Deal Surface Water Management Plan

Summary Report and Action Plan

November 2013

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Glossary and Abbreviations Used in This Report

Term	Definition
AEP	Annual Exceedance Probability. A flood or rainfall event with a 1 in 100 (1%) chance of being exceeded in any year has an AEP of 1/100 or 1%.
Climate Change	Long term variations in global temperature and weather patterns caused by natural and human actions.
Culvert	A channel or pipe that carries water below the level of the ground.
Defra	Department for Environment, Food and Rural Affairs
DTC	Deal Town Council
EA	Environment Agency
FCERM	Flood and Coastal Erosion Risk Management
FDGiA	Flood Defence Grant in Aid – A Defra fund managed by the EA to provide funding for flood defence and coastal erosion works
FMfSW	Environment Agency Flood Map for Surface Water
Flood & Water Management Act 2010	Part of the UK Government's response to Sir Michael Pitt's Report on the Summer 2007 floods, the aim of which (partly) is to clarify the legislative framework for managing surface water flood risk in England.
Fluvial Flooding	Flooding resulting from water levels exceeding the bank level of a Main River (see below).
Groundwater Flooding	Flooding that can be caused by the emergence of water originating from sub-surface permeable strata. The groundwater may emerge from either point or diffuse locations.
KCC	Kent County Council
LLFA / Lead Local Flood Authority	Local Authority responsible for taking the lead on local flood risk management (for Deal this is KCC)
Main River	A watercourse shown as such on the Main River Map, and for which the Environment Agency has responsibilities and powers. N.B. Main River designation is not an indication of size, although it is often the case that they are larger than Ordinary Watercourses.
NRD	National Receptor Dataset – a collection of risk receptors produced by the Environment Agency, including properties
Partner	A person or organisation with responsibility for the decision or actions that need to be taken.
Resilience Measures	Measures designed to reduce the impact of water that enters property and businesses; could include measures such as raising electrical appliances.
Resistance Measures	Measures designed to keep flood water out of properties and businesses; could include flood guards for example.
Risk	In flood risk management, risk is defined as a product of the probability or likelihood of a flood occurring, and the consequence of the flood.
Sewer flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
Stakeholder	A person or organisation affected by the problem or solution, or interested in the problem or solution. They can be individuals or organisations, includes the public and communities.
SuDS / Sustainable Drainage Systems	Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques.
Surface water	Rainwater (including snow and other precipitation) which is on the surface of the ground (whether or not it is moving), and has not entered a watercourse, drainage system or public sewer.
SW	Southern Water

Term	Definition
Swale	A shallow vegetated channel designed to conduct and retain water, but also may permit infiltration. The vegetation filters particulate matter.
SWMP / Surface Water Management Plan	A SWMP (Surface Water Management Plan) identifies the risk of surface water flooding in a local area as well as viable measures to manage that risk.

1 Summary of the Deal SWMP

1.1 Background

A Surface Water Management Plan (SWMP) is a study to understand the risks that arise from local flooding, which is defined by the Flood and Water Management Act 2010 as flooding that arises from surface runoff, groundwater, and ordinary watercourses.

SWMPs are undertaken by a partnership of flood risk management authorities who have responsibilities for aspects of local flooding, including the Local Authorities, Environment Agency (EA), Sewerage Undertaker and other relevant authorities.

Please refer to Figure 101 for a location plan and the extent of the SWMP area.

This SWMP is being undertaken by Kent County Council (KCC) to investigate the local flood risks in Deal as part of their remit for strategic oversight of local flood risk management in Kent, conferred on them as Lead Local Flood Authority (LLFA) by the Flood and Water Management Act 2010. This area has been identified as being at risk due to the history of local flooding in the area. This SWMP maps the local flood risk and identifies potential mitigation options.

1.2 Background

Flood risk in Deal arises from a complex combination of sources: coastal, ordinary watercourses, surface water and groundwater. This SWMP focuses on ordinary watercourses, surface water and groundwater as the primary local flood risks.

Deal was highlighted in the Kent Preliminary Flood Risk Assessment as being at significant risk of flooding from localised flooding.

The risk of surface water flooding is high within the town centre and a number of areas within Mill Hill, Walmer and Middle Deal, with a high intensity storm draining off the urban area and overloading the surface water drainage system. This flood risk is exacerbated by a large area of the town served by combined sewer systems, particularly in the northern and central areas of Deal.

In June 2007 and August 2010 Deal experienced significant surface water flooding, with flood water entering numerous residential and commercial properties.

1.3 Objectives

The purpose of a SWMP is to

- Identify what the local flood risk issues are
- Identify potential sustainable flood mitigation options
- Develop an Outline Action Plan to provide to guidance on the next steps for flood risk management within Deal.

The purpose of the SWMP study is to identify sustainable responses to manage surface water flooding. The Outline Action Plan provides an evidence base for future decisions and funding applications for putting the recommendations into practice. Preparation of the Action Plan for Deal has followed the latest Defra guidance[1]. The Action Plan is presented in Section 4.

[1] SWMP Technical Guidance, Defra 2010

1.4 Previous Studies

The Initial Flood Risk Assessment for Deal was finalised in July 2012. This report set out the basic principles of the Deal SWMP summarising data sources and provided an initial assessment of flood risk within Deal Town. The IFRA also included interviews with local residents which as been used to confirm the models assessment of flood risk.

The Dover SWMP and Preliminary Flood Risk Assessment have been undertaken in parallel to this study. Findings and lessons learnt have been fed into the current study. Of particular relevance are the representation of buildings and roads in the hydraulic modelling, the treatment of runoff from chalk catchments and option identification.

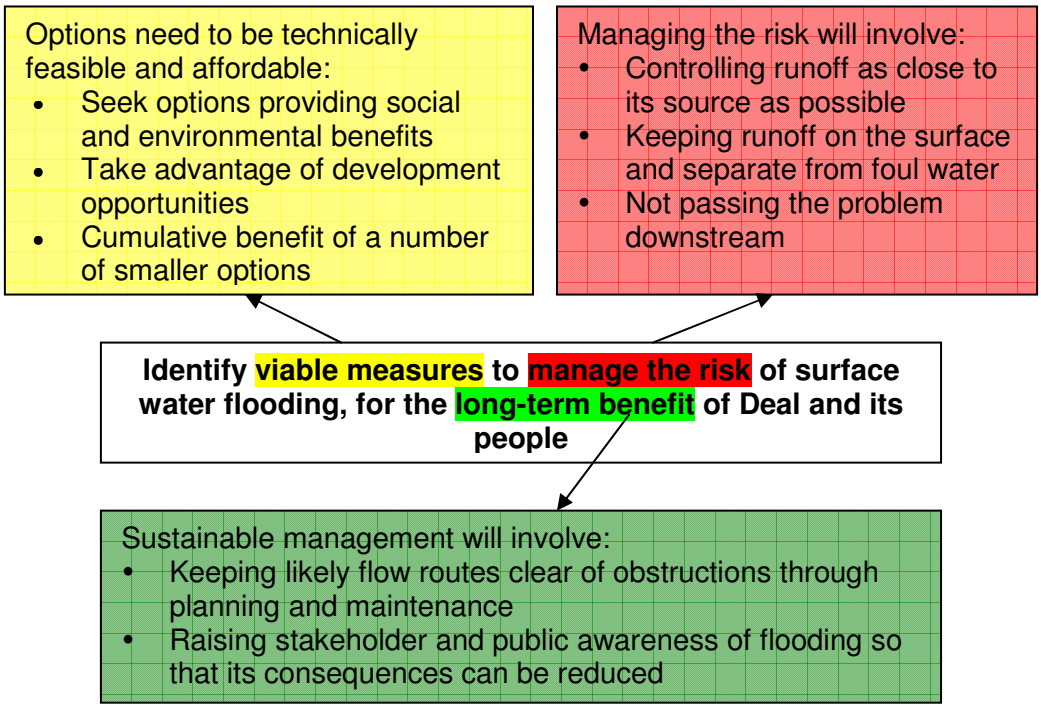
The EA are currently progressing a scheme to reduce the risk of flooding from the sea in Deal. Some areas of Deal have a 5% AEP risk of tidal flooding. The scheme will reduce this risk to 0.33% AEP, for 1,418 homes and 148 commercial properties in Deal. Flooding from the sea continues to be managed by the EA and is not considered further in this SWMP.

1.5 Partnership Approach to Flood Risk Management

The partnership approach to integrated flood risk management, as encouraged by the Flood & Water Management Act 2010[2], has been strengthened in this SWMP through integrated working between KCC (lead partner), Deal Town Council (DTC), the EA and Southern Water (SW). The vision for the project was agreed by the SWMP Partnership as shown in Figure 1.

[2] http://www.legislation.gov.uk/ukpga/2010/29/contents

Figure 1: The SWMP vision statement highlighting key concepts



Consultation with partner organisations, stakeholders and representatives of the public has been a key element throughout the development of the SWMP. A 'stakeholder workshop' was held on 13 June 2012 and on 6 March 2013 with a number of councillors, technical experts from the councils, SW and the EA to discuss key flooding issues and gather local information to help direct the study.

Key flooding issues identified at the outset of this SWMP are summarised in Box 1. More detailed observations for each key risk area are provided in Appendices A to G. Predicted flood risk is mapped for a range of return periods in Figures 201 to 207.

Box 1 Key flooding issues

Key flooding issues identified for Deal Town

- There is demonstrable history of surface water and groundwater flooding across the urban area of Deal, for example in June 2007 and August 2010. The flooding has affected both residential and non-residential properties.
- There are natural valleys, apparently dry (as on chalk geology) which could during heavy rainfall when the hills are saturated or frozen give rise to significant overland flow paths.
- There are numerous basement premises throughout Deal with entrances at or near road level where surface water could readily flow into the basement if it overtops the kerbs. There is evidence of deep flooding in some of these basements which poses a significant hazard.

1.6 Risk Assessment through Modelling

A two dimensional hydraulic model has been constructed to support the SWMP Action Plan. The model has been used to better understand the locations and

mechanisms of flooding and inform identification and development of management options. General observations arising from analysis of the model results are presented in Box 2. More details on the model build process is included in Section 2.3 and in Appendix H.

The hydraulic modelling has indicated that exceedance of the capacity of the surface water drainage system poses the greatest risk of flooding to Deal. Risk of flooding from ordinary watercourses and groundwater are far lower in comparison.

Box 2 General observations from the modelling

General observations from the modelling

- Predictions of deep and/or extensive flooding are largely consistent with recorded evidence of surface water flooding.
- The key areas of flood risk identified are Deal town centre and Lower Walmer. Each of these areas has over 20 properties at 'Very Significant' risk of flooding. (as defined under FDGiA funding as at risk of flooding from >=5% AEP event)
- The model confirms observed flooding at Church Street in Upper Walmer, Albert Road and the junction of Church Lane and Southwall Road.
- The model predicts observed highway flooding in Sholden.

Maximum depths at individual properties in National Receptor Dataset (NRD) have been used to estimate economic damages due to surface water flooding in the existing ('do minimum') situation. It is estimated that approximately £17.4M of damage (including indirect, intangible and emergency service costs where applicable) due to surface water flooding will be experienced across the modelled urban area of Deal in the next 50 years. Of the 13,575 ground floor residential properties in the study area, 497 are predicted to incur flooding damages over the next 50 years.

1.7 Options for Sustainable Management of Surface Water Flooding

In order to manage the local flood risks that have been identified in Deal, a range of options has been developed for surface water management in the town.

Box 3 Philosophy for the identified options

Philosophy for the Identified Options

- Seek management options providing social and environmental benefits – schemes with multiple benefits are more likely to attract funding
- Manage runoff close to its source and keep runoff on the surface wherever possible – this will be sustainable and have reduced maintenance costs
- Keep likely flow routes clear of obstructions through planning and maintenance – to reduce both the likelihood and consequences of flooding
- Raise stakeholder and public awareness of flooding – this will reduce the consequences of flooding and improve reporting and evidence of issues
- Implement identified options incrementally and take advantage of opportunities as they arise – 'piggy-back' flood risk management activities with other schemes

Options have been developed by combining individual measures (which are introduced in Appendix H) under the following headings:

Source control and Sustainable Drainage Systems (SuDS): Source control measures aim to reduce the rate and volume of surface water runoff through infiltration or storage. They can also provide some natural removal of pollutants and sediments, as well as aquifer recharge, which all provide environmental benefits. In constrained and urban areas like Deal, controlling inflows entering the urban area will be a particularly desirable option, as will reducing sediments and pollutants from entering the drainage system.

Design for exceedance: Roads, buildings and other features can be designed to control overland flow and direct it safely through the urban environment, such that floodwater is less likely to enter buildings or other structures. Designing for exceedance recognises that flows that exceed the below ground drainage capacity are always possible but can be managed to some degree by creating designated flow routes or other measures such as threshold raising at access points.

Increasing capacity: Adding storage and/or increasing the capacity of the sewer network could improve the conveyance of floodwater and limit overland flow and flooding.

Separation of foul and surface water: Alongside effective surface water management, this can reduce flooding and pollution. Misconnections between the surface water and foul systems should be rectified as opportunities arise throughout Deal.

Non-structural measures: Non-structural measures can reduce the consequences for the receptors of flooding, e.g. people, property and the environment. These measures include the application of planning policy to reduce flood risk. This could involve the direction of development away from the highest risk areas; for instance the excluding areas for development in areas at risk of flooding from events more severe than required by the NPPF. Another option could be to place more onerous requirements on developers to reduce runoff, for example by 50% of existing[3]. In most cases, these are likely to be implemented across Deal through the introduction of council policy.

The principal concepts for improved surface water management are listed for each key risk area in Appendices A to G. Location-specific options included in the Outline

[3] London Plan, GLA ,2011

Action Plan are marked on Figure 401. Options have been appraised through an analysis of the following criteria:

Technical – Is the option technically possible and will it actually improve management of surface water flooding? The effectiveness of the options has not been tested in the hydraulic model. However the model has been used to assess the flooding mechanism and as a source of data to identify a solution, such as identifying sections of the drainage capacity with spare capacity.

Economic – A high-level assessment has been made to determine the maximum cost of a financially viable scheme, based upon the predicted flood damages.

Social – Will the community benefit or suffer from implementation of the option?

Environmental – Will the environment benefit or suffer from implementation of the option?

SWMP – The majority of proposed options were discussed at an Options Workshop held on 6 March 2013, to which all SWMP Partners and other stakeholders were invited. The degree of support for each option has informed selection those options included in the Action Plan in Section 4.

2 Methodology

2.1 Data Collection

The collection of data for the construction of the hydraulic model is dealt with in detail in Appendix H. In addition to the modelling data the following data was used in the damages assessment and the identification and appraisal of options.

2.1.1 National Receptor Dataset

The EA provided National Receptor Dataset (NRD) records for Deal, which were used to provide information on property types for estimating flood damages (see Section 2.6).

2.1.2 Historic Flooding Records

Records of previous flooding were available from a range of sources. The data has been used to verify the models prediction of flood risk and to assess the areas of greatest risk.

(a) Southern Water

SW provided records of their recorded instances of sewer flooding between 2004 and 2010.

(b) Deal Town Council

Information about a number of flood incidents caused, at least in part, by local sources within Deal town have been provided by Deal Town Council via KCC. These records show widespread surface water and sewer flooding problems, varying in scale from only affecting single properties to whole streets.

(c) Questionnaire

Based on flooding records and the EA Flood Map for Surface Water (FMfSW), questionnaires were distributed in 2012 to gather local knowledge of previous flood incidents and issues with the local drainage system. The responses are summarised in the Initial Flood Risk Assessment Report (Jacobs, July 2012).

(d) Kent Fire and Rescue Service

Kent Fire and Rescue Service (KFRS) provide records of their call-outs to flooding related incidents.

2.2 Surveys and Site Visits

Site visits, undertaken in Spring 2012 to develop the Initial Flood Risk Assessment which, were used to inform the identification of key flood risk areas. A further site visit was undertaken in May 2013 to review key flood risk areas and identify and appraise mitigation options.

2.3 Hydraulic Modelling

A hydraulic model was constructed of Deal using InfoWorks ICM software. It was constructed as a combined 1D and 2D model which simulates flow in the below-ground drainage network and also the path of flooding on the surface.

The model includes the following key elements:

- direct rainfall on the urban area;
- overland flow through the built environment at a suitably high resolution;
- groundwater discharge from the surrounding Chalk valleys;
- interaction with SW's surface water and combined sewer network;

- influence of the tidal boundary.

The model was used to produce flood extents, depths, velocities and hazard for the 20% (1 in 5), 10% (1 in 10), 3.33% (1 in 30), 2% (1 in 50), 1.33% (1 in 75) 1% (1 in 100) and 0.5% (1 in 200) AEP events. The predicted flooding was used to estimate financial damages and to inform the option appraisal process.

The estimated flood extents for the modelled return periods may be found in Figures 203 to 207. Model verification has been undertaken by a visual comparison of the models predicted flooding against recorded flood history and the observations of local residents.

Details of the model construction may be found in Appendix H. It is noted that the model represents a large and hydrologically complex area and that a number of simplifications have had to be made. Therefore, the model should only be used for large-scale purposes similar to this study and any detailed design should include necessary local improvements and refinements to the model.

2.4 Hotspot Identification

Key flooding locations (or hotspots) were identified based on a combination of the flood risk predicted by the hydraulic model and the records of historic flooding. These were discussed with all parties at a workshop on 6 March 2013. The details of each hotspot are included in Appendices A to G.

2.5 Option Identification and Appraisal

In addition to the generic mitigation options listed in Appendix H site-specific options were identified for each flooding hotspot. These have been summarised in Appendices A to G and are listed in full in Table 6.

2.6 Damages Assessment

An initial assessment has been made of the financial cost of flooding in Deal based upon the hydraulic model results. The calculation of economic damages due to flooding has been undertaken using standardised guidelines and figures, provided in the Flood and Coastal Defence Project Appraisal Guidance (FCDPAG) published by DEFRA in the UK, and also the Middlesex University's Flood Research Centre's 'Multi-Coloured Manual' (MCM). The methodology allows for the assessment of the overall economic damages associated with flooding which is comprised of the following components:

- **Direct property damage:** damage to fabric and contents of building;
- **Indirect damage:** indirect costs incurred as a result of flooding (e.g. temporary accommodation);
- **Intangible damage:** human health impacts (physical and psychological); and
- **Emergency services:** emergency works and recovery operations.

The approach provides an economic, as opposed to financial assessment. For example, residential property damages take account of depreciation of the value of contents (e.g. replacing items like-for-like, as opposed to purchasing new items). Indirect damages to non-residential properties (i.e. loss of business) are generally not included as this is assumed to be displaced to elsewhere within the economy. Vehicle damage is excluded from the Multi-Coloured Manual damage calculation.

Under FCERM guidelines the baseline for damages assessment should be the Do-Nothing case (which assumes a cessation of current maintenance activities),

however this scenario was outside the scope of the SWMP and the Do-Minimum case has been used as the appraisal baseline. We have estimated an initial indication of maximum costs of a likely scheme for flood mitigation works under FCERM for each flooding hotspot. We have assumed a 50-year appraisal period commensurate with the likely design life of the probably intervention measures. In order to assess the impact of potential options we have assumed that they will provide a 2% AEP Standard of Protection (SoP). Consequently the financial appraisal includes the residual damages that are assumed to continue to accrue post-intervention from events of greater severity than the assumed SoP.

3 Flood Risk Summary

3.1 Overview

An assessment of the number of properties (and the associated economic cost) at risk of flooding in Deal has been made using the hydraulic model. The total Present Value (PV) damages under the current situation in Deal are estimated to be £17.4M over 50 years. This is broken down between the hotspots in Table 1.

3.2 Flood Risk

The number of properties predicted to be at risk of flooding in each hotspot is summarised in Table 1.

Table 1: Predicted Flood Risk Summary

Hotspot	Predicted Property Flooding by AEP Event					
	20%	10%	3.3%	2%	1%	0.5%
Risk	**Very Significant**		**Significant**		**Moderate**	**Low**
A –Town Centre (South)	12	17	25	36	53	76
B - Town Centre (South)	19	26	37	44	51	59
C - Church Street	0	4	34	37	37	39
D - Walmer (South)	4	5	8	8	10	13
E - Walmer (North)	3	4	4	4	4	11
F - Lower Walmer	11	16	20	24	26	33
G - North Deal	0	0	0	0	0	0
H - Albert Road	0	0	0	0	0	11
I - Mill Hill	9	11	17	26	38	54
TOTAL	**58**	**83**	**145**	**179**	**219**	**296**

NB: These figures are cumulative and assume a global property threshold of 150mm.

Risk categorisation is based upon the FDGiA Partnership Funding calculator bands[4]. Please note however that the modelled events do not match the FDGiA bandings exactly so a reasonable re-classification has been made. Outcome Measure OM2 for a project funding application is based upon the improvement to flood risk by moving residential properties into a lower risk band. Band classification is summarised in Table 2.

Table 2: FDGiA Flood Risk Bands and Property Risk

Risk	Very Significant	Significant	Moderate	Low
AEP	>= 5%	<=5% but >1.33%	<= 1.33% but >0.5%	<- 0.5%
No.	**83**	**96**	**40**	**77**

[4] http://www.environment-agency.gov.uk/research/planning/33700.aspx

3.3 Flood Hazard

Flood hazard plans have been produced for the 20%, 3.3% and 1% AEP events. Please refer to figures 301 to 303.

Flood hazard has been calculated by the methodology contained within the Defra Guidance: Flood Risk Assessment Guidance for New Development; FD2321/TR2.

The degree of flood hazard provides a guide of the risk to people from a combination of predicted flood depth and velocity. A 'Debris Factor' is added to the calculation to account for the additional hazard posed by floating debris.

A summary of the flood hazard classifications and their description is included in Table 3.

Table 3: Flood Hazard Classification

Classification	Degree of hazard	Description
Low	Caution	Flood Zone with shallow flowing or deep standing water
Moderate	Dangerous for some (i.e. children)	Danger: flood zone with deep or fast flowing water
Significant	Dangerous for most	Danger: flood zone with deep fast flowing water
Extreme	Dangerous for all	Extreme danger: flood zone with deep fast flowing water

Based on FD2321/TR2 Table 4.2

The areas at greatest hazard (e.g. 'Significant' hazard under a 20% AEP event) are in Walmer, Dover Road and Liverpool Road. Church Street in Upper Walmer and Mildale in Mill Hill.

3.4 Hotspot Overview

This section provides a brief summary of flood risk in each hotspot. More detailed information may be found in Appendices A to G.

3.4.1 Hotspots A & B – High Street

Hotspots A and B are located in the centre of Deal Town. The model predicts 'Very Significant' flooding at this location, with 31 properties at risk from a 20% AEP event. Flooding results from exceedance of the surface water drainage capacity combined with ponding of direct rainfall which cannot escape as land rises towards the sea wall, trapping flooding in this low-lying area. There are a number of basement properties in this area that could give rise to a potentially dangerous situation without adequate warning. Predicted flooding is confirmed by flooding records, particularly in August 2010.

3.4.2 Hotspot C – Church Street

Properties in Church Street are at risk of flooding from exceedance of the capacity of the public surface water sewer which drains the area. Four properties are predicted to flood during a 10% AEP event. These properties are located in a local depression and flood water cannot escape overland due to the presence of a stone wall. Flooding has been observed at this location confirming the prediction of flooding.

3.4.3 Hotspots D & E – Walmer

Flooding in Hotspot D results from exceedance of the surface water drainage network serving the area, with the properties at greatest risk predominantly located at the lowest point in the area. There are also properties at risk of flooding on Dover Road as a result of exceedance of the capacity of the surface water drainage network.

Flooding in Hotspot E is as a result of overland flow from the chalk valley to the South, with overland flow along Liverpool Road towards Walmer Castle. Highway

flooding was reported along this road in August 2010. The model estimates that three properties are at 'Very Significant' risk of flooding (>=20% AEP event).

3.4.4 Hotspot F – Lower Walmer

Flooding in Lower Walmer occurs as a result of the exceedance of the capacity of the surface water drainage network resulting in localised ponding in this urban area. The model predicts eleven properties at 'Very Significant' risk of flooding (>= 20% AEP).There are a number of properties in this area with basements which could lead to a risk to life.

3.4.5 Hotspot G – North Deal

The model predicts a flow path northwards along Church Lane to this location; however it does not predict any existing property to be at risk. Planning proposals have been discussed to re-develop the industrial estate which is directly in the line of the overland flow path. Flooding was recorded in this area in August 2010.

3.4.6 Hotspot H – Albert Road

The model predicts limited flooding at this location, however flooding has been recorded twice in four years. Consequently it is possible that the model is under predicting the degree of flood risk, it currently estimates properties are only at risk from a 0.5% AEP event upwards.

3.4.7 Hotspot I – Mill Hill

The model predicts 'very significant' flood risk to properties in Mildale Close (nine properties at risk from a 20% AEP event). The Close is in a localised depression which receives flow from an overland flow path along Dover Road. Flooding has been recorded in this area although not specifically in Mildale Close.

3.5 Economics

Based on the estimate of flood risk, the property damages in each hotspot over a 50-year appraisal period have been calculated. Using this assessment of damages we have estimated the maximum amount that could be spent to deliver financially viable flood mitigation measures at each of the hotspots. The results are included in Table 4.

Table 4: Summary of Estimated Damages (£k)

Hotspot	PV Damages	Residual Damages	Damage Avoided	BCR	Maintenance Estimate	Scheme Maximum Cost
A	1,682	668	1,015	1	123	892
B	2,268	643	1,625	1	123	1,502
C	456	181	276	1	123	153
D	1,248	350	898	1	123	775
E	452	109	343	1	123	220
F	1,450	396	1,054	1	123	931
G				N/A		
H	15	15		N/A		
I	1,856	598	1,259	1	123	1,136

PV Damages were calculated based upon the flood extents generated by the hydraulic modelling. The methodology is detailed in Section 2.6. The residual

damages are those that continue to occur, post-intervention, from events more severe than the SoP (i.e. those events more severe than a 2% AEP event). Subtracting these from the PV damages, produces the damages the intervention avoids (or the Benefits of the option). A Cost-Benefit Ratio (CBR) of 1 is the minimum threshold required to achieve a financially viable scheme. (Ideally the BCR would be maximised and further option appraisal and design would attempt to maximise the benefits of the intervention or reduce costs attain a CBR greater than 1.) We have subtracted from the damages avoided assumed maintenance costs over the 50-year appraisal period (assumed to be £5k per annum in each hotspot area). This produces the final figure which is the maximum cost (over 50 years) of the mitigation measures that can be financially justified under FCERM for each hotspot i.e. what can be spent on mitigating the flood risk in each hotspot.

Damages are effectively zero in hotspots G and H due to a lack of flooding. These areas have however been highlighted because there are extensive development plans for these locations.

3.5.1 Assumptions

A number of assumptions were made in estimating the FDGiA funding available for flood mitigation works for each hotspot as follows:

- A Do-Nothing run has not been undertaken as it was outside the project scope, therefore it has been assumed that the current situation / Do-Minimum result provides sufficient benefit to be viable (i.e. has a Benefit-Cost ratio in excess of 3 against the Do-Nothing run as would be required under FCERM guidance);
- Residual damages for the post-scheme runs have been based on the existing damages from the 2% event upwards. This is a simplification and also takes no account of improvement to residual damages provided by a scheme;
- We have assumed that as the Do-Minimum event is viable the Benefit-Cost ratio to the next option only needs to be above 1;
- We have assumed that the mitigation measures are individually viable (i.e. have a BCR of at least three against the Do-Nothing run);
- The proposed measures will provide a 2% AEP SoP, consequently there will be no damages from more frequent events, this is a simplification but is commensurate with the level of confidence in the final estimate;
- We have assumed a maintenance cost of £5k per annum for DDC, KCC, EA and SW for each hotspot which converts to a present value of approximately £123k across the 50-year appraisal period.

4 Action Plan

4.1 Generic and Location-specific Actions

Based on the work summarised in previous Sections, the Outline Action Plan presented in Table 5 and Table 6 and presents the list of the most viable options to manage the risk of surface water flooding, for the long-term benefit of Deal. Table 5 lists the options which could be implemented generically across the area and Table 6 lists the location-specific options which are illustrated in Figure 401. Both tables provide the following information:

- **Where?** For location-specific options, the location.
- **What?** The description of the option.
- **How?** The suggested approach to implementing the option, including any identified priority actions.
- **Who?** The partner organisation which is best placed to lead implementation.
- **When?** An indication of the timescales within which the option is suggested to be implemented:
- Priority 1: A 'quick win' or action urgently required within 12 months
- Priority 2: Consider now for implementation in the next 1-5 years
- Priority 3: Consider now for longer term implementation (5 years+)
- Priority O: Consider implementing if opportunity arises
- This priority therefore balances the degree of flood risk with the likely required timescale for implementation.
- **Multi-Criteria Appraisal:** For location-specific options we have provided an outline appraisal of the key Technical, Economic, Social and Environmental constraints in delivering the identified option.

Ideas for funding opportunities are provided in Section 4.3. The location-specific options are indicated in Figure 401. Each option has been appraised against the following criteria:

- Technical feasibility
- Economic cost (see Section 3.4)
- Social impact – what benefits aside from flood mitigation will the option provide
- Environmental– What constraints are there to the proposed option

The generic options presented in Table 5 were developed as part of the Dover SWMP project. However given the similar urban nature of Deal surrounded by Chalk geology and the geographical proximity these remain valid for Deal. These could be combined with those of the Dover SWMP as generic Dover DC-wide options.

Table 5: Generic flood Mitigation Measures

Generic Option ('What?')	Priority Actions ('How?)	Primary Action Owners ('Who?')[1]	Priority ('When?')[2]
Develop and implement a targeted maintenance schedule KCC, EA and SW should develop and implement a targeted maintenance schedule so that the highway gullies, drains and other drainage assets (including SuDS) operate effectively to their design capacity.	1. Partners to develop a maintenance schedule using information in the SWMP (areas at high risk of flooding, natural flow routes).	• KCC • EA • SW	1
	2. Communicate coordinated maintenance activities with the public to manage expectations.	• KCC • DDC	2
Raise awareness of surface water flood risk Raise awareness of surface water flood risk within DDC and with the wider public, particularly focussing on basement properties. Link with encouraging use of rainwater harvesting, rain gardens and other source control measures, as well as uptake of property level resistance and resilience measures. Improved recording of flood events will benefit future funding applications.	1. Brief DDC (and KCC) council teams (particularly Development Management officers) on surface water flood risk using SWMP materials 2. Using information in this SWMP, maintain a list of properties with basements and target owners for awareness raising and guidance on resistance/resilience measures.	• DDC • KCC	1
	3. EA and DDC to work jointly to provide guidance and, where possible, to enforce policy of not paving over front gardens with impermeable material.	• DDC • EA	1
Explore options for DDC planning policy with respect to flood risk (including use of SuDS) Adopt a map indicating natural drainage routes which future development should respect. Development should also respect local landform to ensure sufficient property thresholds. Adopt a map indicating the suitability of locations for appropriate SuDS. Where appropriate, develop Supplementary Planning Documents (SPDs) to encourage developers of a particular site to contribute to flood risk management of the wider area.	1. EA, DDC and KCC to agree that the SWMP material can be used in response to planning applications and to develop policy. DDC to consider making the SWMP a material consideration. 2. Brief DDC council teams on natural drainage routes and suitability of locations for appropriate SuDS using simplified maps	• DDC • EA • KCC	1
	3. Promote use of appropriate SuDS through enhancing council policy (currently DM17) using information in the SWMP 4. Investigate feasibility of developing SPDs which can inform applications for redevelopment of strategic sites. Link drainage targets with seeking multiple benefits.	• DDC	2
Explore options for KCC policy for highways to be used as exceedance routes Develop policies to permit temporary routing of surface flow along roads, using traffic calming as required.	1. Develop KCC policy regarding use of roads for temporary flow routing, using traffic calming as required. Also consider shallow storage in lowered roundabouts and use of green street planters for kerb-side drainage.	• KCC	2
Misconnections and surface water sewer interruption SW (with council support) should proactively seek to rectify misconnections. SW should develop a policy (in conjunction with other Partners) which could permit schemes to interrupt surface water sewers to provide overground attenuation and storage in extreme events. Individual schemes would still need to be justified.	1. SW (supported by DDC) to proactively identify/rectify misconnections between the foul and surface water sewers 2. SW to develop policy of sewer interruption based on discussions with Ofwat and other providers	• SW • DDC	2

Notes: [1] *EA – Environment Agency; DDC – Dover District Council; KCC – Kent County Council; SW – Southern Water*
[2] *Priority 1: A 'quick win' or action urgently required within 12 months; Priority 2: Consider now for implementation in the next 1-5 years; Priority 3: Consider now for longer term implementation (5 years+); Priority O: Consider implementing if opportunity arises*

Table 6: Location-specific Flood Mitigation Options

Area	Option[1] Location ('Where?')	Location-specific Option ('What?')	Priority Actions ('How?')	Primary Action Owners ('Who?')[2]	Technical	Economic	Social	Environmental
Town Centre	**AB01**	New sea outfall	Construct new sea outfall to increase conveyance from flood affected area	DDC	Delivery: Construction in busiest area and congestion of services in town centre streets	Delivery: Potentially expensive Benefits: Reduced flood damages	Delivery: Potential for business disruption during construction Benefits: Reduced disruption and nuisance	Delivery: Risk of contaminated floodwater pumped to sea, requires discharge consent Benefits: Reduced risk of cross-contaimation with foul network. Less sediment requiring clean-up
	AB02	Sewer separation	Construct new surface water sewer to increase capacity	SW DDC	Delivery: Requires sewer to be laid in street likely to be congested with services	Delivery: Requires SW support and funding Benefits: Reduces SW pumping and treatment costs	Delivery: Construction in busy street Benefits: Reduced risk of contaminated flood waters	Delivery: Reduces risk of contamination of flood flows Benefits: Lower contamination risk
	AB03	Temporary pumping equipment	Install facility for temporary pumping during flood events e.g. permanent sump with equipment	DDC	Delivery: Identify optimum location of permanent sump Identify 'owner' of pumping equipment and storage	Delivery: A transferable asset which could be used in other locations Benefits: Requires commitment to ongoing support and replacement iin longer-term	Delivery: Minimal disruption required for installation Benefits: Reduces flood risk	Delivery: Discharge of contaminated floodwater directly to the sea
	AB04	Individual Property Protection	IPP for key properties at risk	DDC	Delivery: Requires householder buy-in	Delivery: Relatively low cost Benefits: Reduced flood damage for more frequent events	Delivery: Property owners can view measures negatively Benefits: Direct benefit to householders	Delivery: No discernable impact Benefits: None
Church Street	**C01**	Roadside verge runoff storage	Provide storage for overland flow in roadside verges	KCC	Delivery: Minor modifications required. Requires services search can complicate proposals	Delivery: Could be undertaken as part of highway maintenance works High cost Benefits Reduced flood damages	Delivery: None Benefits Encourage 'ownership' and interest amongst local residents	Delivery: Potential for perceived as short-term loss of amenity during construction Benefits Potential improvements if well designed and maintained
	C02	Soakaways 1	New soakaways in grounds of Walmer College	DCC KCC	Delivery: Confirmation of infiltration capacity	Delivery: Costs could be reasonable Limited space Benefits: Reduced flood damages	Delivery: Agreement with college Benefits Reduced non-tangible impact of flooding, stress etc	Delivery Discharge of potentially contaminated runoff to ground - potential to 'polish' through swale Benefits: None
	C03	Soakaways 2	New soakaway to take flows from ponding on highway	DCC KCC	Delivery: Requires land - limited space in region of low point	Delivery: Costs could be reasonable Limited space Benefits: Reduced flood damages	Delivery: No discernable impact Benefits: Reduced non-tangible impact of flooding, stress etc	Delivery: Discharge of potentially contaminated runoff to ground Benefits: None

Area	Option[1] Location ('Where?')	Location-specific Option ('What?')	Priority Actions ('How?')	Primary Action Owners ('Who?')[2]	Technical	Economic	Social	Environmental
	C04	Seal Gullies	Seal gullies to prevent egress of flooding from public sewer, provide soakaways to store exceedance flow	KCC SW	Delivery: Will require exceedance management in place first. Confirmation of impact upon other parties on drainage network	Delivery: Low cost Benefits: Reduced flood damages	Delivery: Potential to pass on problem to others Benefits: Reduced non-tangible impact of flooding, stress etc	No discernable impact
	C05	Pumping	Additional pumping capacity to convey flows to sewer in London Road	DDC SW	Delivery: Modifications to public sewer network require SW acceptance	Delivery: If permanent measure then costs could be high Benefits: Reduced flood damages	No discernable impact	No discernable impact
Walmer	**D01**	Kerb raising	Modify kerbs along Liverpool Road to retain overland flow path	KCC	Delivery: Ephemeral flow path - requires confirmation	Delivery: Costs could be reasonable Benefits: Reduced flood damages	Delivery: May require re-siting of dropped kerbs which could impede access Benefits: None	No discernable impact
	D02	Tanking	Tanking of properties to protect against potential groundwater flooding	DDC	Delivery: Groundwater flood risk to be confirmed	Delivery: Potentially expensive for properties protected Benefits: Reduced flood damages	Delivery: Requires acceptance of residents	No discernable impact
	E01	Offline storage	Offline storage from the surface water sewer at Marke Wood Recreation Ground	DDC SW	Delivery: Bunding may be required	Delivery: Potentially expensive	Delivery: Requires acceptance of local users – recreation ground will be occasionally unavailable	Potential clean-up costs of contaminated runoff
	E02	Flow re-direction	Re-direct flows in the Dover Road sewer to Granville Road sewer	SW	Delivery: Confirmation of capacity in sewer and sea outfall	Delivery: Potentially expensive Benefits: Reduced flood damages	No discernable impact	Delivery: Increased risk of discharge of contaminated runoff (heavy metals) to sea as discharging larger area into this outfall which currently has a small catchment Benefits: None
Lower Walmer	**F01**	New sea outfall	Increase drainage network capacity via new sea outfall	SW	Delivery: Construction in busy area	Delivery: Potentially expensive Benefits: Reduced flood damages	Delivery: Potential for disruption during construction Benefits: Reduced flooding disruption	Delivery: Risk of contaminated floodwater pumped to sea, requires discharge consent Benefits: None.
	F02	Local Bunding	Local bunding in Havelock Street to protect properties	DDC	Delivery: Requires property survey to confirm scope of works	Delivery: Costs could be reasonable Benefits: Reduced flood damages	Delivery: May need to consider access to properties Inconvenience Benefits: Reduced flooding disruption	No discernable impact
	F03	Individual Property Protection	IPP to protect properties at risk in Havelock Street	DDC	Delivery: Requires householder buy-in Requires property survey to confirm scope of works	Delivery: Relatively low cost Benefits Reduced flood damages	Delivery: Property owners can view measures negatively Benefits: Reduced flooding disruption	No discernable impact

Area	Option[1] Location ('Where?')	Location-specific Option ('What?')	Priority Actions ('How?')	Primary Action Owners ('Who?')[2]	Technical	Economic	Social	Environmental
North Deal	**G01**	Upstream storage	Offline attenuation storage at Church Lane / Southwall Road to reduce flows through industrial estate	DDC KCC	Delivery: Need to confirm scale of downstream impact	Delivery: Potentially expensive Benefits: Reduced flood damages	Delivery: Requires use of sports ground Benefits: Reduced flooding disruption	Delivery: Potential contaminated runoff to public area Benefits: Potential to introduce habitat
Albert Road	**H01**	Attenuation storage	Kerb raising and other measures to retain overland flow on highway	KCC	Delivery: Could be undertaken as part of maintenance works	Delivery: Costs could be reasonable Benefits: Reduced flood damages	Delivery: Increased disruption to traffic Benefits: Reduced flooding disruption	No discernable impact
	H02	Additional storage	Construct below-ground storage to receive flow from the drainage network	SW	Delivery: Connected to surface water sewers	Delivery: Likely to be expensive Benefits: Reduced flood damages	Delivery: Disruption during construction Benefits: Reduced flooding disruption	No discernable impact
Mill Hill	**I01**	Offline Storage	Intercept Mill Road overland flow path and re-direct to Fremman's Way Playing Field	DDC KCC	Delivery: Need to confirm viable hydraulic connection into storage area	Delivery: Potentially expensive Benefits: Reduced flood damages	Delivery: Acceptance of users of playing field required Benefits: Reduced flooding disruption	Delivery: Potential for contaminated runoff in public open space - clean up required Benefits: Could be incorporated into habitat creation scheme
	I02	Raised Kerbs	Raised kerbs to retain overland flow on the highway	KCC	Delivery: Will need to maintain access to properties	Delivery: Costs could be reasonable - undertaken as part of maintenance works Benefits: Reduced flood damages	Delivery: May require re-siting of dropped kerbs which could impede access Benefits: Reduced flooding disruption	No discernable impact
	I03	Offline Storage	Re-direct exceedance flow from the drainage network to the recreation ground to attenuate flows and allow to infiltrate	DDC	Delivery: Need to confirm viable hydraulic connection into storage area	Delivery: Potentially expensive Benefits: Reduced flood damages	Delivery: Acceptance of users of recreation ground required Benefits: Reduced flooding disruption	Delivery: Potential for contaminated runoff in public open space - clean up required Benefits: Potential to incorporate habitat creation

4.2 Implementation and Review

Improved and sustainable management of surface water flooding is unlikely to arise through implementation of some of the proposed options alone. Instead, the overall philosophy developed through the SWMP study is for *incremental* change which *takes advantage of opportunities* as they arise to implement options which *cumulatively* have the effect of better managing flood risk. Therefore, all options should be kept in mind by the key DDC, KCC, EA and SW teams and their potential reviewed on a regular basis. To this end, it is **strongly recommended that the SWMP Partnership continues to meet bi-annually** (in the first instance) to review the progress of implementing the options and identify further opportunities. An ongoing forum may be best facilitated by KCC in its Lead Local Flood Authority role. Box 4 highlights some similar key messages which have been developed throughout the SWMP study. It is **recommended that these key messages are considered alongside the options** in Table 5 or Table 6.

4.3 Funding Opportunities

The following streams may provide opportunities to fund implementation of the options:

- **Kent County Council:** Limited budget to promote schemes. FDGiA funding would be required.
- **Local Levy (Environment Agency):** The EA administers this source of funding which is raised by way of a levy on the county councils and unitary authorities within the Southern Regional Flood and Coastal Committee boundary. The local levy is used to support, with the approval of the relevant committee, flood risk management projects that are not considered to be national priorities and hence do not attract national funding through Flood Defence Grant in Aid (see next). The local levy allows locally important projects to go ahead to reduce the risk of flooding within the committee area.
- **Environment Agency/Defra Flood Defence Grant-in-Aid (FDGiA) funding**: The EA administers Flood Defence Grant in Aid (FDGiA) which is government funding for delivering flood risk management schemes. Projects arising from flooding from ordinary watercourses, surface runoff, or from groundwater, are now eligible, although those arising from flooding from sewerage systems are not (which are paid for by the water company). To allocate FDGiA funding, the EA collates and appraises applications on an annual basis. From 2012/13 onwards, each scheme will be able to receive a grant, based on the outcomes it will deliver. If this not sufficient to deliver the scheme then cost savings will have to be found and/or local contributions to proceed.
- **Developer's Section 106 contribution / Community Infrastructure Levy (CIL):** When new development occurs within Deal, a levy can be charged by the council which is designed to cover the cost of new public facilities required as a result of the development. Any larger strategic developments proposed within Deal have the potential to generate Section 106 / Community Infrastructure Levy (CIL) funds which could be used to contribute to some of the options proposed in this SWMP and especially those which will have multiple benefits, e.g. ponds or wetlands which can receive surface water as well as providing improved amenity value.

- **Southern Water - Investment Plan 2010 – 2015:** By 2015, SW has committed to reduce flooding to around 80 properties on its 'risk register' which have flooded internally and around 90 which have flooded externally at least once every twenty years. For SW to consider implementing a scheme to reduce flooding, the cause must be related to the hydraulic inadequacy of the public sewerage system. SW works within a framework of cost and benefit so that where solution options do not meet specific criteria for affordability or benefit they do not proceed and more local measures (e.g. property resistance/resilience) may be considered. Working with the councils and the EA to implement some of the schemes proposed in this SWMP may be more cost-beneficial than, for example, enlarging the sewers. However, SW investment in any scheme will have to be justified by the severity and frequency of sewer flooding and must be agreed with Ofwat at the start of the next five year period (2016 - 2020). Reporting sewer flooding to SW is therefore crucial to seeking future investment.

5 Conclusions and Recommendations

5.1 Flood Risk

The hydraulic model developed as part of the SWMP has been used to identify flood risk and flood hazards within Deal. The outputs of the model have been verified against recorded flooding.

Key flooding locations have been identified based upon flood risk to properties and flood hazard. These are listed in Table 1 and more detail is provided in Appendices A to G.

Based upon FCERM classifications of flood risk, 83 residential and commercial properties within Deal are a 'Very Significant' risk of flooding and 96 at 'Significant' risk. We have estimated the flooding damages within Deal over a 50-year timeframe as approximately £17.4M.

5.2 Option Appraisal

Generic and location-specific flood mitigation options have been identified and appraised for each of the flooding hotspots. These are summarised in Table 6 and Table 7 respectively.

The appraisal process has provided an indication of the key constraints for each location-specific option. We have also identified potential sources of flooding for the options. We have included a high-level assessment of the maximum cost of a financially viable scheme over a 50-year period for each hotspot. Key assumptions have been made to estimate this, which are summarised in Section 3.5.1.

5.3 Recommendations

The following recommendations are made to progress the mitigation of flood risk within Deal:

- The SWMP partners: DCC, DTC, KCC, EA and SW should review and agree the outline action plan included in the SWMP;
- The options identified should be appraised further (including hydraulic modelling) to confirm their viability and subsequently the action plan updated;
- Generic options could be combined with those from the DDC SWMP as a DC-wide list.