Somerset County Council

Minehead Surface Water Management Plan

Detailed Assessment and Options Appraisal Report

Final

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Glossary	
ArcView	Software package used for spatial mapping and analysis of data
Annual Exceedance Probability	Annual chance of an event (rain storm) of a given magnitude occurring in any given year e.g. 1% AEP has a 1 in 100 annual chance of occurring in any given year.
Area Action Plan	An optional Development Plan Document forming part of a Local Development Framework. It is aimed at establishing a set of proposals and policies for the development of a specific area, such as an urban extension.
Areas Susceptible to Surface Water Flooding (AStSWF)	Environment Agency produced maps showing the outputs of simple surface water flood modelling at a national scale.
Aquifer	Layer of water-bearing permeable rock, sand, or gravel which is capable of providing significant amounts of water.
Awarded Watercourse	Ordinary watercourses that have been awarded to the respective Local Authority by the Enclosure Acts, such that the Local Authority is responsible for the maintenance of the public drain or watercourse.
Catchment Flood Management Plan	Strategic planning tool through which the Environment Agency works with other key decision-makers within a river catchment to identify and agree policies for sustainable flood risk management.
Combined Sewer Overflow	Discharge, during rain storms, of untreated wastewater from a combined sewerage system; diluted sewage is forced to overflow into streams and rivers through CSO outfalls.
Combined Sewer System	Sewer system that carries both sewage and storm water
Community Strategy	Overarching documents, which promote a long term vision for improving the economic, environmental and social wellbeing of an area.
Critical Drainage Area	Defined in the Town and Country Planning act as an area within Flood Zone 1 which has critical drainage problems and which has been notified… [to]…the local planning authority by the Environment Agency
Defacto Defences	Non flood defence infrastructure that can act as flood defence infrastructure e.g. road/rail embankments
DG5 Register	Register of sewer flooding maintained by a sewerage undertaker
Digital Terrain Model	A graphical representation of the Earth's surface with trees, buildings etc removed.
Exception Test	When a development type is not compatible with flood risk in a particular location, the exception test may be applied if there are valid reasons as to why the development should proceed.
Flood and Water Management Act (2010)	Act which aims to improve both flood risk management and the way in which water resources are managed by creating clearer roles and responsibilities and instilling a more risk based approach. The Floods Directive was transposed into UK law by the Flood Risk Regulations 2009. It places duties on the Environment Agency and local authorities to prepare flood risk assessments, flood risk maps and flood risk management plans.
Flood Estimation Handbook	Produced by the Natural Environment Research Council, this provides guidance on rainfall and river flood frequency estimation in the UK.
Flood Maps for Surface Water	An update to the Environment Agency's AStSWF maps, taking account of buildings and the underground drainage system.

Flood Risk Management	Use of a wide range of techniques including hard engineering, development management and education to manage flood risk
Flood Risk Regulations 2009	The Flood Risk Regulations transpose the EU Floods Directive 2007/60/EC into UK law and were introduced on 10 December 2009
Flood Zones	These are a national data set held by the Environment Agency and show the predicted probability of flooding for any given area. They were created following Defra's Making Space for Water pilot study. This was a Government programme that sought to take forward the developing strategy for flood and coastal erosion risk management in England.
Flood Zone 1	Low probability of flooding: Land assessed as having a less than 1-in-1000 year annual probability of river or sea flooding in any given year, as defined fully in National Planning Policy Framework table 1.
Flood Zone 2	Medium probability of flooding: Land assessed as having between a 1-in-100 and 1-in-1000 year annual probability of river flooding or between a 1-in-200 year and 1-in-1000 year annual probability of sea flooding in any given year, as defined fully in National Planning Policy Framework table 1.
Flood Zone 3a	High probability of flooding: Land assessed as having a 1-in-100 year or greater annual average probability of river flooding or greater than 1-in-200 year annual average probability of sea flooding, as defined fully in National Planning Policy Framework table 1.
Flood Zone 3b (Functional Flood Zone)	Land where water has to flow or be stored in times of flood. Local planning authorities have identified areas of functional floodplain, in agreement with the Environment Agency. The identification of functional floodplain takes account of local circumstances and is not defined solely on rigid probability parameters, but land which would flood with an annual probability of 5% AEP (1 in 20 chance of occurrence) or greater in any year, or is designed to flood in an extreme (0.1%) flood, provides a starting point to identify the functional floodplain, as defined fully in National Planning Policy Framework table 1.
Flow to Full Treatment	This is the maximum flow that a Wastewater Treatment Works can effectively treat before excess flows spill to the storm tanks.
Green Roofs	Vegetated roofs, or roofs with vegetated spaces having a wide range of environmental, social and economic benefits.
Greywater	Wastewater generated from domestic activities such as dish washing, laundry and bathing
Habitat Regulations Assessment	Assessment of whether a particular plan or strategy will impact on a European Site. A European Site is any classified SPA, SAC, potential SPA, candidate SAC or listed Ramsar Site.
Hyetograph	A graphical representation of the distribution of rainfall over time
InfoWorks Model	Computer software used to simulate flow through the sewer system in order to identify and solve issues
Integrated Urban Drainage	Philosophy which considers all aspects of urban drainage (surface water, foul water, fluvial flows) in conjunction with one another in order to improve surface water management.

Internal Drainage Boards	Drainage districts have been established in the most drainage sensitive parts of the country; low lying areas constantly at risk from flooding. Drainage boards are responsible for the improvement and maintenance of rivers, drainage channels and pumping stations, as well as consenting, planning advice, adopting SuDS, and emergency response within their Districts.
Lead Local Flood Authority (LLFA)	Lead Local Flood Authorities are unitary authorities or county councils, and were created as part of the Flood and Water Management Act. They are responsible for leading the co-ordination of flood risk management in their areas, but can delegate flood or coastal erosion functions to another risk management authority by agreement.
Local Area Agreements (LAA)	Local Area Agreements set out the priorities for a local area agreed between central government and a local area (the local authority and Local Strategic Partnership) and other key partners at the local level. LAAs simplify some central funding, help join up public services more effectively and allow greater flexibility for local solutions to local circumstances.
Local Development Framework	A portfolio of Local Development Documents which provides the framework for delivering the spatial planning strategy for the area.
Local development scheme	Plan detailing how all parts of the local development framework will come together; listing the documents to be produced and the timetable for producing them. A local development scheme must be approved by the secretary of state.
Local Plan	Sets out detailed policies and specific proposals for the development and use of land in a district and guides most day-to-day planning decisions. Local development frameworks will gradually replace local plans over the coming years.
Main River	Main Rivers are usually larger streams and rivers, but also include smaller watercourses of strategic drainage importance. A main river is defined as a watercourse shown as such on a main river map, and can include any structure or appliance for controlling or regulating the flow of water in, into or out of a main river. The Environment Agency's powers to carry out flood defence works apply to main rivers only. Main rivers are designated by the Department of Environment, Food and Rural affairs.
Making Space for Water	Government strategy for flood and coastal erosion risk management in England
MapInfo	Software for spatial mapping and data analysis
Multi-Coloured Manual	Common name for the Flood Hazard Research Centre's publication "The Benefits of Flood and Coastal Risk Management: A Handbook of Assessment Techniques"
National Flood and Coastal Defence Database	Definitive database for all data on flood and coastal defence assets held by the EA in England and Wales. Use in analysis and decision making on defence investments to help the Government prioritise expenditure for high-risk areas.
National Planning Policy Framework (NPPF)	Sets out Government policy on development and flood risk to ensure that flood risk is taken into account at all stages in the planning process, to avoid inappropriate development in areas at risk of flooding, and to direct development away from areas of highest risk.
Ordinary Watercourses	An ordinary watercourse is every river, stream, ditch, drain, cut, dyke, sluice, sewer (other than a public sewer) and passage through which water flows which does not form part of a Main river as defined by the Environment Agency (EA). These are generally maintained by local authorities and internal drainage boards. Ordinary Watercourses are now regulated by LLFA.

Pitt Review	Report into the summer 2007 flooding. The report examines both how to reduce the risk and impact of floods, and the emergency response to the floods in June and July 2007. The report made 92 recommendations to be addressed by Government.
Preliminary Flood Risk Assessment (PFRA)	Requirement under the EU Floods Directive / Flood Risk Regulations. The LLFA must complete a preliminary assessment report on past and future flood risk, and identify significant flood risk areas using national datasets.
Ramsar Site	Wetlands of international importance designated under the Ramsar Convention (Convention on Wetlands of International Importance especially as Waterfowl Habitat) of 1971
Revitalised Flood Extent (ReFH)	Runoff model developed to model flood events. Update to existing FEH runoff model.
Regional Flood and Coastal Committee (RFCC)	RFCC's have replaced Regional Flood Defence Committees following the Flood and Water Management Act. They consult with the EA to help develop flood risk management solutions, as well as providing advice on community engagement, coastal erosion, incident management and emergency planning within their regions. They also have responsibility for raising local levies and providing an accountable forum for testing new ideas and ways of working.
River Basin Management Plan	Outline the management of the water environment, provide a framework for more detailed decision making and provide a summary of the programmes of measures required for the River Basin District to achieve Water Framework Directive objectives.
Riparian Owner	Anyone owning property or land adjoining a watercourse. Riparian Owners have various rights and responsibilities recognised under common law.
Section 106 Agreement	Section 106 of the Town and Country Planning Act 1990 allows a local planning authority to enter into a legally binding agreement or planning obligation with a landowner in association with the granting of planning permission. These agreements are a way of delivering or addressing matters that are necessary to make a development acceptable in planning terms.
Separate Sewer System	Sewer system where surface water (rainfall) is kept separate from foul flows
Sequential Test	A planning principle that seeks to identify, allocate or develop land in low flood risk zones before land in high flood risk zones.
Source Protection Zone	Zones defined by the EA for 2000 groundwater sources (wells, boreholes and springs used for public drinking water supply) showing the risk of contamination from any activities that might cause pollution in the area.
Stakeholders	Individuals and organizations that are actively involved in a project, or whose interests may be affected as a result of the project's execution
Strategic Flood Risk Assessment	An approach to assessing flood risk which enables Local Planning Authorities to apply the Sequential Test to land allocations
Surface Water Management Plan	Framework through which key local partners with responsibility for surface water and drainage 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
Sustainability Appraisal	Assessment of the environmental, social and economic effects of a plan and appraisal in relation to the aims of sustainable development.
Sustainable Development	Development which meets the needs of the present generation without compromising the ability of future generations to meet their own needs.
Sustainable Drainage Systems	An approach to managing rainwater failing on roofs and other surfaces through a sequence of actions and measures, that manages the flow rate and volume or surface runoff to reduce the risk of flooding and protect and improve water quality.

TUFLOW	TUFLOW is one-dimensional (1D) and two-dimensional (2D) flood and tide simulation software. It simulates the complex hydrodynamics of floods and tides using the full 1D St Venant equations and the full 2D free-surface shallow water equations.
UK Climate Impacts Programme	UKCIP publishes climate change scenarios on behalf of the Government showing how the UK's climate might change in this century. The UKCIP02 climate change scenarios are widely used in research into the impacts of climate change
Unitary Authority	A single tier local authority responsible for all local government functions within its area.
Urban Extension	Planned expansion of a city or town
Water Cycle	The continuous movement of water on, above, and below the surface of the Earth. The urban water cycle is the movement of water through the urban environment, through pipes, rivers
Water Cycle Strategy	Plan for new development in a holistic manner to ensure the sustainable and timely provision of necessary water services infrastructure
Water Framework Directive	EC water legislation designed to improve and integrate the way water bodies are managed throughout Europe It came into force on 22 December 2000. Member States must aim to reach good chemical and ecological status in inland and coastal waters by 2015.
Zero Carbon Development	A development that achieves zero net carbon emissions from energy use on site, on an annual basis.

AA	Appropriate Assessment
AAP	Area Action Plan
ABI	Association of British Insurers
AEP	Annual Exceedance Probability
AStSWF	Areas Susceptible to Surface Water Flooding
BGS	British Geological Society
CFMP	Catchment Flood Management Plan
CIRIA	Construction Industry Research and Information Association
CLG	Communities and Local Government
CSO	Combined Sewer Overflow
CWS	County Wildlife Site
DAP	Drainage Area Plan
DDF	Depth Duration Frequency
DEFRA	Department for Environment, Food and Rural Affairs
DPD	Development Plan Document
DTM	Digital Terrain Model
EA	Environment Agency
EVY	Edenvale Young Associates Ltd
FEH	Flood Estimation Handbook
FMfSW	Flood Maps for Surface Water
FRA	Flood Risk Assessment
FRM	Flood Risk Management
FRR	Flood Risk Regulations
GIS	Geographical Information Systems
Hyder	Hyder Consulting (UK) Limited
HRA	Habitat Regulations Assessment
IDB	Internal Drainage Board
IUD	Integrated Urban Drainage
LDD	Local Development Documents
LDF	Local Development Framework
LiDAR	Light Detecting And Ranging
LPA	Local Planning Authority
MCM	Multi-Coloured Manual
NFCDD	National Flood Coastal Defence Database
NNR	National Nature Reserve

NPPF	National Planning Policy Framework
PE	Population Equivalent
RBD	River Basin District
RBMP	River Basin Management Plan
ReFH	Revitalised Flood Hydrograph
SAC	Special Area of Conservation
SCC	Somerset County Council
SFRA	Strategic Flood Risk Assessment
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
SPG	Supplementary Planning Guidance
SPS	Sewage Pumping Station
SPZ	Source Protection Zone
SuDS	Sustainable Drainage Systems
SWMP	Surface Water Management Plan
UKCIP	UK Climate Impacts Programme
WFD	Water Framework Directive
WSC	West Somerset Council
WTW	Water Treatment Works
WwTW	Wastewater Treatment Works
WW	Wessex Water Services Limited

1 Introduction

1.1 Terms of Reference

Hyder Consulting (UK) Limited (Hyder) was appointed by Somerset County Council (SCC) to produce a Surface Water Management Plan (SWMP) for Minehead. This detailed SWMP is formed from the outputs of all the stages of the study, from a strategic assessment of the overall study area through to optioneering of the prioritised Wetspots. The options assessed at this stage provide a theoretical assessment of how best to mitigate against flood risk in the Wetspots. This provides an analysis of where investment could be directed in the future if finance is available.

1.2 What is a Surface Water Management Plan

A Surface Water Management Plan (SWMP) is a plan which outlines the preferred surface water management strategy in a given location. In this context surface water flooding describes flooding from sewers, drains, groundwater, and runoff from land, small water courses and ditches that occurs as a result of heavy rainfall.

This SWMP study has been undertaken as part of the Somerset SWMPs for the urban areas of Minehead and Taunton in consultation with key local partners who are responsible for surface water management and drainage across Somerset – including the Somerset Drainage Board Consortium, Wessex Water, West Somerset Council and the Environment Agency. The Partners have worked together to understand the causes and effects of surface water flooding and agree the most cost effective way of managing surface water flood risk for the long term.

This document also establishes a long-term action plan to manage surface water and will influence future capital investment, maintenance, public engagement and understanding, land-use planning, emergency planning and future developments. Future iterations will be required to help address the historical decisions and to help achieve stronger water quality drivers associated with surface water management.

1.3 Background

The wide scale flooding experienced during 2007 precipitated the publication of the Pitt Review[1] which contained a large number of recommendations for Government to consider. The key recommendation in the Pitt Review with respect to surface water management is Recommendation 18, reproduced below, which in turn refers to Planning Policy Statement 25 Development and Flood Risk (PPS25)[2], now replaced by the National Planning Policy Framework (NPPF)[3] and the associated Technical Guidance for the NPPF[4].

"*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."*"

Surface Water Management Plans (SWMPs) are referred to in NPPF 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 Strategic Flood Risk Assessments (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.

Guidance on the production of SWMPs was published in March 2010[5] informed by the Integrated Urban Drainage (IUD) Pilot Studies carried out under the Government's Making Space for Water (MSfW)[6] strategy.

A SWMP outlines the preferred strategy for the management of surface water in a given location and the associated study is carried out in consultation with local partners having responsibility for surface water management and drainage in that area. The goal of a SWMP is to establish a long term action plan and to influence future strategy development for maintenance, investment, planning and engagement.

The framework for undertaking a SWMP is illustrated using a wheel diagram, reproduced from the Defra Guidance[3] as shown in Figure 1-1.

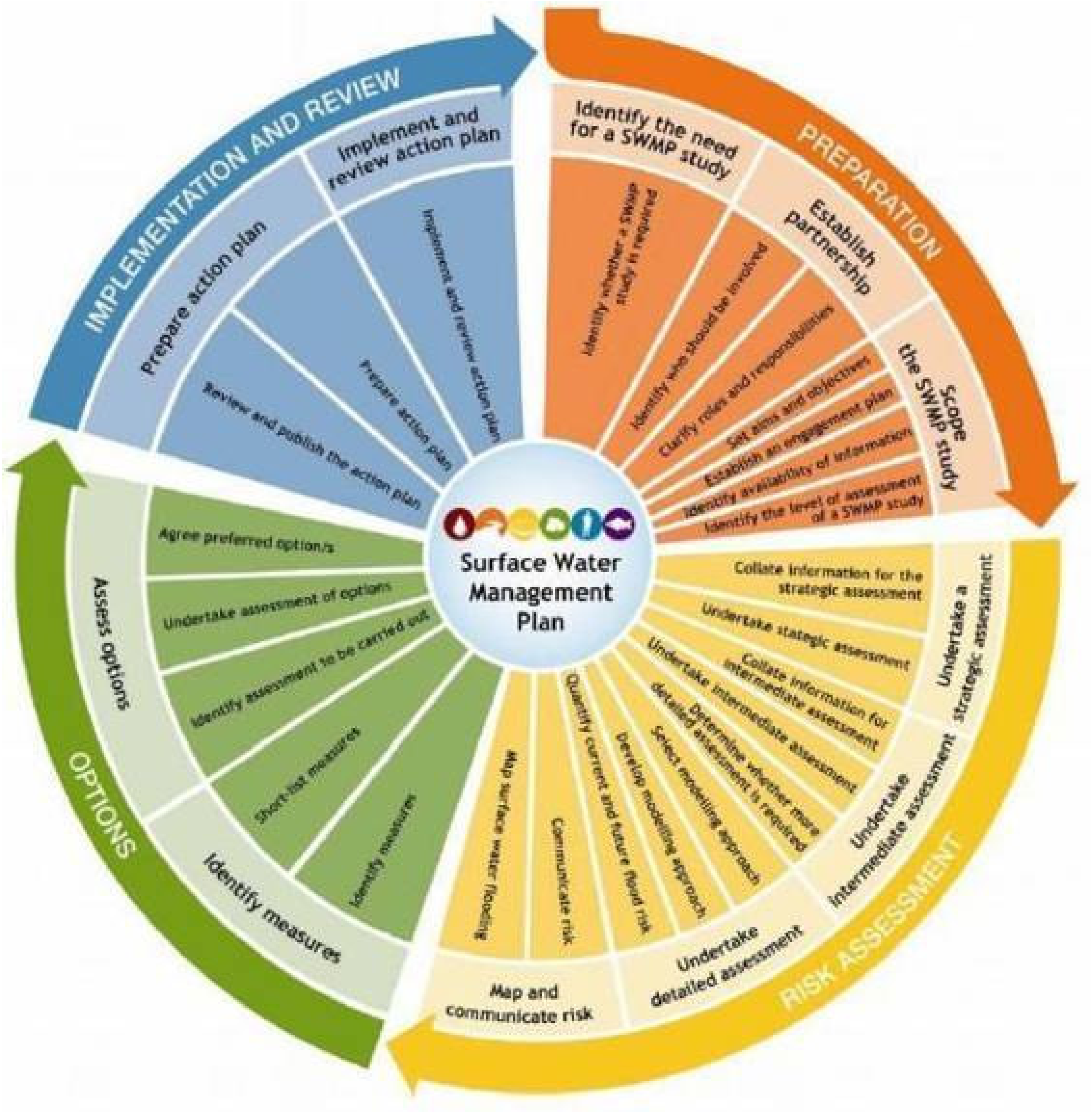


Figure 1-1 SWMP Wheel (source Defra Guidance[3])

The SWMP process is formed of four principal phases;

- preparation,
- risk assessment,
- options, and

- implementation and review.

This report contains the findings from the first three stages and presents recommendations for the developing Surface Water Management Action Plan for inclusion within the Local Flood Risk Manaagement Strategy for Somerset.

This current round of SWMP development has been predominantly focused on delivering improvements in understanding and awareness of the risks associated with surface water flooding. However, the management of surface waters should not be wholly focussed on quantity improvements as better and more sustainable approaches will help to deliver multiple benefits, including the ability to help improve the health and quality of the water within the watercourses.

Further works are required to help redress the issues resulting from the development across Somerset County Council area and as such water quality improvements should feature high within the current Action Plan and future iterations of the SWMP. Furthermore, specific studies should be commenced to help deliver these requirements to help address additional drivers, such as the Water Framework Directive.

1.4 Flooding Interactions

1.4.1 Sources of Flooding

Flooding From Rivers (Fluvial Flooding)
Watercourses flood when the amount of water in them exceeds the flow capacity of the watercourse channel. Where flood defences exist, they can be overtopped or breached during a severe event. Flooding can either develop gradually or rapidly, depending on the characteristics of the catchment. Land use, topography and development can have a strong influence on flooding from watercourses. Flooding can also occur as a result or culverts and bridges becoming blocked with debris.
Flooding from Surface Water (Pluvial Flooding)
Intense rainfall, often of short duration, that is unable to soak into the ground or enter drainage systems can run quickly off land and result in local flooding. In developed areas, this flood water can become polluted with domestic sewage where foul sewers surcharge and overflow. Local topography and built form can have a strong influence on the direction and depth of flow. The design of development down to a micro-level can influence or exacerbate this. Flooding can be exacerbated if development increases the percentage of impervious area and it is not appropriately managed.
Groundwater Flooding
Groundwater flooding occurs when groundwater levels rise above ground levels (i.e. groundwater issues). Groundwater flooding is most likely to occur in low-lying areas underlain by permeable rocks (aquifers). Chalk is the most extensive source of groundwater flooding.
Sewer Flooding
In urban areas, rainwater is frequently drained into sewers. Flooding can occur when sewers are overwhelmed by heavy rainfall, or become blocked. Sewer flooding continues until the water drains away.
Flooding from Other Artificial Sources (i.e. reservoirs, canals, lakes and ponds)
Non-natural or artificial sources of flooding can include reservoirs, canals and lakes. Reservoir or canal flooding may occur as a result of the facility being overwhelmed and/or as a result of dam or bank failure.

Table 1-1 Sources of Flooding (Adapted from Technical Guidance to the National Planning Policy Framework)

1.4.2 Surface Water Flooding

In the context of SWMPs, the technical guidance[5] defines surface water flooding as:

- Surface water runoff; runoff as a result of high intensity rainfall when water is ponding or flowing over the ground surface before it enters the underground drainage network or watercourse, or cannot enter it because the network is full to capacity, thus causing flooding (known as pluvial flooding);
- Flooding from groundwater where groundwater is defined as all water which is below the surface of the ground and in direct contact with the ground or subsoil;
- Sewer flooding; flooding which occurs when the capacity of underground systems is exceeded due to heavy rainfall, resulting in flooding inside and outside of buildings. Note that the normal discharge of sewers and drains through outfalls may be impeded by high water levels in receiving waters as a result of wet weather or tidal conditions;
- Flooding from any watercourse not designated a “Main River”, including culverted watercourses which receive most of their flow from inside an urban area and perform an urban drainage function;
- Overland flows from the urban/rural fringe entering the built-up area; and
- Overland flows resulting from groundwater sources.

This report aims to consider surface water flooding issues in Minehead as above but it does not address sewer flooding where it is occurring as a result of operational issues, i.e. blockages and equipment failure. It should also be noted that the compilation of all historical flooding within the county area does include some flooding due to main rivers, although further investigation of these occurrences is outside the remit of this report.

Information on Main River Flooding is covered under other strategic planning documents such as Strategic Flood Risk Assessments, produced by district councils.

1.5 Linkages with Other Plans

As part of this study, it has been critical to identify the links to other local and regional delivery plans which may influence or be influenced by the SWMP. The SWMP will seek to integrate and align these plans and processes to provide a clear and robust path to delivering flood risk management objectives throughout Minehead. These studies listed below have already been completed, however the information from the SWMP and future Local Flood Risk Management Strategy can be used to inform any updates to these studies.

1.5.1 West Somerset CFMP

The Catchment Flood Management Plan (CFMP) for West Somerset was published in 2009 by the Environment Agency and sets out policies for the sustainable management of flood risk across the whole of West Somerset over the long-term (50 to 100 years) taking climate change into account. More detailed flood risk management strategies for individual rivers or sections of river may sit under these.

The Plan emphasises the role of the floodplain as an important asset for the management of flood risk, the crucial opportunities provided by new development and regeneration to manage risk, and the need to re-create river corridors so that rivers can flow and flood more naturally.

This Plan will be periodically reviewed, approximately five years from when it was published, to ensure that it continues to reflect any changes in the catchment.

The Minehead study area falls within the area covered by the West Somerset Catchment Flood Management Plan (CFMP), which was published by the Environment Agency (EA) in December 2009. The catchment covers approximately 320 km^2, and is predominantly rural catchment with urban areas making up only four per cent of the total. Its main urban areas, generally located on the coastal plain include Minehead.

For Minehead, the main sources of flood risk were identified as:

- Tidal flooding
- surface water drainage flooding in Minehead

A number of flood risk management policy options were identified across the whole catchment, and the policy option covering Minehead was Policy Option 5 - Areas of moderate to high flood risk where we can generally take further action to reduce flood risk.

The promoted actions relevant for Minehead for Policy Option 5 are:

1. Maintain the streams and culverts in order to maximise their hydraulic capacities and to reduce the likelihood of blockages.
2. Review the maintenance programme periodically to ensure that the correct activities are being undertaken at the right time intervals, and monitor the costs of these maintenance activities.
3. Provide development control advice and promote Sustainable Drainage Systems to ensure that there is no increase in surface water run-off from new developments in Minehead. Monitor the implementation of advice and planning conditions.
4. Investigate the feasibility of a flood warning service for Minehead by considering possible telemetry and other data requirements.
5. Review emergency contingency planning in the light of climate change, especially for Butlins.

Encourage re-siting of critical amenities and caravan parks outside flood risk locations

The CFMP identified much of the urban area of Minehead (pop 10,000) as having a high likelihood of surface water flooding and recommends the preparation of a Surface Water Management Plan for Minehead. The South West River Basin District Management Plan (RBMP)

The South West River Basin District Management Plan was published in 2009 by the Environment Agency. In accordance with the Water Framework Directive, the RBMP contributes to the requirement of all countries throughout the European Union to manage the water environment to consistent standards. Minehead is located within the South and West Somerset sub region. This plan focuses on the protection, improvement and sustainable use of the water environment.

The RBMP describes the river basin district, and the pressures that the water environment faces. It shows what this means for the current state of the water environment, and what actions will be taken to address the pressures as well as setting out what improvements are possible by 2015 and how the actions will make a difference to the local environment including the catchments, the estuaries and coasts, and groundwater.

This plan has been prepared under the Water Framework Directive, which requires all countries throughout the European Union to manage the water environment to consistent standards. Each country has to:

- prevent deterioration in the status of aquatic ecosystems, protect them and improve the ecological condition of waters;
- aim to achieve at least good status for all water bodies by 2015. Where this is not possible and subject to the criteria set out in the Directive, aim to achieve good status by 2021 or 2027;
- meet the requirements of Water Framework Directive Protected Areas;
- promote sustainable use of water as a natural resource;
- conserve habitats and species that depend directly on water;
- progressively reduce or phase out the release of individual pollutants or groups of pollutants that present a significant threat to the aquatic environment;
- progressively reduce the pollution of groundwater and prevent or limit the entry of pollutants; and
- contribute to mitigating the effects of floods and droughts.

Minehead lies within the South and West Somerset Catchment Policy Unit, which is largely rural, with the main land uses being agricultural, however faces significant pressure for urban development.

Several relevant key actions are proposed to help address the key pressures across the catchment to help maintain the current level of water bodies achieving good ecological status over the plan period. These are listed below and could also have an impact on the surface water flood risks exhibited across the catchment:

- Somerset County Council will work with partners to develop water level management improvement schemes to enhance floodplain and habitat connectivity in Somerset Levels and Moors through the WAVE (Water Adaptation is Valuable for Everyone) Project.
- The Environment Agency will work with Wessex Water to carry out investigation of the impact of water company assets on shellfish and bathing water quality and of pressures on drinking water quality.

1.5.2 Preliminary Flood Risk Assessment

The PFRA for Somerset was completed in June 2011. Minehead was not identified as a significant flood risk area as defined in the final PFRA guidance[5]. However, the PFRA did identify ‘blue squares’ (where >200 people, >20 non-residential properties or more than one item of critical infrastructure were affected in 1km^2) within Minehead. Three blue squares within the study area were identified by the Environment Agency. The PFRA did not identify any new blue squares within the zone of the SWMP study area.

1.5.3 West Somerset Council SFRA

A Level 1 SFRA was completed in March 2009, which prepared strategies and development control policies to allow WSC to apply the sequential test to proposed development sites. This report identified the need to undertake a Level 2 SFRA to further develop the sequential test.

A Level 2 SFRA covering Minehead was completed by Scott Wilson in October 2010. The main aim of the study was to provide supplementary information to the WSC Level 1 SFRA on flood risk issues specific to the three strategic development areas. The SFRA aids developers in producing site specific Flood Risk Assessments and highlights the importance of using SuDS. The main focus of this SFRA was to consider the affects of residual tidal flood risk associated with overland flood routing following overtopping and breaching events of the coastal flood defences, which has been used to derive flood extent, depth and hazard mapping.

The WSC Core Strategy identified three strategic development areas for future growth within West Somerset, located at Minehead, Watchet and Williton. This Level 2 report focused on these general areas, which were identified as requiring further investigation in terms of flood risk.

The SFRA considered that each of the strategic development areas could be suitable for future development. However, significant consideration is required with respect to the mitigation and management of flood risk. The outputs of the Level 2 SFRA have demonstrated that it is unlikely that any of the three strategic development areas can be developed without some form of flood mitigation.

1.5.4 Local Development Documents (LDD)

LDDs including the Core Strategy, Development Planning Documents, Supplementary Planning Documents and relevant Area Action Plans (AAPs) will need to reflect the results from this SWMP. This may include policies for the whole borough or for specific parts of the Districts, for example the ‘Wetspot’ areas. There may also be a need to review Area Action Plans where surface water flood risk is a particular issue. Any future updates to the SFRA will assist with this as will the reviewed RFRA.

1.5.5 Local Flood Risk Management Strategies

The Flood and Water Management Act 2010 (FWMA) requires each Lead Local Flood Authority (LLFA) to produce a Local Flood Risk Management Strategy (LFRMS). Whilst this report is not actually a LFRMS, the SWMPs, PFRAs and their associated risk maps will provide the necessary evidence base to support the development of LFRMS. No new modelling is anticipated to produce these strategies.

The strategy must be consistent with the National Flood and Coastal Erosion Risk Management Strategy for England, the regional CFMPs and River Basin Plans, and should be developed and maintained with consultation from other stakeholders, such as the public and other risk management authorities. The strategy must specify:

- the risk management authorities in the authority's area,
- the flood and coastal erosion risk management functions that may be exercised by those authorities in relation to the area,
- the objectives for managing local flood risk (including any objectives included in the authority's flood risk management plan prepared in accordance with the Flood Risk Regulations 2009),
- the measures proposed to achieve those objectives,
- how and when the measures are expected to be implemented,
- the costs and benefits of those measures, and how they are to be paid for,
- the assessment of local flood risk for the purpose of the strategy,
- how and when the strategy is to be reviewed, and

- how the strategy contributes to the achievement of wider environmental objectives.

The schematic diagram below (Figure 1-2) illustrates how the CFMP, PFRA, SWMP and SFRA link to and underpin the development of a Local Flood Risk Management Strategy.

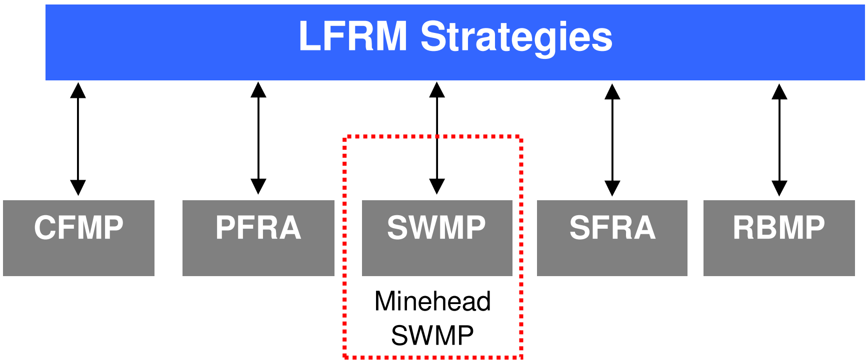


Figure 1-2 Supporting studies used to develop a Local Flood Risk Management Strategy

1.6 Existing Legislation

1.6.1 Flood Risk Regulations 2009

The Flood Risk Regulations 2009 (FRR) transpose the European Floods Directive 2007/60/EC into English and Welsh law. The Regulations bring together key partners to manage flood risk from all sources and in doing so reduce the consequences of flooding on key receptors. Local authorities are assigned responsibility for management of surface water flooding.

As part of the ongoing cycle of assessments, mapping and planning, the FRR required the undertaking of a 'Preliminary Flood Risk Assessment' (PFRA). National guidance was published by the Environment Agency initially as a 'living draft' in July 2010 which was subsequently replaced by the final guidance issued in December 2010[7].

The Regulations requires three main types of assessment / plan:

1. Preliminary Flood Risk Assessments (maps and reports for Sea, Main River and Reservoirs flooding) to be completed by Lead Local Flood Authorities and the Environment Agency by the 22 December 2011. Flood Risk Areas, at potentially significant risk of flooding, will also be identified. Maps and management plans will be developed on the basis of these flood risk areas.
2. Flood Hazard Maps and Flood Risk Maps. The Environment Agency and Lead Local Flood Authorities are required to produce Hazard and Risk maps for Sea, Main River and Reservoir flooding as well as 'other' relevant sources by 22 December 2013.
3. Flood Risk Management Plans. The Environment Agency and Lead Local Flood Authorities are required to produce Flood Risk Management Plans for Sea, Main River and Reservoir flooding as well as 'other' relevant sources by 22 December 2015.

Under Flood Risk Regulation 19-1 a Lead Local Flood Authority must prepare a flood hazard map and a flood risk map in relation to each relevant Flood Risk Area (FRA), if identified by the PFRA process. No significant FRA has been identified by the EA nationally within Somerset, nor the first cycle of the Somerset PFRA at a local level. However, depth, velocity and hazard maps (Section 6.4) have been prepared for the Minehead SWMP study area and they will inform

Somerset's Local Flood Risk Management Strategy development (Section 2.1.3) and the second cycle of the PFRA process in six years time.

1.6.2 Water Framework Directive

The Water Framework Directive (WFD) is a European Directive which came into force on 22 December 2000. This European legislation is designed to improve and integrate the way water bodies are managed throughout Europe. Member States must aim to reach good chemical and ecological status in inland and coastal waters by 2015.

1.6.3 Flood and Water Management Act 2010

The Flood and Water Management Act 2010 (FWMA) presents a number of challenges for policy makers and the flood and coastal risk management authorities identified to co-ordinate and deliver local flood risk management (surface water, groundwater and flooding from ordinary water courses). 'Upper Tier' local authorities have been empowered to manage local flood risk through new responsibilities for flooding from surface and groundwater as their role as Lead Local Flood Authorities (LLFAs), but allows for the delegation of flood risk management functions to other statutory authorities.

The FWMA reinforces the need to manage flooding holistically and in a sustainable manner. This has grown from the key principles within Making Space for Water (Defra, 2005) and was further reinforced by the summer 2007 floods and the Pitt Review (Cabinet Office, 2008). It implements several key recommendations of Sir Michael Pitt's Review of the Summer 2007 floods, whilst also protecting water supplies to consumers and protecting community groups from excessive charges for surface water drainage.

The Act also seeks to encourage the uptake of Sustainable Drainage Systems (SuDS) by agreeing new approaches to the management of drainage systems and allowing, where delegated, for district councils and Internal Drainage Boards (IDBs) to adopt SuDS for new developments and redevelopments.

The FWMA must also be considered in the context of the EU Floods Directive, which was transposed into law by FRR (the Regulations) on 10 December 2009.

The diagram overleaf (Figure 1-3) illustrates how this SWMP fits into the delivery of local flood and coastal risk management, and where the responsibilities for this lie.

1.6.4 National Planning Policy Framework (NPPF)

The NPPF proposes to review all existing planning policies and to restructure the planning process[2]. The aim of this new framework is to make planning more streamlined and transparent. The NPPF also aims to give local councils more control over local planning with more emphasis being placed on sustainable local growth.

The consultation period ended on the 17th of October 2011 and the Government's response to consultation and the final version was published in March 2012, including specific Technical Guidance for Flood risk and Minerals Planning[4]. In summary, the NPPF retains the key elements of Planning Policy Statement 25, including the requirement for new development to not increase flood risk, and requires developers to design, build and fund the maintenance of SuDS; a SWMP will support this by informing the Local Planning Authority (LPA) of areas at risk of surface water flooding 'and by providing an evidence base to aid the consideration of future development options. The guidance document produced is seen as an interim measure pending a wider review of guidance to support planning policy.

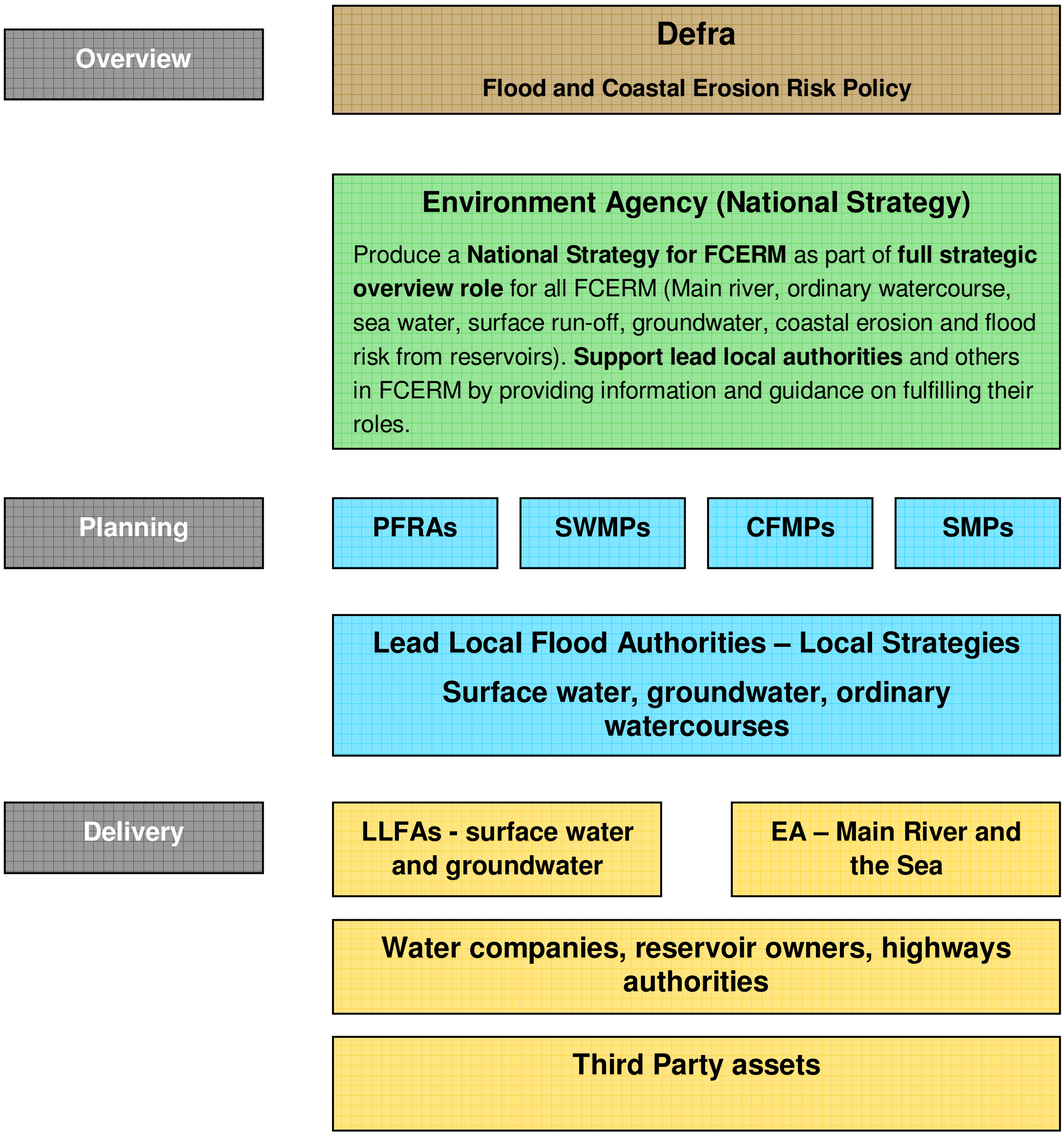


Figure 1-3 Local Flood Risk and Coastal Management Responsibilities

1.7 Sustainable Drainage Systems (SuDS)

Throughout this report, reference is made to SuDS. SuDS encompass a range of techniques which aim to mimic the natural processes of runoff and infiltration as closely as possible. SuDS schemes should be based on a hierarchy of methods termed the 'SuDS management train' as illustrated in Figure 1-4.

CIRIA Report C522 (Sustainable Urban Drainage Systems – Design Manual for England and Wales, 2000) suggests an approach for setting the level of treatment that surface water runoff should pass through before being discharged. It recommends that the management of surface water runoff should use a combination of site specific and strategic SuDS measures, encouraging source control where possible to reduce flood risk and improve water quality. Table 1-2 describes some of the SuDS techniques that will be considered in the development of the SWMP.

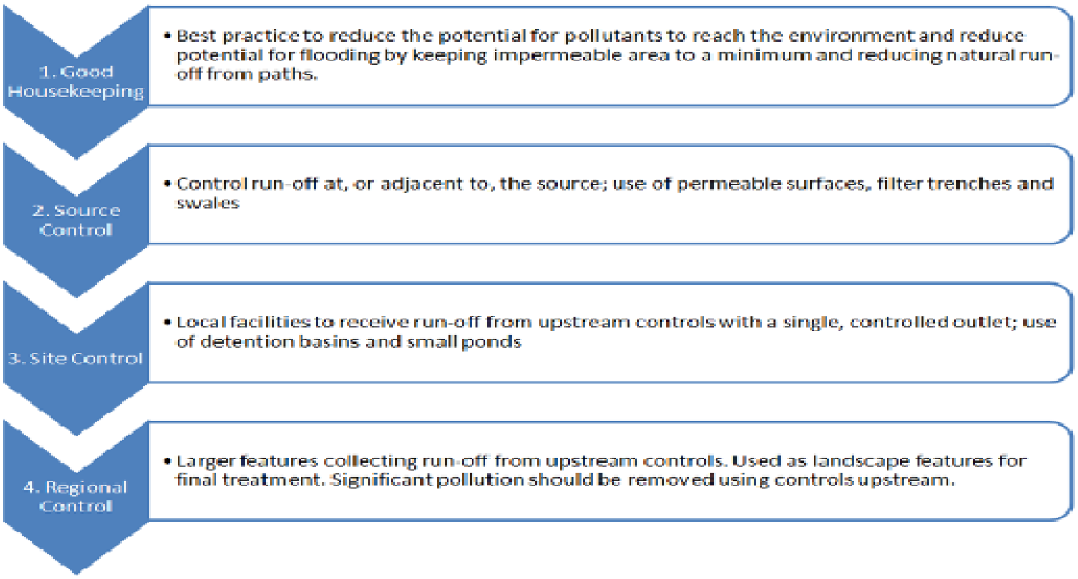


Figure 1-4 SuDS Treatment Train

Type	Description
Balancing Pond	A pond designed to attenuate flows by storing runoff during the peak flow and releasing it at a controlled rate during and after the peak flow has passed. The pond always contains water. Also known as wet detention pond.
Brown Roof	A roof covered with a locally sourced material, its main aim is to partly mitigate any loss of habitat when new developments are constructed.
Detention Basin	A vegetated depression, normally dry except after storm events constructed to store water temporarily to attenuate flows. May allow infiltration of water to the ground
Filter Strip	A vegetated area of gently sloping ground designed to drain water evenly off impermeable areas and filter out silt and other particulates.
Green Roof	A roof with plants growing on its surface, which contributes to local biodiversity. The vegetated surface provides a degree of retention, attenuation and treatment of rainwater, and promotes evapotranspiration. Sometimes referred to as a "living" roof.
Infiltration Basin	A dry basin designed to promote infiltration of surface water to the ground.
Road Side Rain Gardens	Where space allows, these can be constructed alongside roads to allow run-off from roads or pavements to filter slowly through the root system of plants, rather than entering underground drainage systems.
Permeable Surface	A surface formed of material that is itself impervious to water but, by virtue of voids formed through the surface, allows infiltration of water to the sub-base through the pattern of voids, e.g. concrete block paving.
Rainwater Harvesting	A system that collects rainwater from where it falls rather than allowing it to drain away. It includes water that is collected within the boundaries of a property, from roofs and surrounding surfaces. The harvested water is then re-used in applications where potable water is not essential.
Swale	A shallow vegetated channel designed to conduct and retain water, but may also permit infiltration; the vegetation filters particulate matter.

Table 1-2 SuDS Techniques (source Ciria[8])

SuDS techniques can be divided into two main groups; infiltration based or attenuation based. Infiltration based SuDS facilitate the discharge of water directly into the ground through soil and rocks; this is only possible where the underlying geology is permeable enough to allow the passage of water downwards. Attenuation based SuDS retain water on a site and allow it to discharge at a prescribed and controlled rate into a watercourse or sewer.

The feasibility for the use of any SuDS technique should be investigated prior to their installation.

1.8 Geographic Extent

This SWMP has been undertaken for the Minehead study area as shown in Figure 1-5. It is recognised that surface water may enter the study area from adjacent areas, most notably from the steep hill slopes to the south and west, and that these should be included in the scope where they could cause flooding in the study area itself.

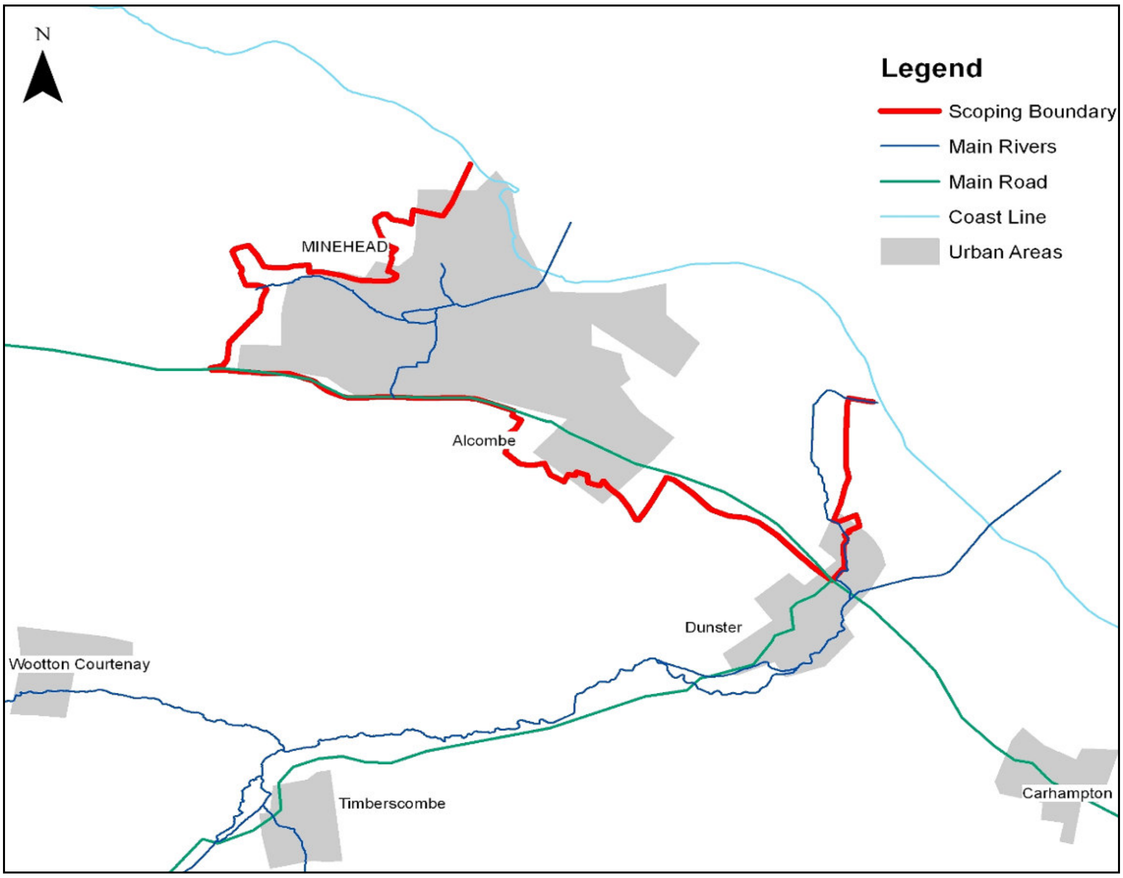


Figure 1-5 Study Area - The Urban Area of Minehead.

The area within the scoping boundary (Figure 1-5) is some 6.5km². Due to the steep sided nature of the surrounding catchments and the large catchment area which contributes runoff into the study area it was considered that the study area, or 'wetspots' within the study area, could not be assessed in isolation from the wider catchment. Therefore, the total modelled catchment area used in the study was 22.2km².

Minehead is a dense urban area and as such the watercourses have been culverted, modified and largely encroached upon by development. The town is situated within the floodplain of the Bratton Stream and its tributaries and flooding has historically been associated with out of channel flow as a result of under capacity or blocked structures. Minehead contains a significant amount of key services, commercial properties and infrastructure and is also an important employment centre and tourist destination. The land surrounding Minehead is primarily agricultural and the Dunster Park and Heathlands SSSI and the Exmoor Heath SAC are located on the periphery of the study area. The study area is also on the edge of a Heritage Coast and National Park Area.

The topographical setting of Minehead is that the town is largely located within a natural low lying bowl, which is formed by the steeply sided catchments of the Bratton Stream, Hopwood Steam, Holloway Stream, River Avril and Tributaries.

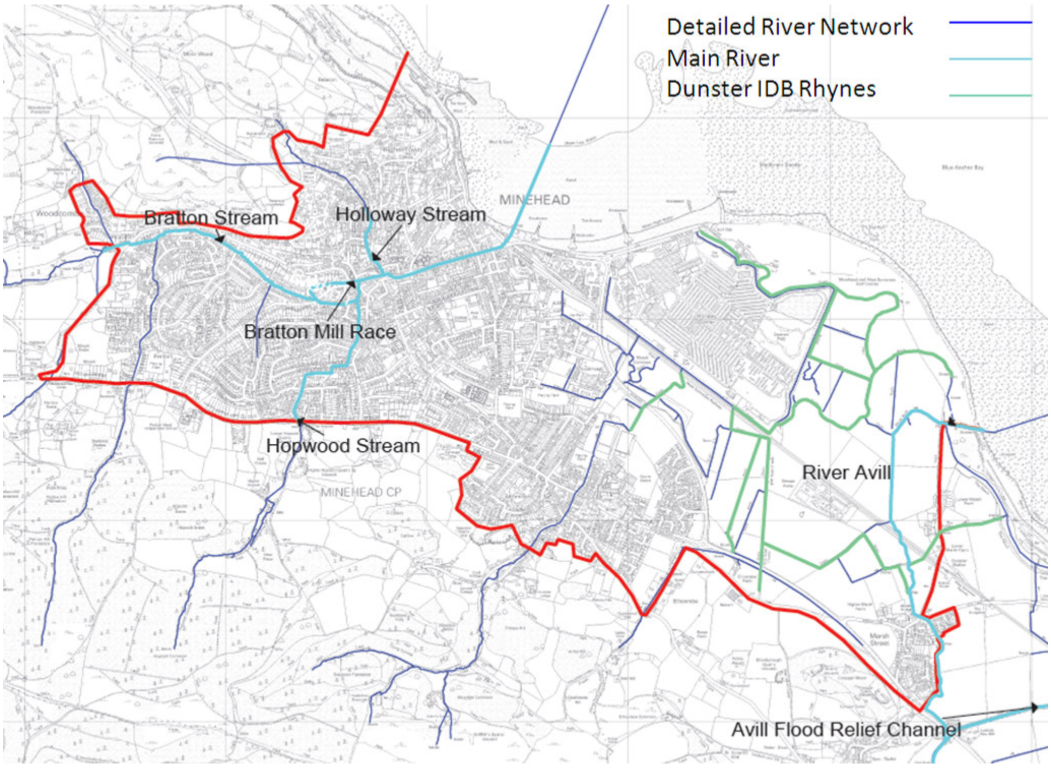


Figure 1-6 Watercourse locations and designations within Minehead.

1.9 Methodology

The methodology used to carry out this SWMP follows the advice set out in the Defra SWMP guidance5 for the preparation stage and the strategic risk assessment phase. Figure 1-7 illustrates the process carried out to inform this detailed assessment and options appraisal report, a key output of Minehead SWMP. It should be noted that this figure only shows the steps subsequent to the formal identification of the Minehead settlement as a priority wetspot within the County, as requested by SCC.

Further details on the methodology are discussed throughout the report in the relevant sections. The work undertaken for the study is also informed by the EA's PFRA guidance[5] in order to assist in meeting the obligations of SCC as the Lead Local Flood Authority (LLFA). Information on the methodology for subsequent phases of the SWMP is set out in Section 2 of this report.

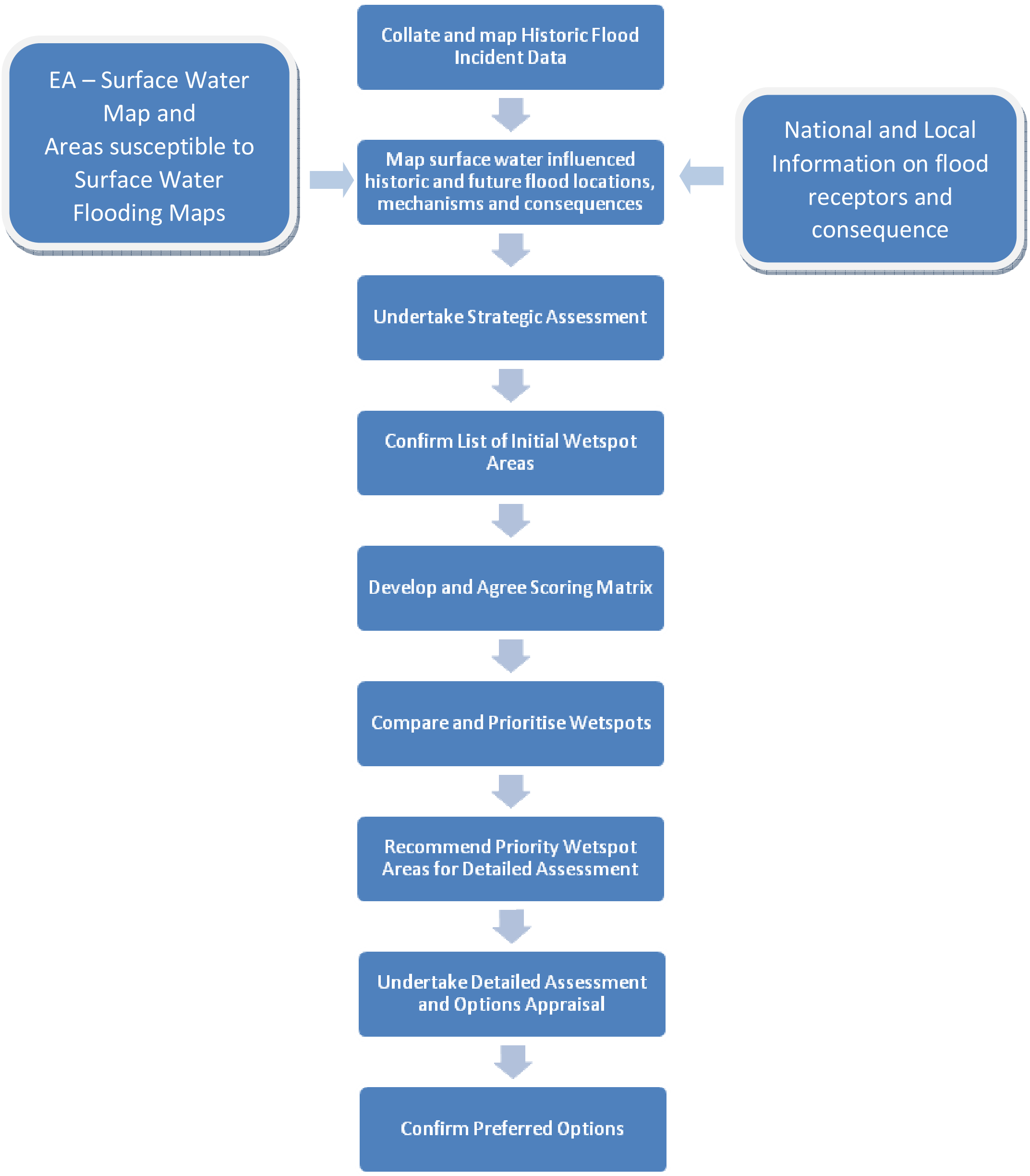


Figure 1-7 Overall Approach to Study Methodology

The specific methodology adapted for the Minehead study is further explained in Sections 2 to 3.

2 Phase 1 – Preparation

2.1 Need for SWMPs in Somerset

2.1.1 Background

Minehead is the administrative headquarters for West Somerset Council, and accommodates the area highways office. As a relatively small coastal town, the number of properties at high risk represents a relatively high proportion (approx 36%) of the total number of properties in the town, (and almost 100% of business properties), and accordingly represents a relatively high severity of risk, in terms of the effects of surface water flooding on the town, its residents and businesses. The town also has a relatively elderly age profile. Minehead scores highly on the Flood Hazard Research Centre's Social Flood Vulnerability Index. The town also receives a large influx of holiday makers throughout the year visiting Butlins Holiday Park, and destinations nearby such as the Exmoor National Park.

Principal highway routes and bus services to the Exmoor coast and North Devon also pass through the town. In the event of these principal routes being blocked by flooding, diversionary routes are long. A flooding event would cause widespread disruption.

Minehead also has a history of tidal flooding (recent events in March 1990, August 1994, January 1996). (These factors also emphasise the severity of the combined risks.)

2.1.2 Defra Application

Defra had previously divided England into 4350 settlements. These settlements were then ranked with regard to their possible susceptibility to surface water flooding and SCC received funding for the preparation of a Taunton Surface Water Management Plan, which was ranked 56.

SCC subsequently applied for early action revenue funding from DEFRA to progress the Minehead SWMP based on the fact that Minehead was identified by DEFRA as the second highest priority for a Surface Water Management Plan in Somerset (Ranked 219 overall), with 1,600 properties at high risk of surface water flooding.

Unfortunately, funding was not awarded for Minehead, but SCC felt that the need for a SWMP was strong enough to proceed with the study and pursue potential new innovative funding mechanisms, where possible, through pooling of funding from stakeholders and direct application of development finance.

2.2 Partnerships

The formation of partnerships has an important role in the undertaking of a SWMP, and is required under Defra's SWMP guidance documentation. The SWMP guidance details the identification of those partners / organisations that should be involved and what their roles and responsibilities should be.

It recommends the formation of an engagement plan, which should include objectives for the individual partners, and detail how and at what stages of the SWMP the engagement with stakeholders should take place. The following sections describe the partners, their roles and responsibilities and their objectives as required by the SWMP guidance.

The Minehead SWMP will build on the Level 1 SFRA with an additional Stakeholder Engagement Plan being compiled to support and inform the SWMP process.

The Somerset Strategic Flood Risk Management Partnership (SSFRMP) comprises all the flood risk authorities including Somerset County Council, the District Authorities, the Environment Agency, Somerset Drainage Boards Consortium and Wessex Water. A SWMP Project Management Board was formed as a sub group of the SSFRMP to steer the production of the Minehead SWMP, and this is discussed in more detail in Section 2.2.3.

SCC has developed a Stakeholder Engagement Plan, which will aid in communicating the work of the partnership to the key stakeholders, and is discussed in further detail in Section 2.3. It is of great importance that collaborative working of this nature is undertaken in order to share experience and expertise.

2.2.1 Partners

Members include all those partners or stakeholders who have an interest in flooding within the county area. More details of the SSFRMP, SWMP Project Management Board and additional stakeholders are included in the following sections.

2.2.2 Somerset Strategic Flood Risk Management Partnership (SSFRMP)

Anticipating the Floods and Water Act and noting the Government's response to the Pitt review recommendations, Somerset County Council formed the 'Somerset Strategic Flood Risk Management Partnership' (SSFRMP).

The role of the partnership, made up of SCC, the District Councils, Environment Agency, Wessex Water and the county's Internal Drainage Boards is to provide a coordinated approach to flood risk management across the County. The partnership will provide a strategic overview to the delivery of actions related to the relevant Pitt Review recommendations, the Flood and Water Management Act (2010) and the Flood Risk Regulations (2009). The partnership will enable Somerset County Council to fulfil its role as 'Lead Local Flood Authority' (LLFA) in coordinating local flood risk management activities.

2.2.3 SWMP Project Management Board

The SWMP Project Management Board sits within the SSFRMP and is responsible for overseeing the production of the SWMP, one of the current projects being overseen by the SSFRMP. The Defra guidance defines SWMP partners as those with responsibility for decision or actions regarding surface water management. In Minehead, these partners are:

- Somerset County Council (SCC)
- West Somerset Council (WSC)
- Environment Agency (EA)
- Wessex Water Services (WW)
- Somerset Drainage Boards Consortium (SBDC) incorporating the Lower Axe, Lower Brue and Parrett Drainage Boards

2.2.4 Stakeholders

Stakeholders are defined as those affected by, or interested in a problem or solution relating to surface water management.

- Natural England
- Bourne Leisure (Butlins)
- Emergency Services
- Wildlife Trusts
- Neighbouring Authorities
- Landowners and developers

Further details of additional stakeholders have been identified in the SWMP Engagement Plan which is currently being written in conjunction with this study. As the SWMP develops, it is possible that other stakeholders will be identified and become involved; these organisations will be highlighted in future update reports and outputs as required.

2.2.5 Roles and Responsibilities

Somerset County Council

- Lead Partner for the Minehead SWMP;
- Lead Local Flood Authority;
- Highways Drainage (other than M5);
- SuDS;
- Preparation for emergencies (though joint Civil Contingencies Unit);
- Procurement

West Somerset Council

- Land Use Planning & Urban Development, including Local Development Framework & Urban Extensions Master Planning;
- Strategic Flood Risk Assessment;
- Urban Green Space;

- SuDS;
- Ordinary Watercourses.

Environment Agency

- Main River Flood Risk Management, including information management and modelling;
- West Somerset Catchment Flood Management Plan;
- Procurement technical support, including contract interpretation;

Wessex Water

- Sewer Network, including information management and modelling;
- Developer Liaison;
- Drainage Area Plans & Sewerage Management Plans;
- Procurement technical support, including contract interpretation;
- SuDS.

Parrett Internal Drainage Board

- Legal corporate body with powers and duties that fall to them from the Land Drainage Act as well as the environmental and health and safety legislation.
- The main activity of the Board is to manage water levels for the protection of people, property and the environment.
- Follow a series of policies which cover a number of areas including activities in or adjacent to watercourses and the control of development in their areas.

2.2.6 Public Engagement

Some members of the public have valuable information to contribute to the SWMP and to help improve the understanding and management of local flood risk within the study area and are currently engaged through the works included within the local Parish Councils, who were consulted during the development of the PFRA.

Public engagement provides significant benefits to local flood risk management including building trust, gaining access to additional local knowledge and increasing the probability of stakeholder acceptance of options and decisions proposed in future flood risk management plans.

However, it is also recognised that it is crucial to plan the level and timing of engagement with communities predicted to be at risk of flooding from surface water, groundwater and ordinary watercourses. This is to ensure that the potential for future management options and actions is adequately understood and costed without raising expectations before solutions can reasonably be implemented.

It is important to undertake some public engagement when formulating local flood risk management plans (including LFRM Strategies) as this will help to inform future levels of public engagement. It is recommended that SCC follow the guidelines outlined in the Environment Agency's "Building Trust with Communities" which provides a useful process of how to communicate risk including the causes, probability and consequences to the general public and professional forums such as local resilience forums.

Guidance for SCC Residents

A sample of guidance adopted by Gloucestershire City Council was presented to the project partners. It was agreed that SCC would take this forward as lead authority and incorporate this within the ‘global’ context of flood risk management marketing and communications from SCC.

2.3 Stakeholder Engagement Plan

A draft Stakeholder Engagement Plan[9] was produced by Hyder and this is being taken forward by SCC in conjunction with Hyder as part of the SWMP, presented in Appendix A (supporting documentation). The purpose of the engagement plan is to improve how SCC consults and involves citizens and other stakeholders in decision making, and to ensure that their views are used to develop a targeted and appropriate SWMP for the Urban Area of Minehead. The strategy will set out clear objectives, principles, standards and an action plan for consultation and engagement throughout the forthcoming stages of the SWMP. The objectives and principles of the SSFRMP engagement strategy are tabulated below.

	Objective / Principle
Objectives	Raise awareness and provide an understanding about the SSFRMP programme of work and its objectives for all key stakeholder groups
	Ensure that the key stakeholders are aware of who they should contact for different flood risk management activities and how
	Provide all key stakeholder groups with an update on the progress of the programme of work, the programme governance arrangements, who the key project representatives are in each area
	Identify the most appropriate communication methods for communicating with each stakeholder group
	Providing key stakeholders with a mechanism to feedback to the Programme and Project Managers in relation to the work of the partnership
	Ensure communication identifies clear links with other inter-dependent projects/areas of work to avoid confusing and conflicting messages to key stakeholder groups
	Effectively monitor communication activities and use this to influence future planning, messages and communication activities throughout the programme
Principles	Tell stakeholders what they can expect from the work of the Partnership
	Provide clear, accurate and easy to understand information – using plain English and offering a range of formats
	Make sure the communications and messages are consistent with one another
	Get the right balance in relation to the amount and level of communications with each of the stakeholder groups

Table 2.1 Objectives / Principles of the SSFRMP Engagement Strategy

During the progression of the SWMP, Hyder has contributed to the Stakeholder Engagement Plan through various media: meetings and workshops have been held throughout the study, providing an opportunity for all stakeholders to present their opinions on the development of the SWMP.

A GIS meta-database has been developed allowing the clear visualisation and communication of the outputs of the SWMP; and draft output consultations have been undertaken to explain and discuss the study’s findings. The GIS meta-database is discussed further in Section 3.1.

2.4 Data Collection

The collection and collation of strategic level data was undertaken during this Scoping/Screening study. Data was collected from each of the following organisations:

- Somerset County Council
- Environment Agency
- Highways Agency
- Natural England
- Somerset Drainage Boards Consortium
- Wessex Water

A list of the data provided by stakeholders to date is below.

Stakeholder	Information Provided	
	Publicly Available	Not Publicly Available
Somerset County Council	West Somerset Local Plan (2009)	Ordinary watercourses, critical infrastructure (fire stations, schools etc), historical flooding locations, transport infrastructure, Administrative boundaries, OS 10k and 50k Mapping, OS Master Maps
Environment Agency	West Somerset Catchment Flood Management Plan, South West River Basin District Management Plan Provisions of flood risk studies of local area.	National Receptor Databases, historical and modelled flood event outlines, main rivers, detailed river network, modelled flood outlines for surface and fluvial sources, LiDAR
Highways Agency		Drawings of drainage assets (where available) for several main highways across the county
Natural England	SACs, SSSIs, SPAs, Ancient woodland, LNRs, NNRs, RAMSARs, woodland, agricultural land classifications	
West Somerset Council	Strategic Flood Risk Assessment (Level 1) 2009 Strategic Flood Risk Assessment (Level 2) 2010	
Wessex Water		Sewerage networks, asset information, DG 5 Register, Drainage Area Plan (model pre 2010) used for the study. New DAP model released end June 2012 for records.

Table 2-2 Stakeholders contacted and the information provided

The documents and anecdotal evidence provided by SCC provided the main source of information on local flood risk used within this SWMP. The two SFRA studies were completed within the last 5 years and have been reviewed and approved by WSC and the Environment

Agency. This suggested that these were reliable sources to use to establish the main local flood risk areas across Minehead.

2.4.1 Data Review

The SWMP guidance highlights the importance in understanding the quality of the data in order to inform the later stages of the SWMP. Therefore, data incorporated into the data registers was assigned a quality score between one and four based on a high level assessment:

1. Best Possible
2. Data with known deficiencies
3. Gross assumptions
4. Heroic assumptions

2.4.2 Data Gaps & Limitations

A register of outstanding data was maintained throughout the duration of the study.

One key limitation identified is the differing formats of the data received, both between stakeholders and within each individual stakeholder. This was most apparent when data was provided in PDF format, resulting in the need for increased processing to digitise the information into a GIS format.

In addition, the compilation of the Flood Incident Register was difficult due to the number of different formats that the historical flooding data was received in. Some datasets contained complete addresses and national grid co-ordinates, while other datasets were simply a graphical representation with no information contained within the GIS tables.

2.4.3 Data Use & Licensing

A number of datasets used in the preparation of this SWMP are subject to licensing agreements and use restrictions.

The following national datasets provided by the Environment Agency are available to local authorities and their consultants for emergency planning and strategic planning purposes:

- Flood Map for Rivers and the Sea
- Areas Susceptible to Surface Water Flooding
- Flood Map for Surface Water
- National Receptor Database

A number of the data sources used are publicly available documents, such as:

- Strategic Flood Risk Assessments
- Catchment Flood Management Plan

The use of some of the datasets made available for this SWMP has been restricted and is time limited, licensed to SCC for use under the SWMP project, which includes the production of this SWMP. The restricted datasets include records of property flooding held by the Councils, Somerset Drainage Board and by Wessex Water, and data licensed by the Environment Agency.

Necessary precautions must be taken to ensure that all information given to third parties is treated as confidential. The information must not be used for anything other than the purpose stated in the agreement. No information may be copied, reproduced or reduced to writing, other than what is necessary for the purpose stated in the agreement. The primary data provided for use in the SWMP is covered by licensing, however, the resulting SWMP report should be made available without a licence.

2.4.4 Objectives

The final aim of the SWMP study is to produce a long term surface water management Action Plan for Minehead, once in place this Action Plan should be reviewed every six years at a minimum.

The objectives of this study are to:

- Map historical flood incident data
- Engage with partners and stakeholders
- Map surface water influenced flooding locations
- Identify surface water flooding Wetspot areas
- Assess, compare and prioritise Wetspot areas for detailed assessment
- Identify measures, assess options and confirm preferred options for the prioritised 'Wetspots'
- Make recommendations for next steps

A wetspot is defined as being an area susceptible to Surface Water flooding following analysis of Modelled Surface Water outputs or historical records.

These objectives will be met following the progression of a number of project stages. The first stage is data collection, involving contact with the varying partner organisations to obtain all relevant information. During this stage the collation of historical and future flooding along with information on flood receptors and flood consequences will take place.

Once the data collection stage is complete, the surface water flooding information will be analysed to identify wetspots that have a history of flooding incidents or potentially could be at risk of future flooding. Those wetspots identified as being at higher risk or priority through agreed local assessment criteria will then progress forward to the next stages, detailed assessment and optioneering.

Following the optioneering stage, recommendations for flood alleviation or mitigation will be considered.

2.5 Drivers for Change

The SSFRMP are undertaking this SWMP in order to:

- Better understand the risks and consequences of surface water flooding in Minehead;
- To meet or significantly assist in meeting some of the requirements on SCC as Lead Local Flood Authority under the Flood Risk Regulations 2009;
- To meet a number of the requirements of the Flood and Water Management Act specifically in terms of developing an asset register and producing a local flood risk management strategy.

At this point it is worth noting that the developed area of Minehead is steadily increasing due to a number of residential developments already constructed, and further developments are planned across the study area. These will have had significant impacts on the natural environment, as greener rural areas have been replaced in part by housing and commercial developments, roads and other forms of community infrastructure.

The SWMP process allows the opportunity to enhance the condition of these urbanised catchments helping to improve the water quality. Additionally, the implementation of the SWMP and Action Plan can help to provide significant economic and environmental benefits to the community through better preparation against these potential extreme rainfall events, which to a large extent has not occurred since this development has occurred.

2.6 Phase 1 Summary

Phase 1 of the SWMP has:

- Engaged key stakeholders including the Environment Agency, Wessex Water, Somerset Drainage Boards, West Somerset Council and Somerset County Council, to discuss and agree on local flood risk management within Minehead in the future;
- As part of the first phase of Somerset SWMPs, a local flood risk partnership working approach across Somerset was engaged for managing local flood risk in the future, and;
- Collected and reviewed flood risk data and knowledge from key stakeholders and partner organisations.

3 Phase 2 – Risk Assessment

3.1 Strategic Level Assessment

The first stage of the SWMP risk assessment phase, as defined by Defra guidance, is the strategic assessment. A strategic level assessment identifies broad locations which are considered to be more or less vulnerable to surface water flooding and is valuable at the county level. This then informs the locations requiring an intermediate assessment.

The strategic assessment phase was undertaken by Somerset County Council, prior to the commissioning of this report, through the CFMP, SFRA, national ranking from Defra and the likely level of future development. The CFMP and SFRA reviewed available data and both highlighted the requirement to provide a SWMP for Minehead. Further discussion on these is given in Section 1.5.

3.1.1 Asset Register

The FWMA requires all LLFAs to maintain a register of structures or features which they consider have a significant effect on flood risk in their area. It is recommended that Somerset County Council is the custodian of this asset data and through this role is responsible for coordinating the maintenance of the databases / registers.

To ensure that the databases remain current and thus useful, all partners should be assigned the responsibility for providing updates to their assets in GIS format (at least on a yearly basis). There are two main options for keeping these databases current;

1 The data custodian at SCC receives updated data and alters it on the local system

2 All partners have access to a web enabled interface which allows individual organisations to update their data

Currently SCC have commenced works on collating information on assets into an internal GIS based Asset Register, which is aimed primarily at capturing all the ‘readily available information’. With this information in place, SCC will be able to identify what additional data is required to meet the current requirements under the FWMA. The information being collated currently and entered into the register includes:

- Received as built information
- Historical records
- Information collated during routine site inspections.

3.1.2 LiDAR Issues

LiDAR (Light Detecting and Ranging) is a technique used to map the surface of the Earth’s terrain. It works by bouncing light off the surface of the ground and recording the length of time it takes for the light to be reflected. For the purposes of this study, the LiDAR data, provided by the EA, was used to determine overland flow paths during the modelling stages of this detailed assessment.

This section highlights specific issues that arose in terms of the LiDAR provided and steps taken to overcome such issues.

LiDAR was initially received from the Geomatics team, the standard provider of LiDAR to the Environment Agency. This was provided for the majority of Minehead at either a 1m or 2m grid resolution. While the majority of the data provided was good, and consistency was evident between LiDAR and spot levels provided, there were a number of issues identified.

The provided LiDAR did not cover all of the residential areas and hill based catchment to the south of Minehead. Therefore, to the south of Minehead, the hillside is represented using a 50m grid SAR DTM to bridge the data gap in this location and to complete the range of surface elevations required for the model domain. Due to the nature of a rainfall model, the inclusion of the adjoining hillside to the south of Minehead was crucial to accurately represent the conveyance of surface water within Minehead. Figure 3.1 and 3.2 shows the extents of the LiDAR data and the gaps identified.

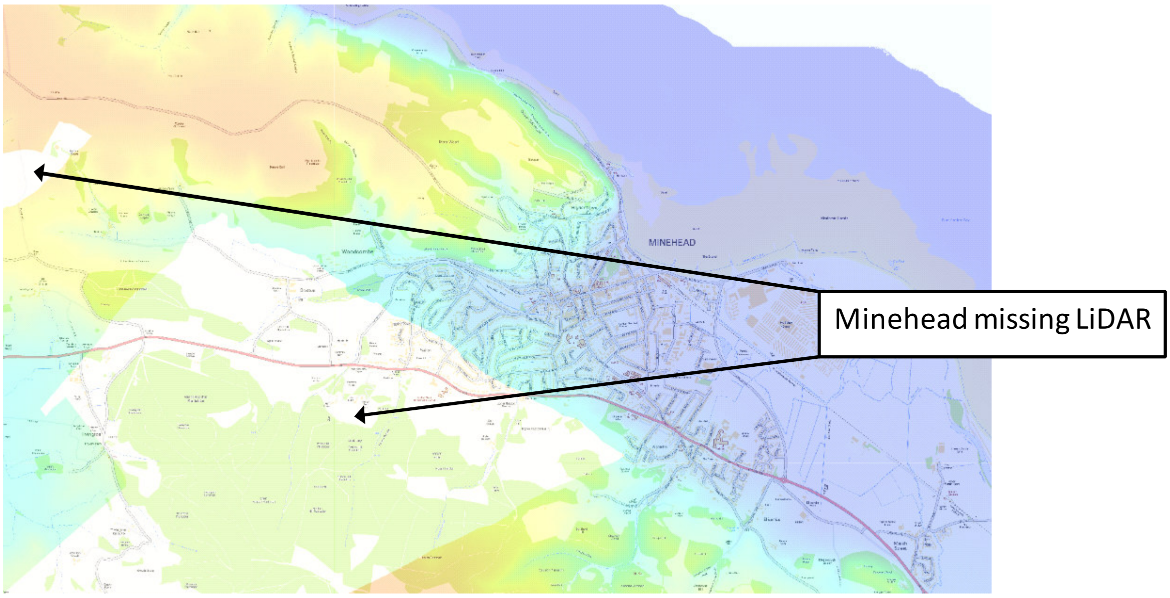


Figure 3.1 Existing LiDAR

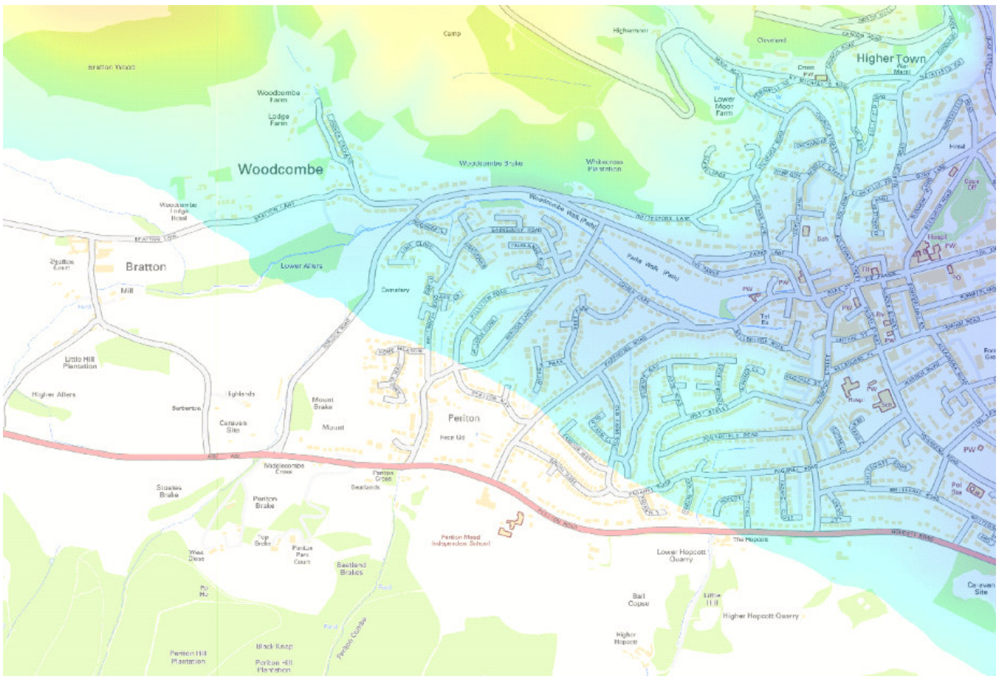


Figure 3.2 - Overlap of residential area between LiDAR and non-LiDAR to the south of Minehead

3.1.3 Flood Incident Register

A sub task within the data assimilation stage was the development of a flood incident register to show all the historical surface water flooding incidents in the Minehead area. For each event the location of each flood incident was registered and the easting and northing for the incident recorded. Each flooding incident was assigned a unique flood incident reference number.

Figure M4 in Appendix C illustrates the extent of the incident database. For some incidents the exact location of flooding was not reported for example "flooding occurred on Smith Street". Where the exact location was not known, an indicative location was picked at a central point on the street. Where known the house number and the incident date and time was recorded. Information on where the flood incident report had originated from e.g. WW incident register and who reported the flood incident e.g. resident or highway inspector was included in the register. The type of flooding was recorded; the reports of flooding generally provided detailed information about the flood type for example property, highway, agricultural or open space.

A crucial component of the incident register is recording the confidence in the source of the information. Some flood events were well reported, with a high level of detail regarding the source, pathway and receptor and other reports did not provide such details. The criteria in Table 3-1 were used to assess the confidence in the flood source.

Flood Source	Confidence in Flood Source
Little or no evidence to support flood source in incident report	Low - Source assumed
Flood source provided by residents or non technical experts with high level of detail in the incident report	Medium - Some evidence
Flood source provided by 'technical experts' e.g. IDB staff or residents with compelling evidence i.e. photos	High - Compelling evidence

Table 3-1 Confidence in flood report sources

A review of the data sets received was undertaken and it was evident that the historical information associated with Surface Water Flooding within Minehead was comparatively sparse with few records in relation to the spatial extent of flooding and the frequency of inundation to properties attributable to a specific source. This could be due to under reporting of problems with flooding by the general public to the Local Authority / EA which means that there is little evidence of "clusters" of flood affected properties.

There was limited correlation between the historical flooding, most of which pre-dates the sea defence works, and the latest version of the EA's Surface Water Maps. This coupled with the delayed delivery of the EA Flood Map for Surface Water (FMfSW) meant that it was extremely difficult to assign a high level of confidence to the results of the Stage 1 assessment. This knowledge gap presented an issue which had to be addressed early in Stage 2 to allow screening and identification of options.

3.1.4 GIS Meta-Database

A GIS meta-database has been developed that allows the user to store and assess information on historic and future flooding. A review of the quality and coverage of the available data has been carried out and the data has been logged and catalogued into the meta-database, so that all project partners are aware of the extent, quality and suitability of available data.

In addition to showing modelled results, the meta-database also allows information regarding historical flooding to be uploaded. Therefore, if decided by SCC, this GIS meta-database tool can be used in maintaining a “live” flooding register that can be updated by the Stakeholders whenever flooding occurs in future.

3.2 Intermediate Assessment

3.2.1 Local Reports of Historical Flooding

This chapter sets out the evidence base used to inform the intermediate risk assessment and covers occurrences of historical flooding, work previously carried out to assess future flooding and existing maintenance regimes.

Overview

Surface water runoff occurs as a result of high intensity rainfall causing water to pond on or flow over the ground surface before entering the underground drainage network or watercourse, or when water cannot enter the network due to insufficient capacity.

In these conditions surface water builds up locally where ground terrain is flat and then would travel following prevailing terrain gradients. Surface water flooding then occurs at locations where surface water flow paths converge, at local dips in the ground and/or due to overland obstructions.

Surface water flooding may in some cases, be exacerbated by the misuse of the below ground infrastructure (for example partial or full blockages resulting from the accumulation of fats, oils and greases within the sewer network) or the failure of infrastructure.

No single organisation has overall responsibility for surface water flooding with responsibility for different aspects of the drainage systems (watercourses, drains and sewers) falling to the Highway Authority (in this case SCC), SDBC, WW and riparian owners.

The following sections outline the historical surface water flooding recorded in Minehead within the context of the definition given in Section 1.3 of this report. This text should be read in conjunction with Figure M4 in Appendix C. The following sources of flooding have been considered.

- Surface Water Flooding
- Groundwater Flooding
- Sewerage Incident Flooding (DG5 Register)
- Open Channel / Culverted Watercourse Flooding
- Flood Risk from the Urban Rural Fringe
- Overland flows from Groundwater sources

This report is based on the information supplied by partners upto February 2012; the occurrence of surface water flooding is not static and thus this represents an understanding of the situation as of then.

A data quality score was assigned in line with Table 3-1 of the SWMP guidance. In this case all data has been tagged as ‘2’ which is data with known deficiencies, indicating that further work could be undertaken to improve the data set. Table 3-2 details the sources of historic flooding data.

Data	Source	Information Included	Data Quality Score
Historic Flooding Hotspots	EA, SCC	Locations of flooding	2
SFRA Shape files	EA, SC	All sources of flooding available at SFRA publication (including Historical Fluvial events)	2
Floods Database	Wessex Water Services	Sewer Flooding (to 2011)	2

Table 3-2 Summary of historic data set types received

The most extensive database is the EA's historic Flood Risk Information System (FRIS) and WW DG5 incident database which recorded major flooding events in Minehead. There are a total of 60 recorded historic flooding events from 1959 to 2007:

- Coastal – 25 records
- Fluvial – 17 records
- Fluvial/Coastal – 4 records
- Pluvial/fluvial- 3 records
- Pluvial – 7 records
- Pluvial/Coastal – 1 record
- Unknown- 3 records

The EA's historic Flood Risk Information System (FRIS) and WW DG5 databases seek to attribute the source (or cause) of the flooding for the majority of the records (e.g. pluvial, fluvial, sewer, groundwater, multiple etc). However, there is a lack of consistency in the application of terminology particularly in the distinction between pluvial, surface water and sewer flooding. An example of flooding on The Avenue from the Bratton Stream in 1960 is shown in Figure 3.3.

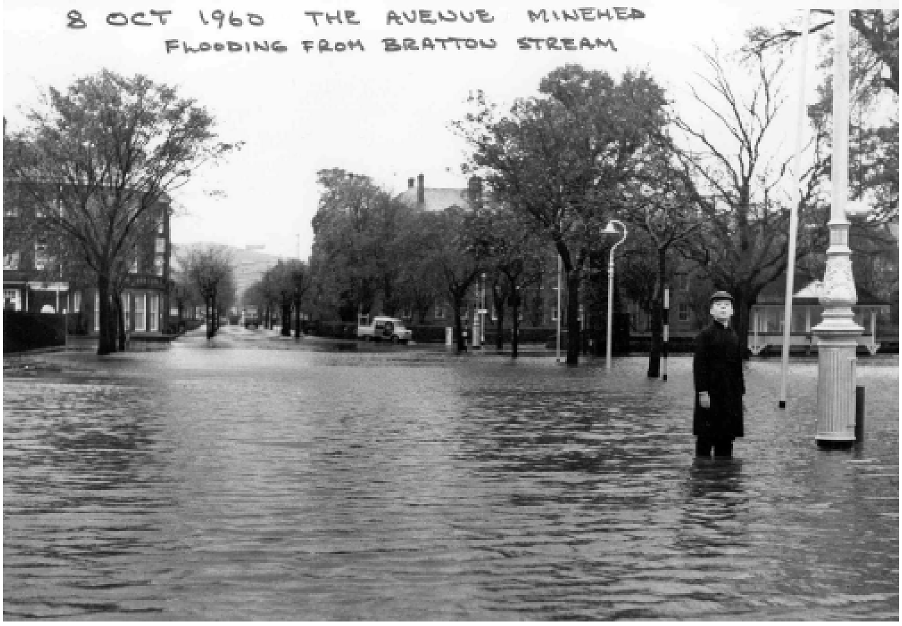


Figure 3-3 Historical Flooding on The Avenue Minehead, October 1960

Accordingly, there is a high probability that flooding within Minehead is under-reported. In general, the historical information associated with surface water flooding in Minehead is comparatively poor with few records in relation to the spatial extent of flooding and the frequency of inundation to properties. As discussed this is possibly due to under reporting of problems with flooding by the general public to the Local Authority / Environment Agency. Figure 3.4 shows the location of historical flood events in Minehead based upon the above data.

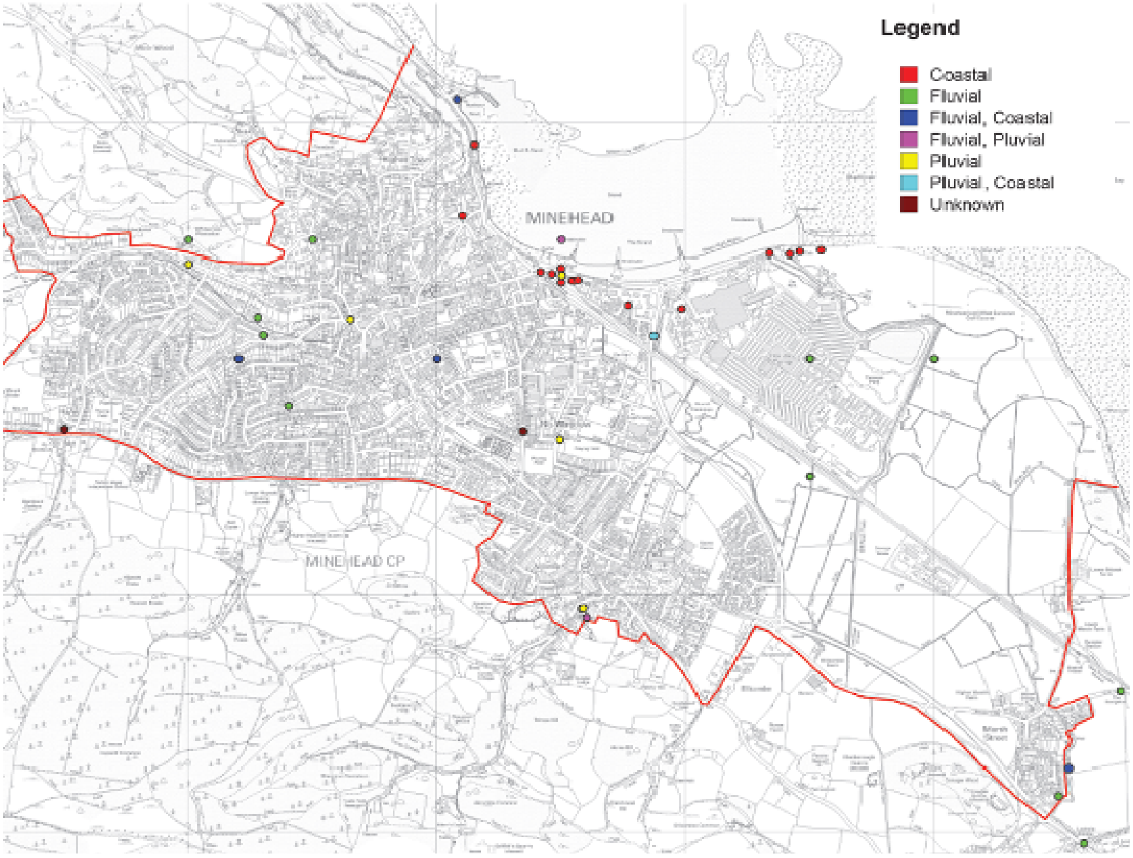


Figure 3-4 Historical Flooding in Minehead

Whilst every effort has been made to analyse the data there is a high probability that there are deficiencies in quantity and the attribution of historical information. It is considered that the majority of the information pertinent to the SWMP falls within the Low to Medium Confidence categories (see Table 3.1). In addition, there is limited correlation between the historical flooding and latest version of the Environment Agency's Surface Water Maps. Caution has therefore been exercised within this section of the report in interpreting the historical record

Surface Water Runoff

Surface water runoff occurs as a result of high intensity rainfall causing water to pond or flow over the ground surface before entering the underground drainage network or watercourse, or when water cannot enter the network due to insufficient capacity.

Pluvial flooding is defined as flooding that result from rainfall-generated overland flow. The historical records include a significant number of descriptive records of flooding which imply that there are issues with pluvial flooding. The records clearly demonstrate that there are problems with pluvial flooding but it should also be recognised that flooding will be the result of numerous factors rather than solely rainfall intensity or duration.

There are 11 reports, collated to date, of direct surface water flooding in the Minehead area, some of which date back to 1980 and so may no longer be applicable due to improvement works. Typically these accounts of flooding are also associated with Coastal or Fluvial Flooding events and so are likely caused by flood waters restricting outfalls.

Groundwater

There are no reported incidences of groundwater flooding in the Minehead area.

Sewers

WW have provided information in relation to flooding incidents identified to have been caused by hydraulic inadequacies. There are 2 known recent reports of water flooding in the Minehead area as taken from the WW DG5 incident database, both of which occurred on the 20th March 2007, however some historic flooding has also occurred at the western end of The Parks. This database is updated annually and so does not include any recent flooding events which may have taken place. No information in relation to other forms of flooding from WW assets has been provided due to relevance to the SWMP (blockages, collapses, etc).

Sewer flooding occurs when the capacity of underground systems is exceeded due to heavy rainfall, resulting in flooding inside and outside of buildings. A flooding issue at King George Road, Minehead has been reported and an account was provided by Ross Hartgen, Highway Superintendent, Environment Directorate, West Somerset Area Office:

"We have over the years had a problem with the whole of the highway (carriageway and footway) being under a couple of foot of water. The flood generally happens in conjunction with the spring tides (which can be very high) and a heavy rainfall. I have attended this site on a couple of occasions as a firefighter to pump away the flood water to protect properties. When the tide drops the standing water does go very quickly. We had the gullies upgrade a couple of years ago to larger trapped pits which replace some old style cast iron trapped gullies and some small brick built catch pits, this was in the main section of Lower King George Road. We are unsure of where these gullies outfall i.e. sewer or join the surface sewer. The plan shows the drainage on the new section of King George Road which was built around 1996 (No work has taken place here as the gully pots are to a good standard). I have also obtained the Wessex Water plans and put together where everything joins up. (New build only).

I met a resident onsite who has informed me that Wessex Water has been and lifted their manholes this week and that the Saw Mills have also cleaned out the ditch where this drainage outfalls. The trouble is that WSC have their sections to clean out and we have already cleared our sections and jetted the culverts which cross Seaward Way."

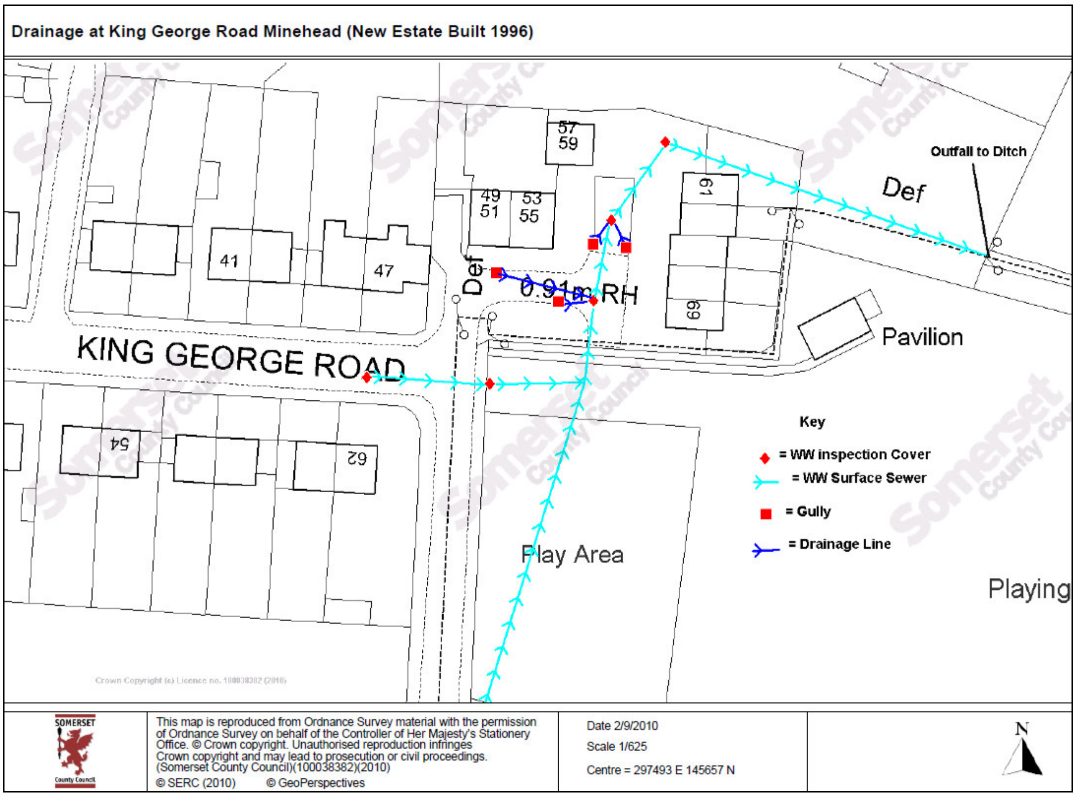


Figure 3-5 Drainage on the new section of King George Road

It was also indicated that when the Sea Defence wall was replaced 10/12 years ago it was possible that not all of the outfalls were picked up, although no further information on this was available at the point of writing and that this should be investigated further as part of the SSFRMP and the developing Local Flood Risk Management Strategy.

3.2.2 Open Channel and Culverted Watercourses

Main Rivers

Under the Water Resources Act 1991, the EA has powers to maintain and improve designated main rivers for the efficient passage of flood flow and the management of water levels for flood defence purposes. These powers are permissive only and there is no obligation on the Agency to carry out such works. The current maintenance regime for designated main rivers uses a risk based approach and government funding via Defra. The ultimate responsibility for maintaining the bed and banks of any watercourse, including its vegetation, rests with the riparian owner(s).

The EA offers a flood warning service to areas covered by main rivers and some ordinary watercourse tributaries. They also provide protection to certain areas at risk from Main River flooding in the form of strategic flood defences.

The main rivers in the Minehead study area are the Bratton Stream, Hopwood Stream, Holloway Stream and Bratton Mill Race and the River Avill. Locations of the main rivers are detailed in Figure 1.6 in Section 1.8. Information on the main rivers in the county area was provided by the EA.

The Bratton Stream discharges into the sea via a flapped outfall. There is a significant risk of tide locking and there is a risk of a combined river- tidal event causing increased out of channel flows. Flooding from this source would result in a greater flood extent and more hazardous flooding to people and property. In addition, the urban nature of the lower Bratton Stream means that surface water flooding is likely to be an issue in Minehead. Whilst the EA has no records of surface water flood events in this location, spatial analysis indicates a high likelihood of surface water flooding in Minehead.

The steep flashy nature of the catchment also leads to rapid runoff into the town. The topography of the town centre and main street is effectively a big receptor bowl,

Awarded Watercourses

Awarded watercourses are any watercourses for which responsibility has been transferred to the Council under Enclosure Acts. The Town Stream, which is culverted for under roads and properties within Minehead is a County asset.

It has been indicated that within areas of Minehead the urban drainage system has not been maintained properly due to mixed ownership. This is primarily associated with The Town Stream, which is located under a main road, but sections of the stream pass under properties. Where the stream passes under properties they are the responsibility of riparian owners and the dual ownership complicates the maintenance responsibilities.

Ordinary Watercourses

Ordinary watercourses are all rivers, streams, ditches and drains that have not been designated as main rivers. The main responsibility for all watercourses lies with the riparian owners. Local Authorities are responsible for any ordinary watercourses that fall within areas where they are the land owner. Details of ordinary watercourses were provided by the Local Authority.

In April 2012 Lead Local Flood Authorities took over all regulatory responsibility for Ordinary Watercourses from the Environment Agency.

In dense urban areas where residential gardens extend up to the edge of the watercourse, blockages can also happen when the watercourse is in flood and it can easily pick up debris. Locations of the ordinary watercourses are detailed in Figure 1.6 in Section 1.8.

There exists anecdotal evidence of localised nuisance flooding on the hockey pitch adjacent to the Alcombe Brook. It is assumed the original ditch was undersized and overgrown vegetation and silt has resulted in the ditch overflowing due to the reduced capacity. The new development plans at the ‘New Horizons’ site may take measures to address this issue.

Anecdotal evidence of flooding in the local area is still outstanding from the Parrett IDB. This could provide some useful additional information on the drainage system and pinch points.

3.2.3 Overland Flows from Groundwater Sources

There are no reported incidences of overland flows resulting from groundwater sources.

3.2.4 Further Consultation

The list below identifies areas where there have been historically reported incidents or there are perceived flood risk issues through additional consultation with the stakeholders:

SCC Highways Department

The dates of the major flooding events that affected Minehead, as well as the rest of Somerset, approximately ten years ago were:-

18 December 1999	29/30 October 2000
24 December 1999	7/8 December 2000

These dates all featured in major and widespread flooding throughout Somerset. In the specific case of Minehead the major flooding locations were:-

1. The Bratton Stream surcharging the Town Culvert as it enters it at The Parks portal. The water then ran down through the town along Park Street, The Parade and The Esplanade, flooding roads and properties on the way.
2. Flooding of the roads on the "Marsh" part of the town around Mart Road. Also some of the roads that lead into this such as the eastern end of King George Road. This is thought to relate to the effects of heavy rain coinciding with high tides.
3. Surcharging of the various small streams that run through and under Minehead leading to flooding of roads and properties.

3.3 Potential Indicators of Surface Water Flood Risk

3.3.1 EA Areas Susceptible to Surface Water Flooding (AStSWF) Maps

The Environment Agency have produced the outputs of a simple surface water flood modelling at a national scale. The modelling did not take into account underground sewerage and drainage systems or smaller over ground drainage systems. No buildings were included and a single rainfall event was applied. The model parameters used to produce the maps were:

- 0.5% AEP (1 in 200 chance of occurring in any given year)
- 240 minute storm duration
- 1km^2 resolution
- No allowance for underground pipe network
- No allowance for infiltration

The AStSWF map gives three bandings indicating areas which are 'less', 'intermediate' and 'more' susceptible to surface water flooding. The map is not suitable for identifying individual properties at risk of surface water flooding.

These maps were updated and republished in January 2009. Figure M3 in Appendix C illustrates the distribution of surface water flooding risk across the Minehead Area.

3.3.2 EA Flood Maps for Surface Water (FMfSW)

Following on from the release of the Areas Susceptible to Surface Water Flooding, The EA updated the original mapping in order to produce the Flood Maps for Surface Water (FMfSW), which were released in October 2010. The existing maps were updated to take account of buildings and a simplified representation of the underground drainage system, and more storm events were analysed. It should be noted that these maps do not take into account artificial drainage regimes. The model parameters used to create these new maps were:

- External Publication Scale 1:25,000
- 3.33% AEP (1 in 30 chance of occurring in any given year) and 0.5% AEP (1 in 200 chance of occurring in any given year)
- 66 minute storm duration
- $5m^2$ resolution with country split into 5km squares
- In rural areas, rainfall was reduced to 39% to represent infiltration
- In urban areas, rainfall was reduced to 70% to represent infiltration
- Global use of Manning's 'n' of 0.1 for rural and 0.03 urban areas

The new maps have two bandings of "deep" or "shallow" and are produced for both 3.3 % AEP (1 in 30 chance of occurring in any given year) and 0.5% AEP (1 in 200 chance of occurring in any given year) events.

Summary of Results

As a result of National Surface Water modelling undertaken (ASTSWF and FMfSW) modelling the following mechanisms of flooding were identified:

- Ponding of flow in topographical depressions.
- Ponding upstream of structures with small underpasses/subways
- Overland flow along topographical lows and valley channels such as residential streets, gardens and through property

The surface water modelling was validated through a comparison of the FMfSW shallow and deep outlines, Areas Susceptible modelling and the historic flood incidents to establish if there was a correlation between the mapped areas identified at risk.

The mapping did not correspond with all of the historic flood incidents, however it may be that the source and location of the exact flood incident has not been accurately reported or recorded in the past.

3.3.3 British Geological Survey Groundwater Flooding Susceptibility Maps

Groundwater flood risk has been assessed by the British Geological Survey (BGS) for the whole country via national flood hazard maps. The groundwater flooding susceptibility data shows the degree to which areas of England, Scotland and Wales are susceptible to groundwater flooding on the basis of geological and hydro-geological conditions.

The dataset does not show the likelihood of groundwater flooding occurring, i.e. it is a hazard not risk-based dataset. The risks have been derived using set 'rules' in order to identify areas "based on geological considerations, where groundwater flooding could not occur, i.e. areas where non-aquifers are present at the ground surface" (BGS).

Areas susceptible to groundwater accumulation are passed through a second set of rules in order to create a groundwater level surface (this was taken from groundwater contours, inferred river levels, borehole data and other BGS datasets). The final groundwater level was then compared to a DTM, and the resulting modelled depths of groundwater level above the surface were translated into associated risk categories 'Very High', 'High', 'Moderate', 'Low' and 'Very Low'.

BGS note that “The susceptibility data is suitable…to establish relative, but not absolute, risk of groundwater flooding at a resolution of greater than a few hundred metres. In all cases it is strongly recommended that the confidence data is used in conjunction with the groundwater flooding susceptibility data”. In addition, “the susceptibility data should not be used on its own to make planning decisions at any scale, and, in particular, should not be used to inform planning decisions at the site scale. The susceptibility data cannot be used on its own to indicate risk of groundwater flooding”.

At this stage of the SWMP, these maps have not been purchased by SCC so have not been used to assess the hazard of groundwater flooding as there is a perception that the risk of groundwater flooding is low in Minehead based on the Jacobs report.

3.4 Maintenance Regimes

Maintenance regimes are critical to ensuring the continued and effective functioning of assets to manage surface water flood risk. Existing maintenance tasks/ responsibilities have been reviewed as part of the SWMP where information is currently available and these are listed below. The SWMP will also assist in identifying and focussing needs in terms of future maintenance and it is recommended that all partners and stakeholders provide the relevant information for inclusion in the final version of this report as appropriate.

Somerset County Council Highways Authority

The SCC Highways Authority has the over-riding responsibility for all highways and highway structures throughout the council area (with the exception of motorways and some major trunk roads), and operates programmes of inspection and maintenance for bridges and gullies within the county area.

West Somerset Council

West Somerset Council is the Land Drainage Authority for Minehead and undertakes maintenance to the Ordinary Watercourses. It carries out annual weed cutting and de-silting when required, and also undertakes regular inspections of assets, including those that it is responsible for, as well as private assets.

Wessex Water

Maintenance regimes are critical to ensuring the continued and effective functioning of assets. Wessex Water has a proactive and risk-based approach to asset management. All sewers on the WW GIS system have been allocated a risk score, based on the likelihood of failure and the impact, should a failure occur.

Due to the public health reasons, foul/combined sewers have a higher impact than surface water sewers on the system. WW proactively inspect the highest risk sewers and the findings of CCTV surveys drive a programme of proactive sewer rehabilitation. Problematic sewers are investigated on a reactive basis and if necessary added onto the WW maintenance programme (e.g. regular inspections or jetting).

Environment Agency

The Environment Agency carries out maintenance on those rivers or streams designated as main rivers. The Environment Agency's annual maintenance programme can be viewed by using their website[10].

Somerset Drainage Board Consortium - IDB

The Somerset Drainage Boards is the organisation that manages the operations of three drainage Boards in Somerset. The three Boards are:

- The Lower Axe District Drainage Board
- The Lower Brue District Drainage Board
- The Parrett Internal Drainage Board

The main activity of a Board is to manage water levels for the protection of people, property and the environment. The IDB manages rhynes or smaller watercourse on the floodplains of the Somerset Levels and Moors. The River Parrett IDB is located in the Minehead vicinity. The area of the River Parrett IDB district is 24 ha, within which there are 140 structures operated and maintained and the length of watercourses maintained is 507km (317 miles).

3.5 Intermediate Level - Model Development

3.5.1 Model Evolution

As discussed in Section 3.1, there are a number of factors influencing surface water flooding as a result of localised heavy rainfall event in Minehead. These include:

- Surface water runoff from surrounding recreational / agricultural land towards residential and commercial regions
- A relatively steep topography providing a focused collection of flow paths toward the centre of Minehead.
- Highway conveyance of surface water
- Percentage of urbanisation
- The capacity of the sewer network

Recent advances in hydrological and hydraulic modelling techniques have allowed for a gradual improvement in assessing sources of flooding and flood risks. Of particular note for this study, advances in direct rainfall modelling allow representation of storms that are not purely fluvial. This technique allows analysis of surface water runoff, infiltration, depression storage and rainfall distribution and its effects on flooding. This is particularly important in meeting the requirements of a SWMP in an environment such as Minehead, where historical data has shown that flooding from the Bratton Stream and other watercourses is not the only significant source of flooding.

This method of 'raining' on the model domain allows sites at risk of surface water flooding to be identified and also illustrates the main flood pathways by which flooding occurs. In doing so the model represents a means of identifying areas at risk of flooding; from which multi-criteria analysis scores and financial damages can be calculated. Once the baseline flood risk has been identified, the model then provides a useful tool to assess the viability of potential flood alleviation measures.

1D-2D ISIS-TUFLOW hydraulic modelling is designed to ensure that the flooding mechanisms are appropriately represented by the model. This approach enables the effect of the topography on overland flood routes to be simulated by direct application of a rainfall profile to a 2D hydraulic model domain. TUFLOW's 2D solution is based on the Stelling solution scheme. It is a finite difference, fixed grid, alternating direction implicit (ADI) scheme solving the full 2D free surface shallow water flow equations. TUFLOW is suited to modelling flooding in major rivers through to complex overland and piped urban flows, and estuarine and coastal hydraulics.

TUFLOW utilises standard GIS packages to manage, manipulate and present input and output data. In order to model surface flows, TUFLOW requires terrain data. This can be from any source (GPS, LiDAR, photogrammetry etc.) but the more detailed and accurate the source of the data, the more accurate and reliable the solution is likely to be. For this study, terrain used by TUFLOW has been generated from 1m resolution LiDAR data within the town of Minehead and 50m resolution SAR data to the south of Minehead (see Section 3.5).

In order to address the specific issues relating to the Minehead SWMP, a three stage modelling strategy was developed for this study.

- Stage 1 - Hydrological Analysis and development of the bare earth model of Minehead (see Section 3.5).
- Stage 2 – Identification and evaluation of Wetspots using the bare earth model developed in Stage 1 and Prioritisation using Scoring and Weighting techniques (see Section 3.5.4).
- Stage 3 - Detailed modelling assessment of specific Wetspots within Minehead. This included the development and testing of engineering options and economic analysis (see Section 3.6).

The three stages are also associated with increasing refinement of the model. As noted above the Stage 1 and 2 modelling was based upon bare earth modelling with infiltration rates deemed to be appropriate to the catchment area.

3.5.2 Hydraulic Modelling - Common Principles

Roughness

Material layers were applied to the model domain to cover areas of houses, trees and roads. These surfaces were then assigned appropriate Manning's Roughness Coefficient values (n) to reflect differences in hydraulic roughness. The 2D model representation of roughness includes depth varying Manning's coefficients. Roughness is defined at two depths - shown in Table 3-3.

No.	Material Type	d_1 (m)	n_1	d_2 (m)	n_2
1	Grazed Fields / Short Grass	0.1	0.3	0.2	0.05
2	Roads	-	-	-	0.02
3	Kept Fields	0.05	0.3	0.1	0.04
4	Urban	0.05	0.1	0.1	0.065
5	Scrubland	0.1	0.3	0.3	0.06
6	Trees / Wooded	0.1	0.3	0.2	0.1
9	Buildings	-	-	-	1

Table 3.3 TUFLOW Material Roughness Values

For kept fields, the Manning's roughness for depths of flow less than 0.05m (= d1) is 0.3 (= n1). Similarly for depths greater than 0.1m (= d2) the Manning's roughness is 0.04 (= n2). Between 0.05m and 0.1m the value of roughness varies linearly. This was specifically introduced to account for shallow depths associated with the flow across surfaces in direct rainfall conditions.

The materials layer used to assign roughness to the model was derived from Mastermap data provided under the project data request. Within this dataset, different land use types are identified using land use codes and detailed descriptions of land use type. An example is shown in Table 3.4.

Code	Theme	Description	Make
10172	Roads	Earth Track	-
10111	Land	Natural Environment	Rough Grassland

Table 3.4 Mastermap Code Allocation

The Mastermap data was trimmed to the boundaries of the Minehead study domain in order to remove land uses that were irrelevant to the study. Using a GIS filtering process, land use codes that appear within the model domain are identified. Each of the land use descriptions were interrogated against Manning's coefficient that would be appropriate for that specific land use. A materials file was created utilising the land use code and appropriate roughness. This allowed roughness to be applied in detail to the model domain.

Representation of Buildings

Buildings have been represented by applying a high manning's roughness of 1.0 to the footprint of a building. This encourages water to flow around buildings where the roughness values are lower and representative of the surrounding materials. Whilst the higher roughness values are used to denote buildings, surface water can be conveyed through buildings to represent residential and commercial inundation during flood events.

3.5.3 Hydrological Analysis / Bare Earth Modelling

Stage 1 - Bare Earth Model Construction

The boundary of the Minehead SWMP model was determined by the surrounding catchment boundary. This is represented in Figure 3-6.

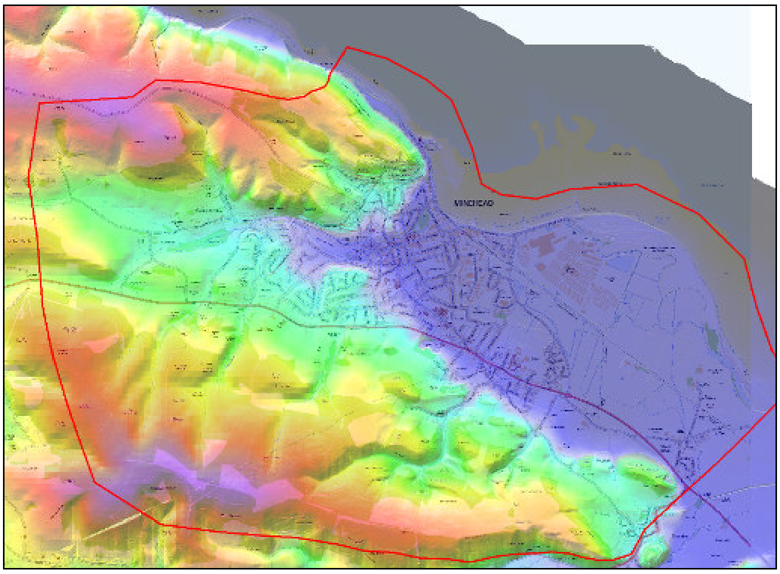


Figure 3-6 Minehead Direct Rainfall Model- Extents of TUFLOW Domain (5.0m grid)

The Minehead domain was established using a code polygon, which was drawn around the surface water catchment and available surface elevation data, allowing a reasonable extra distance as a buffer. This buffer was to ensure that the surface water catchment had been encompassed. The downstream boundary for the model is a HQ line, which has been snapped around the entire perimeter of the domain code region. The HQ line is designated as a Water Level ("H") versus Flow ("Q"). TUFLOW assigns a water level to cells selected by this line, based on a stage-discharge curve. This curve was automatically generated by TUFLOW, using a slope ('b' value) of 0.0001. This value was chosen to give a suitably steep slope, based on its use in other rainfall models.

It was not necessary to be too precise in assigning a value to the HQ line, as its only purpose is to remove water from the domain as it reaches the edges and drains away from the modelled region. This prevents ponding or glass-walling of water at the edge of the model domain and therefore reduces instabilities and erroneous results. As a buffer was included around the catchment, it was decided that the HQ line is sufficiently far from any point of interest as to not affect the results. For the broad scale investigation that is required under Stage 1, a grid size of 5 m was chosen for the TUFLOW domain as noted in Table 3.5. This grid size is considered to be representative of the wide area of the initial modelling because it is approximate to street width (understood to be the dominant flow paths through urban environments)

Model Parameters

Grid Size	**5 m**
Time Step	**1 second**
Bare Earth Storm Durations	**240 minutes**
Bare Earth Model Return Periods	**0.5 % AEP**
Modelling Return Periods	**3.33%, 2%, 1.33%, 1% 1% CC, 0.5% and 0.1% AEP events**
Storm Duration	**4 hours**
Total Run Time	**16 hours**

Table 3.5 Stage 1 Model Parameters

The results for a 0.5% AEP 240 minute storm with infiltration rates in equal to 30% for the duration of the model run are shown in Figure 3.7. Depths above 0.1m but below 0.3 m are shown in light purple; depths above 0.3 m are shown in dark purple. This model output shows a clear problem associated with flooding around the town centre of Minehead, but also that surface water flooding is apparent throughout the model domain due to the outlying steep catchment.

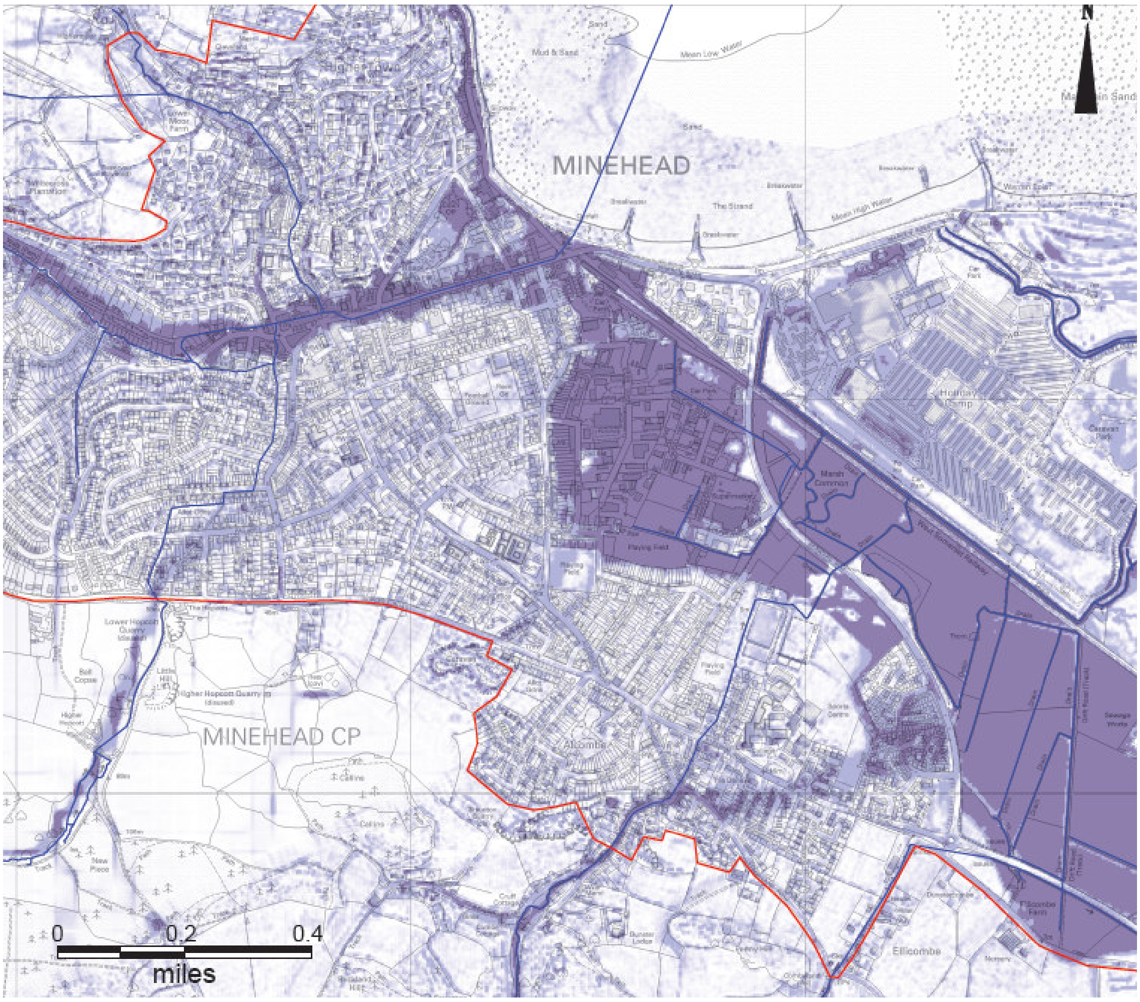


Figure 3-7 Minehead Pluvial Model Results for Do Minimum 0.5% AEP

Hydrological Analysis

As noted above the purpose of developing a TUFLOW model of Minehead was to analyse the effects of rainfall on the town by looking at flow paths, velocities and catchment response. This was achieved by applying Depth Duration Frequency (DDF) rainfall derived from the FEH CD Rom over the model area. The application of direct rainfall to a 2D model domain is a fairly novel approach to assess flood risk. One advantage of the approach is that the model does not require estimation of flow at discrete locations since flow is automatically generated from the incident rainfall according to the way in which it is channelled by the modelled topography.

Whilst the direct rainfall model explicitly simulates the channelling and pooling of surface water, losses to the ground through infiltration are not immediately accounted for. Such a scenario – in which no infiltration losses are represented – could be assumed to be indicative of a frozen or highly saturated catchment response. However this is a very conservative assumption and hence it is desirable to include a measure of infiltration losses in the model to make it more representative. It was determined and agreed at the onset of the project that a uniform value of 30% infiltration will be estimated across all areas of the model domain.

Due to the proximity of watercourses within the model domain, the three watercourses were represented in ISIS (1D) and hydraulically linked to the 2D TUFLOW domain. The three watercourses are the Bratton Stream, Holloway Stream and Hopwood Stream. Due to the nature of a relatively steep catchment the response time for rainfall events will be low. As such, a standard 2-year return period flow was adopted for the fluvial conditions in all watercourses for each model run.

TUFLOW Rainfall Boundary

The ISIS-TUFLOW model was designed to simulate the effects of combined fluvial and pluvial induced flooding to Minehead. Fluvial input aside, a rainfall hyetograph was applied over the catchment through a TUFLOW rainfall boundary region. The hyetograph defines point rainfall and duration and is applied homogeneously over the entire extent of the model. Figure 3.8 shows an example hyetograph used in the modelling for a 1 in 0.5 % AEP event for a storm duration of 4 hours equivalent to the FEH DDF rainfall of 55mm. No internal boundaries were defined within the TUFLOW domain.

For the initial assessment it was necessary to model flooding throughout the whole of Minehead in order to identify the areas most susceptible to flooding.

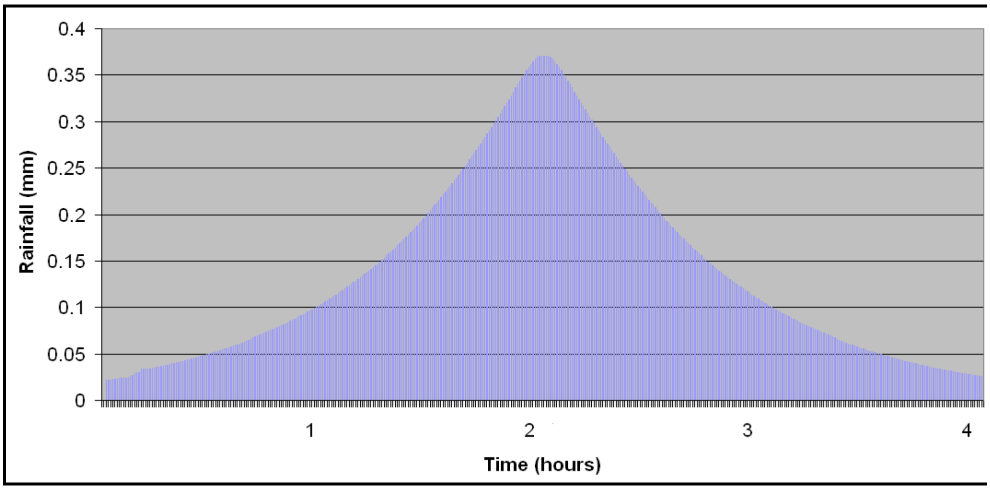


Figure 3-8 Example Hyetograph

3.5.4 Wetspot Selection and Prioritisation

Approach

The principal purpose of a strategic assessment is to identify broad locations which are considered more or less vulnerable to surface water flooding. These are then taken through an intermediate assessment. This chapter describes the selection and prioritisation of areas in line with the strategic and intermediate risk assessment phases. This section is divided into three sub-sections to facilitate the above objective. These are:

- Identification of Potential Wetspot Areas within Minehead using the results of the bare earth modelling described in Section 3.5.3. This is referred to as Stage 2 of the modelling strategy
- Scoring and Weighting Methodology. This describes the Scoring and Weighting technique agreed with the SWMP Project Board.
- Prioritisation of Wetspots within Minehead using the Scoring and Weighting methodology.

The objective of the Scoring and Weighting assessment and prioritisation is the identification of agreed Wetspots to be taken forward to the intermediate assessment stage. The workflow to establish the prioritisation is shown in Figure 1.2.

Stage 2 - Identification of Potential Wetspot Areas

A Wetspot is an area deemed to be at significant risk of surface water flooding. This risk is identified using either historical flooding reports and / or the Environment Agency's Flood Maps and localised modelling. A number of principles were established in relation to identifying Wetspot areas within the Minehead SWMP. These were:

- The Wetspots were initially identified by depth using the Stage 1 bare earth modelling of Minehead, historical data and supporting information from Somerset County Council.
- The Wetspots must include all of the upstream contributing areas to ensure that flood flows to the area where water accumulates are considered by the detailed assessment. In order to meet this criterion the velocity and flow outputs from the Stage 1 bare earth model were interrogated to delineate the Wetspot, sub-catchment areas.

In order to short list sites with an emphasis on surface water, a method of assessing the whole study area in 1km grid squares was undertaken to narrow down the potential areas to be taken forward for detailed study in Stage 3. In order to provide a direct comparison to more available data, the preliminary Direct Rainfall Modelling outputs were broken down in a similar fashion to the Flood Map for Surface Water. The 3 layers of mapping taken forward for modelling were the 4% AEP Deep, 0.5% AEP Shallow and 0.5% Deep events.

These represent where surface water would be expected to flow or pond under two rainfall events, one with a 1 in 25 and the other with a 1 in 200 chance of occurring in any year. However, users must note that this is the chance of this rainfall, and not of the resulting flood extent occurring. Consequently it only provides a general indication of areas which may be more likely to suffer from surface water flooding in these rainfall probabilities. The general assumption used by the EA for the FMfSW was that a 1 in 200 rainfall event resulted in approximately a 1 in 100 flood event. For each rainfall probability, the map shows two layers which can be used individually to indicate:

- Surface Water Flooding' - flooding **greater than 0.1m deep**
- Deeper Surface Water Flooding' - flooding **greater than 0.3m deep**

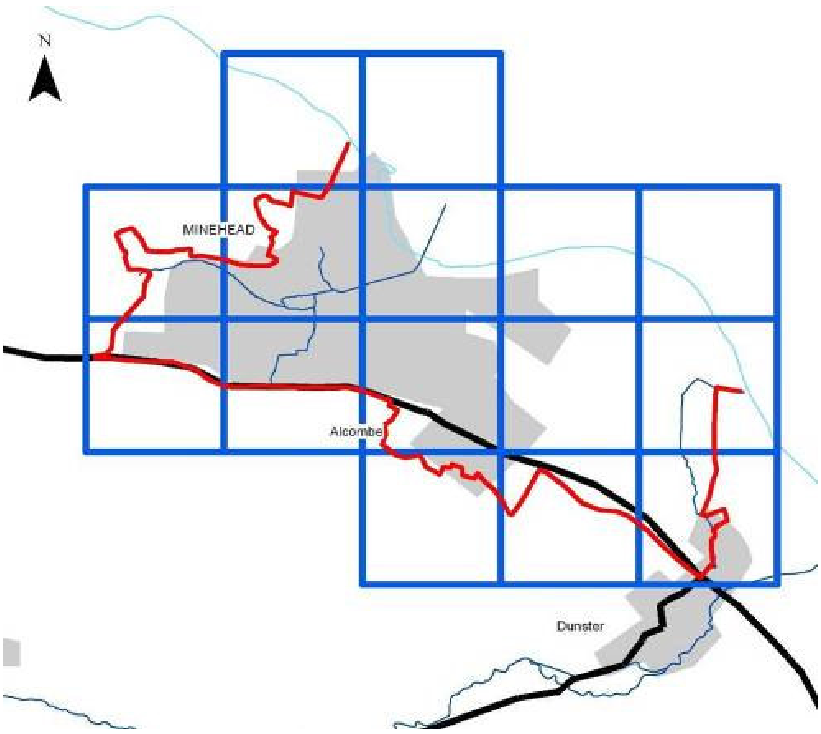


Figure 3.9: The Minehead Study Area with 1km^2 Grid squares

This mapping was used to calculate the percentage area of flooding within each grid square for the available events. To rank the squares the 3 percentage values were then summed to give an overall value of flooding, which would group areas at a higher risk of flooding above those areas only at risk during certain events.

From the above analysis those squares which had a flood percentage of ≥ 30% were prioritised for further analysis. This process identified 5 squares as having the greatest percentage risk of surface water flooding and these were taken forward for further analysis of the surface water flood risk and other potential flood risks in Section 3.2.1. A summary of the percentage surface water flooding within each of the five 1km² is shown in the table below and Figure M3 in Appendix B shows the mapped results of this study.

% Surface Water Flooding within 1km² Study Area

Ref.	4% AEP High	0.5% AEP Shallow	0.5% AEP Deep	Sum Total
M1	10	13	21	44
M2	11	15	12	38
M3	16	23	15	54
M4	8	34	24	66
M5	5	10	16	31

Table 3.6 Percentage Surface Water Flooding in Study Area

Flood Risk Constraints Mapping

Due to the potential for errors within Surface Water modelling, it is necessary to assess the areas against other sources of flooding to ensure that the Wetspots taken forward for detailed study are those at greatest risk and that any flood risk mitigation strategies respond to the inter-related flood risk issues.

The following assessment categories were used to summarise the surface water flood risk and other potential flood risks for the 5 areas identified in Minehead. A summary sheet for each of these squares is presented below and supporting information can be found in Appendix B.

Flood Constraint Mapping Assessment Categories

1. **Preliminary Direct Rainfall Model** – Percentage of Study Square Flooding, represented:

   a 4% AEP > 0.3m (Deep)

   b 0.5% AEP - 0.1m – 0.3m (Shallow)

   c 0.5% AEP > 0.3m (Deep)

Note: Where the extent of modelling has spilled onto the beach beyond the coastline, the grid square calculation does not take into account these points.

2 Areas Susceptible to Surface Water Flooding (ASTSWF) – Comparison to the Flood Map to Surface Water

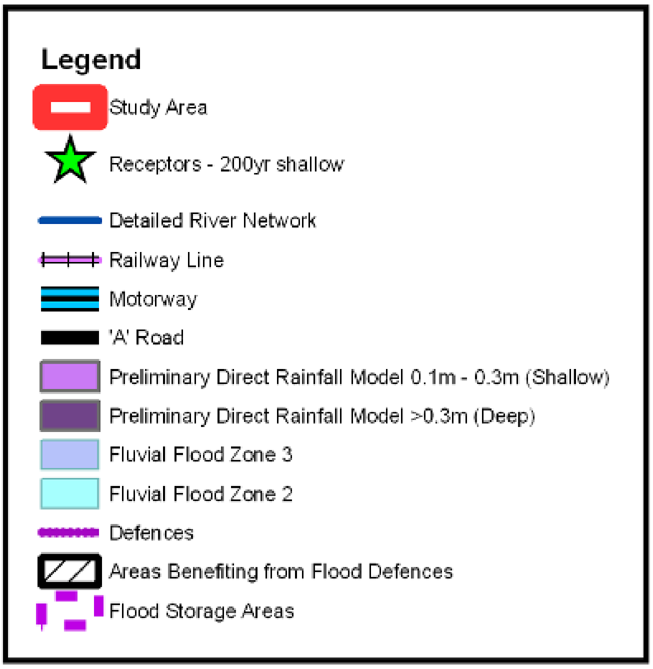
3 **Fluvial** – Name of Watercourse(s) flooding where given

4 **Historic** – Count of number of incidents from Historic Flood Risk Register

5 **Sewer** – Count of 2% AEP Flood Volume Nodes from Wessex Model

6 Groundwater – Yes or None

7 **Reservoir –** None, Intermediate, Major


Legend
Study Area
Receptors - 200yr shallow
Detailed River Network
Railway Line
Motorway
'A' Road
Preliminary Direct Rainfall Model 0.1m - 0.3m (Shallow)
Preliminary Direct Rainfall Model >0.3m (Deep)
Fluvial Flood Zone 3
Fluvial Flood Zone 2
Defences
Areas Benefiting from Flood Defences
Flood Storage Areas

Location M1

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- Majority Urban area, approximately 25 dwellings at risk of 0.5% AEP Shallow Flooding.
- Flooding largely follows the fluvial flood route along the A39 and The Avenue.
- Outline show flooding of Minehead Hospital.
- Flooding at the A39 / The Avenue Junction could be a severe impedance on evacuation routes from Minehead

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1 **Preliminary DR Modelling**

A:10% B:13% C:21%

2 **ASTSWF**

Similar extent although additional flooding reduced along Summerland Avenue and Irnham Road

3 **Fluvial**

Flooding along The Town Stream

4 **Historic**

6 Fluvial incidents, 2 Fluvial/Coastal, 2 Pluvial, a number of which are on Periton Lane

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5 **Sewer – 2% AEP Flood Volume**

Yes – 17

6 **Groundwater**

None

7 **Reservoir**

None

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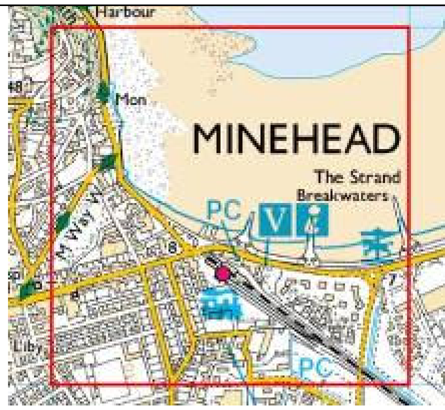
Location M2

- Approximately 50% Urban area (with remainder on the beach), approximately 25 dwellings at risk of 0.5% AEP Shallow Flooding.
- Surface Water flood routing appears similar to Fluvial flood routing backing up from the culverted Town Stream
- Although not deemed critical infrastructure, the West Somerset Railway Station and Line is shown to be at risk.



1 Preliminary DR Modelling

A:11% B:15% C:12%

2 ASTSWF

Larger flood extent over Tregonwell Road and Summerland Avenue

3 Fluvial

Land Drains from the east within Dunster Marsh as well as overland flow from the Culverted Town Stream.

4 Historic

1 Coastal incident comprising of a retail unit on Warren Road

5 Sewer – 2% AEP Flood Volume

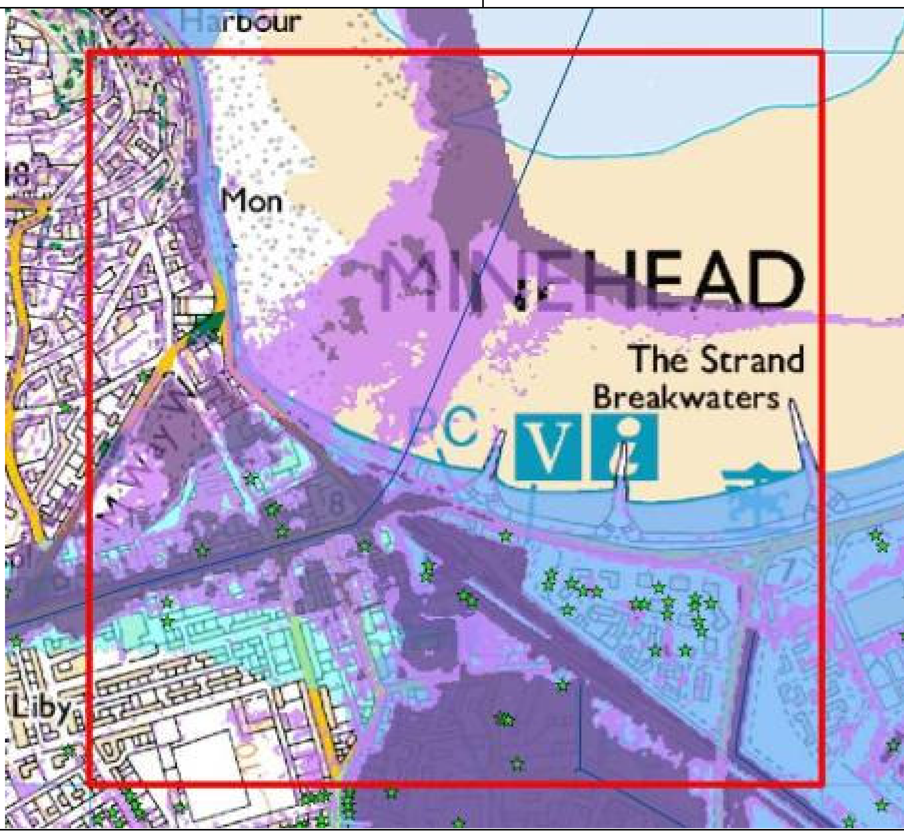
Yes - 8

6 Groundwater

None

7 Reservoir

None



Location M3

- Urban area including industrial estate, approximately 289 dwellings at risk of 0.5% AEP Shallow Flooding.
- Extent of Surface Water flooding of the industrial estate very similar to the fluvial extent, therefore likely low spot in the terrain
- Intermittent flooding along the A39 and Alcombe Road.

1 Preliminary DR Modelling

A:16% B:23% C:15%

2 ASTSWF

Similar Flooding of Industrial Estate although significant routing across recreation ground and across Marshfield way towards Seaward Way.

3 Fluvial

Land Drains to the east within Dunster Marsh

4 Historic

1 Pluvial, 1 unknown located in/near the industrial estate.

5 Sewer – 2% AEP Flood Volume

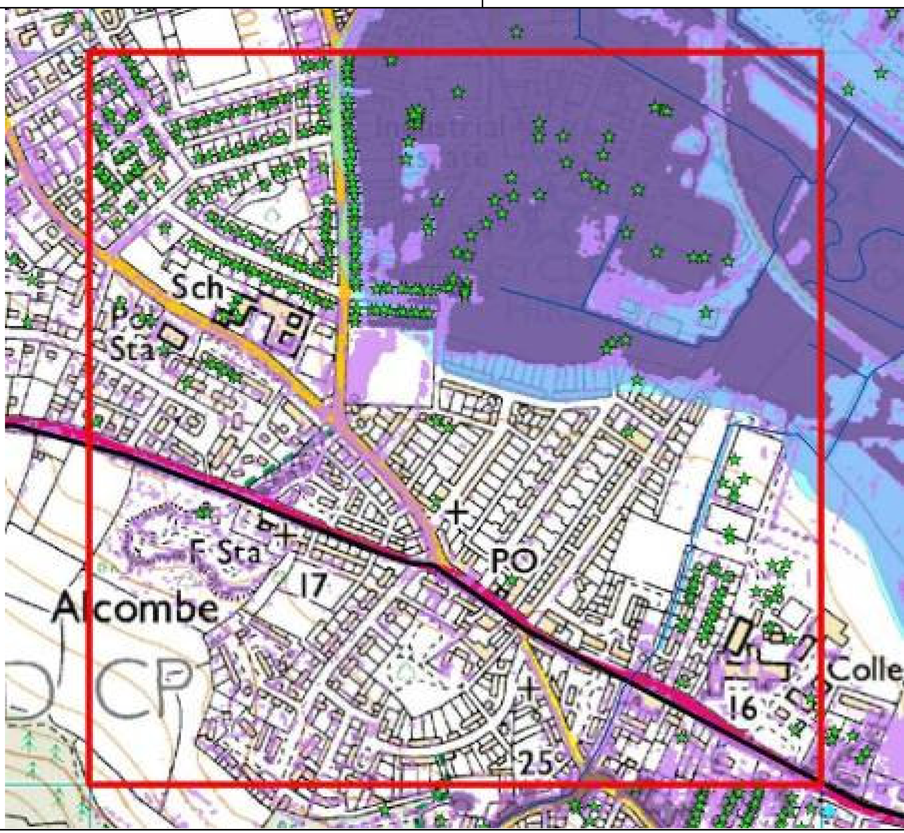
Yes - 6

6 Groundwater

None

7 Reservoir

None



Location M4

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- Largely open area with northern portion being the Butlins Holiday Village and the south west corner comprising of the Mallard Road Housing Estate and College grounds, with approximately 229 dwellings at risk of 0.5% AEP Shallow Flooding.
- Although not deemed critical infrastructure, the West Somerset Railway Station and Line is shown to be at risk.

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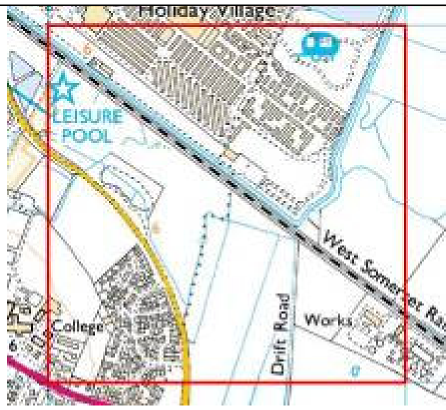

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1 Preliminary DR Modelling

A:8% B:34% C:24%

2 ASTSWF

Lesser flooding showing on the south side of the railway, with more flooding shown on the north west side of the railway.

3 Fluvial

Significant flooding from numerous land drains within Dunster Marsh

4 Historic

7 Fluvial incidents, the earliest record being in 1954.

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5 Sewer – 2% AEP Flood Volume

None

6 Groundwater

None

7 Reservoir

None

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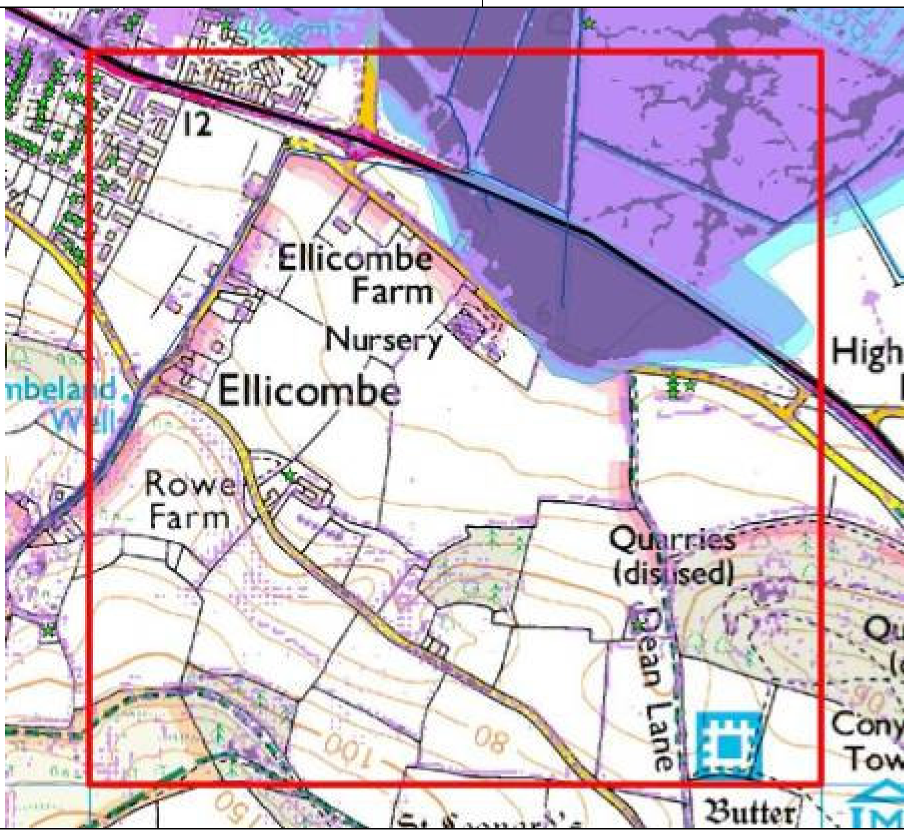
Location M5

▪ Largely rural area with approximately 8 dwellings at risk of 0.5% AEP Shallow Flooding. ▪ Flooding apparent along the A39 near Ellicombe Farm.	
1 Preliminary DR Modelling A:5% B:10% C:16% **2 ASTSWF** Greater flooding along Ellicombe Lane with differences in depth either side of the A39 **3 Fluvial** Flooding from numerous land drains within Dunster Marsh from the North **4 Historic** None	**5 Sewer – 2% AEP Flood Volume** None **6 Groundwater** None **7 Reservoir** None



Receptors Present in Squares

In order to move forward to the detailed modelling stage, it was necessary to prioritise areas where the surface water flood risk combined with the likely risk to key receptors is greatest.

To understand the likely risks within the 5 identified areas above, a GIS query was run to output the receptors from the National Receptor Dataset that fall within the Direct Rainfall 0.5% AEP Shallow event. These datapoints were then identified using the multicoloured manual code in the dataset to provide the following table of results.

1km² Area	Receptors Flooding at 200yr Shallow Within Km²												
Ref.	Household	Shop/ Store	Vehicle Services	Retail Service	Office	Distribution/ Logistics	Leisure	Sport	Public Building	Industry	Miscellaneous	Unknown	SUM
M1	25							1				6	**32**
M2	25	1										13	**39**
M3	289	8	1		1		2	2	1	1	1	72	**378**
M4	229	8		3	1			1		1	3	78	**324**
M5	8											3	**11**

Table 3.7 Number of Receptors Flooding at 200 year Shallow within km^2

3.5.5 Locations for Further Assessment

In the analysis undertaken above 5 areas were initially identified for further assessment based on the percentage surface water flooding within 1km^2 i.e. those with ≥ 30 % of surface water flooding within the square. These 5 areas were then assessed further by looking at surface water flood risk and other potential flood risks in more detail and a GIS query was run to identify the receptors susceptible to flooding in the Direct Rainfall 0.5% AEP Shallow event.

The exclusion of an area from further detailed analysis as part of the SWMP does not negate the requirement to fully consider surface water flood risk as part of site specific FRAs.

3.5.6 Outputs for Identified Locations

This assessment has identified 5 flood Wetspots which require further, more detailed assessment (possibly through modelling approaches). Identification of plausible mitigation measures, including quick wins or immediate measures which can be put in place have been identified and are discussed further in Section 4.3.

Further detailed options appraisal has been undertaken based on detailed modelling for the areas agreed in Minehead. The detailed option investigations are based on providing alleviation options. Non specific options to help manage surface water risk in the 5 study areas have also been identified. This ensures that each area is considered at some level of detail even if it is not taken forward for full detailed analysis. These options include SuDS measures.

3.5.7 Identification and evaluation of Wetspots

The model results concluded that the effects of such a steep surrounding catchment and low lying coastal town would result in surface water flooding throughout Minehead. Due to the nature of rainfall modelling, when considering the derivation of Wetspots there must also be the consideration with regards to the source of flooding. As such, the catchment which affects the intended Wetspot must be fully represented to accurately quantify the effects of surface flooding.

Due to the nature of the steep surrounding topography and low lying centre of Minehead it was unreasonable to create smaller and more refined models without affecting the total rainfall catchment. Therefore, it was agreed that the model domain used in Stage 1 would be taken forward to detailed modelling within Stage 3.

3.6 Detailed Model Development

Following the identification of the entire region of Minehead being taken forward for detailed modelling, the possible refinement of the existing model was reviewed. Following this review, the model is then developed to enable a greater level of detail to be represented within the model domain. The main aspect of this increased level of detail is the inclusion of the Wessex Water storm water sewer network.

Owing to the large size of the model domain taken forward to Stage 3, it was determined that further refinement of the model grid could not be undertaken. At the time of the model construction in 2010, ISIS-TUFLOW Double Precision models could only be performed using the 32-bit version of the software. 32-bit software is limited by a specific amount of memory (3.2Gb) which, in turn limits the amount of computational processes available. Creating a finer grid for what was already considered as a large rainfall catchment was beyond the software capability at the time of this study for a hydraulically linked ISIS-TUFLOW model.

The objective of Stage 3 modelling is to understand and quantify the effects of surface water flooding and to model the effectiveness of any proposed engineering option elements to mitigate for the effects of surface water flooding for ‘doing nothing’, ‘doing the minimum’ and ‘doing something’ options. The following sections include discussion on the development of the doing nothing and doing the minimum models which form the basis of the economic assessment.

Model Parameters	
Grid Size	5m
Time Step	1 sec
Bare Earth Storm Durations	240
Infiltration	30%
Modelling Return Periods	10%, 4%, 2%, 1.33%, 1% 1% CC, 0.5% and 0.1% AEP events
Storm Duration	4 hours
Total Run Time	4 hours

Table 3.8 Minehead Model Parameters

The main progressions between the Stage 1 and Stage 3 assessment was the inclusion of the sewer network system provided by Wessex Water (shown in Figure 3-10). The pipe network system was converted to a suitable format and represented within ESTRY-TUFLOW as a 1D sub-surface pipe network. At suitable locations, the pipe network is connected to the 2D domain to represent the surface water drainage, connectivity and subsequent conveyance.

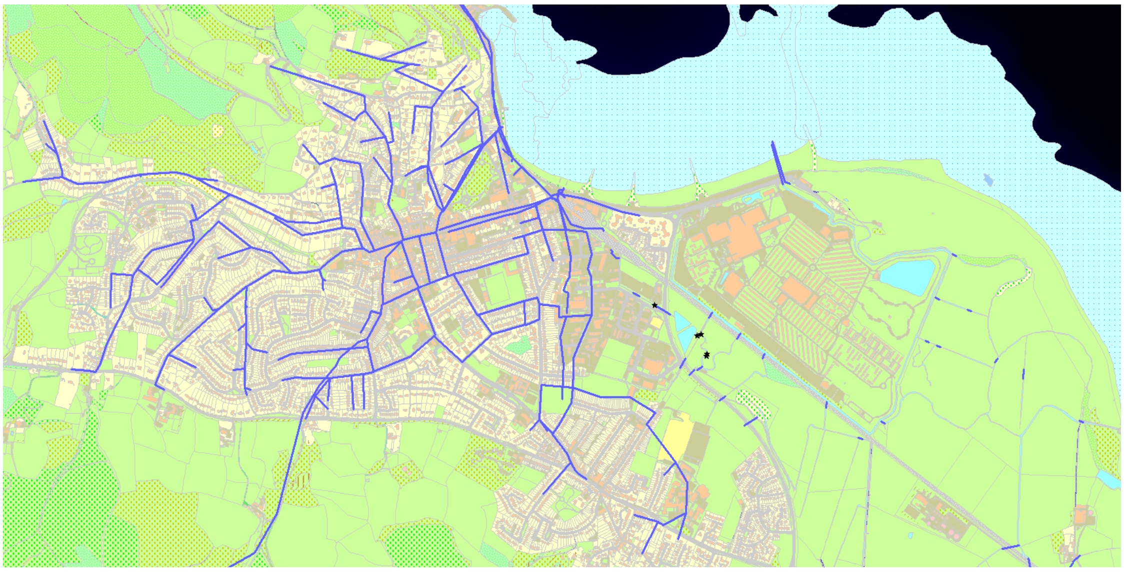


Figure 3-10 Minehead Surface Water Sewer network

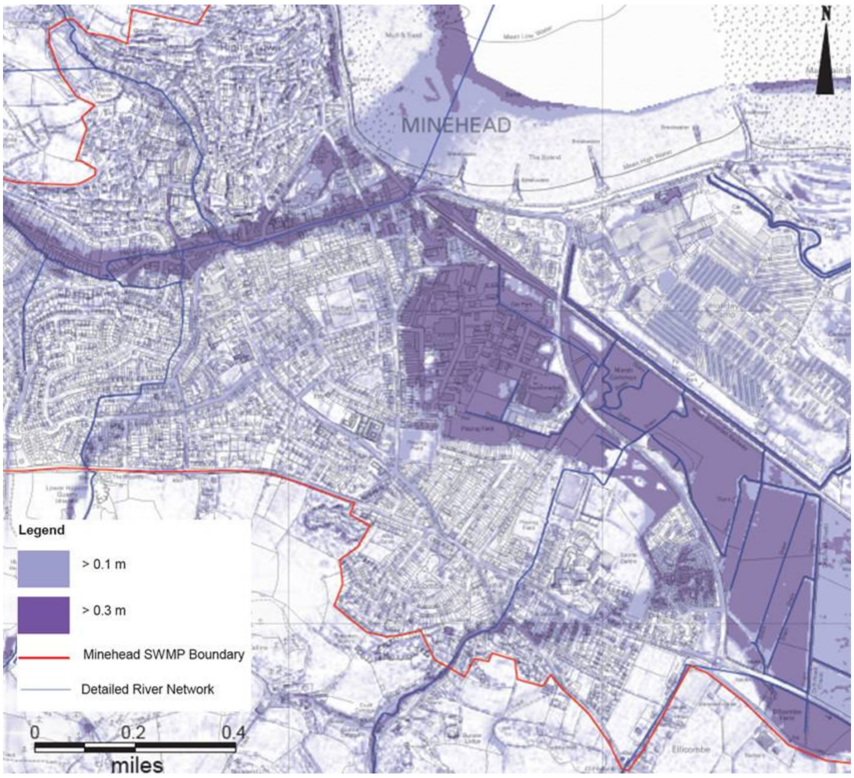


Figure 3-11 – Minehead TUFLOW Model Results (0.5% AEP) – Maximum Depth (Do Nothing Scenario)

3.6.1 Model Sensitivity

Baseline Detailed Model Run with no Tide Locking Scenario

The same model parameters were used as detailed above in Table 8.1. With the baseline there was no inclusion for the sewer system. This assumes that no maintenance of the drainage systems is undertaken and that failure will inevitably occur over time.

3.6.2 Model Verification

Unfortunately, there is currently no information in the form of historical evidence or flow monitoring to verify the TUFLOW model for the Minehead site other than the records of historic surface water flooding. Nevertheless, it is considered that these models are representative of the conditions within the Wetspot.

3.7 Model Outputs

3.7.1 Flood Depth, Velocity and Hazard Maps

Flood depth, velocity and flood hazard mapping has been produced from the Tuflow models for the eight return periods as detailed. The mapping is included within Appendix D.

Flood hazard are important factors in the assessment of flood risk and evacuation of the general public. Three categories of flood hazard have been identified in the DEFRA / Environment Agency Documents: Flood Risk Assessment Guidance for New Development[11], (DEFRA Report FD2320) and Flood Risks to People Methodology[12] (DEFRA Report FD2321). These are "Danger for All", "Danger for Most" and "Danger to Some". The equation below gives the relationship between hazard, depth, velocity and debris:

$H = (v+0.5) \times d + Df$ Where

H = hazard	Df = debris factor
v = velocity	Df = 0.5 for d < 0.25m
d = depth	Df = 1.0 for d > 0.25m

The mapping presented in the SWMP has been based upon the following thresholds, taken from DEFRA Report FD2320. However it should be noted that DEFRA Report FD2321 places a different hazard rating of the transition to Category 3. The FD2320 indicates that the change occurs at 2.0 whereas the FD2321 report indicates that this happens at 2.5. This has a significant impact on the interpretation of the results for the SWMP which are discussed below but it should be noted that the results are presented conservatively as set out below.

Danger to Some	Category 1	H > 0.75
Danger to Most	Category 2	H > 1.25
Danger to All	Category 3	H > 2.00

The colouring of the flood hazard mapping is commensurate with the hazard categorisation given in Figure 3-11. Areas coloured red are considered dangerous for all; areas in dark yellow are dangerous to most; light yellow is dangerous to some and blue areas are inundated areas mainly on the margins of the flood plain which are considered to hold little hazard. The time series graphs show the depth (left axis) and hazard category (right axis) for specific control point locations as discussed above.

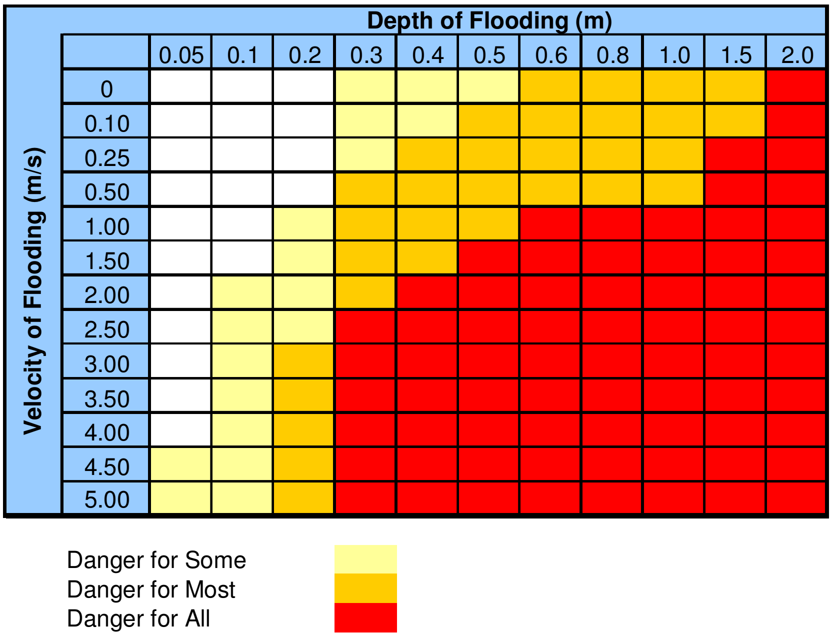


Figure 3-11 Hazard Categorisation

The flood hazard map should include the likely extent (including water level or depth) of possible floods, the likely direction and speed of flow of possible floods, and whether the probability of each possible flood occurring is low, medium or high (in the opinion of the person preparing the map).

A flood risk map is a map showing in relation to each flood risk;

- The number of people living in the area who are likely to be affected in the event of flooding
- The type of economic activity likely to be affected in the event of flooding
- Any industrial activities in the area that may increase the risk of pollution in the event of flooding
- Any relevant protected areas that may be affected in the event of flooding
- Any areas of water subject to specified measures or protection for the purpose of maintaining the water quality that may be affected in the event of flooding
- Any other effect on human health, economic activity or the environment.

3.8 Role in the SWMP

The outputs of the Surface Water Management Plan meet the requirements of the above Flood Risk Regulation. Modelling carried out for Stage 1-2 of the SWMP will produce Hazard outputs in the modelled areas. The return periods run in the modelling allow for determination of probability for medium and high probability flooding.

The scoring and weighting analysis and the reporting of the results of this analysis will meet the Flood Risk Map requirement of the Flood Risk Regulations. The GIS Meta-database contains information on the extent of flooding to Key Flood Receptors.

4 Phase 3 - Options

4.1 Measures Identification

The engineering elements evaluated in this section are based upon employing the most appropriate techniques for the various sites. The engineering elements proposed within this section fall into a range of categories as shown in Figure 4.1 and where possible and economical the use of Sustainable Drainage Systems (SuDS) and surface water reduction strategies has been promoted over hard infrastructure alternatives such as the upgrading of existing sewers.

Accordingly, the engineering options proposed within the report have been designed to be accommodated within the urban environment.

It should be noted that the engineering options proposed are potential solutions to current issues and priorities. During the course of the SWMP time frame, it is possible that these issues or priorities may change and new constraints and priorities may present themselves. The options may, therefore, be difficult to implement, and it should be borne in mind that the engineering works for some options are proposed over a long period.

Somerset County Council, the Lead Local Flood Authority under the Floods and Water Management Act, has powers to carry out works for the management of surface water run-off, ordinary watercourses and groundwater.

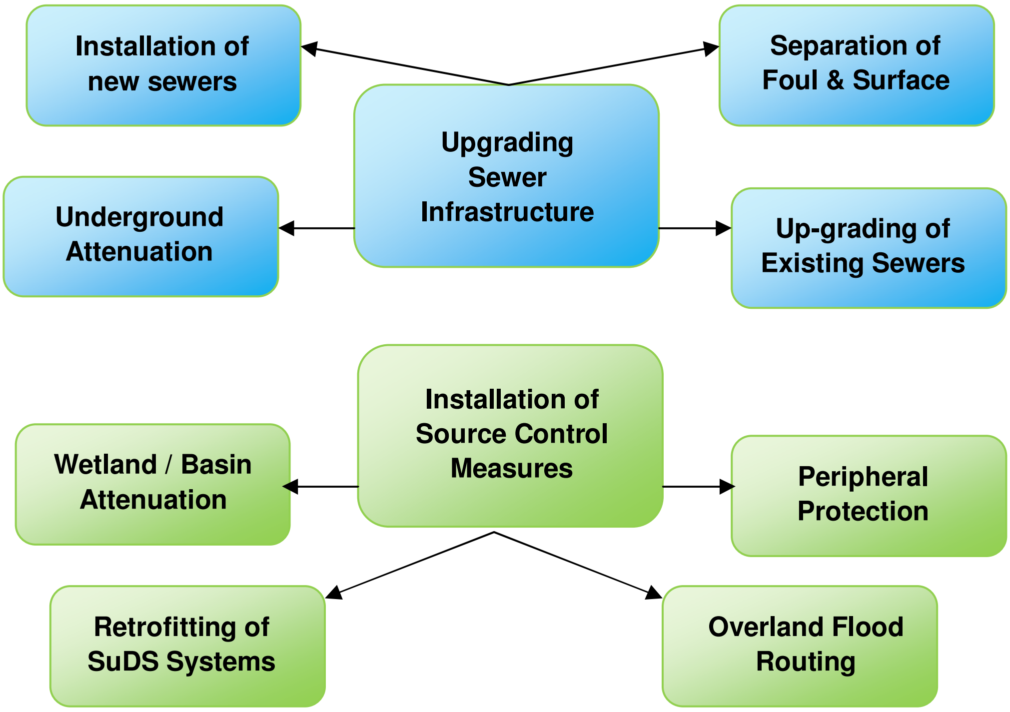


Figure 4-1 Surface Water Flood Mitigation Options

The key constraints (see Figure 4-2) associated with the implementation of all of the options are space and cost.

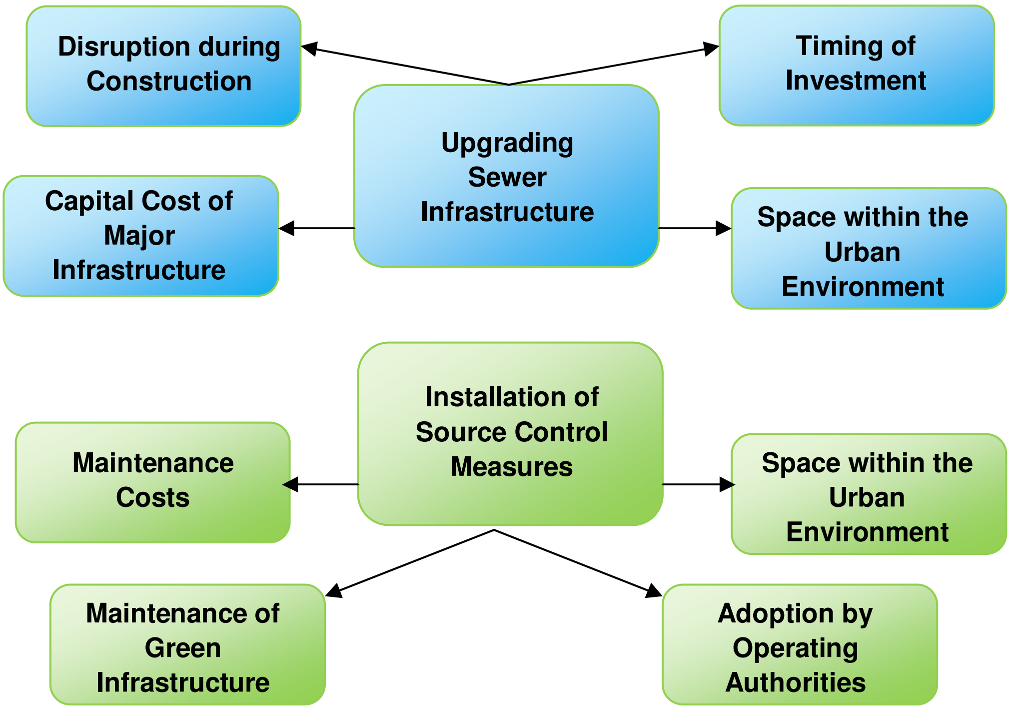


Figure 4-2 Engineering Options Constraints

In Minehead, there are several open spaces which can be utilised for attenuation but in general the surface area is dominated by roads and suburban housing. Nevertheless attenuation has been explored at several locations with the introduction of attenuation basins, wetlands and ponds and there has been consideration of the use of swales where possible.

For example, open spaces at a number of schools have been investigated as potential sites for attenuation structures. It should be noted however that other pressures such as the need to expand and improve existing school sites may be contrary to using school open spaces in flood mitigation works. New developments may however offer alternative opportunities for partnership working, such as utilising green roofs in new school developments.

The street environment is also a significant constraint in the installation of drainage infrastructure. Within these areas techniques including permeable paving, filter drains, Road side rain gardens are discussed in detail in the following section.

4.2 Source Control Measures within highways

The installation or retrofitting of source control measures within highways is an important consideration for two main reasons which are:-

- Roads and highways form an important conveyance route for flood waters
- The majority of roads and highways are within the public domain reducing potential land ownership problems with access and construction.

A range of source control measures have been considered for the purposes of the SWMP and this includes:-

- The installation of permeable paving
- The use of road side rain gardens
- Filter drains
- Swales
- Infiltration basins

Space within the urban environment is a key issue in retro-fitting SuDS solutions. Appendix E describes the range of measures that could potential be utilised within future development to derive opportunities to incorporate source control measures. In addition, the examples should be reviewed to identify locations where retrofit interventions would derive benefit in reducing the surface water entering the below ground infrastructure.

For example, the current street scene could be changed through the introduction of permeable paving and the use of road side rain gardens (see Appendix E). These could have a further benefit of controlling traffic as well as assist storm water drainage within the highway.

Permeable paving provides significant benefits in relation to rainfall interception as well as an option for removal of surface water volume. Permeable paving systems are designed to allow water to infiltrate to the underlying granular sub-grade material and eventually provide local groundwater recharge.

The feasibility for the installation of permeable paving should be considered at every site where this SuDS measure is proposed. To work most effectively, they should be installed in areas with permeable soils and a low risk of groundwater flooding, as this would indicate relatively low levels of groundwater. As with all SuDS, it is essential that they are maintained effectively to prevent blockage by silt and gravel, which will reduce their effectiveness. If not maintained regularly, the ability of permeable paving to remove surface run-off will decrease until they become, in effect, impermeable surfaces.

The purpose of the road side rain gardens system is to create a chain of surface water storage areas each connected with a filter / French drain. Surface water is temporarily stored in the soil and granular layer at the base of the structure before being gradually released into the groundwater through infiltration into the ground below. Intentionally situated in roadside verges, this will provide areas of storm water infiltration and planting into the smallest of places. Road side rain gardens typically contain hydrophilic flowers, grasses, shrubs and trees.

4.3 Option Consultation

Hyder presented possible locations for investigating attenuation options, see Figure 4.6. Location 1, 3, 4 and 5 were discounted because they were identified as proposed development areas by WSC or considered too steep. During discussions it became apparent that other options including storage on the Bratton Stream had previously been considered and discounted by the EA. Indeed, Location 2 had been looked at in the past and was not feasible.

Hyder carried out a review of the detailed rainfall model results in conjunction with aerial mapping to assess where options could be implemented to alleviate rather than prevent surface water flooding and identify Quick Win measures.

4.3.1 Quick Win Measures

A pre-feasibility study was completed for Minehead in 2008 which looked at options for upstream attenuation and new culverts. At the time, this study concluded that none of the schemes would qualify for FDGiA but one might attract Local Levy contributions. Subsequently, all large scale capital options have been discounted on economic grounds. This SWMP therefore considers smaller scale, retrofitted, soft options for managing surface water flood risk in Minehead.

A review of the detailed rainfall model results was carried out in conjunction with aerial mapping to assess where options could be implemented to alleviate rather than prevent surface water flooding. The options identified for specific locations are classed into nine types which are described in Table 4.1.

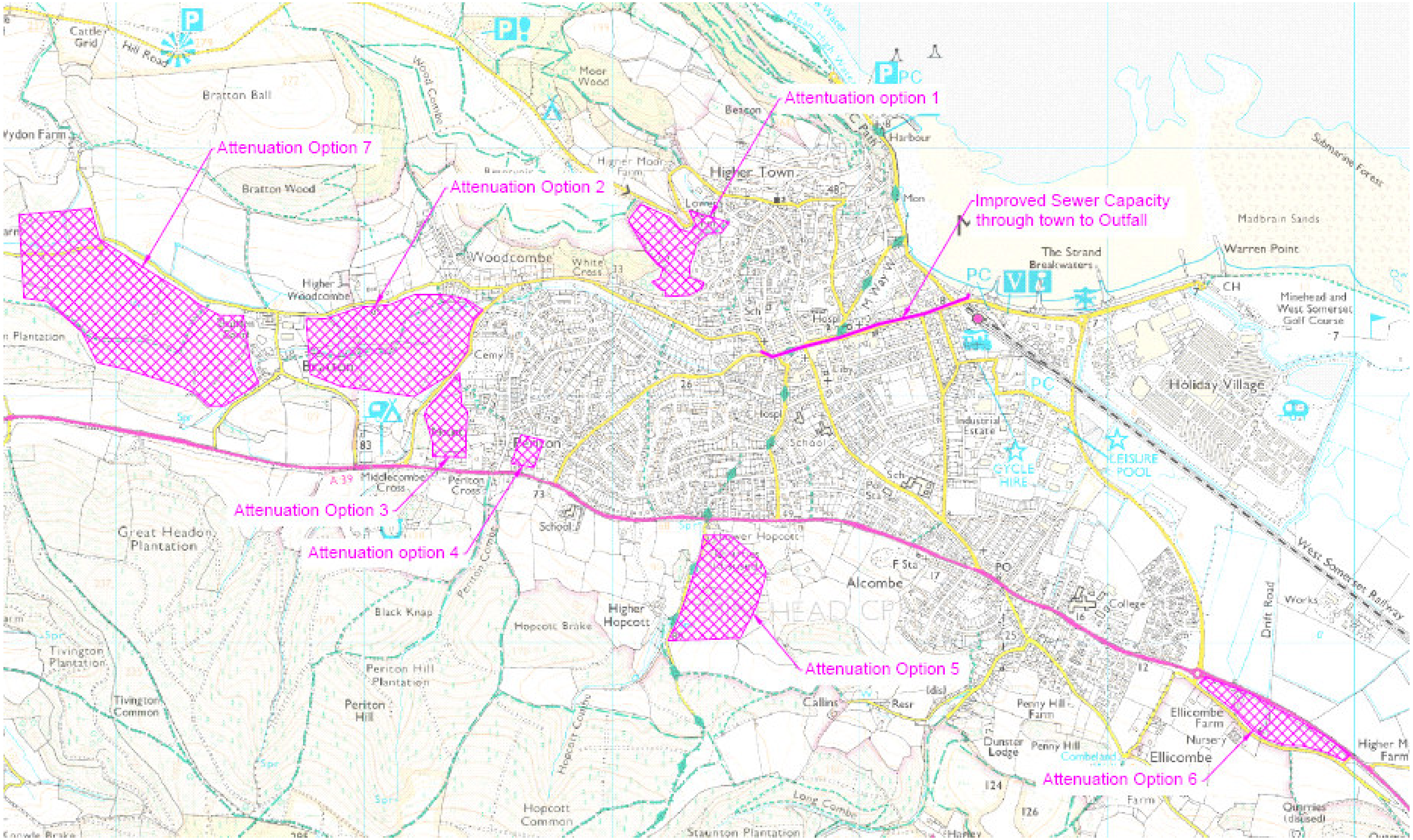


Figure 4.6 Possible Locations for Attenuation Features and Improved Sewer Capacity from Options Appraisal

Option Type	Description
Earth Bund	Addition of a small earth bund in strategic locations to assist in diverting surface flows away from the natural course
Increase surface permeability	Investigate the feasibility of increasing the permeability of large currently impermeable surfaces. This will allow great infiltration and will also slow the flow of surface water to the sewer system thus helping to alleviate pressure on the sewer network.
Kerb Works	Local raising or lowering of kerbs to divert surface water flows away from key locations or into roadside vegetation / ditches
Local attenuation and infiltration	Making use of existing green spaces and roadside vegetation to store and infiltrate surface water flows. May need to be in conjunction with kerb works to ensure they are utilised.
Maintenance	Develop a proactive maintenance regime for critical structures such that cleaning and clearing takes place in advance of a storm event(- the EA have a pre and post check round on structures on the Minehead streams ahead of any bad weather.)
Property level protection and resilience	Where flooding cannot be prevented on a wider scale, consider property level protection such as raised thresholds, internal waterproofing and flood recoverable products
Reduce storm water to combined system	Wessex Water records suggest that there is a high proportion of combined sewers in Minehead. Benefits could be obtained by encouraging residents and businesses to collect rain water and reduce the level of impermeable surfacing around their properties. This would help to reduce pressure on the combined system.
Riparian education	There are a number of watercourses in Minehead which pass through private properties. An information campaign explaining the responsibilities of riparian owners and the specific consequences in the local area of failing to meet these can help to address flood risk.
Roadside Rain Garden	A roadside rain garden is a planter containing an appropriate mix of plants and substrate which receives flood flows and slows the response of rainfall into the sewer system. During small events, all flood flows can be accommodated and used by the plants.

Table 4.1 Option Types

The selected locations listed in Table 4.2 should not be seen as an absolute and Somerset County Council should seek to work with residents and businesses to explore further options for reducing surface runoff throughout Minehead.

ID	Priority Square	Location	Type	Description
XX-G		Whitecross Lane	Kerb Works	Lower kerb to encourage water from road into open park.
XX-A		Whitecross Lane/ Woodside Close	Kerb Works	Re-profile kerb to hold water on road away from properties and direct to park.
XX-B		Whitecross Lane / Woodside Close	Riparian Education	Education / communication campaign on riparian ownership.
M1-C	M1	Larkhouse Road Park	Local Attenuation and Infiltration	Some scope to open area up to capture more flood flow.
M1-A	M1	The Parade	Roadside Rain Garden	Make use of central flower beds as roadside rain gardens.
M2-K	M2	Esplanade	Local Attenuation and Infiltration	Gardens / PO space.
M2-A	M2	Esplanade	Local Attenuation and Infiltration	Gardens / open space - potential to store excess flows.
M2-B	M2	Esplanade	Kerb Works	Localised kerb works to move flows off road into open space.
M2-C	M2	Esplanade	Kerb Works	Localised kerb works to move flows off road into open space.
M2-D	M2	Glenmore Road	Reduce Storm water to Combined	Large number of combined sewers - keep surface water out by using water butts / permeable paving.
M2-E	M2	West Somerset Railway car park	Increase surface permeability	Surfacing potential scope for increasing permeability / storage.
M3-F	M3	Mart Road	Local Attenuation and Infiltration	Green fringes existing-develop into swales / storage. Lower kerbs.
M3-A	M3	Mart Road	Local Attenuation and Infiltration	Green fringes existing-develop into swales / storage. Lower kerbs.
M2-F	M2	Vulcan Road	Increase surface permeability	Scope for increasing permeability
M2-G	M2	Mart Road	Local Attenuation and Infiltration	Green fringes existing-develop into swales / storage. Lower kerbs.
M2-H	M2	Vulcan Road	Local Attenuation and Infiltration	Scope for directing flows into green area.
M3-B	M3	Cats Lane	Local Attenuation and Infiltration	Make use of existing ditch and green area – re-camber to redirect flood flows away from houses. Infiltrate / attenuate.
M3-C	M3	Hawksworth Road	Local Attenuation and Infiltration	Scope to lower this area to pond more water - re-profile away from buildings.
M4-C	M4	Puffin Close	Earth Bund	Raised embankment is preventing flood flows from moving onto open space downstream. Potential for re-profiling / drainage outlets to release flow.

M4-A	M4	Wigeon Drive area	Earth Bund	Local works to stop flows from running off rural area into housing development - small earth bund along back of estate.
M5-A	M5	Ellicombe	Kerb Works	Small scale road re-profiling to encourage flood flows away from the road.
XX-C		Manor Road	Riparian Education	Riparian ownership. Small bridges crossing watercourse.
XX-D		The Hopcott	Earth Bund	Topography channels rural runoff. Small scale re-grading to reduce this.
XX-E		Paganel Road	Reduce Storm water to Combined	Combined sewers in this area. Aim to keep surface water out where possible.
XX-F		Whitworth Road	Riparian Education	Riparian ownership – education.
M3-D	M3	Spring Gardens	Riparian Education	Alcombe Brook - riparian ownership.
M1-B	M1	The Avenue	Maintenance	Proactive maintenance regime for brook culvert.
M2-I	M2	Blenhiem Road	Local Attenuation and Infiltration	Potential to make more use of this open area to alleviate flows onto properties opposite. Re-camber road.
M2-J	M2	Mart Road	Reduce Storm water to Combined	Combined sewers - aim to keep surface water out.
M3-E	M3	Mart Road	Reduce Storm water to Combined	Combined sewers - need to keep surface water out.
M4-B	M4	Puffin Drive are	Property Level Protection	Property level protection / resilience if there is a significant problem.

Table 4.2 Option Locations

Other options for further consideration include:

- Policy framework – the use of a Supplementary Planning Document for flood risk and drainage to more specifically guide flood risk management.
- Tighter development control to reduce increases in permeable area on new and existing developments
- Use of surface water mapping to improve emergency planning including improved communication between partners, stakeholders and the public. Consider instigating flood wardens.
- Improved data capture during and after events which can be used to inform future funding bids, maintenance work and responses to events.

4.3.2 Preferred Options Identification

In order to address flooding within Minehead study area and for the purposes of the SWMP, options have been developed. These have been tested for their effectiveness of reducing flooding in the study area.

Following Consultation with SCC and the IDB, it was considered that if surface water could be passed through the downstream end of the system quicker to the other side of the Railway Embankment and out towards Butlins then this may alleviate the bottleneck of surface water flow. The preferred Do Something options taken forward for detailed analysis involve modifications to existing railway culverts. Refer to Section 4.4 for a description of the preferred options taken forward for detailed analysis. Should this option be pursued further, it is recommended that WSC are involved in the discussions as it is believed that parts of the area identified below are allocated within the future Development Plan for WSC for housing.

Options Modelled.

After a meeting with SCC and the IDB the Option Elements were combined into 'Do Something', which includes 'Do Minimum' and Option 1, 2 and 3. The 'Do Something' Options are listed below:-

Do Nothing The "Do Nothing" option assumes that no maintenance, clearance or other intervention is made to interfere with the natural fluvial processes or sewer network. The evaluation of the "Do Nothing" option is a technical requirement required by the Treasury in order to enable comparisons to be made between the "Do Minimum" and "Do Something" options. The flood loss damages associated with the "Do Nothing" option are the benefits of the economic assessment. A bare earth model for this analysis will provide the 'Baseline' model for this study.

Do Minimum Maintenance of the existing storm sewer, ordinary watercourse and highway drainage including, gully cleaning, jetting, removal of debris / vegetation; treeworks and periodic removal of deposition and sediments (Figure 4.7).

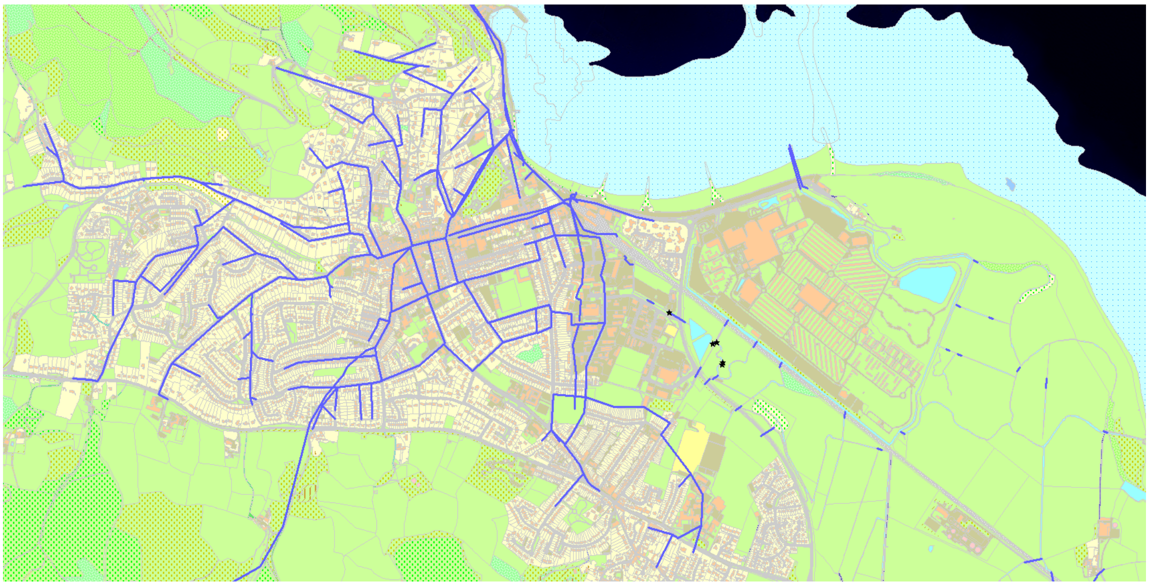


Figure 4.7 Representation of the drainage network under the Do Minimum scenario

Do Something 1 Maintenance of the existing storm sewer, ordinary watercourse and highway drainage including, gully cleaning, jetting, removal of debris / vegetation; treeworks and periodic removal of deposition and sediments. Three Railway Culverts (3 No.) are blocked and keep the fourth southern culvert is increased to 1.5m (y) and 3.0m (x) (Figure 4.8).

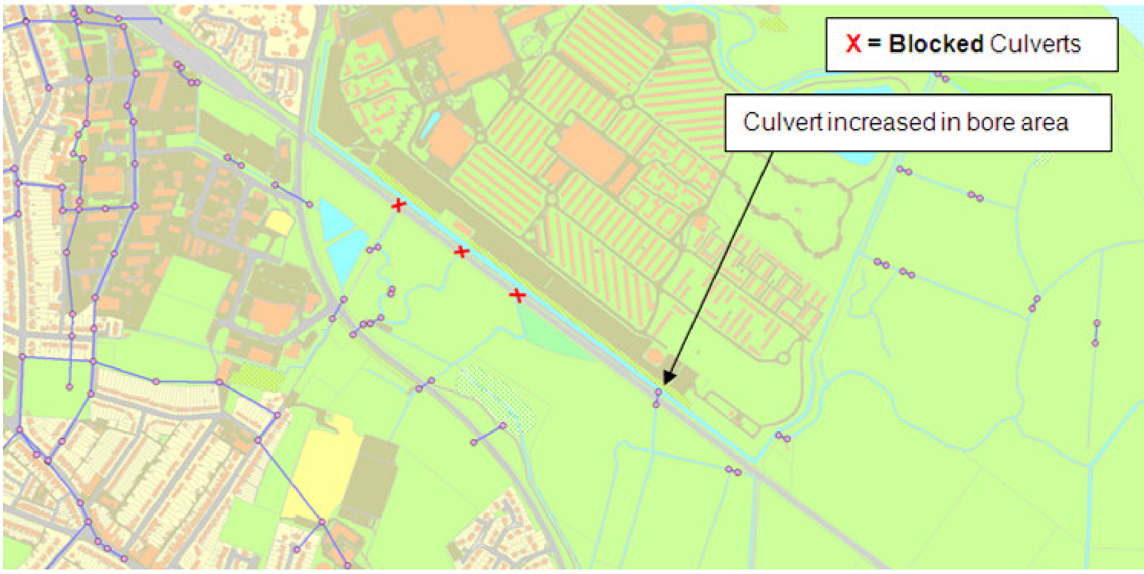


Figure 4.8 Representation of the drainage network under Option 1

Do Something 2 Maintenance of the existing storm sewer, ordinary watercourse and highway drainage including, gully cleaning, jetting, removal of debris / vegetation; treeworks and periodic removal of deposition and sediments. Four Railway Culverts (4 No.) increased to 1.0m (y) and 2.4m (x) (Figure 4.9).

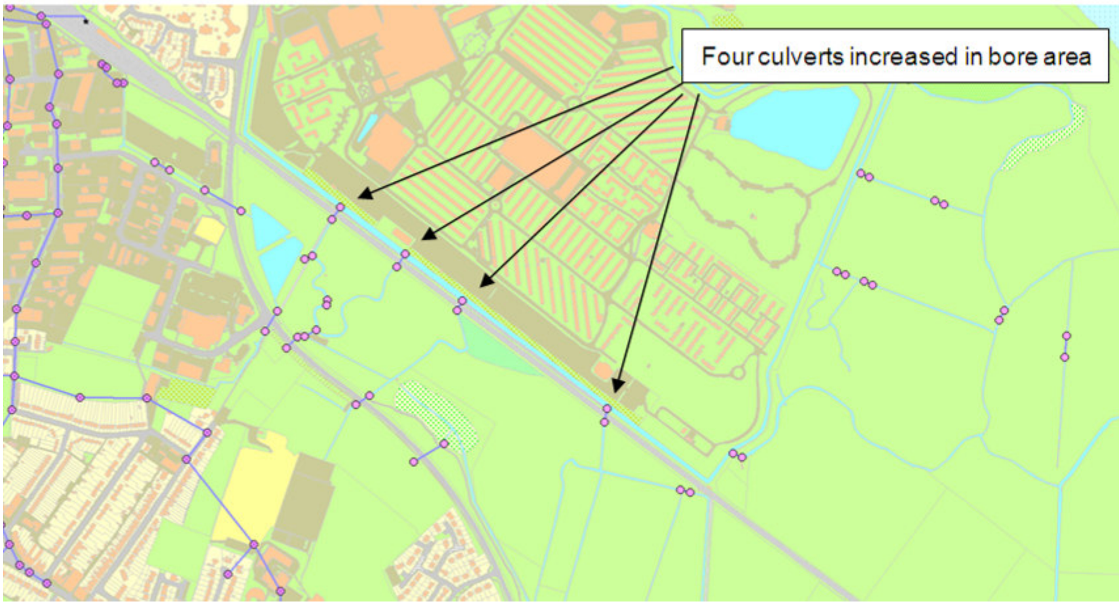


Figure 4.9 Representation of the drainage network under Option 2

Do Something 3 Maintenance of the existing storm sewer, ordinary watercourse and highway drainage including, gully cleaning, jetting, removal of debris / vegetation; treeworks and periodic removal of deposition and sediments. Lock out Railway Culverts (3 No.) and keep the fourth southern culvert open, increasing the size to 1m (y) and 10m (x). An embankment on the northern side of the railway embankment is introduced to encourage flood waters onto the Marsh region east of Butlins.

Figure 4.10 Representation of the drainage network under Option 3

What about realignment of kerbs and alterations to drainage gullies through the town centre as highlighted in the Black and Veatch report of 2009- which was supplied to the project team. Smaller scale works in the town to improve drainage should be considered an option in this section.

4.4 Options Identification

A pre-feasibility study was completed for Minehead in 2008 which investigated options for upstream attenuation and new culverts. The options investigated as part of the 2008 study were:

- **Option 1** - Do Nothing
- **Option 2** - Do Minimum - Maintenance
- **Option 3** - Holloway – new culvert (Minimum 20% Standard of Protection)
- **Option 4** - Bratton Stream – Storage Area (Minimum 99% Standard of Protection)
- **Option 5** - Bratton Stream Storage Area plus Holloway new culvert (minimum 4% SoP)
- **Option 6** - Bratton Stream Main Culvert plus Holloway new culvert (minimum 2% SoP)
- **Option 7** - Bratton Stream Main Culvert, Holloway new culvert and Bratton Storage Area (1% SoP)

At the time, this study concluded that none of the schemes would qualify for FDGiA but Option 5 might attract Local Levy contributions. Subsequently, all large scale capital options have been discounted on economic grounds and have not been investigated further.

4.5 Economic Appraisal

4.5.1 Introduction

This section provides details of the economic analysis carried out in support of the proposed options. Details of the economic appraisal methodology are presented along with the results of the cost-benefit analyses that comprise the business case. The methodology used in this appraisal follows the principles of the recent Flood and Coastal Erosion Risk Management Appraisal Guidance (FCERM-AG; Environment Agency, 2010a) the Multicoloured Manual

(MCM; Flood Hazard Research Centre, 2005), the Multicoloured Handbook (Flood Hazard Research Centre, 2010), the Treasury Green Book (HM Treasury, 2003) and the DEFRA policy statement for Flood and Coastal Resilience Partnership Funding.

A 100 year appraisal period has been used and future damages, costs and benefits have been discounted using HM Treasury discount rates beginning at 3.5%. The appraisal has been carried out using a base date for estimates of February 2012, the most recent date for which inflation information (based on the Retail Prices Index, RPI) is available.

Flood damages from the MCM Handbook (price date January 2010) have been updated to the appraisal base date using RPI.

For further details of regarding the economics assessment refer to Appendix F.

4.5.2 Methodology – Damages Assessment

Property Dataset

SCC provided the National Receptor Dataset (NRD) for use in this study. NRD data contains information on property type, floor area and floor level (differentiating between upper and ground flood properties, for example).

The NRD dataset includes a large number of property entries with '900' MCM codes, identified, for example, as 'electricity substations' and 'tanks'. Given the difficulties with estimating the value and assigning MCM depth-damage data to these types of 'property', all those with '900' codes were removed from the assessment.

The NRD was mapped for Minehead and properties located outside of the study area were removed from the assessment. All properties recorded as upper floor were removed from the assessment. A total of 4763 residential and commercial properties were included in the edited NRD dataset and taken forward for analysis in the economic assessment. The Butlins holiday camp was excluded from the economics assessment, for further details on exclusions and assumptions refer to Appendix F.

The NRD dataset does not provide details of property threshold levels. Therefore, properties were assigned a standard threshold level of 150mm above ground level, in common with best practice when utilising LiDAR data to inform estimates of property floor levels.

Damages

The assessment of flood damages to properties in Minehead has been assessed using the DEFRA and Environment Agency approved approach outlined in the Multi- Coloured Manual. The MCM method for assessing damages refer to depth/damage curves based on property type, age and social class of the dwellings occupants, in order to evaluate the overall damage avoided (also referred to as benefits) in a flood risk area.

Damages are defined as the value of negative social, environmental and economic impacts caused by flooding. In keeping with the need to limit appraisal work to only that which is necessary to justify the proposed works within the timescales available, investigation of any social or environmental benefits associated with flooding have not been progressed in this appraisal. The damages in this assessment relate to the economic impacts associated with property damage and the associated emergency response. An Appraisal Summary Table (AST) has been used to record the social and environmental impacts. The AST is contained within Appendix F.

Key Parameters

For reference, key parameters which have guided the economic assessment process, in line with FCERM-AG/MCM techniques, are repeated below:

Property Values: Properties were assigned a market value in order that present value damages (PVd) were 'capped' if they exceeded a property's market value over the appraisal period. These 'capping values' were derived according to Environment Agency best practice. Distributional impacts (DI) were considered, in order to remove social class bias from the property value estimates. A DI factor was calculated using Approximate Social Grade (UV50) data for the West Somerset, available from neighbourhood.statistics.gov.uk.

Emergency services costs: These were incorporated in the assessment by adding 5.6% to all calculated property damages. This is as stated in the Multi-coloured Handbook and is based on data from the 2007 floods, a revision downwards from the previous values of approximately 10%, reflecting economies of scale of providing emergency services in urban areas during flood events.

Exclusions

The following key items were excluded from the assessment:

Risk to life: whilst all flooding poses a risk to life, it can be argued that the nature of the widespread surface water flooding such as is assessed in this study limits maximum depths and velocities such that overall risk to life is low. Furthermore, its calculation for a large study area could require appraisal time that would be disproportionate to the scale of benefits expected.

Transport disruption: flooding in a populated urban area has the potential for significant impact of transport networks, which can add to the economic impact of flooding. Although surface water flooding is frequently associated with transport disruption, it is not practical to assess, on the scale of this study, the sort of alternative routes and diversions required. Since these are unlikely to result in significant benefits in comparison to property damages, it is recommended that assessment of this is left until further appraisal stages.

Environmental benefits: no accounting has been made for the potential environmental/amenity improvements associated with any of the proposed options.

Health and social benefits: these perceived benefits attributable to undertaking flood prevention works and increasing health and well-being were not included. This view was taken because it was considered unlikely that the local population would necessarily perceive any benefit from a form of flooding which does not result in a noticeable flood pathway or a great depth of flooding (as would be the case for river or sea flooding).

Temporary accommodation costs: A cost for temporary accommodation can be incorporated in the assessment by allowing for an average rental cost, post-flood, of £5.7k per property flooded, determined in an Environment Agency review of the summer 2007 floods. This has not been incorporated into the assessment due to the shallow depths associated with the majority of surface water flooding.

Assumptions

Assumption 1 – Property thresholds across the study area are 0.15m and no below floor level flooding of properties will occur. Due to the number of properties across the study area it would not be possible to estimate threshold levels for each property. As such an assumption of a threshold level of 0.15m at all properties has been made. Furthermore it has been assumed that no damage occurs to property when the flood level at the property is between 0 -

0.15m (below the threshold). It is possible that flood water can still enter properties below the threshold level via airbricks but this is not considered in this damages assessment.

This sensitivity testing has highlighted the importance of establishing accurate property threshold levels to ensure that the most appropriate and effective options can be identified. Therefore, doorstep surveys of a sample of impacted properties are strongly recommended so for any further studies.

Assumption 2 – Damage to property does not occur at return periods lower than 10 year. The lowest return period modelled was the 10 year rainfall event. Whilst it is possible within the flood damages equations to interpolate flood damages for return periods below the lowest return period modelled, these damages are not based on any modelled outputs and as such are subject to significant uncertainty. Furthermore, since they occur more frequently within the appraisal process, they have a disproportionate impact on present value damages. As such, and in keeping with the approach set out in FCERM-AG, it has been assumed that no damages occur to property within the study area at flood events lower than the 10 year return period.

Assumption 3 – Failure of the surface water drainage network under the Do Nothing Option occurs in year 10. Somerset County Council has advised that the surface water drainage network is likely to have failed in 10 years time, without any maintenance or capital works. To represent gradual failure of the surface water network the Do Nothing Present Value damages are constructed by beginning with Do Minimum at Year 0 and gradually moving to Do Nothing by Year 10 by interpolating between the damages for the two options.

Methodology

Property damages were calculated using the MCM depth damage data from the 2010 Multi-coloured Handbook (Flood Hazard Research Centre, 2010). Depth-damage data without basements was used and a flood duration of less than 12 hours was used in the assessment.

For each option, flood depth results for each return period were extracted for all properties within the modelled region using point analysis. With respect to the flood depth, monetary damages within properties result from damage to the building fabric, damage to the building contents and clean up costs.

Depending on the size or severity of each individual flood event of a given annual probability, each flood event will cause a different amount of flood damage. The Average Annual Damage (AAD) is the average damage per year in monetary terms that would occur at each specific address point, within the modelled domain, from flooding over a 100 year period, assuming that present-day conditions (in terms of frequency of extreme rainfall) are maintained.

In many years there may be no flood damage, in some years there will be minor damage (caused by small, relatively frequent floods) and, in a few years, there may be major flood damage (caused by large, rare flood events). Estimation of the AAD provides a basis for comparing the effectiveness of different flood alleviation and management measures (i.e. through measuring the reduction in AAD). The methodology for assessing the benefits of flood alleviation combines:

- An assessment of risk, in terms of the probability or likelihood of future floods to be averted, and
- A vulnerability assessment in terms of the damage that would be caused by those floods and therefore the economic saving to be gained by their reduction.

Through assessment of the associated damage values and the benefits incurred through Engineering Options, proposed schemes are compared against each other using their benefit-cost ratio (BCR).

Benefits

Benefits, or the damages avoided, are any damages that would not occur under an option when compared to the baseline (Do Nothing). The methodology for assessing the benefits of flood alleviation combines:

- An assessment of risk, in terms of the probability or likelihood of future floods to be averted, and
- A vulnerability assessment in terms of the damage that would be caused by those floods and therefore the economic saving to be gained by their reduction.

Through assessment of the associated damage values and the benefits incurred through Engineering Options, proposed schemes are compared against each other using their benefit-cost ratio (BCR).

Within the appraisal of engineering options, a comparison between the consequences of 'Do Something' are assessed against the baseline 'Do Nothing' option. The cost of each option and the relative damages incurred are combined to create a benefit cost ratio. This ratio is used to assess the viability of each option to determine the viability of each option and also the levels of effectiveness for how capital can be spent to protect and alleviate from the effects of flooding. The BCR is the ratio of benefits produced through introduction of flood alleviation options, expressed in monetary terms, relative to its cost, identifying the greatest 'value for money'.

The Multi-Coloured Handbook states that;

'Projects are only viable if the benefits exceed the costs (i.e. the ratio of benefits to costs is greater than 1.0). Where benefits marginally exceed costs, there is often high uncertainty as to whether an option is justified, because only a small change or error in either the benefits or costs would tilt the balance the other way. So when comparing a 'Do Something' option to the baseline option, confidence is needed that a 'Do Something' option is clearly preferable.

In this regard, the decision process explored whether the best value for money is provided while achieving the most appropriate standard of risk management defence. This is undertaken by assessing the incremental benefit-cost ratio of each economically viable option.'

Costs

The principal economic risks associated with the construction of all Engineering Options are:-

- Cost of possible diversion of utilities;
- Cost of land negotiations
- Compensation for disruption
- Buildability

It is recommended that the project lead should approach utility companies to obtain agreements for the relocation of services as necessary. In addition the project lead should engage with all landowners and stakeholders at the earliest opportunity during the design process to ensure their collaboration.

Each of the proposed Option elements has been costed in accordance with information on maintenance expenditure obtained from Somerset County Council, Civil Engineering Standard

Method of Measurement 3rd Edition - CESSMM3 (2010) and SPON's Civil Engineering and Highways Price Book – SPONS(2009)[xiii].

Costs for each option were developed in the form of a capital construction costs (at year 0 and a future construction cost at year 50) and annual maintenance costs. The capital costs for each of the Do Something options were calculated using the sources detailed in Table 4.3. Detailed breakdowns of the option costs are contained within Appendix F.

The maintenance costs for Minehead were provided by Somerset County Council. The suggested annual maintenance cost for the Minehead study area for use in the assessment was £2,000. The maintenance cost is for the entirety of Minehead. The calculations of the annual maintenance costs are show in Table 4.3.

Option	Present Value Maintenance Costs	Present Value Capital Costs	Source
Do Minimum	£59.7K	NA	Somerset County Council
Option 1- Block railway culverts (3 No.) and increase the fourth southern culvert to 1.5m x 3m.	£59.7K	£348.3K	CESMM3 (2010) + SPONS (2009)
Option 2- Increase all 4 railway culverts to 1m x 2.4m.	£59.7K	£772.8K	CESMM3 (2010) + SPONS (2009)
Option 3- Block railway culverts (3 No.) and increase the fourth southern culvert to 1m x 10m.	£59.7K	£748.1K	CESMM3 (2010) + SPONS (2009)

Table 4.3 Maintenance Costs

As all of the Do Something options relate to the ongoing maintenance of the four culverts, and the options do not introduce any new assets to the maintenance schedule the Do Minimum costs have been applied to all Do Something options. It has been assumed that the blocked culverts and the new upsized culverts will need replacing after 50 years and therefore a cost for future construction has been included at year 50.

The FCERM-AG guidance recommends that for strategies, as detailed design will not have been carried out, unit rates can be used to give an indication of the scale of the costs. Unit rates and the experience of the project team are required to be able to assign indicative costs for options. Sufficient allowance for error should be made for the uncertain nature of cost estimates at the strategic level.

The cost estimates reflect the strategic nature of the assessment. The costs are outline and provide indicative costs of the proposed works to the culverts. As the culverts are located under a railway an additional cost allowance of 60% has been built into the costs, to account for potential complications associated with construction under a railway line. This item would need to be subject to further investigation at further stages in the development of potential options. The estimated costs should not be used for detailed assessment and would need refinement for any future studies investigating similar options.

Optimism bias is a risk-based contingency approach, which should be used to ensure that the tendency for early assessments of project costs to be overly optimistic. Optimism bias of 60% has been applied to option costs, since the SWMP is equivalent to a strategy, in line with HM Treasury Green Book policy, restated in 2010 in the Environment Agency FCERM-AG. Future costs were discounted accordingly.

4.5.3 Long List of Options

The Options considered following stakeholder workshop are listed below:-

- Do Nothing. The option assumes that no maintenance, clearance or other intervention is made to interfere with the natural fluvial processes or sewer network. The evaluation of the "Do Nothing" option is a technical requirement required by the Treasury in order to enable comparisons to be made between the "Do Minimum" and "Do Something" options. The surface water drainage network would fail within a short timeframe, with a predicted failure at 10 years.
- Do Minimum. This option assumes the continuation of existing maintenance of the storm sewers, ordinary watercourses and highway drainage including: gully cleaning; jetting; removal of debris / vegetation; treeworks; and periodic removal of deposition and sediments. It is assumed that this maintenance is sufficient to result in preservation of the drainage network throughout the assessment period.
- Do Something Option 1 – This option involves blocking the three existing railway culverts and increasing in size the existing fourth railway culvert to 1.5m x 3m
- Do Something Option 2 – This option involves increasing the size of all four railway culverts to 1m x 2.4m.
- Do Something Option 3 – This option involves blocking the three existing railway culverts and increasing the size of the existing fourth railway culvert to as large as possible to define the flow path connection between the railway culverts and the Marsh rhyne area to the east of Butlins. Proposed dimensions of the fourth culvert are 1m x 10m.
- Again smaller scale works such as kerb alignments should be considered as we have discussed previously in the stakeholder meetings.

4.5.4 Benefit Cost Analysis

Table 4.4 summarises the Present Value Damages associated with the 'Do Nothing' and 'Do Something' Options.

Option	Present Value Damages (£)
Do Nothing	£40.4M
Do Minimum	£40.1M
Option 1	£40.3M
Option 2	£40.0M
Option 3	£40.4M

Table 4.4 Flood and Residual Flood Damages

Based upon the assessment of damages and the cost estimates given for each option, the present value damages have been combined with the whole life cost estimates within Table 4.5. The table summarises the costs, benefits and residual damages associated with each option.

Table 4.5 below presents the option comparison table, where present value damages (PVd) for the Do Something options are compared to generate benefits against the Do Nothing scenario. The benefit-cost ratio (BCR) is the ratio of the present value benefits provided by an option to the present value costs of providing that option. The Net present Value (NPV) is the discounted benefits minus the discounted costs.

	Options				
Costs and benefits (£)	**Do Nothing**	**Do Minimum**	**Option 1**	**Option 2**	**Option 3**
PV costs from estimate	-	£60K	£408K	£832K	£808K
Optimism bias adjustment	-	£36K	£245K	£500K	£485K
Total PV Costs from appraisal (PVc)	-	£96K	£653K	£1.3M	£1.3M
PV damage (PVd)	£40.4M	£40.1M	£40.3M	£40.0M	£40.4M
PV damage avoided	-	£324K	£138K	£457K	£85K
Total PV benefits (PVb)	-	£324K	£138K	£457K	£85K
Net Present Value (NPV)	-	£229K	-£515K	-£875K	- £1.2M
Average benefit cost ratio	-	3.4	0.2	0.3	0.1
Incremental benefit cost ratio	-	-	0	0	0

Table 4.5 Option Summary Table

The Do Minimum Option is the preferred option, as the option is shown to result in present value benefits of £324K over the appraisal period and an average BCR of 3.4:1.

The benefits of the Do Something Options 1, 2 and 3 are £138K, £457K and £85K respectively. All options include capital works, the cost of which exceeds the benefits of all options and therefore all options have negative NPV. All Do Something options have a benefit cost ratio of less than 1, indicating that the options are not likely to be economically feasible, with costs outweighing any expected benefit.

The blocking off of the three existing railway culverts under Option 1 and 3 have the lowest benefit and actually increase flood risk within the study area when compared to the Do Minimum. The increase in flood risk under Option 1 and 3 could be due to water backing up behind the blocked culverts, which impacts on the wider study area. Option 2, which increases the flow capacity of all four railway culverts has the highest benefit of £457K, however the costs of constructing the engineered option exceed the benefits.

It was considered that if surface water could be passed through the downstream end of the system quicker to the other side of the Railway Embankment and out towards Butlins then this may alleviate the bottleneck of surface water flow. However, the results of the direct rainfall modelling show that all Do Something Options have a limited effect on reducing flood risk in the study area. Table 4 shows that, when compared to the Do Minimum Option, the properties flooded under the Do Something options increase or remain the same. This indicates that the Do Something options have no affect on reducing flood risk and actually increases the flood risk to some properties. This could be due to the uncertainties of the application of direct rainfall modelling results to properties and the sensitivity of the model to the shallow flood depths which occur over this large study area.

To reflect those areas of the appraisal where assumptions were made or uncertainty was high, and to provide an assessment of the consequences for the decision rule applied in the SWMP, a number of sensitivity tests were carried out on the economic appraisal results. Details of the sensitivity testing are contained within Appendix F.

There are 4,300 residential properties in the study area and residential properties contribute the majority of the damages. The sensitivity tests show that the results are heavily dependent on the method which is used to apply depth values to properties, and whether or not below-floor level damages are included. Since surface water flooding is typically characterised by rapid flood mechanisms and shallow flood depths, it is considered reasonable to ignore below floor level damages, associated with more prolonged exposure of the building fabric to flood waters (as following fluvial or coastal flooding). This does not suggest that surface water flooding does not result in this type of damage, but when considering a large study area, there are likely to be far more properties where below floor level damages overestimate total damage than accurately reflect it.

There is an inherent uncertainty regarding the application of direct rainfall modelling results to properties, as in reality buildings can act as pathways to rainfall as well as receptors. When rainfall falls onto a building the slope of the roof and the guttering has an effect of directing rainfall to the ground and towards the surface water drainage network. Properties only begin to flood when the capacity of the drainage network or local topography is exceeded and the level of ponded flood water exceeds the threshold level of buildings. Using the direct rainfall approach, can, however, mean that water immediately ponds on the flat surface representing the bare earth of the building, resulting in a perceived depth of flooding at that property.

Given this uncertainty, and the fact that surface water flooding typically occurs in rapid, short-duration events, below floor level damages were excluded from the assessment.

The standard 0.15m threshold level has been selected to use as the final appraisal value as it is an in common with best practice guidance and the 0.15m value provides a conservative assessment.

The modelling indicates that surface water flows into the Marshes, which connects to the town centre. This connectivity may be contributing to the similarity in damages values for the Do Nothing, Do Minimum and Do Something Options 1 through to 3.

As the results of the direct rainfall modelling show that all Do Something Options have a limited effect on reducing flood risk in the study area it is recommended that retrofitting options are considered at the study area. Implementing smaller scale works across the catchment may have an impact on controlling and reducing surface water runoff. Retrofitting options are discussed in the following section.

4.5.5 SuDS Retrofitting Options

The Environment Agency has completed a review of the cost benefit of undertaking SuDS retrofit in urban areas (Science Report – SC060024). The SuDS (Sustainable Drainage Systems) approach to managing surface water is increasingly important in drainage planning. This approach uses a range of techniques including swales, permeable paving and green roofs to mimic the natural drainage of a site. They increase infiltration of water where it lands and reduce the speed of run-off. The use of SuDS in new developments is an important component of the flood risk planning process of NPPF.

SuDS can be retrofitted under a number of conditions, for example at the “end of life” of existing paved areas. Other conditions include:

- at the time of building refurbishment;
- during drainage improvement for large areas such as trading estates or where improvements are required to CSO performance;
- through incentives to property owners to “disconnect” roof or driveway run-off from the public drainage system.

Table 4.6 is taken from the SC060024 report and contains a description regarding the implementation scenarios for SuDS retrofitting.

Technique	Description	Implementation scenario	Coverage potential for retrofit (UK)
Permeable paving	Instead of using impervious bituminous or concrete (conventional surfaces), permeable paving blocks are used.	When conventional surfaces require resurfacing, approximately every 20-40 years, it is possible to replace with permeable surfaces. Benefits will come from reduced drainage charges and from reduced CAPEX and OPEX costs.	It is estimated that it is possible to retrofit around 50 per cent of OFF ROAD hard standing surfaces with porous paving. This is a conservative judgement based on an expert view. Further research might indicate that this percentage could be increased.
Rainwater harvesting	Disconnection of premises from the drainage system to provide an “in-house” collection and storage system for rainwater that can be used for non-potable water use.	Large premises could disconnect from drainage infrastructure and install a rainwater harvesting system. This would most likely be done during building refurbishment programmes. Benefits would arise in reduced drainage charges and water bills.	Around 75 per cent of industrial and commercial premises could adopt rainwater harvesting systems, and 50 per cent of public buildings, such as schools and hospitals, could do the same.
Water butts	Water butts store rainwater from roof drainage and are particularly applicable for household properties with gardens. Their attenuation benefits are limited when they are full.	This is a relatively easy and cheap option for all households (not individual apartments). Water butts are however likely to be full when attenuation for flooding is required and some further storage needed. Benefits for households will be reflected in lower water bills.	There is the potential for 90 per cent of semidetached and detached properties to install water butts, and for around 45 per cent of terraced housing.
Swales, infiltration ditches, filter drains	These drainage systems provide good attenuation for surface water run-off, particularly from highways.	Generally these SuDS techniques have greater benefits for new roads and hard surfaces – greenfield or brownfield – but can also be introduced during road upgrading projects. Benefits are most likely to be realised in their local context.	These SuDS techniques are more limited in a retrofit context, particularly in an urban situation. Roads in rural areas have a greater potential for retrofitting, around 20 per cent, whilst in urban areas this might be as low as four per cent.

Table 4.6- Description and implementation scenario for SuDS retrofit (SC060024)

The SC060024 study also investigated the option of retrofitting “green roofs”. For the study the available information on roof areas was used to assess the benefits of rainwater harvesting and water butts, but green roof retrofitting has other requirements, particularly on the load-bearing capability of buildings and damp proofing requirements. It was not possible to estimate the potential for retrofitting in the study without more information on the load-bearing capacity of current building stock.

Capital Costs

The following table has indicative costs for SuDS retrofitting options. A number of sources were reviewed in order to obtain best estimates of the indicative capital costs associated for retrofitting options. These costs were updated where necessary, with the Retail Price Index (RPI) as of February 2012. Table 4.7 sets out the values obtained for each measure and the data source.

Measure	Cost	Unit	Source
Water / Rain Butt	£1	Per m^2 of property	Environment Agency, Cost-Benefit of SuDS Retrofit in Urban Areas, average value for detached, semi detached, terraced domestic housing
Swale	£14	Per m^2	Environment Agency, Cost-Benefit of SuDS Retrofit in Urban Areas
Filter Drain	£141	Per m^3	CIRIA SuDS Manual[xiv]
Basins and Ponds	£23	Per m^3	CIRIA SuDS Manual
Permeable Paving	£62	Per m^2	Environment Agency, Cost-Benefit of SuDS Retrofit in Urban Areas
Green Roofs	£148	Per m^2 roof	Design for London, Living Roofs and Walls Technical Report: Supporting London Plan Policy[xv]
Raising / Lowering Kerbs	£10	Per m	Spon's Civil Engineering and Highway Works Price Book 2009[xvi]
Underground Storage	£780	Per m^3	Hyder project experience
Ground Re-profiling	£4	Per m^3	Spon's, general excavation
Re-cambered Road	£26	Per m^2	Spon's, dense bitumen
Road Humps to direct flows into SuDS	£1,270	Per hump	Research into existing and proposed schemes for variety of local authorities
Upsizing Sewers	£232	Per m	Hyder project experience
	£1,458	Per manhole	

Table 4.7- Capital Costs

In order to estimate these costs, a number of assumptions were made at this stage:

- The cost of providing rain butts is based on the provision of rain butts to all domestic properties in the sub-hotspot having an average property area of $50m^2$.
- Modelled swales have a 2m top width and depths have been set at 0.5m.
- The costs of swales do not include the associated ground re-profiling that may be required in the adjacent roads and footways.
- Filter drains are assumed to be laid at a constant gradient in line with modelled swales. A diameter of 0.45m has been assumed.
- Detention basins are set to have side slopes of 1 in 4, in line with guidance set out in the CIRIA SuDS manual.
- Permeable paving is assumed to be retrofitted to existing urban areas.

- The cost of a green roof is inclusive of waterproofing and insulation; the use of large trees, furniture, planters and irrigation will increase costs. The cost quoted is for a 'semi intensive' green roof. Semi intensive green roofs are commonly 120 – 250mm deep with saturated weight of 120 – 200 kg per square metre[xvii].
- Costs obtained from the CIRIA SuDS Manual and Environment Agency SuDS Retrofitting Report are inclusive of: erosion and sediment control during construction, material costs, construction (labour and equipment costs), planting and landscape costs.
- Costs for any necessary kerb works remote from swales and ponds are assumed to be comprised of 125mm by 225mm precast concrete units which are bedded, jointed and pointed in cement mortar. They are assumed to be laid either straight or with a curve greater than 12m radius. It is noted here that project experience suggests that the rate quoted in Spons is low.
- The price per cubic metre of underground storage has been obtained from previous Hyder experience outside Minehead. It is assumed that online storage is provided in the form of over sized pipe work within the existing network.
- General excavation costs have been taken from Spon's 2009 price book and it is assumed that excavations no greater than 2m are required.
- Any re-cambering of roads can be achieved by a top surfacing of dense bitumen; the full standard road width is used to calculate the area for costing to ensure a continuous surfacing is achieved.
- Road hump costs are an average figure for a round top, full width hump and have been sourced from a variety of local authority schemes as reported in publically available documents.
- None of the above costs include:
  - Land acquisition
  - Provisions for consultancy, design and supervision,
  - Planning process, permits, environmental assessment
  - Provision for access constraints
- Costs of retrofitting options are inherently variable and will be dependent on several other factors such as those listed below which are not fully accounted for in the above costs:
  - Soil type
  - Groundwater vulnerability
  - Design features such as planting type
  - Access and space requirements
  - Location
  - Hydraulic control structures

No remedial costs have been allowed for; i.e. there are no costs for replacing the assets. The frequency with which remedial works are required is dependent on a range of site specific constraints which should be considered at the feasibility and detailed design stages.

Although the RPI has been used to update the costs as part of this SWMP, any future detailed design stages should take into account other price indices such as the Baxter Index which have been developed to price contracts in the construction industry.

Operational Costs

Where available, estimates were made of operational costs occurring on an annual basis; these are set out in Table 4.8.

Measure	Cost	Unit	Source
Swale	£0.10	Per m²	CIRIA SuDS Manual
Filter Drain	£0.60	Per m²	CIRIA SuDS Manual
Basins and Ponds	£0.30	Per m³	CIRIA SuDS Manual
Permeable Paving	£0.40	Per m²	Environment Agency, Cost-Benefit of SuDS Retrofit in Urban Areas SC060024

Table 4.8- Capital Costs

Operational costs obtained from the CIRIA SuDS manual are for regular maintenance only and were based on a review of limited UK literature regarding whole life costing for SuDS. Costs are comprised of:

- Labour and equipment costs
- Material costs
- Replacement and / or additional planting costs
- Disposal costs (e.g. contaminated sediments, vegetation)

The cost of maintenance activities will however be dependent on several other factors such as those listed below which are not fully accounted for in the above costs:

- Location of the scheme, which influences material, labour and equipment costs
- Accessibility of sites, noting that confined sites are more expensive to maintain
- Occurrence of upstream activities, for example new development
- Design of the sediment management system

Indicative assessment of costs and benefits

The following section is from the cost benefit of undertaking SuDS retrofit in urban areas (Science Report – SC060024) and does not consider the indicative capital and operational costs discussed above. Although the results are not specific to Minehead, the results of the study may help to guide which SuDS techniques have the potential to provide greatest economic benefit in the study area. The SuDS techniques reviewed as part of the study were the scenarios described in Table 4.6, and the following results emerged.

- Widespread use of permeable paving provides net financial benefits for property owners as well as overall net economic benefits. Permeable paving costs less on a lifecycle basis than traditional surfaces, with reduced maintenance costs outweighing increased capital costs. While extra excavations are required to lay permeable paving, replacing worn out paving blocks is less costly than the digging required to renew worn out tarmac. For those areas where water companies only charge for surface drainage on hard surfaces, there will be further financial savings of no charges for permeable surfaces. A nationwide application of permeable paving covering approximately 50 per cent of current non-road hard surface areas retrofitted at their “end of life” would provide discounted economic benefits of nearly £1.7 billion. The majority of these benefits would accrue to the site owners and operators.
- Water butts also provide economic benefits, as they repay their cost via savings in the cost of water. For those with water meters, this would lead to increased net benefits. For

a national cost outlay of just over £325 million, the widespread use of water butts could deliver national savings of nearly £1 billion to households. However, these benefits would only be realised if the butts were regularly used through the summer months, when maximum water savings could be achieved.

- Other types of SuDS, such as swales and filter drains, tend to show a benefit-cost ratio of less than one, implying that these schemes cost more and provide fewer benefits. Benefits are not clear when presented in a uniform national context, but are likely to appear at a local level where conditions permit their realisation.

The results of the study indicate that permeable paving and water butts have the greatest potential for economic benefit. However, when considering retrofitting options in Minehead it is recommended that a site specific investigation is conducted.

4.6 Non Capital Options

This chapter considers the non capital options that could be implemented in Minehead and across Somerset. They are discussed under the following headings:

- Data and Asset Management (Section 4.6.1)
- Planning Policy (Sections 4.6.2 – 4.6.4)
- Development Control (Section 4.6.5)
- Campaigns and Communication (Section 4.6.6)
- Emergency Planning (Section 4.6.7)

4.6.1 Data and Asset Management

Somerset County Council should ensure that it keeps up to date with current guidance concerning the development and maintenance of asset registers. SCC is currently using GIS to assimilate existing information and this should be continued. As the database develops, SCC will be in a position to identify those assets which they consider critical.

In addition, opportunities should be sought to obtain additional data on the drainage network to improve understanding. This may include new surveys, condition assessments and capacity analysis for example.

4.6.2 Planning Policy - Existing

Planning policy has a key role in guiding the principles of surface water management and ensuring that they are sustainable, appropriate and enforceable. There is one key document locally which discusses surface water management in relation to planning policy.

Local Plan

The contents of this report may be published before the WDSC local plan- this report needs to be careful it does not provide information on the plan before the plan is published by WSDC!

The West Somerset Local Plan[xviii], is currently in development, with the Draft Preferred Strategy published in February 2012, and currently out for consultation until 15th May 2012. The Strategy includes:

- Policy MD1 Minehead Development, which states that development should *"Where appropriate, contribute towards resolving the flood risk issues which affect the* *settlement including improving the sea defences protecting the eastern end of the town".*

- Policy MD2 Strategic Development around Minehead which states that the provision of the strategic development identified in the policy will *"help to minimise the risk of flooding"*

- Policy CC2 Flood Risk Management which states that *"Development must be designed to mitigate any adverse flooding impact which would arise from its implementation, and where possible should contribute towards the resolution of existing flooding issues".*

- Policy CC6 Water Management which states in relation to surface water management that *"The effective safeguarding of groundwater, watercourses, and the proper management of surface water runoff are key to maximising the benefits and minimising the dangers of water to the community"*.

4.6.3 Planning Policy - Future

It is recommended that these policies mentioned above are pursued and strengthened further with specific reference to the development of the Surface Water Management Plans to include the following:

"All development within the study areas of the two developing Surface Water Management Plans for Minehead and Taunton, and any major development proposals, demonstrate that surface water will be managed in a sustainable and coordinated way. Proposals should be supported by either a Surface Water Management Statement or Plan, depending on the scale of the development

All developments including changes to existing buildings, include appropriate sustainable drainage systems (SuDS) to manage surface water. All developments should aim to achieve a reduction in the existing runoff rate, but must not result in an increase in runoff.

Further guidance on designing safe developments, surface water management and water efficiency will be provided in a Water Management SPD".

Supplementary Planning Document (SPD)

A future Water Management SPD should be pursued to help communicate local solutions for mitigating any increases in surface water flood risk as well as adapting to the existing risks. The SPD should make use of the wide evidence base collected as part of the Local Development Framework and consequently share this with planning applicants, the development industry and the community. The Planning Advisory Service[xix] notes the following benefits to addressing sustainable development through SPDs:

Sustainability SPDs can address sustainable development and climate change by:

- Providing more detail on policies in the core strategy;
- Giving local evidence and guidance to applicants on the requirements and opportunities in an area;
- Being flexible enough to account for changing local, regional and national policies;
- Helping development management officers implement strategic policies;

- Forming the basis for collaboration and internal training with officers, councillors and external partners; and
- Making the case for sustainable development by outlining the benefits to developers and the community.

Local Flood Risk Management Strategy (LFRMS)

The FWMA states that a LFRMS must contain certain information and draft guidance was produced by the Local Government Association (LGA) in February 2011, updated November 2011, to assist LLFAs in producing the first round of local FRM strategies[xx]. The local FRM strategy will specify the following:

- The risk management authorities in the LLFA area and what flood and coastal erosion risk management functions they may exercise in relation to the area. It will be important for the local strategy to identify any special arrangements agreed in the area where functions normally carried out by one authority are done by another.
- The objectives for managing local flood risk. These should be relevant to the circumstances of the local area and reflect the level of local risk. The Regulations have a narrow scope focussing on identifying and addressing 'significant' flood risk. The scope of the local FRM strategy is not specified in FWMA and can be much wider to reflect the local circumstances.
- The measures proposed to achieve the objectives.
- How and when the measures are expected to be implemented.
- The costs and benefits of those measures and how they are to be paid for.
- The assessment of local flood risk for the purpose of the strategy. In the first instance it is likely that the LLFA will use the findings from the PFRA and any other studies that are available, such as Catchment Flood Management Plans and Strategic Flood Risk Assessments. The strategy can identify gaps in understanding of the local flood risk and specify what actions need to be taken to close these gaps.
- How and when the strategy is to be reviewed. A review cycle is not specified, so it is up to the LLFA to decide what is appropriate. It may be advisable to link it to the cycles for the Flood Risk Regulations outputs.
- How the strategy contributes to the achievement of wider environmental objectives

The LFRMS must consider a full range of measures including resilience and other approaches which minimise the impact of flooding. It must also interact with the National Flood and Coastal Erosion Risk Management strategy (published May 2011)[xxi] whilst maintain distinct objectives relevant to the local community.

The National strategy sets out long-term objectives for flood and coastal erosion risk management and how these will be achieved. The LGA draft LFRMS guidance is to be updated in line with this recent publication. In guiding the LFRMS, the national strategy aims to improve the communities who are at greatest risk. The strategy should also aim to encourage more effective risk management by enabling people, communities, business and the public sector to work together to:

- Ensure a clear understanding of national and local flood and erosion risks in order to effectively prioritise investment in risk management;
- Make clear and consistent risk management plans for risk management so that communities and businesses can make informed decisions;
- Encourage innovative management of flood and coastal erosion risks taking account of the needs of communities and the environment;
- Support communities in their response to flood warnings whilst also ensuring that emergency responses to flood incidents are effective;
- Assisting communities with rapid and effective recovery post flooding.

The LLFA has a duty to maintain and monitor the LFRMS.

4.6.4 Planning Policy - Specific

The following specific policies for Minehead should be considered as part of the SPD or future Development Management Policies:

Definition and maintenance of blue and green corridors

Efforts should be made and opportunities taken to create additional and protect the existing blue and green corridors. This will incorporate de-culverting of watercourses, protection of the natural floodplain and seeking ways to link existing areas.

Regular and effective maintenance of watercourses

All watercourses should be inspected and maintained regularly to ensure that they are free of debris. Any structures on or in the watercourse should also be regularly inspected and maintained. Any known restrictive points in the system should be proactively inspected prior to significant rainfall events.

4.6.5 Development Control

Planned New Development

Although the level of planned development at present appears low, due attention should be paid to that which is planned and also to the potential for windfall sites. It is also highlighted that the cumulative impacts of piecemeal development can also be significant.

Requirements for Specific Guidance

It is recommended that a specific guidance document for developers setting out the Council's requirements for surface water management is produced, particularly with reference to the forthcoming commencements of the SuDS Adoption Body roles as part of the FWMA. This document could be developed as a specific water management SPD. It is recommended that SCC, or it's delegated authorities, should be consulted with reference to the key guidance points from this document which fall under the heading of:

- Runoff Rates; considering new development and re-development
- Surface water drainage; disposal methods, network requirements, ownerships and responsibilities

- SuDS; location, capacity, maintenance and responsibilities
- Designing for exceedance: principles and assessment of routes
- Role of river corridors

Proposed Additional Guidance

It is recommended that the following additional development guidance is provided:

- Information should be provided on any contributions required for strategic measures or local schemes. Refer to Section 4.2.6 (economic assessment) for information on funding protocol.
- Information on any planned deviation from national guidance, permitted development rights or Article 4 Directions.
- Who should be consulted on new development and links to the asset register required under the FWMA in order to clarify ownership and responsibility.
- Use of the wetspots identified in this SWMP to further guide site specific flood risk assessments.
- How to generate / where to find information on SuDS suitability and proposals. For example CIRIA guidance, Buildings Regulations, ground investigations.

SuDS Specific Guidance

As well as the potential to produce specific water management guidance, the following should be consulted and adhered to where necessary.

<u>Standards and Regulations</u>

The existing CIRIA SuDS guidance (SuDS Manual[xxii], Preliminary Rainfall Runoff Management for New Development[xxiii]. Following the Flood and Water Management Act, Defra is developing national standards for the design, operation and maintenance of SuDS which will set out the criteria on which the type of drainage appropriate to any given site or development can be determined. These national standards will, however, make allowance for local conditions and take into account the costs and benefits of SuDS. These standards will be consulted on prior to their publication; consultation. Following this, the requirements of the Flood and Water Management Act relating to sustainable drainage are not expected to come into effect before October 2012.[xxiv]

<u>Adoption</u>

The Flood and Water Management Act introduces the concept of a SuDS Approving Body (SAB), to be constituted by unitary authorities or county councils.

The role of a local SAB will be to approve local SuDS applications where construction work will have implications for a drainage system. They will apply strict standards that will achieve benefits for water quality as well as flood risk management. The SAB also has a duty to adopt SuDS providing they are constructed in accordance with the approved proposals and the system functions accordingly. As part of the approval process, the SAB can require a non-performance bond to be paid which would be refunded in full once the work was completed to the satisfaction of the approving body.

The Act also enables SABs to devolve the responsibility of SuDS adoption to other organisations such as land owners on the condition that all partners are in agreement.

This will ensure that the proposed ownership responsibilities are suitable and, in particular, that the responsibility for SuDS serving more than one property rests with an organisation that is both durable and accountable.

4.6.6 Campaigns and Communication

Alongside any capital schemes and proposed planning policies, there is a need to engage communities with the concept of surface water flood risk. Education is key to achieving this and, therefore, it is recommended that SCC and WW, in conjunction with Minehead Town Council and the Somerset Drainage Boards Consortium, where appropriate, consider the following:

Raising awareness of the impacts of increased impermeable areas

Educate residents and businesses with regard to the impacts of increasing impermeable areas within their properties. Use this opportunity to encourage the minimisation of impermeable areas. In conjunction with this raise awareness of the WW scheme for reduced sewerage charges which gives a reduction if a property owner can demonstrate that no surface water drains to the public sewer system[xxv]. SCC should also look for opportunities to provide subsidies for permeable materials and any national schemes to this effect.

The responsibilities of riparian owners

Raising awareness of the duties of riparian owners, who are the riparian owners and how failure to meet the requirements of riparian ownership will impact on the immediate and wider area.

Supporting community groups

Continued support of community groups and forums as well as looking to broaden their understanding of surface water flooding. Engage these groups to assist SCC by monitoring the local area for littering of assets, rising water levels etc.

Community flood plans

A community flood plan helps community members and groups plan how they can work together to respond quickly in the event of a flood. The Environment Agency has a guidance document for communities which is available on their website[xxvi]. A flood plan will:

- Improve communication and ensure the most appropriate people are involved at each stage
- Optimise resources
- Help share knowledge
- Clarify responsibilities
- Encourage involvement of volunteers
- Reduce damage and distress

Developer forums

Facilitate developer forums where necessary to consider cumulative impacts and strategic solutions, as well as opportunities to reduce local flood risk.

Cumulative benefits of individual actions

Increase the uptake of water butts by householders and businesses either by raising awareness of existing subsidy schemes or by developing a Minehead or Somerset specific scheme. This will, cumulatively, help slow runoff into the surface water system.

Encourage residents to ‘green’ their gardens and cartilages, again to slow the entry of water into the surface water network.

4.6.7 Emergency Planning

Multi Agency Flood Plan

The information provided in the SWMP, including outputs from the FMfSW, AStSWF and modelling should be used to assist in the future development and revisions of the Avon and Somerset Multi Agency Flood Plan (MAFP) which Category 1 Responders (SCC in this case) are required to produce[xxvii]. Specifically this will include identifying safe evacuation routes, meeting points, traffic management arrangements, shelters and reception centres, vulnerable people, critical infrastructure as listed in the MAFP checklist[xxviii].

Environment Agency Flood Warning

Minehead is not currently within a Fluvial Environment Agency flood warning area. The Environment Agency is, however, constantly upgrading its warning service and new areas are added regularly. Minehead lies within the Somerset Coast at Minehead and the Somerset Coast from Porlock to Avonmouth Flood Warning Areas for coastal/tidal flooding issues.

4.7 Phase 3 Summary

In order to address the specific issues relating to the Minehead SWMP, a three stage modelling strategy was developed and implemented:

- Stage 1 - Hydrological Analysis and development of a broad scale, bare earth, model of Minehead and sensitivity testing to determine the hydrological / infiltration response of the catchment.
- Stage 2 – Identification and evaluation of Wetspots using the bare earth model developed in Stage 1 and Prioritisation.
- Stage 3 - Detailed modelling assessment of specific wet-spots within Minehead. This included the development and testing of engineering options and economic analysis.

The SWMP direct rainfall analysis and review of historical data have improved the understanding of future surface water flood risk within the Minehead study area at a strategic level.

The detailed modelling has defined the surface water flood risk to Minehead. The model results have substantially refined the extent of surface water flooding from the Environment Agency AStSWF and FMfSW and been verified where possible by the available historical data.

A range of potential engineering measures and options have been identified, modelled and costed for Minehead, which indicate that the options assessed in this study provide little or no benefit in reducing flood risk. Smaller scale retrofitting works may be an option for controlling and reducing surface water runoff in the catchment. Funding constraints and stakeholder buy-in are likely to be a key obstacle to implement catchment wide solutions, highlighting the need for further stakeholder consultation and prioritisation of viable measures.

This SWMP therefore considers smaller scale, retrofitted, soft options for managing surface water flood risk in Minehead, as opposed to large scale engineering schemes. Reviewing the detailed rainfall model results in conjunction with aerial mapping we’ve assessed where options could be implemented to alleviate rather than prevent surface water flooding. These options will allow SCC to reduce the problem of surface water flooding with the introduction of smaller schemes over a number of years. It is also recommended that greater pressure is placed on developers to provide betterment within any development proposals.

Following Cost-Benefit analysis, the ‘Do Minimum’ option that involves continuation of current maintenance arrangements of the existing drainage system is proving to be the most financially cost effective option. This is almost certainly due to the fact that the surface water sewer systems in Minehead have a significant impact at mitigating the risk of flooding at lower return periods.

It should also be recognised that the ‘Do Minimum’ option does not deliver any reduction in the number of properties vulnerable to flooding and will not address increasing flood risk associated with climate change and this is a critical factor in relation to adopting a strategy to deal with climate change within the town.

The suitability of the ‘Do Minimum’ option is also questionable in terms of new duties imposed by the Flood and Water Management Act, social and environmental acceptance and future uncertainty. This clearly highlights the need for further consideration and implementation of a broad strategy, including the consideration of SuDS retrofitting.

4.8 Key Surface Water Flooding Issues in Minehead

Detailed modelling identified a number of potential issues in the study area:

- The natural topography of the study area, in which Minehead is located within a ‘bowl’ surrounded by several steep catchments, prohibits and constrains the potential mitigation options. Due to the topographical restrictions the options for providing protection against surface water flooding are limited.
- Overland flow paths and ponding of water in natural depressions results in noticeable flood depths and hazards.
- Limitations in the hydraulic capacity of the below ground surface water network causing surcharging at high heavy rainfall events.
- For the watercourses that flow into the study area there is a significant risk of tide locking and there is a risk of a combined river- tidal event causing increased out of channel flows. In addition, the urban nature of the lower reaches of the watercourses means that surface water flooding is likely to be an issue.
- It has been indicated that within areas of Minehead the urban drainage system has not been maintained properly due to mixed ownership. This is primarily associated with The Town Stream, which is located under a main road, but sections of the stream pass under properties.
- In dense urban areas residential gardens extend up to the edge of the watercourses and blockages can occur which can increase the risk of flooding.
- Connectivity from the town centre to the area of The Marshes give rise to the potential for the flooding from the Marshes impacting the lower areas of the town.

4.9 Preferred Options For Further Investigation

The identified Preferred Options for the study area that require further investigation and consideration are:

1. Smaller scale ‘quick win’ engineering elements and retro-fitting of SuDS in specific locations (Table 10.2)

2. Property level resistance/resilience measures

3. Non Capital improvements options (see Section 4.6)

There are a number of economic risks or uncertainties associated with the development of the cost estimates. The principal economic risks associated with all the quick win measures discussed in Section 4.5 are:

- The availability of land to form the attenuation storage areas
- Cost associated with dealing with utilities which have not been itemised with the cost estimates.
- The cost of land negotiations and compensation for disruption
- Ecological and other environmental risks and associated costs
- Sensitivity of flood damage assessment (e.g. actual property threshold levels and flood levels – see Appendix F)

4.10 Key Mitigation Strategies For Minehead

Whilst the engineering options proposed at this stage are at a strategic level, the modelling work carried out gives a clear indication to the approaches that could be taken during detailed design of surface water mitigation strategies in Minehead. These include;

1. Continuing maintenance of the existing surface water sewer system which provides benefits in mitigating flooding at lower return periods.

2. Development of 'quick win' options in further detail which includes the retro-fitting and installation of attenuation features and SuDS, such as swales within the catchment.

3. Policy measures discussed in Section 4.6, including the potential for development of the Strategic Vision for Water Management across Minehead, including the potential to improve current surface water management (deculverting watercourses, providing space for surface water exceedance pathways through good design).

5 Phase 4 – Implementation and Review

5.1 SWMP Action Plan and Monitoring

The key conclusions, preferred options and flood risk management strategies presented in Section 4.7 should be factored in the development of the Surface Water Action Plan and methods for communicating and monitoring the Action Plan as detailed in Section 15 above.

Minehead SWMP can also be used as a framework for the development of detailed assessments within the Minehead study area.

As part of this study, optioneering has been undertaken within the Minehead study area. The next steps specific to the Minehead area are detailed in the Table 5-1.

ID	Action	Lead Responsibility	Timescale
M1	Identification of Blue Green Corridor along the existing watercourses and promotion of these areas for future management changes so as to allow space for exceedance flowpaths within the urban setting of Minehead.	EA SCC SDBC **WSC**	Short Term
M2	Investigate the viability of protecting the town centre further from The Marshes to the east, through reducing the connectivity. To allow for Do Something Options 1 – 3 to provide greater benefit. Requirement to investigate potential for putting additional flow into the drainage area to east of town around Butlins	**SCC** SDBC	Short Term
M2a	Investigate potential further option of increasing size of Eastern culvert through to the Marshes, whilst maintaining the three Western culverts in details, as part of developing LFRAMS.	**SCC** SDBC	Short Term
M3	Investigate condition of rhyne system to east of Minehead and determine capacity to accept additional surface water flows from Minehead Urban Area	SDBC	Short Term
M4	Investigate the connectivity for historic surface water outfalls through sea defence wall in the location of King Georges Road to answer the perception that there were some historic surface water outfalls that have been removed. This should form part of the LFRAMs and be investigated through the SSFRMP.	**WW** SCC	Short Term
M5	Identify appropriate charging mechanism to allow for the development of surface water storage in Rhyne system to east of Minehead	**SCC** WSC	Short Term
M6	Include additional Core Strategy Policy as identified in Section 4.6 above to incorporate additional surface water management guidance	WCS	Short Term
M7	Undertake delivery of a Somerset County Guidance	**SCC**	Short – Mid Term

	document for Sustainable Water Management with support from Districts to assist with identification of requirements for new development and forthcoming legislative changes	Districts	
M8	Ensure that any propose actions, guidance and policies make appropriate links to the developing Local Plan for West Somerset and specific Minehead development	**SCC** WSC MTC	Short Term
M9	Write LFRMS ensuring consistency with the principles of the national strategy. Consider the need for scrutiny and consultation	SCC	Short – Mid Term
M10	Review the most appropriate vehicle for implementing surface water drainage policies, noting that SPDs can only provide guidance rather than setting policy.	SCC	Short Term
M11	All parties to understand the location of and status of their assets, so as to assist in the derivation of 'Critical' Assets.	**SCC** EA SDBC WW	Short Term
M12	Ensure duties of the SAB, when they arrive, are maintained either by Somerset County Council or by devolving the responsibility to an appropriate third party	SCC	Mid Term
M13	Enhance communication with communities to develop the notion of responsibility for and ownership of flood risk management.	**SCC** MTC SDBC	Continuous
M14	Continue to develop and maintain the Somerset Multi Agency Flood Plan (MAFP)	SCC	Continuous
M15	Investigate feasibility and economics of property level protection in identified wetspots	SCC	Short Term
M16	Regular Review of SWMP for Minehead	SFRMP	Minimum every Six Years

Table 5.1- Action Plan

5.2 Further Details

5.2.1 Benefits of Minehead SWMP

The modelling results, assessments and maps created during this Detailed SWMP, with emphasis on the identified study area, can be used as follows:

- Indication of potential development constraints and opportunities for future development to contribute to the reduction in the predicted flood risk
- Identification of which stakeholders should be consulted with regard to new development
- Highlights broad scale risk and indication as to whether a developer is required to undertake further investigation

- Evidence as to why Developers should undertake further investigation and develop appropriate mitigation measures
- The SCC Highways Department can see where highways flooding has occurred in the past and during times of high rainfall focus maintenance and emergency response efforts in these areas
- The Emergency Planning team can use historical flooding data and flood receptors to identify more vulnerable areas and prepare suitable emergency planning measures
- Development of future planning policies and local flood risk management policies as part of Somerset County Council's and West Somerset District Council's future Local Development Documents and SCC's Local Flood Risk Management Strategy. In particular, with regard to the consideration of surface runoff from any infill development within the study area.

5.2.2 Data Management

The Minehead SWMP report highlights the need for improved data management and these recommendations are also applicable to Somerset.

It is recommended that the data register development is led by the SFRMP as this will allow the capture of all data specific to the different and varying areas of Somerset.

5.2.3 Quick Win Measures

The 'quick win' measures recommended are:

- SCC, West Somerset Council, utility companies, emergency services and their planning teams to undertake assessments of key assets in the area of Minehead SWMP.
- Use of the flood incident register alongside for the Minehead study area to guide future maintenance and inspection investment
- Campaigns to increase the uptake of water butts and other SuDS whilst minimising impermeable areas in existing residential areas
- The SWMP modelling outputs and EA's FMfSW can be used to identify where the risks are critical to their operation, so that suitable steps including contingency planning can be taken.

5.2.4 Role of the SWMP Report in the Planning Process

The Minehead SWMP has included as a next step the production of a planning guidance document that will assist planners in the use of additional surface water information as an evidence base in the planning process. Consideration should be given to this Planning Guidance document, and the comments in the SWMP.

However, the modelling of Minehead has provided additional information and evidence for use in the planning process. Recommendations for planners dealing with planning applications in the Minehead Wetspots are detailed below in Table 5-2.

Recommendation	Verification
Development of a specific SPD for Minehead to integrate the evidence identified during the Detailed Assessment. Redress the balance of urbanisation in the area and mitigate for future climactic uncertainties, improve water quality and provide opportunities for slowing the flow.	Several areas within the study area are shown to be at risk of potential flooding.
Where key flow paths through a site can be identified from the mapping provided, these flow paths should be integrated into the design of the surface water attenuation structures within a new catchment.	From velocity mapping within modelled outputs.
Careful consideration of the use of architectural designs such as drop kerbs in new developments within the Wetspots.	A number of flow paths through the study area are along roads and these should be treated as preferential 'exceedance' flow paths.
Limit, and where possible better, the rate of discharge from new development sites to greenfield runoff rates.	From mapping within modelled outputs.
Careful consideration with regards to installation of additional attenuation and soakaway basins. Provide a suitable storage capacity to reduce negative impacts such as increased localised inundation of nearby dwellings and commercial properties near to attenuation locations.	

Table 5-2 Recommendations for Planners in Minehead

5.2.5 Emergency Planning

Review of Council Emergency Plans

The Emergency Planning team at SCC should use historical data, updated flood receptors and broad Wetspot areas to identify more vulnerable areas and prepare for suitable emergency planning measures.

Review of Asset Vulnerability

All SFRMP partners and utility companies to undertake assessments of their key assets in the areas of surface water flood risk.

The sources of data should include the most detailed flood risk information available for the area of interest. This will allow identification of where the risks are critical to their operation so that suitable steps including contingency planning can be taken.

5.2.6 Sustainable Development and Rainwater Harvesting

Generally planning policies covering the Minehead area encourage the use of SuDS. Developers need to consider the most appropriate SuDS measures for their site. As well as SuDS measures providing mitigation against flood risk, they can also provide environmental and amenity benefits to an area. As well as larger scale SuDS measures on development sites, individual homeowners can provide surface water attenuation through Rainwater Harvesting.

Domestic Level Incentives

Householders should be encouraged to use water butts; either by working with existing schemes or through new initiatives. These schemes are supported and promoted by all the stakeholders, details of which can be found on their websites. Whilst developers should not consider water butts as a method for reducing surface water run-off from a development site, water butts are a component part of SuDS measures.

They should be encouraged across the area as a preventative measure as per CIRIA Interim Code of Practice for SuDS.

6 References

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