCL & DCL VALUES (FLOOD DEFENCE ASSET SURVEY, STH WESSEX AREA, 1996)DESIGN STD (POST PROJECT APPRAISAL, LOWER STOUR, 1996). Design Crest Levels taken from F4151/351A/T.	EMBANKMENT - FLOOD - EARTH - CLAY CORE	GROVE FARM CARAVAN PARK	100	left
3984	raised defence (man-made)	Environment Agency	fluvial	ACTUAL UCL & DCL VALUES (FLOOD DEFENCE ASSET SURVEY, STH WESSEX AREA, 1996). Design crest level taken from F4151/351A/T.	WALL - FLOOD - CONCRETE - MASONRY - CLAD	FLOOD WALL GROVE FARM CARAVAN PARK	100	left
3986	raised defence (man-made)	Environment Agency	fluvial	ACTUAL UCL & DCL VALUES (FLOOD DEFENCE ASSET SURVEY, STH WESSEX, 1996)DESIGN STD (HOLDENHURST SCHEME SUMMARY (G DRIVE). Design crest levels from drawing G4177/054A	EMBANKMENT - FLOOD - EARTH - CLAY CORE	HOLDENHURST ROAD	65	right
3988	raised defence (man-made)	Environment Agency	fluvial	ACTUAL UCL & DCL VALUES (FLOOD DEFENCE ASSET SURVEY, STH WESSEX, 1996)DESIGN STD (HOLDENHURST SCHEME SUMMARY (G DRIVE). Design crest levels from drawing G4177/054A.	WALL - FLOOD - CONCRETE - MASONRY	FLOOD WALL HOLDENHURST	65	right
3989	raised defence (man-made)	Environment Agency	fluvial	ACTUAL UCL & DCL VALUES (FLOOD DEFENCE ASSET SURVEY, STH WESSEX, 1996)DESIGN STD (HOLDENHURST SCHEME SUMMARY, G DRIVE). Design crest levels taken from drawing G4177/054A.	EMBANKMENT - FLOOD - EARTH - CLAY CORE	WOOD FARM LEPERS PLOT	65	right
3995	raised defence (man-made)	Environment Agency	fluvial	ACTUAL UCL & DCL VALUES (FLOOD DEFENCE ASSET SURVEY, STH WESSEX, 1996)DESIGN STD (HOLDENHURST SCHEME SUMMARY, G DRIVE). Design crest levels from	EMBANKMENT - FLOOD - EARTH - CLAY CORE	BLACKWATER JUNCTION - ROAD A338	65	right

NFCDD_ID	Asset type	Maintainer	Type	Comment	Description	Location	Design standard	Bank
				drawing G4177/058A.				
4007	raised defence (man-made)	Environment Agency	tidal	ACTUAL UCL & DCL VALUES (FLOOD DEFENCE ASSET SURVEY, STH WESSEX AREA, 1996)DESIGN STD (POST PROJECT APPRAISAL, LOWER STOUR FAS, 1996). Design crest levels from drawing F4151/263A/P.	WALL - PARAPET - MASONRY	NEW IFORD BRIDGE PARAPET WALL,U/S FACE	100	left
4008	raised defence (man-made)	Environment Agency	fluvial	ACTUAL UCL & DCL VALUES (FLOOD DEFENCE ASSET SURVEY, STH WESSEX AREA, 1996)DESIGN STD (POST PROJECT APPRAISAL, LOWER STOUR FAS, 1996)	WALL - FLOOD - CONCRETE - MASONRY CLAD	NEW IFORD BRIDGE,D/S FACE	100	left
4011	raised defence (man-made)	Environment Agency	fluvial	ACTUAL UCL & DCL VALUES (FLOOD DEFENCE ASSET SURVEY, STH WESSEX AREA, 1996)DESIGN STD (POST PROJECT APPRAISAL, LOWER STOUR FAS, 1996)	WALL - FLOOD - CONCRETE - MASONRY CLAD	LOW FLOODWALL,ADJOINING NEW IFORD BRIDGE	100	left
4012	raised defence (man-made)	Environment Agency	fluvial	ACTUAL UCL & DCL VALUES (FLOOD DEFENCE ASSET SURVEY, STH WESSEX, 1996)DESIGN STD (POST PROJECT APPRAISAL, LOWET STOUR FAS, 1996). Design crest levels taken from drawing F4151/263A/P.	EMBANKMENT - FLOOD - EARTH - CLAY CORE	BERNARDS MEAD F.RELIEF CHANNEL FLOODBANK	100	left
4015	raised defence (man-made)	Environment Agency	fluvial	ACTUAL UCL & DCL VALUES (FLOOD DEFENCE ASSET SURVEY, STH WESSEX AREA, 1996)DESIGN STD (POST PROJECT APPRAISAL, LOWER STOUR FAS, 1996). Design crest levels from drawing F4151/263A/P.	WALL - FLOOD - CONCRETE - MASONRY CLAD	BERNARDS MEAD F.RELIEF CHANNEL FLOODWALL	100	left
4016	raised defence (man-made)	Environment Agency	fluvial	ACTUAL UCL & DCL VALUES (FLOOD DEFENCE ASSET SURVEY, STH WESSEX AREA, 1996DESIGN STD (POST PROJECT APPRAISAL, LOWER STOUR FAS, 1996). Design crest levels taken from drawing F4151/263A/P.	WALL - FLOOD - CONCRETE - MASONRY CLAD	BERNARDS MEAD FLOODWALL,D/S END	100	left
4018	raised defence (man-made)	Environment Agency	tidal	ACTUAL UCL & DCL VALUES (FLOOD DEFENCE ASSET SURVEY, STH WESSEX AREA, 1996)DESIGN STD (POST PROJECT APPRAISAL, LOWER STOUR FAS, 1996). Design crest levels taken from drawing F4151/263A/P.	EMBANKMENT - FLOOD - EARTH - CLAY CORE	BERNARDS MEAD FLOOD EMBANKMENT NO.1	100	left
4020	raised defence (man-made)	Environment Agency	tidal	ACTUAL UCL & DCL VALUES (FLOOD DEFENCE ASSET SURVEY, STH WESSEX AREA, 1996)DESIGN STD (POST PROJECT APPRAISAL, LOWER STOUR FAS, 1996). Design crest level from drawing F4151/263A/P.	WALL - FLOOD - CONCRETE - MASONRY CLAD	BEAULIEU GARDENS CARAVAN PARK FLOOD WALL	100	left

Appendix F – Christchurch flood defences: condition assessment

River and bank Avon; left bank	**Reach/Area of defences** Civic Offices reach, d/s Bridge Street
NFCDD IDs: 1419, 1414, 1412, 1653 and 1652 *(see photographs DSCN2734 to DSCN2742 which are provided on DVD)*	
Description of the defences Most of this length of defence is in the form of a flood wall (1414 – Waterloo Boat Yard and 1653 – d/s Civic Offices), assumed to be reinforced concrete with brick facing and coping, with height between 1 and 1.5m. The defence for the central section (1412) is formed by the Civic Office building. There are three flood gates at the upstream end, two to provide boat access (part of 1419 – Waterloo Bridge) and the third to complete the defence between the wall and the Civic Office building (part of 1412). The downstream section of defence (1652 – RIBS Marine) is the ramped access to the Civic Offices car park, which links the floodwall to a raised embankment running perpendicular to the river. This section of defence protects the Civic Offices and the largely commercial and light industrial development of this part of Christchurch. Access to these defences is generally good, although see the comment below about the main Civic Offices car park floodwall (1653).	
General and condition assessment The overall condition of these defences is generally very good. There is no sign of movement and the joints to the brickwork facing are sound. The only area of minor concern is part of the wall by the main Civic Offices car park (1653) where the floodwall is becoming overgrown with vegetation (ivy, bramble, small trees, etc.) from the riverside, which is making access for inspection difficult. The flood gates are in very good condition with evidence of regular maintenance. There are no visible signs of any deterioration of either the Civic Offices building or the ramped car park access at the downstream end.	
Recommendations and adaptability There is nothing of serious concern but minor maintenance in the form of clearing of the vegetation on the riverside of floodwall by the main Civic Offices car park (1653) is recommended. Regular, routine maintenance in the form of inspection of the floodwalls, and greasing and testing of the floodgates should continue. There is no apparent reason why these defences should not continue to function effectively for another 30 to 40 years, and potentially longer with minor repairs. The floodgates may require replacement after 20 to 30 years. Raising of these defences to cater for climate change impacts should not present major problems, although the floodgates would probably need replacement. The difficulty could be extending the raised defences, particularly at Bridge Street bridge.	

River and bank	**Reach/Area of defences**
Avon; left bank	Bridge Street u/s to A35 road embankment
NFCDD IDs: 1424, 1428, 1429, 1431, 1430, 1434 and 1352 *(see photographs DSCN2743 to DSCN2755 which are provided on DVD)*	

Description of the defences

The defences (1424 – Waterloo Bridge, 1428 – Waterloo Bridge, 1429 – Bridge Place, and 1431 – 38 Bridge Street) immediately upstream of Bridge Street are complicated. They are a mix of the walls of buildings, masonry walls and two small floodgates. Some of these defences (1424 and 1429) are privately owned.

The next section upstream (1430 - Barlins) is a long length of steel sheet piled wall with reinforced concrete wall capping.

The upstream sections (1434 – Stony Lane and 1352 – Stony Lane) are earth embankments. There is a flap gate drainage outlet towards the downstream end of the embankment.

This section of defences protects some residential properties but mostly light industrial and business/commercial park type development.

Access to the defences near Bridge Street and to the steel sheet piled wall is difficult, but the earth embankments are easily accessed.

General and condition assessment

The overall condition of these defences is generally very good, although this assessment is qualified by the limited access and observation of the defences near Bridge Street. This applies to the walls of buildings, masonry walls and two small floodgates, and to the steel sheet piled wall.

The two floodgates are small and in good condition. It was noted, however, that one of the gates is horizontally hinged and is lifted from its horizontal 'rest' position to a vertical position for closure. This means there is the risk of damage to the gate from heavy loads passing over it, although its location makes this most unlikely.

The upstream sections of earth embankment (1434 and 1352) have shallow slopes and the grass is short, apparently as a result of grazing. One section of embankment (in 1434) has vegetation (bushes/small trees) growing on the slopes and crest.

There is one access ramp over the embankment but it is hard surfaced and not susceptible to erosion.

There is also one flap gate outlet through the embankment. It was not accessible for inspection.

Although not part of the assessment inspection, the modelling carried out for the SFRA has revealed that the defences by the A35 embankment are overtopped by the 1% (1 in 100-year) event. This, could be because the earth embankment (1352) does not extend sufficiently far upstream to tie in to the road embankment.

Recommendations and adaptability

There is nothing of serious concern but minor maintenance in the form of clearing of the vegetation on the slopes and crest of the earth embankment (1434) is recommended. Regular, routine maintenance in the form of inspection of the embankments and flood walls, and greasing and testing of the flood gates and flap gate(s) should continue.

There is no apparent reason why these defences should not continue to function effectively for another 30 to 40 years, and potentially longer with regular maintenance, and repairs and rehabilitation as necessary, particularly to the earth embankments. The flood gates and flap gates may require replacement after 20 to 30 years.

Raising of these defences to cater for climate change impacts should not present major problems, although any floodgates would probably need replacement. The difficulty could be extending the raised defences, at Waterloo bridge.

Following from the comment above about the 'weak' spot in the defences at the upstream end it is recommended that this area is surveyed with a view to extending the earth embankment (1352) upstream to tie in to the road embankment.

River and bank	**Reach/Area of defences**
Avon; island	The island north (u/s) of Bridge Street
NFCDD IDs: 1422, 1423, 1425, 1426, and 1500 *(see photographs DSCN2756 to DSCN2761 which are provided on DVD)*	
Description of the defences Access to these defences is very difficult and they were viewed only at Bridge Street, east and west, and one other location (1423). The defences are a mix of the walls of buildings, floodwalls and earth embankments (1425 - Brigands Creek and 1426 – No 16 Bridge Street, but not seen). The floodwalls (1423 – Brigands Creek and 1500 – u/s Town Bridge) are stone faced, and one lift gate drainage outlet was seen (1423). On the east side upstream of Bridge Street (1422 - Brigands Creek) the defence is officially classified as a floodwall but the only wall that could be seen was the lower part of the building wall. This section of defences protects some residential and small business/commercial properties.	
General and condition assessment The overall condition of these defences is generally very good, although this assessment is seriously qualified by the very limited access and observation of the defences. As noted above, the flood embankments were not inspected. Although not part of the assessment inspection, the modelling carried out for the SFRA has revealed that the defences are overtopped by the 1% (1 in 100-year) event somewhere to the north/north west of the island (1426/1500). The exact location is not known.	
Recommendations and adaptability The main area of concern is the limited access and the very small section of these defences that have been inspected. It is recommended that further inspection be undertaken, probably arranged through the Environment Agency. From what has been seen there is nothing of concern. There is no apparent reason why these defences should not continue to function effectively for another 30 to 40 years, and potentially longer with regular maintenance and repairs, and rehabilitation as necessary, particularly to the earth embankments. Any outlet gates may require replacement after 20 to 30 years. Raising of these defences to cater for climate change impacts should not present major problems, although the building wall (1422) could present some issues and property owner consent could be another issue. These defences are limited at each southern end by Waterloo and Town bridges and cannot be extended. Following from the comment above about the 'weak' spot in the defences to the north/north west (1426/1500) of the island needs further investigation and survey with a view to remedial works to ensure a consistent stand of protection throughout.	

River and bank	**Reach/Area of defences**
Avon; island	The island south (d/s) of Bridge Street
NFCDD IDs: 1413, 1660, 1658, 1656, 1657 and 1415 *(see photographs DSCN2762 to DSCN2768 which are provided on DVD)*	

Description of the defences

Access to these defences for inspection is better than to those to the north of Bridge Street, but it is still not good, especially for heavy/large vehicles.

The majority of the defence to this part of the island is in the form of a sheet piled wall (1656 – Rossiters Quay and 1657 – Avon Wharf). Most of it is clad with either stone or timber and little of the piling is visible. What could be seen was in good condition, although it was noted that it is unprotected.

Walls form the defences adjoining Bridge Street (1413 – Bridge Place, 1660 - Bridge Place, 1658 - Bridge Place and 1415 – Avon Wharf). Those on the west side (1413, 1660 and 1658) are masonry walls but they were not inspected closely. From what could be seen from Bridge Street the top section, about 1m, of the defence near Town bridge on the west side of the island (1413) is a brick wall that could not be described as substantial; it is certainly very different to the wall on the north side of Bridge Street. The defence on the east side (1415) is a flood wall, thought to be reinforced concrete with brick cladding.

This section of defences protects largely residential properties. Those along Bridge Street are older but the others are relatively new and associated with the marina development.

General and condition assessment

The overall condition of these defences is generally very good. This assessment is qualified by the limited access and observation of the defences near to Bridge Street.

As noted above, the masonry (brick) wall of the defence near Town Bridge on the west side of the island (1413) does not look substantial. This needs further investigation, either through the Environment Agency or access to the property, to check the structure and confirm its condition.

Recommendations and adaptability

The main area of concern is the masonry wall on the west side near Town Bridge (1413). As noted above, it is recommended that further inspection be undertaken, arranged through either the Environment Agency or the property owner.

Other than the concern above (1413), there is no apparent reason why these defences should not continue to function effectively for another 30 to 40 years, and potentially longer with regular maintenance and repairs, and rehabilitation as necessary. The steel sheet piles are unprotected from what could be seen and these will need regular inspection to check for corrosion.

Raising of these defences to cater for climate change impacts should not present major structural problems, but the work would be complicated by the numerous component parts. Property owner consent, however, could be an issue and some objections should be expected. These defences are limited at each end by Town Bridge and cannot be extended.

River and bank	**Reach/Area of defences**
Stour; left bank	Old Pontins site and the Quomps, d/s B3059
NFCDD IDs: 1480, 1481, 1486, 1614, 1615, 1616, 1618, 1619, 1621, 6122, 1624, 1625, 1626, 1627, 1628 and 1629 *(see photographs DSCN2769 to DSCN2776 which are provided on DVD)*	
Description of the defences Most of this length of defence is in the form of a flood wall (1614 – Christchurch Rowing Club, 1615 - Old Pontins Site, 1616 - Old Pontins Site, 1618 - The Quomps, 1619 - The Quomps, 1621 - Old Pontins Site, 1622 - Old Pontins Site, 1624 - The Quomps, 1625 - The Quomps, 1626 - The Quomps, 1627 – Willow Way Car Park and 1629 - Willow Way Car Park), assumed to be reinforced concrete with brick or stone facing and coping, with height between 1 and 1.75m. One section of defence by the Quomps (1628 – The Quomps) is an earth embankment, with height between 1 and 1.5m. The defences are completed by three sections of raised road (1480 – Old Pontins Site, 1481 - The Quomps and 1486 - The Quomps) to provide vehicle access. These defences protect a waterfront hotel and residential properties in this part of Christchurch. Access to these defences is very good.	
General and condition assessment The overall condition of these defences is very good. There is no sign of movement and the joints to the brickwork and stone facing are sound.	
Recommendations and adaptability There is nothing of concern but regular, routine maintenance in the form of inspection of the floodwalls, and inspection and grass cutting on the embankment should continue. There is no apparent reason why these defences should not continue to function effectively for another 40 years, and potentially longer with minor repairs. Raising of these defences to cater for climate change impacts should not present major problems. The difficulty could be raising the road at the three vehicle access points, and possibly objection to increased visual intrusion in parts.	

River and bank	**Reach/Area of defences**
Stour; left bank	Homelands area, d/s railway line
NFCDD IDs: 1475 *(see photographs DSCN2780 to DSCN2785 which are provided on DVD)*	
Description of the defences This is a short section of defence (1475 – Homelands, Kings Avenue) in the form of a reinforced concrete wall with brick cladding and concrete slab coping. It is about 1m high (maximum). The defences protect new residential development. Access to these defences is restricted. There is vehicular access to within a few metres of the wall but foot access thereafter.	
General and condition assessment The condition of these defences is very good, which reflects their age. There is no sign of movement and the joints to the brickwork and stone facing are sound.	
Recommendations and adaptability There is nothing of concern but regular, routine maintenance in the form of inspection of the floodwalls and cladding should continue. There is no apparent reason why these defences should not continue to function effectively for another 40 years, and potentially longer with minor repairs. Raising of these defences to cater for climate change impacts should not present major problems. The buildings downstream are older and on raised ground, so a downstream extension of the defence could require further raising of this ground or continuation of the flood wall. Although not inspected an upstream extension of the defence, possibly to tie in with the railway embankment, should be feasible.	

River and bank	**Reach/Area of defences**
Stour; left bank	Jumpers Common and Iford area, u/s and d/s A35

NFCDD IDs: 3970, 3971, 3972, 3973, 3975, 3978, 3979, 3980, 3982, 3983, 3984, 4007, 4008, 4011, 4012, 4015, 4016, 4018 and 4020 (*see photographs DSCN2786 to DSCN2797 and DSCN2813 to DSCN2817 which were taken downstream of the A35 (Iford Bridge) DSCN2798 to DSCN2812 were taken upstream of the A35 (Iford Bridge)*

Description of the defences

This long defence is a mix of a reinforced concrete wall with brick cladding and earth embankments. From downstream there is a short section of flood wall (4020 – Beaulieu Flood Wall), a section of earth embankment (4018 - Bernards Mead Flood Embankment No 1), two sections of flood wall (4016 - Bernards Mead Flood Wall and 4015 – Bernards Mead Flood Wall), another section of embankment (4012 - Bernards Mead Flood Relief Channel Flood Embankment) and a short length of low wall adjoining the new Iford Bridge (4011 – New Iford Bridge). At the downstream end the defences are about 1 to 1.5m high but this increases to about 2m (4016) before decreasing again to about 1m near Iford Bridge. The sections of embankment have flattish slopes and good wide crests. Near Iford Bridge (4012), behind the embankment towards the A35, there is a triangular shaped flood storage area for local drainage with a flap-gated outlet to the river. The secondary embankments bounding this area are lower than the main defence and, from a distance, looked to have low spots in them.

The New Iford bridge embankment and parapet walls also form part of the defences (4008 – New Iford Bridge D/S Face and 4007– New Iford Bridge Parapet Wall U/S Face).

Upstream of the bridge there is a section of flood wall (3970 – Iford Bowling Club Flood Wall and 3971 – Iford Golf Course Flood Wall), which is about 1.8m to 2m high. There is then a long section of embankment (3972 – Jumpers Common Flood Embankment, 3973 - Iford Golf Course U/S Flood Embankment, 3975 – River Way South Embankment and 3978 – Stour Way Embankment). This section of embankment is high, 2.5m or more in parts, with steep side slopes (1:1 or 1:1.5) and a gravel toe drain on the river side. Further upstream there are flood walls and an embankment (3982 – Grove Farm caravan Park, 3983 – Grove Farm caravan Park and 3984 – Grove Farm Caravan Park), which are about 1.5m high and look to be new. There is a drainage outlet, Grove Farm Outlet, with a vertical lift gate between the embankment and flood wall (3978 and 3982). Two short sections of defence (3979 – Stour Way and 3980 – Stour Way) were not inspected and it may be that these are obsolete now the defences are extended upstream around Grove Farm Caravan Park.

The defences protect mostly residential development, with a mix of semi-detached and detached houses, bungalows and static caravans.

Access to these defences is generally good, especially from the river side and along the crests of the embankments.

General and condition assessment

The condition of these defences is generally very good. There is no sign of movement and the joints to the brickwork facing are sound. The embankments are largely clear of vegetation but there is some evidence of minor rutting on the crest resulting from vehicular access. From what could be seen the outlet gates are in good condition.

Recommendations and adaptability

There is nothing of serious concern but regular, routine maintenance in the form of inspection of the flood walls and cladding, outlet gates and embankments should continue. The embankments require regular grass cutting and the areas where there is evidence of wheel rutting should be carefully monitored. There is no apparent reason why these defences should not continue to function effectively for another 30 to 40 years, and potentially longer with regular maintenance, and repairs and rehabilitation as necessary, particularly to the earth embankments. The outlet gates may require replacement after 20 to 30 years. Raising of these defences to cater for climate change impacts should not present major problems, although it is noted that sections of flood wall and embankment are already over 2m high and design parameters would need to be checked carefully before their height is increased. Extension of the defences should be possible but further investigation at the upstream and downstream limits would be required to confirm this.

Appendix G – Scope of Flood Risk Management Options

Principal Measures	Structural Options	Non-Structural Options	Effectiveness*
A. River and Coastal Engineering			
• Increase flood conveyance (affects d/s)	Channelisation, channel restoration, dikes and embankments, by-pass and diversion channels, structure upgrade/improvement		Major
• Increase flood storage	Dams, floodplain/wetland storage, floodplain restoration, temporary channel storage		Marked
• Flood defences	Flood defence along river, ring dykes for key areas, special structures		Major
• Flood water transfer	Bypass or diversion across river/tributary catchments *- not considered a feasible option for Christchurch catchment.*		Marked/Major
B. Manage Flood Events			
• Pre-flood measures**		Preparedness planning; major incident plans, flood risk mapping, education and awareness raising; family/community flood plans	Marked
• Real time forecasting & warning**		Forecast systems (sensing, incl. g/w monitoring, modelling, etc.), warning dissemination systems	Marked
• Flood fighting**	Demountable defences, water level control structures (weirs, sluices)	Emergency repair, emergency diversions	Marked
• Collective/individual scale damage avoidance	Demountable defences, temporary flood proofing	Evacuation of floodplain, moving assets to safety	Marked
C. Manage Flood Losses			
• Reduce exposure by land-use management		Managed retreat, relocate exposed infrastructure	Minimal
• Reduce exposure through flood proofing		Retro-fit flood proofing – self help programmes	Marked
• Limit increased exposure by land-use planning		Planning of land use, financial measures (floodplain charging), locate critical facilities out of floodplain	Minor
• Limit increased exposure with better construction	Flood proofing	Property/structure designs	Minor
• Facilitate economic and financial recovery		Insurance, state aid and compensation, tax relief on losses, self insurance	n/a
• Lessen health, social and practical impacts**		Target health/counselling services, practical aid (clean up)	n/a
D. Urban (Fabric) Management			
• Increase urban storage	Detention ponds, underground storage, temporary flood storage (parkland), storage along flood system	Building design, urban area development design, source control, groundwater management, design of drainage/ sewerage systems	Minor
• Increase infiltration		Building design, permeable land cover	Minimal
• Manage land surface conveyance	Separate storm and foul sewers, alter river channels to improve outfalls reopen culverted watercourses (daylighting).	Design of building drainage, multiple drainage systems, design of roads and gully pots	Minimal
E. Rural Land Management			
• Increase retention/infiltration	Increase field drainage storage	Change tillage practice, extensification, afforestation, buffer strips/zones	Minimal
• Water retention/storage schemes	Detention pond/bunds	Wetlands/washlands, riparian zone management, rainwater harvesting	Minimal
• Manage conveyance	Realign channels	Maintain channels, manage hillslope connectivity	Minimal