Shropshire Council

Shifnal Surface Water Management Plan

Detailed Assessment and Options Appraisal Report

Final

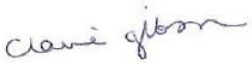
Hyder Consulting (UK) Limited
2212959
Aston Cross Business Village
50 Rocky Lane
Aston
Birmingham B6 5RQ
United Kingdom
Tel: +44 (0)121 333 4466
Fax: +44 (0)121 333 4275
www.hyderconsulting.com

Shropshire Council

Shifnal Surface Water Management Plan

Detailed Assessment and Options Appraisal Report

Final

Author	Claire Gibson	
Checker	Liam Foster	
Approver	Liam Foster / Neil Evans	

Report No 5006-UA002182-BMR-06

Date October 2013

Revision	Description	Date
05	Final report issued to Shropshire Council	November 2011
06	Updated to include findings of the Priorslee Flood Alleviation Study	October 2013

Executive Summary

Hyder was commissioned by Shropshire Council in May 2010 to produce a Surface Water Management Plan for the town of Shifnal, following the methodology as described in the Defra SWMP Guidance published in March 2010.

Previous studies (including the Outline Water Cycle Study and Strategic Flood Risk Assessments), previous flooding incidents (including the severe flooding experienced during 2007), the proposed growth and the identified future risks to the town of surface water flooding helped to identify that Shifnal was one of six towns across Shropshire that would benefit from a detailed assessment of the surface water flood risk.

Undertaking this study, has allowed the flooding mechanisms and the characteristics of the catchment to be better understood. The catchment:

- displays a mixture of agricultural and urban land uses,
- is regulated by upstream impounding water bodies; and;
- is fast-acting (short time-to-peak) particularly when soil saturation is high.

Changes to land use are also a contributing factor to the flooding issues in the town such as changes to farming practices, urbanisation, motorway development and quarrying across the area.

Following a review of the available information, several wetspots were identified and these were ranked in to priority. Following this and in agreement with Shropshire Council, it was identified that the main risks to Shifnal are exhibited from the Wesley Brook and its tributaries through the town and that updating the river modelling would be the main focus of the Detailed Assessment.

An ISIS Tuflow model for the urban reach of Shifnal was built to route any predicting flooding from river over the ground to simulate the overland flow paths. The model was used to assess the existing open watercourse network, to model any proposed flood mitigation options and to ensure that options proposed do not increase flooding elsewhere.

The study has identified several actions and options that could assist in improving the flood risk situation through the town and these are identified and included within Section 4. The stakeholders were closely involved in this study. An Action Plan was compiled (see Section 5 of this report) and the objectives are supported by the stakeholders. The stakeholders have agreed to work with Shropshire Council to achieve the objectives and deliver the Action Plan to the full extent of their flood risk management responsibilities.

Non structural and council wide measures such as a continuation in the current improvement of data management, stronger flood risk management partnerships, and development management policy guidance play a vital part in the overall process of improving the status quo and to helping to adapt Shifnal, and the other Shropshire Towns to an uncertain climatic future.

Therefore, the Shifnal Surface Water Management Plan should significantly help Shropshire Council, to provide a wide range of measures to manage local flooding in a coordinated way that balances the need for communities, the economy and the environment as expected by a LFRMS.

CONTENTS

Executive Summary 5
1 Introduction 1
1.1 Terms of Reference 1
1.2 What is a Surface Water Management Plan 1
1.3 Background 1
1.4 Flooding Interactions 3
1.5 Linkages with Other Plans 5
1.6 Existing Legislation 10
1.7 Sustainable Drainage Systems (SuDS) 12
1.8 Geographic Extents 14
1.9 Methodology 15
2 Phase 1 – Preparation 17
2.1 Need for SWMPs in Shropshire 17
2.2 Partnerships 17
2.3 Data Collection 19
2.4 Much Wenlock Integrated Urban Drainage Management Plan 21
2.5 Scope the SWMP 21
2.6 Phase 1 Summary 22
3 Phase 2 – Risk Assessment 23
3.1 Strategic Level Assessment 23
3.2 Intermediate Assessment 24
3.3 Detailed Assessment 38
3.4 Flood Hazard Maps 41
3.5 Priorslee Flood Alleviation Study (2013) 41
4 Phase 3 – Options 43
4.1 Identify Measures 43
4.2 Assess Options 48
5 Phase 4 – Implementation & Review 63
5.1 Action Plan 63
6 Conclusions and Recommendations 65
7 References 68
Appendix A Data Register
Appendix B Drawings
Appendix C Multi Criteria Analysis Data
Appendix D Hydraulic Modelling

Glossary

Term	Definition
Aquifer	A source of groundwater comprising water bearing rock, sand or gravel capable of yielding significant quantities of water.
AMP	Asset Management Plan
Asset Management Plan	A plan for managing water and sewerage company (WaSC) infrastructure and other assets in order to deliver an agreed standard of service.
AStSWF	Areas Susceptible to Surface Water Flooding
Catchment Flood Management Plan	A high-level planning strategy through which the Environment Agency works with their key decision makers within a river catchment to identify and agree policies to secure the long-term sustainable management of flood risk.
CFMP	Catchment Flood Management Plan
CIRIA	Construction Industry Research and Information Association
Civil Contingencies Act	This Act delivers a single framework for civil protection in the UK. As part of the Act, Local Resilience Forums must put into place emergency plans for a range of circumstances including flooding.
CLG	Government Department for Communities and Local Government
Climate Change	Long term variations in global temperature and weather patterns caused by natural and human actions.
Critical Infrastructure	For the purposes of this SWMP, this is identified as being Infrastructure identified from the Environment Agency NRD datasets as being hospitals, schools, power (generation & distribution), water, transport etc. For the purposes of this assessment, these items have been defined as being critical so as to identify the risk of surface water flooding to assets other than residential and commercial.
Culvert	A structure that conveys a watercourse below the level of the ground.
Defra	Department for Environment, Food and Rural Affairs
DEM	Digital Elevation Model
DG5 Register	A water-company held register of properties which have experienced sewer flooding due to hydraulic overload.
DTM	Digital Terrain Model
EA	Environment Agency
Indicative Flood Risk Areas	Areas determined by the Environment Agency as indicatively having a significant flood risk, based on guidance published by Defra and WAG and the use of certain national datasets. These indicative areas are intended to provide a starting point for the determination of Flood Risk Areas by LLFAs.
FCERM	Flood and Coastal Erosion Risk Management -
FMfSW	Flood Map for Surface Water
Flood defence	Infrastructure used to protect an area against floods as floodwalls and embankments; they are designed to a specific standard of protection (design standard).
Flood Forum	A group set up to gather information from and to provide flooding and drainage support and advice to communities in the Shifnal and Albrighton area.

Term	Definition
Flood Risk Area	An area determined as having a significant risk of flooding in accordance with guidance published by Defra and WAG.
Flood Risk Regulations (FRR)	Transposition of the EU Floods Directive into UK law. The EU Floods Directive is a piece of European Community (EC) legislation to specifically address flood risk by prescribing a common framework for its measurement and management.
Flood and Water Management Act	Part of the UK Government's response to Sir Michael Pitt's Report on the Summer 2007 floods, the aim of which is to clarify the legislative framework for managing flood risk in England.
Fluvial Flooding	Flooding resulting from water levels exceeding the bank level of a watercourse
IDB	Internal Drainage Board
IUD	Integrated Urban Drainage
LDF	Local Development Framework
Lead Local Flood Authority (LLFA)	Local Authority responsible for taking the lead on local flood risk management. In Shropshire, Shropshire Council is the LLFA.
LiDAR	Light Detection and Ranging
Local Resilience Forum (LRF)	A multi-agency forum, bringing together all the organisations that have a duty to cooperate under the Civil Contingencies Act, and those involved in responding to emergencies. They prepare emergency plans in a co-ordinated manner.
LPA	Local Planning Authority
Main River	A watercourse shown as such on the Main River Map, and for which the Environment Agency is the managing authority and has certain powers
NRD	National Receptor Dataset – a collection of risk receptors produced by the Environment Agency
Ordinary Watercourse	All watercourses that are not designated Main River. The local authority, in this case Shropshire Council is the managing authority for ordinary watercourses and has certain powers in this regard under the Land Drainage Act.
Partner	A person or organisation with responsibility for the decision or actions that need to be taken.
PFRA	Preliminary Flood Risk Assessment
Pitt Review	Comprehensive independent review of the 2007 summer floods by Sir Michael Pitt, which provided recommendations to improve flood risk management in England.
Pluvial Flooding	Flooding from water flowing over the surface of the ground; often occurs when the soil is saturated and natural drainage channels or artificial drainage systems have insufficient capacity to cope with additional flow.
PPS25	Planning and Policy Statement 25: Development and Flood Risk
RBMP	River Basin Management Plan
River Basin Management Plan	A high-level planning strategy through which the Environment Agency works with their key decision makers within a river basin catchment to identify and agree policies to secure the long-term improvement to the water environment.
Resilience Measures	Measures designed to reduce the impact of water that enters property and businesses; could include measures such as raising electrical appliances.
Resistance Measures	Measures designed to keep flood water out of properties and businesses; could include flood guards for example.

Term	Definition
Risk	In flood risk management, risk is defined as a product of the probability or likelihood of a flood occurring, and the consequence of the flood.
Risk Management Authority	As defined by the Floods and Water Management Act
RMA	Risk Management Authority
SC	Shropshire Council
STWL	Severn Trent Water Limited
Sewer flooding	Flooding caused by a blockage or overflowing in a sewer/urban drainage system.
SFRA	Strategic Flood Risk Assessment
Stakeholder	A person or organisation affected by the problem or solution, or interested in the problem or solution. They can be individuals or organisations, includes the public and communities.
SuDS	Sustainable Drainage Systems
Sustainable Drainage Systems	Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner.
Surface water	Rainwater (including snow and other precipitation) which is on the surface of the ground (whether or not it is moving), and has not entered a watercourse, drainage system or public sewer.
SWMP	Surface Water Management Plan
WaSC	Water and Sewerage Company
WW	Dyr Cymru Welsh Water

1 Introduction

1.1 Terms of Reference

Hyder Consulting (UK) Limited (HCL) was appointed by Shropshire Council to produce a Surface Water Management Plan (SWMP) for three Shropshire Towns: Shifnal; Church Stretton and Craven Arms. This report has been written for Shifnal; Church Stretton and Craven Arms are considered in separate reports.

Additional modelling work was commissioned by Shropshire Council in December 2012 with the aim of assessing the potential for using Priorslee Reservoir, in Telford, to further attenuate the pass forward flow into the Wesley Brook and thus manage flood risk to Shifnal through which the Wesley Brook flows.

The Shifnal SWMP has therefore been updated to take account of the findings of this additional work.

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 Shropshire Towns SWMP Framework in consultation with key local partners who are responsible for surface water management and drainage across Shropshire – including Severn Trent Water and the Environment Agency. The Partners have worked together to understand the causes and effects of surface water flooding and agree the most cost effective way of managing surface water flood risk for the long term.

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

1.3 Background

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

> 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 Planning Policy Statement 25 (PPS25) as a tool to manage surface water flood risk on a local basis by improving and optimising coordination between relevant stakeholders. SWMPs will build on 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[3] informed by the Integrated Urban Drainage (IUD) Pilot Studies carried out under the Government's Making Space for Water (MSfW)[4] strategy.

A SWMP outlines the preferred strategy for the management of surface water in a given location. The associated study is carried out in consultation with local partners having responsibility for the management of surface water and any associated drainage systems 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.

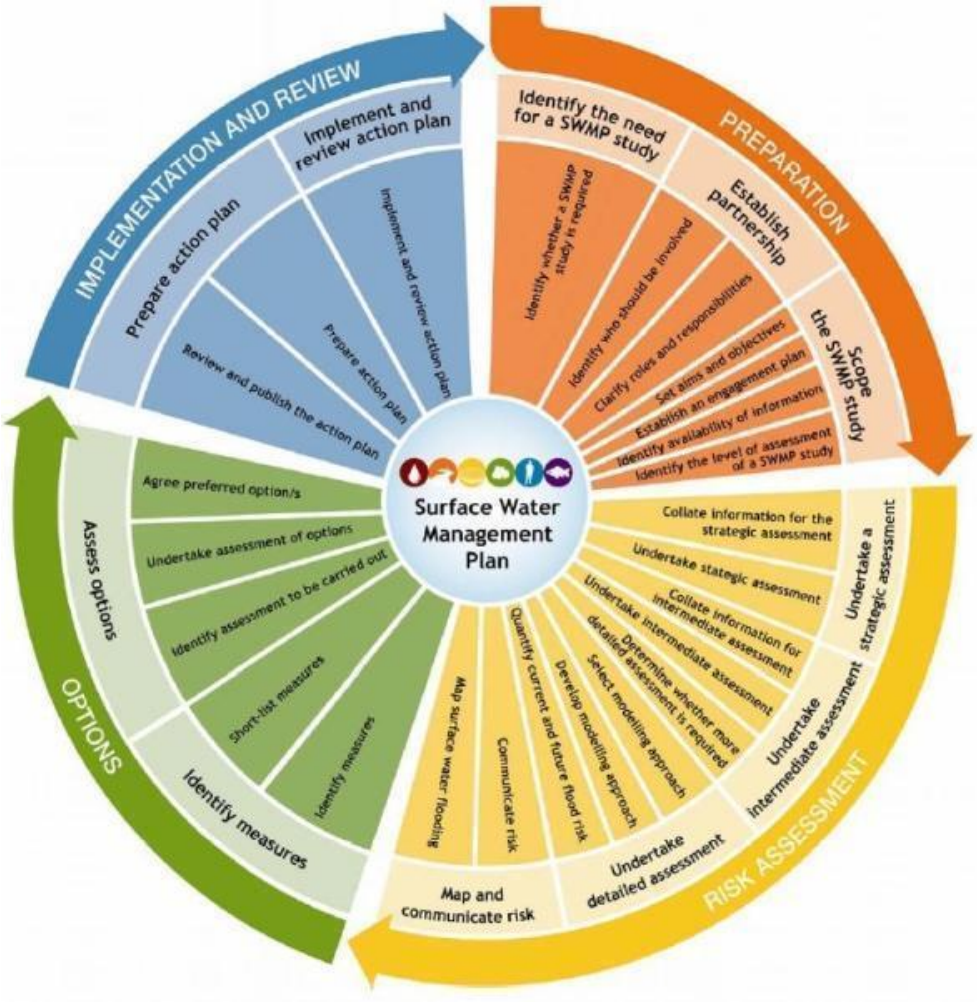


Figure 1-1 SWMP Wheel (Defra guidance[3])

The SWMP process is formed of four principal phases:

- Preparation; Chapter 2;
- risk assessment; Chapter 3;
- options; Chapter 4; and

- implementation and review; Chapter 5.

Green text boxes at the start of each chapter summarise the elements of the guidance addressed within the subsequent text.

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

Further works are required to help redress the issues resulting from the development across Shropshire Council 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

Planning Policy Statement 25 (PPS25) (Communities and Local Government, 2010) provides explanations on the different sources of flooding, and these explanations are provided below.

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 PPS25, Annex C)

1.4.2 Surface Water Flooding

In the context of SWMPs, the technical guidance[3] 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 open-channel and culverted watercourses which receive most of their flow from inside the 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 Shifnal 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 study area does include some flooding due to main rivers, although further investigation of these occurrences is outside the remit of this report.

1.5 Linkages with Other Plans

The increased focus on flood risk over recent years is an important element of adaptation to climate change. The clarification of the role of SC as the LLFA is welcomed. The work on developing a SWMP for Shifnal links to several existing documents:

1.5.1 Regional Flood Risk Appraisal (RFRA)[5]

This was produced by the West Midlands Regional Assembly in 2007[5] and updated in 2009[6], and gives a regional overview of flooding from all sources. The RFRA should be updated in 2012 to reflect the additional information on local sources of flood risk collated from CFMPs, PFRAs, SWMPs and IUD Studies in the intervening time. This may also generate new policies that would be incorporated into local planning when it is reviewed.

The initial RFRA provides thirteen recommendations. More specifically the regional policies that reflect similar recommendations considered as part of this SWMP in the context of the entire study area are detailed below.

- LPAs should be encouraged to collect and record data relating to flooding incidents in a common and consistent manner to enable more precise flood risk indicators to be developed across the region.
- Drainage strategies at regional and strategic level should focus on measures to avoid the risk of flooding and pollution resulting from major development, whilst incorporating wildlife habitat and amenity enhancements wherever possible.
- Drainage strategies at regional and strategic level should also take into account the likely effects of climate change on flood risk over the next hundred years.
- Drainage strategies at regional and strategic level should emphatically recommend that SUDS solutions should be seriously considered for all significant new developments.
- Consideration should be given to extending the coverage of the Environment Agency's 'Warnings Direct' flood warning scheme as urban development in the region proceeds.
- LPAs should be encouraged to develop Surface Water Management Plans (SWMPs) as Supplementary Planning Documents as recommended in PPS25. These should contain policy statements on managing flood risk and a local surface water management plan including :
    - Promoting the use of SUDS at a strategic level for the control of surface water runoff from urban development at source
    - Promoting the use of SUDS, where appropriate, for all major development
    - Providing on-site attenuation and treatment of surface water runoff from urban development and highways prior to discharge into watercourses
    - Using public open spaces to deliver multiple benefits such as the creation of flood storage areas and, where possible, providing facilities for environmental enhancement in the form of wetlands and ponds

- Protection of watercourse corridors, including the avoidance of culverting and encouraging the reopening of culverted watercourses.
- Considering, where feasible, the retrofitting of SUDS when large 'brownfield' sites are redeveloped.

The updated RFRA identified one further recommendation in relation to development in Flood Zones 1 and 2 showing to be at risk from surface water and identified a sequential approach to delivering safer development in these areas including site based layout alterations to reduce the level of risk experienced.

1.5.2 The River Severn Catchment Flood Management Plan (CFMP)

The River Severn Catchment Flood Management Plan was published in 2008 by the Environment Agency and sets out policies for the sustainable management of flood risk across the whole of the Severn catchment 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 Telford & Black Country is the policy sub area relating to Shifnal and it falls within the preferred policy unit of Policy Option 5. This is defined as 'take further action to reduce risk (now and/or in the future). The promoted actions for this Policy Option 5 are:

- Through the implementation of PPS25 and primarily SuDS in FRAs and SFRAs the problem of surface water flooding may be addressed.
- Review maintenance plans and identify new areas for trash screens to reduce blockages caused by large woody debris through the use of Strategic Asset Management Plans and Asset Management Plans.
- Maintain defences through the use of Strategic Asset Management Plans and Asset Management Plans.
- Apply the recommendations from the Integrated Urban Drainage project being undertaken for Telford and Wrekin as part of Defra's 'Making Space for Water project'. Close communication between the Environment Agency Development Control and Local Planning Authority.
- Maintain Flood Warnings and promote other emergency plans and flood plans.

Specific CFMP actions for the sub-area to help achieve the long term vision are:

- Better manage surface water through application of SuDS and through an integrated approach to flood risk management;
- To gain a more complete understanding of surface water and drainage related flooding so that any future improvements are part of a wider strategy for addressing these sources of flooding.
- To ensure that current maintenance operations are proportionate to risk and that they are the most suitable operations / activities for that location.
- Promote the uptake of resistant and resilient flood impact reduction measures.

- Promote sustainable drainage (SuDS) for new development and encourage retrofitting.
- Encourage land management practices that would deliver localised flood risk management benefits.

1.5.3 The Severn River Basin Management Plan (RBMP)

The Severn River Basin 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. 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.

Shropshire lies within the Shropshire Middle Severn Catchment Policy Unit, which is largely rural, however faces significant pressure for urban development. The Wesley Brook is identified as being of ‘Moderate’ status due to current biological elements, with the plan to improve matters to ‘Good Status’ by 2027 and lies within an area that is within an area that is designated under the Nitrate Directive.

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:

- initiatives to provide advice to farmers under the England Catchment Sensitive Farming Delivery Initiative, and;
- investigations to assess the impacts of abstraction on the environment under the Restoring Sustainable Abstraction programme.

1.5.4 Preliminary Flood Risk Assessment

The Preliminary Flood Risk Assessment (PFRA) for Shropshire was completed in May 2011. Shifnal was not identified as a significant flood risk area as defined in the final PFRA guidance. 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 1km²) within Shifnal. Two blue squares within the study area were identified by the Environment Agency. The PFRA then identified one additional blue square to the north of Shifnal.

1.5.5 Level 1 Strategic Flood Risk Assessments[7] for the Former Shropshire Districts / Boroughs

In 2007, Halcrow was commissioned to undertake the Level 1 Strategic Flood Risk Assessments (SFRAs) for each of the five former district and borough councils within Shropshire (Tier 2 local authorities) to help inform the Local Development Plan for the former Shropshire County Council. The study focused on the main market towns within the council area including Shifnal; the issues identified are expanded below

Shifnal, included in the former Bridgnorth District Council SFRA

The Wesley Brook flows through Shifnal; it rises to the west of Shifnal within the Telford and Wrekin Borough Council area and flows approximately 11 kilometres in a southerly direction before joining the River Worfe at Ryton. The River Worfe (catchment area 200km²) flows from north to south parallel with the River Severn through a predominantly rural landscape and meets the River Severn just north of Bridgnorth.

The SFRA identified concern with regards to flooding in Shifnal as "*Shifnal could be affected by flooding from the Telford and Wrekin area through any increased surface water discharges into Wesley Brook (a particularly flashy catchment)*". The SFRA also stated that, "*The Environment Agency advises that Surface Water drainage policies need to be in place to prevent this happening, and liaison with Telford and Wrekin Borough Council on this issue is advised.*"[8]

1.5.6 Shropshire Outline Water Cycle Study[8]

An outline Water Cycle Study (WCS) for Shropshire was completed by Halcrow in June 2010. In terms of fluvial flood risk, Shifnal was classified as 'amber' signalling that flood risk may be a constraint in some parts of the settlement. A key requirement of the WCS was to identify locations at greater risk of surface water flooding within the county to inform the development of a surface water policy for the county.

The Environment Agency AStSWF map (see Section 3.2.1 for further details) was used in conjunction with information from the Level 1 SFRA and the River Severn CFMP. County wide mapping was undertaken to identify the SuDS suitability in any given location. The key findings for Shifnal are summarised in Table 4-2.

Type	Flood Risk
Fluvial Flood Risk	Settlement affected by Flood Zones 2 and 3; Wesley Brook Flows through the centre and an unnamed watercourse flows on the south east boundary.
Surface Water Flood Risk	Shifnal was identified as a settlement with high susceptibility for surface water flooding; over 20% of the existing settlement shown to be affected by the AStSWF maps.
Surface Water Flood Risk	Shifnal has 0.2 historic incidents (ditch and drain blocked) per hectare which ranks it sixth for historic incidents in Shropshire.
Surface Water Runoff	Shifnal could be affected by flooding from the Telford and Wrekin area through increased discharges to Wesley Brook
SuDS Suitability	Infiltration more suitable, but must consider presence of SPZ2 to east of settlement.

Table 1-2 Findings from the Shropshire Water Cycle Study[8]

Overall, the WCS recommended that for Shifnal:

- Further assessment should be undertaken to determine the overall risk of flooding and to identify options for mitigating this risk, taking into consideration future development
- A SWMP should be produced which assesses existing surface water flood risk and strategically plans the provision of drainage for all new development
- SWMPs should focus on risk management and optimising the provision of strategic and sustainable surface water drainage infrastructure (SuDS). They should also take account of the risks of surface water and sewer flooding and the interactions with fluvial flooding.

Shropshire Council has also received communication from local residents highlighting their concerns about flooding in Shifnal. Shifnal is therefore taken forward from the strategic assessment phase through to the Detailed Assessment phases. Chapter 4 sets out this work.

1.5.7 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 boroughs, for example the 'Wetspot' areas. There may also be a need to review Area Action Plans where surface water flood risk is a particular issue. Any future updates to the SFRA will assist with this as will the reviewed RFRA.

1.5.8 Shifnal Place Plan

A Place Plan for Shifnal[9] has been developed by Shropshire Council in partnership with local communities, Shifnal Town Council and local infrastructure and service providers. The Place Plan summarises the infrastructure and investment requirements needed to deliver the community vision and aspirations for Shifnal. The following aspects which have the potential to impact on surface water flooding have been identified as community needs and priorities:

- Open space provision
- Litter and fly tipping

In addition, drainage and flooding was identified as being important to the community at the Shifnal Community Toolkit Event (February 2011). The Place Plan also sets out a local aspiration to maintain and enhance the green network within Shifnal.

1.5.9 Local Flood Risk Management Strategies

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

The 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.

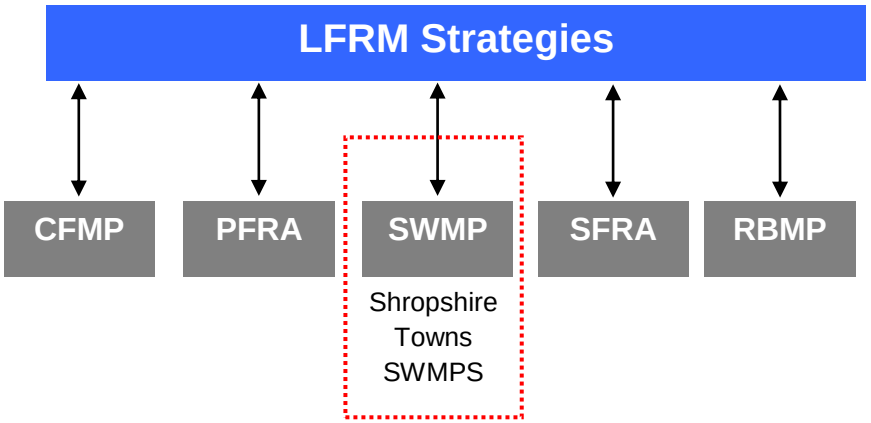


Figure 1-2 Supporting studies used to develop a Local Flood Risk Management Strategy

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[10].

The Regulations requires three main types of assessment / plan:

1 Preliminary Flood Risk Assessments (maps and reports for Sea, Main River and Reservoirs flooding) to be completed by Lead Local Flood Authorities and the Environment Agency by the 22 December 2011. Flood Risk Areas, at potentially significant risk of flooding, will also be identified. Maps and management plans will be developed on the basis of these flood risk areas.

2 Flood Hazard Maps and Flood Risk Maps. The Environment Agency and Lead Local Flood Authorities are required to produce Hazard and Risk maps for Sea, Main River and Reservoir flooding as well as 'other' relevant sources by 22 December 2013.

3 Flood Risk Management Plans. The Environment Agency and Lead Local Flood Authorities are required to produce Flood Risk Management Plans for Sea, Main River and Reservoir flooding as well as 'other' relevant sources by 22 December 2015.

The PFRA, now complete, confirms that Shifnal required further, more a detailed, local investigation. This is due to the number of people, businesses and items of critical infrastructure identified as being at risk of local flooding within the town. National datasets were used for the PFRA process.

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 FWMA presents a number of challenges for policy makers and the flood and coastal risk management authorities identified to co-ordinate and deliver local flood risk management (surface water, groundwater and flooding from ordinary water courses). 'Upper Tier' local authorities have been empowered to manage local flood risk through new responsibilities for flooding from surface and groundwater.

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 FWMA must also be considered in the context of the EU Floods Directive, which was transposed into law by the Flood Risk Regulations 2009 (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 Planning Policy Statement 25

Planning Policy Statement 25 (PPS25) requires that new development should not increase flood risk; a SWMP will support this by informing the Local Planning Authority (LPA) of areas at risk of surface water flooding and developing policy for new development.

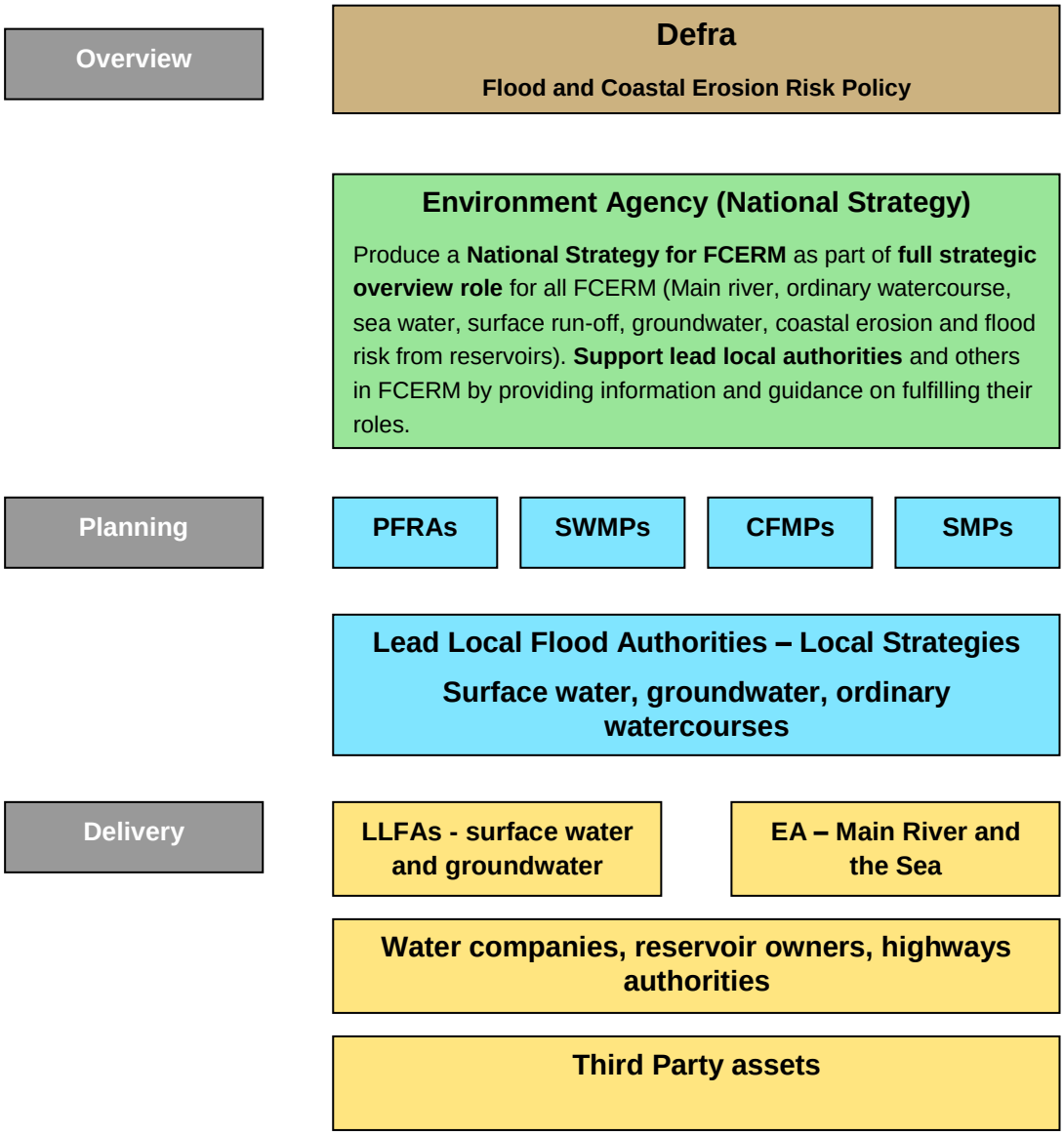


Figure 1-3 Local Flood Risk and Coastal Management Responsibilities

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 below.

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 1-3 describes some of the SuDS techniques that will be considered in the development of the SWMP

Figure 1-4 SuDS Management 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.
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 an alternative roof).
Infiltration Basin	A dry basin designed to promote infiltration of surface water to the ground.
Road Side Rain Gardens	Reversing historical trends in developing impermeable front gardens to develop green open areas to help attenuate flows at a property/street level and link habitats.
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, for use in the property, 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.
Swale	A shallow vegetated channel designed to conduct and retain water, but may also permit infiltration; the vegetation filters particulate matter

Table 1-3 SuDS Techniques (source Ciria[11])

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.

1.8 Geographic Extents

Define the geographic extent of the report and relate to the relevant river basin district and relevant maps

This SWMP has been undertaken for the town of Shifnal; the location of Shifnal in relation to the Shropshire Council boundary, Telford and Wrekin Council boundary and the other study areas is shown in Figure 1-5.

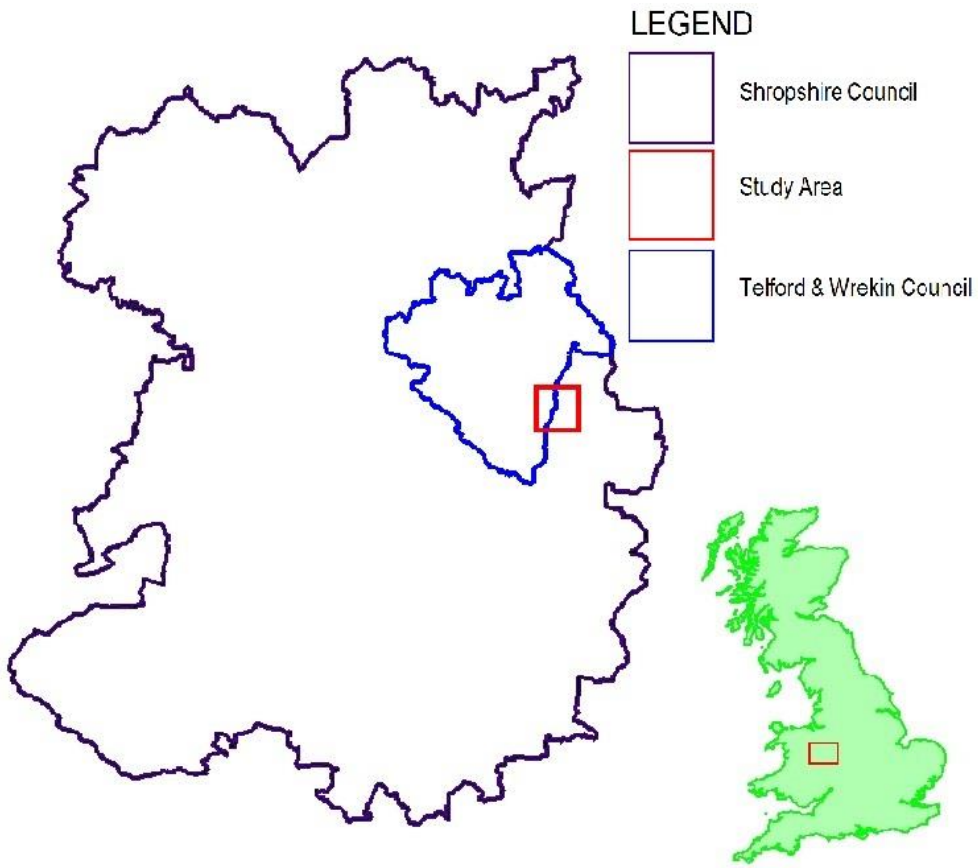


Figure 1-5 Shifnal SWMP Study Area

Shifnal is located within the Severn River Basin District and is served by one Water and Sewerage Company – Severn Trent Water. The study area is served by the Environment Agency Midlands West Region and is part of the Midlands Regional Flood and Coastal committee.

Shifnal is a small market town approximately three miles east of Telford, south of the M54 which straddles Shropshire Council and Telford and Wrekin Council areas. It is predominantly residential, with a small commercial centre, industrial area to the east and is surrounded by farmland. The Shifnal study area includes farmland to the north of the M54, and the eastern side of Telford.

The Wesley Brook, an Environment Agency classified main river, flows north to south through the centre of the town and then continues in a southerly direction until its confluence with the River Worfe near Ryton. The Shifnal study area is shown in Figure 1-6.

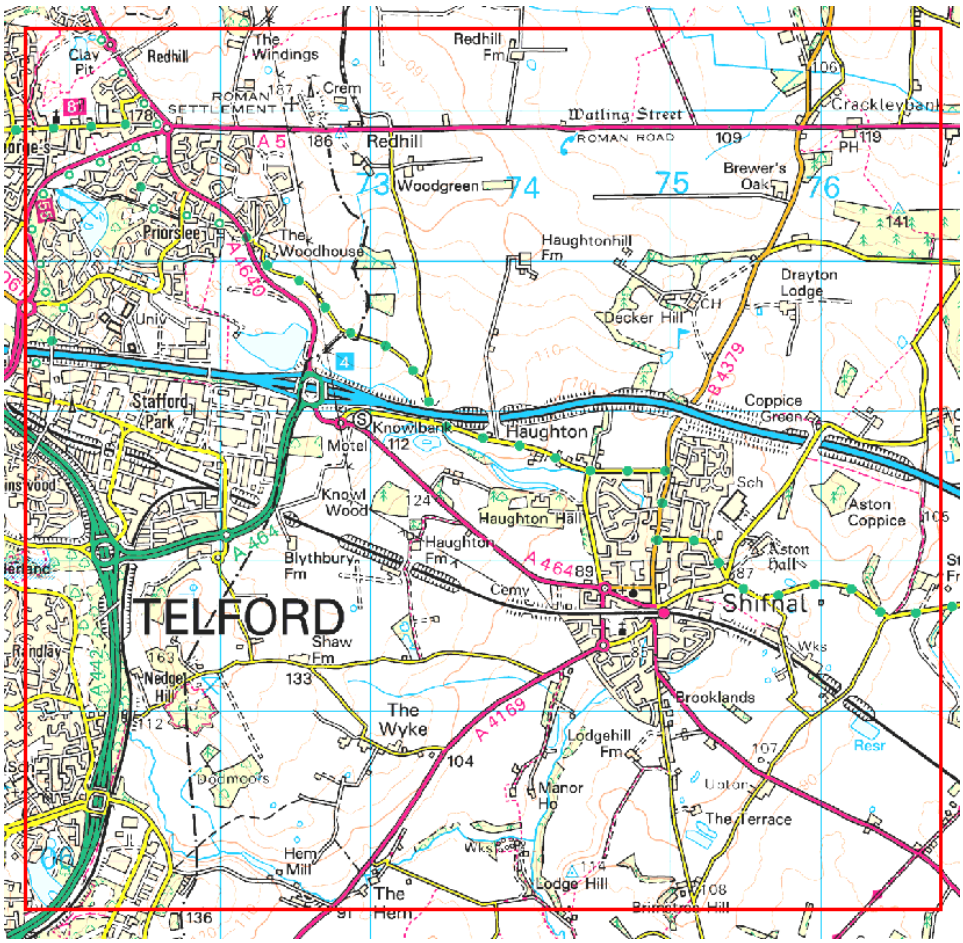


Figure 1-6 Shifnal Study Area (c) Crown copyright and database rights 2011 Ordnance Survey 100049049

1.9 Methodology

The methodology used to carry out this SWMP follows the advice set out in the Defra SWMP guidance3 as shown in Figure 1-7. Further details on the methodology are discussed throughout the report in the relevant sections.

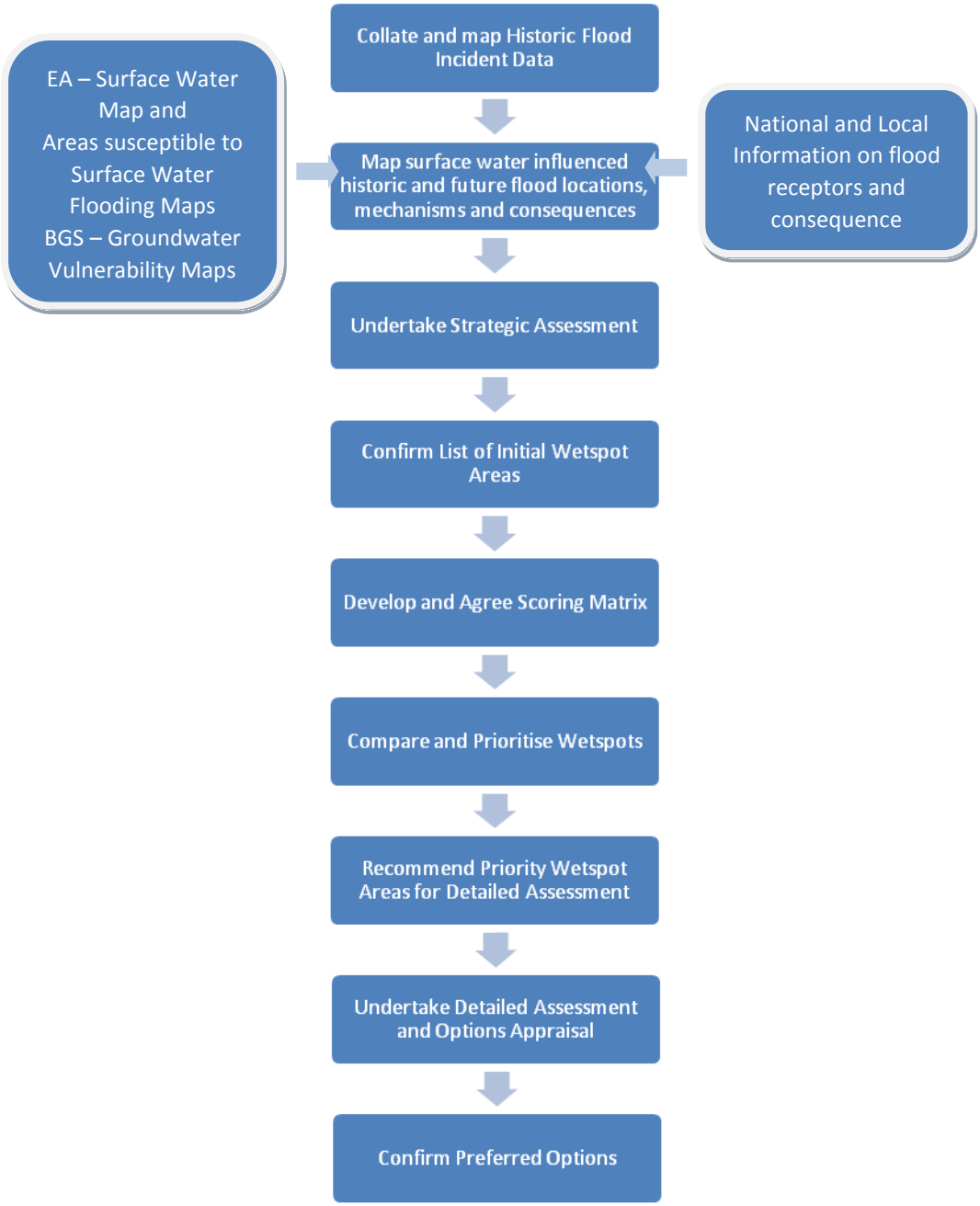


Figure 1-7 Overall Approach to Study Methodology

The specific methodology adapted for this study is further explained in Sections 2 to 5.

2 Phase 1 – Preparation

2.1 Need for SWMPs in Shropshire

Preparation Phase; Identify the need for a SWMP study

2.1.1 National Settlement Ranking

In 2009, Defra allocated £16 million of funding for Local Authorities to address flood risk. As part of the funding process, Defra ranked 4,350 settlements in England with regard to their susceptibility to surface water flooding. The data used for the assessment was based upon the first generation surface water flood maps (AStSWF) produced by the Environment Agency. The top 77 ranked settlements were each given a share of the funding. Shropshire Council did not receive any Defra funding and therefore made a decision to fund SWMPs internally.

The top ten settlements in Shropshire, out of a total of 41 listed within the county, are shown below; Shifnal is ranked third.

Country-wide Settlement Rank	Settlement Name	Estimated Properties at Risk
213	Shrewsbury	1600
383	Oswestry	820
457	Shifnal	660
577	Craven Arms	480
701	Wem	350
803	Ludlow	280
811	Church Stretton	270
1020	Bridgnorth	190
1198	Market Drayton	140
1201	Albrighton	140

Table 2-1 - Top ten settlements at risk from surface water flooding in Shropshire, based on the first generation AStSWF map (source Defra)

2.2 Partnerships

Preparation Phase; Establish partnership

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 and organisations that should be involved and what their roles and responsibilities should be. It recommends the formation of an engagement plan, which should include objectives for the individual partners, and detail how and at what stages of the SWMP the engagement with stakeholders should take place.

The following sections describe the partners, their roles and responsibilities and their objectives as required by the SWMP guidance.

2.2.1 Partners

Partners are defined as those with responsibility for decisions or actions regarding surface water management. In Shropshire, these are:

- Shropshire Council (SC)
- Severn Trent Water Limited (STWL)
- Welsh Water Dwr Cymru (WW)
- Environment Agency

2.2.2 Roles and Responsibilities

SC, as the Lead Local Flood Authority has a number of specific responsibilities:

- to lead and co-ordinate the delivery of the relevant Pitt Review recommendations;
- to ensure a consistent approach in the management of current and future flood risk issues in the borough;
- to fulfil any new duties arising from the FWMA when enacted; and
- to coordinate the delivery of actions arising from the EU Floods Directive and FRR.

In conjunction with these, SC and the other partner organisations have further responsibilities to share relevant information and co-operate to facilitate the management of flood risk.

STWL and WW are the water and sewerage undertaker for the Shropshire Council Area and has a statutory obligation to supply water and wastewater services to its customers. STWL currently has the responsibility to effectually drain the area and maintain the sewerage network within Shifnal.

The EA is a non-departmental public body and has responsibilities for protecting and enhancing the environment as a whole (air, land and water) and contributing to the government's aim of achieving sustainable development in England and Wales. Following the Pitt review of the 2007 Floods and the FWMA, the EA was given the strategic overview role for the management of all types of flooding, including the management of surface water.

2.2.3 Stakeholders

Stakeholders are defined as those affected by, or interested in, a problem or solution relating to surface water management. In Shropshire, it is anticipated at this stage that the following additional stakeholders are involved in, or will become involved in, the SWMP:

- Flood forums
- Residents
- Highways Agency
- Network Rail

As the SWMP develops, it is possible that other stakeholders will be identified and become involved; these organisations will be highlighted in future reports and outputs as required.

2.2.4 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 Flood Forums lead by SC.

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 SC 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.

2.3 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:

- Shropshire Council
- Environment Agency
- Highways Agency
- Natural England
- Severn Trent Water

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

Stakeholder	Information Provided	
	Publicly Available	Not Publicly Available
Shropshire Council	Former Bridgnorth District Council SFRA – Level 1 (2007); Shropshire Core Strategy Final Plan (2010), Shifnal & Surrounding Area Place Plan (2011/2012); Outline Water Cycle Study (2010)	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	River Severn Catchment Flood Management Plan, River Severn River Basin Management Plan	National Receptor Databases, historical and modelled flood event outlines, main rivers, detailed river network, modelled flood outlines for surface and fluvial sources, LiDAR
Highways Agency		Drawings of drainage assets (where available) for several main highways across the county
Natural England	SACs, SSSIs, SPAs, Ancient woodland, LNRs, NNRs, RAMSARs, woodland, agricultural land classifications	
Severn Trent Water		Sewerage networks, asset information, DG 5 Register

Table 2-2 Stakeholders contacted and the information provided

The documents and anecdotal evidence provided by SC provided the main source of information on local flood risk used within this SWMP. The two SFRAs and the WCS were completed within the last 5 years and have been reviewed and approved by SC and the Environment Agency. This suggested that these were reliable sources to use to establish the main local flood risk areas across Shifnal.

2.3.1 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

2.3.2 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 SC for use under the Shropshire Towns project, which includes the production of this SWMP. The restricted datasets include records of property flooding held by the Council and by Severn Trent Water, and data licensed by the Environment Agency.

Necessary precautions must be taken to ensure that, where it is permitted, 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.

2.4 Much Wenlock Integrated Urban Drainage Management Plan

Shropshire Council in conjunction with the Environment Agency and STWL, and supported by Much Wenlock Town Council and the Much Wenlock Flood Action Group, undertook a study into the flooding issues affecting Much Wenlock. The aim of the work was to provide a plan that will appropriately reflect the known flooding issues and suggest the most suitable ways to reduce their impact; the preferred options were then short listed. This work has resulted in the formation of working partnerships between stakeholders which can then be built upon.

2.5 Scope the SWMP

Preparation Phase; Scope the SWMP Study

2.5.1 Objectives

The objectives of the Shifnal SWMP overall are to:

- Develop a robust understanding of surface water flood risk in and around the study area, taking into account the challenges of climate change, population and demographic change and potential for increasing urbanisation in Shifnal;
- Identify, define and prioritise ‘wetspots' (areas considered to be at risk of flooding), including further definition of existing local flood risk zones and mapping new areas of potential flood risk;
- Establish and consolidate partnerships within Shropshire between key drainage stakeholders to facilitate a collaborative culture of data, skills, resource and learning sharing and exchange, and closer coordination to utilise cross boundary working opportunities;
- Make holistic and multifunctional recommendations for surface water management which improve emergency and land use planning, and enable better flood risk and drainage infrastructure investments in the study area;

- Undertake engagement with stakeholders to raise awareness of surface water flooding, identify flood risks and assets, and agree mitigation measures and actions; and
- Deliver outputs through a robust Action Plan and guidance that will help deliver change on the ground rather than just reports and models, whereby partners and stakeholders agree to commit to delivery and maintenance of the recommended measures and actions.

2.6 Phase 1 Summary

Phase 1 of the SWMP has:

- Engaged key stakeholders including the Environment Agency, Severn Trent Water, and Shropshire Council, to discuss and agree on local flood risk management within Shifnal in the future;
- As part of the first phase of Shropshire Towns SWMPs, a local flood risk partnership working approach across Shropshire 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 Shropshire Council, prior to the commissioning of this report, through the SFRA, WCS, national ranking from Defra and the likely level of future development. The SFRA and WCS reviewed available data and both highlighted the requirement to provide a SWMP for Shifnal. Further discussion on these is given in Section 1.6.

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 Shropshire 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 of assets that are considered to have a significant effect, remain current and thus useful, all partners should be assigned the responsibility for providing updates to their identified 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 SC 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 SC 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, SC 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

Shropshire Council maintains a list of all flooding incidents as reported by residents. The register lists the date reported and the incident address, along with a source of the flooding from one of the following categories:

- Ditch – blocked
- Drain – blocked
- Flood
- Water standing

Those designated as “flood” have been used in the identification of wetspots, as discussed further in Section 3.3. In addition, anecdotal evidence from the local flood forum is also maintained in digital format.

A similar principle to the asset database can be applied to the incident database although a web based system would facilitate the entering of event data at the time thus making it a highly useful repository for historical flood information.

3.2 Intermediate Assessment

Risk Assessment Phase; Undertake Intermediate Assessment

3.2.1 Surface Water Flooding

Introduce the Introduce the local sources of flood risk being considered for past floods and possible future floods.
Assess past floods which had significant harmful consequences for human health, economic activity, cultural heritage and the environment.

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 of 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 SC), Severn Trent Water and riparian owners.

Local Reports of Historical Flooding

The following sections outline the historical surface water flooding recorded in Shifnal within the context of the definition given in Section 1.5 of this report. 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 September 2010; the occurrence of surface water flooding is not static and thus this represents an understanding of the situation as of then. A data quality score was assigned in line with Table 3-1 of the SWMP guidance. In this case all data has been tagged as '2' which is data with known deficiencies, indicating that further work could be undertaken to improve the data set. Table 3-2 details the sources of historic flooding data.

Data	Source	Information Included	Data Quality Score
Historic Flooding Hotspots	EA, SC	Locations of flooding	2
Flood Forum Datasets	Data from SC Flood Forum meetings attended by Shifnal Town Council	Locations of flooding and interpretations of cause and effects	2
SFRA Shape files	EA, SC	All sources of flooding available at SFRA publication (including Historical Fluvial events)	2
DG5 Floods Database	Severn Trent Water Limited	Sewer Flooding (to 2010) – No events reported in three towns	2

Table 3-1 Summary of historic data set types received

Many urban areas in Shifnal also experience problems of surface water flooding. The sustainable management of surface water is therefore important through the use of SuDS. 51% of the Shifnal flood reports (provided by Shropshire Council) are classified as being as a result of blocked drains with 4% resulting from blocked ditches and 6% classed 'standing water'.

It must be noted that, due to the nature, type and quantity of this data, it cannot be deemed to be overly comprehensive and as such it is impossible to verify its accuracy. It is suggested that this information is used as a guide only to areas that have suffered flooding from all sources, not as a surrogate for historical information being an indicator of vulnerability to flooding

Environment Agency Areas Susceptible to Surface Water Flooding (AStSWF) Maps

The Environment Agency produced the outputs of a simple surface water flood modelling exercise 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
- 1km² 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.

Environment Agency Flood Map for Surface Water (FMfSW)

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 Map for Surface Water (FMfSW), which was released in October 2010. The existing map was updated to take account of buildings and the underground drainage system, and more storm events were analysed. 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
- 5m² resolution with country split into 5km squares
- Adjustment of 12mm/hr to take into account underground drainage network capacity
- 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 annual 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 the National Surface Water modelling undertaken (ASTSWF and FRMfSW) 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.

3.2.2 Fluvial Flooding

Main rivers are designated by Defra and are generally larger rivers and streams, along with some smaller watercourses that have local significance, and are the only watercourses that the EA can provide flood warning for. Responsibility for the maintenance of all watercourses ultimately lies with the owner of the land through which they pass.

Ordinary watercourses are all rivers, streams, ditches and drains that have not been designated as main rivers. Shropshire Council, as the Land Drainage Authority, is the managing authority for ordinary watercourses.

The Wesley Brook, a main river, runs through Shifnal and drains an area of approximately 40km^2. Many of the properties in Shifnal are constructed on the banks of the watercourse and numerous roads and footbridges also cross it. Between Priorslee Reservoir and the confluence with the River Worfe, there are approximately 28 bridges or culverts on the Wesley Brook; of these, 15 are in Shifnal.

Flooding is reported along a number of sections on the Wesley Brook, particularly where road and other bridge crossings cut the watercourse. This is notable at Shrewsbury Road, where flooding could potentially be attributed to two 90 degree bends in the brook immediately upstream of the bridge. Water from the brook has been known to flow directly across Shrewsbury Road, projecting a direct line across the two bends, through and around the commercial properties that are in the area.

Some residents of the properties with gardens that back onto Wesley Brook (notably Beech Drive) have been reported to constrict the line of the watercourse, through inappropriate developments in the past. This is likely to have increased flood risk to adjacent properties.

Flooding from the unnamed watercourse to the west of Silvermere has been reported by the Flood Forum at Park Lane, Dyas Close and Brooklands Avenue.

Flooding from the Wesley Brook has been recorded at Beech Drive, M54 services culvert, Haughton Road in 2007 (Figure 3-1) and the park on Church Street in 2007 (Figure 3-2).

Figure 3-1 Flooding at Haughton Road from Wesley Brook (Looking Upstream from the Junction with Haughton Lane)

Figure 3-2 Flooding in Church Street Park, Shifnal, 2007

3.2.3 Groundwater Flooding

Groundwater flooding occurs as a result of water rising up from an underlying aquifer or from water flowing from abnormal springs. This tends to occur after long periods of sustained heavy rainfall, and the areas at most risk are often low-lying where the water table is more likely to be at shallow depth. Groundwater flooding is known to occur in areas underlain by major aquifers, although increasingly it is also associated with more localised floodplain sands and gravels.

Groundwater flooding tends to occur sporadically in both location and time, and tends to last longer than fluvial, pluvial or sewer flooding. When groundwater flooding occurs, basements and tunnels can flood, buried services may be damaged, and storm sewers may become ineffective, exacerbating the risk of surface water flooding. Groundwater flooding can also lead to the inundation of farmland, roads, commercial, residential and amenity areas.

It is also important to consider the impact of groundwater level conditions on other types of flooding e.g. fluvial, pluvial and sewer. High groundwater level conditions may not lead to widespread groundwater flooding. However, they have the potential to exacerbate the risk of pluvial and fluvial flooding by reducing rainfall infiltration capacity, and to increase the risk of sewer flooding through sewer / groundwater interactions.

Groundwater may become elevated by a number of means: a) above average rainfall for a number of months in permeable outcrop areas; b) shorter period of above average rainfall in permeable superficial deposits, c) permeable superficial deposits in hydraulic continuity with high water levels in the river, d) Interruption of groundwater flow paths; and e) cessation of groundwater abstraction causing groundwater rebound.

The management of groundwater flooding is responsibility of the LLFA. There are no reported incidents of groundwater flooding in Shifnal.

BGS Groundwater Vulnerability 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 provided 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 were then 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' and '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 been used only in a limited capacity, however, it is expected that during future stages, these maps will be used more extensively to inform the optioneering process.

3.2.4 Sewer Flooding

Introduction

Sewer flooding can be caused by excess surface water, blockages collapses or plant failure.

For public sewers, sewerage undertakers, in this case STWL, are obliged under the Water Industry Act to provide, maintain and operate systems of public sewers and works for the purpose of effectually draining their area. There is no universal level of service associated with the sewer network. Table 3-2 details the three main sewer asset types in urban areas:

Asset Type	Description
Public foul sewer	Maintained and operated by STWL, these should carry only foul sewage but, through misconnections, often also carry surface water
Public surface water sewer	Maintained and operated by STWL. They should carry only surface water. Highway drains are often connected to public surface water sewers.
Public combined sewer	Public combined sewers are maintained and operated by STWL. They carry both foul sewage and surface water, and include the recent transfer of private sewers and lateral drains, that are connected to the public sewerage system, on the 1st October 2011[12]. Again, highway drains are often connected to public combined sewers

Table 3-2 Public Sewerage Systems

Since the publication of Sewers for Adoption in 1980, this document has become the standard for the design and construction of sewers to adoptable standards in England and Wales. Sewers for Adoption currently requires public surface water sewers to accommodate flows up to a 3.33% AEP (1 in 30 year chance) design storm.

It is highlighted however that this level of service will change if ever increasing area are connected to the sewers over time. The design standard also does not account for the capacity of connections such as gutters, gullies, highway drains and private drains which may limit the flow discharging to the sewer.

Severn Trent Water Data - DG5 Register

STWL maintains a register of confirmed internal and external sewer flooding locations due to hydraulic overloading. The Register only contains properties and areas at risk of internal and external flooding if they have suffered flooding from public sewers due to overloading of the system. A sewer is overloaded when the flow from a storm is unable to pass through it due to permanent problem (e.g. small pipe, flat gradient).

The Register does not include properties or areas flooded due to temporary operational problems e.g. blockage, siltation, collapse, equipment failure or operational failure. The Register does not contain properties or areas that have been subject to a flood alleviation scheme (to a satisfactory level of protection) or if new information reveals that the property or area does not meet the criteria to be on the register. STWL has provided its DG5 database for the study area.

As of February 2011, there were two entries on the DG5 register within the Shifnal SWMP Study area. Properties must be recorded on the DG5 register before a scheme to reduce risk is considered. STWL are required to undertake capacity improvements to alleviate some of the most severe sewer flooding problems on the DG5 register during the current 5 Year Asset Management Period (2010-15) with priority being given to more frequent internal flooding problems. There are no plans within the current AMP cycle to address the identified issues within Shifnal.

Severn Trent Water Data - Sewer Network Location

STWL also provided information on their drainage infrastructure including sewers, pumping stations and outfalls. This information has been overlain onto the OS mapping and flood mapping to help identify opportunities for collaboration to help reduce the risk across the area. Subject to their being sufficient cause, STWL is keen to work with Councils in order to manage flood risk and would assist in undertaking combined studies to help provide greater benefits from potential mitigation options.

The majority of Shifnal is served by separate foul and surface water sewerage systems

Sewer Flood Risk Summary

The risk of sewer flooding is perceived to be ***low*** across Shifnal, however future urban growth plans should be undertaken in consultation and agreement with STWL and in line with SC Guidance on surface water management for new developments.

The below ground drainage systems often rely on gravity assisted dendritic systems, which convey water in trunk sewers located at the lower end of the catchment. Failure of these trunk sewers would have serious consequences, which are often exacerbated by topography, as water from surcharged manholes will flow into low-lying urban areas.

3.2.5 Maintenance Regimes

Maintenance regimes are critical to ensuring the continued and effective functioning of assets to manage surface water flood risk. Existing maintenance tasks and 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.

Shropshire Council

SC, as the highway authority, has responsibility for non trunk road highways and associated structures throughout the council area, and operates programmes of inspection and maintenance for the following:

- Bridges
- Retaining walls and highway structures (including large culverts)
- Carriageway and footway gully cleaning

Severn Trent Water

The majority of regular maintenance is carried out on foul / combined sewers since surface water sewers do not convey as many solids in comparison, and so are less prone to blockages. STWL have historically received fewer reports of blockages on surface water sewers. Where there is demonstrable benefit in regular maintenance, in line with the current Business Plan, STWL will undertake this work, regardless whether it is storm or foul.

STWL carry out a range of pro-active CCTV, predictive modelling and cleansing activities, as well as reacting to reports of operational issues as part of the annual maintenance activities, further details of which can be obtained from STWL, if required.

Environment Agency

The Environment Agency can, and does, carry out strategic maintenance on designated main rivers. Details of the Environment Agency's maintenance programmes[13] for Shifnal are shown in Table 3-3.

Maintenance Type	Watercourses included in Programme
Critical Maintenance & Weed Cutting	Wesley Brook from the Head of the Main River at Priorslee Lake Overflow (Telford & Wrekin Borough Council) through Shifnal to Evelith Mill.
Access Improvements[14]	Wesley Brook – two planned interventions (adjacent to Haughton Road to north of town and to Stafford Avenue to south)

Table 3-3 Environment Agency Maintenance Programme

3.2.6 Wetspot Selection and Prioritisation

The assessment of the possible harmful consequences of future floods from local sources of flood risk

Approach

The strategic assessment identified Shifnal as a broad location susceptible to surface water flooding. The intermediate phase will now look in more detail at Shifnal to identify the higher risk areas within the town. This chapter describes the selection and prioritisation of areas; these are:

- Identification of potential wetspot areas within Shifnal using historical flooding incidences and / or future flood risk based on the FMfSW.
- Multi-Criteria Assessment (MCA) Methodology. This describes the MCA approach agreed with Shropshire Council.
- Prioritisation of wetspots within Shifnal using the MCA methodology.

The objective of the MCA assessment and prioritisation is the identification wetspots to be taken forward to the intermediate assessment stage. The overall workflow to establish the prioritisation is shown in Figure 2-3.

The first stage of the assessment was to identify those areas within Shifnal where flooding has occurred historically, and to digitise a wetspot polygon that encompassed all flooding in the nearby vicinity.

The next stage was to incorporate the Environment Agency's National Receptor Database (NRD) property points into the wetspots. All the property points falling within the 0.5% AEP (1 in 200 year annual chance of flooding) deep or shallow FMfSW zones were identified. If these locations were within an existing wetspot, then no further action was taken. Those property points outside a wetspot were analysed to identify if an existing wetspot could be expanded to incorporate them. Finally, for areas where more than 10 properties in an area fell within the deep or shallow FMfSW, new wetspots were created if not previously included in a wetspot.

Some of the identified wetspots either only had main river flooding incidents within them, or a significant proportion of the properties in the FMfSW zones are also within fluvial flood zones 2 and 3. These factors indicate main river dominance or a high level of interaction between the main river and other surface water systems.

3.2.7 Flood Receptor Identification

A flood receptor is anything in the built or natural environment that can be affected by flooding; for example properties, transportation links and environmental sites. The flood receptors in Shifnal have been identified using data sources from the Environment Agency, Shropshire Council and STWL. Once all flood receptors had been compiled, they were divided into six categories:

- Domestic Properties
- Critical Infrastructure
- Non-Domestic Properties
- Transportation
- Statutory Environmental Areas
- Cultural

Property point data was obtained from the Environment Agency; this National Receptor Database (NRD) contains information on all known properties and land features within the area and lists its usage, for instance dwelling, school, pond etc. This database was interrogated to identify critical infrastructure, domestic properties and non-domestic properties for use during the Multi-Criteria Analysis stage.

3.2.8 Domestic and Non Domestic Properties and Critical Infrastructure Identification

Critical Infrastructure

Items of critical infrastructure are those which experience a greater cost or have a greater impact on the community in the event of them being affected by flooding. This cost can be based on the number of people in a property, emergency services, utilities or the possibility of pollution. Those properties identified as critical infrastructure are listed below:

- Education Premises
- Hospital /Surgery / Health Centre / Residential Care Home
- Emergency Service – Fire / Police / Ambulance / Response Centre
- Water / Wastewater Treatment Works[1]
- Pumping Stations[1]
- Gas / Electrical Infrastructure – Refinery / Power Station / Sub-station
- Telecommunications Infrastructure
- Landfill Sites / Waste Licensed Sites / Radioactive Sites / Integrated Pollution Prevention and Control (IPPC)

Domestic Properties

All those properties classified as “dwelling” within the property point database were identified; these domestic properties were then divided into their property type (detached, semi-detached, terrace or flat) using the “house type” field provided in the property point database.

Non-Domestic Properties

Property points not previously classified as domestic or critical were then analysed to identify non-domestic properties. These include shops, hotels, factories and playing fields for example. It should be noted that the NRD property database also contains locations such as ponds, farming or post-boxes but these have not been included within the strategic assessment.

Transportation Infrastructure

Transportation information was taken from the NRD which defines roads as A Roads, B Roads, Local Streets, Minor Roads, Motorways and Private Roads.

Land and Public Open Space

Land and public open space information was obtained from Natural England. This data lists all statutory areas, such as Sites of Special Scientific Interest (SSSIs), Special Areas of Conservation (SACs) and city and county wildlife sites. A full list is shown below:

- Special Area of Conservation (SAC)
- Special Area of Protection (SPA)
- RAMSAR Site

[1] Note - STWL maintain a separate register of their assigned Critical Infrastructure to that identified within the National Datasets used for this study.

- Site of Special Scientific Interest (SSSI)
- County & City Wildlife Site
- County & City Nature Reserve
- RSPB Reserve
- Ancient Woodland, Fens & ESAs
- World Heritage Site
- English Heritage Site
- National Park
- County Park
- Parks and Gardens of Special Historical Interest
- Scheduled Ancient Monuments (SAMs)
- Agricultural Land Classes

Cultural Receptors

Listed buildings, conservation areas and Article 4 Definitions were obtained from the NRD.

3.2.9 Multi-Criteria Assessment (MCA) Methodology

Introduction

Multi Criteria Analysis is a scoring and weighting methodology by which the impact of flooding on a wide range of receptors can be evaluated. It is frequently used in conjunction with benefit cost analysis to prioritise and determine investment strategies to mitigate the risk of flooding. MCA allows for the comparison of severity of flooding between regions based upon the perceived value of buildings, infrastructure, commercial enterprise and services. The receptor types discussed above have been used within the MCA.

Multi-criteria can be adapted through the adjustment of weightings as required to reflect changing needs. This may be of particular concern where there are social, amenity or environmental factors considered to be important but where it is difficult to assign an economic value. For the Shifnal SWMP, MCA has been used as a high level decision making tool to compare and prioritise wetspots. The MCA calculations are based on a flood susceptibility weighting multiplied by a weighting for each receptor type. The general format of the formulae used for the Shifnal SWMP is:

MC Score = Number x Type Weighting x Flood Susceptibility Weighting

Type Weighting - Domestic Properties

The multi-criteria scoring system for domestic properties is:

MC Score = Number of Properties x Type Weighting x Social Class x Flood Susceptibility Weighting

The Type weighting has been set to 2.34 to reflect the average occupancy rates within properties across the United Kingdom. The MCA in this case reflects the number of people affected by flooding. In addition, a social class weighting can be applied to each domestic property although this has not been used in this case.

Type Weighting - Commercial Properties

MC Score = Number of Properties x Type Weighting x Flood Susceptibility Weighting

The property types and associated weightings are based upon the Multi-Coloured Manual (MCM) and include a range of commercial categories which are shown in Appendix B.

Type Weighting - Critical Infrastructure

MC Score = Number of Items of Critical Infrastructure x Type Weighting x Flood Susceptibility Weighting

The type weightings include a range of categories which are shown in Appendix C.

Type Weighting - Transport Infrastructure

The type weighting for the impacted roads has been based on their designation; the categories including weightings are shown in Appendix C.

It has been assumed that roads within the shallow zone only (depths up to 300mm) will remain passable to vehicular traffic; consequently these have been assigned a weighting equal to ¼ of the “deep” weighting. For example, an A-road within a deep zone will have a weighting of 400, but an A-road within the shallow zone will have a weighting of 100.

Type Weighting - Land and Public Open Space

The multi-criteria scoring system for Land and Public Open Space is:

MC Score = Area x Type Weighting x Flood Susceptibility Weighting

The type weightings include a range of categories which are given in Appendix C.

The score for land and public open space is based on the size of the area rather than the number of receptors within the wetspot.

Type Weighting - Cultural Receptors

MC Score = Number of Receptors x Type Weighting x Flood Susceptibility Weighting

Any building designated as a listed building is assigned a type weighting of 1.

3.2.10 Flood Susceptibility Weighting

The FMfSW was used to assign a surface water flood risk weighting score to each flood receptor described above. Any receptor falling within the 0.5% AEP (1 in 200 annual chance of flooding in any given year) shallow zone was assigned a susceptibility score of 1, while receptors in falling within the 0.5% AEP (1 in 200 annual chance of flooding in any given year) deep zone were assigned a susceptibility score of 2. Therefore, the higher the susceptibility score, the greater the risk of surface water flooding of that receptor.

3.2.11 Area Adjustment

The MCA score was divided by the area of the wetspot in order to provide an unbiased score.

3.2.12 Influence of Historic Incidents

In order to reflect the weight that historic events have on the prioritisation of wetspots, a rank score was assigned based on the number of flood incidents recorded in the wetspot. This was then used as a multiplier for the MCA rank to give an overall priority score.

3.2.13 Shifnal Wetspots

Using the process outlined above, a total of 13 wetspots were identified; nine due to historical flooding and a further four with a likely future flood risk based on the FMfSW. The wetspots are shown in Figure 3-3.

Figure 3-3 Wetspots identified in Shifnal

A MCA was then carried out to identify those wetspots with the highest score, and hence, highest vulnerability to surface water flooding. The results of the MCA for Shifnal are shown in Table 3-4.

Wetspot	No. Of Historical Reports	Area Weighted MCA Score	Final Priority Score
Church Meadow	3	73.3	120
Beech Drive	16	39.4	117
Shrewsbury Road	2	97.7	78
Brooklands Avenue	4	7.8	72
Silvermere Park	2	43.3	60
Haughton Road	3	7.1	50
Wesley Crescent	1	9.7	28
Broadway	2	7	24
Newfield Close	2	4	9
Admiral's Way	1	4.1	15
East Shifnal	-	53.5	11
Bluegate	-	24.9	8
Shifnal Schools	-	0.3	1

Table 3-4 Shifnal Wetspots MCA and Prioritisation Results

In agreement with Shropshire Council, eight wetspots were progressed for detailed assessment, as they had exceeded the identified MCA trigger value for the Shifnal study:

- Church Meadow
- Beech Drive
- Shrewsbury Road
- Brooklands Avenue
- Silvermere Park
- Haughton Road
- Wesley Crescent
- Broadway

These wetspots have been chosen for progression as they are the top scoring wetspots within Shifnal. These wetspots are also all located along the Wesley Brook and Silvermere watercourse corridors. Discussion of the river modelling undertaken as part of this SWMP is given in Section 3.3.

3.3 Detailed Assessment

Risk Assessment Phase; Undertake intermediate assessment, determine whether more detailed assessment is required

3.3.1 Wesley Brook Modelling

An ISIS model of the Wesley Brook from Priorslee Lake to Ryton (River Worfe confluence) was constructed by Black and Veatch in 2002 as part of the Environment Agency Section 105 Flood Risk Mapping Study.

Additional survey sections and spot checks were obtained in November / December 2010 and the resulting data used in the modelling study for the SWMP.

3.3.2 Model Review

An outline technical review of the S105 ISIS model was undertaken by Hyder as part of the SWMP study; the results are contained in Appendix D. It was found that, when replicating the original model parameters, the model ran to completion but exhibited non convergence for much of the simulation.

The calculations used by the modelling software to estimate water levels are iterative; as the number of iterations increases the solutions to the equations should become closer together until there is no change between them. Non convergence is observed when this does not happen and indicates potential issues within the model itself such as surcharged structures or sections of rapidly varying channel geometry. The nodes at which non convergence occurs are distributed throughout the model.

Following the model review, additional survey requirements were identified and commissioned.

3.3.3 Survey Data

The new survey data obtained by Hyder in November / December 2010 was found to match well with the existing river model therefore the additional sections obtained to improve the resolution of the model were suitable for use.

Additionally, LiDAR data was provided by the Environment Agency and used in the two dimensional component of the modelling.

3.3.4 Hydrological Assessment

Since the original hydrological assessment was undertaken there have been a number of updates to best practice methodology therefore an updated hydrological assessment was carried out.

For sub-catchment W1, the Priorslee inflow, consultation was undertaken with Severn Trent Water to find out if there had been any more recent studies completed since the S105 study. It was found that a hydraulic review of the reservoir had been undertaken in October 2010 but that the study did not include any work to generate updated inflows. Therefore given that significant work was carried out on the Priorslee catchment for the S105 model and that the catchment is very urban, the inflows were not altered.

For the remaining sub-catchments, FEH statistical flows were adopted and the hydrographs from the S105 study scaled to fit the new peaks. The revised flows are generally lower because the S105 model used the FSR/FEH rainfall runoff method.

Following site visits, some changes were made to the catchment boundaries to take into account the surface water sewer network. This resulted in a new inflow point being generated at Wheatfield Recreation Ground to input flows from north of the M54 and the Drayton Road estate. This flow was taken off the original inflow point at Dyas Close.

3.3.5 2011 Updated ISIS TUFLOW Model

Model Extents

The S105 model was truncated just downstream of the sewage treatment works. The model was linked to a TUFLOW two dimensional model from the M54 culvert outlet to the downstream boundary. The Silvermere tributary was added and the original Wesley Brook inflow point at Dyas Close (W4) moved to the upstream boundary of this tributary.

Model Boundaries

All inflows to the model were input as flow time boundaries. Figure 3-4 shows the input locations and Table 3-5 the peak flows in each case. The downstream boundary on the Wesley Brook was modelled as a normal depth boundary.

Inflow Point	Peak 100-Year Flows
W1 (Priorslee)	13.9 m^3/s
W2	4.6 m^3/s
W3	2.5 m^3/s
W4 (Silvermere)	1.0 m^3/s
W4a	0.8 m^3/s
W5	3.3 m^3/s
W6	5.4 m^3/s

Table 3-5 Wesley Brook ISIS TUFLOW Model 100-Year Inflows

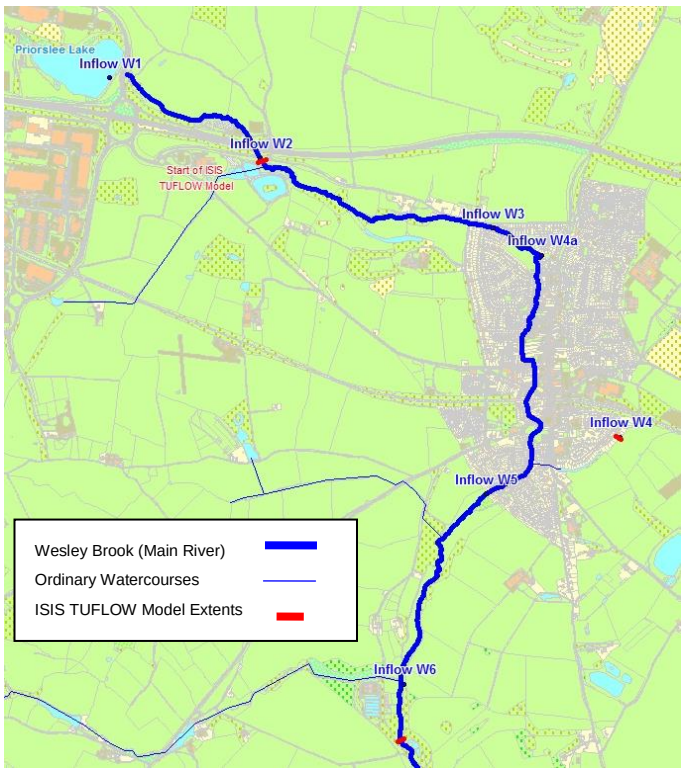


Figure 3-4 Model Schematic

The following events were assessed as part of the river modelling:

- 50% AEP (1 in 2 chance of occurring in any given year)
- 20% AEP (1 in 5 chance of occurring in any given year)
- 4% AEP (1 in 25 chance of occurring in any given year)
- 2% AEP (1 in 50 chance of occurring in any given year)
- 1% AEP (1 in 100 chance of occurring in any given year)

Model Structures

Following a review of the model, the following structures which had previously been omitted in the Section 105 model were added to the ISIS TUFLOW model:

- Haughton Farm Bridge (chainage 8189)
- Wheatfield Recreation Ground Bridge (chainage 7823)
- Woolpack Close Bridge (chainage 7750)

These were included in order that any increase in flood risks resulting from blockages could be assessed in future if required.

Model Verification

Severe flooding has occurred in Shifnal from the Wesley Brook; although no historic outlines are available, anecdotal evidence of flooding at Beech Drive, Haughton Lane, Brooklands Avenue and Silvermere Park was provided. Though no assessment of the rainfall event which generated flooding in these locations has been undertaken, the locations are within the modelled 1% AEP flood outline.

Model Results

Flood depth and hazard maps for the 1% AEP (1 in 100 annual chance) are given in Appendix B.

3.4 Flood Hazard Maps

Risk Assessment Phase; Map and Communicate Risk

Flood depth and flood hazard mapping has been produced for Shifnal based upon the ISIS TUFLOW model of the Wesley Brook.

Flood hazards are used in the assessment of flood risk and evacuation of the general public. Three categories of flood hazard have been identified in Flood Risk Assessment Guidance for New Development[15] (DEFRA Report FD2320) and Flood Risks to People Methodology[16] (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
v = velocity
d = depth
Df = 0.5 for d < 0.25m
Df = 1.0 for d > 0.25m

The mapping presented in the SWMP has been based upon the following thresholds, taken from DEFRA Report FD2320:

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

It is noted that DEFRA Report FD2321 places a different hazard rating at the transition to Category 3; the change occurs at 2.0 in FD2320 and 2.5 in FD2321. This will have a significant impact on the interpretation of the results for the SWMP as the results presented are conservative.

3.5 Priorslee Flood Alleviation Study (2013)

3.5.1 Aim

The overall aim of the Priorslee Flood Alleviation Study (FAS) was to undertake an assessment of the maximum allowable flow from Priorslee Reservoir which would remove all properties in Shifnal from Flood Zone 3. A full copy of the report is provided in Appendix E.

3.5.2 Hydrology

A detailed assessment of the sub-catchments draining to Priorslee Reservoir was carried out using the Severn Trent Water Limited (STWL) Coalport InfoWorks sewer model. The review found that, although there were some minor discrepancies along the catchment boundary, on

balance the additional areas identified as contributing to Priorslee were offset by the areas which had previously been included but which were found to drain out of the Priorslee catchment. Therefore, the SWMP hydrology was deemed suitable for use in the FAS.

The 1% AEP was chosen in order to inform an assessment of the properties within Flood Zone 3 as defined in the study objectives. The 5% AEP was chosen to inform an assessment of the properties at risk during a more frequent event. In addition, both events were assessed with an allowance of 20% for climate change.

3.5.3 Hydraulic Modelling

Model Review

A detailed review of the representation of Priorslee Reservoir in the SWMP model concluded that there were some discrepancies in both the area–elevation relationship defined in the ISIS reservoir unit used to represent Priorslee Reservoir, and in the stage–discharge relationship used to represent the spill weir and discharge culvert controlling outflows from the reservoir.

It was therefore concluded that both the reservoir and outlet structure should be included dynamically within a ***Revised Model*** in order to improve their representation and impact on controlling flows from Priorslee into the Wesley Brook.

Model Updates

Detailed survey data of the reservoir spillway and overflow culvert was used to explicitly model the spill weir, 50m long discharge culvert and stilling basin within the ***Revised Model***.

The reservoir was modelled using an initial water level (IWL) that is set such that the geometry above the initial water level is known. The initial water level was set as 122.55mAOD; this is the level of the spill weir and of the water level surveyed in January 2013.

3.5.4 Results

Comparison of the Revised Model with the SWMP Model

Dynamically modelling the flow out of Priorslee Reservoir reduces the 1% AEP peak flow predicted by the SWMP model through the M54 culvert by approximately 40%. The magnitude of this impact is reduced within Shifnal due to the contributions from intervening sub-catchments. However, there remains a 15% flow reduction in the ***Revised Model*** compared to the ***SWMP Model*** at the upstream end of Shifnal, resulting in an average reduction in flood level of 100-150mm along this reach. Although depths are reduced along the majority of the Wesley Brook, the resulting change in flood extents is minimal. The only significant changes in extent within Shifnal are between Victoria Road and Shrewsbury Road. Mapped flood extents are included with the full report in Appendix E.

Discussion on the option of using Priorslee Reservoir to attenuate pass forward flows into the Wesley Brook and thus alleviate flooding downstream in Shifnal is included in Section 4.2.7

4 Phase 3 – Options

4.1 Identify Measures

Options Phase; Identify Measures

4.1.1 Approach

The options that will be evaluated in this section are based upon employing the most appropriate techniques for the various sites. 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. The key constraints associated with the implementation of all of the options are space and cost.

The street environment is also a constraint in terms of installing and improving drainage infrastructure. Within these areas techniques including permeable paving, filter drains, and road side rain gardens may be suitable; these methods are discussed further in the following sections.

Section 4.2 gives a brief introduction to the range of measures reviewed as part of this SWMP for Shifnal. Section 4.3 then discusses the applicability of these measures to resolving the known issues in Shifnal, in particular, the identified wetspots. Section 4.4 takes these measures and develops them into specific options. These are then assessed from Section 4.4 onwards.

4.1.2 Potential Mitigation Measures

The following sections discuss the potential measures that could be implemented in Shifnal in order to mitigate surface water flooding.

Improved Maintenance

This measure requires the maintenance of the existing systems to a better standard to help ensure that any blockages as a result of excess vegetation or deposition will not reduce the hydraulic capacity of the existing drainage infrastructure. This will apply to watercourses, highway gullies and surface water networks.

Maintenance works include regular inspections of assets, cutting, mowing, pruning, jetting and clearance of debris, gravel and siltation where required. The objective of these works would be to reduce the amount of debris available to block, constrain or otherwise impair the assets.

Improved maintenance also assumes the enforcement of any notices served under the Land Drainage Act[17]. The advantages and disadvantages of improving the maintenance regime are given in Table 4-1.

Measure	Advantage	Disadvantage
Improved Maintenance	Clearance of drains to remove water at the design capacity. Regular/effective maintenance and record keeping could help to support flood defence funding decisions. Regular maintenance is more likely to result in local pride and ownership whereby communities want to look after their assets	Increased inspection frequency and maintenance tasks will have increased cost and time implications

Table 4-1 Improved Maintenance Advantages and Disadvantages

Sustainable Drainage Systems (SuDS)

Attenuation Basins

An attenuation basin is a large area of ground laid to grass. They are dry for the majority of the time and fill up with water during periods of heavy rainfall which is then released slowly. Permanent ponds may be incorporated towards inlets and outlets for visual amenity and settlement of silts. They can also act as offline storage structures when positioned alongside existing watercourses, which fill when river levels are high. This can help to alleviate pressure on the drainage network elsewhere in the catchment.

Swales

Swales are landscape elements designed to remove silt and pollution from surface runoff water. They consist of a drainage channel with gently sloped sides and filled with vegetation. The flow path along the wide and shallow ditch is designed to maximize the time water spends in the swale, which aids the trapping of pollutants and silt. A common application is around car parks or alongside roads, where substantial automotive pollution is collected by the paving and then flushed by rain. The swale treats the runoff before releasing it to the watershed or storm sewer.

Infiltration Basin

An infiltration basin is used to manage surface water runoff, prevent flooding and downstream erosion, and improve water quality in an adjacent river, stream or lake. It is essentially a shallow artificial pond that is designed to infiltrate surface water though permeable soils into the groundwater aquifer. Infiltration basins do not discharge to a receiving water body under most storm conditions, but can be designed with overflow structures (pipes, weirs, etc.) that operate during flood conditions.

Permeable Paving

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

Road Side Rain Gardens

A road side rain garden system creates 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.

Advantages and Disadvantages

The advantages and disadvantages of the above SuDS measures are summarised in Table 4-2.

Measure	Advantages	Disadvantages
Attenuation Basins	Attenuation of storage of flood water Manage the rate of runoff and reduce flooding caused by urbanisation. Encourage natural groundwater recharge	Potential health and safety implications of adding flood storage areas in and around urban areas and the need for warning requirements.
Swales	Decrease conveyance of overland flow of flood water toward an area with historical flooding. Manage the rate of runoff and reduce flooding caused by urbanisation. Encourage natural groundwater recharge	Temporary closure of the areas during construction. Swales to route flow in to structures will need regular maintenance.
Infiltration Basin	A decreased conveyance of overland flow of flood water toward an area with historical records of flooding. Manage the rate of runoff and reduce flooding. Encourage natural groundwater recharge	Temporary closure during construction. Usage dependent on underlying ground conditions / soil type Swales to route flow in to structures will need regular maintenance.
Permeable Paving	Permeable paving surfaces have been demonstrated as effective in managing and reducing runoff from paved surfaces. Management of potential flooding at the source, 'upstream' of any high risk areas. Sustainable alternative to creating a larger capacity sewer network. Encourage natural groundwater recharge. Water treatment by pollutant removal. Reduces net volume required in sewer system	Construction within the road will lead to temporary road closures. High associated construction cost Can only be constructed on highways with low traffic volumes where speed restrictions not exceeding 30mph are present. Annual inspection of permeable pavement will be required.
Roadside Rain Garden	Road side rain gardens have been demonstrated as effective in managing and reducing runoff conveyed by highway surfaces. Sustainable alternative to creating a larger capacity sewer network. Encourage natural groundwater recharge. Reduces net volume entering sewer system. Contribution to aesthetic appeal and habitat in urbanised areas. Flexible for use in areas of various shapes / sizes.	Regular maintenance of vegetation, such as weeding, soil replacement and watering during dry periods. Inspection following large rainfall events. This includes clearing of the access channel from the road to the soil. Periodic replacement of planting is required.

Table 4-2 Advantages and Disadvantages of SuDS Measures

4.1.3 Sub-Surface Drainage Network Improvements

Drainage network improvements could involve increasing highway gully entry capacity and storage, upsizing highway drains / public sewers / culverts, construction of off or on-line storage tanks, for example. Their advantages and disadvantages are listed in Table 4-3.

Measure	Advantage	Disadvantage
Improve sub surface drainage network	Storage tanks control volume/rate of surface water entry into network. Reduce surcharge risk of system. Increase capacity	Temporary closure of the roads during construction causing disruption. Network improvements are generally expensive to carry out. Below ground constructions more costly in comparison with above ground works. Problems tend to be passed downstream

Table 4-3 Advantages / Disadvantages of sub-surface network drainage improvements

4.1.4 Property Level Protection

Property level protection incorporates resistance and resilience measures. Examples of resistance measures at a property level include flood boards for property access points, air brick covers, threshold raising and building 'skirt' systems. Property level resilience measures include replacing timber floors with waterproofed concrete, raising electricity points, replacing gypsum plaster with lime plaster and the use of metal and plastic fittings rather than chipboard or similar. The advantages and disadvantages of these systems are shown in Table 4-4.

Measure	Advantage	Disadvantage
Property Level Resistance	Will keep water wholly out of a property up to a given depth Directly protects property therefore benefits are simple to determine	Can be expensive, especially for prolonged flooding. Can be complicated to fund and assign responsibility
Property Level Resilience	Damage to the property is limited and residents remain out of their properties for less time	Measures can be more expensive than like for like non flood resilient products

Table 4-4 Advantages / Disadvantages of Property Level Protection

4.1.5 Watercourse and Culvert Improvements

Watercourse improvements can involve bank raising, building of walls and increasing channel size, etc. Associated with watercourse improvements is the replacement of inadequate culverts. Their advantages and disadvantages are listed in Table 4-5.

Measure	Advantage	Disadvantage
Watercourse/ Culvert Improvements	Increases conveyance.	Can be expensive to carry out. Problems passed downstream

Table 4-5 Advantages / Disadvantages of Watercourse and Culvert Improvements

4.1.6 Planning Policy and Development Control

Planning policies can be used to set out a framework for best practice and also where work has shown that deviation from national guidance would be appropriate. Further detail and recommendations are set out in Chapter 4.7.

Interim Guidance for Developers

Shropshire Council has produced a guidance document for developers which sets out the council's requirements for surface water management. Consultation on this document was closed in March 2011. It is the aspiration that this document will eventually be replaced by the proposed Sustainable Water Management SPD. Further discussion is given in Chapter 4.7.

Supplementary Planning Documents (SPD)

Supplementary planning documents provide guidance on local planning matters. As they are not required to be listed in the Local Development Scheme, they can be brought forward as circumstances change. An SPD is subject to a process of consultation and engagement with relevant parties. They will take the form of:

- Masterplans
- Development briefs
- Issue based documents (provides additional information on a specific theme)
- Design Guides

Development Management Polices

Development Management Policies set out local authority detailed policies for managing development in the unitary area and support the core strategy.

Development Control

The role of development control is important in ensuring that planning regulations are followed correctly. For example, in certain circumstances, the paving over of areas greater than 5m² without planning consent is not permitted.

4.1.7 Campaigns and Communication

Raising awareness of surface water flooding and efficient communication of the associated risks and responsibilities is an important element in managing surface water flood risk. Further detail and recommendations are set out in Chapter 4.7.

4.1.8 Measures Review

Table 4-6 sets out the applicability of the measures listed above for specific use within Shifnal wetspots.

Measure	Applicability in Shifnal	Suitable Wetspots
Improved Maintenance	Wesley Brook and Silvermere Railway culvert behind Mead Way	All
Attenuation Basins	Parks and public open space within Shifnal could be used to provide attenuation	Haughton Road Beech Drive Broadway Shrewsbury Road Church Meadow Wesley Crescent
Swales	Green space in local parks Green margins besides roads	All apart from Admirals Way and Newfield Close which have limited green space within them.
Infiltration Basin	Parks and public open space within Shifnal Shifnal is underlain by Permian and Triassic sandstone overlain by glacial till and sand. This indicates a high permeability and therefore suitability for infiltration. However, much of Shifnal is underlain by a major aquifer therefore due care must be given to maintaining water quality.	Haughton Road Beech Drive Broadway Shrewsbury Road Church Meadow Wesley Crescent
Permeable Paving	Shifnal is underlain by Permian and Triassic sandstone overlain by glacial till and sand. This indicates a high permeability and therefore suitability for infiltration. However, much of Shifnal is underlain by a major aquifer therefore due care must be given to maintaining water quality.	All
Roadside Rain Garden	Many roads in Shifnal have existing green space between the carriageway and property curtilages.	Majority, at least partially.
Improve Drainage Network	Requirement for further information on these potential assets and their current capacity/performance	All

Table 4-6 Applicability of Measures in Shifnal

4.2 Assess Options

Options Phase; Assess Options

This section of the report considers the options available for the mitigation of surface water flooding in the Shifnal wetspots.

4.2.1 Priority Wetspots – Capital Works

Table 4-7 gives a description of the capital options identified. The nature, feasibility and benefits associated with each of the options are discussed in Section 4.6.

Option Reference	Option Name	Wetspot	Description	Justification
CS-1	Improve Maintenance	All	Implement effective maintenance regime for all existing watercourse and culvert systems. Maintenance would include regular inspection, cutting / mowing / vegetation and clearance of debris as required.	This will reduce the potential for blockages by vegetation or deposition which will consequently reduce the hydraulic capacity of flow routes.
CS-2	Wheatfield Attenuation Basin	Beech Drive, Shrewsbury Road, Church Meadow, Wesley Crescent	Construct attenuation basin in Wheatfield Recreation ground to store excess flows from the Wesley Brook.	This will reduce the flow entering Shifnal during higher rainfall events. There is existing green space available in the recreation ground.
CS-3	Broadway Attenuation Basin	Broadway, Shrewsbury Road, Church Meadow, Wesley Crescent	Construct attenuation basin in open space behind flats on corner of Broadway / Shrewsbury Road to store excess flows from the Wesley Brook.	This will reduce the flow passing through southern Shifnal during higher rainfall events. There is existing green space available.
CS-4	Haughton Bridge Attenuation Basin	Haughton Road, Beech Drive, Shrewsbury Road, Church Meadow, Wesley Crescent	Construct attenuation basin adjacent to Wesley Brook in green area upstream of Haughton Bridge	This will reduce the flow entering Shifnal during higher rainfall events. There is existing green space available within the river corridor.
CS-5	Wesley Brook Channel Modifications	Beech Drive, Broadway, Shrewsbury Road, Church Meadow, Wesley Crescent, Brooklands Avenue	Make main Wesley Brook channel more uniform from Wheatfield Drive to Stafford Avenue	This will help to maintain constant conveyance along the Wesley Brook and thus reduce risks of localised blockages as well as helping to reduce water levels in the brook. Need for assessment of downstream impacts / additional works.
CS-6	Silvermere Culverting	Silvermere Park, Brooklands Avenue	Culvert the entire length of the Silvermere tributary	This may prevent open channel flooding to houses downstream by moving the flooding upstream into rural areas. The need for additional upstream storage should be assessed. Note that this is against EA policy.

Option Reference	Option Name	Wetspot	Description	Justification
CS-7	Upstream Surface Water Attenuation	East Shifnal	Add structure or alter road topography at Newport Road / Haughton Road junction. Construct attenuation basin in adjacent fields.	This will direct surface water flows off the road into an attenuation basin and thus reduce the flow through Shifnal.
CS-8	Property level protection	Haughton Road, Beech Drive, Church Meadow	Add property level resilience and resistance measures to individual properties that have previously flooded.	Economic justification for measures where properties have been flooded previously.
CS-9	Priorslee Reservoir Attenuation	Beech Drive, Broadway, Shrewsbury Road, Church Meadow, Wesley Crescent, Brooklands Avenue	Alter the outlet works at Priorslee Reservoir in order to provide additional attenuation within the reservoir	This has the potential to reduce pass forward flows into the Wesley Brook thus reducing the flow through Shifnal.

Table 4-7 Shifnal Wetspot Options

4.2.2 Non Priority Wetspots

For the wetspots which were not selected as top priority, the wider principles and non capital options set out in Section 4.7 should be followed.

4.2.3 Assessment of Capital Options

Methodology - Modelled Options

In order to assess the technical viability of the channel widening and Silvermere culverting, the ISIS TUFLOW model of the Wesley Brook was altered accordingly. A technical options modelling report is included in Appendix C.

4.2.4 Non-Modelled Options

A numerical assessment was made to estimate the volume of upstream attenuation required to achieve no out of bank flooding and no property flooding.

Option CS-1 Improved maintenance has not been modelled explicitly as to do this would require additional details on the extent and condition of the drainage network, and also the condition of the watercourses in order to assess the benefits in quantifiable terms. A qualitative assessment of the benefits is given in Section 4.6.1.

Option CS-7 has also not been modelled specifically as part of this study, as it is felt that the presence of the open watercourse from north of the M54 through north-east Shifnal and connecting to the Wesley Brook, offers protection to the area shown to be susceptible to surface water flooding. Undertaking detailed pluvial modelling was decided against for the Shifnal SWMP due to the low numbers of surface water specific flooding reports and the presence of

two National mapping studies of this nature (ASTSWF and FMfSW). However, a qualitative assessment of the benefits is given in Section 4.6.5.

Modelling of property level protection is also beyond the scope of this study, and a qualitative assessment has been made and is presented in Section 4.6.6.

4.2.5 Environmental Assessment

At this stage, an assessment of the impacts of each option on the environmental, amenity and cultural receptors has not been undertaken. As part of a pre-feasibility study, a review of the potential impacts, positive and negative, on these receptors must be carried out.

4.2.6 Economic Assessment

In order to justify and present a business case for a proposed scheme, an economic assessment is required. In line with the latest Defra guidance[18] funding levels for a given scheme will relate directly to the number of households protected, level of damage prevented and the other benefits afforded by the scheme.

In a change from previous protocol, grants for surface water management and property level protection schemes will also be available. Where full funding for a scheme is not available, this new approach clarifies how much additional funding need be sourced or by how much the project costs need to be reduced. This contributes to meeting the recommendation from the Pitt Review which states that 'government should allow and encourage communities to invest in measures to protect them, so that more can be done whilst giving communities a bigger say'.

Further work will be required to undertake this economic assessment which will determine the costs and benefits associated with each proposed option.

Costs

The costs of providing the options have been estimated from industry standard pricing methods and are for indicative purposes only to be compared with the potential benefits derived. The costs are a guide as to the potential capital costs for implementation of the scheme only. As a result, costs have been provided as cost bands, reflecting the strategic nature of the SWMP study and options identification:

- Costs do not include provisions for consultancy, design, supervision, planning process, permits, environmental assessment or optimum bias.
- No provision is made for weather (e.g. winter working).
- No provision is made for access constraints
- Where required, it will be stated if costs include approximate land acquisition components.
- No operational or maintenance costs are included.
- No provision is made for disposal of materials (e.g. for flood storage or soakaway clearance).

Benefits

The benefits for any option has been derived by using the strategy level project appraisal method of calculation property damages in the DEFRA multicoloured manual.

4.2.7 Results

Detailed results for modelled options are presented in Appendix D2.

CS1 Improved Maintenance

Following consultation and a site visit, the railway culvert behind the junction of Silvermere Park and Mead Way was identified as a key location where improved maintenance would be beneficial (Figure 4-1). At the time of the site visit, this culvert was blocked with debris. However the FMfSW indicates that this would act as a flow route and consequently by clearing this culvert, some reduction in flood extents would be likely to be experienced upstream.

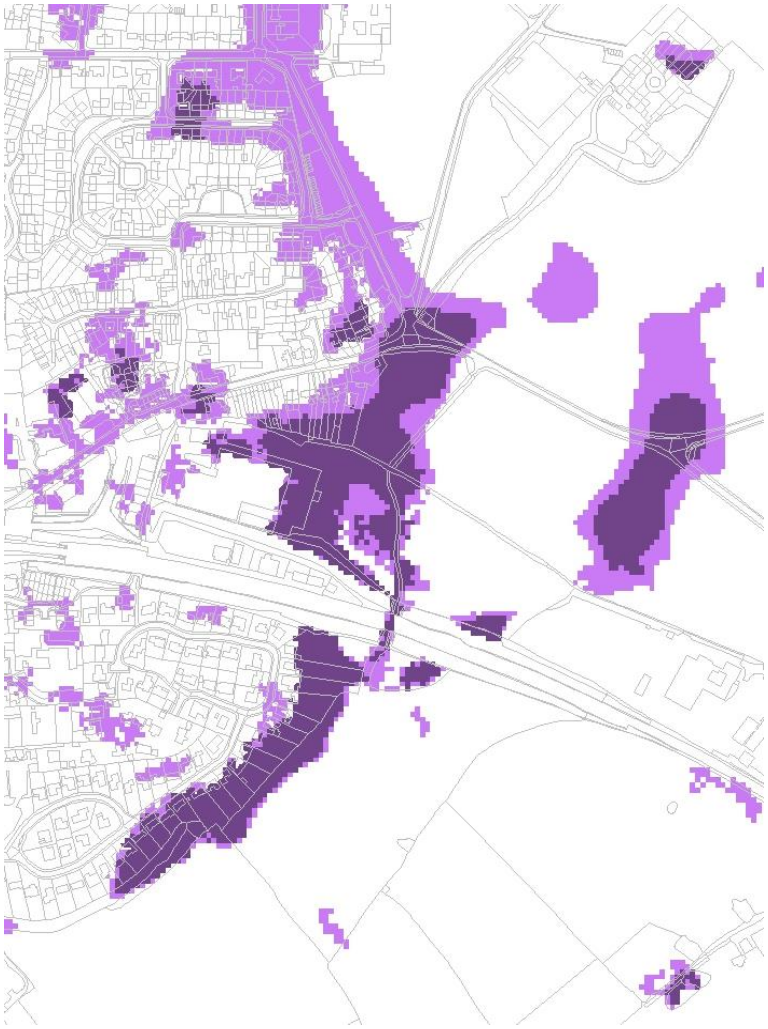


Figure 4-1 Railway culvert behind Mead Way (shown with 0.5% AEP FMfSW)

CS2, CS3, and CS4 Attenuation Basins

The potential volumes required for the attenuation options are given in Table 4-8. The figures given are the total volumes required and are not assigned specifically to CS2, CS3 or CS4. These volumes are such that any individual scheme would be classified as a large raised reservoir under the Flood and Water Management Act (over 10,000m³). This element of the Flood and Water Management Act is yet to be enacted; currently the Reservoirs Act 1975 regulates reservoirs holding more than 25,000m³ of water above ground level. It is therefore considered that the safety, spatial and cost implications of providing this storage are not commensurate with the reduction of flood risk in Shifnal.

Event	No Out of Bank Flooding	No Property Flooding
1% AEP	144,000	117,500
20% AEP	77,000	50,500
50% AEP	26,500	N/A

Table 4-8 Total Attenuation Volumes required helping reduce the flooding risks along the Wesley Brook. The volumes could be provided in either CS2, CS3 or CS4 (approximate to nearest 500m³)

CS5 Wesley Brook Channel Modifications

This option demonstrated that reductions in flood depth through Shifnal could be achieved. Drawings 0125 in Appendix B shows the potential reduction in depths on the floodplain, as a result of widening the channel, for each event.

Model results demonstrate that by widening the channel base and thus improving the conveyance of the Wesley Brook through Shifnal, predicted flood depths are reduced. Notable improvements are observed on the left bank near Brook Drive and at Shrewsbury Road and Victoria Road. The long sections and maps demonstrate that the proposed widening does not increase flood risk to third parties upstream or downstream of the works.

CS6 Silvermere Culverting

Results from modelling the final Silvermere reach before the Wesley Brook confluence as a culvert rather than open channel did not reduce flood risk in the local area. Furthermore, flood risk upstream of the culvert under Park Street was increased. It is therefore not recommended that this option is pursued.

CS7 Upstream Surface Water Attenuation

Figure 4-2 illustrates the potential surface water flow path from the north into Shifnal and a possible location for an attenuation basin to hold these flows. In conjunction with the attenuation basin, some localised topographic work on Newport Road would be required to alter the flow path from its natural path to the south east.

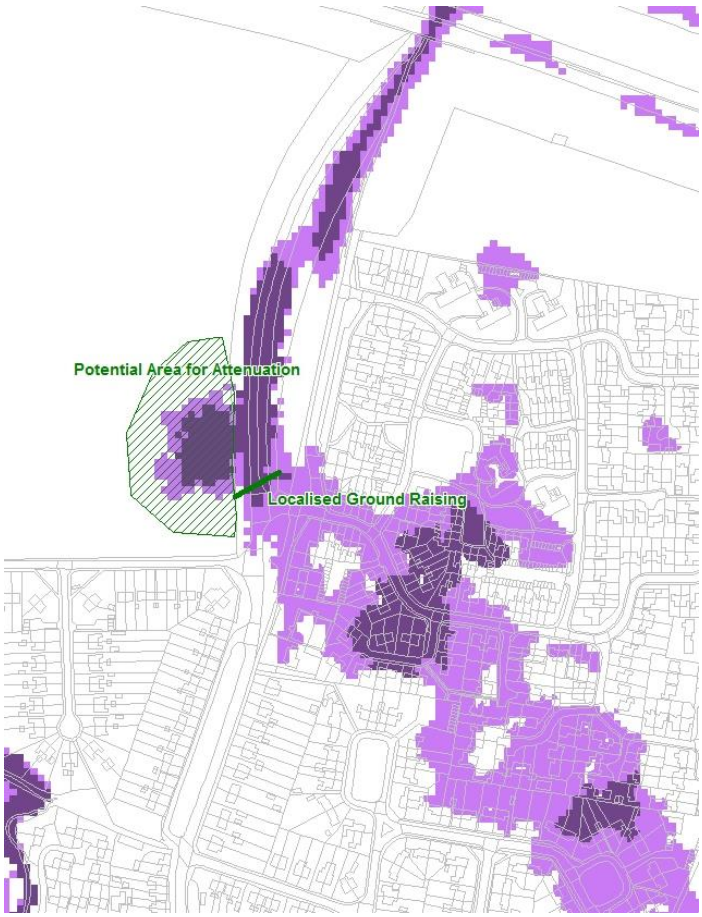


Figure 4-2 Option CS7 (shown with 0.5% AEP FMfSW)

CS8 Property Level Protection

Properties that have previously flooded in Haughton Road, Beech Drive and Church Meadow would benefit from installation of the resilience and resistance measures discussed previously. A Defra study into the benefits of property level protection[19] concluded that:

Resistance measures (designed to keep water out of a property) are economically worthwhile for properties at risk of flooding from a 2% AEP (1 in 50 annual chance) or greater.

- The largest percentage savings are for residential properties at risk of flooding from a 4% AEP (1 in 25 annual chance) or greater.
- Temporary resistance measures (for example temporary flood guards and airbrick covers) reduce the costs of damage by about 50% if they are properly deployed prior to a flood.
- A full package of resilience measures (i.e. the use of flood resilient plaster, resilient kitchens and resilient flooring) will only be economically worthwhile when installed in a building that is at risk of flooding from a 4% AEP (1 in 25 annual chance) or greater.

Within Shifnal, there are properties at risk of flooding from a 4% AEP (1 in 25 annual chance) event in Beech Drive, Shrewsbury Road, Church Meadow and Brooklands Avenue. Therefore it is suggested that this option would be suitable in these locations.

CS9 Priorslee Reservoir Attenuation

Shropshire Council requested an assessment of the maximum allowable outflow from Priorslee Reservoir which would remove all properties in Shifnal from Flood Zone 3. The starting point for

this assessment was to remove the link between Priorslee Reservoir and the downstream Wesley Brook from the model, as a hypothetical scenario.

With the existing reservoir outlet in place, approximately 76% of the peak flow contributing to the Wesley Brook within Shifnal does not come from Priorslee Reservoir, consequently limiting the scope to use Priorslee to control flows through Shifnal. Model results suggest that, at present, Priorslee Reservoir is attenuating flows from Telford and the sub-catchments downstream of Priorslee contribute the significant proportion of flow into the Wesley Brook upstream of Shifnal.

An assessment of the number of properties removed from and remaining within the modelled flood outlines following the hypothetical disconnection of Priorslee Reservoir from the Wesley Brook was made. Results are summarised in Table 4-9.

Event	Properties Removed from Modelled Event Outline*	Properties Remaining Within Modelled Event Outline
5% AEP	27	13
5% AEP plus climate change	30	24
1% AEP	27	39
1% AEP plus climate change	33	57

Table 4-9 Properties Removed From and Within Modelled Event Outlines (*as a result of disconnecting Priorslee Reservoir from the Wesley Brook)

It is not considered feasible to remove all flow contributions from Priorslee into the Wesley Brook as this would give rise to very low flows in the upper reaches of the brook resulting in adverse environmental impacts, and even by doing so a significant number of properties in Shifnal would still remain within Flood Zone 3.

Overall the FAS concluded that given that a number of properties remain within both the 1% AEP and 5% AEP flood extents when no flow contributions from Priorslee are added to the Wesley Brook, it is considered unlikely that using Priorslee to manage flood risk in Shifnal would be a long term, viable option. The study also considered that drawing down Priorslee Reservoir prior to a flood event would not have any significant impacts on reducing flood risk downstream in Shifnal.

4.2.8 Non Capital Options

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

- Data and Asset Management (Section 4.7.1)
- Planning Policy (Sections 4.7.2 – 4.7.4)
- Development Control (Section 4.7.5)
- Campaigns and Communication (Section 4.7.6)
- Emergency Planning (Section 4.7.7)

4.2.9 Data and Asset Management

Shropshire Council should ensure that asset registers are kept up to date in line with current guidance concerning their development and maintenance. Shropshire Council is currently using GIS to assimilate existing information and this should be continued. As the database develops, Shropshire Council 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, where the drivers for such work are identified and understood.

4.2.10 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 are two key planning policy documents which discuss surface water management in relation to planning policy.

Core Strategy

The Shropshire Council Core Strategy[20] was published in February 2010 and states that Shifnal will have development to meet local needs which respect green belt boundaries. Between 500 and 1000 homes are indicated in the Core Strategy. Policy CS18 Sustainable Water Management states in relation to surface water management that:

All development within local surface water drainage areas, as identified by the Water Cycle Study, and any major development proposals, demonstrate that surface water will be managed in a sustainable and coordinated way. Proposals should be supported by either a Surface Water Management Statement or Plan, depending on the scale of the development;

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

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

A new development of 178 homes on the Southern Edge of Shifnal off Park Lane, known as Thomas Beddoes Court is currently under construction. Land in this area drains towards Silvermere therefore monitoring should take place to ensure that any surface water drainage proposals do not increase third party flood risk and the development is constructed in accordance with proposals in the development's Flood Risk Assessment.

Shifnal Place Plan

The Place Plan suggests that surface water management is on the local agenda in Shifnal and therefore it is likely that efforts to engage the community in surface water management activities have the potential to be effective. Increasing open space provision and addressing litter and fly tipping will contribute to improved watercourse maintenance and ultimately reduce flood risk.

4.2.11 Planning Policy - Future

It is recommended that the policy CS18 from the Core Strategy is pursued and that stronger links between surface water management proposals and the Place Plan are made where appropriate as this will further support and strengthen any initiatives.

SPD

The proposed Water Management SPD should be used to communicate local solutions for mitigating any increases in surface water flood risk as well as adapting to the existing risks. The SPD should make use of the wide evidence base collected as part of the Local Development Framework and consequently share this with planning applicants, the development industry and

the community. The Planning Advisory Service[21] 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 to assist LLFAs in producing the first round of LFRMS[22]. The LFRMS will specify the following:

- The risk management authorities in the LLFA area and what flood and coastal erosion risk management functions they may exercise in relation to the area. It will be important for the local strategy to identify any special arrangements agreed in the area where functions normally carried out by one authority are done by another.
- The objectives for managing local flood risk. These should be relevant to the circumstances of the local area and reflect the level of local risk. The Regulations have a narrow scope focussing on identifying and addressing 'significant' flood risk. The scope of the LFRMS is not specified in the 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)[23] whilst maintaining 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 which 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, and;
- assist communities with rapid and effective recovery post flooding.

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

4.2.12 Planning Policy - Specific

The following specific policies for Shifnal 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 across Shifnal. This should incorporate de-culverting of watercourses, protection of the natural floodplain and seeking ways to link existing areas.

Designation of areas as ‘development free’

The area adjacent to the Wesley Brook / Silvermere confluence is highlighted as a location where development should be prevented now, and into the future.

Prevention of floodplain encroachment

The encroachment onto the floodplain of gardens on the banks of the Wesley Brook should be prevented in order to maintain and improve channel conveyance and reduce the risk of blockages.

Regular and effective maintenance of watercourses

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

4.2.13 Development Control

Planned New Development

The Shifnal Place Plan identifies the following new development in Shifnal:

- Wolverhampton Road - full planning permission for 175 units.

- Meadow Drive - Pre application discussions ongoing regarding a potential future site to accommodate up to 90 units.

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

Existing Shropshire Council Guidance

Shropshire Council has produced an interim guidance document for developers which sets out the council's requirements for surface water management. Consultation on this document was closed in March 2011. It is the aspiration that this document will eventually be replaced by the proposed water management SPD. Shropshire Council should be consulted with reference to the key guidance points from this document which fall under the heading of:

- Runoff Rates; considering new development and re-development
- Surface Water Drainage; disposal methods, network requirements, ownerships and responsibilities
- SuDS; location, capacity, maintenance and responsibilities
- Designing for exceedance: principles and assessment of routes
- Role of river corridors

Proposed Additional Guidance

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

- Information should be provided on any contributions required for strategic measures or local schemes. Refer to section 4.5.1 (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.
- Encouragement to use green roofs wherever possible
- 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 interim guidance produced by Shropshire Council, the following should be consulted and adhered to where necessary.

Standards and Regulations

The existing CIRIA SuDS guidance (SuDS Manual[10], Preliminary Rainfall Runoff Management for New Development[24] , Model Agreements and Interim Code of Practice for SuDS[25]) are referenced in the Shropshire Council guidance and provide a useful starting point for promoting SuDS uptake in Shifnal.

Following the FWMA, Defra is developing national standards for the design, operation and maintenance of SuDS which will set out the criteria on which the type of drainage appropriate to any given site or development can be determined. These national standards will, however,

make allowance for local conditions and take into account the costs and benefits of SuDS. These standards will be consulted on prior to their publication; consultation is currently expected during Winter 2011/12. Following this, the requirements of the FWMA relating to sustainable drainage are not expected to come into effect before April 2012.[26]

Adoption

The FWMA introduces the concept of a SuDS Approving Body (SAB), to be constituted by unitary authorities or county councils (LLFAs).

The role of a local SAB will be to approve local SuDS applications where construction work will have implications for the drainage system. They will apply strict standards that will achieve benefits for water quality as well as flood 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 FWMA also enables SABs to devolve the responsibility of SuDS adoption to other organisations such as land owners on the condition that all partners are in agreement.

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

4.2.14 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 Shropshire Council, in conjunction with the Environment Agency, Severn Trent Water and Shifnal Town 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 inappropriate increases in impermeable areas. In conjunction with this raise awareness of the STWL scheme, for reduced sewerage charges; this scheme gives a 36% reduction if a property owner can demonstrate that no surface water drains to the public sewer system[27]. Shropshire Council should also look for opportunities to provide subsidies for permeable materials and any national schemes to this effect.

The responsibilities of riparian owners

Identifying and raising awareness of the duties of riparian owners of watercourses and how failure to meet the requirements of riparian ownership will impact on both the immediate and wider area.

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 which is available on their website[28]. A flood plan should:

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

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 Shropshire Council by monitoring the local area for littering of assets, rising water levels etc.

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 Shropshire specific scheme. This will, cumulatively, help slow runoff into the surface water system.

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

4.2.15 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 Shropshire Multi Agency Flood Plan (MAFP) which Category 1 Responders (SC in this case) are required to produce[29]. 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[30].

Environment Agency Flood Warning

Shifnal is currently within an Environment Agency flood warning area; residents within this area automatically receive flood warnings, to their registered land line, free of charge from the Environment Agency. An enhanced service where additional numbers and email addresses can be registered is also available at no cost. Residents outside defined flood warning areas can also sign up to the scheme, again, at no cost. The flood warning system for Shifnal is currently being updated by the Environment Agency.

Additional Potential Monitoring

Assessment and potential implementation of improved monitoring of flow and levels at both Priorslee Lake and from southern Telford should be considered to assist with emergency planning, flood warning and understanding the relative contributions of flow from Priorslee and the tributary from the south-eastern side of Telford, on levels downstream in the Wesley Brook.

If required this may result in the need for the installation of additional monitoring upstream of the current Environment Agency flow and level monitoring station on Haughton Road Bridge on the Wesley Brook.

5 Phase 4 – Implementation & Review

5.1 Action Plan

Implementation & Review Phase; Prepare Action Plan

The final output from a SWMP is an action plan which sets out the tasks identified, the responsibility for leadership and the timescales. The tasks below are a summary of the actions developed throughout this SWMP report and therefore previous chapters should be consulted for further details. The Shifnal action plan is set out in Table 5-1.

ID	Action	Lead Responsibility	Timescale
SH1	Initial clearance and then regular maintenance of the railway line culvert to north of Mead Way.	Shropshire Council	Short Term
SH2	Feasibility study into channel widening on the Wesley Brook to assess any environmental impacts and engineering constraints	Shropshire Council	Medium Term
SH3	Investigate feasibility and economics of property level protection in identified wetspots	Shropshire Council	Medium Term
SH4	Undertake further investigation into flow route and volumes of surface water from the north (mapped surface water route way down Newport Road). Assess extent of the issue and resultant need to put in place mitigation measures.	Shropshire Council	Medium Term
SH5	Assess and implement telemetered monitoring of the levels within Priorslee Reservoir and identification of Stage Discharge curve for current weir settings to help improve warning times for residents within Shifnal	Seven Trent Water; Environment Agency; Shropshire Council	Short Term
SH6	Assess and implement regular monitoring of surface water runoff contributions from Southern Telford where no attenuation through Priorslee takes place. Consider links with existing EA flood warning scheme.	Shropshire Council; Telford & Wrekin Council; Environment Agency	Medium Term
SH7	Monitor Thomas Beddoes Court development to ensure any planning conditions in relation to surface water management are met.	Shropshire Council	Immediate
SC1	Actively encourage Core Strategy Policy CS8	Shropshire Council	Immediate
SH8	Link any proposed actions, guidance and policies to the Shifnal Place Plan.	Shropshire Council	Continuous
SC2	Publish the proposed Water Management SPD	Shropshire Council	Short Term
SC3	Write LFRMS ensuring consistency with the principles of the national strategy. Consider the need for scrutiny and consultation.	Shropshire Council	Short Term

ID	Action	Lead Responsibility	Timescale
SC4	Review the most appropriate vehicle for implementing surface water drainage policies, noting that SPDs can only provide guidance rather than setting policy.	Shropshire Council	Short Term
SC5	Monitor and maintain the Shropshire Council Developer Guidance prior to the water management SPD being produced	Shropshire Council	Immediate
SC6	Ensure duties of the SAB are maintained either by Shropshire Council or by devolving the responsibility to a third party	Shropshire Council	Short Term
SC7/ SH9	Enhance communication with communities to develop the notion of responsibility for and ownership of surface water management and protection from flooding of private property.	Shropshire Council / Shifnal Town Council	Short Term
SC8	Continue to develop and maintain the Shropshire Multi Agency Flood Plan (MAFP)	Shropshire Council	Immediate
SC9/ SH10	Encourage residents to sign up to the enhanced Environment Agency Flood Warning scheme	Shropshire Council / Shifnal Town Council / Environment Agency	Immediate

Table 5-1 Shifnal Action Plan

5.1.1 Future - Additional Hydraulic Modelling potential

In future, if further flooding occurs in this area, Shropshire Council should consider whether additional hydraulic modelling would be beneficial in assessing solutions and quantifying flood risk. This could include more detailed and integrated urban drainage modelling to include for the presence of the sub-surface drainage network as well as the topographical catchment drainage network.

6 Conclusions and Recommendations

The key findings from this report are summarised below:

- A Surface Water Management Plan has been written for the market town of Shifnal in Shropshire. This report presents the findings from all four phases of the SWMP process.
- Shifnal is located on the Shropshire border, east of Telford. The Wesley Brook runs southwards through the centre of the town.
- The partners identified as part of the Shifnal SWMP are Shropshire Council, Severn Trent Water and the Environment Agency. Data sharing and licensing agreements were put in place to facilitate data sharing between partners

Strategic Level Assessment

- A strategic level assessment was carried out using existing information concerning flood risk for the whole of Shropshire:
  - Shifnal was ranked third in Shropshire by Defra in terms of susceptibility to surface water flooding
  - Shifnal was identified in the former Shropshire Districts Level 1 SFRA as at risk of potential flooding from discharges into the Wesley Brook from the Telford urban area.
  - The Shropshire Water Cycle Study also highlighted Shifnal as at risk of surface water flooding
  - Shropshire Council has also received communication from local residents highlighting their concerns about flooding in Shifnal.
- Shifnal was therefore progressed to the intermediate assessment phase.

Intermediate Assessment

- The intermediate assessment phase looked in detail at flood risk in Shifnal:
  - 51% of the Shifnal flood reports (provided by Shropshire Council) are classified as being as a result of blocked drains with 4% as a result of blocked ditches and 6% classed as ‘standing water’.
  - Flooding from the Wesley Brook has been recorded at Beech Drive, M54 services culvert, Haughton Road in 2007 (Figure 3-1) and the park on Church Street in 2007
  - Flooding from Silvermere has been reported by the Flood Forum at Park Street, Dyas Close and Brooklands Avenue.
  - As of June 2011 there were two entries on the DG5 register with the Shifnal SWMP Study area.
  - There are no reported incidents of groundwater flooding in Shifnal.
  - Surface water flood risk is highlighted in Shifnal by both the AStSWF and FMfSW maps.
- The intermediate phase identified areas of higher risk, termed wetspots, within Shifnal based on historical flood records and future flood risk to properties and infrastructure.
- A type weighting and flood susceptibility weighting were applied to each receptor group as part of a ‘multi criteria analysis’ (MCA). The MCA score was divided by the area of the wetspot in order to provide an unbiased score. A rank score was then assigned based on the number of flood incidents recorded in the wetspot which was used as a multiplier for the MCA rank to give an overall priority score.

- In total, 13 wetspots were identified; nine due to historical flooding, and a further four with a likely future flood risk based on the FMfSW. Eight of these were progressed for detailed assessment:
  - Church Meadow
  - Beech Drive
  - Shrewsbury Road
  - Brooklands Avenue
  - Silvermere Park
  - Haughton Road
  - Wesley Crescent
  - Broadway

Options Review

- The following potential high level mitigation measures were identified for further assessment:
  - Improved maintenance for all existing drainage systems. Maintenance would include regular inspection, cutting / mowing / vegetation and clearance of debris
  - SuDS including attenuation basins, swales, infiltration basins, permeable paving, road side rain gardens,
  - Improvements to the drainage system including modifications to the main Wesley Brook
  - Culverting the downstream reach of Silvermere
  - Property level protection – resistance and resilience
  - Planning policy and development control
  - Campaigns and communication
- An ISIS TUFLOW model of the Wesley Brook was developed and used to identify baseline flood risk and subsequently used to assess the attenuation options, Wesley Brook channel modifications and the Silvermere culvert options:
  - Attenuation on the Wesley Brook was discounted, at this stage, due to the large volumes of storage required and inferred poor benefit cost
  - Wesley Brook channel modifications reduced flooding through Shifnal and did not have any negative impacts upstream or downstream of the modifications
  - Adding a culvert to Silvermere at the confluence of the Wesley Brook did not significantly reduce flood risk in interest area and increased upstream flood risk
- In 2013, the ISIS TUFLOW model was updated to facilitate the assessment of the potential to use Priorslee Reservoir to attenuate pass forward flows on the Wesley Brook. This concluded:
  - Given that a number of properties remain within both the 1% AEP and 5% AEP flood extents when no flow contributions from Priorslee are added to the Wesley Brook, it is considered unlikely that using Priorslee to manage flood risk in Shifnal would be a long term, viable option
- The railway culvert behind Mead Way was identified as a key area for improved maintenance due to the existing debris obstructing it.
- Further work is required to investigate the need for and extent of any attenuation of surface water flows in the north of Shifnal.
- Both Shropshire Council's Core Strategy and the Shifnal Place Plan indicate that surface water management is on the local agenda and further work should be done to consolidate this.

- The proposed future Water Management SPD should be used to communicate local solutions for mitigating any increases in surface water flood risk as well as adapting to the existing risks.
- Recommendations for additional policies for Shifnal are contained in Section 4.7; these could be included as Development Management policies.
- Shropshire Council has produced an interim guidance document for the management of surface water; this should be implemented as a specific SPD and Section 4.7 suggests some further points that could be incorporated.
- Section 4.7.2 sets out a series of recommendations in respect of campaigns and communication including responsibilities and ownership, community flood plans and groups and developer forums.
- The existing Multi Agency Flood Plan should be kept live and the existing Environment Agency flood warning scheme (due to be updated) should be actively communicated and developed with local residents and businesses.
- A Local Flood Risk Management Strategy (LFRMS) for Shropshire should be prepared that is informed by national guidance and includes for the specific elements identified within this SWMP report and Shropshire's PFRA.
- Shropshire Council should keep informed of developing SuDS guidance and protocols and adapt duties both internally and for third parties to help achieve compliance.

Non structural and Council Wide measures such as a continuation in the current improvement of data management, stronger flood risk management partnerships, and development management policy guidance play a vital part in the overall process of improving the status quo and to helping to adapt Shifnal, and the other Shropshire Towns to an uncertain climatic future.

Therefore, the SWMP should significantly help SC to provide a wide range of measures to manage local flooding in a coordinated way that balances the need for communities, the economy and the environment as expected by a LFRMS.

7 References

[1] Sir Michel Pitt (2008) Learning Lessons from the 2007 Floods

[2] Department for Communities and Local Government (2010) Planning Policy Statement 25 Development and Flood Risk

[3] Defra (2010) Surface Water Management Plan Technical Guidance

[4] Making Space for Water; Taking for a new Government strategy for flood and coastal erosion risk management in England (2005)

[5] West Midlands Regional Assembly (2007) – Regional Flood Risk Appraisal

[6] West Midlands Regional Assembly (2009) – Regional Flood Risk Appraisal Update

[7] Bridgnorth District Council (2007) Shropshire Districts Level 1 Strategic Flood Risk Assessment

[8] Shropshire Council (2010) - Outline Water Cycle Study – Final Report

[9] Shropshire Council (2011) LDF Implementation Plan and Local Investment Plan Shifnal & surrounding area Place Plan 2011/2012

[10] Environment Agency (2010) Preliminary Flood Risk Assessment (PFRA) Final Guidance. GEHO1210BTGH-E-E

[11] www.ciria.org.uk

[12] The Water Industry (Schemes for Adoption of Private Sewers) Regulations 2011 - http://www.legislation.gov.uk/uksi/2011/1566/pdfs/uksi_20111566_en.pdf

[13] Environment Agency - Maintenance Programme 2011/2012

[14] Environment Agency Flood & Coastal Erosion Risk Management Schemes - see http://maps.environment-agency.gov.uk/wiyby/wiybyController?x=357683.0&y=355134.0&scale=1&layerGroups=default&ep=map&textonly=off&lang=_e&topic=fcrmschemes

[15] Defra and Agency (2005) Framework and Guidance for Assessing and Managing Flood Risk for New Development, Flood Risk Assessment Guidance for New Development, FD2320 Technical Report 2

[16] Defra and Agency (2006) The Flood Risks to People Methodology, Flood Risks to People Phase 2, FD2321 Technical Report 1

[17] Land Drainage Act 1991

[18] Defra (2011) Flood and Coastal Resilience Partnership Funding – An Introductory Guide

[19] Defra (2008) Developing the Evidence Base for Flood Resistance and Resilience

[20] Shropshire Council Core Strategy: Final Plan Publication. February 2010.

[21] Planning Advisory Service (2010) Using Supplementary Planning Documents to Address Climate Change Locally available at http://www.pas.gov.uk/pas/aio/553457. Accessed July 2011.

[22] Environment Agency Guidance, available at http://learning.environment-agency.gov.uk/courses/FCRM/capacity/legal/responsibility_206.html. Accessed May 2011.

[23] Defra and Environment Agency (23rd May 2011) The National Flood and Coastal Erosion Risk Management Strategy for England

[24] EA/Defra (2004) - Preliminary Rainfall Runoff Management for New Development (W5-074/A)

[25] CIRIA (2004) - SuDS ICOP and model agreements now superseded by SuDS Manual

[26] Local Government Group Alert 109/10 - Flood and Water Management Act (22 September 2010)

[27] http://www.stwater.co.uk/server.php?show=nav.6284

[28] http://publications.environment-agency.gov.uk/PDF/GEHO0111BTJK-E-E.pdf

[29] DEFRA, Civil Contingencies Secretariat and Environment Agency (2010) The National Flood Emergency Framework for England

[30] DEFRA, Civil Contingencies Secretariat and Environment Agency (2010) Checklist for Multi Agency Flood Plans