Somerset County Council

Taunton Surface Water Management Plan

Detailed Assessment and Options Appraisal Report

Final

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Appendices

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 or being exceeded 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)	The Flood and Water Management Act (FWMA) came into effect in April 2010. The Act takes forward a number of recommendations from the Pitt Review into the 2007 floods and places new responsibilities on the Environment Agency, local authorities and property developers (among others) to manage the risk of flooding.
Flood Estimation Handbook	Produced by the Natural Environment Research Council, this provides guidance on best-practice 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.
Wet Spot	Areas vulnerable to flooding are termed 'wet spots'. Within the SWMP once identified wet spots are prioritised for further investigation, and eventual mitigation where economically viable.
Zero Carbon Development	A development that achieves zero net carbon emissions from energy use on site, on an annual basis.

Abbreviations

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
WaSCs	Water and Sewage Companies
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 Taunton. 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 each Wetspot. This provides an analysis of where investment could be directed in the future if finance is available following further project appraisal and consultation.

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 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, Taunton Deane Borough 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 achieve stronger water quality drivers associated with surface water management alongside flood risk considerations.

1.3 Background

The widespread flooding experienced during 2007 precipitated the publication of the Pitt Review[i] 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)[ii], now replaced by the National Planning Policy Framework (NPPF)[iii] and the associated Technical Guidance for the NPPF[iv].

"*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[v] informed by the Integrated Urban Drainage (IUD) Pilot Studies carried out under the Government's Making Space for Water (MSfW)[vi] 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.

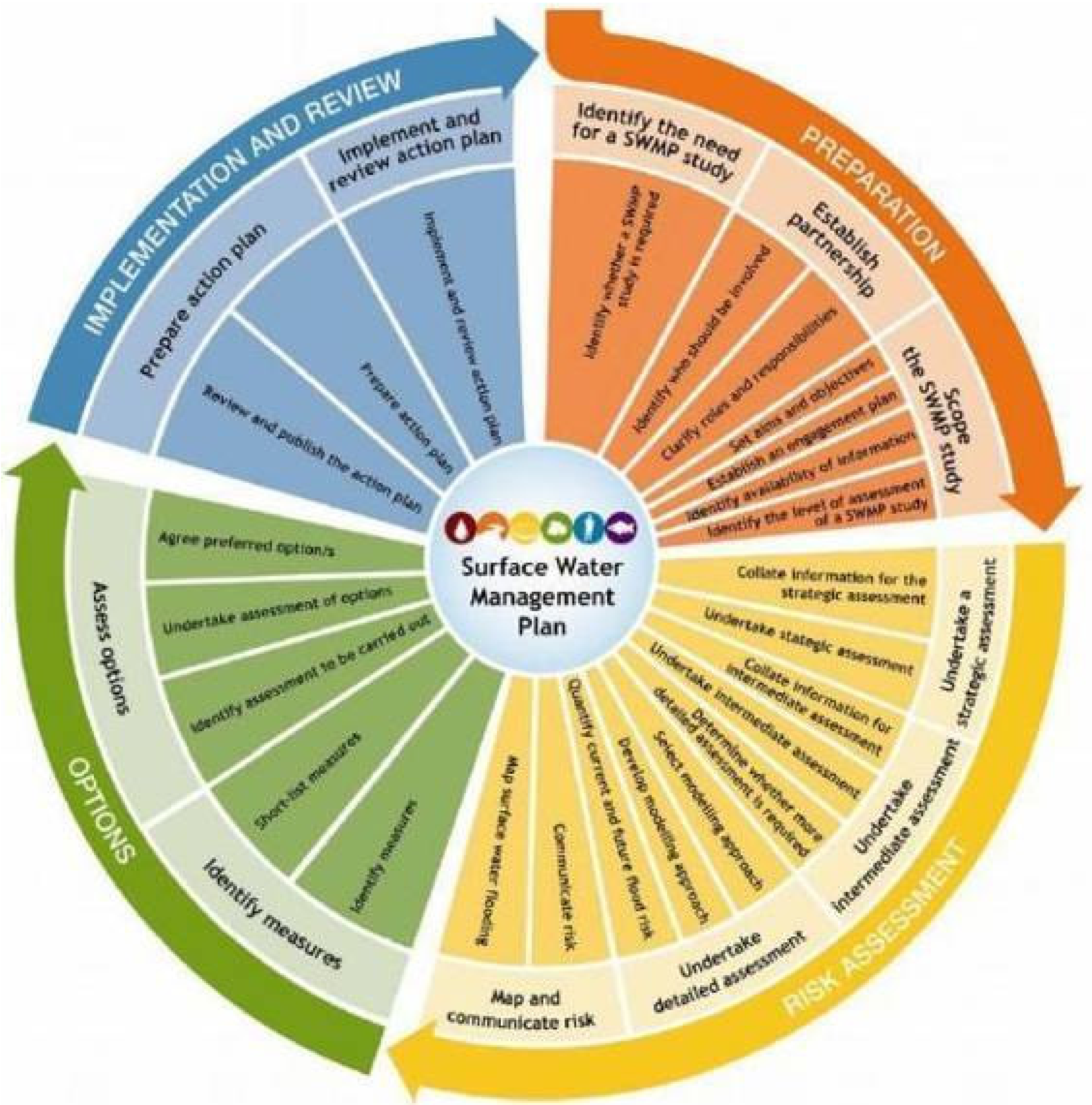


Figure 1-1 SWMP Wheel (source Defra Guidance[3])

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 Management 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 focused 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.

Therefore, further works are required to help redress the issues resulting from the existing and proposed 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[v] 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 Taunton 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 Taunton. 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 Parrett CFMP

The Catchment Flood Management Plan (CFMP) for the Parrett catchment was published in 2009 by the Environment Agency and sets out policies for the sustainable management of flood risk 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 Taunton study area falls within the area covered by the Parrett CFMP. The catchment covers approximately 1700 km² with a population of around 300,000 and is a Glossary predominantly rural catchment with urban areas making up only four per cent of the total. Its main urban areas include Taunton.

The Parrett catchment has a history of flood risk. Over the last 70 years numerous engineering schemes have been implemented to reduce flood risk in the catchment. At present 3,300 properties are at risk in the catchment in a 1% annual probability flood event. This takes account of flood defences already in place. This is expected to increase to over 6,600 properties in the future.

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

- River flooding from the River Parrett and its tributaries particularly in Taunton
- Breaching/failure of embankments
- Surface water drainage and sewer flooding, which has occurred in parts of Taunton

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

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

1. Work with communities to increase flood awareness, pre-flood planning and promote flood warning.
2. Review maintenance activities to ensure best value for money.
3. Prepare development guidance for proposed developments in Taunton, identifying methods to reduce runoff rates and include Sustainable Drainage systems (SuDs) in all new developments.
4. Investigate the current and future capacity of the existing surface water drainage systems, focusing on the effects of climate change. Develop surface water management plan with consideration of receiving watercourses and climate change.
5. Investigate existing critical transport links into Taunton and vulnerability and resilience to flooding. Implement improvements where practical.
6. Investigate identified marginal deficiencies in River Tone flood defences and implement improvements in connection with urban regeneration.
7. Investigate potential to reduce flood risks from tributary flooding and implement improvements where practical.

1.5.2 River Basin Management Plan

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. Taunton 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.

Taunton 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. Major growth is planned at Taunton and it is identified as a growth point and has an ambitious development agenda centred, in part, on renewal of the urban River Tone frontage.

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.

1.5.3 Preliminary Flood Risk Assessment

The PFRA for Somerset was completed in June 2011. Taunton 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 Taunton. A 'cluster' of blue squares within the study area was identified by the Environment Agency

1.5.4 Taunton Deane SFRA

A Level 1 SFRA was completed in 2007, which prepared strategies and development control policies to allow Taunton Deane Borough Council (TDBC) to apply the sequential test to proposed development sites. The Level 2 SFRA was prepared by JBA in 2011. The SFRA aids developers in producing site specific Flood Risk Assessments and highlights the importance of using SuDS.

Within the borough as a whole there are a number of mechanisms by which flooding can occur. Within the urban areas surface water flooding resulting from intense pluvial events is potentially a significant source of flood risk depending on the capacity of the sewer system.

Within Taunton fluvial flooding may occur as a result of structures such as bridges and culverts becoming blocked or due to overtopping of the defences. Flooding can occur due to overtopping of the defences (likely only in the largest flood events) or if a breach occurs.

Across the borough one key consideration in determining flood risk is event duration. For very short durations (< 5 hours) the primary flood risk is likely to be surface water flooding, for moderate durations (10-25 hours) the primary flood risk is likely to be fluvial with peak flows overtopping bank levels.

The SFRA identified the following key flooding issues for Taunton that need to be addressed:

- Areas of Taunton where defences are not of the required standard
- Mechanism for updating modelling following redevelopment of town centre sites to ensure that current flood risk is up to date.
- Prevention of blockage at key structures
- Longer duration events (River Parrett flows)

1.5.5 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.

1.5.6 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 LFRMSs. 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 RBMPs, 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.

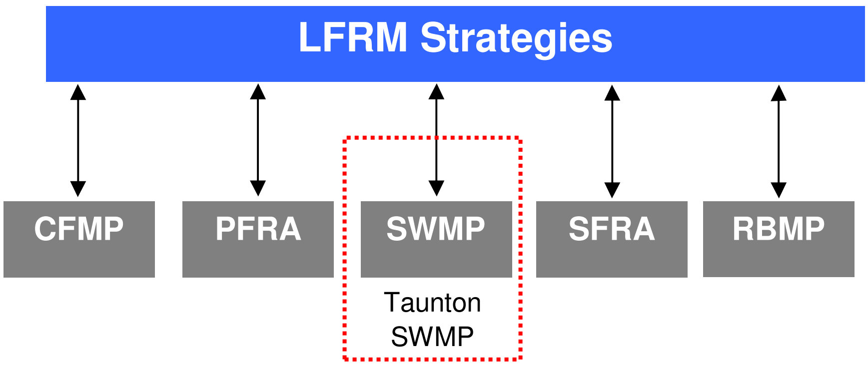


Figure 1-2 Supporting studies used to develop a Local Flood Risk Management Strategy

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[vii].

The Regulations require three main types of assessment / plan:

1 Preliminary Flood Risk Assessments (maps and reports for surface water runoff, groundwater flooding and flooding from ordinary watercourses) 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 in subsequent stages 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 4.5) have been prepared for the Taunton SWMP study area and they will inform Somerset's Local Flood Risk Management Strategy development 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 watercourses). 'Upper Tier' local authorities have been empowered to manage local flood risk through new responsibilities for flooding from surface and groundwater in their role as Lead Local Flood Authorities (LLFAs), but the FWMA 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 reviews 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.

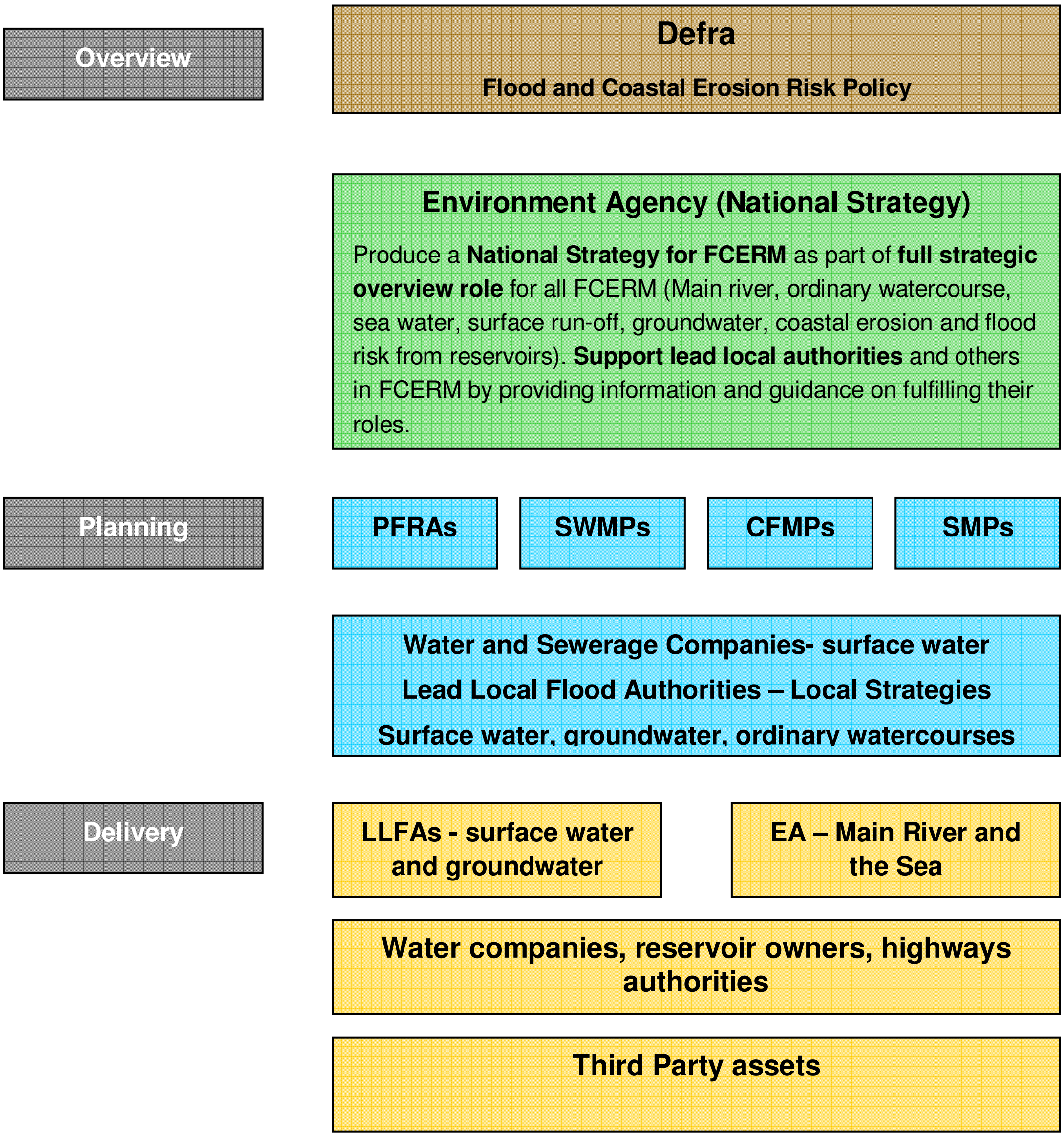


Figure 1-3 Local Flood Risk and Coastal Management Responsibilities

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.

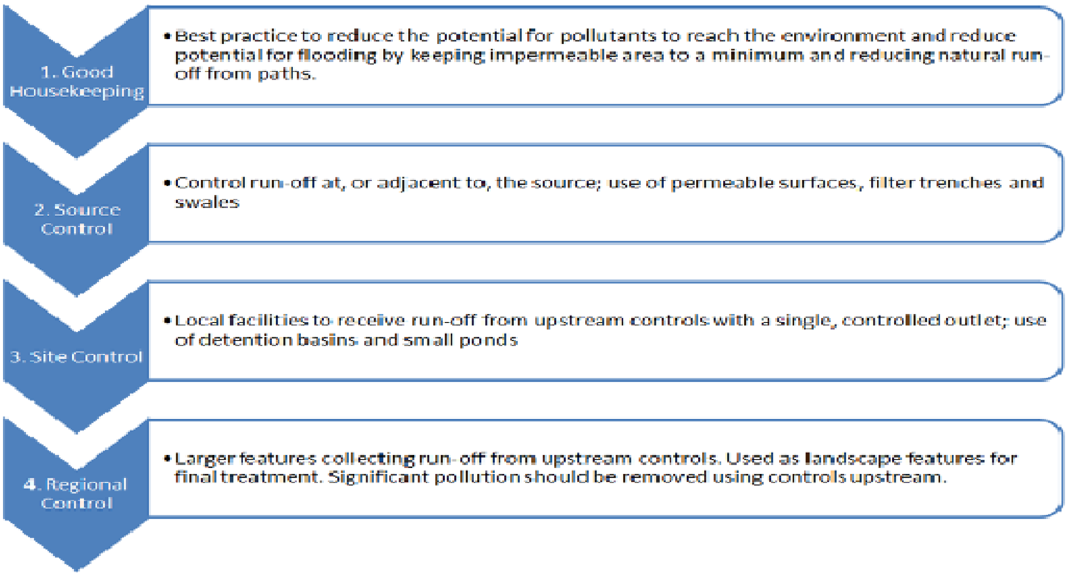


Figure 1-4 SuDS Treatment Train

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[viii])

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 Taunton study area as shown in Figure 1-5.

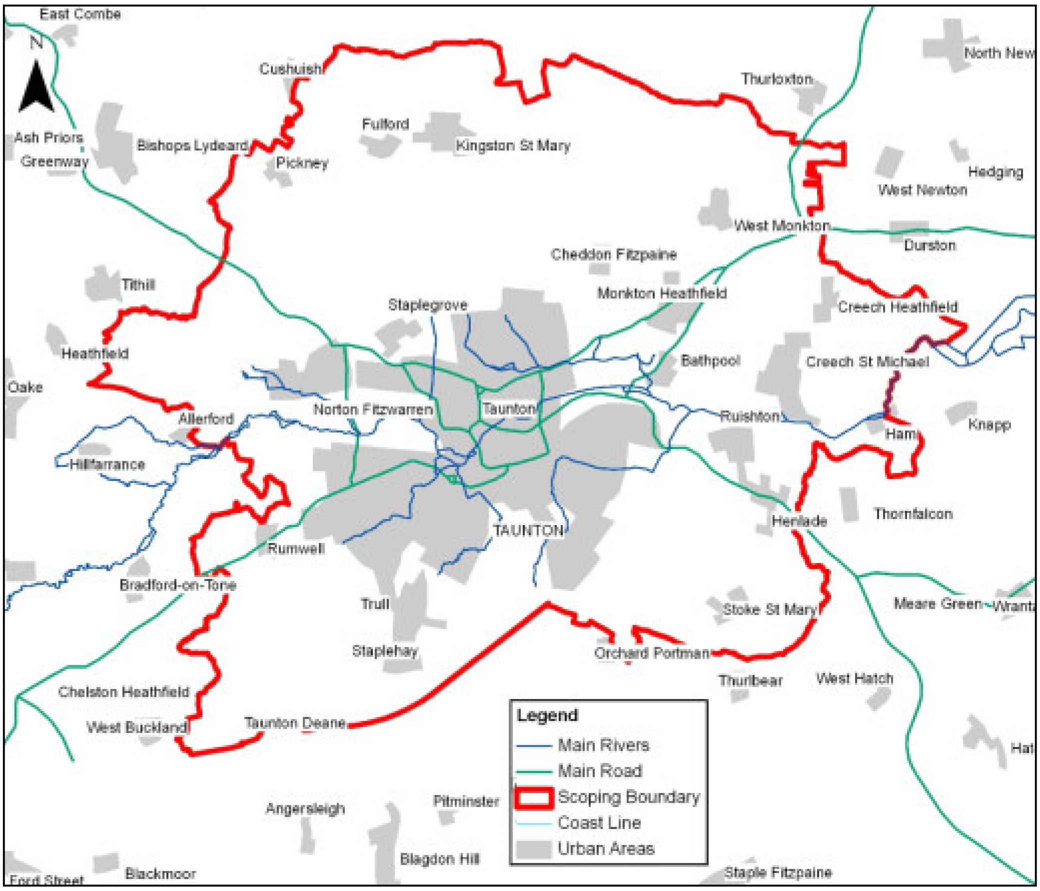


Figure 1-5 Study Area - The Urban Area of Taunton.

The area within the scoping boundary (Figure 1-5) is some 89km². Due to the steep sided nature of the catchment small watercourses in the upland area will respond rapidly to rainfall. As such, the varying configuration of the catchment means that flood waters reach Taunton at different times. The contrasting geology in the catchment means there are variable runoff responses into the study area, as such it was considered that the study area, or 'wetspots' within the study area, could not be assessed in isolation from the wider catchment.

Taunton is a dense urban area and as such the watercourses have been culverted, modified and largely encroached upon by development. The highly modified landscape, which has resulted from a history of modifying watercourses and water levels to create and maintain agricultural land, and local ecosystem are reliant on this artificially made system. Figure 1-6 shows the key watercourses within the study area. The town is the primary area that is at risk of flooding, with a significant amount of river fronting development situated within the floodplain of the River Tone. In the 1960's a large scale flood defence scheme was developed to afford protection to the town. Taunton contains a significant amount of key services, commercial properties and infrastructure and is also an important employment centre and tourist destination. The land surrounding Taunton is primarily agricultural and the Somerset levels SPA is located downstream of the study area.

The topographical setting of Taunton is that the town is largely located within a natural low lying bowl, which is formed by the surrounding Brendon Hills, Blackdown Hills and Quantock Hills.

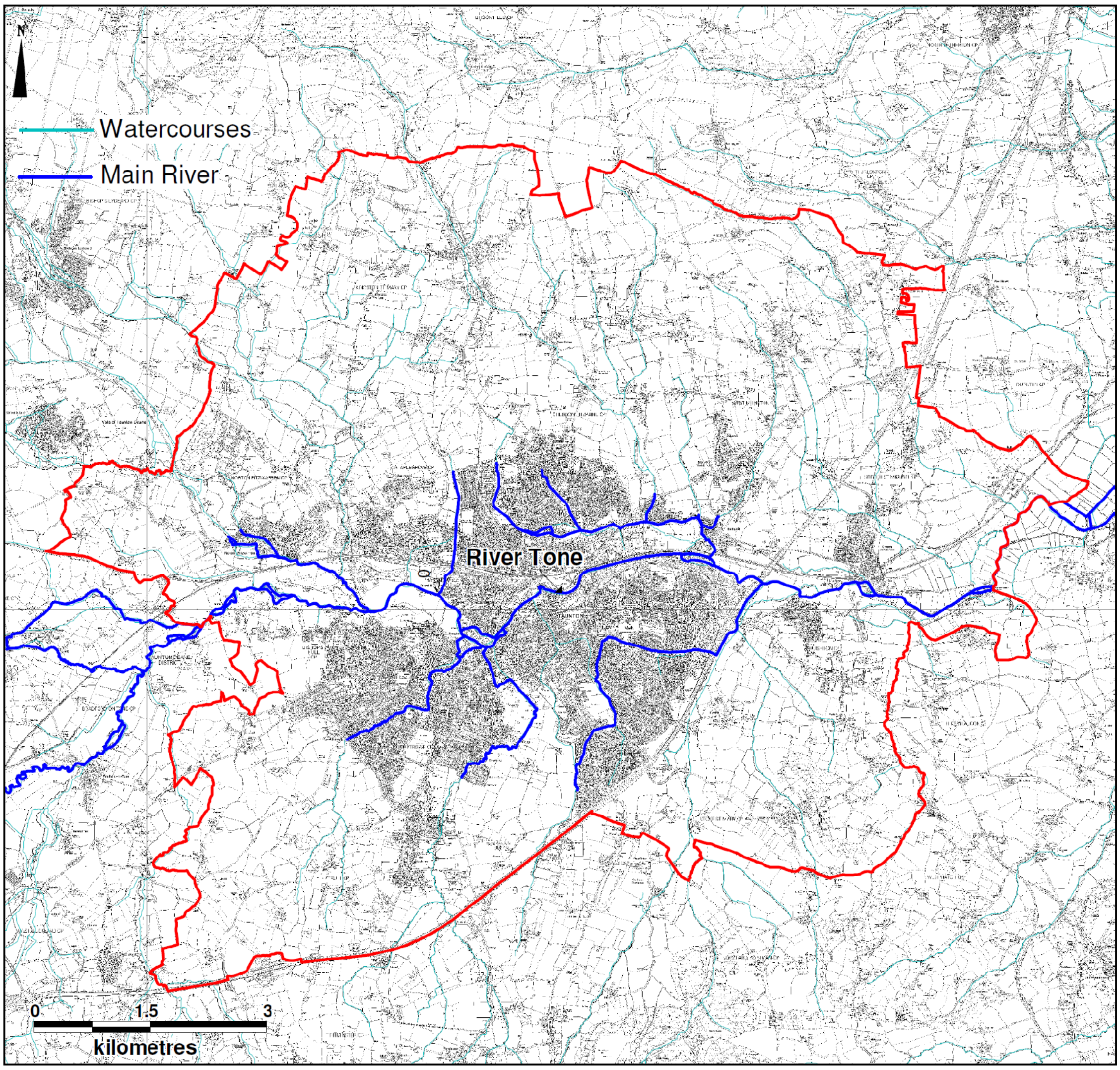


Figure 1-6 Watercourse locations within Taunton.

1.9 Methodology

The methodology used to carry out this SWMP follows the advice set out in the Defra SWMP guidance 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 Taunton SWMP. It should be noted that this figure only shows the steps subsequent to the formal identification of the Taunton 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.

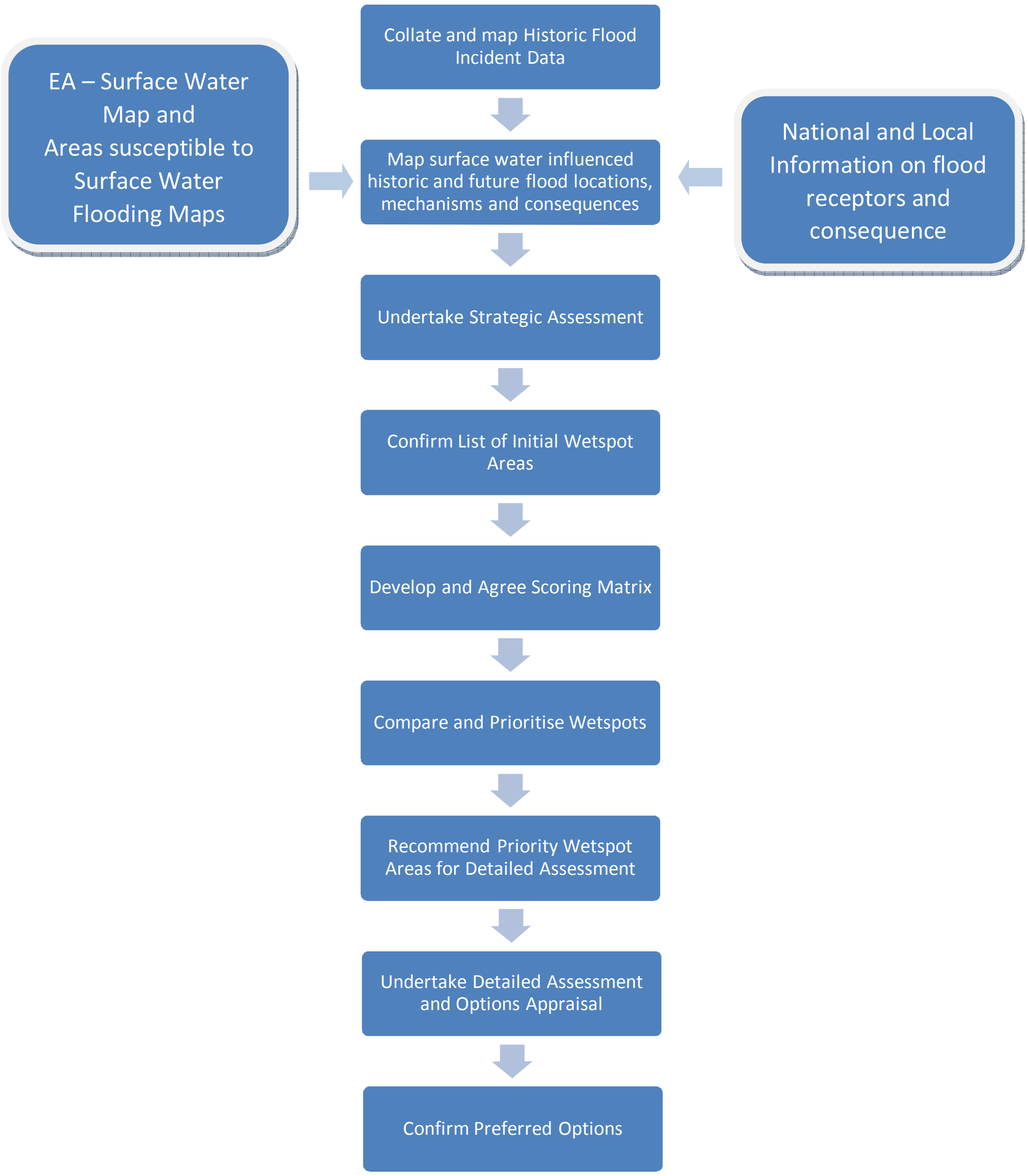


Figure 1-7 Overall Approach to Study Methodology

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

2 Phase 1 – Preparation

2.1 Need for SWMPs in Somerset

2.1.1 Background

A Level 2 SFRA was completed in 2011, which prepared strategies and development control policies to allow TDBC to apply the sequential test to proposed development sites.

Taunton was also included in the Parrett Catchment Flood Management Plan (CFMP) which identified proposed actions regarding preparation of development guidance for proposed developments in Taunton and identifying methods to reduce runoff rates and include SuDS in all new developments. In addition the study investigated the current and future capacity of the existing surface water drainage systems, focusing on the effects of climate change and developing a surface water management plan with consideration of receiving watercourses and climate change.

Taunton is the administrative headquarters for Taunton Deane Borough Council and accommodates the Somerset County Council offices at County Hall. Taunton is seen as a strategically important town which has attracted government investment for large scale regeneration projects. The town also receives a large influx of holiday makers throughout the year as a nucleus for visiting the town and surrounding areas of Somerset.

2.1.2 Defra Application

Defra divided England into 4350 settlements. These settlements were then ranked with regard to their possible susceptibility to surface water flooding and Taunton was ranked 56. SCC subsequently applied for and received early action revenue funding from Defra to progress the Taunton SWMP based on the fact that Taunton was identified by Defra as the highest priority for a Surface Water Management Plan in Somerset with 5,200 properties at high risk of surface water flooding.

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 details 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 Taunton SWMP will build on the Level 2 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 Taunton 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 Flood and Water Management 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 Taunton, these partners are:

- Somerset County Council (SCC)
- Taunton Deane Borough Council (TDBC)
- 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. They include:

- Natural England
- 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 Taunton SWMP;
- Lead Local Flood Authority;
- Highways Drainage (other than M5);
- SuDS;
- Preliminary Flood Risk Assessment;
- Preparation for emergencies (though joint Civil Contingencies Unit);
- Procurement

Taunton Deane Borough Council

- Local Development Framework and the Core Strategy;
- Strategic Flood Risk Assessment Level 1 and Level 2;
- Urban Green Space;
- SuDS;
- Ordinary Watercourses.

Environment Agency

- Main River Flood Risk Management, including information management and modelling;
- Parrett Catchment Flood Management Plan;
- River Basin 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 (likely to come in 2014).

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 County 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[ix] was produced by Hyder and this is being taken forward by SCC 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 Taunton. 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.

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		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	Parrett Catchment Flood Management Plan, South West District River Basin	National Receptor Databases, historical and modelled flood event outlines, main rivers, detailed river

	Management Plan, Preliminary Flood Risk Assessment Provisions of flood risk studies of local area.	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	
Taunton Deane Borough Council	Strategic Flood Risk Assessment (Level 1) 2007 Strategic Flood Risk Assessment (Level 2) 2011 Taunton Deane Local Development Framework	
Wessex Water		Sewerage networks, asset information, DG 5 Register, Drainage Area Plan.

Table 2-2 Stakeholders contacted and the information provided

The documents listed in Table 2-2 and anecdotal evidence provided by the stakeholders provided the main source of information on local flood risk used within this SWMP. The Level 1 and 2 SFRA studies were completed in 2007 and 2011 respectively and have been reviewed and approved by TDBC and the Environment Agency. This suggested that these were reliable sources to use to establish the main local flood risk areas across Taunton.

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.

Historic Flood Records

A review of the data sets received was undertaken and it is evident that the historical information associated specifically with Surface Water Flooding within Taunton is 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.

Assets

The asset database has been developed to allow the addition of further data into the future and the attributes set up accordingly. However, it is possible that in future additional changes will be required in order to make the database achieve future unforeseen requirements at a given time.

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 Taunton; 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 is undertaking this SWMP in order to:

- Better understand the risks and consequences of surface water flooding in Taunton;
- 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.

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 urbanisation has occurred.

2.6 Phase 1 Summary

Phase 1 of the SWMP was completed by SCC prior to this commission and it has:

- Engaged key stakeholders including the Environment Agency, Wessex Water, Somerset Drainage Boards, Taunton Deane Borough Council and Somerset County Council, to discuss and agree on local flood risk management within Taunton 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 SCC, 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 Taunton. 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 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 Taunton 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 T4 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 5-1 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 report of incident	Low - Source assumed
Flood source provided by residents or non-technical experts with high level of detail in the report of the incident	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 Taunton 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, and the latest version of the EA's Surface Water Maps.

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), TDBC, WW and riparian owners.

The following sections outline the historical surface water flooding recorded in Taunton 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 up to February 2012; the occurrence of surface water flooding is not static and thus this represents an understanding of the situation at that time.

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, SCC	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 databases are the EA's historic Flood Risk Information System (FRIS) and WW DG5 incident database which recorded major flooding events in Taunton. There are a total of 1,426 recorded historic flooding events from 1960 to 2007:

- Fluvial – 716 records
- Pluvial – 37 records
- Unknown- 673 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.

Accordingly, there is a high probability that flooding within Taunton is under-reported. In general, the historical information associated with surface water flooding in Taunton 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 Taunton based upon the above data.

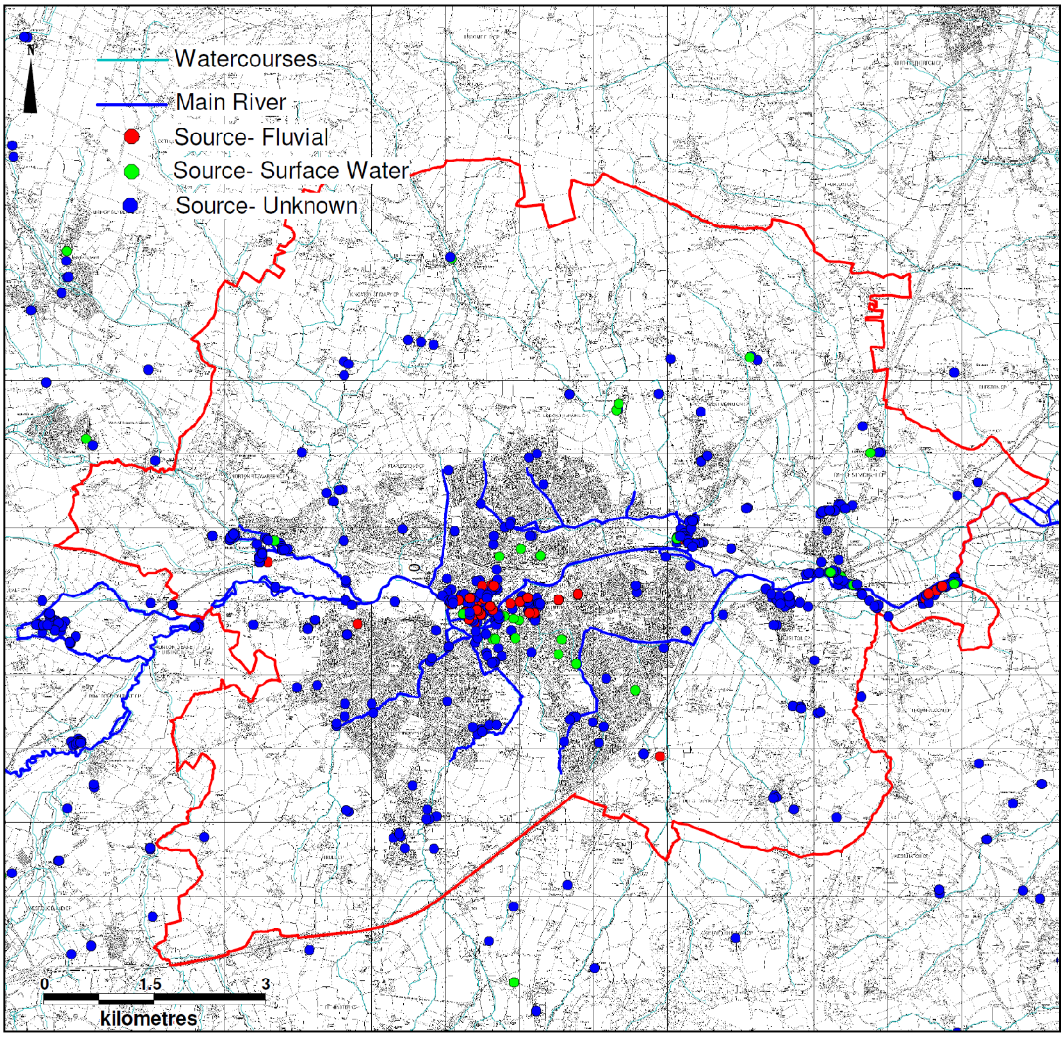


Figure 3-4 Historical Flooding in Taunton

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 results 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. However, it should also be recognised that flooding will be the result of numerous factors rather than solely rainfall intensity or duration.

Groundwater

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

Sewers

WW have provided information in relation to flooding incidents identified to have been caused by hydraulic inadequacies. 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.

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 river in the Taunton study area is the River Tone, which has a number of tributaries which flow into it. 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 River Tone flows into the Somerset Levels and the river is prone to tidal locking and can also be influenced by the River Parrett. 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, due to the steep sided nature of the catchment small watercourses in the upland area will respond rapidly to rainfall. As such, the varying configuration of the catchment means that flood waters can reach Taunton at different times. Flooding from this source would result in a widespread flood extent and hazardous flooding to people and property.

The steep flashy nature of the surrounding catchment and tributaries also leads to rapid runoff into the town. The topography of the River Tone catchment makes Taunton effectively a receptor bowl.

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 landowner. 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 can easily pick up debris.

3.2.3 Overland Flows from Groundwater Sources

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

3.3 Potential Indicators of Surface Water Flood Risk

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

The Environment Agency has produced the outputs of 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 predicted surface water flooding risk across the Taunton 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) 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 Taunton based on the Making Space for Water report (Jacobs, 2006).

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

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.

Taunton Deane Borough Council

Taunton Deane Borough Council is the Land Drainage Authority for Taunton 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[x].

Somerset Drainage Board Consortium - IDB

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

- The Axe 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 Taunton vicinity. The area of the River Parrett IDB district is 24,607 ha, within which there are 279 structures operated and maintained and the length of watercourses maintained is 584km (362miles). The Axe Brue district is 30,398 ha, within which there are 216 control structures operated and maintained and the length of watercourse maintained is 601km (373 miles).

4 Model Development

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

- Stage 1 - Hydrological Analysis and development of the bare earth model of Taunton. As noted above this included the development of two models: to the north and south of the River Tone
- Stage 2 – Identification and evaluation of wetspots using the bare earth model developed in Stage 1 and prioritisation of wetspots for further consideration in Stage 3
- Stage 3 - Detailed modelling assessment of specific wetspots within Taunton. This included the development and testing of engineering options and economic analysis

The three stages are also associated with increasing refinement of the model which are as follows:-

- Stage 1- Development of direct rainfall models for areas to the north and south of the River Tone using a grid size of 5m and incorporating variations in roughness in accordance with Master Map data to reflect different surface covers. The modelled infiltration rates for soft areas were set at 66% of the Depth Duration Frequency (DDF) rainfall for the Stage 1 modelling.

- Stage 2 – Based on the results of Stage 1 modelling, the multi-criteria analysis and prioritisation requirements of the Project Board, a second generation model was developed for a smaller area (Catchment B – see Figure 4-7) located to the north and north east of the town. The Stage 2 modelling used a grid size of 5m. The modelled infiltration rates for soft areas were set at 33% of the DDF rainfall for the Stage 2 modelling. The objective of this stage was to identify individual wetspots within catchment B. The stage 2 modelling included representation of surface water sewers and SUDS features supplied by Wessex Water and Somerset County Council.

- Stage 3 – Based on the results of Stage 2 modelling and further assessment by the Project Board a third generation model was developed for the Staplegrove area of Taunton to facilitate the development of potential mitigation options. This included assessment of Do Nothing, Do Minimum and Do Something options. The Stage 3 modelling included representation of surface water sewers supplied by Wessex Water and sensitivity testing associated with infiltration.

As noted above the Stage 1 was based upon bare earth modelling and Stage 2 also included representation of the surface water sewers. Stage 3 included a sensitivity analysis which was designed to refine infiltration rates within the model. The model development throughout the three stages is discussed in detail in the sections below.

4.1 Stage 1- Bare Earth Model

4.1.1 Bare Earth Model Construction

The boundary of the Stage 1 Taunton SWMP models to the south and north of the River Tone was determined by the surrounding catchment boundary and is shown in Figure 4-1 and 4-2.. 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 4-1.

Model Parameters	
Grid Size	5 m
Time Step	0.5 seconds
Bare Earth Storm Durations	240 minutes
Modelling Return Periods	1 in 10, 50, 75, 100, 100+CC and 200 years
Total Run Time	165 hours

Table 4-1 - Stage 1 Model Parameters

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). The results for a 200 year (0.5% AEP) 240 minute storm with infiltration rates commensurate with the first generation surface water flood maps for the duration of the model run are shown in Figure 4-3.

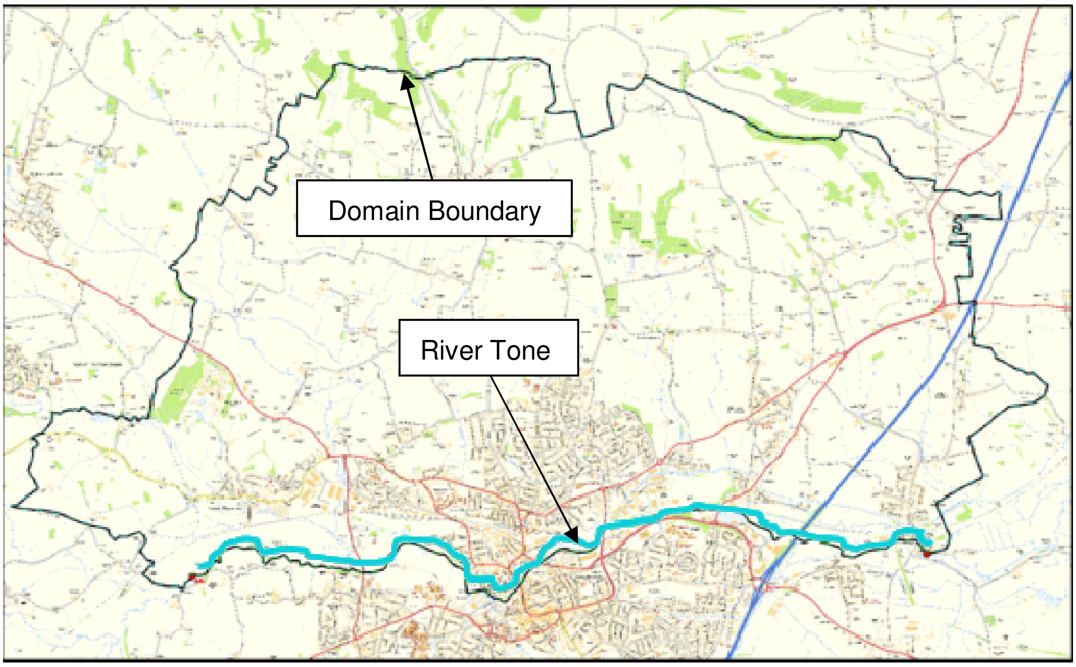


Figure 4-1– North Taunton Direct Rainfall Model- Extents of TUFLOW Domain (5.0m grid)

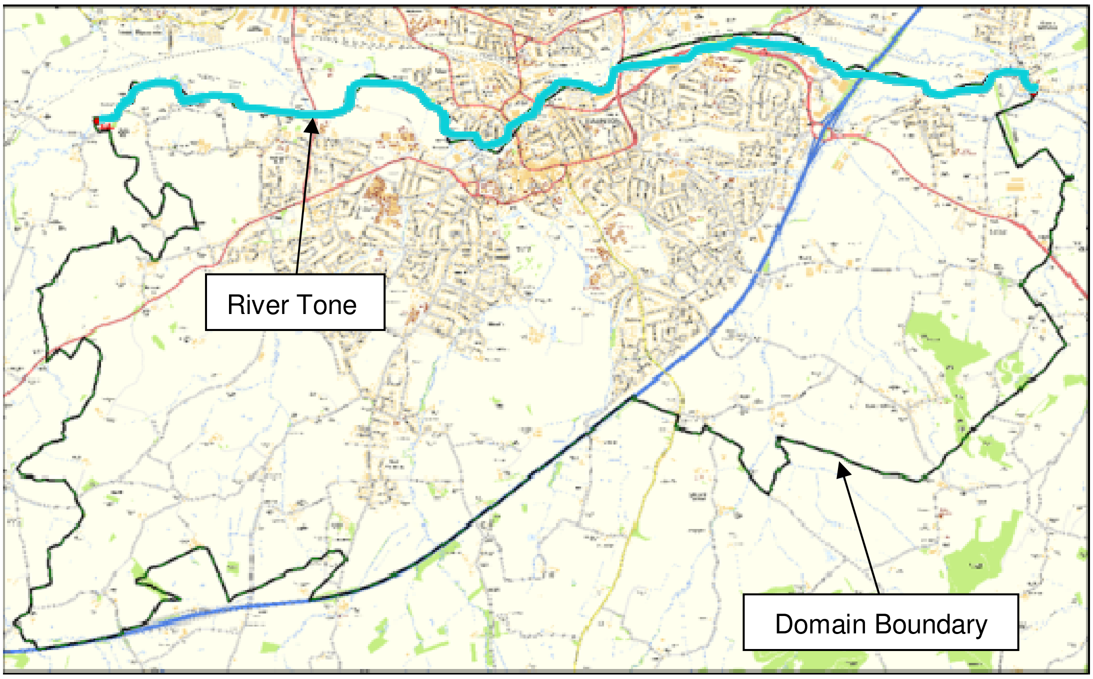


Figure 4-2 - South Taunton Direct Rainfall Model- Extents of TUFLOW Domain (5.0m grid)

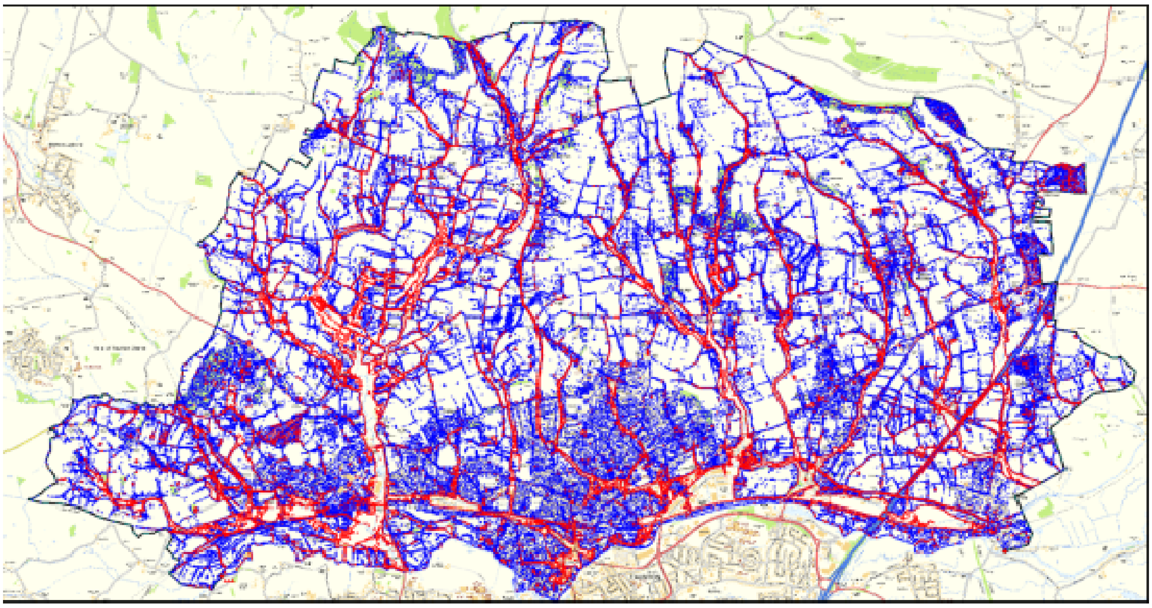


Figure 4-3 – North Taunton Bare Earth Pluvial Model Results for 200 year (0.5% AEP)

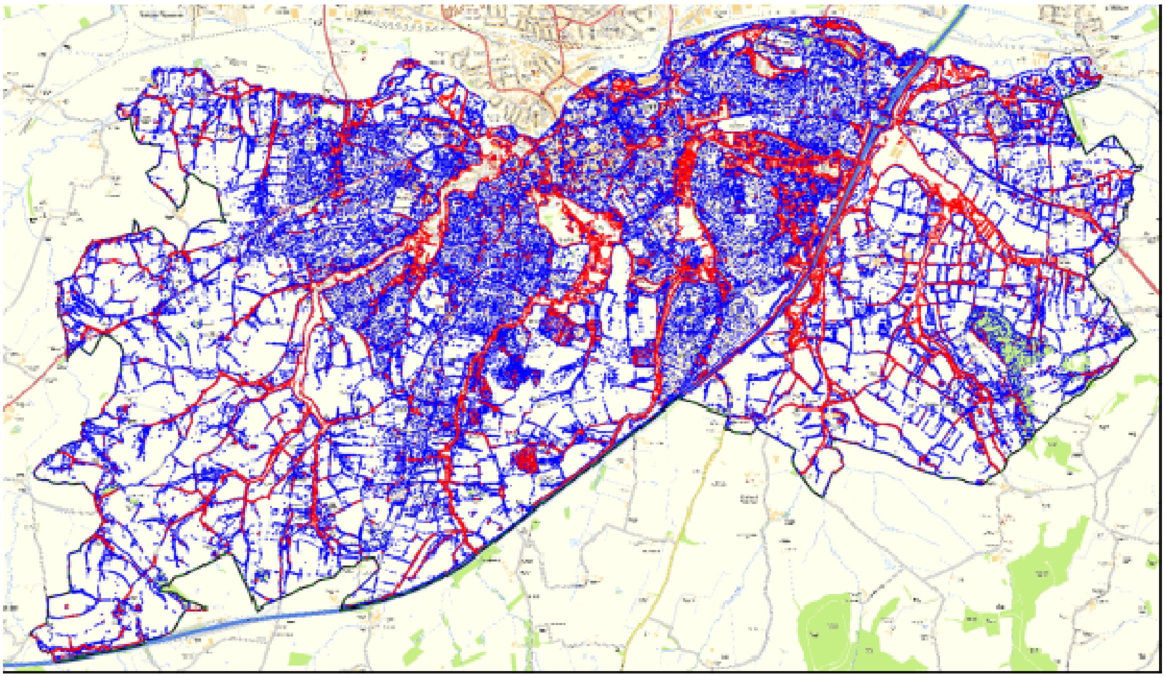


Figure 4-4 - South Taunton Bare Earth Pluvial Model Results for 200 year (0.5% AEP)

Key

0.1m Depth Contour

0.3m Depth Contour

4.1.2 Hydrological analysis

As noted above the purpose of developing a TUFLOW model of Taunton 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 an increasingly standard 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. The modelled infiltration rate was set at 66% of the DDF rainfall for the Stage 1 modelling.

4.1.3 TUFLOW Rainfall Boundary

The ISIS-TUFLOW model was designed to simulate the effects of combined fluvial and pluvial induced flooding to Taunton. 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 4-5 shows an example hyetograph used in the modelling for a 1 in 200 year rainfall 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.

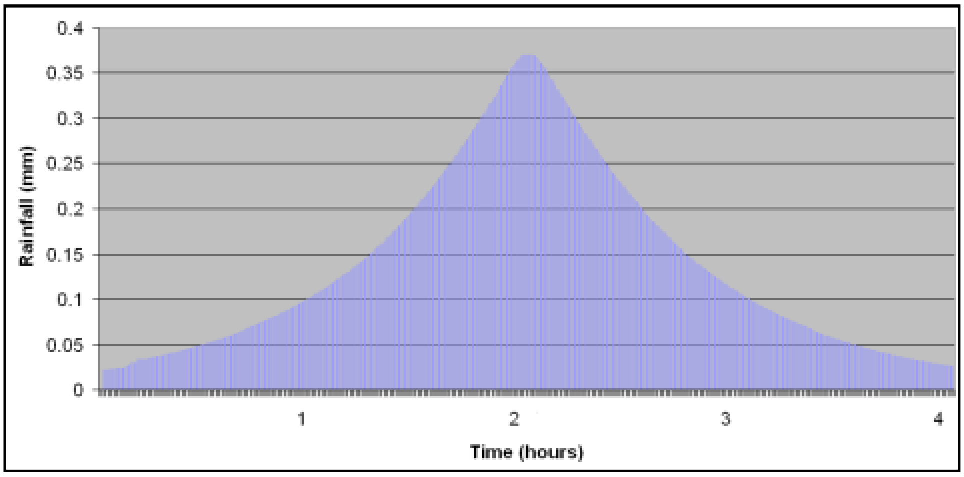


Figure 4-5 - Example Hyetograph

4.1.4 Model Evolution

LiDAR

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 Taunton at either a 1m or 2m grid resolution. Due to the nature of a rainfall model, the inclusion of the adjoining hillside to the north and south of Taunton was crucial to accurately represent the conveyance of surface water within Taunton.

The DTM surface elevation tiles were spliced together to create two topographical grids for Taunton separately representing the catchment areas to the north and south of the river Tone. The grids were then inspected to ensure consistency and accuracy. These include using numerous cross sections drawn over the map to check the consistency between tiles that had been stitched together.

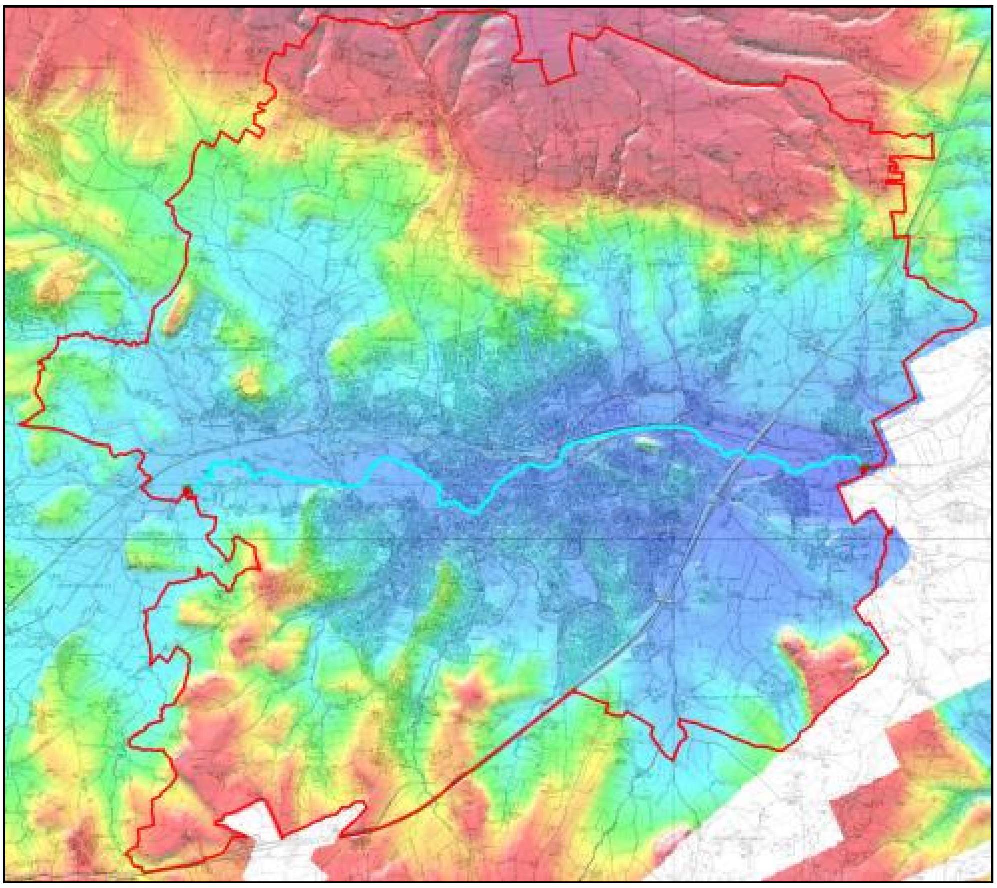


Figure 4-6 LiDAR Data Extent (study area indicated by red line boundary)

There are a number of factors influencing surface water flooding as a result of localised heavy rainfall events in Taunton. These include:

- Surface water runoff from surrounding recreational / agricultural land towards residential and commercial regions
- Conveyance and out of bank flows associated with ordinary watercourses
- Capacity of storm water sewer systems.
- Highway conveyance of surface water
- Urbanisation

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 Taunton.

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

4.1.5 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 as shown in Table 4-2. For 'kept fields', for example, 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.

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 4-2 - TUFLOW Material Roughness Values

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 4-3.

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

Table 4-3 - Mastermap Code Allocation

The Mastermap data was trimmed to the boundaries of the Taunton 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 was 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.

4.2 Stage 2 - Identification and evaluation of wetspots

4.2.1 Stage 2 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 Taunton using the results of the bare earth modelling described in Section 4.1.
- Scoring and Weighting Methodology. This describes the Scoring and Weighting technique agreed with the SWMP Project Board.
- Prioritisation of Wetspots within Taunton 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 Stage 2 intermediate assessment. The workflow to establish the prioritisation is shown in Figure 1.2.

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 Taunton SWMP. These were:

- The Wetspots were initially identified by depth using the Stage 1 bare earth modelling of Taunton, 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 Stages 2 and 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**

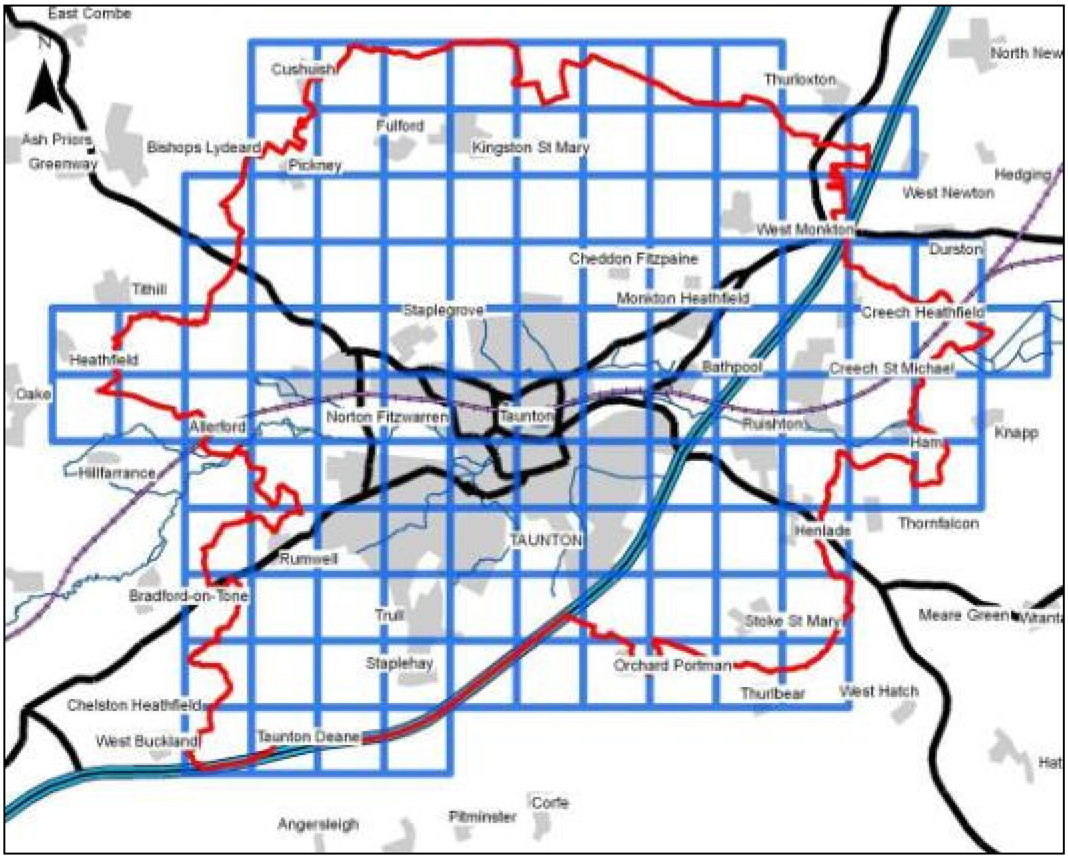


Figure 4.7: The Taunton Study Area with 1km^2 Grid squares

This mapping was used to calculate the percentage area of flooding within each grid square for the available modelled events (see Figure 4.7). 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.

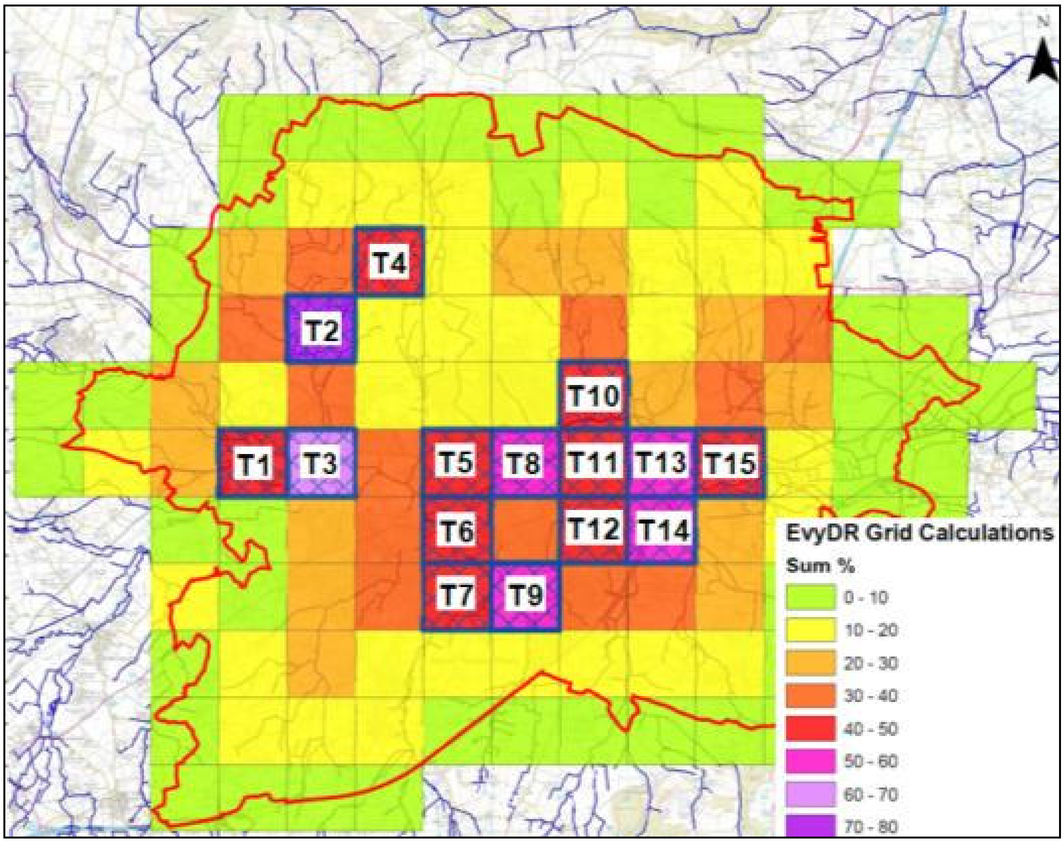


Figure 4.8: The Taunton Study Area with 1km2 Grid squares

From the above analysis those squares which had a flood percentage of ≥ 40% were prioritised for further analysis. This process identified 15 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 fifteen 1km² is shown in the table below and Figure 4.8.

% Surface Water Flooding within 1km² Study Area				
Ref.	1 in 30 High	1 in 200 Shallow	1 in 200 High	Sum Total
T1	9	21	19	49
T2	18	27	29	74
T3	11	34	18	63
T4	10	14	17	41
T5	12	18	13	43
T6	12	20	17	49
T7	10	18	19	47
T8	16	25	17	58
T9	13	19	20	52
T10	16	20	8	44
T11	14	19	12	45
T12	5	13	25	43
T13	17	23	15	55
T14	14	24	18	56
T15	7	22	18	47

Table 4-4 Percentage Surface Water Flooding in Study Area for the prioritised grid squares

Flood Risk Constraints Mapping

Due to the potential for errors and limitations 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.

Therefore, an assessment was undertaken to summarise the surface water flood risk and other potential flood risk sources for the prioritised grid squares. A summary sheet for each of these squares and supporting information can be found in Appendix B.

The key categories/ sources assessed are:

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)

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

4.2.2 Stage 2 Model Parameters

The model results and above assessment identified a number of wetspots located in the north and south of Taunton. The wetspots are indicated as $1km^2$ grids on Figure 4-8. The catchment areas contributing to these wetspot areas are shown as A to D (Figure 4-9). The catchment area approach was selected as the catchment which affects the intended 'wetspot' must be fully represented to accurately quantify the effects of surface water flooding. In agreement within the Project Board it was decided that catchment area B would be progressed for Stage 2 modelling rather than the specific identified wetspots. Catchment B was selected for analysis as the catchment contained a high number of 1km grid squares which had a flood percentage of ≥ 40%. In addition it was considered that the source of flooding within Catchment B was more related to surface water flooding, rather than fluvial flooding.

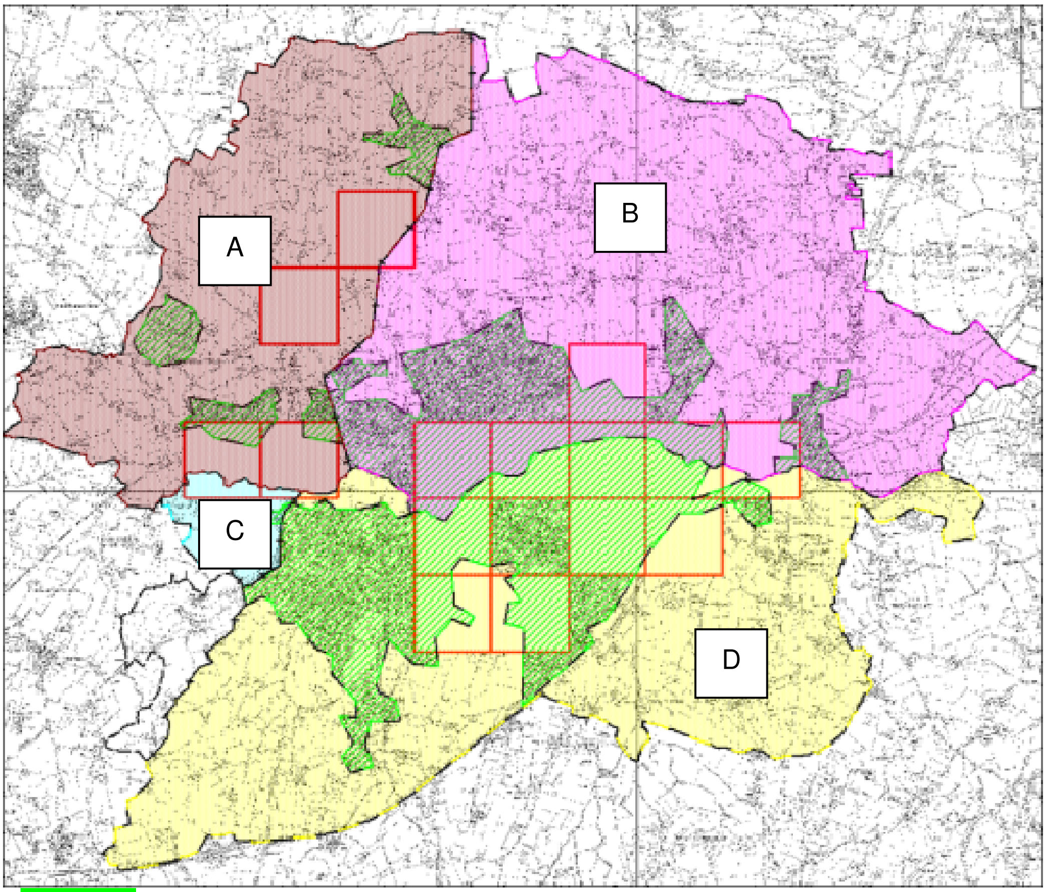


Figure 4-9 - Taunton Catchments A (Brown), B (Magenta), C (Cyan), D (Yellow) and E (Green) Prioritised 1km Wetspots (Red squares)

The model for catchment area B was developed to evaluate surface water flooding to urban areas in north Taunton. A grid size of 5 m was selected for the TUFLOW domain as noted in Table 4.6 and Figure 4-10. 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	0.5 seconds
Storm Durations	240 minutes
Modelling Return Periods	1 in 10, 50, 75, 100, 100+CC and 200 years
Total Run Time	65 hours

Table 4-6 - Stage 2 Model Parameters

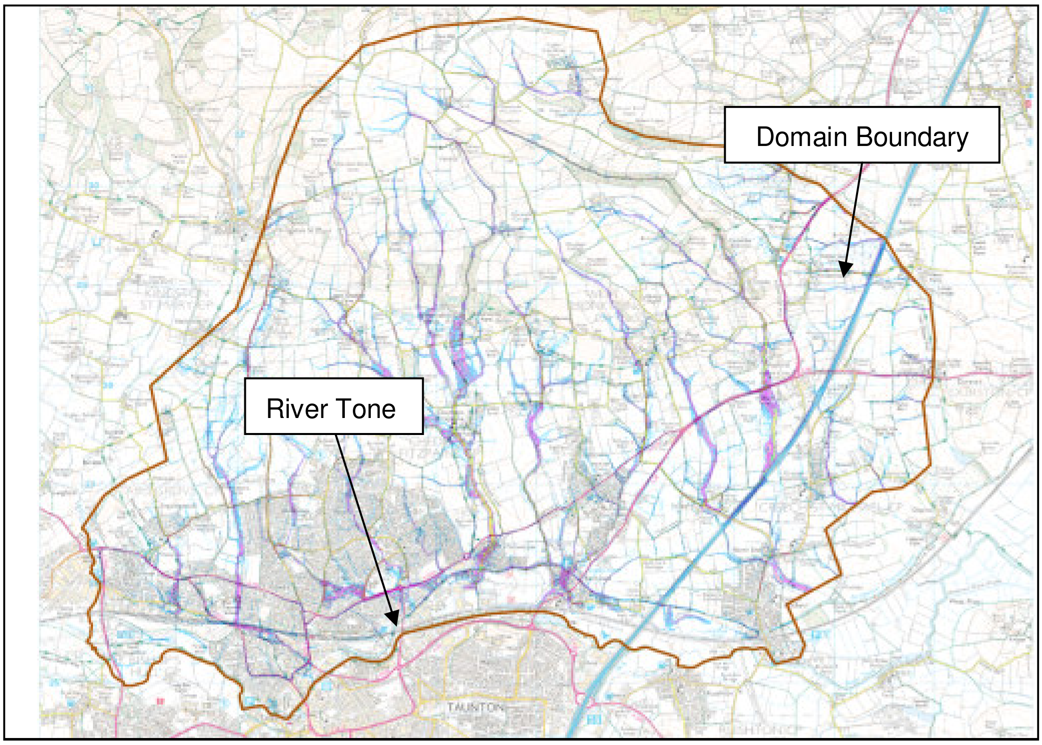


Figure 4-10- North Taunton Catchment B Model Extents

The reduction in the size of the model domain and the corresponding reduction in model run times allowed for improvements to be made in the schematisation of the model. In particular, Wessex Water's InfoWorks model of the storm water sewer was converted into ESTRY (the 1D component of TUFLOW) and introduced to the model. Figure 4-11 shows a portion of the storm sewer network centred on the Lyngford area of north Taunton. The catchment wide results for a 200 year (0.5% AEP) 240 minute storm with infiltration rates commensurate with the first generation surface water flood maps for the duration of the model run are shown in Figure 4-12.

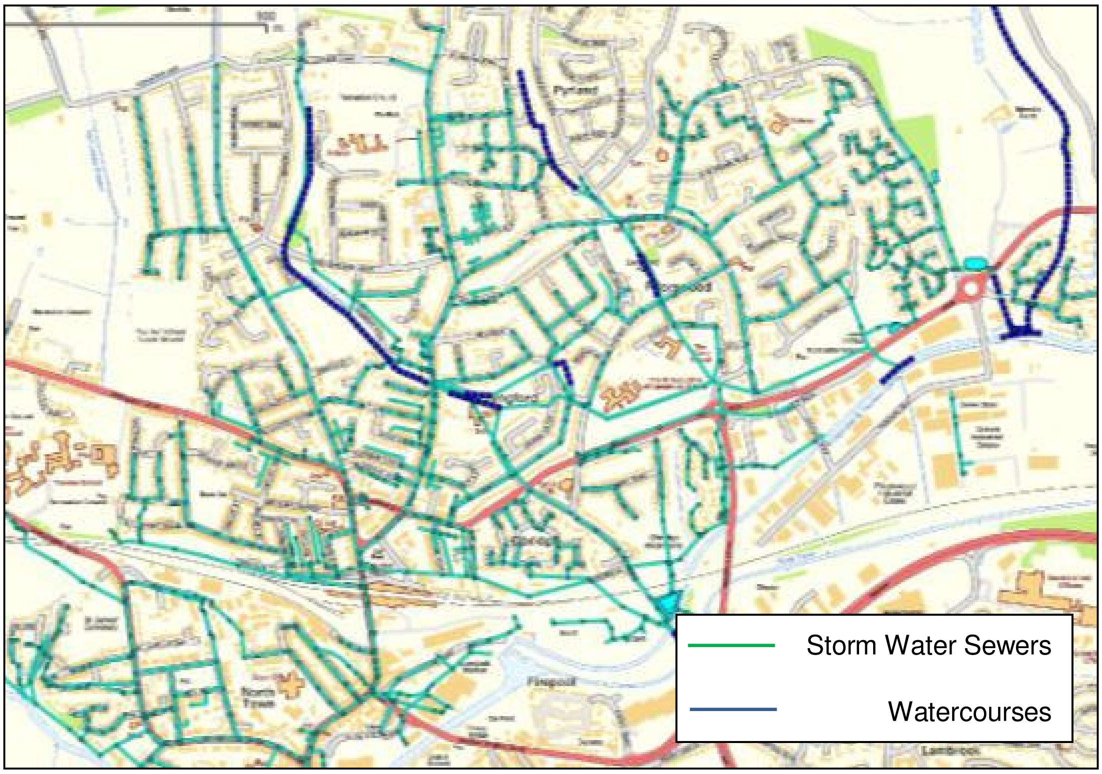


Figure 4-11- Part of north Taunton Storm Sewer Network

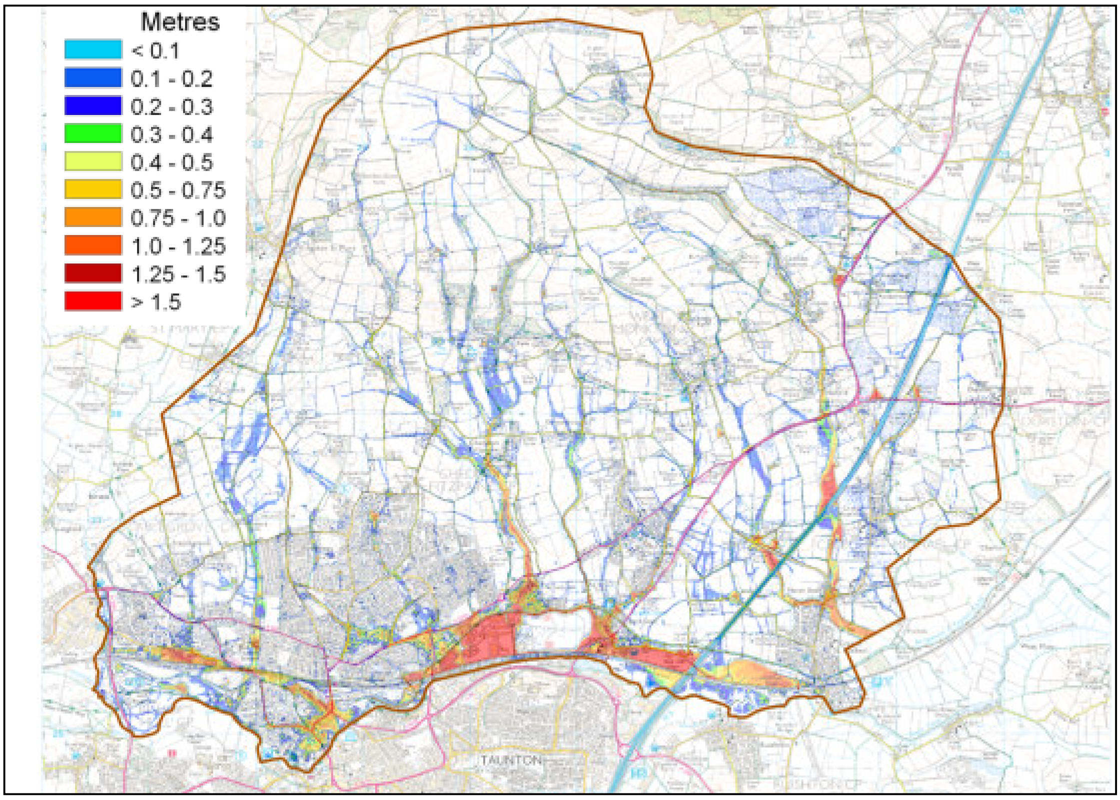


Figure 4-12– Stage 2 Catchment B Model Depth Results for 200 year (0.5% AEP) event

4.3 Stage 3 – Detailed Modelling Assessment

4.3.1 Identification of Stage 3 Wetspots

Further options appraisal has been undertaken in catchment area B based on the Stage 2 modelling. The engineering option investigations are aimed to provide potential flood alleviation measures for the prioritised Stage 3 wetspots. Non-specific engineering options to help manage surface water risk in all the Stage 3 wetspots have also been identified. This approach ensures that each area is considered at some level of detail even if it is not taken forward for full detailed analysis.

Following a stakeholder group meeting in May 2012 and following the review of the recently developed Wessex Water Drainage Area Plan information, key areas with flooding issues were identified to be taken forward to the detailed Stage 3 modelling. The key areas identified are listed below and also shown in Figure 4-13.

1. Staplegrove
2. Northtown
3. Barber’s Mead & Hale Way
4. Lyngford
5. Bathpool
6. Creech St Michael

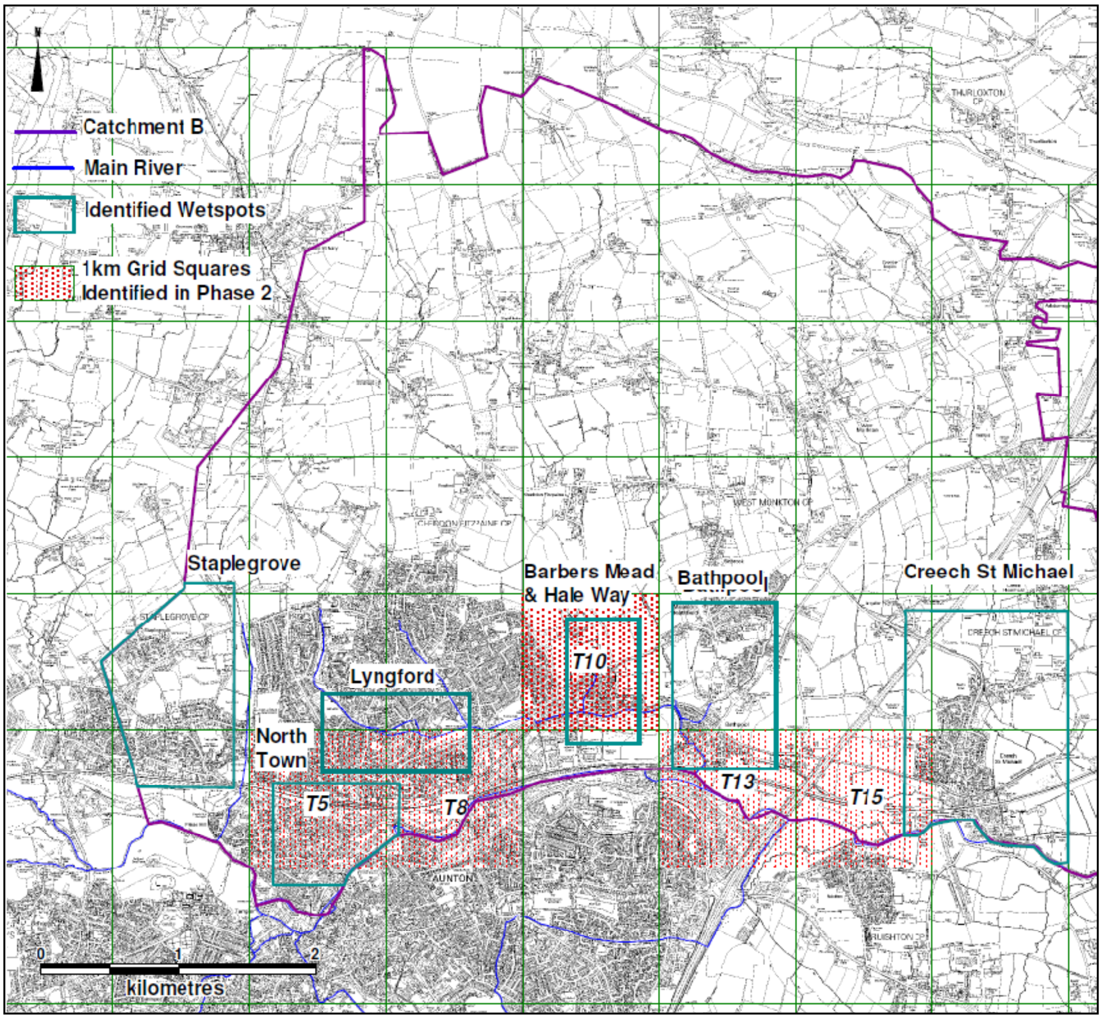


Figure 4-13– Wetspots recommended for Stage 3 Modelling

Following agreement by the Project Board it was decided that the six identified wetspots in catchment B would be taken forward for further analysis.

Based on a Project Board meeting it was concluded that the areas taken forward for Phase 3 would be based on the Wessex Drainage Area Plan (DAP) modelling data. Therefore, the areas selected to be taken forward for Phase 3 modelling were based on locations within Catchment B that the DAP modelling indicated had surface water flooding issues.

The review of the DAP modelling identified six areas to the north of the River Tone and within catchment B that had flooding issues. Following this review the Stage 2 model was utilised to undertake a more detailed assessment of flooding at the six locations identified within catchment B. The modelled outputs from the six areas were summarised and the flooding mechanisms, number of properties affected, possible mitigation options and recommendations were issued to the stakeholders for comment. This information was used to select two Wetspots to take forward for the detailed modelling and options assessment. The information issued for the six areas identified from the DAP review is contained in Appendix D, and summarised in Table 4.7 below is the reasoning for taking these options forward.

			Stakeholder Review Comments			
Wetspot	**Problem**	**Option/ *Recommendation***	**Somerset County Council**	**Environment Agency**	**Wessex Water**	**Somerset IDB**
Staplegrove	Overland flow on Manor Road and Rectory Road results in overland flow to Staplegrove Road with flooding to properties to the south of the highway. This includes Scott Way and Binder Road. In addition, members of the stakeholder workshop did consider that flooding could be a problem at this location. Also Information received from Wessex Water indicates that the combined foul / surface water system in the area has limited capacity to address surface water flooding	Attenuation pond in fields to the north of Staplegrove Road. Improvements to the surface water drainage system ***Undertake modelling of options at this location***	Agree with recommendation	Agree with recommendation Looks like a surface water flood risk problem. The surcharging sewers are some way to the south of the problem origin, so may be a showing a consequence, rather than a cause of the overland flooding?	Agree with recommendation although this is not strongly supported by a strong evidence base. Although Wessex have not indicated that there are surface water flooding issues in Staplegrove they do acknowledge that there are foul (possibly combined) problems in the area	Agree with recommendation
Northtown	Overland flow from north Taunton results in flooding to properties south of the railway line. This includes Albermarle Road, and Chip Lane. Flooding may well be exacerbated by blockage to culverts and / or high water levels in the Tone. However, members of the workshop doubted that there were problems with flooding in this area. This may be due to the storm water system not being well represented in the hydraulic model, particularly in the vicinity of the railway	Installation of trash screens (if blockage of the storm water system is considered to be a problem). Improvements to the surface water drainage system. ***Review representation of surface water system in the model.*** ***Set aside and monitor possible problems with flooding in the area***.	Agree with recommendation	Given the proximity to the town centre, railway station, and TDBC Council offices, this could be a better option for further assessment and modelling	Agree with recommendation	Agree with recommendation
Barbers Mead -	Fluvial flooding from the Maiden Brook	Installation of trash	Agree with	Agree to set aside and	Agree with	This system links to Bathpool and Priorswood

	results in flooding to properties on Barbers Mead and Hale Way. However, members of the workshop did not indicate that there were flood issues and there are no records of historical flooding in this area	screens (if blockage of the storm water system is considered to be a problem). Improvements to the surface water drainage system. ***Review representation of surface water and fluvial system in the model.*** ***Set aside and monitor possible problems with flooding in the area.***	recommendation	monitor as recommended .looks to be a fluvial principal cause	recommendation	Depot. The A3259 has suffered where its crosses the stream valley but it was improved some many years ago, however this indicates an issue. Historic flooding in Waterleaze Road near to the attenuation pond done as part of the development.
Lyngford -	Fluvial and overland flow from the Kingston Stream results in flooding to properties on Cheddon Road, Wellesley Street and Grange Drive. However, members of the workshop doubted that there were problems with flooding in this area.	Installation of trash screens (if blockage of the storm water system is considered to be a problem). Improvements to the surface water drainage system. ***Review representation of surface water and fluvial system in the model.*** ***Set aside and monitor possible problems with flooding in the area***	Agree with recommendation	Agree to set aside and monitor as recommended.	Agree with recommendation	Agree with recommendation
Bathpool	The flooding mechanism in Bathpool is complex with fluvial flooding from Allen's and Dyer's Brooks and the River Tone. This is exacerbated by	***Undertake comprehensive study of flooding in Bathpool***	Agree with recommendation. However, Bathpool area is	Agree with recommendation	Agree with recommendation. Bathpool area is very complicated and affected	Agree with recommendation

	surface water run-off from fields to the north of Bathpool. There are longstanding problems with flooding in this area. An integrated study of flooding which incorporates all sources of flooding is required to drive potential flood alleviation options for Bathpool. It was considered that this was outside the scope of the SWMP		very complicated and better looked at outside of the SWMP		by the Tone, Allen's Brook and surface water run-off. WW information confirms that there are foul (possibly combined) problems at Hyde Lane, Swingbridge Lane, Acacia Gardens and Dyer Lane.	
Creech St Michael	Fluvial flooding occurs to the north of the village affecting a number of properties on the left bank of the watercourse to the north of the village. Wessex Water has also reported problems associated with foul / combined surface water flooding in the centre of the village.	Construction of formal flood defences to the north. Reduction in surface water run-off to the watercourse through the installation of SuDS features in proposed developments to the NW of Creech St Michael. Separation of foul and surface water in the centre of the village. ***Wessex Water has indicated that separation of surface and foul water may exacerbate risk of fluvial flooding to Creech St Michael. Undertake modelling of options at this location.***	Agree with recommendation	It is believed this is a fluvial problem, with poor maintenance of channels and culverts (silt) causing flood risk, not any real overland surface water cause. This location, could be set aside and monitored.	Agree with recommendation	Agree with recommendation

Table 4-7– Stakeholder Review Comments for the Option Recommendations for the Six Identified Areas

Following the review of the available information and the stakeholder comments received, the summary of the agreed recommended decisions for the six areas were:

1. **Staplegrove** - Undertake modelling of both promoted options at this location.

2. **Northtown** - Set aside and monitor possible problems with flooding in the area.

3. **Barbers Mead and Hale Way** - Set aside and monitor possible problems with flooding in the area.

4. **Lyngford** - Set aside and monitor possible problems with flooding in the area.

5. **Bathpool** – Promote further steering group review of potential for delivering integrated work in this area in light of new development upstream and identified issues. Include within SCC Local FRM Strategy development.

6. **Creech St Michael** – Undertake modelling of promoted option at this location.

During the initial option review the stakeholder group also identified the following areas and options to be taken forward for detailed analysis. The two areas selected to be modelled were Staplegrove and Creech St Michael and three options (total) were selected to be investigated.

1- Staplegrove

Options to be modelled-

- Attenuation pond in fields to the north of Staplegrove Road
- Improvements to the surface water drainage system

2- Creech St Michael

Option to be modelled

- Surface water separation/improvements to surface water system through Creech St Michael

In addition, three areas were selected where the Project Board should keep a watching brief and perhaps include in future iterations or developing LFRMS. The three areas selected by the stakeholders were:

- **Northtown**
- **Barbers Mead and Hale Way**
- **Lyngford**

Bathpool was selected as the one area where it was recommended that a separate investigation should be launched to determine the opportunities that new development in the catchment could deliver. It is recommended that the LFRMS should investigate this further outside of the SWMP process.

4.4 Detailed Model Development

As discussed in the previous section the stakeholders selected Creech St Michael and Staplegrove as the locations to be taken forward for detailed modelling and economic analysis within the SWMP. The two study areas are examined further below.

4.4.1 Creech St Michael

The Stage 1 and 2 modelling identified there were properties to the north of Creech St Michael which were vulnerable to flooding from the watercourse located on the outskirts of the village (Figure 4-14). Creech St Michael was therefore identified by the Stage 2 modelling as a potential area where fluvial flooding could be a problem. The TUFLOW model did not show any significant flooding to the centre of Creech St Michael.

Wessex Water indicated there were potential problems with the sewer system in Creech St Michael and agreed to supply further details. Information was supplied detailing the flood mechanism which was related to the foul and combined system in the centre of the village. The mechanism was not related to the fluvial issue in the north. It was confirmed by Wessex Water that the flooding mechanism is a function of domestic and commercial foul flows; highway and roof drainage (where it discharges into the foul) and lack of capacity in the foul water system. It is understood that the hydraulic restrictions causing the problem could be within the pipe network or at one of the three pumping stations in the area.

It should be noted that the TUFLOW model did not include Wessex Water's foul network in Creech St Michael. In addition the model only included a small number of surface water storm sewers located within comparatively modern development to the south of the village. Due to the sewer network not being fully represented in the model it was not possible to undertake baseline modelling to assess the foul flooding mechanism in the centre of the village.

Wessex Water specified that flooding only affected the highway and that properties were not affected. As flooding impacts on the highway, results in negligible property flooding and it is likely that any separation of the system could increase flood risk, no further investigation was undertaken. Therefore, it was decided that Creech St Michael would not be taken forward for detailed modelling after all. SCC confirmed that it was not appropriate to investigate foul flooding as part of the SWMP and it was decided Creech St Michael would not be taken forward for further analysis. In its place further engineering options were evaluated at Staplegrove as an alternative.

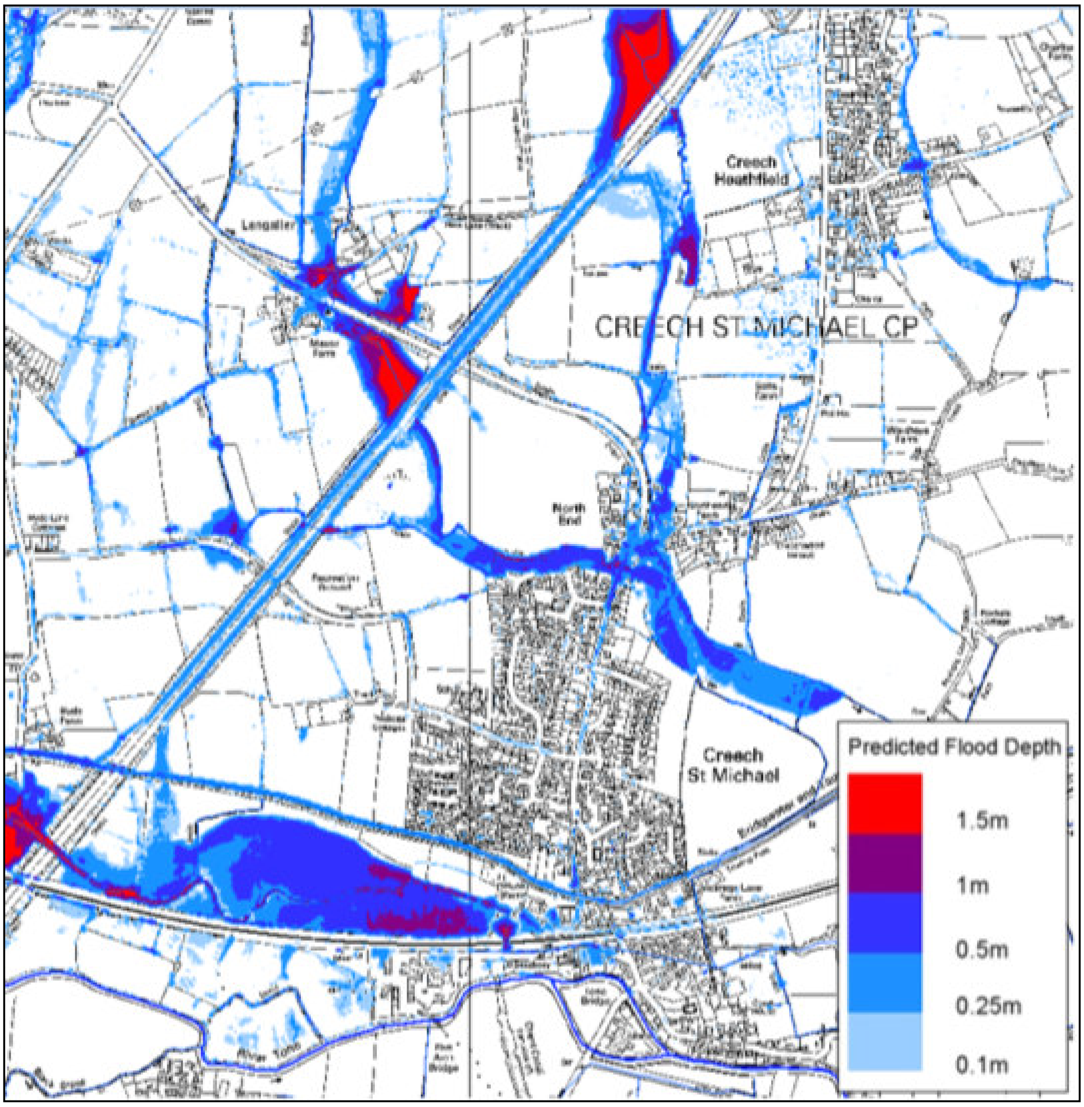


Figure 4-14– Stage 2 Model Outputs- Creech St Michael 1 in 200 year flood event

4.4.2 Staplegrove

The Staplegrove study area was selected for detailed modelling. The Stage 2 modelling identified there were properties to the south of Staplegrove which were vulnerable to flooding from the surface water runoff, which flows across the fields to the north (Figure 4-15). Flood risk to the roads within the study area was also identified. Table 4-7 details why the stakeholders supported the need for a detailed study within Staplegrove.

The options modelled were Do Nothing, Do Minimum and seven Do Something options which investigated attenuation and improvements to the surface water drainage system. The Phase 3 modelling undertaken at Staplegrove is discussed further in Section 5.3.

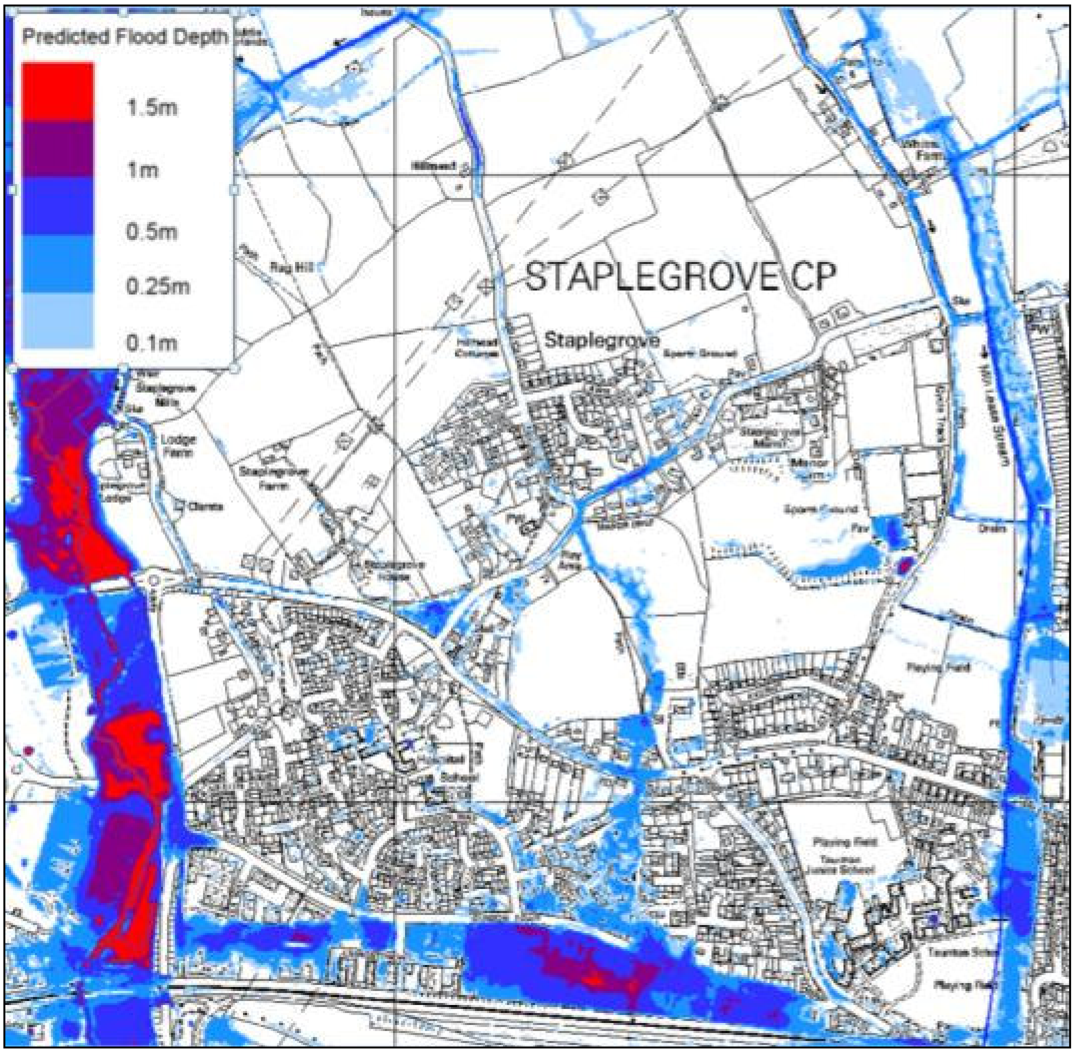


Figure 4-15– Stage 2 Model Outputs- Staplegrove 1 in 200 year flood event

4.4.3 Stage 3 Model Parameters

The objective of the Stage 3 modelling was to understand and quantify the effectiveness of the Do Something options to mitigate the effects of surface water flooding in Staplegrove. Owing to the large size of the model domain for Stage 2, it was considered that the Stage 3 Staplegrove model should be refined and the size of the domain reduced. The model boundary is shown in Figure 6 and encompasses the sub-catchment contributing to flooding in Staplegrove. This meant that there was a significant reduction in run times and a greater degree of flexibility within the modelling of engineering options (Table 4-7). The existing surface water pipe network incorporated in the model for the Do Minimum and Do Something options is shown in more detail in Figure 4-16.

Model Parameters	
Grid Size	5 m
Time Step	1 second
Storm Durations	240 minutes
Modelling Return Periods	1 in 10, 50, 75, 100, 100+CC and 200 years
Total Run Time	4 hours

Table 4-7 - Stage 3 Model Parameters

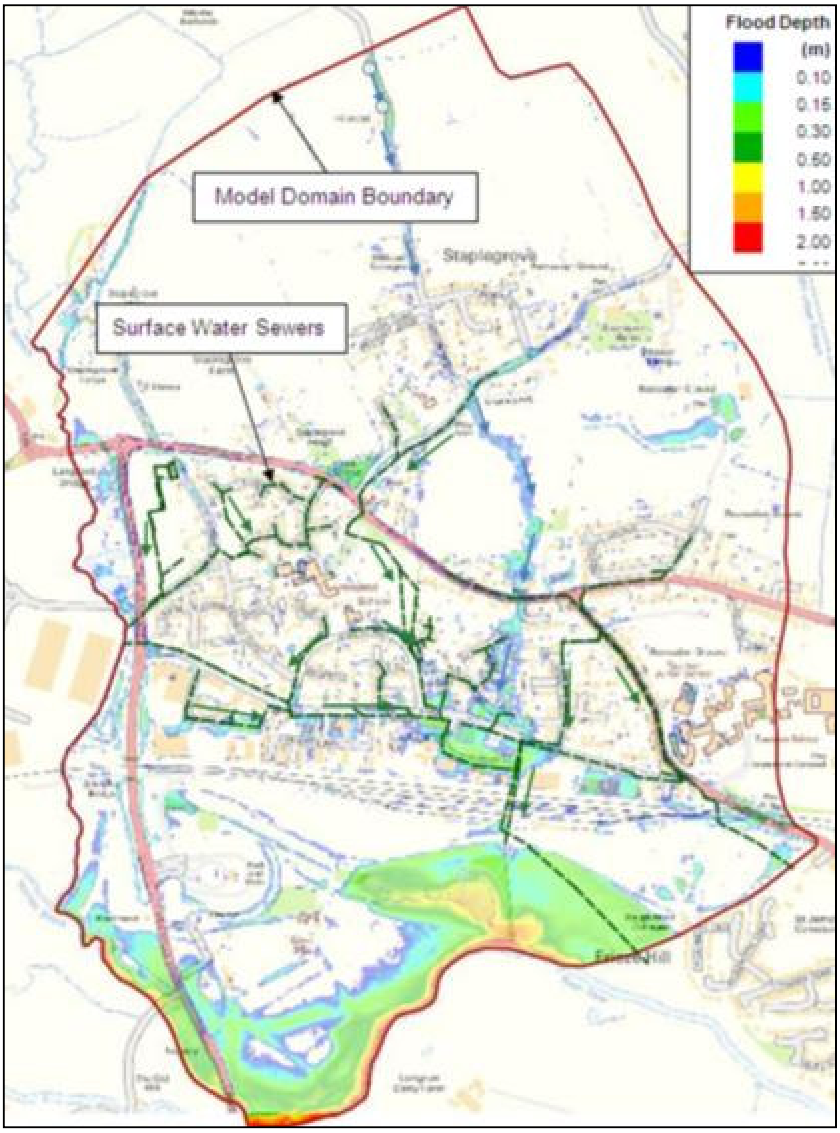


Figure 4-16 - Stage 3 Model Domain- Do Minimum (Option A) 1 in 100 year return period flood depths with 240 minute storm duration. Direction of flow is indicated by arrows.

4.4.4 Model Sensitivity

Infiltration and other losses

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.

The Environment Agency has produced the outputs of 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:

- 1 in 200 year return period
- 240 minute storm duration
- 1km^2 resolution
- No allowance for underground pipe network
- No allowance for infiltration

Following on from the release of the Areas Susceptible to Surface Water Flooding, the Environment Agency updated the original mapping in order to produce the Flood Risk Maps for Surface Water (FMfSW), which was released in October 2010. The existing maps were updated to take account of buildings and the underground drainage system, and more storm events were analysed. In relation to infiltration the model parameters used to create these new maps were:

- In rural areas, rainfall was reduced to 39% to represent infiltration
- In urban areas, rainfall was reduced to 70% to represent infiltration

For the Stage 1 and 2 modelling infiltration rates commensurate with national practice were adopted and in urban areas modelled rainfall was reduced to 66% of the DDF rainfall to represent infiltration. For Stage 3 a sensitivity analysis was undertaken in relation to infiltration / losses and the model was run with:

- Rainfall reduced to 33% of the DDF rainfall to represent infiltration and other losses within the Staplegrove sub-catchment commensurate with a catchment with high infiltration. Losses through infiltration were applied to soft surfaces across the sub-catchment. The hard surfaces within the sub-catchment did not include losses.
- Rainfall reduced to 66% of the DDF rainfall to represent infiltration and other losses within the Staplegrove sub-catchment. Losses through infiltration were applied to soft surfaces across the sub-catchment. The hard surfaces within the sub-catchment did not include losses.

The bedrock geology of the catchment is described as falling within the Mercia Mudstone group which comprises green-grey mudstones and sub-ordinate siltstones with thick halite bearing units in some basinal areas. It is also noted that the BGS record also includes thin beds of Gypsym /anhydrite and sandstones are also present within the bedrock geology. This is overlaid by superficial sediments (River Terrace Deposits) of sands and gravels. These deposits are likely to be highly permeable depending on ground water levels.

The modelled rainfall was reduced to 33% of the DDF rainfall to be representative of higher infiltration and losses. This was cross referenced against the ReFH method which indicated that rainfall losses for the Staplegrove catchment were also in the order of 66%. Figure 4-17 and Figure 4-18 show the comparison between the flood extents for a 1 in 100 year event with a rainfall duration of 240 minutes. As anticipated the extent and depth of flooding is more widespread in the situation where infiltration within the model is less.

Figure 4-17 - Stage 3 Do Minimum (Option A) Rainfall = 33% of DDF rainfall (1 in 100 year return period flood depths with 240 minute storm duration)

Figure 4-18- Stage 3 Do Minimum (Option A) Rainfall = 66% of DDF Rainfall (1 in 100 year return period flood depths with 240 minute storm duration)

Water Levels River Tone

For the Stage 1 and 2 modelling, water levels in the River Tone were set at 21mAOD upstream and 9mAOD downstream, commensurate with a 1 in 10 year event in the River Tone.

For the Stage 3 modelling a sensitivity check was undertaken to determine the impact of reduced downstream water levels on flooding in Staplegrove. The sensitivity analysis indicated that there were no significant changes to flood levels in Staplegrove when the 1 in 10 year event in the Tone was compared to QMED in the Tone. This is because Staplegrove is set well back from the river at a sufficient elevation which means that the area is not subject to high water level locking in the Tone. Therefore, the Staplegrove downstream levels were derived from the ISIS model with 1 in 10 year flows and were 19.81mAOD and 16.98 mAOD at the upstream and downstream ends respectively of the model.

It should be noted that a joint probability of pluvial rainfall across the Staplegrove sub-catchment in conjunction with fluvial flow in the Tone has not been undertaken. However, it is considered that the combination of a 1 in 10 year event on the Tone in conjunction with high pluvial return periods is a reasonable assumption.

4.4.5 Model Verification

There is very limited information in the form of historical evidence and flow monitoring to verify the TUFLOW model for the Taunton SWMP. The lack of historical flood information has resulted in the model not being verified and subsequently there is a level of uncertainty in the model output.

Verification could have been attempted by assessing the rainfall records and predicted catchment response compared to a gauged flow. However, this was not possible due to a lack of gauged data. Additionally, verification may have been possible by undertaking a sensitivity analysis which involved deriving estimates of flow from the catchment for a range of return periods estimated by different methods (FEH, ReFH, Rational, IoH 124 etc) and comparing this to the predicted run off from the model. However, this was not possible as this would comprise a detailed exercise which is outside the scope of this SWMP.

All of the above would have enabled infiltration rates to be adjusted so that predicted run-off was commensurate with flows within the catchment. Due to verification not being possible for the reasons described above there is inevitable uncertainty and this introduces uncertainty in the results.

In addition to the uncertainties due to the model not being verified, further uncertainty is introduced as there could be gaps in the data supplied. This is particularly relevant regarding the location of the outfalls to the River Tone. It has not been possible to confirm the presence of additional outfalls during this study.

There are two outfalls to the River Tone located within the Wessex Water drainage system information provided (as indicated on Figure 4-19). This effectively limits the water which can 'drain out' of the sewer network within the model and results in water backing up behind the railway line. This is especially prominent in the vicinity of Cook Way where modelled flood depths on the road are in the region of 0.5m during the 1 in 10 year event for the Do Minimum Option. There is no historical flood information to verify flooding to such a depth and it is possible that the flood depths are a result of water 'ponding' behind the railway line.

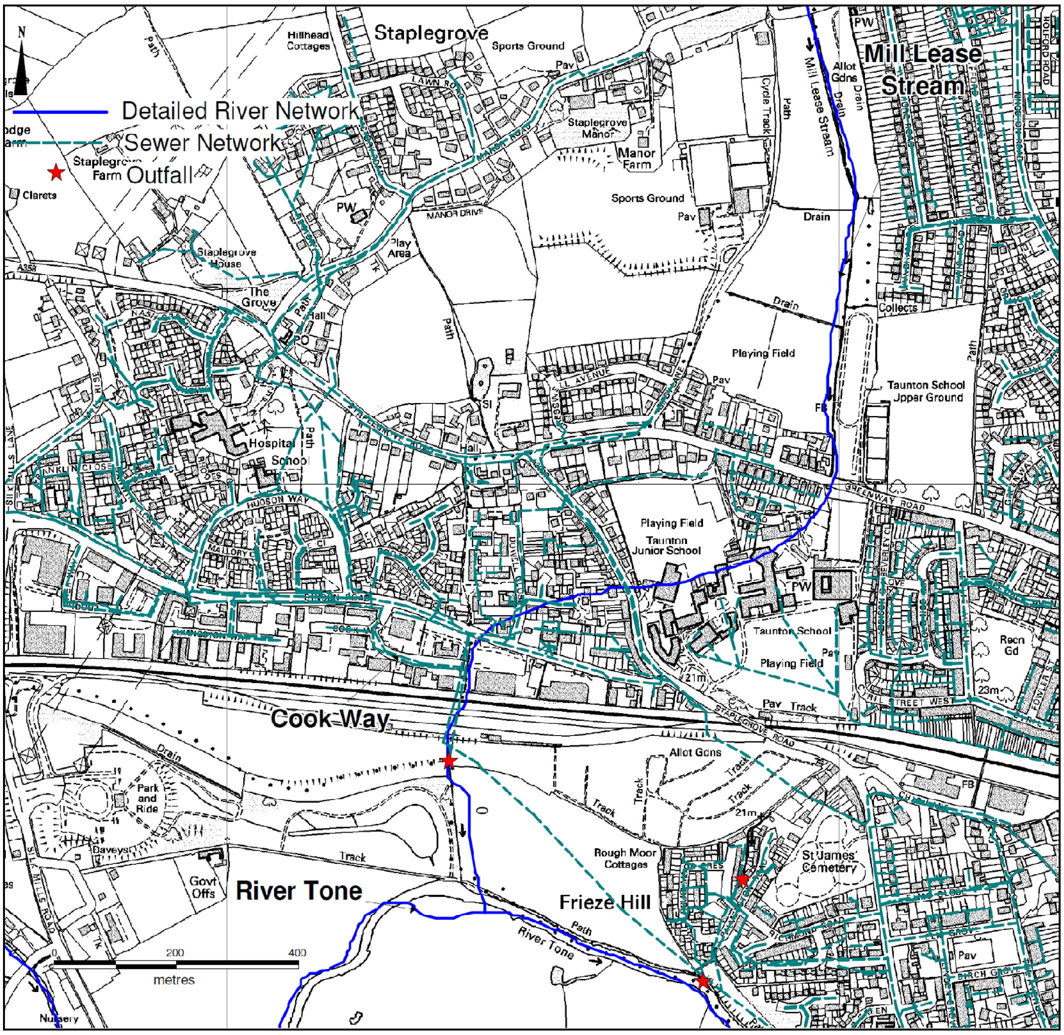


Figure 4-19- Sewer Network and outfalls in Staplegrove

4.4.6 Flood Risk Issues in Staplegrove

The main flooding mechanism identified in Staplegrove during the Phase 2 modelling is from surface water flow routes from north to south from Rectory Road. Overland flow on Manor Road and Rectory Road results in overland flow to Staplegrove Road with flooding to properties to the south of the highway. This includes Scott Way and Binder Road. In addition, based on local knowledge members of the stakeholder workshop did consider that flooding could be a problem at this location. Also, information received from Wessex Water indicates that the combined foul and surface water system in the area has limited capacity to address surface water flooding. The Stage 2 modelling confirmed the risk of surface water flooding - there are approximately 40 domestic and commercial properties predicted to be at risk.

4.5 Model Outputs

4.5.1 Flood Depth, Velocity and Hazard Maps

Flood depth, velocity and flood hazard mapping has been produced from the Stage 3 Tuflow model for Staplegrove. The mapping is included within Appendix E.

Flood hazard is an important factor in the assessment of flood risk and evacuation of the general public from areas at risk. Three categories of flood hazard have been identified in the DEFRA / Environment Agency Documents: Flood Risk Assessment Guidance for New Development[xi], (DEFRA Report FD2320) and Flood Risks to People Methodology[xii] (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 $d < 0.25$m
d = depth	$Df = 1.0$ for $d > 0.25$m

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 at the transition to Category 3. The FD2320 report indicates that the change occurs at $H > 2.0$, whereas the FD2321 report indicates that this happens at $H > 2.5$. 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 for Some	Category 1	$H > 0.75$
Danger for Most	Category 2	$H > 1.25$
Danger for All	Category 3	$H > 2.00$

The colouring of the flood hazard mapping is commensurate with the hazard categorisation given in Figure 4-18. Areas coloured red are considered dangerous for all; areas in dark yellow are dangerous for most; light yellow is dangerous for some and blue areas are inundated areas mainly on the margins of the flood plain which are considered to hold little hazard.

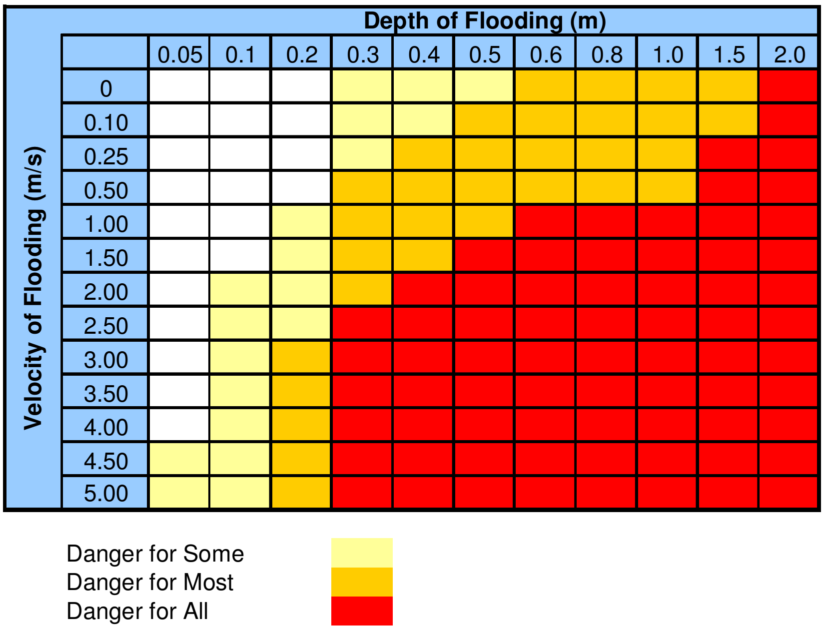


Figure 4-18 Hazard Categorisation

5 Phase 3 - Options

5.1 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 5.1 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 timeframe, 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 Flood and Water Management Act, has powers to carry out works for the management of surface water run-off, ordinary watercourses and groundwater.

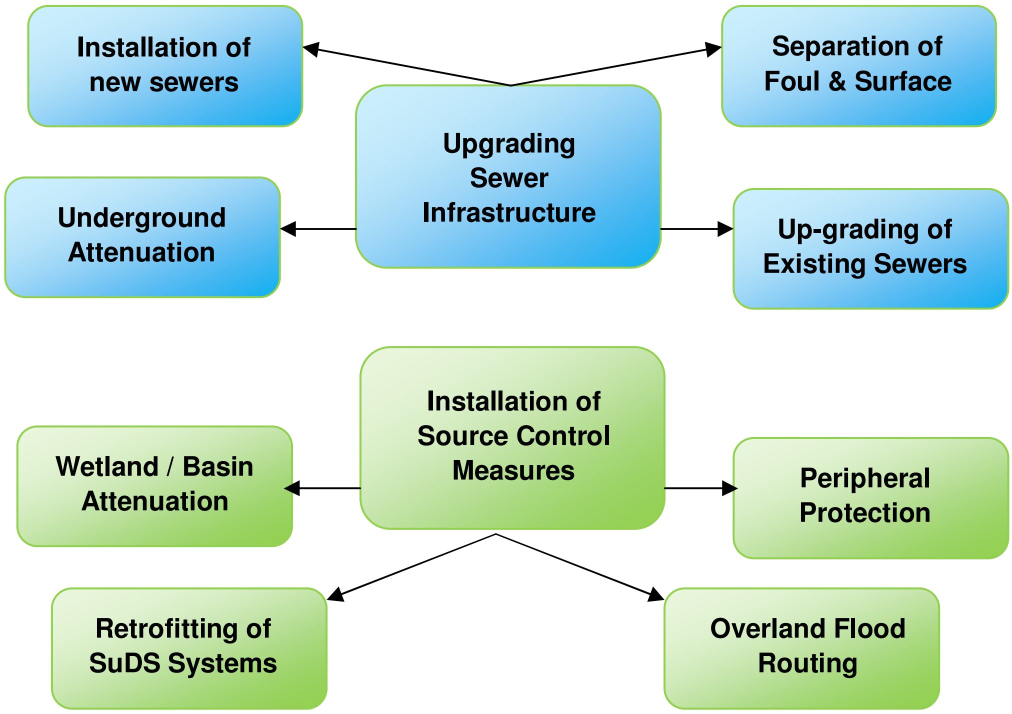


Figure 5-1 Surface Water Flood Mitigation Options

The key constraints (see Figure 5-2) associated with the implementation of all of the options are space and cost.

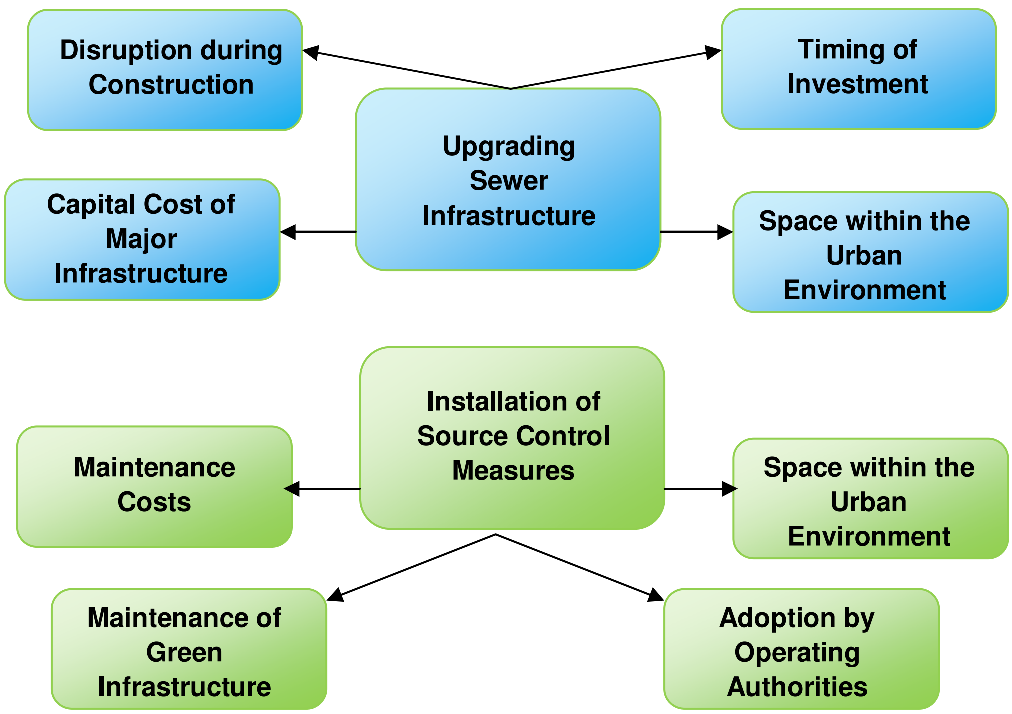


Figure 5-2 Engineering Options Constraints

In Taunton, 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 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.

5.2 Source Control Measures

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 has 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 F describes the range of measures that could potentially 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 F). These could have a further benefit of controlling traffic as well as assisting 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.

5.3 Option Consultation

Hyder carried out a review of the Stage 2 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.

Sections 5.3.1 to 5.3.6 summarise the non-modelled options, whereas Section 5.4 discusses the modelled options.

5.3.1 Non-Modelled Options

The SWMP Options Paper (issued July 2012) identified four further areas which should be monitored. These areas have been reviewed with a view to recommending smaller scale, retrofitted, soft options for managing surface water flood risk. The options identified for specific locations are classed into nine types which are described in Table 5.1

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 Taunton 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 Taunton. 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 Taunton 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

Option Type	Description
	used by the plants.

Table 5.1 Option Types

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 impermeable 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 the creation of flood wardens.
- Improved data capture during and after events which can be used to inform future funding bids, maintenance work and responses to events.

The following sections set out where the non-modelled measures described in Table 5-1 could be implemented. The stakeholders identified four areas that required monitoring and further investigation:

- Northtown
- Barbers Mead and Hale Way
- Lyngford
- Bathpool

Non-modelled measures have been assessed that are appropriate for the identified flooding mechanisms in the areas listed above. The measures available to potentially reduce flooding in each of the four areas are discussed in the following section.

5.3.2 Northtown

Figure 5.3 highlights potential locations for the introduction of some of the measures described in Table 5.2.

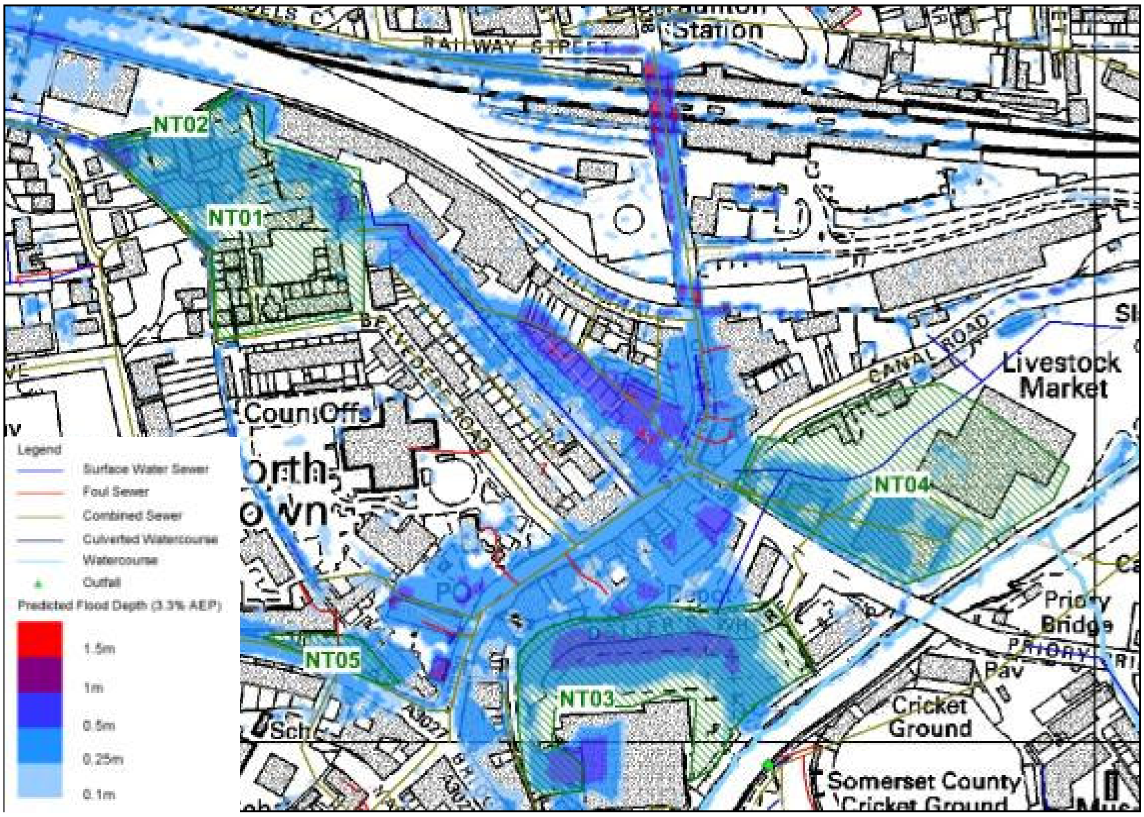


Figure 5.3 Northtown potential options

ID	Location	Type	Description
NT01	Industrial Estate, Belvedere Road	Increase surface permeability	The industrial estate is generating high levels of runoff. Increasing the surface permeability would assist in slowing runoff to the sewer system as well as overland flows moving along Albermarle Road. Methods could include introducing planted areas along the existing business boundaries or using a more permeable surfacing for car parking areas.
NT02	Industrial Estate, Belvedere Road	Local attenuation and infiltration	Surface water modelling highlights that water ponds against the boundary between the industrial estate and the Sorting Office. Aerial mapping shows that this boundary is formed of a hedge and is therefore already permeable. Therefore there is potential to make use of this area to infiltrate flows in lower events. Local kerb works may also be required to channel surface water into the desired locations.
NT03	Morrison's Car Park	Increase surface permeability	Increasing the permeability of the car park will help to slow the movement of surface water into the sewer system and therefore alleviate pressure downstream. Swales could also be added along the boundaries to further attenuate flows.

ID	Location	Type	Description
NT04	Livestock Market	Increase surface permeability	Increasing the permeability of the hard standing areas around the Livestock Market (depending on water quality constraints) will help to slow the movement of surface water into the sewer system.
NT05	Staplegrove Road	Increase surface permeability	There is an existing car park adjacent to Staplegrove Road where there is the potential to alter the surfacing and use it to infiltrate additional surface water. This option should be combined with kerb works to facilitate the flow of surface water into the car park.

Table 5.2 Northtown potential options

There are combined sewers draining this area, therefore residents and businesses in the locality should be encouraged to reduce the amount of surface water discharged to the sewer system by making use of water butts, rain water collection systems and by minimising areas of hardstanding within their property boundaries.

5.3.3 Barbers Mead and Hale Way

Figure 5.4 highlights potential locations for the introduction of some of the measures described in Table 5.3. Flood depths greater than 1.5m are predicted along the corridor of the Maiden Brook. The modelling undertaken used LiDAR data to determine ground levels, therefore the capacity of the brook is underestimated and consequently flood depths and extents may differ from those shown. Aerial mapping suggests that the watercourse is well defined with a depth of approximately 1m, compared to 0.45m recorded by the LiDAR data.

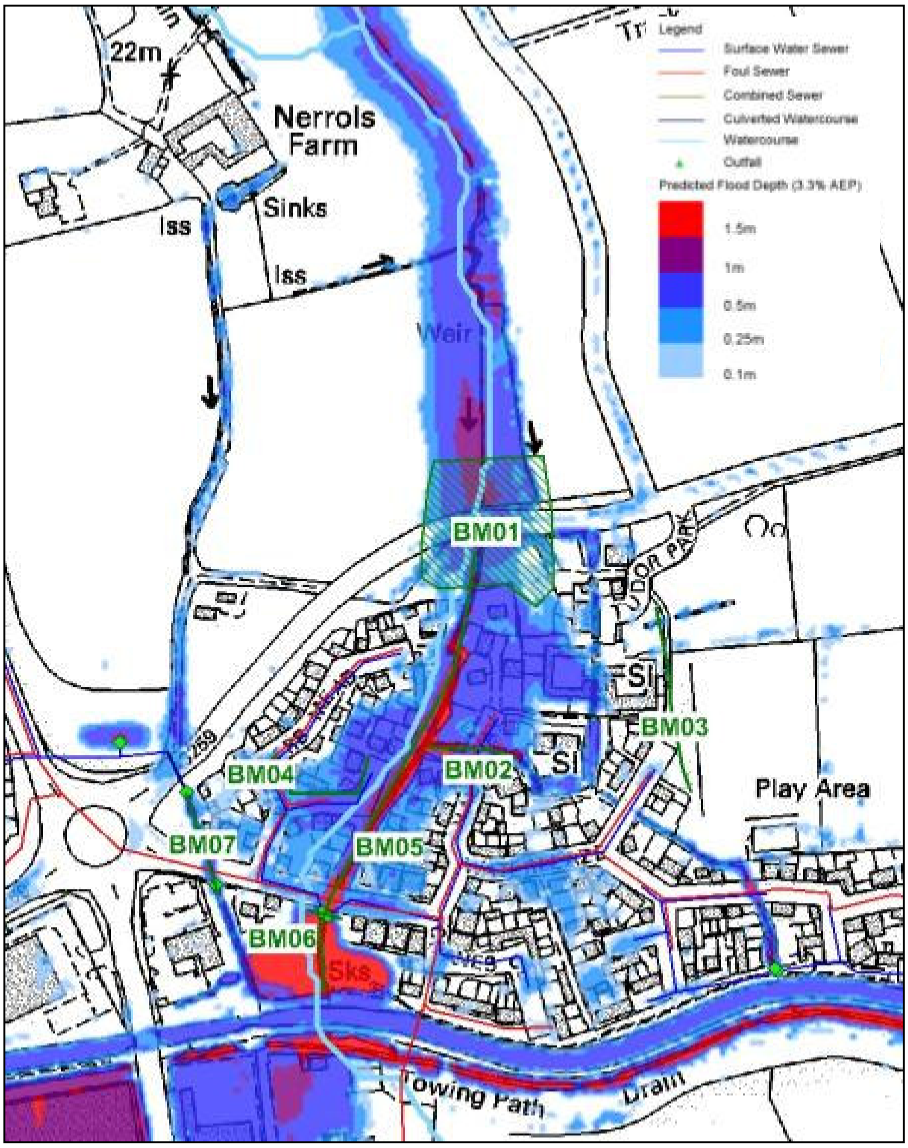


Figure 5.4 Barbers Mead and Hale Way potential options

ID	Location	Type	Description
BM01	A3259 Tudor Park	Local attenuation and infiltration	Existing green space offers the potential to provide additional storage upstream and/or downstream of the A3259. However, it is understood that infill development in this area could preclude any attenuation options.
BM02	Hale Way	Local attenuation and infiltration	Formalise / increase storage available in the tributary watercourse corridor as this watercourse appears less well defined than the Maiden Brook.
BM03	Tudor Park	Earth Bund	If surface water flows are known to originate from the rural area to the east, a bund and swale along the boundary between the field and residential area may help to reduce flow onto the residential area.
BM04	Barbers Mead	Kerb Works	Raised kerbs to encourage surface water flow to remain in the highway, away from residential properties.
BM05	Barbers Mead	Maintenance	Ensure that the Maiden Brook is kept clear of debris and any culverts or bridges are free flowing.
BM06	Waterleaze	Maintenance	Ensure that the sewer outfalls are kept clear to avoid any backing up in the system which could exacerbate flooding upstream.
BM07	Waterleaze	Maintenance	Ensure that this tributary watercourse and associated culverts are kept clear.

Table 5.3 Barbers Mead and Hale Way potential options

In addition, the riparian owners responsible for the Maiden Brook watercourse should be identified and informed of their responsibilities.

Where flooding is known to cause problems for residents, property level protection measures could be installed on individual properties to afford additional protection.

5.3.4 Lyngford

Figure 5.5 highlights potential locations for the introduction of some of the measures described in Table 5.4.

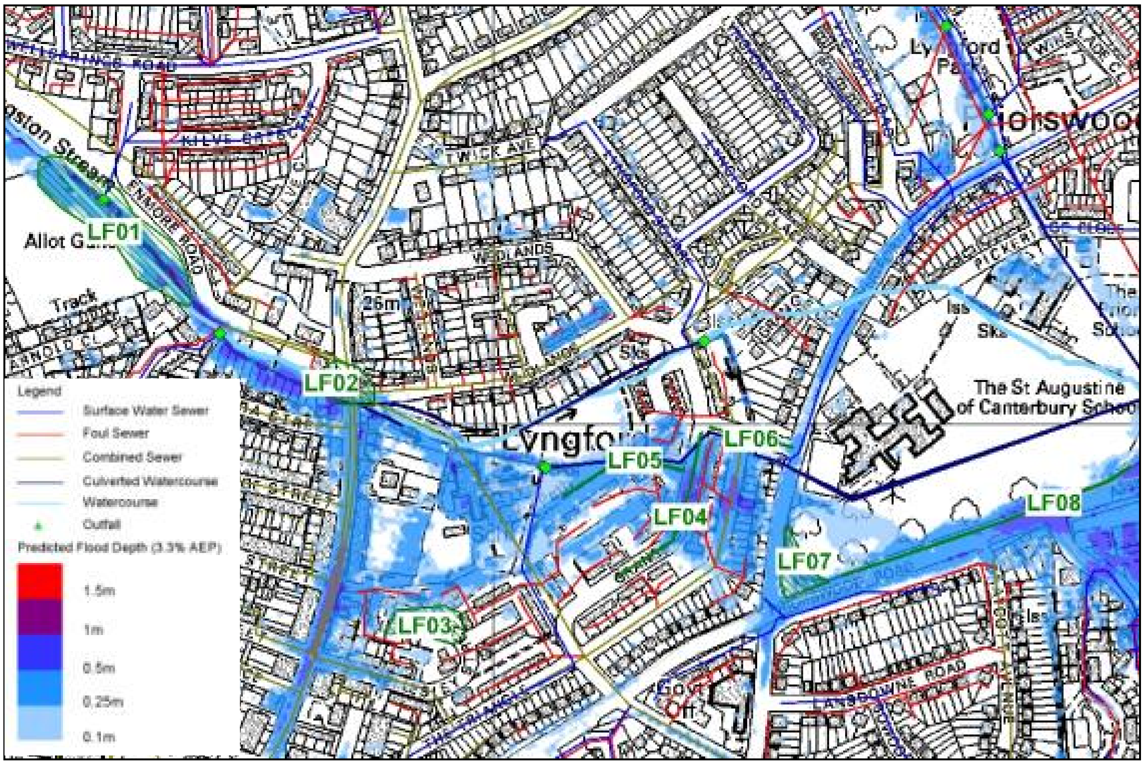


Figure 5.5 Lyngford potential options

ID	Location	Type	Description
LF01	Enmore Road	Local attenuation and infiltration	Provide additional, more formalised storage in existing green area to attenuate flows passed down the catchment.
LF02	Wedlands	Kerb Works	Lower kerbs in conjunction with some small scale re-profiling of ground levels ground to allow some surface water flows into existing green areas surrounding this road junction
LF03	Wellesley Street	Kerb Works	There is an existing green area here where kerbs could be lowered in conjunction with minor ground reprofiling to allow surface water flow into permeable areas and reduce pressure on sewer system downstream.
LF04	Grange Drive	Roadside Rain Gardens	This road is wide with sufficient space between the road and properties to install roadside rain gardens to attenuate flows
LF05	Priorswood School	Local attenuation and infiltration	The footpath from the school to Grange Drive is adjoined by green areas. Ground reprofiling could be undertaken in this area to encourage the attenuation of flows.

ID	Location	Type	Description
LF06	Grange Drive	Roadside Rain Gardens	This road is wide with sufficient space between the road and properties to install roadside rain gardens to attenuate flows
LF07	Priorswood Road	Kerb Works	Kerbs on the junction of Priorswood Road / Lyngford Road could be lowered to allow surface water flows onto the existing green area adjoining the road.
LF08	Priorswood Road	Kerb Works	Kerbs along Priorswood Road could be lowered to allow surface water flows onto the existing green area adjoining the road.

Table 5.4 Lyngford potential options

There are combined sewers draining this area, therefore residents and businesses in the locality should be encouraged to reduce the amount of surface water discharged to the sewer system by making use of water butts, rain water collection systems and by minimising areas of hardstanding within their property boundaries.

In addition, the riparian owners responsible for the Kingston Brook should be identified and informed of their responsibilities. These may include Priorswood School and owners of residential property on Vera Street and Enmore Road.

5.3.5 Bathpool

Figure 5.6 highlights potential locations for the introduction of some of the measures described in Table 5.5.

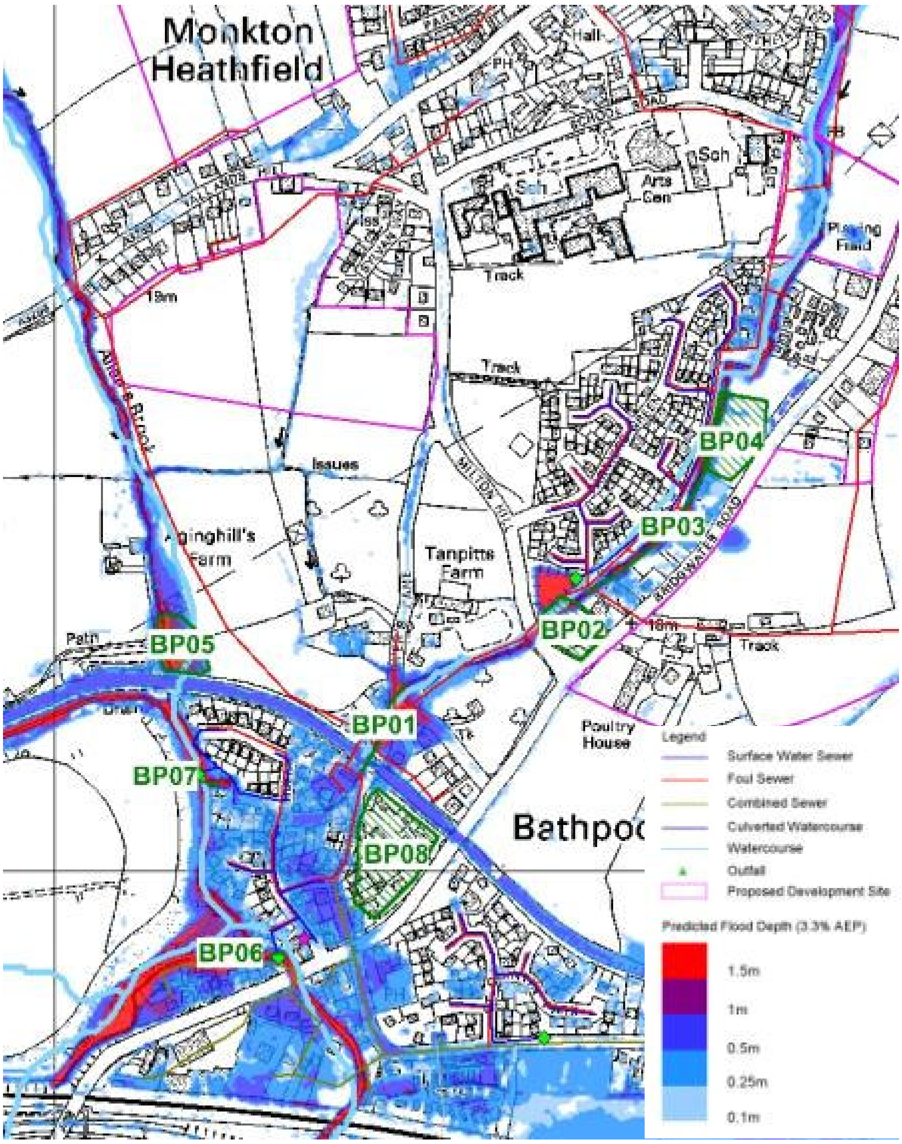


Figure 5.6 Bathpool potential option

ID	Location	Type	Description
BP01	Dyer's Lane	Maintenance	Ensure that the watercourse is kept clear to improve conveyance, ensure any culverts or bridges are free flowing and that there is no unauthorised encroachment into the watercourse from adjacent properties.
BP02	Milton Hill	Local attenuation and infiltration	Provide online attenuation for watercourse in this location. In order to control the flows passed on through the catchment. There is the possibility to link in any works with the proposed development to east . (The topography suggests that the adjacent FSA balances flows from the residential development to the north.)

ID	Location	Type	Description
BP03	Farrier's Green	Maintenance	Ensure that the watercourse is kept clear to improve conveyance. Consider whether the floodplain can be improved to provide additional storage.
BP04	Bridgwater Road	Local attenuation and infiltration	There is the possibility to use the existing green area to attenuate flows on the watercourse
BP05	Aginghill's Farm	Local attenuation and infiltration	Consider providing on line attenuation to reduce pass forward flows but how effective this is will depend on the means by which the Allen's Brook is conveyed beneath the canal.
BP06	Acacia Gardens	Maintenance	Ensure the surface water outfall is kept clear to allow the system to discharge and prevent backing up of the surface water sewer system exacerbating flooding in the residential area.
BP07	Acacia Gardens	Maintenance	Ensure the surface water outfall is kept clear to allow the system to discharge and prevent backing up of the surface water sewer system exacerbating flooding in the residential area.
BP08	Swingbridge	Local attenuation and infiltration	Review surface water flow mechanisms downhill towards Swingbridge and determine any potential for lowering or slowing these flows by implementing localised storage or infiltration.

Table 5-5 Bathpool potential options

There are new developments proposed in the vicinity of Bathpool and opportunities to improve surface water management alongside these developments should be investigated. Possibilities could include provision of online attenuation for watercourses and the enhancement of existing watercourse corridors.

Several developments within Bathpool already have planning permission or have commenced construction and therefore there is little scope to gain anymore from the extant permissions. The EA have confirmed that a section 106 planning agreement negotiated by the EA allows for improvements within the Bathpool area on local watercourses and drainage.

5.3.6 Summary of Non Modelled Options

The selected locations listed in Tables 5.2 to 5.5 should not be seen as absolute and Somerset County Council should seek to work with residents and businesses to explore further options for reducing surface runoff throughout Taunton.

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 the creation of flood wardens.
- Improved data capture during and after events which can be used to inform future funding bids, maintenance work and responses to events.

5.4 Detailed Modelling- Preferred Options Identification

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

5.4.1 Description of Options

Based on the results of Stage 2 modelling and further assessment by the stakeholder group a third generation model was developed for the Staplegrove area of Taunton. This included an assessment of Do Nothing, Do Minimum and Do Something options. The stage 3 modelling included representation of surface water sewers supplied by Wessex Water and sensitivity testing associated with infiltration and downstream boundary conditions.

Following consultation with the stakeholder group, Somerset County Council and Wessex Water it was decided that the flooding mechanisms within the Staplegrove study area would be brought forward and evaluated in detail. Detailed modelling was undertaken to assess the following options:

- Do Nothing (economic baseline)
- Do Minimum
- Seven Do Something options to mitigate the risk of surface water flooding

A description of all the options is contained within Table 5-6.

Option	Description	Modelled scenario / Engineering Option
F	Do Nothing	Assumes that no maintenance, clearance or other intervention is made to interfere with the natural fluvial processes or sewer network. The surface water drainage network would fail within a short timeframe and SCC indicated that with no maintenance the surface water drainage network would fail in 10 years time. This option has been modelled as it is the baseline for the economic assessment. As the option involves the abandonment of the drainage network it is not considered a viable Do Something option for the study area.
A	Do Minimum	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.
B	Water diverted from Staplegrove Rd- 15,500m³	A 15,500m³ partly-bunded attenuation pond with a bed elevation of 25m AOD. The attenuation pond would be located along Staplegrove Road, south of Westerkirk Gate. Water would be diverted from Staplegrove Road by a 0.75m diameter gully drain discharging into the pond.
C	Water intercepted at Rectory Rd- 15,500m³	Option C would channel surface water from Manor Road (south of Manor Road-Rectory Road junction) to discharge into a partly-bunded attenuation pond with the same specification as Option B without the drainage from Staplegrove Road. The water would be diverted into the attenuation pond via a 350m

Option	Description	Modelled scenario / Engineering Option
		long, 0.75m diameter culvert.
D	Water diverted from Staplegrove Rd- 25,700m³	Option D is the same as Option B with a greater storage capacity of 25,700m³, achieved through higher embankments and a larger plan area of the attenuation pond.
E	Water intercepted at Rectory Rd- 25,700m³	Option E is the same as Option C with a greater storage capacity of 25,700m³, achieved through higher embankments and a larger plan area of the attenuation pond.
G	Water intercepted at Rectory Rd "maximum intervention" 27,500m³	Option G is a large-scale attenuation feature that has been termed the "maximum intervention option" at Rectory Road since it is designed to provide complete attenuation of a flow pathway which results in flooding to the south. The volume of water within the attenuation area would be approximately 27,500m³, but this option would be designed without raised embankments, with the entire volume provided through excavation below existing ground levels.
H	Water intercepted at Rectory Rd "minimum intervention" 800m³	In contrast to Option G, Option H is a series of low-level scrapes designed to maximise existing undulations and provide additional attenuation, although not elimination, of the main flow route. It is therefore termed the 'minimum intervention option' in comparison to Option G. The maximum depth of the attenuation would be 300mm to keep the attenuation shallow, with small local embankments used to simply accentuate existing areas where larger pools would form following heavy rain.
I	Water intercepted at Rectory Rd "medium intervention" 4,300m³	Option I is designed to sit between Options G and H, dealing with the same flood flow pathway, but striking a balance between small scrapes and a significant volume of storage. The volume of water within the attenuation area would be approximately 4,300m³.

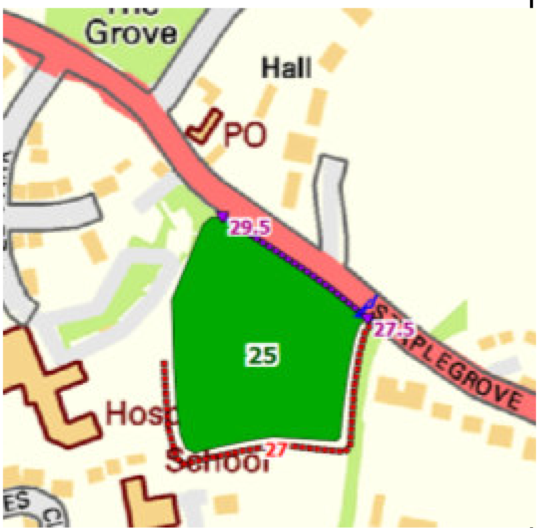
Table 5-6 - Modelled Options

The Do Something Options are detailed graphically in **Table 5-7.**

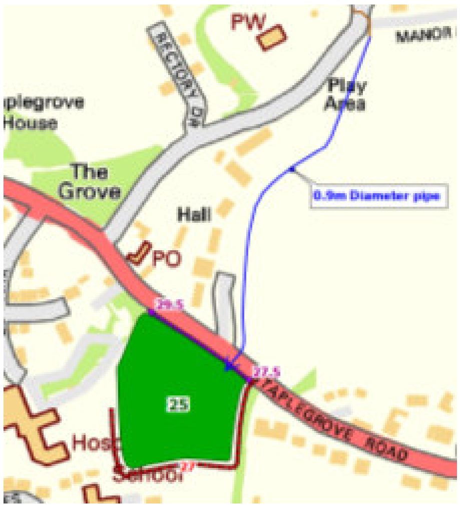
Option B

Option C

Option D



Option E



Option G

Option H

Illustration of pool locations (green = base level; red = embankment level)

Option I	*Contains Ordnance Survey data © Crown copyright and database right 2012*
	

Table 5-7 - Modelled Do Something Options

5.4.2 Option Short listing

The long list of options described above have been analysed in a high-level review considering technical, economic and environmental factors to determine which options were appropriate to short-list for further consideration. This is in line with the approach detailed in the FCERM-AG, which aims to ensure that appraisal work is not abortively spent pursuing options which could be ruled out based on a considered analysis without detailed appraisal. This review is summarised and presented in Table 5-8 below.

Option	Technical Details	Economic Factors	Environmental Factors	Shortlisted
Option A- Do Minimum	Undertake maintenance works to existing surface water sewer system. It is assumed that, with regular maintenance, the drainage network will continue to operate as it currently does.	Outline assessment indicates that this option currently prevents a maximum of nine properties from flooding. Costs would remain as under the current maintenance regime. Property flooding occurs during a 1 in 10 (10% AEP) event under this option.	No impacts predicted as this option maintains the current maintenance regime.	Yes
Option B- Water diverted off Staplegrove Rd- 15,500m³	A 15,500m³ attenuation pond with a bed elevation of 25m AOD. The attenuation would be located along Staplegrove Road, south of Westerkirk Gate. Attenuation would be contained within an embankment with an elevation of 27mAOD tying into higher ground in the north-west corner of the attenuation pond. There would be a further bund along the Staplegrove Road boundary to reduce the rate of surface water inundation discharging into the pond. Water would be diverted from Staplegrove Road by a gully drain discharging into the attenuation area. Once the relevant parts of the Flood and Water Management Act are enacted, the resultant pond would require classification and management as a reservoir under the Reservoirs Act 1975 and amendments.	Outline assessment indicates that this option would remove a maximum of only 20 properties from flood risk. Wider benefits would be attributed to reductions in flood risk at other properties still flooded for equivalent events. This would be a large scale intervention, likely to result in high capital and maintenance costs, including those associated with classification as a reservoir. Property flooding occurs during a 1 in 10 (10% AEP) event under this option.	Large-scale attenuation in a school playing field would give rise to potential health and safety issues with water depths approaching 1m. Due to the volume of water attenuated it is likely the storage would be classified as a reservoir. It would be expected that additional onerous heath and safely requirements would result from the location in a residential area.	No – significant long term commitment required to maintain and preserve safety associated with significant storage option. Health and Safety implications could render it unachievable, especially given the magnitude of flooding it is designed to protect against and the disproportionate nature of this as a proposed solution.
Option C- Water intercepted at Rectory Rd- 15,500m³	Option C would channel surface water from Manor Road (south of Manor Road-Rectory Road junction) to discharge into an attenuation pond with the same specification as Option B minus the drainage from Staplegrove Road. The water would be diverted into the attenuation pond via a 350m long, 0.75m diameter culvert. Once the relevant parts of the Flood and Water Management Act are enacted, the resultant pond would require classification and management as a reservoir under the Reservoirs Act 1975 and amendments.	Outline assessment indicates that this option would remove a maximum of 25 properties from flood risk. Wider benefits would be attributed to reductions in flood risk at other properties still flooded for equivalent events. As Option B, this would be a large scale intervention likely to result in high capital and maintenance costs. Property flooding occurs during a 1 in 10 (10% AEP) event under this option.	This option would actually increase flood risk on Manor Road and in the vicinity of the school building. Large scale attenuation in a school playing field would give rise to potential health and safety issues with flood depths up to 1.4m. Due to the volume of water attenuated it is likely the storage would be classified as a reservoir. It would be expected that additional onerous heath and safely requirements would result from the location in a residential area.	No – as option B, this would be a costly option that would require a long-term commitment to maintain and would be subject to significant health and safety considerations which could render it unachievable.

Option	Technical Details	Economic Factors	Environmental Factors	Shortlisted
Option D- Water diverted off Staplegrove Rd- 25,700m³	Option D is the same as option B with a greater storage capacity of 25,700m³. This would mean that the storage area would be considered a reservoir under the current Reservoirs Act and amendments, regardless of the implementation of the Flood and Water Management Act.	Outline assessment indicates that this option would remove a maximum of 21 properties from flood risk. Wider benefits would be attributed to reductions in flood risk at other properties still flooded for equivalent events. As Option B, this would be a large scale intervention likely to result in high capital and maintenance costs. Property flooding occurs during a 1 in 10 (10% AEP) event under this option.	Large scale attenuation in a school playing field would give rise to potential health and safety issues with flood depths up to 0.50m. This attenuation area would be classified as a reservoir. It would be expected that additional onerous heath and safely requirements would result from the location in a residential area.	No – as option B, this would be a costly option that would require a long-term commitment to maintain and would be subject to significant health and safety considerations which could render it unachievable.
Option E- Water intercepted at Rectory Rd- 25,700m³	Option E is the same as Option C with a greater storage capacity of 25,700m³.	Outline assessment indicates that this option would remove a maximum of 26 properties from flood risk. Wider benefits would be attributed to reductions in flood risk at other properties still flooded for equivalent events. As Option B, this would be a large scale intervention likely to result in high capital and maintenance costs. Property flooding occurs during a 1 in 10 (10% AEP) event under this option.	This option would actually increase flood risk on Manor Road and in the vicinity of the school building. Large scale attenuation in a school playing field would give rise to potential health and safety issues with flood depths up to 1.0m. Due to the volume of water attenuated it is likely the storage would be classified as a reservoir. It would be expected that additional onerous heath and safely requirements would result from the location in a residential area.	No – as option B, this would be a costly option that would require a long-term commitment to maintain and would be subject to significant health and safety considerations which could render it unachievable.
Option G- Water intercepted at Rectory Rd- Maximum intervention 27,500m³.	Option G is a large-scale attenuation feature which has been termed the “maximum intervention option” at Rectory Road since it is designed to provide complete attenuation of a flow pathway which results in flooding to the south. The attenuation would be located on the flow path running north-south through the fields between Manor Road and Staplegrove Road. The attenuation feature would be situated where existing terrain had the least incline to make use of the existing elevations. The attenuation area would result in the land being excavated to an elevation of	Outline assessment indicates that this option would remove a maximum of only 20 properties from flood risk. Wider benefits would be attributed to reductions in flood risk at other properties still flooded for equivalent events. This would be a large scale intervention, likely to result in high capital and maintenance costs.	Large-scale attenuation in a school playing field would give rise to potential health and safety issues with water depths approaching 1m. It would be expected that additional onerous heath and safely requirements would result from the location in a residential area.	No – significant long term commitment required to maintain safety associated with significant storage option. Health and Safety implications could render it unachievable, especially given the magnitude of flooding it is designed to protect against and the

Option	Technical Details	Economic Factors	Environmental Factors	Shortlisted
	27m AOD, 4-2m below ground level. The volume of water within the attenuation area would be approximately 27,500m³.	Property flooding occurs during a 1 in 10 (10% AEP) event under this option.		disproportionate nature of this as a proposed solution.
Option H- Water intercepted at Rectory Rd- Minimum Intervention- 800m³	In contrast to Option G, Option H is a series of low-level scrapes designed to maximise existing undulations and provide additional attenuation, although not elimination, of the main flow route. It is therefore termed the 'minimum intervention option' in contrast to Option G. A series of four small attenuation areas would be located in the same location as the proposed storage area in Option G, designed to 'hold up' the flow of surface water without storing large volumes. The maximum depth of the attenuation would be 300mm to keep the attenuation shallow and just accentuating existing areas where larger puddles would form.	Outline assessment indicates that this option would remove a maximum of 11 properties from flood risk. Wider benefits would be attributed to reductions in flood risk at other properties still flooded for equivalent events. This option is likely to be less costly, in tandem with a reduction in benefits, but its appearance may be more proportionate to the risk of flooding and the historic records in the local area. Property flooding occurs during a 1 in 10 (10% AEP) event under this option.	Series of small scrapes could be achieved through landscaping and would not represent a large-scale engineering option. Health and safety implications would be minimised by simply augmenting existing areas of ponding during heavy rainfall.	Yes – by augmenting existing areas of ponding, it may be possible to reduce the intensity of flooding experienced "down-slope". Further investigation warranted.
Option I- Water intercepted at Rectory Rd- Medium Intervention 4,300m³	Option I is designed to sit between Options G and H, dealing with the same flood flow pathway, but striking a balance between small scrapes and significant volume of storage. The attenuation area has been located on the flow path running north-south through the fields between Manor Road and Staplegrove Road. The scrape was situated where existing terrain had the least incline and makes use of the existing elevations. The attenuation area above has a constant elevation of 29m AOD, the elevation is tied into existing ground elevations (approximately 1-2m below ground level). The volume of water within the attenuation area would be approximately 4,321m³.	Outline assessment indicates that this option would remove a maximum of 17 properties from flood risk. Wider benefits would be attributed to reductions in flood risk at other properties still flooded for equivalent events. Although not as intrusive as Options B-G, this option would still involve creation of storage requiring high capital and maintenance costs. Property flooding occurs during a 1 in 10 (10% AEP) event under this option.	Location of the attenuation area to capture flow would result in three field boundaries being crossed. A footpath is located through the proposed attenuation area.	Yes – by providing storage but avoiding the onerous requirements associated with large volumes, it may be possible to reduce the intensity of flooding experienced "down-slope". Further investigation warranted.

Table 5-8 – Summary of High Level Option Review

5.4.3 Options Selected Following High Level Option Review

Option A, which includes continuing with the current maintenance regime has been taken forward for detailed assessment against the Do Nothing economic baseline.

Option H - Water intercepted at Rectory Rd “minimum Intervention”

The option would be hydraulically connected to the flow path and affect the progress of flood flow. The option would comprise a series of four small scrapes. It could be considered a ‘minimum intervention’ in terms of attempts to impact on this flow path since the scrapes would be dry features for the majority of the time, simply increasing natural ground undulation to provide some small degree of attenuation. The maximum depth in the attenuation features would be around 300mm to keep flooding shallow and proportionate. This is not a whole-scale solution designed to store or attenuate extreme events, rather a more nuanced scheme to reduce regular flooding and limit the need for time-consuming and costly future maintenance. The total volume of water that would be attenuated over the four attenuation ponds is approximately 800m^3.

Option I- Water intercepted at Rectory Rd “medium Intervention”

The option would be hydraulically connected to the flow path and capture flood flows. The attenuation would be located in fields, not adjacent to residential areas. To capture the existing flow path, the attenuation area would have to be located on the route of an existing footpath, which would most likely require diversion. There would, however, be potential for additional benefits in terms of landscaping to form an attractive feature alongside the diverted footpath subject to land-use. This option could be considered a “medium intervention” option since it would provide 4,300m^3 of potential storage and as such sits between the smaller and larger options G and H respectively. It would provide greater attenuation than the also short-listed Option H, but does not involve storage of such a significant amount of water as Option G, which was ruled out from further consideration because of its disproportionate size and onerous long-term maintenance and safety requirements.

5.5 Economic Appraisal

5.5.1 Introduction

This section provides details of the economic analysis carried out in support of the potential 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 October 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 G.

5.5.2 Options Assessed

The Options considered following stakeholder workshop and the high level review are listed below:-

- Do Nothing - This 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 of the FCERM-AG 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 complete failure predicted to occur after 10 years. The modelled results for the Do Nothing option are shown in Figure 5-7.
- 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. The modelled results for the Do Nothing option are shown in Figure 5-8.
- Option H - Water intercepted at Rectory Rd “minimum Intervention”. The option would comprise a series of four small scrapes. Example results for Option H are shown in Figure 5-9.
- Option I- Water intercepted at Rectory Rd “medium Intervention”. The option would provide 4,300m³ of potential storage. Example results for Option I are shown in Figure 5-10.

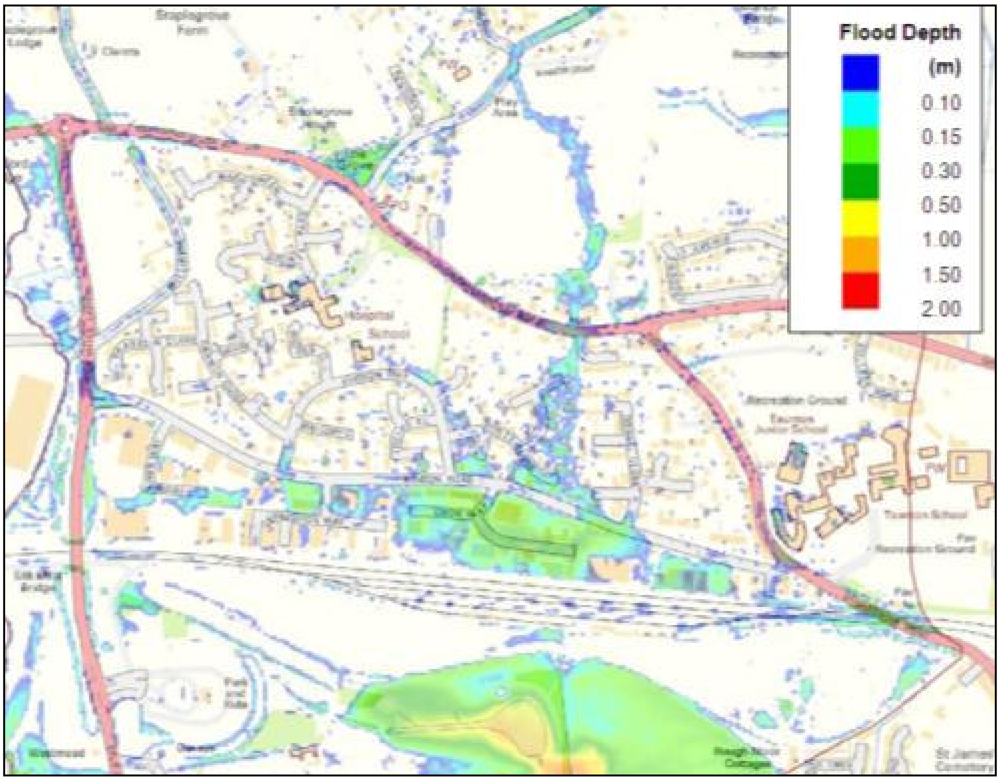


Figure 5-7 - Stage 3 Do Nothing 1 in 100 year return period with 240 minute storm duration

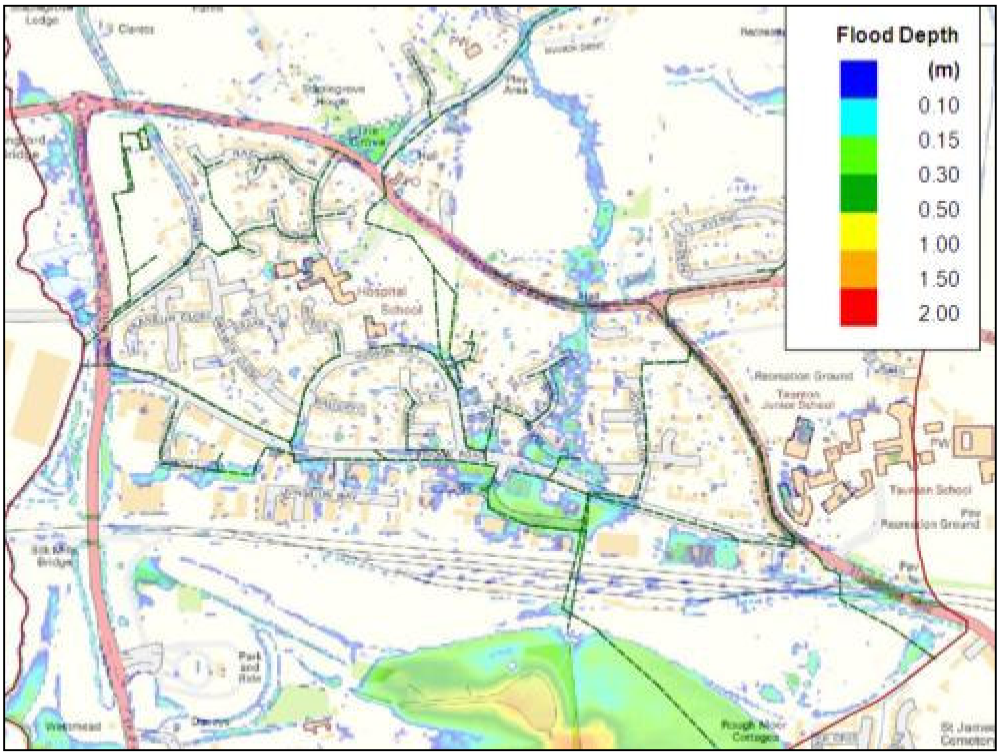


Figure 5-8 - Stage 3 Do Minimum 1 in 100 year return period with 240 minute storm duration

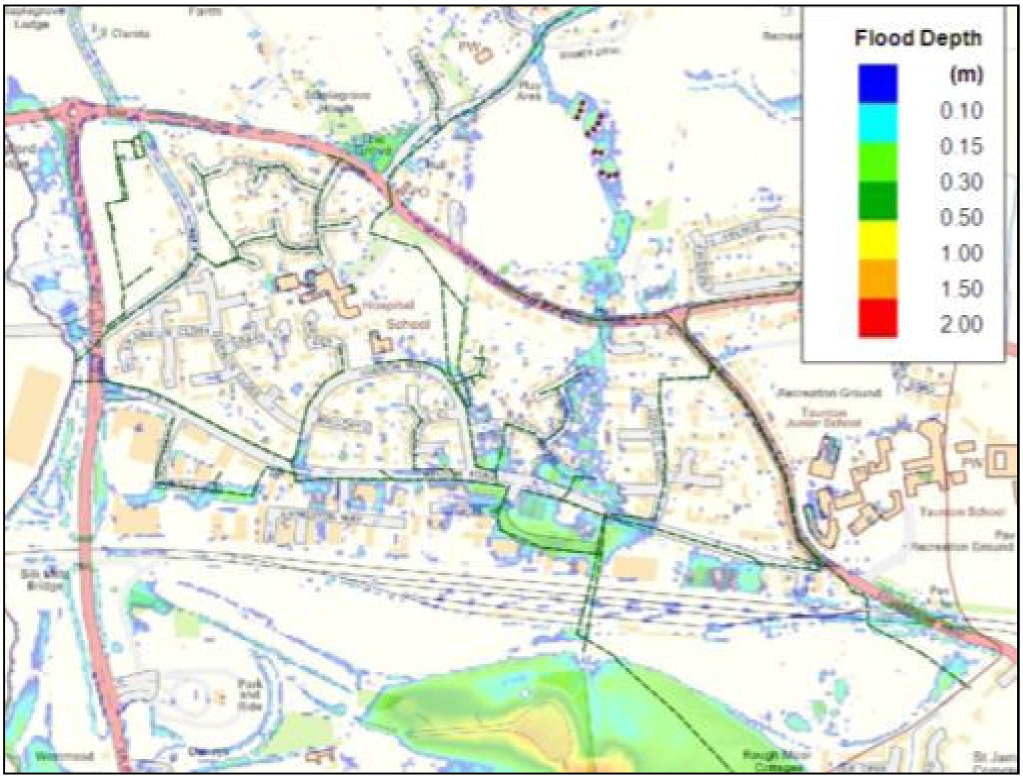


Figure 5-9 - Stage 3 Option H Minimum Intervention 1 in 100 year return period with 240 minute storm duration

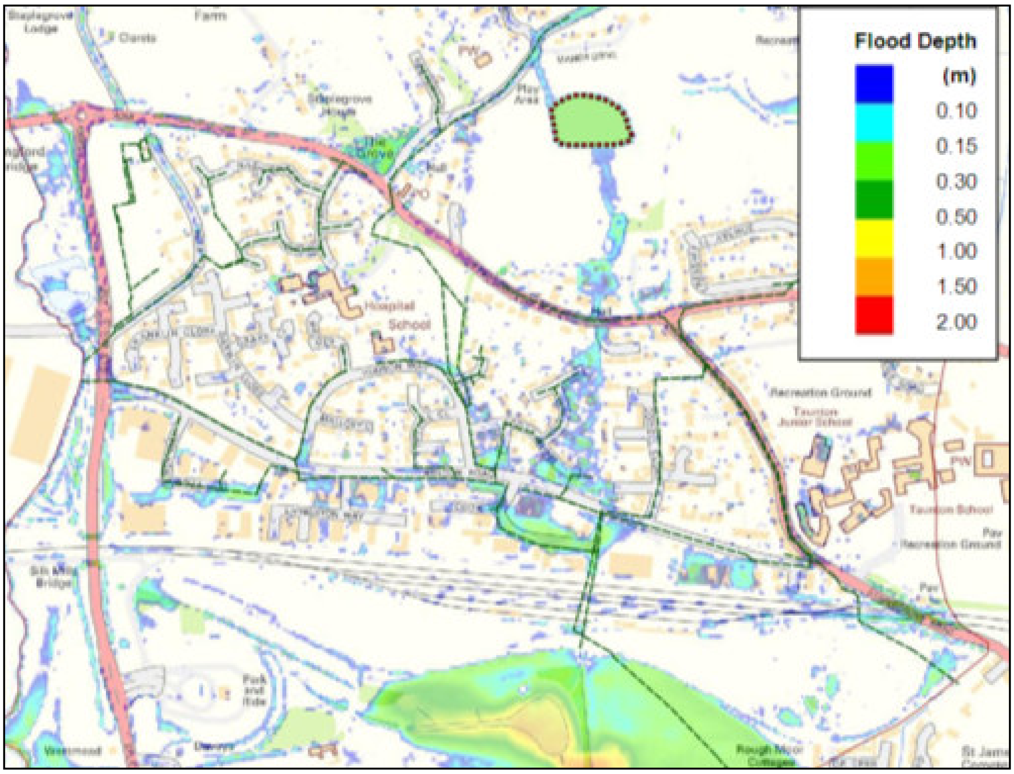


Figure 5-10 - Stage 3 Option I Medium Intervention 1 in 100 year return period with 240 minute storm duration

5.5.3 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 was mapped for Taunton and properties located outside of the Staplegrove study area were removed from the assessment. All properties recorded as upper floor were also removed from the assessment. In order to focus the appraisal and ensure that baseline damage values were proportionate, the study area for Staplegrove was refined based on the area that would directly benefit from the proposed options that address a particular flood pathway and area of ponding. A total of 157 properties were included in the edited NRD dataset for Staplegrove.

Properties were assigned a standard threshold level of 150mm above a ground level extracted from LiDAR data. This threshold was applied to each property, in common with best practice when utilising LiDAR data to inform estimates of property floor levels. Since there is a level of uncertainty regarding the threshold level of properties, this assumed threshold level is explored further in the sensitivity analysis section. In practice, since the nature of the direct rainfall modelling undertaken means that every cell in the flood model experiences a depth of rainfall, thresholds were incorporated by subtracting the 150mm from the flood depth values assigned to each property.

Damages

The assessment of flood damages to properties in Staplegrove 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 dwelling 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 indicate viability of the potential options 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.

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).

Within the appraisal of engineering options, a comparison between the consequences of 'Do Something' is 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 and also the levels of effectiveness for how capital can be spent to protect from and alleviate 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, should potential options be progressed, 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.

High-level cost estimates 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. Breakdowns of these cost estimates are contained within Appendix G.

The existing maintenance costs for Staplegrove were provided by Wessex Water and confirmed by Somerset County Council. The suggested annual maintenance cost for the Staplegrove study area for use in the assessment was £10,000, for the entirety of Staplegrove. The calculations of the annual maintenance costs are show in Table 5.9.

Option	Capital Costs	Annual Maintenance Costs
Do Minimum	-	£10,000
Option H- Water intercepted at Rectory Rd- Minimum Intervention	£64,500	£10,500
Option I- Water intercepted at Rectory Rd- Medium Intervention	£359,000	£12,000

Table 5.9 Maintenance Costs

Optimism bias is a risk-based contingency approach to ensure the tendency for early assessments of project costs to be overly optimistic is accounted for in appraisal. Optimism bias of 60% has been applied to option cost estimates, since the SWMP is a strategic study, in line with HM Treasury Green Book policy, restated in 2010 in the Environment Agency FCERM-AG. Future costs have been discounted accordingly.

5.5.4 Benefit Cost Analysis

Table 5.10 summarises the Present Value Damages associated with the 'Do Nothing' and 'Do Something' Options.

Option	Present Value Damages
Do Nothing	£1.1M
Do Minimum	£595k
Option H	£583k
Option I	£372k

Table 5.10 Flood and Residual Flood Damages

Based upon the assessment of damages and the cost estimates developed for each option, the present value damages have been combined with the whole life cost estimates within Table 5.9. The table summarises the costs, benefits and residual damages associated with each option.

Table 5.11 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.

Option number Option name	Baseline Do Nothing	Option 1 Opt A - Do Minimum	Option 2 Opt H- Minimum Intervention	Option 3 Opt I - Medium Intervention
COSTS:				
PV capital costs		0	65	359
PV maintenance costs		298	313	356
PV future construction		0	77	430
Optimism bias adjustment		179	273	687
Total PV Costs £k excluding contributions		477	727	1,831
BENEFITS:				
PV monetised flood damages	1,121	595	583	372
PV monetised flood damages avoided		526	538	749
Total PV damages £k	**1,121**	**595**	**583**	**372**
Total PV benefits £k		**526**	**538**	**749**
DECISION-MAKING CRITERIA: ***Based on total PV benefits***				
Net Present Value **NPV**		49	-189	-1,082
Average benefit/cost ratio **BCR**		1.10	0.74	0.41
Incremental benefit/cost ratio **IBCR**			-1.5	-0.1

Table 5.11 Option Summary Table (modified from Defra template)

Based on the high-level appraisal undertaken as part of the SWMP, the Do Minimum option, maintaining existing maintenance, is the preferred option. This is shown to result in present value benefits of £526k over the appraisal period and an average BCR of 1.10:1, indicating that maintaining the existing drainage network is economically viable by a small margin.

The benefits of the Do Something Options H and I are £538k and £749k respectively. Both options include capital works, the costs of which are likely to exceed the benefits of both options and therefore both options have negative NPV. Both of the Do Something options have a benefit cost ratio of less than 1, indicating that both options are not likely to be economically feasible, with costs outweighing any expected benefit.

The results of the direct rainfall modelling show that both Do Something options have a limited effect on reducing flood risk in the study area. When compared to the Do Minimum option, the number of properties flooded under the Do Something options remains the same or decreases slightly. This could be due to uncertainties of the application of direct rainfall modelling results to properties and the sensitivity of the model to the shallow flood depths.

Economically, there is no justification for undertaking either of the Do Something options investigated. In order to increase the benefit provided by options, a larger-scale option would most likely be required. This would increase costs and, as indicated in the short-listing process, result in a disproportionately large option requiring onerous future commitment to maintain. Were there historic records to support the predicted baseline model results, then further consideration of options may be justified. Sensitivity testing of the economic assessment, however, indicates that the number of properties flooded is heavily dependent on the threshold levels used in the assessment. Combined with known assumptions and limitations of the modelling approach, this suggests that further assessment of options is unlikely to be justified at the present time. For further details of the economics assessment refer to Appendix G.

As the results of the direct rainfall modelling show that both Do Something Options have a limited effect on reducing flood risk in the study area it is recommended that property level protection and 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 5.5.6.

5.5.5 Allocated Development in Staplegrove

The proposed developments within Taunton Deane were set out in the borough council's Core Strategy which was released for consultation in January 2010. The strategy identifies the potential areas for future development up to 2028. Between 2015 and 2028 there are between 500 and 1,500 dwellings planned at Staplegrove (Figure 5-11).

The main flood risk issue resulting from any proposed developments will be an increase in impermeable areas. There is the potential that, if the volume of runoff from this increase in impervious area is not mitigated in some way, there will be an increase in the flood risk either at the point of development or at a receptor downstream.

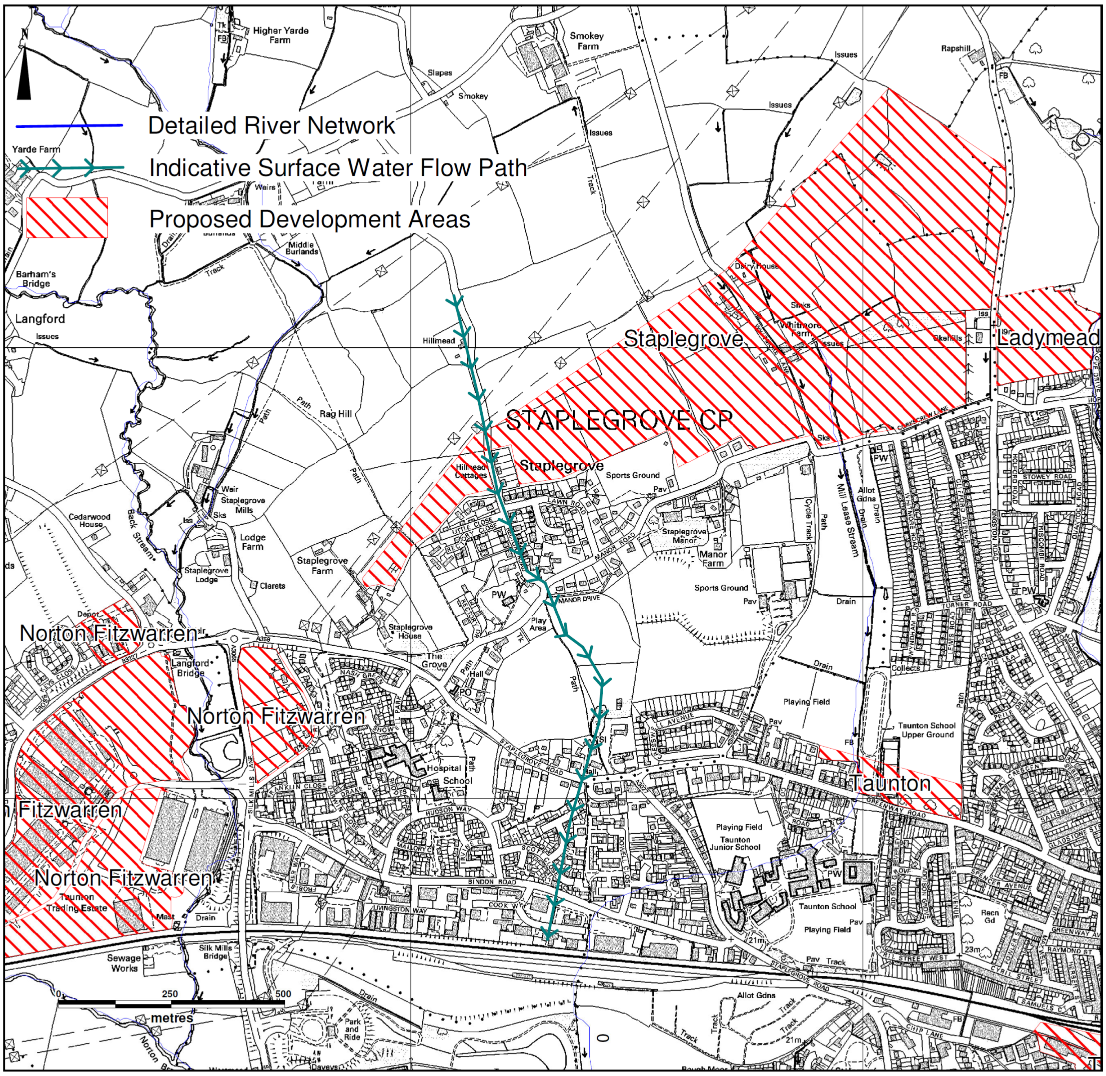


Figure 5-11– Proposed Development Areas within Staplegrove

The Stage 3 modelling undertaken as part of the SWMP has indicated that there is a surface water flow path, which runs north to south though the fields south of Rectory Road. This flow path runs through the allocated development site. It is recommended that this flow path is investigated further and that development is not located in the route of the flow path. Additionally, there is the potential that increasing impermeable surfaces within the area could increase runoff and subsequently increase flood risk downstream. Due to the presence of the north- south flow path and the location of downstream receptors, it is recommended that surface water runoff from the development is carefully managed. It is recommended that Wessex Water is consulted on any planning applications submitted for the sites allocated for development.

The Staplegrove development area is proposed to be a mixed use development area of approximately 50ha (Figure 5-11). A new local centre, primary school, community hall, doctor's surgery, affordable housing, employment and improved bus, cycle and pedestrian facilities are proposed. Recreation and open space, together with sustainable drainage systems are proposed in a new green wedge area.

The mapping undertaken as part of the SFRA indicates that the site is located in Flood Zone 1, apart from the corridor of Flood Zone 3 and 2 surrounding the Mill Lease Stream, which is located to the east of the site. The SFRA has identified that fluvial flooding is unlikely to be an issue and the dominant risk is from surface water flooding.

Specific recommendations regarding surface water management cannot be made as the layout and form of the development is currently not known. It is recommended that the site employs the best practice SuDS techniques to manage surface water runoff. The SFRA has identified that the majority of the site is comprised of soils judged to have slightly impeded drainage. Therefore, infiltration techniques may not be appropriate and attenuation techniques may be more suitable at the proposed development sites. The potential options available and the indicative costs and benefits of SuDS options available to the Staplegrove development area are discussed further in the sections below.

5.5.6 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 retrofitting of SuDS 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 5.12 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 5.12- 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 October 2012. Table 5.13 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	£15	Per m^2	Environment Agency, Cost-Benefit of SuDS Retrofit in Urban Areas
Filter Drain	£144	Per m^3	CIRIA SuDS Manual[xiii]
Basins and Ponds	£24	Per m^3	CIRIA SuDS Manual
Permeable Paving	£63	Per m^2	Environment Agency, Cost-Benefit of SuDS Retrofit in Urban Areas
Green Roofs	£151	Per m^2 roof	Design for London, Living Roofs and Walls Technical Report: Supporting London Plan Policy[xiv]
Raising / Lowering Kerbs	£11	Per m	Spon's Civil Engineering and Highway Works Price Book 2009[xv]
Underground Storage	£798	Per m^3	Hyder project experience
Ground Re-profiling	£5	Per m^3	Spon's, general excavation
Re-cambered Road	£27	Per m^2	Spon's, dense bitumen
Road Humps to direct flows into SuDS	£1,300	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 5.13- Capital Costs of SuDS retrofitting options

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[xvi].
- 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 Taunton. 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 5.14.

Measure	Cost	Unit	Source
Swale	£0.10	Per m^2	CIRIA SuDS Manual
Filter Drain	£0.60	Per m^2	CIRIA SuDS Manual
Basins and Ponds	£0.30	Per m^3	CIRIA SuDS Manual
Permeable Paving	£0.40	Per m^2	Environment Agency, Cost-Benefit of SuDS Retrofit in Urban Areas SC060024

Table 5.14- 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 Taunton, 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 5.12, 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 Taunton it is recommended that a site specific investigation is conducted.

5.6 Non Capital Options

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

- Data and Asset Management (Section 5.6.1)
- Planning Policy (Sections 5.6.2 – 5.6.4)
- Development Control (Section 5.6.5)
- Campaigns and Communication (Section 5.6.6)
- Emergency Planning (Section 5.6.7)

5.6.1 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.

5.6.2 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 Taunton Deane Local Plan forms part of the Local Development Framework for Taunton Deane. It provides a comprehensive planning basis for development, investment and related decisions for the Borough.

The proposed developments within Taunton Deane were set out in the borough council's Core Strategy which was adopted in August 2012. The strategy identifies the potential areas for future development up to 2028. Between 2015 and 2028 there are between 500 and 1,500 dwellings planned at Staplegrove (Figure 5-11). TDBC are now in the process of the 'call for sites'; this involves identifying the best sites for development over the next 17 years which involves land owners, and developers identifying potential sites for new homes, employment, potential gipsy and traveller sites. The 'call for sites' is part of national planning policy to maintain an up-to-date database to feed into the Local Development Framework process /Local Plan.

The Local Development Scheme May 2009 sets out the Local Plan policies that are saved until the relevant Development Plan Documents replace them. The Local plan has the following policies regarding flooding due to development:

EN29 Development which would result in a greater risk of flooding due to increased surface water run-off will not be permitted. Appropriate mitigation measures will be required to prevent run-off from increasing, using sustainable drainage systems wherever practicable.

All development, whether it is within an area at risk of flooding or not, has the potential to create or exacerbate flooding problems through the generation of increased run-off. Although in some cases the redevelopment of existing urbanised land may result in a reduction in run-off, more commonly development will result in vegetated areas where percolation can occur being replaced by impermeable hard surfaces such as roofs, roads and other paved areas.

It is imperative that the run-off implications of development proposals are assessed, and appropriate mitigation measures, to prevent any increase, are incorporated. Within the catchment of the River Tone, which encompasses the majority of the Borough, the regulation of surface water run-off is essential in view of the existing extent of flooding problems.

Traditionally, surface water drainage systems sought to remove water from sites as quickly as possible through underground pipes. Whilst protecting the sites involved from flooding, such systems could create problems elsewhere through the increased rate of run-off.

Sustainable drainage systems take a different approach, using techniques to control run-off as close to its source as possible, and before it enters a watercourse. These tend to mimic natural drainage processes. There is a wide range of options, including dry or wet storage areas, soakaways, and infiltration areas. They have a number of advantages, including management of the environmental impact of development close to its source, possible opportunities for wildlife habitat creation, and the recharge of groundwater. The use of such systems will be encouraged wherever practicable.

5.6.3 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 rates, 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/ Local Plan and consequently share this with planning applicants, the development industry and the community. The Planning Advisory Service[xvii] 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 LFRM strategies[xviii]. The LFRM strategy is a key policy document and it 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 Flood Risk 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)[xix] 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.

5.6.4 Planning Policy - Specific

The following specific policies for Taunton 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 and SuDS

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

5.6.5 Development Control

Planned New Development

Attention should be paid to planned development within Taunton and also to potential windfall sites in terms of surface water flood risk management. It is also highlighted that the cumulative impacts of piecemeal development and urban creep can also be significant unless effective control measures are taken.

Requirements for Specific Guidance

It is recommended that a specific guidance document for developers setting out the Council's requirements for surface water management in new developments is produced, particularly with reference to the forthcoming commencements of the SuDS Approving Body (SAB) roles as part of the FWMA. This document could be developed as a specific water management SPD as discussed in Section 5.6.3 before. 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 key 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

Additional Considerations

It is recommended that the following additional considerations are also incorporated within the SPD or alternatively separate guidance is provided:

- Information should be provided on any contributions required for strategic measures or local schemes. Refer to Section 5.4.3 (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.

Standards and Regulations

The existing CIRIA SuDS guidance (SuDS Manual[xx], Preliminary Rainfall Runoff Management for New Development[xxi]). 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 by 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.

Adoption

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.

5.6.6 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 Taunton Deane Council, 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[xxii]. 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[xxiii]. 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 Taunton or Somerset specific scheme. This will, cumulatively, help slow runoff into the surface water system.

Encourage residents to 'green' their gardens and curtilages, again to slow the entry of water into the surface water network.

5.6.7 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[xxiv]. 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[xxv].

Environment Agency Flood Warning

Taunton is currently within a Fluvial Environment Agency flood warning area. Taunton lies within the three flood warning areas:

- River Tone from Bishops Hull to Creech St Michael
- River Tone at Taunton, the cricket green and areas between Dellers Wharf and Weirfield Green.

- River Tone at Taunton, Tangier area including French Weir and Castle Street.

5.7 Phase 3 Summary

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

- Stage 1 - Hydrological Analysis and development of a broad scale, bare earth, model of Taunton 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 using Stage 2 updated model outputs.
- Stage 3 - Detailed modelling assessment of a specific wet-spot within Taunton, which the stakeholders selected to be Staplegrove. This included the development and testing of potential engineering options and economic analysis.

The SWMP direct rainfall analysis has improved the understanding of future surface water flood risk within the Taunton study area at a strategic level.

A range of potential engineering measures and options has been identified, modelled and costed for the Staplegrove study area, which indicates that the options assessed in this study provide little or no economic benefit in reducing flood risk compared to the 'Do Minimum' case. Therefore, smaller scale SuDS retrofitting works is an option for controlling and reducing surface water runoff in the catchment alongside property level flood resilience and resistance measures where flood risk is significant. Funding constraints and stakeholder buy-in are likely to be a key obstacle to implement catchment wide engineering solutions, highlighting the need for further stakeholder consultation, low cost measures and community flood resilience.

This SWMP therefore considers smaller scale, retrofitted, soft options for managing surface water flood risk in Staplegrove and the wider Taunton area, 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 Staplegrove and the wider Taunton area have a significant beneficial impact in mitigating the risk of flooding at lower return periods.

It should be recognised however 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 alone 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 and policy interventions.

5.8 Key Surface Water Flooding Issues in Taunton

Modelling has identified a number of potential issues in the study area:

- 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 during heavy rainfall.
- There are only two outfalls to the River Tone contained within the Wessex Water data for Staplegrove.
- It is believed that a lack of outfalls/drainage through the railway in the vicinity of Cook Way is resulting in water ponding behind the railway line.
- Surface water runoff from surrounding recreational / agricultural land towards residential and commercial regions
- Conveyance and out of bank flows associated with ordinary watercourses
- Highway conveyance of surface water
- Urbanisation

5.9 Preferred Options For Further Investigation

The identified potential options for the Staplegrove study area that require further investigation and consideration are:

1. Smaller scale non modelled elements and retro-fitting of SuDS in specific locations (Section 5.3.1)

2. Property level resistance/resilience measures

3. Non Capital improvements options (see Section 5.6)

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 5.5 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 G)

5.10 Key Mitigation Strategies For Taunton

Whilst the engineering options assessed at this stage are at a strategic level, the modelling work carried out gives a clear indication to the approaches that could be taken to develop detailed surface water mitigation strategies and solutions in Taunton. 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 5.6, including the potential to improve current surface water management across Taunton (deculverting watercourses, providing space for surface water exceedance pathways through good design).

The SWMP Action Plan recommendations are presented in Section 6.

6 Phase 4 – Implementation and Review

6.1 SWMP Action Plan and Monitoring

The key conclusions, preferred options and flood risk management strategies presented in Section 5 should be factored into the development of the Surface Water Action Plan and methods for communicating and monitoring the Action Plan as detailed below.

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

As part of this study, optioneering has been undertaken within the Staplegrove study area and non-modelled options have been suggested for the wider Taunton study area. The next steps specific to the Taunton area are detailed in the Table 6-1. Actions TN1 to TN5 are specifically related to the prioritised areas in Catchment B whereas the remaining actions are applicable across the entire Taunton study area. Lead responsibility is shown in bold where multiple organisations are involved in implementing an action.

ID	Action	Lead Responsibility	Timescale
TN1	**Staplegrove** Investigate the surface water overland flow route from Manor/Rectory Road. Promote the use of SuDS in the allocated development to the north of Staplegrove to manage surface water runoff from new development. Investigate small scale retrofitting options to manage surface water runoff route which occurs north to south from Rectory Road (refer to Table 5.12).	**SCC** TDBC WW EA	Short Term
TN2	**Creech St Michael** Wessex Water has indicated that separation of surface and foul water may exacerbate risk of flooding to Creech St Michael. A solution could be reducing the surface water discharged to the sewer system by making use of water butts, rain water collection systems and by minimising areas of hard standing within property boundaries. Monitor possible problems with fluvial flooding in the area, undertake maintenance and encourage implementation of SuDS systems in new development areas which would reduce discharge to the watercourses. Set aside and monitor possible problems with flooding in the area whilst exploring the opportunities and benefits of potential small scale retrofitting options (refer to Table 5.12).	**WW** SCC	Short Term
TN2a	**Northtown** There are combined sewers draining this area. Residents and businesses in the locality should be encouraged to reduce the amount of surface water discharged to the sewer system by making use of water butts, rain water collection systems and by minimising areas of hard standing within their property	**SCC** WW	Short Term

ID	Action	Lead Responsibility	Timescale
	boundaries. Set aside and monitor possible problems with flooding in the area whilst exploring the opportunities and benefits of potential small scale retrofitting options (refer to Table 5-2 and Table 5.12).		
TN3	**Barbers Mead and Hale Way** The riparian owners responsible for the Maiden Brook should be identified and informed of their responsibilities. Where flooding is known to cause problems for residents, property level protection measures could be installed on individual properties to afford additional protection. Set aside and monitor possible problems with flooding in the area whilst exploring the opportunities and benefits of potential small scale retrofitting options (refer to Table 5-3 and Table 5-12).	**SCC** WW EA	Short Term
TN4	**Lyngford** There are combined sewers draining this area therefore residents and businesses in the locality should be encouraged to reduce the amount of surface water discharged to the sewer system by making use of water butts, rain water collection systems and by minimising areas of hard standing within their property boundaries. In addition, the riparian owners responsible for the Kingston Brook should be identified and informed of their responsibilities. These may include Priorswood School and owners of residential property on Vera Street and Enmore Road. Set aside and monitor possible problems with flooding in the area whilst exploring the opportunities and benefits of potential small scale retrofitting options (refer to Table 5-4 and Table 5-12).	**SCC** WW EA	Short Term
TN5	**Bathpool** There are new developments proposed and opportunities to improve surface water management alongside these developments should be investigated. Possibilities could include provision of online attenuation for watercourses and the enhancement of existing watercourse corridors. Undertake an integrated study of flooding which incorporates all sources of flooding is required to drive potential flood alleviation options for Bathpool. There is the potential for collaborative working between SCC and the EA to try and deliver local watercourse/drainage improvements in Bathpool using Section 106 funding from developments.	**SCC** TDBC WW EA	Short Term-Mid term
TN6	Following flood events or incident reports, carry out further investigations into locations of cross connections between surface and foul sewers to inform scheme appraisal and design	**WW**	Short Term

ID	Action	Lead Responsibility	Timescale
TN7	Cary out inspections of watercourses (ordinary and main rivers) where condition not known	**SCC** EA	Short Term
TN8	Undertake asset condition assessments (including non fluvial)	**SCC** WW	Short Term
TN9	Continue current maintenance actions	**SCC** WW EA	Short Term
TN10	Carry out additional proactive targeted maintenance	**SCC** WW EA	Short Term
TN11	Focus on Surface Water Management through the Development Control Process	**SCC**	Short Term
TN12	Include additional Local Plan Policy as identified in Section 5.6 above to incorporate additional surface water management guidance	SCC	Short Term
TN13	Undertake delivery of a Somerset County Guidance document for Sustainable Water Management with support from Districts to assist with identification of requirements for new development and forthcoming legislative changes	**SCC** Districts	Short – Mid Term
TN14	Ensure that any proposed actions, guidance and policies make appropriate links to the developing Local Plan for Taunton Deane and specific Taunton development	**SCC** TDBC	Short Term
TN15	Write LFRMS ensuring consistency with the principles of the national strategy whilst noting the role of SWMP in managing surface water flood risk. Consider the need for scrutiny and consultation	SCC	Short – Mid Term
TN16	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
TN17	All parties to understand the location of and status of their assets, so as to assist in the derivation of 'Critical' Assets.	**SCC** EA WW	Short Term
TN18	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
TN19	Enhance communication with communities to develop the notion of responsibility for and ownership of flood risk management.	**SCC** TDBC	Continuous
TN20	Continue to develop and maintain the Somerset Multi Agency Flood Plan (MAFP) whilst taking into account SWMP outputs	SCC	Continuous
TN21	Investigate feasibility and economics of property level protection in identified wetspots	SCC	Short Term

ID	Action	Lead Responsibility	Timescale
TN22	Regular Review of SWMP for Taunton	SCC	Minimum every Six Years

Table 6.1- Action Plan

6.2 Further Details

6.2.1 Benefits of Taunton SWMP

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

- 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
- Indication of potential development constraints and opportunities for future development to contribute to the reduction in the predicted flood risk
- 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 Taunton Deane Borough 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.

6.2.2 Data Management

The Taunton 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.

6.2.3 Quick Win Measures

The 'quick win' measures recommended are:

- SCC, Taunton Deane Borough Council, utility companies, emergency services and their planning teams to undertake assessments of key assets in the area of Taunton SWMP.
- Use of the flood incident register for the Taunton 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.

6.2.4 Role of the SWMP Report in the Planning Process

The Taunton 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 Taunton has provided additional information and evidence for use in the planning process until the Guidance document is produced. Recommendations for planners dealing with planning applications in the Taunton Wetspots are detailed below in Table 6-2.

Recommendation	Verification
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.
Development of a specific SPD for Taunton 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.
Limit, and where possible better, the rate of discharge from new development sites to Greenfield runoff rates.	From mapping within modelled outputs.
Careful consideration of the use of architectural designs such as drop kerbs in new developments to account for 'exceedance 'flow routes within the highlighted Wetspots.	A number of flow paths through the study area are along roads and these should be treated as preferential 'exceedance' flow paths.
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 6-2 Recommendations for Planners in Taunton

6.2.5 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.

6.2.6 Sustainable Development and Rainwater Harvesting

Generally planning policies covering the Taunton 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. It should be noted that Wessex Water provides incentives for households. Water butts are available at discounted rates if purchased through their website (http://www.wessexwater.co.uk/saving-water/products/default.aspx). 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.

It is recommended that if sustainable development is to be encouraged then further incentives could be offered. An example of a domestic level incentive is reduced water rates for property owners to replace hard surfaces with permeable ones.

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

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