Shropshire Council

Shrewsbury Surface Water Management Plan

Intermediate Report

Final

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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 Shrewsbury 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
STW	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 Shrewsbury which is the county town in Shropshire.

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 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.

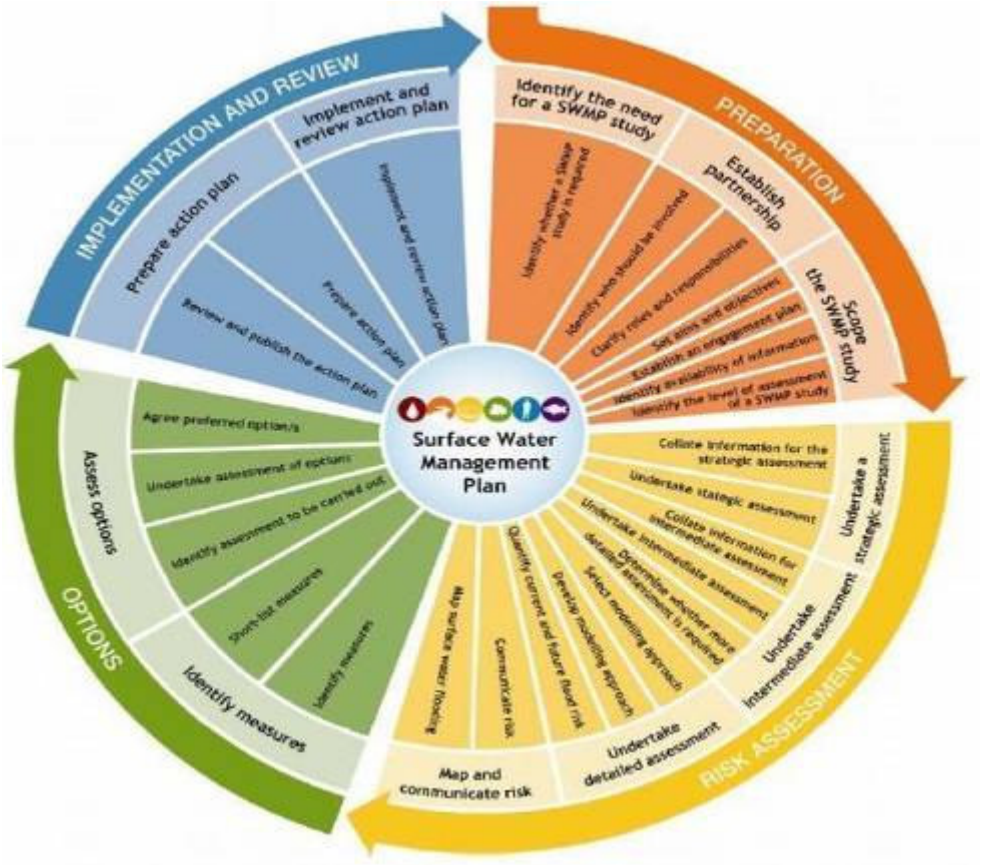

Figure 1-1 SWMP Wheel (Defra guidance[3])

The SWMP process is formed of four principal phases;

- Preparation,
- Risk assessment,
- Options, and
- Implementation and review.

This report is set out as follows and contains the findings from the preparation stage and the strategic risk assessment phase for Shrewsbury. 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 Objectives

The final aim of the SWMP study is to produce a long term surface water management action plan for Shrewsbury. The objectives of this Scoping study are to:

- Map historical flood incident data
- Engage with partners and stakeholders
- Map surface water influenced flooding locations
- Identify surface water flooding, termed 'wetspot', areas
- Assess, compare and prioritise 'wetspot' areas for detailed assessment
- Make recommendations for next step – Need for a Detailed Level Assessment

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

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

Once the data collection stage is complete, the surface water flooding information will be analysed to identify 'wetspots' that have a history of flooding incidents or potentially could be at risk of future flooding. Those 'wetspots' identified as being at higher risk or priority through agreed local assessment criteria, will then be presented in this report to all the stakeholders involved to identify how the study can best progress, given current funding and time constraints within Local Authorities.

Subject to agreement, by the stakeholders, a number of these 'wetspots' would then be progressed (as part of a separate and future commission) through the detailed assessment and option stages of the SWMP process to arrive at the most suitable and sustainable methods for managing the local flood risk in the identified areas. Following this options stage, recommendations for flood alleviation or mitigation will be consolidated.

1.5 Drivers for Change

Shropshire Council are undertaking this SWMP in order to:

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

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

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

1.6 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 in Table 1-1 overleaf.

1.6.1 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 flooding. Flooding can either develop gradually or rapidly, depending on the characteristics of the catchment. Land use, topography and the 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.
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, and 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)

1.6.2 Surface Water Flooding

In the context of SWMPs, the technical guidance[3] defines surface water flooding as:

- Surface water runoff which is 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 which is 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 Shrewsbury 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, alongside the more extreme risks that could occur, such as those from overtopping or breaching of reservoirs or main river defences.

1.7 Evidence Base – Previous studies

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

1.7.1 Regional Flood Risk Appraisal (RFRA)

A Regional Flood Risk Appraisal (RFRA) for the West Midlands was originally produced in 2007 and updated in 2009. The updated RFRA provided a broader more rigorous assessment of flood risk across the region and a basis for policy development. The key recommendations from the RFRA which are relevant to Shrewsbury are listed below:

- Floodplains should be safeguarded from future development and local authorities must apply the sequential test to ensure all new development is directed towards Flood Zone 1 in the first instance. Opportunities should be taken to reinstate areas of functional floodplain which have been previously developed and areas in Flood Zone 2 and 3 should be left as open space.

- Surface water should be managed appropriately in all Flood Zones, with Environmental Stewardship Schemes considered in rural and upland areas to help ensure farming practices help reduce runoff to decrease flood risk in urban areas downstream.
- Local authorities should be aware of the progress made in surface water modelling techniques and undertake Surface Water Management Plans (SWMPs) where high surface water flood risk has been identified. All new developments should make allowances for climate change by designing safe and sustainable homes.

It is recommended that for high flood risk/high growth areas where potential flood risk constraints to development have been identified, opportunities to locate future development in lower risk areas in the wider authority or in adjoining local authorities should be sought.

1.7.2 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 River 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 River Severn catchment was split into 20 sub catchments known as policy units. Shrewsbury fell into the middle Severn corridor Policy unit, which was given the preferred option of Policy Option 4. This is defined as 'taking further action to sustain the current level of flood risk into the future (responding to the potential increases in risk from urban development, land use change and climate change)'. Specific CFMP actions for the Shrewsbury area are:

- Ensure floodplains are not inappropriately developed. Follow the 'sequential approach' of PPS25, and consider land swapping opportunities.
- Encourage compatibility between urban open spaces and their ability to make space for rivers to expand as flood flows occur. One example of a flood-compatible use is playing fields. Develop strategies to create 'blue corridors' by developing/redeveloping to link these flood-capable spaces.
- Encourage rural and urban best practices in land-use and in land-management to restore more sustainable natural flood plains and to reduce run-off.
- Review how effective and sustainable each flood defence is. Review maintenance operations to ensure they are proportionate to flood risk, focus efforts on protecting communities and making them more resilient to flooding. It should be noted that protecting large areas of agricultural land in the flood plain tends to increase flood risk for downstream communities.
- Develop a better understanding of flooding from surface water, from drainage systems and from 'non-main' watercourses. Produce a strategy for operation and investment, integrating all of these with main rivers.
- Raise awareness of flooding among the public and key partners, especially main operators of infrastructure, allowing for them to be better prepared. Encourage them all to increase the resilience and resistance of vulnerable buildings and businesses.

- Seek ecological improvements.
- Maintain flood warning systems and seek opportunities to improve effectiveness and coverage.

1.7.3 Preliminary Flood Risk Assessment (PFRA)

These are required as part of the Flood Risk Regulations which implement the requirements of the European Floods Directive. Shropshire Council has produced one of these to give an overview of all local sources of flood risk, based on current understanding. Future iterations of the PFRAs will benefit from an increased level of information relating to surface water from the ongoing cycle of Shropshire Towns SWMPs and increasing focus on the management of local flood risk. Shropshire Council will need to review the PFRA every six years.

The Preliminary Flood Risk Assessment (PFRA) for Shropshire was completed in May 2011. Shrewsbury 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 1km^2) within Shrewsbury. Four blue squares within the study area were identified by the Environment Agency of which three were rejected through the PFRA process. The PFRA identified five additional blue squares.

1.7.4 Outline Water Cycle Strategy

An Outline Water Cycle Study for Shropshire was completed in June 2010. In terms of flood risk, Shrewsbury was classified as 'red' 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 county surface water policy. The Environment Agency AStSWF map (see Section 6.2 for further details) was used in conjunction with information from the Level 1 and Level 2 SFRA and the River Severn CFMP. County wide mapping was undertaken to identify the SuDS suitability in any given location.

Each local planning authority is required to produce evidence that development proposed within the area can be achieved sustainably, taking into account the current water, waste water and environmental infrastructure capacity. This provides an important tool to guide planning policies and land use decisions, based on the ability of the area to cope with the additional demands of increased development in the area. The key findings are summarised in Table 1-2.

Type	Flood Risk
Fluvial Flood Risk	Settlement affected by Flood Zones 2 and 3; The River Severn flows through Shrewsbury centre with the Rad, Rea and Bagley Brook tributaries out falling into the River Severn in the centre of Shrewsbury.
Surface Water Flood Risk	Shrewsbury is identified as a settlement which is highly vulnerable to pluvial flooding. Over 10% of the town is shown to be affected by the AStSWF maps.
Surface Water Flood Risk	Shrewsbury has 0.1 historic incidents (ditch and drain blocked) per hectare which ranks it number 20 for historic incidents in Shropshire.
SuDS Suitability	Due to the varying permeability of the site a range of SuDS are applicable. However this will need to be confirmed by site specific investigations. There are no SPZs or NVZs which will affect the urban extension and infiltration of runoff should be promoted where practicable.

Table 1-2 Water Cycle Strategy Key Findings for Shrewsbury

Overall, the WCS recommended for Shrewsbury that:

- Generally the proposed urban extension areas in Shrewsbury are at low fluvial flood risk. There is some predicted surface water flooding within the urban extensions, which will need to be considered during master planning of the sites. Proposed development within central Shrewsbury will be more constrained by fluvial flood risk, and each development proposal will need to be accompanied by a site specific FRA to ensure that inappropriate development is avoided.
- The assessment for the urban extension areas has indicated that the surface water drainage requirements to ensure runoff rates and volumes do not exceed greenfield runoff rates and volumes will not be a constraint to development. Approximately 2-4% of the available land will be required to attenuate runoff. Infiltration of surface water runoff may be applicable in certain parts of Shrewsbury, particularly in the urban extension to the west.
- New discharge consent required at Monkmoor Waste water Treatment Works (WwTW) to ensure no deterioration of water quality downstream of the WwTW. The analysis has shown a new discharge consent can be set within the limits of conventional treatment to ensure no deterioration of current water quality. The analysis has also shown that growth should not hinder the ability to meet WFD downstream of the works. The findings indicate there are no water quality constraints to accommodating growth at Monkmoor WwTW.

1.7.5 Strategic Flood Risk Assessments (SFRA)

Each local planning authority is required to produce a SFRA under Planning Policy Statement 25 (PPS25). This provides an important tool to guide planning policies and land use decisions. Current SFRAs have a strong emphasis on flooding from main rivers and the sea and are relatively weak in evaluating flooding from other local sources including surface water, groundwater and ordinary watercourses. The information from the SWMP will improve this understanding.

Former Shropshire Districts Level 1 SFRA[5]

In 2007, Level 1 SFRAs for each of the five former Shropshire Districts and Boroughs were completed to help inform the Local Development Plan for Shropshire Council. The study focused on the main market towns within the council area and included Shrewsbury. The SFRA stated that, in Shrewsbury, surface water runoff is an issue in the most densely populated areas. It was recommended for Shrewsbury that a Level 2 SFRA be conducted with detailed modelling of the River Severn. The Level 1 SFRAs are currently being updated to a single document covering the whole of Shropshire.

Shrewsbury Level 2 SFRA[6]

In 2009, a Level 2 SFRA for Shrewsbury was undertaken to help inform the Local Development Plan for Shropshire Council. The study included a 1D-2D model of the River Severn and Rea Brook through Shrewsbury. The model results indicated that there are important flood routes and high hazard informal flood storage areas. The model also indicated that there is a residual risk of breach or overtopping to developments proposed behind the defence.

1.7.6 National Planning Policy Framework (NPPF)

The National Planning Policy Framework (NPPF) has reviewed all existing planning policies and restructured the planning process[7]. The aim of this new framework is to make planning more streamlined and transparent. The NPPF also aims to give local councils more control over local

planning with more emphasis being placed on sustainable local growth. This new national Framework replaces PPS25 however retains the same attention to minimising flood risk and increasing the use of SuDS in new developments.

The final version of the NPPF was published on 27th March 2012 along with a Technical Guidance document for local planning authorities.

1.7.7 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 County or parts of the County, 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 or PFRA .

1.7.8 Local Flood Risk Management Strategies

The Flood and Water Management Act (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.

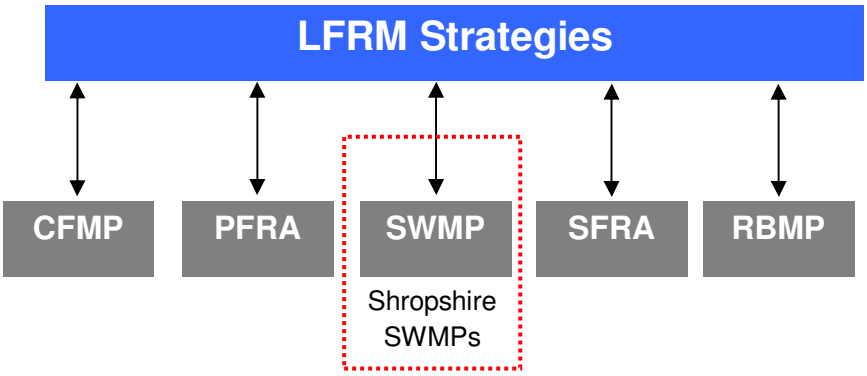

Figure 1-2 Supporting studies used to develop a Local Flood Risk Management Strategy

1.8 Existing Legislation

1.8.1 Flood Risk Regulations 2009

The Flood Risk Regulations 2009 (FRR) transpose the European Floods Directive 2007/60/EC into English and Welsh law and bring together key partners to manage flood risk from all sources and in doing so reduced 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 requires 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 20108. This task has now been completed by SC and has been published on their website[9].

1.8.2 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 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 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.

1.8.3 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.

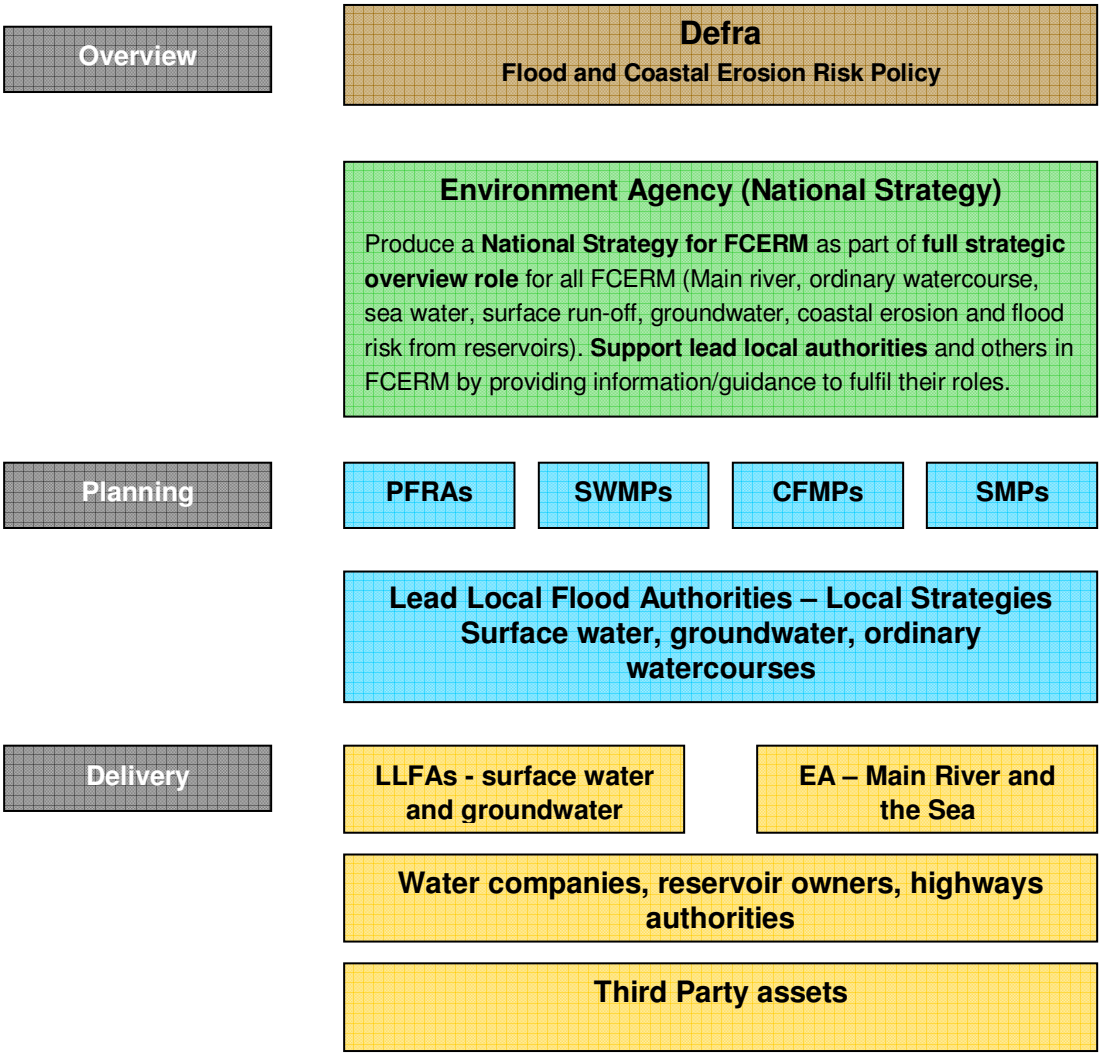

Figure 1-3 Local Flood Risk and Coastal Management Responsibilities

1.9 Sustainable Drainage Systems (SuDS)

SuDS encompass a range of techniques which aim to mimic the natural processes of runoff and infiltration as closely as possible. SuDS schemes should be based on a hierarchy of methods termed the 'SuDS management train' as illustrated in **Error! Reference source not found.**4.

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 proposed to help mitigate current and future flood risk.

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.

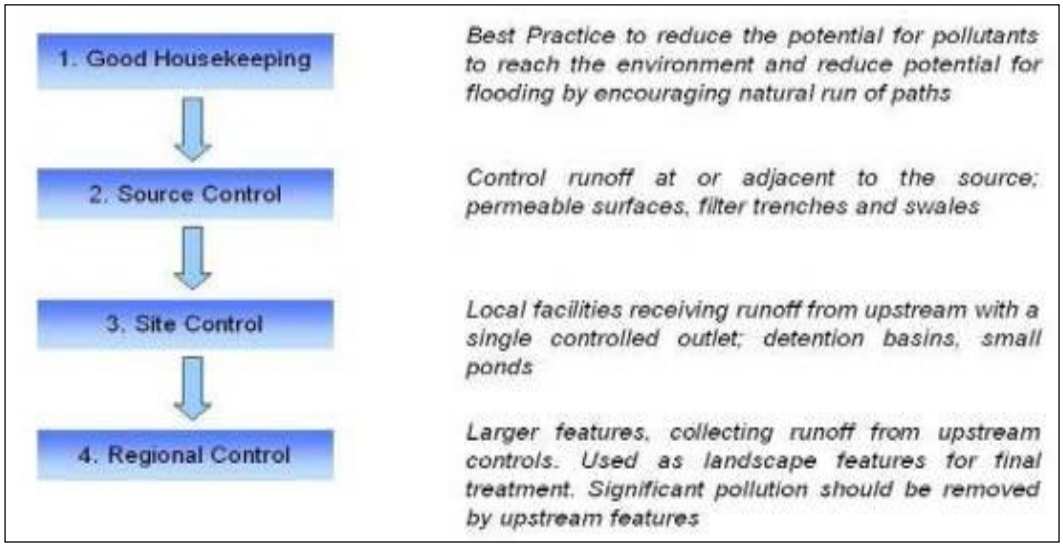

Figure 1-4 SuDS Management Train

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.
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 back to green open areas to help attenuate flows at a property level and improve 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[10])

1.10 Geographic Extents

This SWMP has been undertaken for the Shrewsbury; the location of Shrewsbury in relation to the Shropshire Council boundary is shown in Figure 1-5.

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

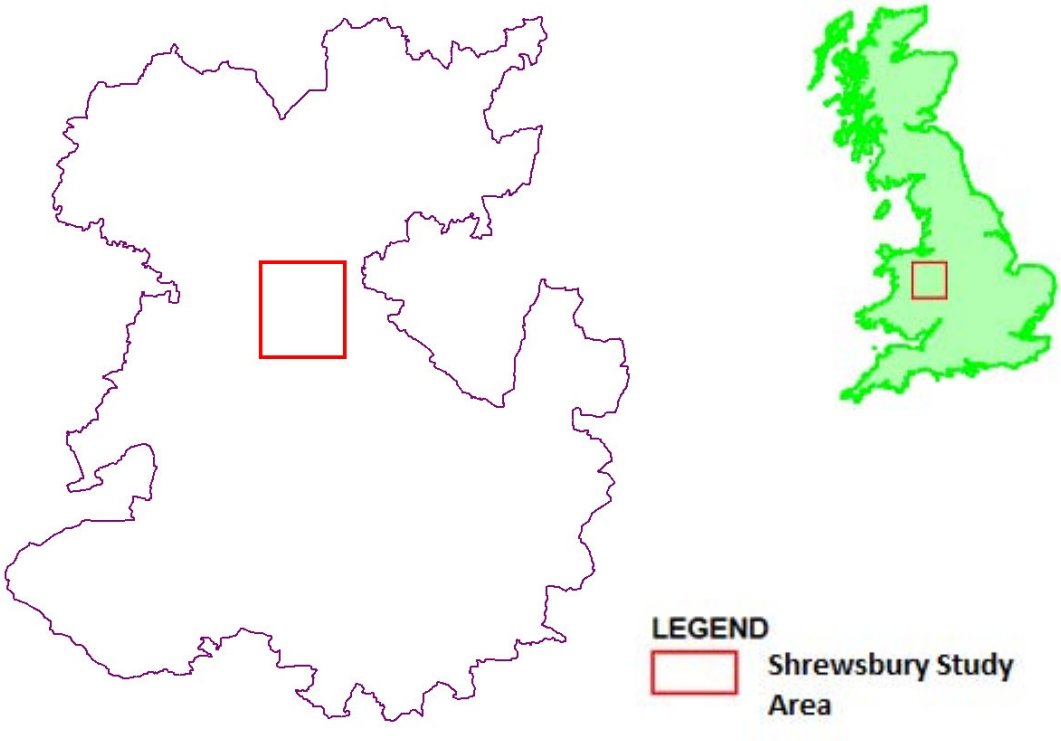

Figure 1-5 Shrewsbury SWMP Study Area

Shrewsbury is the county town of Shropshire in the West Midlands of England. The town lies 14km east of the Welsh border. It is 14km west of Telford and 69 km west of Birmingham. Shrewsbury is approximately 3km north of the A49 and the large village of Bayston Hill. It is predominantly residential, with a commercial centre.

1.10.1 Topography, Hydrology & Land Use

LiDAR data has been provided of the study area as shown in Figure 1-6. There is full LiDAR coverage of the study area except in an area towards the south west of Shrewsbury near Bow Brook. The Shrewsbury catchment has ground levels, which range from 9 – 143 mAOD. The lower ground levels are found along the area surrounding the River Severn and its tributaries that run through Shrewsbury.

The lowest points are found along Sharpestone Quarry, which is to the South East of Shrewsbury. The higher ground levels are generally found away from the watercourses towards Upper Pulley, Bayston Hill, Bicton Heath and Broad Oak.

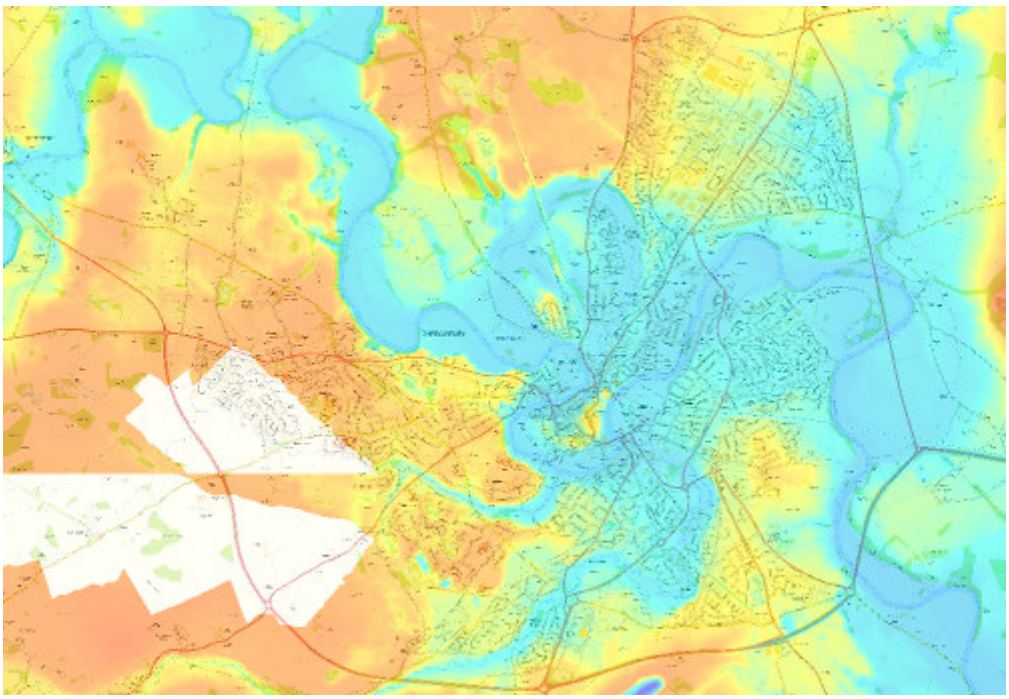

Figure 1-6 **Shrewsbury LiDAR Coverage** © Crown copyright and database right 2012 Ordnance Survey licence number 100049049 © Environment Agency 2012

There are a number of main rivers which flow through Shrewsbury, all of which are 'tributaries' of the River Severn.

- The River Severn is an Environment Agency classified Main River flowing through the centre of Shrewsbury in a north-west to south-east direction.
- The Rad Brook is an Environment Agency classified Main River flowing along the western fringes of Shrewsbury and entering the River Severn on the right bank in the centre of Shrewsbury at the southern tip of the Severn meander.
- The Rea Brook is an Environment Agency classified Main River flowing south-west to north-east and outfalls on the right bank of the River Severn downstream of the Rad / Severn confluence in central Shrewsbury.
- The Bagley Brook is an Environment Agency classified as Main River, flowing in a southerly direction and outfalls on the left bank into the River Severn in central Shrewsbury.
- The Battlefield Brook and one its tributaries are Environment Agency classified Main Rivers, which flows in a southerly direction and outfalls on the left bank into the River Severn to the east of central Shrewsbury, just upstream of the village of Uffington.
- The Money Brook is an Environment Agency classified Main River flowing south to north where it outfalls on the right bank of the Rea Brook, north of Meole Brace Industrial Park.

Agricultural/open land surrounds the town and coincides with areas of higher ground to the north and west of the town. The urbanised area of Shrewsbury is generally within the lower lying river valleys. The Shrewsbury study area is shown in Figure 1-7.

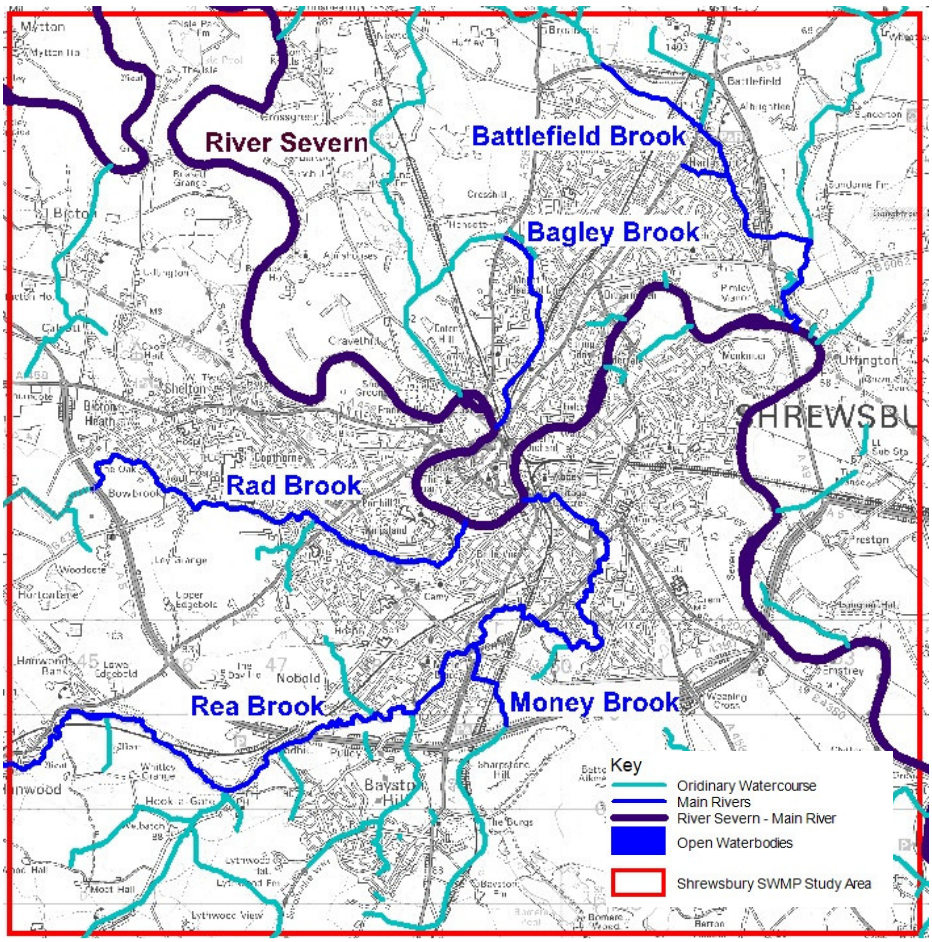

Figure 1-7 Watercourses within the study area

1.10.2 Flood Risk overview

According to the Environment Agency's property count for their Areas Susceptible to Surface Water Flooding Water (AStSWF) maps, approximately 124 residential properties and 101 non-residential properties are classed to be in the 'more' susceptible to surface water flooding region. Furthermore, 2177 residential properties and 1199 non residential properties in the study area are classed to be in the 'less' susceptible to surface water flooding area.

Under United Kingdom Climate Projections 2009 (UKCP09), predictions for future rainfall in the UK up to 2080 show that there could be around three times as many days in winter with heavy rainfall (defined as more than 25mm in a day). It is plausible that the amount of rain in extreme storms (with a 1 in 5 probability of occurrence in any given year (20% AEP) or rarer) could increase locally by 40%. The Environment Agency has produced a summary report with guidance on how LLFAs should account for climate change[11].

Actual extreme weather data and reports in Shropshire have been gathered and it has shown Shropshire has responded adequately to extreme weather events in the past 10 years, but there have been occasions when services have been under pressure and significant costs incurred. A number of key messages as follows were highlighted;

- Flooding (river, flash and storm waters) has been the most frequent cause of incidents affecting council services, there were 5 significant events affecting multiple Council services.

- There has been an increase in flash flood incidents in Shropshire in the study period. Storms and high winds have occurred regularly over the 10 year study period.
- UKCP09 data highlighted that the County was likely to experience climate changes which would include more storms and floods and increased winter rainfall, indicating that Shropshire will be vulnerable to an increasing number of severe events. It has already been shown that Shropshire is experiencing higher frequency and intensity of flash flooding events and impacts on services are high.

It has been noted that it is not possible to eradicate these problems but it is possible to enable Shropshire Council to become more resilient to extreme weather events. Recommendations for this include;

- Maintaining the highway network as highways are crucial in the effective delivery of services by departments across the Council.
- Include climate change on the corporate risk register. This highlights the threats and opportunities as a result of climate change and can be integrated with the Emergency Planning Team.
- Staff training is important and staff from all offices should have access to training which will better equip them and their service for dealing with extreme weather events related to Climate Change.

1.10.3 Significant Infrastructure

There are a large number of critical infrastructure assets distributed throughout Shrewsbury. These assets have been split into three sub-categories based on the Flood Vulnerability Categories from the PPS25 guidance.

Category	Description
Essential Infrastructure	▪ Essential transport infrastructure ▪ Mass evacuation routes ▪ Tube stations and entrances ▪ Essential utility infrastructure ▪ Electricity generating power stations, grids and sub stations
Highly Vulnerable	▪ Police stations, ambulance stations, fire station, command centres and telecommunication installations ▪ Emergency dispersal points ▪ Installations requiring hazardous substances consent
More Vulnerable	▪ Hospitals ▪ Health services ▪ Educational establishments ▪ Landfill, waste treatment and waste management facilities for hazardous waste ▪ Electricity installations (street level electricity supply control units) ▪ Sewage treatment works ▪ Prisons

Table 1-4 Definition of Infrastructure Sub-Categories

1.10.4 Significant Future Development Plans

Shrewsbury is one of 29 original new growth points in the UK and has been awarded £5 million by the Government for infrastructure projects to develop the town. This will include significant housing provision and creating a focus for employment, facilities and services.

Shropshire Council is working closely with Central Government, infrastructure providers and developers to deliver approximately 6,500 additional homes by 2026, including 100 affordable homes per year.

1.11 Methodology

The methodology used to carry out this SWMP follows the advice set out in the Defra SWMP guidance3 as shown in **Error! Reference source not found.**8. Further details on the methodology are discussed throughout the report in the relevant sections.

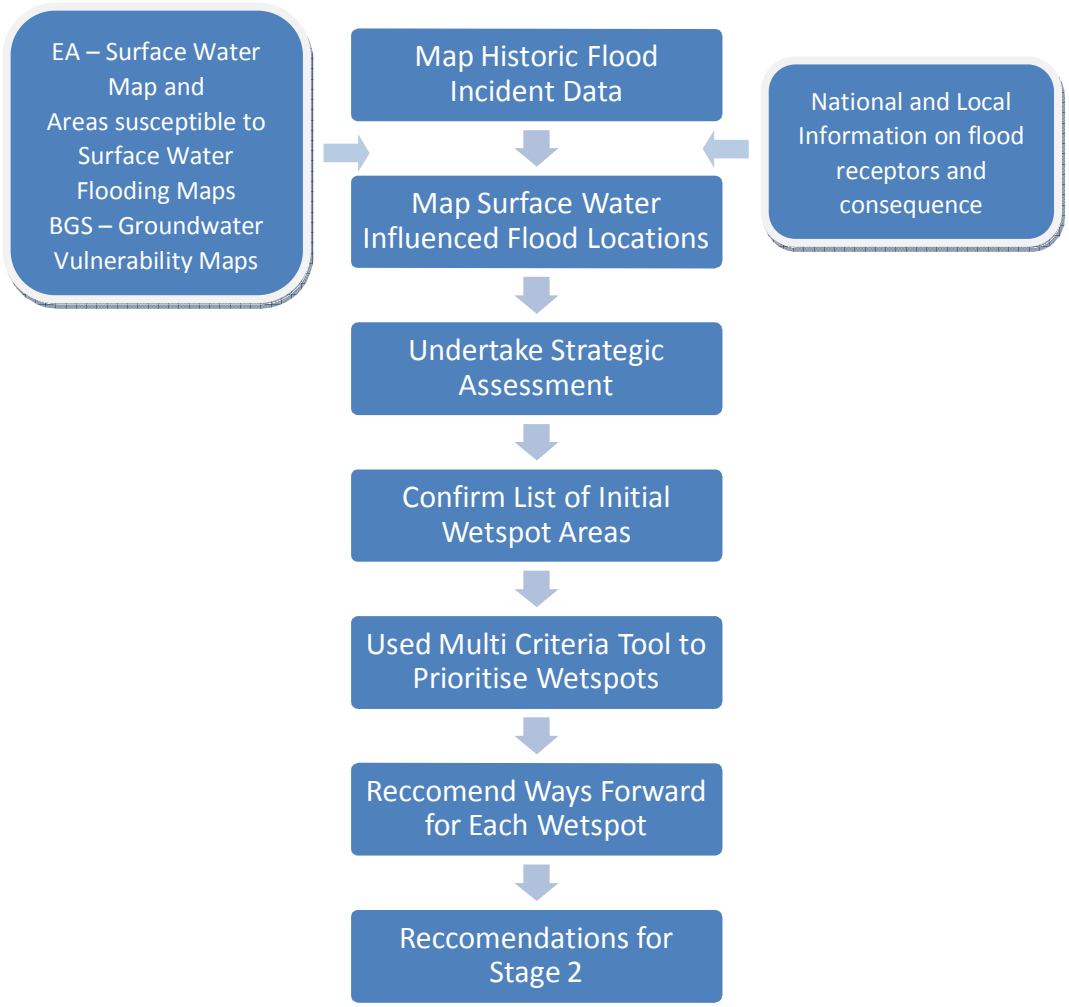

Figure 1-8 Overall Approach to Scoping Study Methodology

The specific methodology adapted for this study is further explained in Sections 2 to 4.

2 Phase 1 – Preparation

2.1 Need for SWMPs in Shropshire

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 a SWMP internally.

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

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 maps

2.2 Partnerships

The formation of partnerships has an important role in the undertaking of a SWMP, and is required under Defra's SWMP guidance documentation. The SWMP guidance details the identification of those partners 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:

- Environment Agency (EA)
- Severn Trent Water (STW)
- Shropshire Council (SC)
- Welsh Water Dwr Cymru (WW)
- United Utilities (UU)

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.

STW, WW and UU are the water and sewerage undertakers for the SC area and both have a statutory obligation to supply water and wastewater services to its customers. STW currently has the responsibility to effectually drain the area and maintain the public sewerage network within Shrewsbury.

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
- Town and Parish Councils

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

For the purposes of the SWMP a stakeholder is defined as anyone affected by, or interested in, the surface water problem or proposed solution. Stakeholders are often individual homeowners

but they can include organisations, the public and communities. Different stakeholders should be engaged with to provide a rounded view of the problem and proposed solution.

It is important that SC liaise with stakeholders as some members of the public have invaluable 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 knowledge and increasing the probability of stakeholder acceptance of options / 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 understood 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 EA'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.

The Environment and Planning Directorate have undertaken community engagement through contacting local town and parish councils, through a series of nine Flood Food Forums[xii] covering the County and have held a 'Flood Fair' to both communicate and gather information on local flood risk issues. It is suggested that as the SWMP continues to move forward to Phases III and IV (options and implementation stages) that local stakeholders are contacted for their views on flood risk mitigation options and to exchange ideas about what they would like to see as potential outcomes.

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:

- British Waterways
- Environment Agency
- Natural England
- Shropshire Council
- Severn Trent Water

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

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

Stakeholder	Information Provided	
	Publicly Available	Not Publicly Available
British Waterways		BW canals network, GIS dataset showing historic overtopping and breaches
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
Natural England	SACs, SSSIs, SPAs, Ancient woodland, LNRs, NNRs, RAMSARs, woodland, agricultural land classifications	
Shropshire Council	SFRA Level 1, SFRA Level 2, Core Strategy Final Plan, Shrewsbury and Surrounding Area Place Plan, Surface Water Management - Interim Guidance for developers	Ordinary watercourses, critical infrastructure (fire stations, schools etc), historical flooding locations, transport infrastructure, Administrative boundaries, OS 10k and 50k Mapping, OS Master Maps
Severn Trent Water		Sewerage networks, asset information, DG 5 Register

Table 2-1 Stakeholders contacted and the information provided

2.3.1 Data Review

One of the key components of a shared understanding of flood risk is the sharing of flood risk data between and across organisations. This section sets out the results of the comprehensive data collection and review. Data has been collated, recorded and analysed in a data register which documents the source of the data and its completeness. In line with the SWMP technical guidance (Defra 2009), the quality of the data has been scored using the following classifications:

1 Best Possible – No known deficiencies. Not possible to improve in near future.

2 Data with known deficiencies – Best replaced as soon as new data is available

3 Assumed – based on experience and judgement

4 Gross assumptions – Educated guess

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 EA 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 SWMPs project, which includes the production of this SWMP. The restricted datasets include records of property flooding held by the Council and by STW, and data licensed by the EA.

Necessary precautions must be taken to ensure that all information given to third parties is treated as confidential. The information must not be used for anything other than the purpose stated in the agreement. No information may be copied, reproduced or reduced to writing, other than what is necessary for the purpose stated in the agreement.

2.4 Scope the SWMP

2.4.1 Level of assessment for SWMPs

SWMPs can function at different geographical scales and therefore different levels of detail are used when considering the outputs. Table 2-2 defines the three potential levels of assessment within a SWMP. At a strategic level, SC identified a number of settlements based on their strategic significance, future growth requirements and potential for surface water flooding as shown in Section 3-1.

Level of Assessment	Appropriate Scale	Outputs
Strategic Assessment (discussed in Section 1.6)	Shropshire Council Administrative area	• Broad understanding of locations that are more vulnerable to surface water flooding • Prioritised list for further assessment • Outline maps to inform spatial and emergency planning
Intermediate Assessment	City / Large Town	• Identify flood hotspots which might require further analysis through detailed assessment. • Identify immediate mitigation measures which can be implemented • Inform spatial and emergency planning
Detailed Assessment (subsequent to this study)	Known flooding hotspots, small towns	• Detailed assessment of cause and consequences of flooding • Use to understand the mechanisms and test mitigation measures, through modelling of surface and sub-surface drainage systems.

Table 2-2 Level of Assessment for SWMPs

2.4.2 Intermediate Assessment Objectives

The objectives of this Intermediate Level SWMP for Shrewsbury 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 Shrewsbury;

- 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;
- Identify an appropriate methodology for the Detailed SWMP for the Shrewsbury SWMP, including identifying and agreeing stakeholder actions to aid delivery, and;
- Make holistic and multifunctional recommendations for improving surface water management activities locally which improve emergency and land use planning across the study area, which may include improved maintenance, clearance of blockages or strengthening of community resilience measures.

The SWMP for Shrewsbury will be approached in three stages:

Stage 1 (this report) details the findings of the Intermediate Assessment confirms the scope of the study (up to Preparation Phase):

Stage 2 (provides the methodology for infilling the missing information/evidence required to help with the Detailed SWMP development) and the confirmation of the key wetspots requiring further investigation as part of the Detailed SWMP.

Stage 3 (including Risk assessment, Options, Implementation and Review Phases) will focus in on the key wetspots and look to see if there are appropriate options to deliver flood risk improvements across the key wetspots.

The Detailed SWMP will look to address both existing areas at risk of surface water flooding and the impacts of new developments on drainage patterns and surface water flood risk.

2.5 Phase 1 Summary

Phase 1 of the SWMP has:

- Engaged key stakeholders including the EA, STW, and SC, to discuss and agree on local flood risk management within the Shrewsbury 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 SC prior to the commissioning of this report through the SFRA and WCS. These documents reviewed available data and both highlighted the requirement to provide a SWMP for Shrewsbury. 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 SC be the custodian of this asset data and through this role is responsible for coordinating the maintenance of the databases / registers.

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

1 The data custodian at 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 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.

Existing Survey Data

A review of existing survey data has been carried out in order to determine the locations of any gaps. From this review and the identified strategy to develop a Detailed SWMP for Shrewsbury, further survey information of open and culverted sections of the watercourses is required to enable the missing data to be captured to assist with the project.

Further discussion on the completing this information is given in Section 4.2.

3.1.2 Flood Incident Register

SC 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’. 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

3.2.1 Surface Water Flooding

This chapter sets out the evidence base used to inform the Intermediate level 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 or flow over the ground surface before entering the underground drainage network or watercourse, or when water cannot enter the network due to insufficient capacity.

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

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

No single organisation has overall responsibility for surface water flooding with responsibility for different aspects of the drainage system (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 Shrewsbury 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;
- Sewer Infrastructure Flooding (DG5 Register)
- Open Channel / Culverted Watercourse Flooding;
- Flood Risk from the Urban Rural Fringe; and
- Overland flows from Groundwater sources

This report is based on the information supplied by partners up to July 2011; 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 '3' which is data with known deficiencies, indicating that further work could be undertaken to improve the data set. Table 3-1 details the sources of historic flooding data.

Data	Source	Information Included	Data Quality Score
Historic Flooding Hotspots	EA, Shropshire Council	Locations of flooding	3
Flood Forum Datasets	Data from Shrewsbury Flood Forum meetings with stakeholders	Locations of flooding and interpretations of cause and effects	3
SFRA Shape files	EA, Shropshire Council	All sources of flooding available at SFRA publication (including Historical Fluvial events)	3
Floods Database	Severn Trent Water Limited	Sewer Flooding (to June 2011)	3

Table 3-1 Summary of historic data set types received

Many urban areas in Shrewsbury also experience problems of surface water flooding. The sustainable management of surface water is therefore important through the use of SuDS. 54% of the Shrewsbury flood reports (provided by SC) are classified as being as a result of blocked drains with 10% as a result of blocked ditches, 32% classed as 'flood' and 4% classed as '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

3.2.2 Fluvial Flooding

The watercourses in the study area are shown in Figure 1-7. Further details on their categorisation and those responsible for their upkeep are given in the following sections

Main Rivers

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

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

The River Severn runs through the centre of Shrewsbury with the Bagley Brook, Battlefield Brook, Rad Brook and Rea Brook out falling into the River Severn. Hence large areas of the

town are at risk of flooding. Many of the properties in Shrewsbury were constructed on the banks of the brooks and numerous roads and footbridges cross the watercourse. Shrewsbury has a long history of flooding problems with notable events occurring in 1795, 1941, 1946, 1947, 1960, 1964, 1965, 1968, 1998, 2000, 2002, 2003, 2004, 2006 and 2007.

Throughout the town Flood Zone 2 extends for up to 300m on either side of the main channel, and includes part of areas such as Frankwell, Castlefields and Monkmoor. At the points where the Rad, Rea and Bagley Brooks enter the River Severn the area predicted to be affected by flooding is wider, particularly in the case of the Rea Brook.

In addition, a network of drains that occupy a former channel of the River Severn are shown to flood, affecting a large area in the Coton Hill, Greenfields, Spring Gardens and Mount Pleasant suburbs. The majority of this area within Flood Zone 3 is currently not developed though substantial areas of housing in Greenfields/Spring Gardens are shown to be located in Flood Zone 2.

Ordinary Watercourses

Ordinary watercourses are all rivers, streams, ditches and drains that have not been designated as main rivers. The main responsibility for all watercourses lies with the riparian owners. Local Authorities are responsible for any ordinary watercourses that fall within areas where they are the land owner. Details of ordinary watercourses were provided by SC. There are several ordinary watercourses within the study area, all tributaries of the Main Rivers listed above and shown in Figure 1-7.

3.2.3 Groundwater Flooding

Overview

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.

Groundwater flooding is responsibility of the LLFA.

Methodology

In order provide an intermediate assessment of the potential for groundwater flooding a number of data sources have been used within the analysis. These include the review of bedrock and superficial geology, available information from borehole monitoring and borehole drilling logs, historical records of groundwater flooding, groundwater modelling (where available) and existing reports on groundwater resources

These sources of information have been used to build a conceptual understanding of the hydrogeology for each settlement and have allowed an intermediate assessment to be undertaken to provide the following:

- Potential groundwater flooding mechanisms;
- Evidence for groundwater flooding;
- Areas susceptible to groundwater flooding (See Section 3.2.5); and
- Recommendations for further investigation.

These findings are used in conjunction with results from the pluvial modelling, and the linkages with flooding from sewer and ordinary watercourses, to provide a wider understanding of surface water flooding issues.

A conceptual understanding of the hydrogeology for Shrewsbury has been developed based on data provided. This has been used to identify groundwater flooding mechanisms, evidence of groundwater flooding, areas susceptible to groundwater flooding and potential requirements for long term monitoring. It has also been used to identify constraints with regards to using infiltration SuDS.

Potential Groundwater Flooding Mechanisms

The key groundwater flooding mechanisms that could exist for Shrewsbury are:

- Superficial geology aquifers in hydraulic continuity with the watercourses: Groundwater flooding may be associated with fluvio-glacial deposits, or to a lesser degree Alluvium, where they are in hydraulic continuity with watercourses. Stream levels may rise following high rainfall events but still remain “inbank”, and this can trigger a rise in groundwater levels in the associated superficial geology. The properties at risk from this type of groundwater flooding are most likely to be limited to those with basements / cellars, which have been constructed within the superficial geology and lie within areas in close proximity to the river channels.
- Superficial aquifers not in hydraulic continuity with the main Rivers: Groundwater flooding is also associated with substantial quaternary deposits (gravel and sand), Alluvial Fan Deposits and Head deposits, but occurs where they are not in immediate hydraulic connection with watercourses. Perched groundwater tables can exist within these deposits, developed through a combination of natural rainfall recharge and artificial recharge e.g. leaking water mains. The properties at risk from this type of groundwater flooding are most likely to be limited to those with basements / cellars.

Evidence of Groundwater Flooding

No available reports of groundwater flooding were collated during the scoping study stage. In addition, Jacobs[xiii] (2004) did not identify any incidences of groundwater flooding on the outcrop of the Permo-Triassic sandstones of England.

Long Term Groundwater Level Monitoring

Groundwater flow direction, depth to groundwater, topography and the degree of artificial influence in the subsurface (e.g. leaking water mains or groundwater abstractions) play an important role when considering the susceptibility of an area to groundwater flooding.

Groundwater level data for the Carboniferous Keele Beds (Westphalian and Stephanian Coal Measures) are limited to recorded water strikes or rest water levels on BGS borehole logs.

Long term monitoring of the Permo-Triassic members associated with the Shropshire Groundwater Scheme, indicate that the recorded levels are substantially lower than the surrounding topography generally tending to ground level near the River Severn, with Quaternary glacial and fluvio-glacial sediments overlaying the permeable nature of the Permo-Triassic sandstones. Resting groundwater levels[xiv] are shown to be approximately 52m AOD in and around the Harlescott area of Shrewsbury.

It is also important to understand how changing policies relating to infiltration SuDS can impact upon groundwater levels. For example the introduction of infiltration SuDS (e.g. soakaways) may cause a localised rise in groundwater levels. This could prevent soakaways from operating and the reduction in unsaturated zone thickness.

Where considered necessary, long term groundwater level monitoring may be implemented to support decision making with respect to future land development and future co-ordinated investments to reduce the risk and informing the assessment of suitability for infiltration SuDS.

Infiltration SuDS Suitability

Improper use of infiltration SuDS could lead to contamination of the superficial or bedrock geology aquifers, leading to deterioration in aquifer quality status or groundwater flooding / drainage issues. However, correct use of infiltration SuDS is likely to help improve aquifer quality status and reduce overall flood risk.

Environment Agency guidance on infiltration SuDS is available on their website at: http://www.environment-agency.gov.uk/business/sectors/36998.aspx. This guidance should be considered by developers and their contractors and by Shropshire Council during the planning application process.

The areas that may be suitable for infiltration SuDS (e.g. soakaways, permeable paving) exist where there is a combination of higher ground (interfluves) and permeable geology (are shown in Figure 8-2 in the Outline Water Cycle Study). However, consideration should be given to the impact of increased infiltration SuDS on properties further down gradient. An increase in infiltration / groundwater recharge will lead to an increase in groundwater levels, thereby increasing the susceptibility to groundwater flooding at the down gradient location. This type of analysis is beyond the scope of the current report.

Restrictions on the use of infiltration SuDS apply to those areas within Source Protection Zones (Figure 1 in Appendix A). Developers should seek advice from the EA on proposed drainage designs where they are located within an SPZ.

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 STW, 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 STW, these should carry only foul sewage but, through misconnections, often also carry surface water
Public surface water sewer	Maintained and operated by STW. They should carry only surface water. Highway drains are often connected to public surface water sewers.
Public combined sewer	Maintained and operated by STW. They carry both foul sewage and surface water. Highway drains are often connected to public surface water sewers.
Private Sewers and Lateral Drains	Maintained and operated by STW, following recent transfer of assets connected to the public sewerage system, on the 1st October 2011[xv].

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 require 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 impermeable areas are connected to the sewers over time.

Much of the sewer system across Shropshire was installed in the early 20th century. Parts of the sewers have been upgraded over the years to cope with significant population growth but the current levels of surface water runoff would not have been factored in when the systems were developed.

The expanding urban area has led to more impermeable surface coverage, causing a significant increase in surface water runoff. This in turn, can lead to the surface water sewer system being overwhelmed on a more frequent basis. Overflows from the foul sewers through gullies and manholes (where their covers are blown due to the internal water pressure) into roads, footpaths, etc, can also occur during large storm events in excess of current design standards.

Severn Trent Water Data - DG5 Register

STW 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 capacity of the pipe is exceeded by the flow.

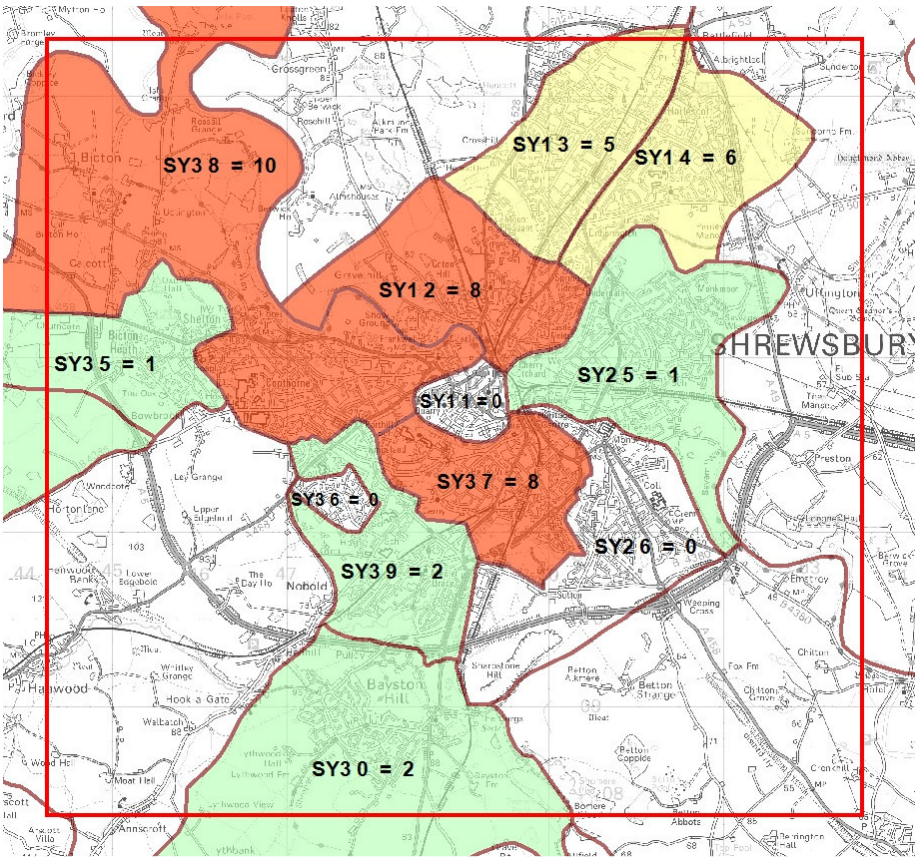

Figure 3-1 – DG5 records per four digit postcode area (Red – High, Yellow – Moderate and Green – Low) © Crown copyright and database right 2012 Ordnance Survey licence number 100049049

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. STW has provided its DG5 database for the study area.

As of April 2011, there were seven areas in Shrewsbury with properties on the DG5 register; the highest recorded number of sewer flooding incidents in Shrewsbury occurred in the SY3 8, SY3 7 and SY1 2 areas.

Postcode	No of Properties	Postcode	No of Properties
SY1 2	8	SY3 5	1
SY1 3	5	SY3 7	8
SY1 4	6	SY3 8	10
SY2 5	1	SY3 9	2
SY3 0	2		

Table 3-3 Summary of DG5 Register (as of April 2011)

Properties must be formally recorded on the DG5 register before a scheme to reduce risk can be considered. STW is required to undertake work 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. Under STWs current Sewer Management Plan (SMP) a number of works are currently being assessed and actioned in the highest risk areas identified in the DG5 register.

Severn Trent Water Data - Sewer Network Location

STW also provided information on its 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 there being sufficient cause, STW 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 Shrewsbury is served by separate sewers. As with many places, these will, no doubt, have been subject to misconnections and inappropriate usage as the area has been developed. It is likely that the sewers across Shrewsbury have varying standards of capacities.

Sewer Flood Risk Summary

The risk of sewer flooding is perceived to be ***moderate to high*** across Shrewsbury for a number of historical reasons highlighted above, which include but are not limited to:

- Misconnections;
- Cross connections;
- Urban intensification;
- Inappropriate use (fats, oils and greases);
- Poor historical planning decisions;
- Surcharged outfalls (high river levels);
- Natural catchment - impermeable soils
- Urban creep (e.g. paving of front drives); and
- Diversion of 'natural' watercourses into the sewerage system

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 can have serious consequences, which are often exacerbated by topography, as water from surcharged manholes will flow into low-lying urban areas.

STW is currently addressing the understanding of sewerage flood risk through the development of a Sewerage Management Plan (SMP). This is currently on-going for Shrewsbury, and, as such findings presented in this SWMP should be revisited once work on the SMP is complete.

Future urban growth plans should be undertaken in consultation and agreement with STW and in line with SC guidance on surface water management for new developments.

3.2.5 Potential Indicators of Local Flood Risk

EA Areas Susceptible to Surface Water Flooding (AStSWF) Maps

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

- 0.5% AEP (1 in 200 chance of occurring in any given year)
- 240 minute storm duration
- 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.

This study was used to identify the Properties at Risk of surface water flooding shown within Table 2-1 and used by Defra as the basis for ranking settlements at risk of flooding to help prioritise efforts to understand and address surface water flooding across these communities. Figure 2 in Appendix A shows the mapping for the whole study area.

EA Flood Maps for Surface Water (FMfSW)

Following on from the release of the Areas Susceptible to Surface Water Flooding, The EA updated the original mapping in order to produce the Flood Maps for Surface Water (FMfSW), which were released in October 2010. The existing maps were updated to take account of buildings and 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 Mannings '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 return period events. The FMfSW maps have not been used in this study due to the uncertainty of the outlines. The FMfSW maps don't seem very consistent and seem to only show localised ponding in the area. It was felt the AStSWF maps were more accurate. Figure 3 in Appendix A shows the mapping for the whole study area.

Summary of Results

The surface water modelling identified the following flooding mechanisms:

- 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.

EA Areas Susceptible to Groundwater Flooding Maps

The Environment Agency has produced a dataset referred to as 'Areas Susceptible to Groundwater Flooding (AStGWF)', on a 1 km grid. This utilises the BGS 1:50,000 Groundwater Flood Susceptibility dataset for consolidated aquifers (bedrock) and superficial geology, as

shown in Figure 4 in Appendix 3. 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 are passed through a second set of rules in order to create a groundwater level surface (this was taken from groundwater contours, inferred river levels, borehole data and other BGS datasets). The final groundwater level was then compared to a DTM, and the resulting modelled depths of groundwater level above the surface were translated into associated risk categories 'Very High', 'High', 'Moderate', 'Low' and 'Very Low'. An absence of values for any grid square means that no part of that square is identified as being susceptible to groundwater emergence.

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. It does not show the probability / risk of groundwater flooding occurring; this can only be determined following site specific investigation works and desk studies. It also does not take into account groundwater level rebound following cessation of abstraction.

The areas that are identified as being most susceptible to groundwater flooding, compare favourably with the underlying geology, and are located within the high permeability Permo-Triassic Sandstone area to the North west of Shrewsbury Town Centre, with lower levels at risk to the south east associated with the lower permeability Carboniferous Keele Beds.

It is thought that the approximate areas identified by the Environment Agency as being susceptible to groundwater flooding are reasonable. However it should also be noted that the groundwater contours within the Permo-Triassic Sandstone show a flow direction either towards the River Severn from the north of Shrewsbury or the Quaternary glacial or fluvio-glacial sediments. In addition, levels within this aquifer can be heavily modified during the operation of the Shropshire Groundwater Scheme.

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.

3.2.6 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 culverts)
- Carriageway and footway gully cleaning

As a landowner, SC is also responsible for the maintenance of watercourse on, or forming the boundary to, its property.

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. STW has 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, STW will undertake this work, regardless of whether it is a surface water, combined or foul sewer.

STW carries out a range of pro-active CCTV, predictive modelling and cleansing activities, as well as reacting to reports of operational issues as part of its annual maintenance activities. For example in North Shrewsbury STW have a blockage reduction strategy in place to ensure targeted maintenance activities take place on the system. Further details of which can be obtained from STW, if required.

Environment Agency

The EA can, and does, carry out strategic maintenance on designated main rivers. Details of the current Environment Agency's maintenance programme[16] are available on its website.

3.3 Wetspot Screening Assessment

3.3.1 Approach

The strategic assessment identified Shrewsbury as a broad location susceptible to surface water flooding. This Scoping phase will now look in more detail 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 Shrewsbury using historical flooding incidences and / or future flood risk based on the ASTSWF.
- Multi-Criteria Assessment (MCA) Methodology. This describes the MCA approach agreed with Shropshire Council.
- Prioritisation of wetspots within Shrewsbury 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 first stage of the assessment was to identify those areas within Shrewsbury 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 EA's National Receptor Database (NRD) property points into the 'wetspots'. This database contains information on all known properties / land features in

England and Wales, and has multiple potential entries for the land/property use such as for instance dwelling, school, pond, farming etc.

All the property points falling within “more”, “intermediate” or “less” modelled areas of the ASTSWF maps were identified using simple database queries. If these properties were already contained within an existing ‘wetspot’, then no further action was taken. Those property points outside a ‘wetspot’ were then analysed to identify if the existing ‘wetspot’ could be expanded to incorporate them or required the creation of a new ‘wetspot’.

Where more than 10 properties in an area fell within the deep, intermediate or shallow ASTSWF and there was no historical flooding information/records, new ‘wetspots’ were created. These ‘wetspots’ are, therefore, those with a perceived high chance of future flooding.

Some of the identified wetspots have a significant proportion of the properties in the ASTSWF zones being 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.

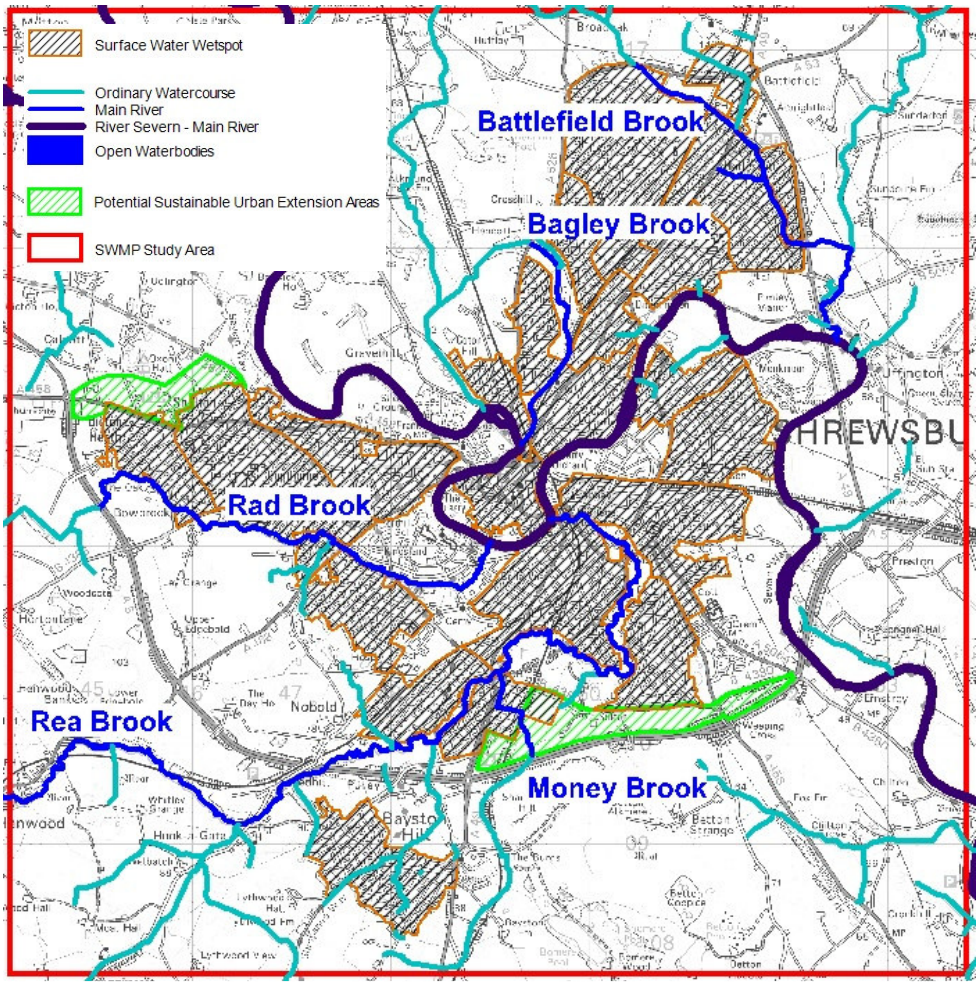

Figure 3-2 – Identified Surface Water ‘Wetspots’ © Crown copyright and database right 2012 Ordnance Survey licence number 100049049 © Environment Agency 2012

3.3.2 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 Shrewsbury have been identified using data sources from the EA, SC and STW. 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 Geostore; 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. The database was interrogated to identify critical infrastructure, domestic properties and non-domestic properties for use during the Multi-Criteria Analysis stage.

3.3.3 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 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[a]
- Pumping Stations[a]
- 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.

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

Land and Public Open Space

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

- Special Area of Conservation (SAC)
- Special Area of Protection (SPA)
- RAMSAR Site
- Site of Special Scientific Interest (SSSI)
- County Wildlife Site
- County 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.

3.3.4 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 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 Shrewsbury 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 Shrewsbury 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 B.

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 B.

It has been assumed that roads within the “less” zone only will remain passable to vehicular traffic; consequently these have been assigned a weighting equal to ¼ of the “more” 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 B.

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.

Flood Susceptibility Weighting

The ASTSWF 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) zones as below were assigned differing susceptibility scores:

“less” 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) “more” 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

Area Adjustment

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

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.

3.3.5 Shrewsbury Wetspots

Using the process outlined above, a total of 23 wetspots were identified; 17 due to historical flooding and a further six with a likely future flood risk based on the ASTSWF. The wetspots are shown in Figure 3-3 and in Figure 5 in Appendix A.

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 Shrewsbury are shown in Appendix B.

3.3.6 Implications for Future Development

As shown in Figure 3-2, the preferred option for strategic Sustainable Urban Extension developments proposed at the time of writing are located on the outskirts of the town on predominantly Greenfield sites. These are located to the south (land adjacent to Meole Brace Retail Park) and the west (Land north of Welshpool Road).

Proposed developments are subject to the requirements of the planning system and therefore it is considered that the findings of the SWMP should be taken into account during the design and layout of the developments. It is envisaged that due to the scale of development, an FRA will be required as part of the planning process for each planning application. This should address surface water issues at the development scale.

Figures 3-3 and 3-4 provides an overview of the proposed development areas to the south and north-west of Shrewsbury respectively, along with the Environment Agency FMfSW.

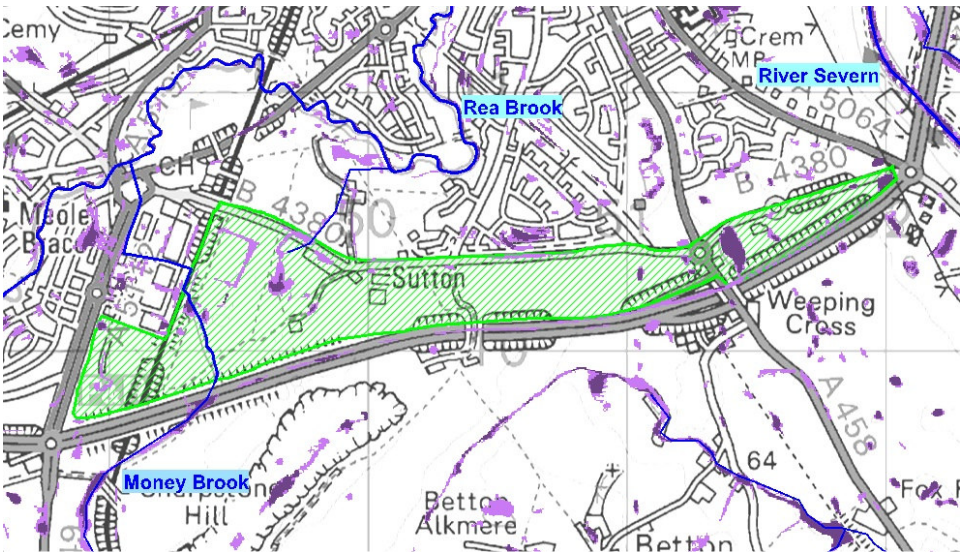

Figure 3-3 – FMfSW results for the 0.5% AEP rainfall event for the Southern SUE © Crown copyright and database right 2012 Ordnance Survey licence number 100049049

Where flow paths exist, these follow the route of existing drainage ditches and ordinary watercourses across the agricultural land. Proposed development should accommodate such areas within the Masterplanning process and provide open space, for example by setting development back from these features or retaining a corridor within the locality.

Further investigation should be undertaken in conjunction with relevant stakeholders (in particular The Highways Agency and leaseholders of the Meole Brace Retail Park) with regard to the capacity of culverts along the Money Brook and the potential for blockages and ponding upstream of these features.

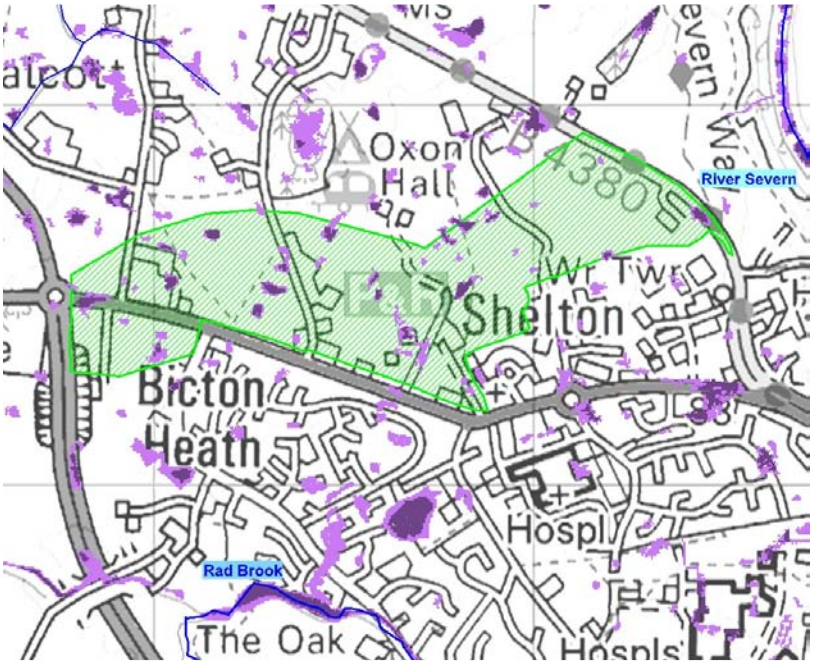

Figure 3-4 – FMfSW results for the 0.5%AEP rainfall event for the Western SUE © Crown copyright and database right 2012 Ordnance Survey licence number 100049049

The Western SUE area does not have significant flow paths and therefore surface water flooding in this area would not be deemed a significant flood risk on a strategic scale. Where

flow paths exist, these are likely to follow the route of existing drainage ditches and topographical depressions across the agricultural land.

Proposed development should accommodate such areas within the Masterplanning process and provide open space, so as not to exacerbate the scale of surface water flooding in these locations and provide opportunities for amenity, habitat creation and sustainable drainage.

At the development scale, this should be investigated further as part of the site design process. In addition, opportunities to reduce the contributions of surface water into the system should be investigated so as to help alleviate downstream surface water flood risk within the Rad Brook.

The STW sewer maps indicate that no foul or surface water sewer network exists on either of these SUE sites (they are predominantly Greenfield areas at present). Where development is proposed, new infrastructure will be required to manage surface water runoff from the site. The feasibility of suitable SuDS techniques for use onsite will need to be identified. Where management of surface water onsite is not reasonably practicable via infiltration systems, attenuated discharge to a nearby watercourse or sewer will need to be sought (see Schedule 3 of the FWMA for guidance).

Proposed development must also ensure it meets the requirements of the NPPF and the Shropshire Council Developer Requirements with regard to surface water management.

4 Recommendations for future works – Detailed Level Assessment

4.1 Detailed Study – Methodology, outputs and requirements.

A key aspect of this Report was to review the available information and the aspirations for the delivery of the SWMP for Shrewsbury to help select an appropriate approach to the risk assessment, which includes the modelling technique and methodology and to define the overall approach to delivering the Detailed level Action Plan in agreement with the key stakeholders across the Study area.

4.1.1 Selecting an approach for undertaking the Detailed Level Risk Assessment.

Risk is the product of probability of occurrence and consequence. The consequence comprising damage to property, infrastructure or injury to people and is linked with hydraulic parameters (or hazards) such as flood depth, runoff volumes and flow velocities.

Hydraulic parameters are determined from modelling and boundaries for probability are normally defined in planning documents. For instance, high probability defined in PPS 25 for fluvial flooding is 1% AEP event. The climate change scenario assumes a 10% and 30% rise in rainfall as per current PPS 25 guidance for the 2055 and 2115 horizons.

SWMP Technical Guidance

Sections 3.11-3.14 of the SWMP Technical Guidance provide different techniques for carrying out risk assessments. These were reviewed and the discussion below summarises their advantages and limitations.

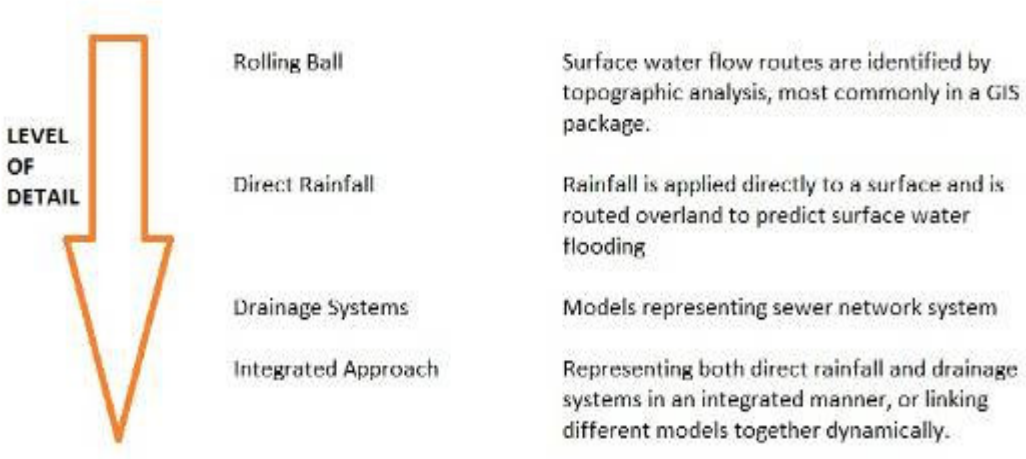

Figure 4-1 SWMP Technical Guidance – Modelling Option Levels

The Rolling Ball method is the simplest method available which utilises GIS software to compute flood levels. The major disadvantage from this method is that it analyses only pathways and receptors, and the magnitude of risk (velocities and depths) is not calculated.

The Direct Rainfall method applies rainfall events of known probability to hydraulic models built using DEM/DTM data directly. Runoff volumes and depths of water can be estimated. These have already been completed for the Study Area, as identified in Section XX, through National Mapping studies carried out by the Environment Agency.

The Drainage System methods can model underground drainage networks. However this heavily depends on availability of information from the Water Company. For this SWMP, STW has advised that sewer models could be provided, but are currently being updated with results available from the latter part of the financial year 2012-13.

The last method discussed is the Fully Integrated Model, which combines a surface model with the underground network. This method can be highly resource and data/information intensive and requires specialist skills and modelling software. This approach would usually best serve specific flood risk area investigations, however, with computational software and hardware improvements wider scale modelling of the scale of Shrewsbury is becoming achievable.

Flood Risk to People Guidance Document (FD2320)

The guidance provides information on how to assess flood risk to people. In summary, flood risk is dependent on flood hazards (such as velocity, depth and debris), area vulnerability (e.g. percentage of area affected by a flood warning system), and people's vulnerability (e.g. elderly and ill persons).

Further to our request, the Environment Agency has advised that information on people's vulnerability can only to be released for Civil Contingencies Act purposes, and hence the method proposed in FD2320 cannot be applied fully in this study. However, the principles underlying hazards assessment and area vulnerability outlined in the guidance will be used in the assessment of flood risk for this SWMP study.

Modelling Approach Selected for the SWMP Study

Based on guidance from the Draft SWMP Technical Guidance, best practice in the industry, local knowledge and current stakeholder activities in this area we have developed the following two stage modelling approach to assess the local flood risk hazards for Shrewsbury.

1. Individual Stakeholder Modelling Activities during 2012/13, including ordinary watercourse and surface water sewer modelling.

2. Combine individual models during early 2013, to deliver an Integrated Surface Water Model for Shrewsbury to assist with undertaking a Detailed Risk Assessment for Shrewsbury and the development of appropriate options to aid flood risk management improvements across the Study Area.

Section 4.2 details the Action Plan for activities in relation to modelling to be undertaken over the coming months, however in short, the development of the Detailed SWMP and subsequent Action Plan, would benefit from an interim stage of works and overall, a minor extension to the programme of delivery, so as to take full advantage of emerging works being developed by the key stakeholders in the area, for example:

- STW is currently involved in delivering a Sewerage Management Plan for Shrewsbury. This involves a review and update of the existing sewer model(s) from before 2005, to incorporate capital schemes delivered in the intervening period and other developments and network performance information gained from operational staff. This new specification for producing a sewerage model will allow STW to identify performance and risk to the network and the potential risks to the resident population.

- SC and the EA are undertaking works in the area to identify and understand local flood risks including the delivery of the requirements for the Local Flood Risk Management Strategy as identified within the Floods and Water Management Act 2010.
- Additional surveys are planned across Shrewsbury to improve the flood risk information of several surface water features, including CCTV surveys to identify the current condition of several important assets across the Study Area. In addition, watercourse and structure surveys are planned for many watercourses where, to date, information is missing on the asset including its connectivity to the Environment Agency classified Main Rivers.

Following these activities highlighted in more detail below, the EA, STW and SC have agreed to permit the use of the modelling information gained to deliver an Integrated Drainage Model for Shrewsbury to aid the understanding of flood risks across the study area and help develop suitable solutions to help address identified risks. Subsequent to the model build phase, the model would then be used to:

- Check results for any discrepancies, including stakeholder workshops to identify the results and test the model outputs against known flooding issues and events.
- Produce hazard maps (velocities and depths)

4.1.2 Approach to Interpretation of Results & Spatial Analysis

The interpretation of results will be based firstly on the understanding of why the hazards are materialising, and thereafter verifying the hazards with:

- Historical flood records
- Severn Trent Water DG5 records and other high risk areas (as per STW Sewerage Management Plan findings and other supplied information).

The impacts of the identified hazards will be assessed against the following receptors using GIS mapping:

- National Receptor Dataset including Address Point data and the Social Flood Vulnerability Index information
- Critical infrastructure
- Development areas (Sustainable Urban Extensions, SHLAA/ELR Sites)

Based on the above, drawings will be produced showing refined surface water flood maps, impact of surface water flooding on the critical infrastructure and proposed development areas.

4.1.3 Constraints

The accuracy of the LiDAR information has a direct influence on the 2D modelling exercise. It is advisable that all digital terrain models are carried out using LiDAR information with +/- 0.15m accuracy (vertical). Data with coarser resolutions may generate outputs with limited application and may lead to erroneous solutions and unnecessary work.

4.1.4 Approach to Developing Solutions (Options)

As recommended in the SWMP guidance, the approach to the Options Phase will initially identify and short list mitigation measures, based on which cost benefit analyses will be carried out. This will determine the preferred option for the key wetspots.

Options for these sites will be developed on the basis that the reasons behind the surface water flooding are defined as described in the previous section. For the key wetspots, agreed with the stakeholders, indicative solutions will be developed, taking into consideration its location (urban or rural), proximity to any existing water feature, level of contamination in the area (suitability of SuDS) and any existing plans for alleviating surface water flooding planned by STW. The options will be reported and discussed in the Detailed SWMP for each of the key wetspots, which will include:

- A shortlist of potential solutions (scored to eliminate undesirable ones) to mitigate against surface water flooding in areas at high risk
- Cost Benefit Analyses of shortlisted options, taking into consideration maintenance costs where possible.
- Final preferred solutions, which will include, as initial examples some or all of the following:
    - The most appropriate sustainable drainage system for existing or new developments (for example, swales, ponds, alleviation channels). Indicative sizes and volumes may be recommended where appropriate.
    - Use of existing water features (such as ponds, marshy areas and natural depressions) in public domain to solve surface water flooding
    - Use of highways as a mode to convey surface water emanating from overland flooding
    - Potential requirements for improving the sewerage infrastructure
    - Identification of impacts and requirements for future development areas, based on the Sequential approach of PPS 25
    - Identification of protection works for key identified critical infrastructure

This wetspot information will provide the Council, Developers and STW with enough information to include the SWMP's recommendations in their Strategic Plans for addressing flood risks. This could include for example, modifications to existing maintenance regimes, such as cleansing activities for gullies, watercourses or structures.

4.1.5 Approach to Implementation and Review

The approach to this Phase will include the prioritisation of works depending on the Council's policies for regeneration, growth and funding available. The development of the implementation programme with realistic targets will be undertaken in consultation with the Key Partners.

In order to summarise the findings of the consultations on this matter and facilitate implementation, it is proposed that the Detailed SWMP phase includes further detail on activities and actions required and highlights the implementation plans, funding requirements and additional linkages to other Council activities.

The SWMP report will produce information based on the preferred option for each of the key wetspots selected for investigation, an action plan required by Key Partners and Stakeholders. This may include some or all of the following:

- Capital and maintenance action plans, and who will be responsible for them
- Advice and information to local authorities and planners
- Advice and information to local resilience forums and emergency planners
- A communication strategy to disseminate findings of the plan to all stakeholders
- A reference to when the plan will be reviewed and updated

4.2 Intermediate Stage - Action Plan

A strategic level action plan has been developed and is outlined below.

4.2.1 2011/12 Programme Activities – Stage 2 - Modelling

2a - Collection of missing information – Further Asset Surveys

SC to procure further asset and CCTV surveys to fill in the gaps in knowledge for the Shrewsbury's surface water system, as identified in Figure 6 in Appendix A.

4.2.2 2012/13 Programme Activities – Stage 2 - Modelling

2b - Identification of appropriate Flow Surveys

SC to maintain liaison with STW so as to minimise costs associated with the delivery of flow surveys on surface water sewer system in terms of timings and locations.

SC to investigate the potential costs and areas for commissioning a short term flow survey for a number of the receiving watercourses across Shrewsbury to run concurrently with sewer system flow survey as far as is practical.

2ci- Continuation of STW activities for developing a Sewerage Management Plan Model

STW is currently updating an InfoWorks CS model of the sewer network in Shrewsbury. Communication between SC and STW should be maintained in order to:

- Agree extents to be included in the model, particularly with respect to the surface water sewer system. This will highlight the areas to be addressed by SC.
- Agree critical storm durations, downstream boundary conditions (e.g River Severn event compared to local storm) and sub catchment boundaries for initial model testing to assess validity of the works carried out.

2cii– Watercourse Modelling & processing survey data

SC will then utilise the information gathered from the new survey data for the watercourses identified, to procure and produce appropriate hydraulic models for each of the key unnamed ordinary watercourses within Shrewsbury, using Industry standard software (InfoWorks RS).

In addition, existing Main River models will be reprocessed from current ISIS and ISIS/TuFlow models to InfoWorks RS and tested to assess the impacts of the model migration and to deliver useable inputs for a future model integration exercise. The choice to develop the watercourse models within the Industry standard (InfoWorks RS) software was taken as it will facilitate the future combination of the watercourse and below ground sewerage models.

2d - Develop Combined Model

On completion of the river model and the STW sewerage model works, a combined sewer and river model within InfoWorks ICM would be constructed for Shrewsbury to allow for the better representation of risks to Shrewsbury for surface water flood risks, taking into account the key links, in terms of risk between the surface water elements (pluvial, sewerage and other watercourses) and the Main Rivers of Shrewsbury and their influence on each other.

4.2.3 2012/13 Programme Activities – Stage 3 - Plan Development

Detailed Surface Water Management Plan Delivery

Following the completion of the baseline combined model, works will focus on the confirmation of the key wetspots, so that the Risk Assessment can be completed in full. At this stage, the key wetspots will be investigated further to understand the risk and help identify potential measures and options that can be instigated to help deliver flood risk improvements. Furthermore, the works will help confirm the key assets at risk within Shrewsbury that perform a flood management duty to inform the Asset Register as required under legislation.

This could include the need for modelling of the potential interventions across a number of the key wetspots to identify the potential costs and benefits associated, so that a preferred option can be reached and the key actions for each stakeholder can be identified to deliver an agreeable and appropriate Action Plan.

4.3 Ongoing Flood Risk Management Activities Recommendations

4.3.1 Data and Asset Management

SC should ensure that its existing GIS based asset registers are kept up to date in line with current guidance concerning their development and maintenance. As the database develops, SC will be in a position to identify those assets which they consider critical.

In addition, any new survey information arising from the hydraulic modelling recommendations should be added to the asset register.

4.3.2 Planning and Policy

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.

SC 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 the proposed Water Management SPD will replace the interim guidance document. The SPD should be published and used to communicate local solutions for mitigating increases in surface water flood risk as well as adapting existing risks.

SC should monitor and maintain the Developer Guidance prior to the Water Management SPD. SC should review the most appropriate vehicle for implementing surface water drainage policies, noting that SPDs can only provide guidance rather than setting policy.

SC should write the LFRMS ensuring consistency with the principles of the national strategy. Consider the need for scrutiny and consultation. The Detailed SWMP study would deliver further specific information for the LFRMS for Shrewsbury.

Ensure duties of the SAB are maintained by SC.

4.3.3 Campaigns and Communication

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 Shrewsbury Town Council where appropriate, consider the following:

- Raising awareness of increased impermeable areas
- 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.
- 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.
- Facilitate developer forums where necessary to consider cumulative impacts and strategic solutions, as well as opportunities to reduce local flood risk.
- 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.

4.3.4 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[17].

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[18].

4.3.5 Emergency Planning - Environment Agency Flood Warning

Shrewsbury is currently covered by five Environment Agency flood warning areas. The areas include the River Severn and the Rea Brook, where residents 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.

4.4 SWMP Next Stages

The next stage of the SWMP should be carried out on completion of the hydraulic modelling actions discussed above. The Detailed SWMP would then interrogate the integrated model in key wetspots to identify and review potential solutions including delivering costs and benefits for proposed solutions to allow for the submission of appropriate information for submissions for funding applications to support potential projects.

A detailed Action Plan should then be compiled which identifies key responsibilities and timescales for implementing the preferred options.

4.4.1 Future work and Programme

Task / Stage	Detail	Estimated Deliverable Date	Comments
Stage 1 – Scoping Report	Scoping Report	Feb 2012	Inclusive of survey scope & management
Stage 2a	Survey Stages	June 2012	
Stage 2b (optional)	Watercourse Flow & Level Survey	June 2012	Based on 3 month programme for two installations
Stage 2ci and Stage 2cii	Watercourse & STW Modelling – note this activity could be added into Stage 2d	March 2013	• Inclusive of modelling several Watercourses • No costs identified for STW works
Stage 2d	Model Integration	September 2013	Assumed undertaken in Infoworks ICM
Stage 3	Detailed SWMP Delivery including: • Risk Assessment • Options • Implementation & Review • Evidence to support potential solutions identification	February 2014	Agreement of Detailed Action Plan for flood risk management activities in the area.

Table 4-1 Indicative Stages and proposed remaining programme for development of a Detailed SWMP for Shrewsbury

5 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] Halcrow (2007) Shropshire Districts Level 1 Strategic Flood Risk Assessment

[6] Halcrow (2009) Shropshire Districts Level 2 Strategic Flood Risk Assessment

[7] http://www.communities.gov.uk/planningandbuilding/planningsystem/planningpolicy/planningpolicyframework/

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

[9] Downloaded from Shropshire Council's website - http://www.shropshire.gov.uk/environmentmaintenance.nsf/viewAttachments/DCLN-8LEM36/$file/shropshire-council-PFRA.pdf

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[xii] Shropshire Flood Forums text taken from Shropshire Council Website (09/12/2011) - http://www.shropshire.gov.uk/environmentmaintenance.nsf/open/E57DA61A042F100E8025772E00578FC8

[xiii] Jacobs (2004) - Strategy for flood and coastal erosion risk management: groundwater flooding scoping study (LDS 23) Final Report

[xiv]

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

Vesey, K (2009) Groundwater Management: the Shropshire Groundwater Scheme. Proceedings of the Shropshire Geological Society, 14, 20–29

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

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

Appendix A

Drawings

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

LEGEND

- SWMP Study Area
- Ordinary Watercourses
- Main River
- River Severn - Main River
- Open Waterbodies

Source Protection Zones (50k)

- Zone 3 - Total Catchment
- Zone 2 - Outer Zone
- Zone 1 - Inner Zone

Hyder

Shropshire Council

Shropshire County Council

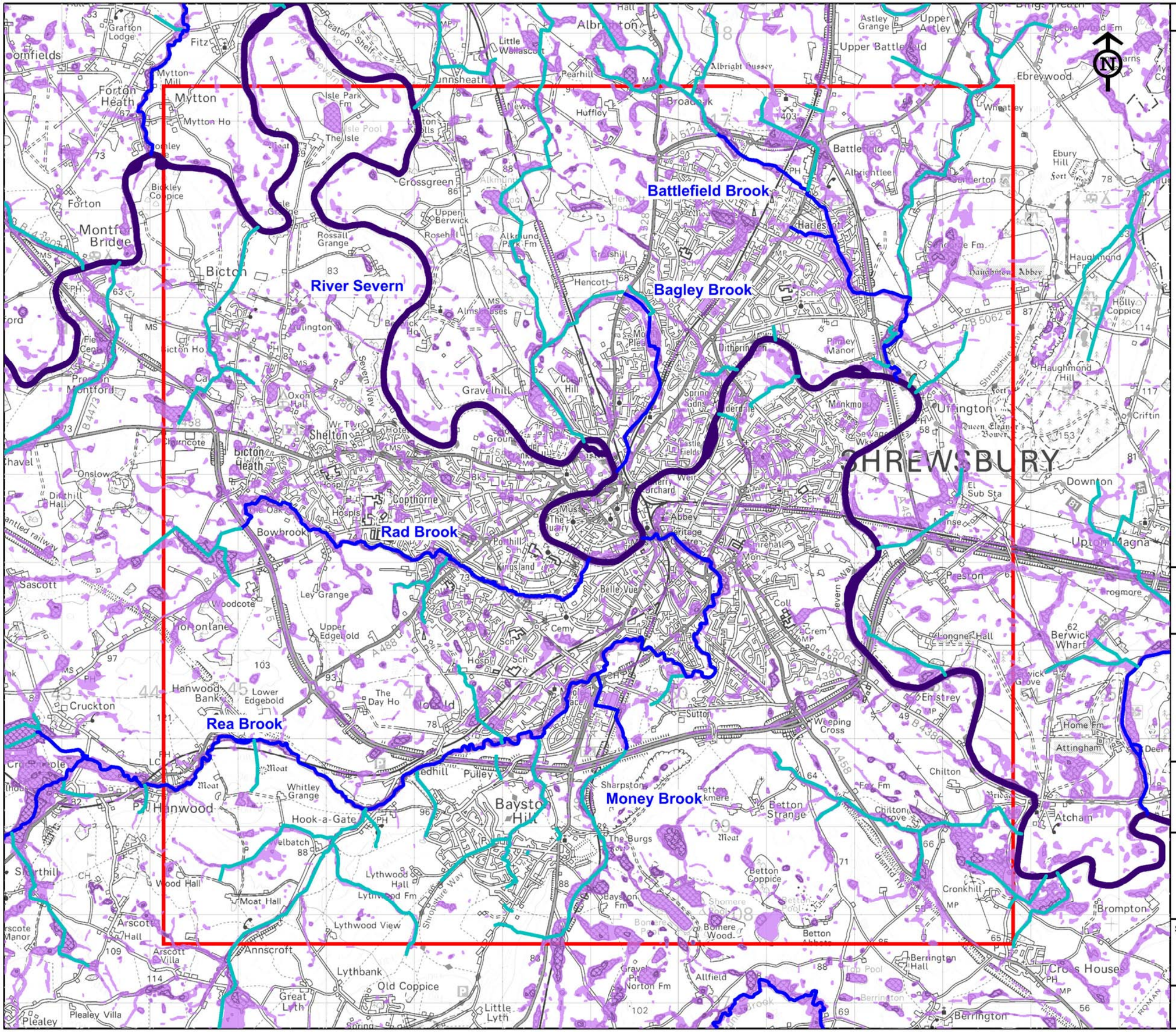
Shirehall, Abbey Foregate, Shrewsbury, SY2 6ND

SHREWSBURY SURFACE WATER MANAGEMENT PLAN

FIGURE A1 SOURCE PROTECTION ZONES

SCALE			
N.T.S	Produced	CG	Feb 2012
	Checked	LF	Feb 2012
	Approved	LF	Feb 2012

DRAWING NO.
5045-UA002182-06-BMD-00



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LEGEND

- SWMP Study Area
- Ordinary Watercourses
- Main Rivers
- River Severn - Main River
- Open Waterbodies

Areas Susceptible to Surface Water Flooding

- More Susceptibility
- Intermediate Susceptibility
- Less Susceptibility

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Shropshire County Council

Shirehall, Abbey Foregate, Shrewsbury, SY2 6ND

SHREWSBURY SURFACE WATER MANAGEMENT PLAN

FIGURE 2
AREAS SUSCEPTIBLE TO SURFACE WATER FLOODING

SCALE			
N.T.S	Produced	CG	Feb 2012
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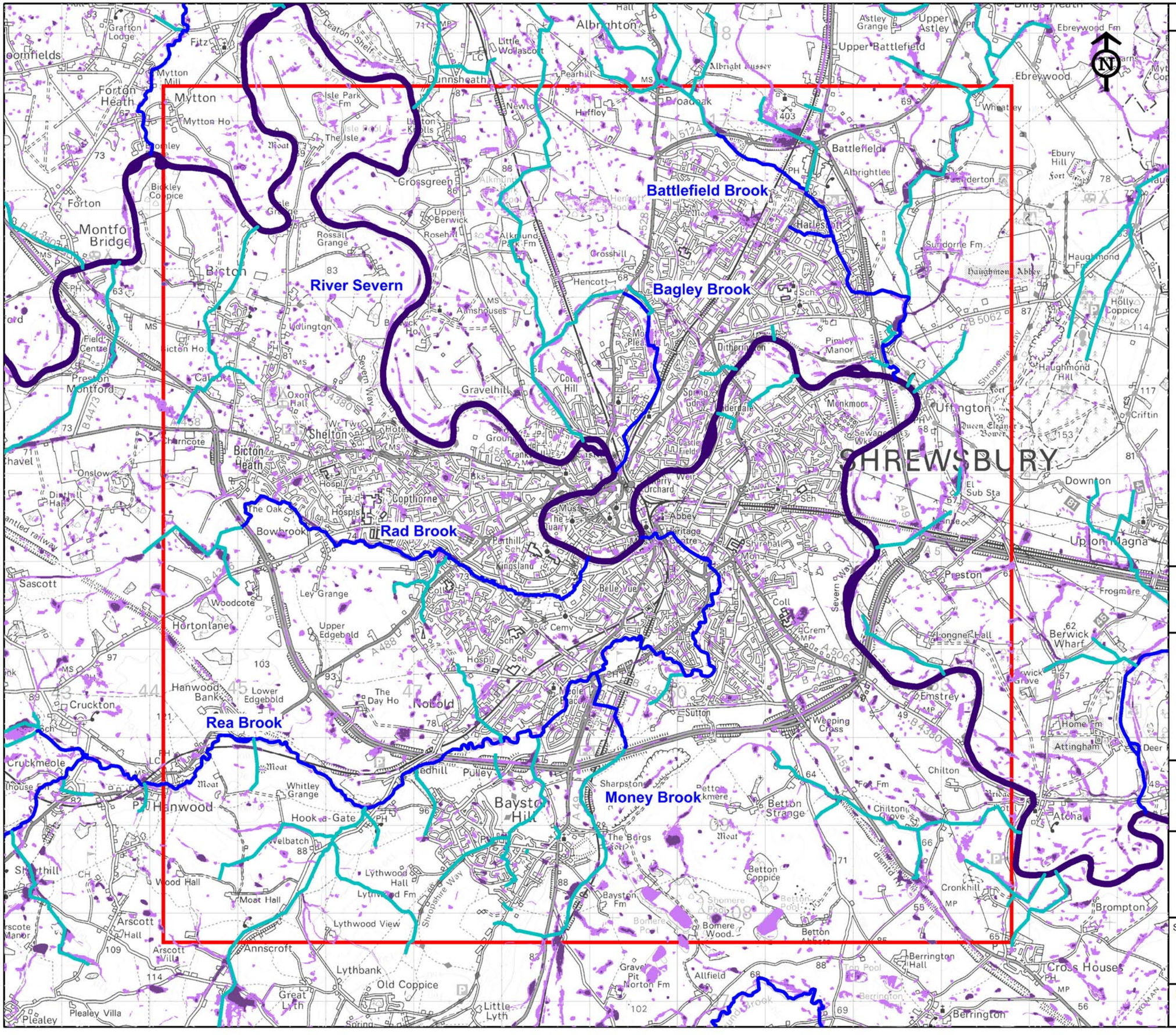
	Approved	LF	Feb 2012

DRAWING NO.
5045-UA002182-06-BMD-00



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LEGEND

- SWMP Study Area
- Ordinary Watercourses
- Main Rivers
- River Severn - Main River
- Open Waterbodies

Flood Maps for Surface Water Mapping

- 30 year deep
- 30 year shallow
- 200 year shallow
- 200 year deep

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Shropshire County Council

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SHREWSBURY SURFACE WATER MANAGEMENT PLAN

FIGURE A3 FLOOD MAP FOR SURFACE WATER

SCALE			
N.T.S	Produced	CG	Feb 2012
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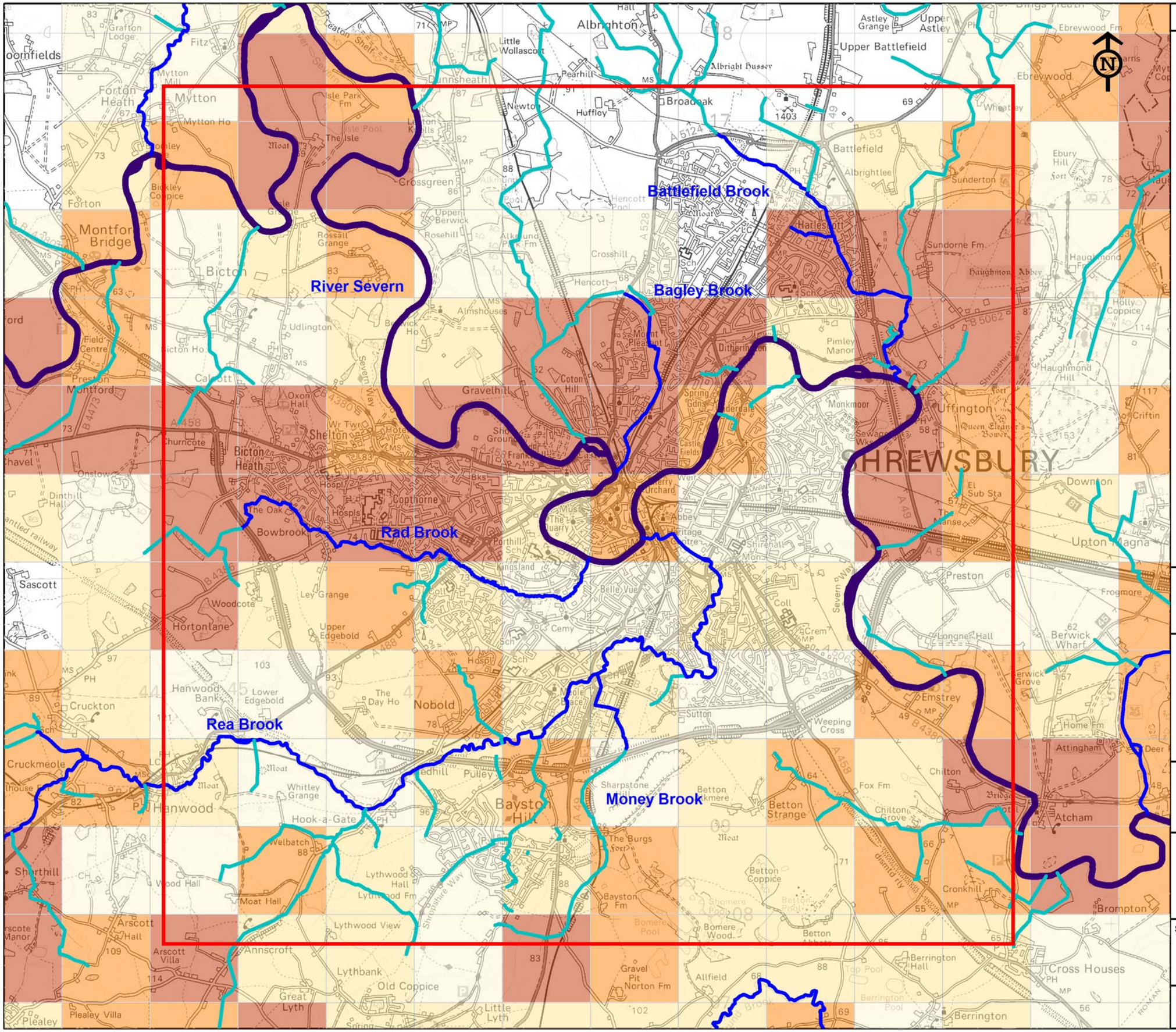
	Approved	LF	Feb 2012

DRAWING NO.
5047-UA002182-06-BMD-00



THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

LEGEND

- SWMP Study Area
- Ordinary Watercourses
- Main Rivers
- River Severn - Main Rivers
- Open Waterbodies

Areas Susceptible to Groundwater Flooding (%)

- < 25
- >= 25 < 50
- >= 50 < 75
- >= 75

This map forms an approximate guide to areas that may be susceptible to groundwater flooding. However, for all new developments, site investigation is required to confirm local groundwater levels and therefore risk of groundwater flooding.

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SHREWSBURY SURFACE WATER MANAGEMENT PLAN

FIGURE A4
AREAS SUSCEPTIBLE TO GROUNDWATER FLOODING MAP

SCALE			
N.T.S	Produced	CG	Feb 2012
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	Approved	LF	Feb 2012

DRAWING NO.
5044-UA002182-06-BMD-00

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LEGEND

- Surface Water Wetspot
- Ordinary Watercourse
- Main River
- River Severn - Main River
- Open Waterbodies
- Potential Sustainable Urban Extension Areas
- SWMP Study Area

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Shirehall, Abbey Foregate, Shrewsbury, SY2 6ND

SHREWSBURY SURFACE WATER MANAGEMENT PLAN

FIGURE A
SWMP IDENTIFIED WETSPOTS

SCALE			
N.T.S	Produced	CG	Feb 2012
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LEGEND

- Potential Culverted Watercourse Survey
- Potential Structure Survey
- Potential Open Channel Survey
- Potential CCTV & Asset Survey

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Shropshire County Council

Shirehall, Abbey Foregate, Shrewsbury, SY2 6ND

SHREWSBURY SURFACE WATER MANAGEMENT PLAN

FIGURE A6 POTENTIAL SURVEY REQUIREMENTS

SCALE			
N.T.S	Produced	CG	Feb 2012
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DRAWING NO.
5051-UA002182-06-BMD-00

Appendix B

Multi-Criteria Analysis

Wetspot No	Wetspot Name	Multi-Criteria Analysis				Rank MCA	Area	Area Weighted				Rank on weighted total	Historical Reports	Rank on Historical Scores	Final Score	Final Ranking
		Domestic	Critical	Non-Domestic	Total		Ha	Domestic	Critical	Non-Domestic	Total					
		A	B	C	D = A+B+C	RANK D	E	F = A/E	G = B/E	H = C/E	I = F+G+H	RANK I	J	RANK J	K = I x J	RANK K
1	Harlescott	1185.21	95.00	302.75	1582.96	5	192.95	6.14	0.49	1.57	8.20	11	20	19	209	6
2	Sundorne	217.62	25.00	11.50	254.12	18	21.11	10.31	1.18	0.54	12.04	18	4	3	54	18
3	Sundorne_Trade_Park	312.39	162.25	156.50	631.14	13	113.89	2.74	1.42	1.37	5.54	9	16	16	144	9
4	Heathgates	72.54	0.00	50.00	122.54	24	66.74	1.09	0.00	0.75	1.84	2	33	23	46	21
5	North_of_Mount_Pleasant	97.11	0.00	40.50	137.61	23	42.57	2.28	0.00	0.95	3.23	4	4	3	12	25
6	Ditherington	341.64	89.75	34.75	466.14	16	40.18	8.50	2.23	0.86	11.60	16	4	3	48	20
7	Spring Gardens	177.84	40.13	22.38	240.34	19	47.55	3.74	0.84	0.47	5.06	8	6	9	72	16
8	Castlefields	788.58	372.50	121.50	1282.58	6	73.60	10.71	5.06	1.65	17.43	22	37	24	528	1
9	Underdale	155.61	274.13	97.75	527.49	14	47.48	3.28	5.77	2.06	11.11	15	9	11	165	8
10	Monkmoor	749.97	35.00	182.50	967.47	8	93.25	8.04	0.38	1.96	10.37	13	9	11	143	10
11	Area_surrounding_Cherry_Orchard	311.22	1735.13	322.88	2369.22	1	131.23	2.37	13.22	2.46	18.05	23	30	21	483	2
12	Coton_Hill	73.71	61.13	8.25	143.09	22	31.81	2.32	1.92	0.26	4.50	7	18	18	126	12
13	Shrewsbury_Centre	113.49	25.00	62.00	200.49	21	48.98	2.32	0.51	1.27	4.09	6	28	20	120	13
14	North_Shelton	273.78	571.63	146.00	991.41	7	108.10	2.53	5.29	1.35	9.17	12	31	22	264	4
15	BellE_Vue	796.77	643.88	152.25	1592.90	4	146.17	5.45	4.41	1.04	10.90	14	43	25	260	5
16	Sutton	189.54	0.00	23.00	212.54	20	79.40	2.39	0.00	0.29	2.68	3	5	6	18	23
17	Meole_Brace_Retail_Park	353.34	295.00	23.00	671.34	11	52.94	6.67	5.57	0.43	12.68	19	5	6	114	15
18	Meole_Brace	420.03	50.00	48.00	518.03	15	65.98	6.37	0.76	0.73	7.85	10	10	13	130	11
19	Area_south_of_Copthorne	175.50	62.50	58.75	296.75	17	78.43	2.24	0.80	0.75	3.78	5	12	14	70	17
20	Area_north_of_Copthorne	315.90	438.25	189.00	943.15	9	15.17	20.82	28.89	12.46	62.17	25	3	2	50	19
21	South_of_Shelton	181.35	289.75	169.00	640.10	12	43.43	4.18	6.67	3.89	14.74	20	5	6	120	13
22	Bicton_Heath	689.13	0.00	107.00	796.13	10	66.78	10.32	0.00	1.60	11.92	17	8	10	170	7
23	Upper_Pulley	50.31	0.00	4.50	54.81	25	107.76	0.47	0.00	0.04	0.51	1	17	17	17	24
24	RingRoadNorth	15.21	1671.75	8.00	1694.96	3	34.39	0.44	48.61	0.23	49.29	24	2	1	24	22
25	Hospital	445.77	1252.50	215.50	1913.77	2	119.85	3.72	10.45	1.80	15.97	21	13	15	315	3

Higher Scores equal Higher Rank

	MCH Code	Type of use	Criteria Weighting	Comments
Household	1	**Household**	1	
Shop/store	21	**Shop/store - Undefined**	1	
	211	High street shop	1.5	
	213	Super/Hyperstore	1.5	
	214	Retail Warehouse	1.5	
	215	Showroom	1.5	
	216	Kiosk	1	
	217	Outdoor market	0.5	
	218	Indoor market	1.5	
Vehicle Services	22	**Vehicle Services - Undefined**	1	
	221	Garage/vehicle repair	2.5	
	222	Filling Station	2.5	
	223	Car Showroom	2	
	224	Plant Hire	0.5	
Retail Services	23	**Retail Services - Undefined**	1	
	231	Hairdresser	0.5	
	232	Betting Shop	0.5	
	233	Launderette	0.5	
	234	Public House/Club	1.5	
	235	Restaurant	1.5	
	236	Café/Fast Food	1.5	
	237	Post Office	2.5	
	238	Garden Centre	0.5	
Office	3	**Office - Undefined**	1	
	310	Office (non specific)	1	
	311	Hi-Tech Office	1.5	
	320	Bank	1.5	
Distribution/Logistics	4	**Distribution/Logistics - Undefined**	1	
	410	Warehouse	0.25	
	411	Warehouse – electrical goods	0.5	
	412	Warehouse – non-frozen goods	0.25	
	413	Warehouse – frozen goods	0.5	
	420	Land used for storage	0.25	
	430	Road Haulage	0.25	
Leisure	51	**Leisure - Undefined**	1	
	511	Hotel	5	
	512	Boarding House	2.5	
	513	Caravan – touring	1	
	514	Caravan – static	0.5	
	515	Self catering unit	2	
	516	Hostel	2	
	517	Bingo	0.5	
	518	Theatre/Cinema	0.5	
	519	Beach hut	0.5	
Sport	52	**Sport - Undefined**	1	
	521	Playing fields/grounds	0.25	
	522	Golf Course	0.5	
	523	Sports/Leisure Centre	1.5	
	524	Amusement park/arcade	1.5	
	525	Football ground	1.5	
	526	Mooring/Wharf/Marina	0.25	
	527	Swimming Pool	1	
Public Building	6	**Public Building - Undefined**	100	
	610	School University College	50	
	620	Surgery/Health care centre	75	
	625	Residential Home	75	
	630	Hall/Community Centre	10	
	640	Library	2.5	
	650	Fire/Ambulance	150	
	651	Police station	150	
	660	Hospital	250	
	670	Museum	10	
	680	Law Court	10	
	690	Church	2.5	
Industry	8	**Industry - Undefined**	1	
	810	Workshop	1	
	820	Factory/Works/Mill	1	
	830	Extractive/Heavy Industry	1	

	840	Sewage Treatment	75	
	850	Laboratory	1	
	9	**Miscellaneous - Undefined**	1	
	910	Car Park	0.5	
	920	Public Conveniences	0.5	
Miscellaneous	930	Cemetery/Crematorium	1	
	940	Bus Station	5	
	950	Dock Hereditament	0.5	
	960	Electricity Hereditament	25	
Unknown	91	Unknown A	1	
	999	Unknown B		
Historic Property		National Trust Site	1	Case by case basis
		English Heritage Listed Buildings Site	1	Case by case basis
		CADW Listed Buildings Site	1	Case by case basis
		Article 4 Designations	1	Case by case basis
Transport Infrastructure		Motorway	1	Possibly based on traffic flow
		Trunk Road	0.5	Possibly based on traffic flow
		County Highway	0.75	Possibly based on traffic flow
		Priority Route (to Emergency Services Centres)	0.75	Possibly based on traffic flow
		Priority Route (to rural communities without a	0.5	Number of Properties
		Guided Busway	0.5	
		Railway	1	Set on all railways
		Metro / Underground Railway	1	None in area
		Tramway	0.2	None in area
		National (Footpath or Cycle) Trail	0.1	
Land and Open Space		Special Area of Conservation (SAC)	5	Case by case basis
		Special Areas of Protection (SPA)	5	Case by case basis
		RAMSAR Site	5	Case by case basis
		Site of Special Scientific Interest (SSSI)	5	Case by case basis
		Area of Outstanding Natural Beauty (AONB) an	3	Case by case basis
		County & City Wildlife Site	2	Case by case basis
		County & City Nature Reserve	2	Case by case basis
		RSBP Reserve	2	Case by case basis
		WWF Reserve	2	Case by case basis
		Woodland	2	Case by case basis
		Ancient Woodland, Fens & ESAs (Natural Englai	2	Case by case basis
		World Heritage Site	2	Case by case basis
		Heritage Coast	2	Case by case basis
		English Heritage Battlefield Site	2	Case by case basis
		National Park	2	Case by case basis
		County Park	2	Case by case basis
		Parks and Gardens of Special Historical Interest	2	Case by case basis
		Conservation Areas	1	
		Scheduled Ancient Monuments (SAMs)	1	
		Grade 1 Agricultural Land	2.5	Consult with NFU
		Grade 2 Agricultural Land	2	Consult with NFU
		Grade 3 Agricultural Land	1.5	Consult with NFU
		Grade 3a Agricultural Land	1	Consult with NFU
		Grade 3b Agricultural Land	0.5	Consult with NFU
		Grade 4 Agricultural Land	0	Consult with NFU
		Grade 5 Agricultural Land	0	Consult with NFU
		Non-Agricultural Land	0	Consult with NFU