2018s0765 – Shropshire Level 1 Strategic Flood Risk Assessment

Final Report

October 2018

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Shropshire Council

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Revision history

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Contract

This report describes work commissioned by Joy Tetsill, on behalf of Shropshire Council, by an email dated 13th June 2018. Joanne Chillingworth, Lucy Finch and Joe Esgate of JBA Consulting carried out this work.

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Purpose

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JBA Consulting has no liability regarding the use of this report except to Shropshire Council.

Acknowledgements

We would like to acknowledge the assistance of:

- Shropshire Council, including Highways;
- Environment Agency;
- Canal and River Trust;
- Severn Trent Water;
- Welsh Water;
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- Fire & Rescue; and
- Planners at the neighbouring authorities

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Executive summary

Introduction

The Strategic Flood Risk Assessment (SFRA) Level 1 2018 document was created with the purpose of supporting the production of the Council's Local Plan Review. This will provide an understanding of the risk from all types of flooding across Shropshire, and to present clear and robust evidence. It will also provide useful information to inform future Infrastructure Planning and Neighbourhood Plans.

Strategic Flood Risk Assessment Objectives

The key objectives of the Level 1 Strategic Flood Risk Assessment are:

- Inform Shropshire Council's Local Plan review by assessing flood risk from all sources, current and future
- Produce a comprehensive set of maps presenting flood risk from all sources that can be used as evidence base for use in the Local Plan
- Take into account climate change
- Assess the cumulative impact that development will have on flood risk
- Inform selection of suitable sites for allocation in the Local Plan Review
- Provide a description of any opportunities to reduce flood risk to existing communities
- Provide a description of existing measures for the management of flood risk
- Provide advice for applicants carrying out site specific flood risk assessments making it clear what the requirements are for identified locations to assess and manage flood risk.
- Provide advice on the use of sustainable drainage techniques for appropriate locations

Strategic Flood Risk Assessment Outputs

The outputs of the Level 1 SFRA are as follows:

- Identification of policy and technical updates.
- Identification of any strategic flooding issues which may have cross boundary implications.
- Identification of any critical flood modelling and data gaps.
- Appraisal of all potential sources of flooding, including Main River, ordinary watercourse, surface water, sewers, groundwater, reservoirs and canals.
- Mapping showing distribution of flood risk across all flood zones from all sources of flooding including climate change allowances, including new and amended data sources.
- Review of historic flooding incidents.
- Identification of any specific locations within Shropshire at risk of sewer flooding and if so, to consider whether there is a need for hydraulic modelling to be undertaken.
- Reporting on the standard of protection provided by defences.
- Assessment of surface water management issues and Sustainable Drainage Systems guidance.

- Flood Risk Assessment guidance for developers.
- Sequential Test guidance and sequential approach to flood risk.
- Assessment of strategic flood risk solutions that can be implemented to reduce risks.
- Assessment of cumulative impacts of new development on flood risk.

Summary of Level 1 Assessment

Sources of flood risk

Parts of Shropshire are at risk from the following sources; fluvial, surface water, groundwater, sewers, reservoir inundation, canal overtopping / breaches. This study has shown that the most significant sources of flood risk in Shropshire are fluvial and surface water.

- *Fluvial flooding*: The primary fluvial flood risk is along the River Severn and its tributaries. These present fluvial flood risk to rural communities as well as to the main urban centres in Shropshire. The floodplain of the Severn is extensive through Shrewsbury and Bridgnorth (Low Town), with less extensive floodplains in the north-west and south of the County, where higher ground constrains the river.
- *Surface water:* The Risk of Flooding from Surface Water map shows a number of prominent overland flow routes; these predominantly follow topographical flow paths of existing watercourses or dry valleys with some isolated ponding located in low lying areas. There are notable areas of risk driven by the topography e.g. at the bottom of hills in the south of the County.
- *Sewer*: The majority of sewers in Shropshire are managed by Severn Trent Water with Welsh Water and United Utilities managing sewers in some areas. The combined DG5 registers of recorded historical sewer flooding was supplied and indicates a total of 347 recorded incidences of sewer flooding in Shropshire from 1990 (Severn Trent record) and 1999 (Welsh Water record). The settlements with the most recorded incidents include Shrewsbury, Ludlow, St Martins, Whitchurch and Church Stretton.
- *Groundwater:* The Areas Susceptible to Groundwater Flooding map shows that in general, the south of Shropshire is within the <25% susceptible classification, therefore is at a lower risk of groundwater flooding. Parts of the north of Shropshire fall within higher susceptibility classifications and are therefore at higher risk from groundwater flooding.
- *Canals*: There are three canals in Shropshire the Llangollen Canal, the Montgomery Canal, and the Shropshire Union Canal. These have the potential to interact with other watercourses and become flow paths during flood events or in a breach scenario. There has been one recent incident of overtopping in Shropshire, in 2014 on the Llangollen Canal near Fenn's Moss in north Shropshire.
- *Reservoirs:* There is a potential risk of flooding from reservoirs both within the County and those outside, such as Llyn (Lake) Clywedog and Llyn Vyrnwy in Wales. There are no records of flooding from reservoirs in the study area. The level and standard of inspection and maintenance required under the Reservoirs Act means that the risk of flooding from reservoirs is relatively low. However; there is a residual risk of a reservoir breach and this risk should be considered in any site-specific Flood Risk Assessments (where relevant).

Defences

The main flood defences are in Shrewsbury, including the Frankwell and English Bridge areas. Water levels on the Severn in Shrewsbury are highly dependent on the operation of an 'argae' system upstream at the Severn and Vyrnwy confluence in Wales. These are agricultural flood embankments that act as an interconnected flood storage area. In rural areas there are defences in Much Wenlock, Walcot, Wem, Pentre and Melverley, comprising flood walls and embankments. The level of protection these offer against flooding varies.

The Environment Agency are currently investigating improvements to the existing flood defences as part of an 'invest to save' programme. Developers are able to contribute to this scheme as part of the Community Infrastructure Levy (CIL) and/or developer contributions where necessary and relevant.

Shropshire Council are taking forward a scheme for Shifnal and investigating where future works might be needed in priority urban and rural locations identified in their Local Flood Risk Management Strategy (2015).

Development and flood risk

The Sequential and Exception Test procedures for both Local Plans and Flood Risk Assessments have been documented, along with guidance for planners and developers. Links have been provided for various guidance documents and policies published by other Flood Risk Management Authorities such as the Lead Local Flood Authority and the Environment Agency.

When necessary, development and redevelopment within Shropshire will require a Flood Risk Assessment appropriate to the scale of the development and to the scope as agreed with the Lead Local Flood Authority and/ or Environment Agency. Flood Risk Assessments should consider flood risk from all sources including residual risk, along with promotion of Sustainable Drainage Systems to create a conceptual drainage strategy and safe access/egress at the development in the event of a flood. Latest climate change guidance (published in February 2016) should also be taken into account, for the lifetime of developments.

Recommendations

The following recommendations are made for the Council to consider as part of their planning policy and flood risk management:

Sequential and Exception tests

Areas of the County are at high risk from river and/ or surface water flooding. Shropshire Council should use the information in this SFRA when deciding which development sites to take forward in their Local Plan by applying the Sequential Test. Developers should consult Shropshire Council and the Environment Agency (where relevant), at an early stage to discuss flood risk including requirements for site-specific FRAs, detailed hydraulic modelling, and drainage assessment and design. A Level 2 SFRA is recommended, which will explore flood hazard in greater detail should sites be allocated in high flood risk areas and the Exception Test required.

Site-specific Flood Risk Assessments

Developers should, where required, undertake more detailed hydrological and hydraulic assessments of the watercourses to verify flood extent (including latest climate change allowances), inform development zoning within the site and prove, if required, whether

the Exception Test can be passed. Developers should include an assessment of the residual risk where developments are located in areas benefitting from defences. They should consider both the impact of breach, including the effect on safe access and egress, as well as potential for flood risk to increase in the future due to overtopping, particularly with climate change increases on peak flows. Any improvements to defences should ensure they are in keeping with wider catchment policy.

The assessment should also identify the risk of existing flooding to adjacent land and properties to establish whether there is a requirement to secure land to implement strategic flood risk management measures to alleviate existing and future flood risk.

Windfall sites

The acceptability of windfall applications in flood risk areas should be considered at the strategic level through a policy setting out broad locations and quantities of windfall development that would be acceptable or not in Sequential Test terms.

Drainage assessments and promotion of Sustainable Drainage Systems

Planners should be aware of the role of the Flood and Water Team as a Statutory Consultee and refer to the guidance and standards in the Shropshire SuDS Handbook when assessing planning applications. The developer should submit the proforma in the SuDS Handbook alongside a Flood Risk Assessment/ Surface Water Drainage Strategy to demonstrate how the Local SuDS Standards have been met.

Strategic solutions

Developers should consult with Shropshire Council at pre-application stage to determine the latest progress with the programme of flood alleviation schemes and opportunities for NFM, culvert day lighting and river restoration on/ off site. RMAs should work together through flood risk studies for high priority locations to determine where land should be safe guarded for future flood alleviation works, such as flood storage, SuDS retrofit or NFM.

Developers should also contact the Environment Agency Sustainable Places (planning) team to engage in pre-application discussions on master-planning and individual planning applications.

Cumulative Impact

The following Planning Policy recommendations have been made for the catchments where cumulative development is likely to have the greatest impact on flood risk:

1. That a Level 2 SFRA or detailed local area Strategic Drainage Study considers further how the cumulative effects of potential peak rates and volumes of water from development sites would impact on peak flows, duration of flooding and timing of flood peaks on receiving watercourses. Such studies could be used to justify greater restrictions/ enforce through Local Planning Policy development site runoff rates and volumes specific to each catchment that are over and above those required by National and Local SuDS Standards. They could also identify where there are opportunities with allocated sites to provide off-site betterment e.g. online/ offline flood storage and where land should be safeguarded within proposed site allocations to fulfil this purpose.
2. Where appropriate, that the opportunity for Natural Flood Management in rural areas, SuDS retrofit in urban areas and river restoration should be maximised in these catchments. In support of policy 6 in the Local FRM Strategy, culverting should be opposed, and day-lighting existing culverts promoted through new developments.

3. Developers should explore through site specific FRAs opportunities to provide wider community flood risk benefit through new developments.
4. Developers should contribute to community flood defences outside of their red line boundary in these catchments to provide wider benefit and help offset the cumulative impact of development.
5. That the LLFA and other RMAs should use this information, alongside the high priority settlement information in the Local FRM Strategy to inform a long-term pipeline of flood alleviation studies and schemes to help inform points 2. to 5. above.
6. That the Environment Agency, in consultation with Shropshire Council, should consider whether to formally designate these catchments as Critical Drainage areas. This would mean that a detailed Flood Risk Assessment would be required for all developments that are proposed, regardless of their size.

Use of Strategic Flood Risk Assessment data

It is important to recognise that Level 1 Strategic Flood Risk Assessments are high-level strategic documents and, as such, do not go into detail on an individual site-specific basis. The primary purpose of this Strategic Flood Risk Assessment data is to provide an evidence base to inform Shropshire's Local Plan and any future flood risk policies. This Strategic Flood Risk Assessment is intended to help Shropshire Council in applying the Sequential Test for their site allocations and identify where the application of the Exception Test may be required via a Level 2 Strategic Flood Risk Assessment. The Strategic Flood Risk Assessment can also be used by private developers, as a starting point, to help appraise the flood risk to their proposed development or re-development site.

This SFRA should be a 'living document' and as a result should be updated when new information on flood risk, flood warning or new planning guidance or legislation becomes available. At the time of writing, this report was developed using the best available information but should be updated when new information on flood risk, new planning guidance or legislation becomes available.

It is recommended that the Strategic Flood Risk Assessment is reviewed internally on a quarterly basis, in line with the Environment Agency's Flood Zone map updates to ensure latest data is still represented in the Strategic Flood Risk Assessment, allowing a cycle of review and a review of any updated data by checking with Shropshire Council, the Highways Authority, Severn Trent Water, Welsh Water, United Utilities and the Environment Agency for any new information.

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Abbreviations and Glossary of Terms

Term	Definition
1D model	One-dimensional hydraulic model
2D model	Two-dimensional hydraulic model
AEP	Annual Exceedance Probability – The probability (expressed as a percentage) of a flood event occurring in any given year.
AStGWf	Areas Susceptible to Groundwater flooding
Brownfield	Previously developed parcel of land
CC	Climate change - Long term variations in global temperature and weather patterns caused by natural and human actions.
CDA	Critical Drainage Area - A discrete geographic area (usually a hydrological catchment) where multiple and interlinked sources of flood risk (surface water, groundwater, sewer, Main River and/or tidal) cause flooding in one or more Local Flood Risk Zones during severe weather thereby affecting people, property or local infrastructure.
CFMP	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.
CIRIA	Construction Industry Research and Information Association
Cumecs	The cumec is a measure of flow rate. One cumec is shorthand for cubic metre per second; also m^3/s.
Defra	Department for Environment, Food and Rural Affairs
Designated Feature	A form of legal protection or status reserved for certain key structures or features that are privately owned and maintained, but which make a contribution to the flood or coastal erosion risk management of people and property at a particular location.
Design flood	This is a flood event of a given annual flood probability, which is generally taken as: fluvial (river) flooding likely to occur with a 1% annual probability (a 1 in 100 chance each year), or; tidal flooding with a 0.5% annual probability (1 in 200 chance each year), against which the suitability of a proposed development is assessed and mitigation measures, if any, are designed.
DTM	Digital Terrain Model
EA	Environment Agency
EU	European Union

Exception Test	Set out in the NPPF, the Exception Test is a method used to demonstrate that flood risk to people and property will be managed appropriately, where alternative sites at a lower flood risk are not available. The Exception Test is applied following the Sequential Test.
FCERM	Flood and Coastal Erosion Risk Management
FEH	Flood Estimation Handbook
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 Map for Planning	The Environment Agency Flood Map for Planning (Rivers and Sea) is an online mapping portal which shows the Flood Zones in England. The Flood Zones refer to the probability of river and sea flooding, ignoring the presence of defences and do not account for the possible impacts of climate change.
Flood Risk Area	An area determined as having a significant risk of flooding in accordance with guidance published by Defra and WAG (Welsh Assembly Government).
Flood Risk Regulations	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.
Floods 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 surface water flood risk in England.
FWA	Flood Warning Area
Fluvial Flooding	Flooding resulting from water levels exceeding the bank level of a River
FRA	Flood Risk Assessment - A site-specific assessment of all forms of flood risk to the site and the impact of development of the site to flood risk in the area.
FRM	Flood Risk Management
FRMP	Flood Risk Management Plan
FSA	Flood Storage Area
FWMA	Flood and Water Management Act
FWS	Flood Warning System
GI	Green Infrastructure – a network of natural environmental components and green spaces that intersperse and connect the urban centres, suburbs and urban fringe
Greenfield	Undeveloped parcel of land
Ha	Hectare

IDB	Internal Drainage Board
Indicative Flood Risk Area	Nationally identified flood risk areas based on the definition of 'significant' flood risk described by Defra and WAG.
JBA	Jeremy Benn Associates
Jflow	2D generalised hydrodynamic modelling software.
LFRMS	Local Food Risk Management Strategy
LIDAR	Light Detection and Ranging
LLFA	Lead Local Flood Authority - Local Authority responsible for taking the lead on local flood risk management
LPA	Local Planning Authority
m AOD	metres Above Ordnance Datum
Main River	A watercourse shown as such on the Main River Map, and for which the Environment Agency has responsibilities and powers
NFM	Natural Flood Management
NPPF	National Planning Policy Framework
NPPG	National Planning Practice Guidance
NRD	National Receptor Database
NRIM	National Reservoir Inundation Mapping
NVZs	Nitrate Vulnerability Zones
Ordinary Watercourse	All watercourses that are not designated Main River. Local Authorities or, where they exist, IDBs have similar permissive powers as the Environment Agency in relation to flood defence work. However, the riparian owner has the responsibility of maintenance.
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 as a result of high intensity rainfall when water is ponding or flowing over the ground surface (surface runoff) before it enters the underground drainage network or watercourse or cannot enter it because the network is full to capacity.
PPS25	Planning Policy Statement 25: Development and Flood Risk – superseded by the NPPF and PPG
RBMP	River Basin Management Plan
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.
Return Period	Is an estimate of the interval of time between events of a certain intensity or size, in this instance it refers to flood events. It is a statistical measurement denoting the average recurrence interval over an extended period of time.
Riparian owner	A riparian landowner, in a water context, owns land or property, next to a river, stream or ditch.
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	Operating authorities who's remit and responsibilities concern flood and / or coastal risk management.
RoFfSW	Risk of Flooding from Surface Water (formerly known as the Updated Flood Map for Surface Water (uFMfSW)
Sequential Test	Set out in the NPPF, the Sequential Test is a method used to steer new development to areas with the lowest probability of flooding.
Sewer flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
SFRA	Strategic Flood Risk Assessment
SMP	Shoreline Management Plan
SoP	Standard of Protection - Defences are provided to reduce the risk of flooding from a river and within the flood and defence field standards are usually described in terms of a flood event return period. For example, a flood embankment could be described as providing a 1 in 100-year standard of protection.
SPD	Supplementary Planning Document
SPZ	(Groundwater) Source Protection Zone
Stakeholder	A person or organisation affected by the problem or solution or interested in the problem or solution. They can be individuals or organisations, includes the public and communities.
SuDS	Sustainable Drainage Systems - Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques
Surface water flooding	Flooding as a result of surface water 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 what is known as pluvial flooding.

SWMP	Surface Water Management Plan - The SWMP plan should outline the preferred surface water management strategy and identify the actions, timescales and responsibilities of each partner. It is the principal output from the SWMP study.
WFD	Water Framework Directive – Under the WFD, all waterbodies have a target to achieve Good Ecological Status (GES) or Good Ecological Potential (GEP) by a set deadline. River Basin Management Plans (RBMPs) set out the ecological objectives for each water body and give deadlines by when objectives need to be met.

1 Introduction

1.1 Purpose of the Strategic Flood Risk Assessment

JBA Consulting were commissioned by Shropshire Council to prepare a Strategic Flood Risk Assessment (SFRA). The purpose of this study is to provide a comprehensive and robust evidence base to support the production of the Local Plan to 2036. This SFRA replaces the 'Shropshire Council SFRA for Local Development Framework - Level 1 – Update Report (Vol. I)' prepared by Halcrow Group Limited for Shropshire Council in June 2012.

The 2018 SFRA will be used in decision-making and to inform decisions on the location of future development and the preparation of sustainable policies for the long-term management of flood risk.

1.2 SFRA Objectives

The key objectives of the Level 1 Strategic Flood Risk Assessment are:

- Inform Shropshire Council's Local Plan review by assessing flood risk from all sources, current and future
- Produce a comprehensive set of maps presenting flood risk from all sources that can be used as evidence base for use in the Local Plan
- Take into account climate change
- Assess the cumulative impact that development will have on flood risk
- Inform selection of suitable sites for allocation in the Local Plan Review
- Provide a description of any opportunities to reduce flood risk to existing communities
- Provide a description of existing measures for the management of flood risk
- Provide advice for applicants carrying out site specific flood risk assessments making it clear what the requirements are for identified locations to assess and manage flood risk.
- Provide advice on the use of sustainable drainage techniques for appropriate locations.

1.3 Levels of SFRA

The Planning Practice Guidance advocates a tiered approach to risk assessment and identifies the following two levels of SFRA:

1. Level 1: where flooding is not a major issue in relation to potential site allocations and where development pressures are low. The assessment should be of sufficient detail to enable application of the Sequential Test.
2. Level 2: where land outside Flood Zones 2 and 3 cannot appropriately accommodate all necessary development, creating the need to apply the NPPF's Exception Test. In these circumstances the assessment should consider the detailed nature of the flood characteristics within a Flood Zone and assessment of other sources of flooding.

This update focusses on a Level 1 SFRA assessment. Should the Council be unable to place development outside of Flood Zones, a Level 2 assessment may be required in the future.

1.4 SFRA outputs

To meet the objectives, the following outputs have been prepared:

- Identification of policy and technical updates.
- Identification of any strategic flooding issues which may have cross boundary implications.
- Inclusion of new and / or amended data sources.
- Identification of any critical flood modelling and data gaps.
- Appraisal of all potential sources of flooding, including Main River, ordinary watercourse, surface water, sewers, groundwater, reservoirs and canals.
- Mapping showing distribution of flood risk across all flood zones from all sources of flooding including climate change allowances.
- Review of historic flooding incidents.
- Identification of any specific locations within Shropshire at risk of sewer flooding and if so, to consider whether there is a need for hydraulic modelling to be undertaken.
- Reporting on the standard of protection provided by existing flood risk management infrastructure.
- Assessment of the potential increase in flood risk due to climate change.
- Assessment of surface water management issues, how these can be addressed through development management policies and the application of Sustainable Drainage Systems.
- Flood Risk Assessment guidance for developers.
- Recommendations of the criteria that should be used to assess future development proposals and the development of a Sequential Test and sequential approach to flood risk.
- Assessment of strategic flood risk solutions that can be implemented to reduce risks.

1.5 SFRA Study Area

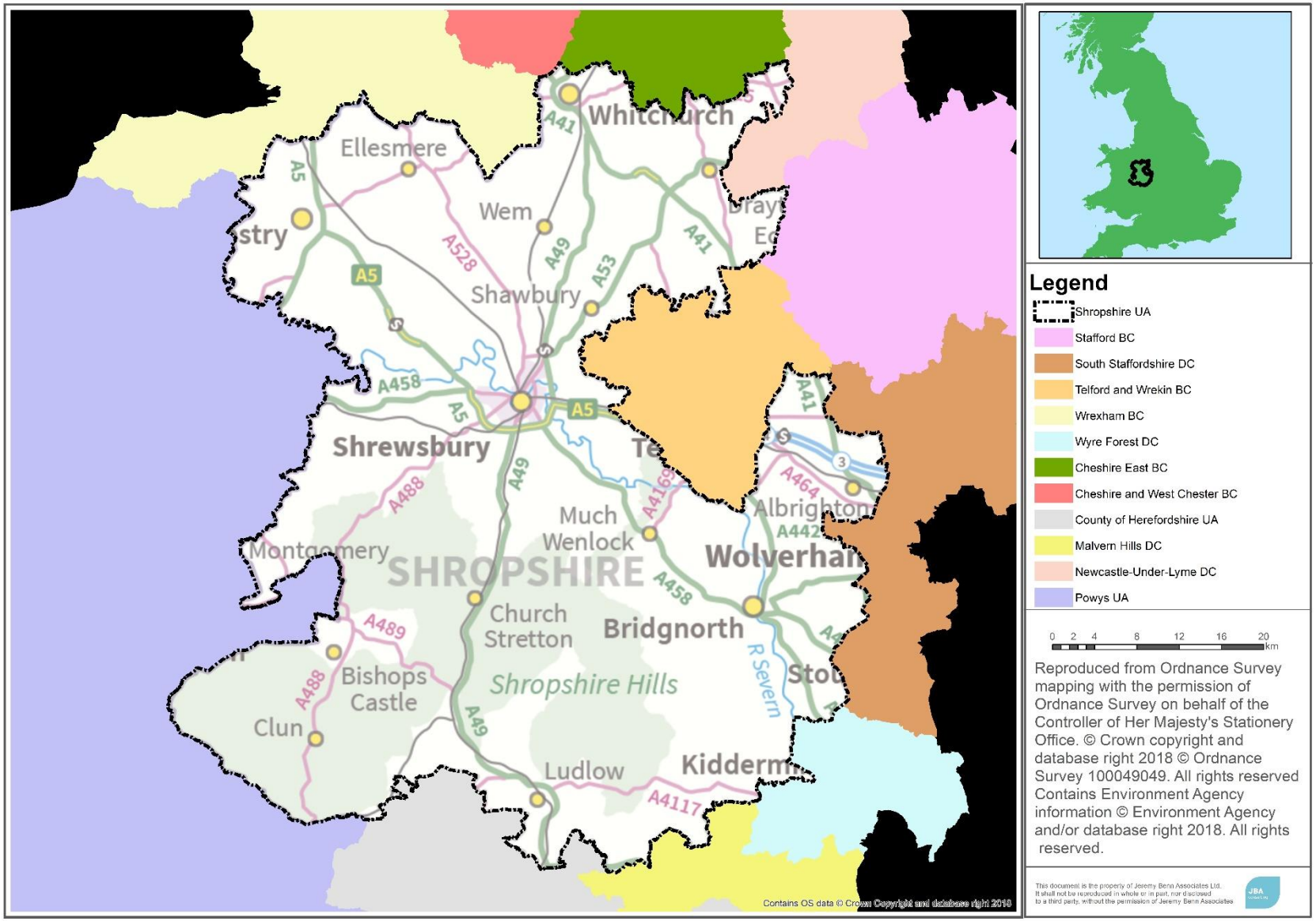
Shropshire Council administrative area covers an area of approximately 3197.36km^2 and has a population of approximately 306,129 (2011 census).

Shropshire is a county within the West Midlands bordering Wales, which is mostly made up of rural and market towns. The main urban areas are Shrewsbury, Oswestry, Bridgnorth, Ludlow and Market Drayton.

The main rivers in Shropshire are the River Severn, River Teme, River Tern, River Onny, River Roden, River Worfe and the River Rea. The River Severn is the principal watercourse in the study; the vast majority of the watercourses in the county drain to this river. The River Severn flows from Wales in the west, through

Shropshire towards Worcestershire where it goes on to flow towards the Bristol Channel. An overview of the study area is shown in Figure 1-1.

Figure 1-1 Study Area



1.6 Consultation

SFRAs should be prepared in consultation with other risk management authorities. The following parties (external to Shropshire Council) have been consulted during the preparation of this version of the SFRA:

- Environment Agency
- Shropshire LLFA
- Canal & River Trust
- Shropshire Highways
- Shropshire Fire and Rescue
- Severn Trent Water, Welsh Water and United Utilities
- Neighbouring authorities including:
    - South Staffordshire Council
    - Powys County Council
    - Wyre Forest District Council
    - Newcastle-under-Lyme Borough Council
    - Telford and Wrekin Council
    - Herefordshire Council
    - Wrexham County Borough Council
    - Stafford Borough Council
    - Malvern Hills District Council
    - Cheshire East Council
    - Cheshire West and Chester Council

1.7 Use of SFRA data

It is important to recognise that Level 1 SFRAs are high-level strategic documents and, as such, do not go into detail on an individual site-specific basis. The primary purpose of this SFRA data is to provide an evidence base to inform Shropshire Council's Local Plan and any future flood risk policies, as detailed in the objectives listed in Section 1.1. This SFRA is intended to aid Shropshire Council in applying the Sequential Test for their site allocations and identify where the application of the Exception Test may be required via a Level 2 SFRA.

The data contained in this SFRA also has a number of other uses, in addition to that which is noted above. Table 1-1 sets out the structure and content of the SFRA report and associated mapping, alongside how the data can be used, primarily by Shropshire Council or private developers.

Hyperlinks to external guidance documents/ websites are provided in **green** throughout the SFRA.

Advice to users has been highlighted in **amber boxes** throughout the document.

Table 1-1 SFRA report contents

Section	Contents	Use of data
1. Introduction	Provides a background to the study, defines objectives, outlines the approach adopted and the consultation performed.	For users to understand the purpose, objectives and outputs of the study.
2. The Planning Framework and Flood Risk Policy	Includes information on the implications of recent changes to planning and flood risk policies and legislation, as well as documents relevant to the study.	There are other studies and policy / legislation that complement the SFRA and these may need to be referred to in the Local Plan and / or site-specific FRAs (where relevant).
3. The sequential, risk-based approach	Provides an overview of Flood Zones, application of the Sequential Approach and Sequential/Exception Test process.	Provides guidance for the Council on the application of the Sequential and Exception Test.
4. The impact of climate change	Outlines climate change guidance published by the Environment Agency in February 2016.	Updated climate change guidance must be considered in all new developments and planning applications.
5. Summary of SFRA mapping for all sources of flood risk and methodology	Outlines what information has been used in the preparation of the SFRA including any data gaps.	The methodology will provide users with an understanding of where broad-scale or detailed models have been used to identify the fluvial flood risk. Any data gaps identified may help to shape future strategic flood risk studies or indicate where studies need to be undertaken at a site-specific level.
6. Understanding flood risk in Shropshire	Gives an introduction to the assessment of flood risk and provides an overview of the characteristics of flooding affecting Shropshire including historical flooding incidents, flood risk from canals and reservoirs and flood warning arrangements.	The outputs (including mapping) will identify communities in the study area at flood risk and the potential sources. This will be used to help the Council apply the Sequential Test and if necessary the Exception Test to site allocations proposed in the Local Plan. Private developers should consider the findings of this SFRA, particularly in relation to site-specific FRAs, the application of the Sequential and Exception Test, and / or drainage strategies. The Council should also review the findings in relation to any strategic flood emergency plans.
7. Flood defences and assets, residual risk	Assessment of residual risk from flood defences, including future protection from climate change and on-going flood defence schemes.	The residual risk must be considered in relation to new development, alongside how the residual risk is to be mitigated.

Section	Contents	Use of data
8. Cumulative impact of development and cross boundary issues	Broadscale assessment of areas where the cumulative impact of development may be detrimental to flood risk. An assessment of potential cross boundary flood risk issues as a result of future large-scale developments.	The Council and neighbouring authorities should consider the policy recommendations in this section.
9. Flood Risk Assessment and Surface Water Drainage Strategy requirements and guidance for developers	Outlines requirements for Flood Risk Assessments (FRAs) and Surface Water Drainage Strategies as well as providing guidance for developers	This section is intended to offer guidance for developers in preparation of site-specific FRAs and / or drainage strategies. It links to advice from the Environment Agency and Shropshire Council.
10. Surface water management and SuDS	Advice on managing surface water run-off, and how SuDS play an important role.	This section is intended to offer guidance for developers and the Council in the use of SuDS and the management of surface water at development sites. This complements but does not replace national or local SuDS / surface water guidance / requirements.
11. Strategic Flood Risk Solutions	Summary of Strategic Flood Risk Solutions.	The potential strategic flood risk solutions that could be considered by the Council and other flood management authority partners.
12. Summary	Summary of SFRA assessment and key findings	
13. Recommendations	Outlines key recommendations	Key recommendations should be considered by the Council.
Appendices		
Appendix A: Level 1 SFRA mapping - GeoPDFs **Appendix B: Cumulative Impact Maps**		The appendices are intended to map the sources of flood risk in Shropshire and to help users identify whether a site is at flood risk and from what source. The appendices are intended to complement EA datasets and do not seek to replace these. Developers should refer to both the SFRA and EA datasets (where relevant). The SFRA outputs do not remove requirements for site-specific FRAs, drainage strategies or further detailed modelling at a site-specific level.

1.8 Future updates

This SFRA provides an overview of the flood risk to Shropshire and draws together all sources of flooding including surface water, reservoir, canal, sewer and groundwater. The SFRA has been developed using the best available information at the time of preparation. This relates both to the current risk of flooding from rivers, and the potential impacts of future climate change.

The SFRA should be a **'living document'**, and as a result should be updated when new information on flood risk, flood warning or new planning guidance or legislation becomes available. New information on flood risk may be provided by Shropshire Council, the Highways Authority, Canal and River Trust, Severn Trent Water, Welsh Water, United Utilities, neighbouring authorities and the Environment Agency. Such information may be in the form of:

- New hydraulic modelling results
- Flood event information following a future flood event
- Policy/ legislation updates
- Environment Agency flood map updates
- New flood defence schemes etc.

The Environment Agency regularly reviews their flood risk mapping, and it is important that they are approached to determine whether updated (more accurate) information is available prior to commencing a detailed Flood Risk Assessment. It is recommended that the SFRA is reviewed internally on a quarterly basis, in line with the Environment Agency's Flood Zone map updates to ensure latest data is still represented in the SFRA, allowing a cycle of review and a review of any updated data by checking with the above bodies for any new information.

2 The Planning Framework and Flood Risk Policy

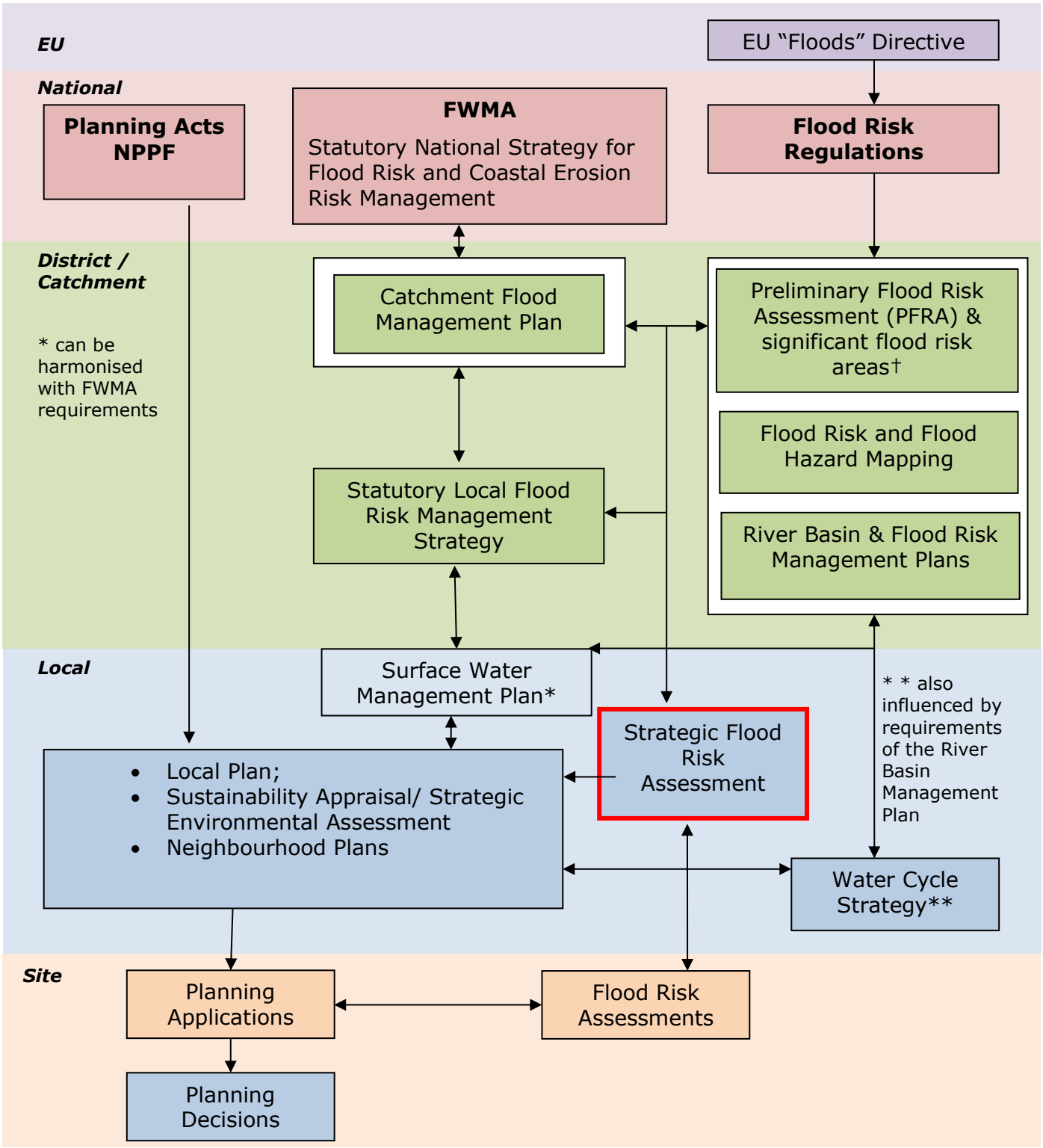
2.1 Introduction

The overarching aim of development and flood risk planning policy in the UK is to ensure that the potential risk of flooding is taken into account at every stage of the planning process. This section of the SFRA provides an overview of the planning framework, flood risk policy and flood risk responsibilities. In preparing the subsequent sections of this SFRA, appropriate planning and policy amendments have been acknowledged and taken into account.

SFRAs contain information that should be referred to in responding to the Flood Risk Regulations and the formulation of local flood risk management strategies and plans. SFRAs are also linked to the preparation of Catchment Flood Management Plans (CFMPs), Surface Water Management Plans (SWMPs) and Water Cycle Strategies (WCSs).

Figure 2-1 outlines the key strategic planning links for flood risk management and associated documents. It shows how the Flood Risk Regulations and Flood and Water Management Act, in conjunction with the Localism Act's "duty to cooperate", introduce a wider requirement for the mutual exchange of information and the preparation of strategies and management plans.

Figure 2-1 Strategic planning links and key documents for flood risk



Legend: Responsibilities are indicated using colour coding as follows

European Union	National Government	Local Planning Authority	EA/LLFA/Local Authorities	Developer

† See Table 2-1 for roles and responsibilities for preparation of information

2.2 Roles and responsibilities for Flood Risk Management in Shropshire

There are a number of different organisations in and around Shropshire that have responsibilities for flood risk management, known as Risk Management Authorities (RMAs). These are shown on Table 2-2, with a summary of their responsibilities. It is important to note that land and property owners are responsible for the maintenance of watercourses either on or next to their properties. Property owners are also responsible for the protection of their properties from flooding. More information can be found in the Environment Agency publication "**Owning a watercourse**" (2018).

When it comes to undertaking works to reduce flood risk, the Environment Agency, IDBs and Shropshire Council as LLFAs do have powers but limited resources must be prioritised and targeted to where they can have the greatest effect.

Table 2-1 Roles and Responsibilities for flood risk management in Shropshire

Risk Management Authority	Strategic Level	Operational Level
Environment Agency	• Strategic overview for all sources of flooding • National Strategy • Reporting and general supervision	• Main rivers (e.g. Severn, Teme) • Reservoirs
Shropshire Council as Lead Local Flood Authority (LLFA)	• Preliminary Flood Risk Assessment • Local Flood Risk Management Strategy	• Surface Water • Groundwater • Ordinary Watercourses (consenting and enforcement) • Ordinary watercourses (works)
Shropshire Council as Local Planning Authority	• Local Plans as Local Planning Authorities	• Determination of Planning Applications as Local Planning Authorities • Managing open spaces under Unitary Council ownership
Internal Drainage Boards: *Melverley* *Rea*	• Water Level Management Plans	• Ordinary Watercourses within Internal Drainage Districts
Water Companies: *Severn Trent Water*	• Asset Management Plans, supported by Periodic Reviews (business cases)	• Public sewers

United Utilities *Welsh Water Dwr Cymru (Shropshire only)*		
Highways Authorities *Highways Agency (motorways and trunk roads)* *Shropshire Council (other adopted roads)*	• Highway drainage policy and planning	• Highway drainage

Telford and Wrekin Council is a Unitary Authority which means they are responsible for all local government services within their areas and so are also a Lead Local Flood Authority themselves. Shropshire Council works in partnership with all neighbouring authorities (including those in Wales) to promote joined up flood risk management on shared watercourses and catchments.

2.2.1 Shropshire Council as Lead Local Flood Authority

There are both strategic and operational elements to the role of Lead Local Flood Authority and these are set out in Table 2-2

Table 2-2 Roles and responsibilities as Lead Local Flood Authority

Strategic	Operational
Develop, maintain, apply and monitor a Local Flood Risk Management Strategy. Co-ordinate partnership working between relevant organisations. Represent Staffordshire/ Shropshire on the River Trent/ English Severn and Wye Regional Flood and Coastal Committee. To comply with the European Floods Directive, produce a Preliminary Flood Risk Assessment and for nationally significant Flood Risk Areas, surface water mapping and a Flood Risk Management Plan (on a six-year cycle).	Investigate flooding incidents and set out who has responsibilities and what actions can be taken. Hold a register of significant drainage/ flood alleviation assets. Power to designate third party assets acting as flood defences so they cannot be altered or removed. Powers to enforce land drainage legislation to ensure ordinary watercourses flow properly and a duty to consent to certain works on these watercourses. Powers to build new flood alleviation schemes for local sources of flooding. Statutory Consultee for Planning Applications for surface water drainage on major developments

2.3 Relevant flood risk policy documents

This section summarises relevant national and local flood risk and water management documents and policies. Some of these are required by EU legislation. The UK is due to leave the EU in March 2019. However, both the Floods Directive and Water Framework Directive have been applied into English law using secondary legislation. Until this secondary legislation is reviewed, these requirements will remain.

2.3.1 Flood Risk Regulations (2009)

The **Flood Risk Regulations (2009)**[1] translate the EU Floods Directive into UK law. The EU requires Member States to complete an assessment of flood risk (known as a Preliminary Flood Risk Assessment (PFRA)) and then use this information to identify areas where there is a significant risk of flooding. For these Flood Risk Areas, States must then undertake Flood Risk and Hazard Mapping and produce Flood Risk Management Plans.

The Flood Risk Regulations direct the Environment Agency to do this work for river, sea and reservoir flooding. LLFAs must do this work for surface water, Ordinary Watercourse and Groundwater flooding. This is a six-year cycle of work and the second cycle started in 2017.

The **Shropshire PFRA** (2011) provides information on significant past and future flood risk from localised flooding in Shropshire. This was **updated in 2017**, and no nationally significant Flood Risk Areas for localised flooding have been identified in Shropshire.

The Environment Agency are currently undertaking a PFRA for river, sea and reservoir flooding and identifying nationally significant Flood Risk Areas for these sources. This will be published by December 2019. They exercised an exemption clause for the first six-year cycle and so there are no current FRAs from these sources in Shropshire. However, the **Severn Flood Risk Management Plan** does provide information on flood risk management work in the County.

2.4 Flood and Water Management Act (2010)

The Flood and Water Management Act (2010)[2] (FWMA) aims to create a simpler and more effective means of managing flood risk and implements Sir Michael Pitt's recommendations following his review of the 2007 floods. The responsibilities for Shropshire Council as LLFA are covered in Table 2-2. Below is a summary of some of the work Shropshire Council has undertaken to date as a LLFA.

- **Shropshire Council's Local Flood Risk Management Strategy** was published in December 2015.
- Formal flood investigations have been undertaken for Severnside, Highley (February 2014), Minsterley (July 2013) and Hopstone (June 2013). These can be requested from Shropshire Council.

1 Flood Risk Regulations (2009): http://www.legislation.gov.uk/uksi/2009/3042/pdfs/uksi_20093042_en.pdf

2 Flood and Water Management Act (2010): http://www.legislation.gov.uk/ukpga/2010/29/pdfs/ukpga_20100029_en.pdf

- Register of Flood Risk Features: LLFAs must establish and maintain a register of structures or features which, in their opinion, are likely to have a significant effect on flood risk in the LLFA area. A Flood Asset Register has been prepared for Shropshire (see Section 7.3).
- Shropshire Council constructed a flood alleviation scheme for **Much Wenlock**, which opened in 2017. They are currently taking forward schemes in other locations, including for the Wesley Brook at Shifnal.
- Shropshire Council are promoting a natural flood risk management project, known as **Slow the Flow** and have completed work to date at Battlefield in Shrewsbury and Culmington in south Shropshire.

2.4.1 Shropshire Local Flood Risk Management Strategy (LFRMS) 2015

Shropshire Council is responsible for developing, maintaining, applying and monitoring a LFRMS. The most recent Strategy was published in July 2015 and is used as a means by which the LLFA co-ordinates Flood Risk Management on a day-to-day basis. The seven high-level objectives proposed in the Strategy for managing flood risk include:

- Develop a strategic understanding of flood risk from all sources
- Promote effective management of drainage and flood defence systems
- Support communities to understand flood risk and become more resilient to flooding
- Manage local flood risk and new development in a sustainable manner
- Achieve results through partnership and collaboration
- Be better prepared for flood events
- Secure and manage funding for flood risk management in a challenging financial climate

The Action Plan in **Part 2** of the Strategy sets out how the objectives will be delivered and by whom. The actions are monitored by a strategic Flood Risk Management Board.

Part 2 of the Strategy also contains eight policies for local flood risk management:

- Policy 1: Investigation and Reporting of Flood Events
- Policy 2: Register of Structures and Features (Asset Register)
- Policy 3: Designation of Structures and Features
- Policy 4: The Role of the Lead Local Flood Authority in the Consideration of Proposals for Sustainable Development
- Policy 5: Maintaining, Improving or Constructing Works to Ordinary Watercourses
- Policy 6: Consenting Activities relating to Ordinary Watercourses
- Policy 7: Enforcement Activities relating to Ordinary Watercourses
- Policy 8: Environmental Opportunities

Those of most relevant to new development are policies 4 and 6.

2.4.2 LLFAs, surface water and SuDS

The revised 2018 NPPF states that: 'Major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate' (Para 165). When considering planning applications, local planning authorities should consult the LLFA on the management of surface water in order to satisfy that:

- the proposed minimum standards of operation are appropriate
- through the use of planning conditions or planning obligations, there are clear arrangements for on-going maintenance over the development's lifetime.

Shropshire Council's requirements for new developers on SuDS are set out on their **website**, alongside supporting documents. At the time of writing this SFRA policies relevant to SuDS are:

- Shropshire Local Development Framework: Adopted Core Strategy. Policy CS18: Sustainable Water Management
- Site Allocations and Management of Development (SAMDev) Plan. Policy MD2: Sustainable Design
- Local Flood Risk Management Strategy. Policy 4: The Role of the Lead Local Flood Authority in the Consideration of Proposals for Sustainable Development
- SuDS Handbook. This is currently being prepared and is expected shortly. **Surface Water Management: Interim Guidance for Developers should be used in the interim**

Developers should check **this webpage** for the latest information on the SuDS Handbook, which is due for public consultation in 2018.

2.4.3 The National Flood and Coastal Erosion Risk Management Strategy for England (2011)

The **National Flood and Coastal Erosion Risk Management Strategy** for England provides the overarching framework for future action by all risk management authorities to tackle flooding and coastal erosion in England. It was prepared by the Environment Agency with input from Defra.

The Strategy builds on existing approaches to flood and coastal risk management and promotes the use of a wide range of measures to manage risk. It describes how risk should be managed in a co-ordinated way within catchments and along the coast and balance the needs of communities, the economy and the environment. The Strategy is currently being updated and will be published in 2019.

2.5 Water Cycle Studies

Water Cycle Studies assist local authorities to select and develop growth proposals that minimise impacts on the environment, water quality, water resources, infrastructure and flood risk and help to identify ways of mitigating such impacts.

Shropshire Outline Water Cycle Study was completed in 2010 with **Updated Water Cycle Evidence for Shropshire Local Plan** published in 2014. The latest

update is currently being prepared by Shropshire Council. The studies highlighted the following:

- *Water resources*: The study area falls within Severn Trent Water's supply areas. The sources are supplied by a mixture of river abstraction, groundwater boreholes/wells and from surface water reservoirs. The study concluded by reinforcing the need to reduce water demand to a sustainable level, with a focus on new and sustainable building.
- *Wastewater and sewerage*: Public sewerage is provided by Severn Trent Water. It was recommended that the automatic right for surface water to drain into the sewers is removed, foul flow from new developments can be reduced with the proper water efficiency measures, draining into the sewers must ensure there is no risk to water quality. As well as improvement of capability and capacity of existing buildings.
- *Water Quality*: With the predicted growth in the study area, water quality can become an issue. Where it is predicted to be an issue, discharge to the watercourses should be limited to achieve no deterioration of water quality; as well as to demonstrate if growth will make it more difficult to achieve the requirements of the Water Framework Directive.
- *Flood risk and drainage*: Surface and ground water sources are noted to be flood risk across the Water Cycle Area. The report recommends a series of varying recommendations that are site specific.

2.6 Surface Water Management Plans

Surface Water Management Plans (SWMPs) outline the preferred surface water management strategy in a given location. SWMPs are undertaken, when required, by LLFAs in consultation with key local partners who are responsible for surface water management and drainage in their area. SWMPs establish a long-term action plan to manage surface water in a particular area and are intended to influence future capital investment, drainage maintenance, public engagement and understanding, land-use planning, emergency planning and future developments. The following SWMPs and Integrated Urban Drainage Management Plans have been undertaken in Shropshire and are available on the Council's website.

- **Oswestry Surface Water Management Plan**
- **Church Stretton Surface Water Management Plan**
- **Shifnal Surface Water Management Plan**
- **Shrewsbury Surface Water Management Plan**
- **Craven Arms Surface Water Management Plan**
- **Much Wenlock IUDMP**

2.7 Catchment Flood Management Plans

Catchment Flood Management Plans (CFMPs) are a high-level strategic plan providing an overview of flood risk across each river catchment. The Environment Agency use CFMPs to work with other key-decision makers to identify and agree long-term policies for sustainable flood risk management.

The **River Severn Catchment Flood Management Plan** is the one that is most relevant to Shropshire. The actions of this were brought forward into the 2015 Flood Risk Management Plan for the Severn.

2.8 The Water Framework Directive

The EU Water Framework Directive (WFD) seeks to integrate and enhance the way in which water bodies are managed throughout Europe by the preservation, restoration and improvement of the water environment. On 23 October 2000 the European Commission established the WFD Directive (WFD) requiring each Member State of the European Union to satisfy the environmental objectives set by the Directive and implement the legislation. This was transposed into law in England and Wales in 2003. In England, the Environment Agency is responsible for the delivery of the WFD objectives.

The Directive requires that Environmental Objectives be set for all surface and ground waters in England and Wales to enable them to achieve Good Ecological Status (or Good Ecological Potential for Heavily Modified and Artificial Water Bodies) by a defined date.

Shropshire is made up of four catchments: the Severn Uplands, Severn Middle Shropshire, Severn Middle Worcestershire and Teme. Of these catchments, there are several waterbodies within Shropshire which are not achieving 'good status' for the Water Framework Directive, including parts of the River Corve, River East Onny, River Clun, River Redlake, Rea Brook, River Severn, River Perry, River Roden and River Tern. The Environment Agency is working with its partners, businesses and the community to investigate improvements to the ecological status of these water bodies and techniques. Further information on the ecological status of waterbodies in Shropshire is available on the Environment Agency's **Catchment Data Explorer**.

It is important that developments aim to take positive measures to conform to the WFD, which can be impacted as a result of development, for example in terms of 'deterioration' in ecological status or potential.

2.8.1 River Basin Management Plans

The WFD requires the production of Management Plans for each River Basin District. River Basin Management Plans (RBMPs) aims to ensure that all aquatic ecosystems, riparian ecosystems and wetlands reach 'good status'. To achieve 'good status', a waterbody must be observed to be at a level of ecological and chemical quality.

Shropshire Council primarily falls within the Severn River Basin District, but in the northern region its footprint reaches into both the River Dee Basin District and the North-West River Basin District. The River Basin Districts management plans highlight a number of actions to a number of issues raised either within the district as a whole or in sub districts. Further information can be found in the RBMP and the **Catchment Based Approach (CaBA) website**.

2.9 National Planning Policy and Guidance

The **National Planning Policy Framework** (NPPF) was published in July 2018, replacing the previous version published in March 2012. The NPPF sets out Government's planning policies for England and how these are expected to be applied. The Framework is based on core principles of sustainability and forms the national policy framework in England. It must be taken into account in the preparation of local plans and is a material consideration in planning decisions.

The NPPF sets out the Government's requirements for the planning system and provides a framework within which local people and councils can produce distinctive local and neighbourhood plans to reflect the needs and properties of

their communities. The NPPF must be taken into account by local planning authorities when preparing Local Plans and for applicants preparing planning submissions.

The key changes in the revised 2018 NPPF compared to the 2012 NPPF include:

- Strategic policies should also now consider the 'cumulative impacts in, or affecting, local areas susceptible to flooding' (para 156), rather than just to or from individual development sites;
- Future risk from climate change. The 'sequential approach should be used in areas known to be at risk now or in the future from any form of flooding' (para 158);
- Natural Flood Management. 'Using opportunities provided by new development to reduce the causes and impacts of flooding (where appropriate through the use of natural flood management techniques)' (para 157c);
- SuDS. 'Major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate' (Para 165); and
- Emergency planning. Emergency plans are required as part of an FRA that includes the inclusion of safe access and egress routes (para 163e).

National Planning Practice Guidance (NPPG) was published in 2014 and sets out how the NPPF should be implemented. This will be updated in due course to reflect the changes to the NPPF. **NPPG: Flood Risk and Coastal Change** advises on how planning can account for the risks associated with flooding and coastal change in plan making and the application process. It sets out Flood Zones, the appropriate land uses for each Zone, flood risk assessment requirements, including the Sequential and Exception Tests and the policy aims for developers and authorities regarding each Flood Zone. Further details on Flood Zones and associated policy is provided in Chapter 3 and throughout this report. The Sequential and Exception tests are covered in greater detail in Sections 3.1 and 3.2.

The Sequential Test

"The Sequential Test ensures that a sequential approach is followed to steer new development to areas with the lowest probability of flooding. The flood zones, as refined in the Strategic Flood Risk Assessment for the area, provide the basis for applying the Test. The aim is to steer new development to Flood Zone 1 (areas with a low probability of river or sea flooding). Where there are no reasonably available sites in Flood Zone 1, local planning authorities in their decision making should take into account the flood risk vulnerability of land uses and consider reasonably available sites in Flood Zone 2 (areas with a medium probability of river or sea flooding), applying the Exception Test if required. Only where there are no reasonably available sites in Flood Zones 1 or 2 should the suitability of sites in Flood Zone 3 (areas with a high probability of river or sea flooding) be considered, taking into account the flood risk vulnerability of land uses and applying the Exception Test if required."

(National Planning Practice Guidance, paragraph 019)

The Exception Test

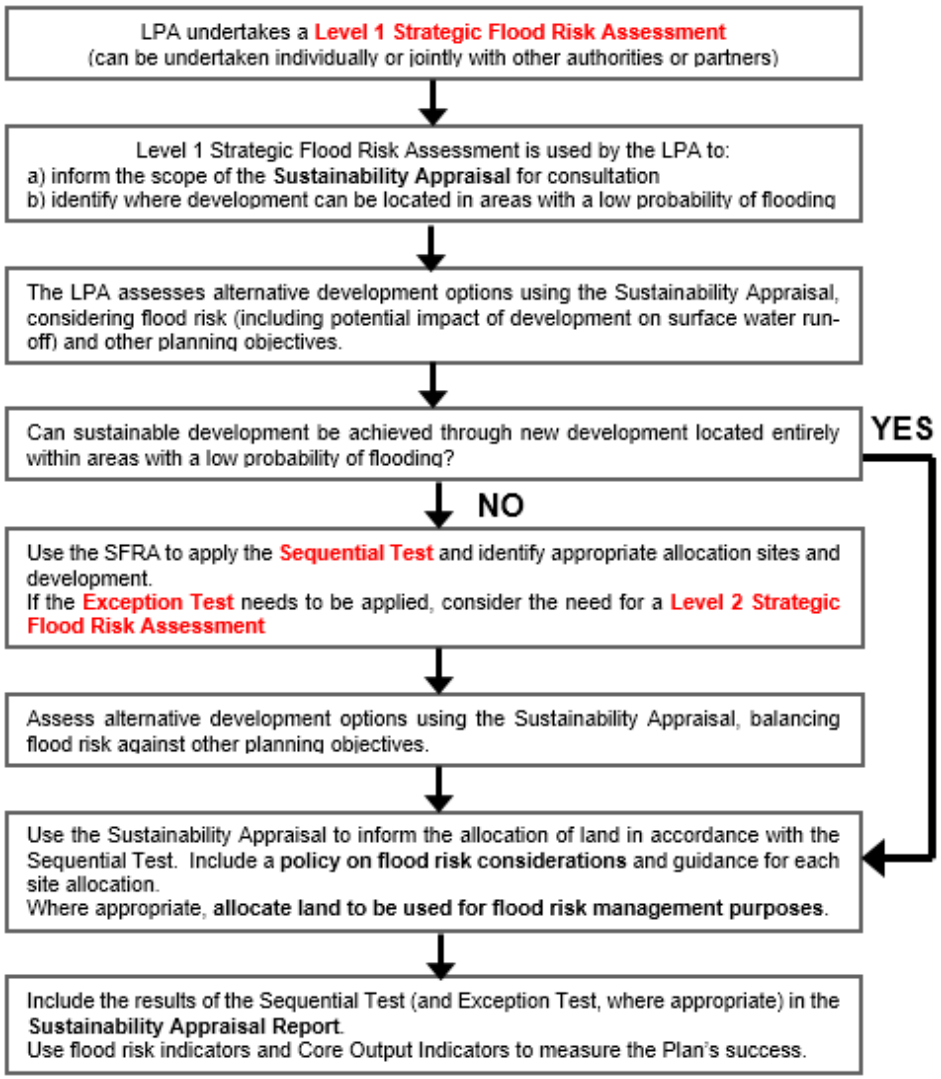
"The Exception Test, as set out in paragraph 102 of the NPPF, is a method to demonstrate and help ensure that flood risk to people and property will be managed satisfactorily, while allowing necessary development to go ahead in situations where suitable sites at lower risk of flooding are not available.

Essentially, the two parts to the Test require proposed development to show that it will provide wider sustainability benefits to the community that outweigh flood risk, and that it will be safe for its lifetime, without increasing flood risk elsewhere and where possible reduce flood risk overall."

(National Planning Practice Guidance, paragraph 023)

A description of how flood risk should be taken into account in the preparation of Local Plans is outlined in Diagram 1 contained within the Planning Practice Guidance (Figure 2-2).

Figure 2-2: Flood Risk and the preparation of Local Plans†



† Diagram 1 of NPPG: Flood Risk and Coastal Change (paragraph 004, Reference ID: 7-005-20140306) March 2014

3 The sequential, risk-based approach

The NPPF advocates a sequential approach to development allocation via the Sequential Test. This approach is designed to ensure areas with little or no risk of flooding (from any source) are developed in preference to areas at higher risk, with the aim of keeping development outside of medium and high flood risk areas (Flood Zones 2 and 3) and other sources of flooding, where possible. The sequential approach can be applied both between and within Flood Zones. Table 3-1 describes the Flood Zones from the Flood Map for Planning.

The preference when allocating land is, whenever possible, to place all new development on land in Zone 1. Since the Flood Zones identify locations that are not reliant on flood defences, placing development on Zone 1 land means there is no future commitment to spending money on flood banks or flood alleviation measures. It also does not commit future generations to costly long-term expenditure that would become increasingly unsustainable as the effects of climate change increase.

However, it is often the case that it is not possible for all new development to be allocated on land that is not at risk from flooding. In these circumstances the Flood Zone maps (that show the extent of inundation assuming that there are no defences) are too simplistic and a greater understanding of the scale and nature of the flood risks is required. In these instances, the Exception Test will be required.

Table 3-1 Flood Zone descriptions

Zone	Probability	Description
Zone 1	Low	This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).
		All land uses are appropriate in this zone.
		For development proposals on sites comprising one hectare or above the vulnerability to flooding from other sources as well as from river and sea flooding, and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water run-off, should be incorporated in a flood risk assessment.
Zone 2	Medium	This zone comprises land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (0.1% - 1%) or between 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.1% – 0.5%) in any year.
		Essential infrastructure, water compatible infrastructure, less vulnerable and more vulnerable land uses (as set out by NPPF) as appropriate in this zone. Highly vulnerable land uses are allowed as long as they pass the Exception Test.
		All developments in this zone require an FRA.

Zone 3a	High	This zone comprises land assessed as having a greater than 1 in 100 annual probability of river flooding (>1.0%) or a greater than 1 in 200 annual probability of flooding from the sea (>0.5%) in any year Developers and the local authorities should seek to reduce the overall level flood risk, relocating development sequentially to areas of lower flood risk and attempting to restore the floodplain and make open space available for flood storage.
		Water compatible and less vulnerable land uses are permitted in this zone. Highly vulnerable land uses are not permitted. More vulnerable and essential infrastructure are only permitted if they pass the Exception Test.
		All developments in this zone require an FRA.
Zone 3b	Functional Floodplain	This zone comprises land where water has to flow or be stored in times of flood. SFRAs should identify this Flood Zone in discussion with the LPA and the Environment Agency. The identification of functional floodplain should take account of local circumstances.
		Only water compatible and essential infrastructure are permitted in this zone and should be designed to remain operational in times of flood, resulting in no loss of floodplain or blocking of water flow routes. Infrastructure must also not increase flood risk elsewhere.
		All developments in this zone require an FRA.

Important note on Flood Zone information in this SFRA

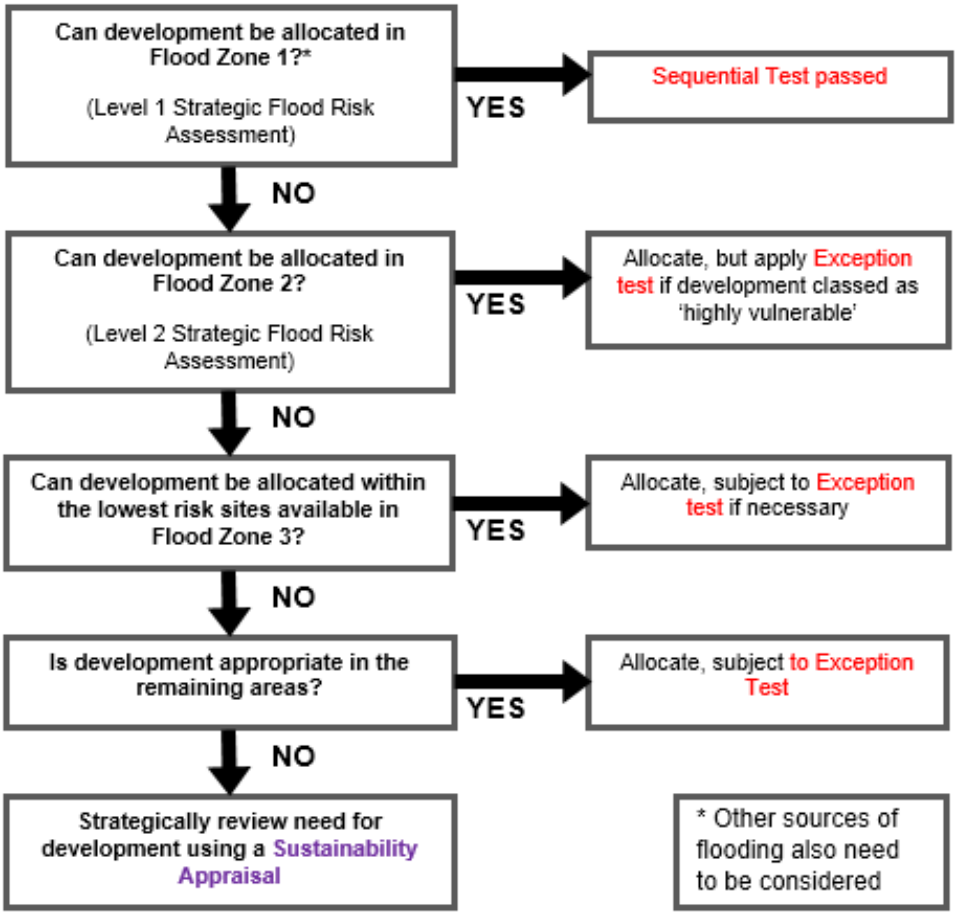
The Flood Zones presented in Appendix A Geo-PDFs are the same as those shown on the Environment Agency's 'Flood Map for Planning'.
The Environment Agency Flood Zones do not cover all catchments or ordinary watercourses. As a result, whilst the Environment Agency Flood Zones may show an area is in Flood Zone 1, it may be that there is actually a degree of flood risk from smaller watercourse not shown in the Flood Zones.
Functional floodplain (Flood Zone 3b) is identified as land which would flood with an annual probability of 1 in 20 years; where detailed modelling exists, the 1 in 20-year flood extent has been used to represent Flood Zone 3b (provided by the Environment Agency). For areas outside of the detailed model coverage, this is represented by Flood Zone 3a (indicative Flood Zone 3b) as a conservative indication. Further work should be undertaken as part of a detailed site-specific flood risk assessment to define the extent of Flood Zone 3b where no detailed modelling exists.

3.1 Applying the Sequential Test and Exception Test in the preparation of a Local Plan

When preparing a Local Plan, the Local Planning Authority should demonstrate it has considered a range of site allocations, using SFRAs to apply the Sequential and Exception Tests where necessary.

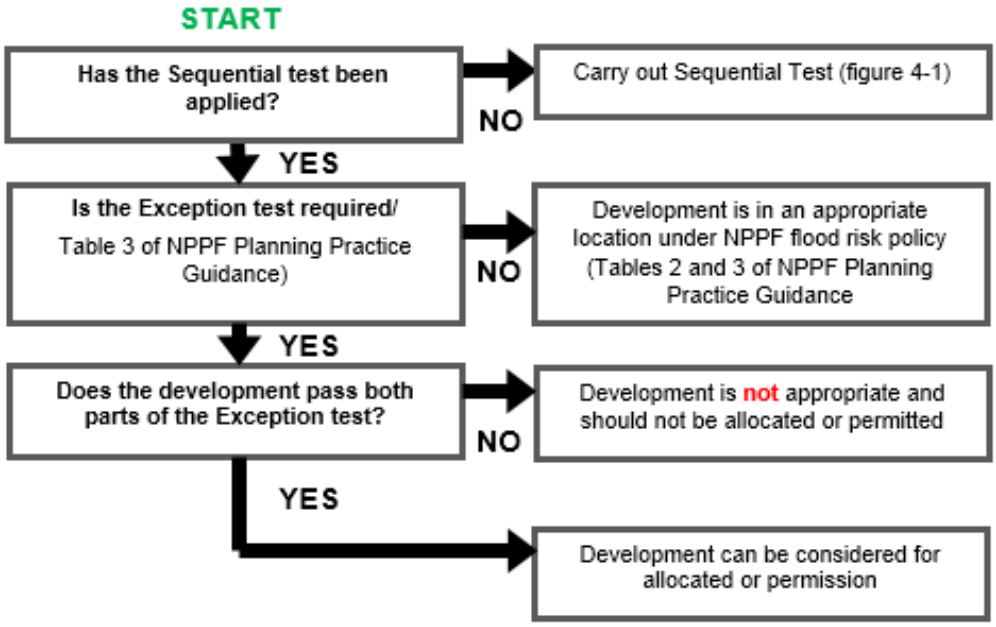
The Sequential Test should be applied to the whole Local Planning Authority area to increase the likelihood of allocating development in areas not at risk of flooding. The Sequential Test can be undertaken as part of a Local Plan Sustainability Appraisal. Alternatively, it can be demonstrated through a free-standing document, or as part of strategic housing land or employment land availability assessments. NPPF Planning Practice Guidance for Flood Risk and Coastal Change describes how the Sequential Test should be applied in the preparation of a Local Plan.

Figure 3-1 Applying the Sequential Test in the preparation of a Local Plan



The Exception Test should only be applied following the application of the Sequential Test and as set out in Table 3 of the NPPF Planning Practice Guidance: Flood Risk and Coastal Change. The NPPF PPG describes how the Exception Test should be applied in the preparation of a Local Plan (Figure 3-2).

Figure 3-2: Applying the Exception Test in the preparation of a Local Plan



3.2 Applying the Sequential Test and Exception Test to individual planning applications

3.2.1 Sequential Test

Local circumstances must be used to define the area of application of the Sequential Test (within which it is appropriate to identify reasonably available alternatives). The criteria used to determine the appropriate search area relates to the catchment area for the type of development being proposed. For some sites this may be clear, in other cases it may be identified by other Local Plan policies. A pragmatic approach should be taken when applying the Sequential Test.

Shropshire Council, with advice from the Environment Agency, are responsible for considering the extent to which Sequential Test considerations have been satisfied and will need to be satisfied that the proposed development would be safe and not lead to increased flood risk elsewhere.

The Sequential Test does not need to be applied for individual developments under the following circumstances:

- The site has been identified in development plans through the Sequential Test.
- Applications for minor development or change of use (except for a change of use to a caravan, camping or chalet site, or to a mobile home or park home site).

It is normally reasonable to presume and state that individual sites that lie in Zone 1 (subject to appropriate assessment, noting the 'Advice to User' on page 22) satisfy the requirements of the Sequential Test; however, consideration should be given to risks from all sources, areas with critical drainage problems and critical drainage areas and the increasing risk of flooding in the future.

3.2.2 Exception Test

If, following application of the Sequential Test it is not possible for the development to be located in areas with a lower probability of flooding, the Exception Test must then be applied if deemed appropriate. The aim of the Exception Test is to ensure that more vulnerable property types, such as residential development can be implemented safely and are not located in areas where the hazards and consequences of flooding are inappropriate. For the Test to be satisfied, both of the following elements have to be accepted for development to be allocated or permitted:

1. *The development would provide wider sustainability benefits to the community that outweigh the flood risk*

   Local planning authorities will need to consider what criteria they will use to assess whether this part of the Exception Test has been satisfied and give advice to enable applicants to provide evidence to demonstrate that it has been passed. If the application fails to prove this, the Local Planning Authority should consider whether the use of planning conditions and / or planning obligations could allow it to pass. If this is not possible, this part of the Exception Test has not been passed and planning permission should be refused[3] .

2. *The development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall*

   A Level 2 SFRA can be used to inform the Exception Test at planning allocation stage.

   At Planning Permission stage, a site-specific Flood Risk Assessment should demonstrate that the site will be safe, and the people will not be exposed to hazardous flooding from any source. The following should be considered[4:]

   - The design of any flood defence infrastructure.
   - Access and egress.
   - Operation and maintenance.
   - Design of the development to manage and reduce flood risk wherever possible
   - Resident awareness.
   - Flood warning and evacuation procedures.
   - Any funding arrangements required for implementing measures.

The NPPF and Technical Guidance provide detailed information on how the Test can be applied.

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3 NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 037, Reference ID: 7-056-20140306) March 2014

4 NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 038, Reference ID: 7-056-20140306) March 2014

3.3 Actual and residual flood risk

3.3.1 Actual flood risk

If it has not been possible for all future development to be situated in Zone 1 then a more detailed assessment is needed to understand the implications of locating proposed development in Zones 2 or 3. The assessment of actual risk takes account of the presence of flood defences and provides a picture of the safety of existing and proposed development. It should be understood that the standard of protection afforded by flood defences is not constant and it is presumed that the required minimum standards for new development are that residential development should be protected against flooding to the 1 in 100 year with climate change river flooding event.

The assessment of the actual risk should take the following issues into account:

- The level of protection afforded by existing defences might be less than the appropriate standards and hence may need to be improved if further growth is contemplated.
- The flood risk management policy for the defences will provide information on the level of future commitment to maintain existing standards of protection. If there is a conflict between the proposed level of commitment and the future needs to support growth, then it will be a priority for this to be reviewed.
- The standard of safety must be maintained for the intended lifetime of the development. Over time the effects of climate change will erode the present-day standard of protection afforded by defences and so commitment is needed to invest in the maintenance and upgrade of defences if the present-day levels of protection are to be maintained and where necessary, land secured and safe guarded that is required for affordable future flood risk management measures.
- The assessment of actual risk can include consideration of the magnitude of the hazard posed by flooding. By understanding the depth, velocity, speed of onset and rate of rise of floodwater it is possible to assess the level of hazard posed by flood events from the respective sources. This assessment will be needed in circumstances where consideration is given to the mitigation of the consequences of flooding or where it is proposed to place lower vulnerability development in areas that are at risk from inundation.

3.3.2 Residual Flood Risk

Residual risk refers to the risks that remain in circumstances after measures have been taken to alleviate flooding (such as flood defences). It is important that these risks are quantified to confirm that the consequences can be safely managed.

Chapter 7 considers this risk in more detail.

3.4 Review of developer Flood Risk Assessments

The Council should consult the Environment Agency West Midlands Shropshire, Herefordshire, Worcestershire and Gloucestershire (SHWG) area 'Flood Risk Standing Advice (FRSA) for Local Planning Authorities', last updated in September 2018, when reviewing planning applications for proposed developments at risk of flooding. When considering planning permission for developments, planners may wish to consider the following:

- Will the natural watercourse system which provides drainage of land be adversely affected;
- Will a minimum 8m width access strip be provided adjacent to the top of both banks of any Main River (5m for Ordinary Watercourses), for maintenance purposes and is appropriately landscaped for open space and biodiversity benefits;
- Will the development ensure no loss of open water features through draining, culverting or enclosure by other means and will any culverts be opened up;
- Sustainable drainage systems are given priority to manage surface water flood risk;
- Will there be a betterment in the surface water runoff regime; with any residual risk of flooding, from drainage features either on or off site not placing people and property at unacceptable risk;
- Is the application compliant with the conditions set out by the LLFA and
- Flood risk reduction opportunities should be sought/improved in the fluvial flood risk regime

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4 Impact of Climate Change

The Climate Change Act 2008 creates a legal requirement for the UK to put in place measures to adapt to climate change and to reduce carbon emissions by at least 80% below 1990 levels by 2050. Shropshire Council published its **Sustainability, Environment and Climate Change Strategy** in 2011 which details how the council intend to reduce emission and advancement with the climate change agenda.

4.1 Revised Climate Change Guidance

The Environment Agency published **updated climate change guidance** on 19 February 2016, which must now be considered in all new developments and planning applications, along with local guidance for the SHWG area published by the Environment Agency's SHWG sustainable places team. The SHWG climate change guidance is reflective of the national climate change guidance but is tailored locally to assist planning applications.

These allowances are based on UK Climate Impacts predictions from 2009. The UK Climate Impacts Programme are due to publish new allowances for climate change in late 2018. The Environment Agency will, in due course, use this information to update their climate change guidance for planners.

The peak river flow allowances show the anticipated changes to peak flow by river basin district which the subject watercourse resides. Once this is determined, guidance on uplift in peak flows are assigned for three allowance categories, Central, Higher Central and Upper End which are based on the 50th, 70th and 90th percentiles respectively. The allowance category to be used is based on the vulnerability classification of the development and the flood zones within which it resides.

These allowances (increases) are provided for three climate change 'epochs':

- Total potential change anticipated for '2020s' (2015 to 2039)
- Total potential change anticipated for '2050s' (2040 to 2069)
- Total potential change anticipated for '2080s' (2070 to 2115)

One or two of the percentiles are provided for each combination of vulnerability and flood zone, which in the latter case provides a 'range' of allowances. The peak river flow allowances show the anticipated changes to peak flow by river basin district, for three future epochs and percentiles, as shown in Table 4-1.

Table 4-1 Peak river flow allowances by river basin district

River basin district	Allowance category	Total potential change anticipated for '2020s' (2015 to 39)	Total potential change anticipated for '2050s' (2040 to 2069)	Total potential change anticipated for '2080s' (2070 to 2115)
Severn	Upper end	25%	40%	70%
	Higher central	15%	25%	35%
	Central	10%	20%	25%

4.1.1 High ++ allowances

High++ allowances only apply in assessments for developments that are very sensitive to flood risk and that have lifetimes beyond the end of the century. Further information is provided in the Environment Agency publication, **Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities.**

4.1.2 Which peak river flow allowance to use?

The flood zone and flood risk vulnerability classification should be considered when deciding which allowances apply to the development or the plan. The guidance states the following:

Flood Zone 2

Vulnerability classification	Central	Higher Central	Upper end
Essential infrastructure		✓	✓
Highly vulnerable		✓	✓
More vulnerable	✓	✓	
Less vulnerable	✓		
Water compatible	None		

Flood Zone 3a

Vulnerability classification	Central	Higher Central	Upper end
Essential infrastructure			✓
Highly vulnerable	Development not permitted		
More vulnerable		✓	✓
Less vulnerable	✓	✓	
Water compatible	✓		

Flood Zone 3b

Vulnerability classification	Central	Higher Central	Upper end
Essential infrastructure			✓
Highly vulnerable	Development not permitted		
More vulnerable			
Less vulnerable			
Water compatible	✓		

4.1.3 Nominal climate change allowance for non-major development

For non-major developments, the SHWG Sustainable Places Team recommends that a model is produced, or an existing model is rerun for climate change. However, in the absence of modelled climate change information, nominal climate change allowances as shown in Table 4-2 should be considered as appropriate with any FRA.

Table 4-2 Nominal allowances

Watercourse	20-25%	35-40%	70%
Upper Severn **River Wye** **River Teme**	600mm	850mm	1500mm
River Avon **Lower Severn**	400mm	600mm	1000mm
Tributaries and 'ordinary watercourses'	200mm	300mm	500mm

4.2 Peak rainfall intensity allowance

Increased rainfall affects river levels and land and urban drainage systems. The table below shows anticipated changes in extreme rainfall intensity in small and urban catchments.

For Flood Risk Assessments, both the central and upper end allowances should be assessed to understand the range of impact.

Table 4-3 Peak rainfall intensity allowance in small and urban catchments

Applies across all of England	Total potential change anticipated for 2010 to 2039	Total potential change anticipated for 2040 to 2059	Total potential change anticipated for 2060 to 2115
Upper end	10%	20%	40%
Central	5%	10%	20%

4.3 Using climate chance allowances

To help decide which allowances to use to inform the flood levels that the flood risk management strategy will be based on for a development or development plan allocation, the following should be considered:

- likely depth, speed and extent of flooding for each allowance of climate change over time considering the allowances for the relevant epoch (2020s, 2050s and 2080s)
- vulnerability of the proposed development types or land use allocations to flooding
- 'built in' resilience measures used, for example, raised floor levels
- capacity or space in the development to include additional resilience measures in the future, using a 'managed adaptive' approach

4.4 Impact of climate change in Shropshire

The Working Together in a Changing Climate section of Shropshire Council's Sustainability, Environment and Climate Change Strategy predicts the following climatic changes within Shropshire:

- Average annual maximum temperatures are expected to rise by 4°C by 2080
- Average summer temperatures increased by 4.7°C by 2080
- Average winter temperatures increased by 3.4°C by 2080
- Summer rainfall is expected to decrease by 25% by 2080
- Winter rainfall is expected to increase by 24% by 2080
- Increased rainfall intensity in summer months
- More short duration extreme weather events such as storms and flooding

Important note on Climate Change mapping in this SFRA

For this SFRA update, the existing hydraulic models provided by the Environment Agency and LLFA (River Severn, River Tern, Rea Brook, Rad Brook, River Roden, Wesley Brook and Shrewsbury SFRA) were re-run for climate change scenarios to account for the new climate change guidance. It should be noted that different mapping techniques have been applied, depending on the type of hydraulic model (e.g. 1D-2D or 1D-only). In some areas, there were gaps in the detailed LIDAR (ground topography) coverage, and therefore a slightly coarser resolution LIDAR needed to be used. LIDAR ground levels will also have updated in some places along with newer model software versions since some of the much older models were originally run, and hence mapped outputs may differ slightly in some areas compared against the original studies.

Three scenarios were modelled to reflect the three climate change allowances for the '2080s' timeframe in the Severn River Basin District, therefore the 100-year plus 25%, 35% and 70%. The climate change mapping reflects the defended scenario.

Where no detailed hydraulic models are present, Flood Zone 2 has been used as a proxy. More detailed hydraulic modelling in these areas may be required at site-specific Flood Risk Assessment stage to confirm flood risk and climate change impacts.

This modelling was undertaken to assist the Council with the preparation of their Local Plan. Developers will need to undertake a more detailed assessment of climate change as part of the planning application process when preparing FRAs.

Climate change mapping has been provided in Appendix A: Geo-PDFs. The Indicative Flood Zone 2 layer provided under the climate change sub-heading should be viewed in conjunction with the modelled climate change outlines. The Indicative FZ2 extent has been provided where climate change models are not available or could not be run, to serve as an indication of possible extents.

It is recommended that the impact of climate change on a proposed site is considered as part of a detailed Flood Risk Assessment, using the percentage increases which relate to the proposed lifetime and the vulnerability classification of the development as described in Section 4 and in the SHWG Climate Change Guidance. The Environment Agency should be consulted to provide further advice for developers on how best to apply the new climate change guidance.

5 Sources of information used in preparing the SFRA

5.1 Data used to inform the SFRA

Table 5-1 provides an overview of the supplied data, used to inform the appraisal of flood risk for Shropshire

Table 5-1 Overview of supplied data for Shropshire SFRA

Source of flood risk	Data used to inform the assessment	Data supplied by
Historic (all sources)	Historic Flood Map and Recorded Flood Outlines Hydraulic Modelling Reports	Environment Agency
	2012 SFRA	Shropshire Council
	Historic flood incidents/records	Shropshire Council Highways Canal and River Trust Fire and Rescue
	Historic sewer flooding records	Welsh Water Severn Trent Water United Utilities
Fluvial (including climate change)	Abermule – Worcester River Severn Model (2012, JBA) Rad Brook (2002, Binnie, Black and Veatch) River Tern (2004, Environment Agency) Rea Brook (2011, JBA) River Roden (2011, Hyder) Shrewsbury Level 2 SFRA (2012) Wesley Brook (2003, Environment Agency) River Corve (2007)* River Teme (2008, Capita Symonds)** Severn Vyrnwy Confluence (2011, JBA Consulting)**	Environment Agency / Shropshire Council
Surface Water	Risk of Flooding from Surface Water dataset Reported flood incident data Communities at Risk from Surface Water flooding dataset	Environment Agency Shropshire Council
Groundwater	Areas Susceptible to Groundwater Flooding Bedrock geology/superficial deposits	Environment Agency
Sewer	Historic flooding records	Severn Trent Water Welsh Water United Utilities
Reservoir	National Inundation Reservoir Mapping	Environment Agency
Canal	Description of flood incidences	Canal and River Trust

*The River Corve model was not run as the model was very unstable and the outputs were not deemed sensible.

**The River Teme model was not run as the model extent was not in the vicinity of any of the proposed sites in within Shropshire. The Severn Vyrnwy model was not run as the extent was covered by the River Severn model.

Mapping of surface water flood risk in Shropshire has been taken from the Environment Agency's Risk of Flooding from Surface Water (RoFfSW) mapping, which is a slightly more detailed resolution than that published online by the Environment Agency. Surface water flood risk is subdivided into the following four categories:

- **High**: An area has a chance of flooding greater than 1 in 30 (3.3%) each year.
- **Medium**: An area has a chance of flooding between 1 in 100 (0.1%) and 1in 30 (3.3%) each year.
- **Low**: An area has a chance of flooding between 1 in 1,000 (0.1%) and 1in 100 (1%) each year.
- **Very Low**: An area has a chance of flooding of less than 1 in 1,000 (0.1%) each year.

Mapping of groundwater flood risk has been based on the Areas Susceptible to Groundwater Flooding (AStGWF) dataset. The AStGWF dataset is strategic-scale map showing groundwater flood areas on a 1km square grid. It shows the proportion of each 1km grid square, where geological and hydrogeological conditions indicate that groundwater might emerge. It does not show the likelihood of groundwater flooding occurring and does not take account of the chance of flooding from groundwater rebound. This dataset covers a large area of land, and only isolated locations within the overall susceptible area are actually likely to suffer the consequences of groundwater flooding.

The AStGWF data should be used only in combination with other information, for example local data or historical data. It should not be used as sole evidence for any specific flood risk management, land use planning or other decisions at any scale. However, the data can help to identify areas for assessment at a local scale where finer resolution datasets exist.

Historical incidents of flooding are detailed by Severn Trent Water and Welsh Water through their respective DG5 registers and list of recorded flood incidents (contained in Table 6-2). The DG5 database records incidents of flooding relating to public foul, combined or surface water sewers and displays which properties suffered flooding. For confidentiality reasons this data has been supplied on a postcode basis.

Note on the Environment Agency Flood Map for Planning

Where outlines are not informed by detailed hydraulic modelling, the Flood Map for Planning is based on generalised modelling to provide an indication of flood risk. Whilst the generalised modelling is generally accurate on a large scale, they are not provided for specific sites or for land where the catchment of the watercourse falls below 3km^2. For this reason, the Flood Map for Planning is not of a resolution to be used as application evidence to provide the details of possible flooding for individual properties or sites and for any sites with watercourses on, or adjacent to the site. Accordingly, for site-specific assessments it will be necessary to perform more detailed studies in circumstances where flood risk is an issue. Where the Flood Map for Planning is based on generalised modelling, developers should undertake a more detailed analysis and assessment of the flood risk at the planning application stage.

All of the mapping can be found in the appendices to this SFRA. More details of the mapping structure can be found in Table 1-1.

5.1.1 Other relevant flood risk information

Users of this SFRA should also refer to other relevant information on flood risk where available and appropriate. The Planning Framework and Flood Risk Policy chapter includes information on the implications of recent changes to planning and flood risk policies and legislation, as well as documents relevant to this study.

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6 Understanding flood risk in Shropshire

6.1 Historical flooding

Shropshire has a history of documented flood events with the main source being from fluvial and surface water sources. Significant historic flood events since the 2012 SFRA are highlighted in Table 6-1.

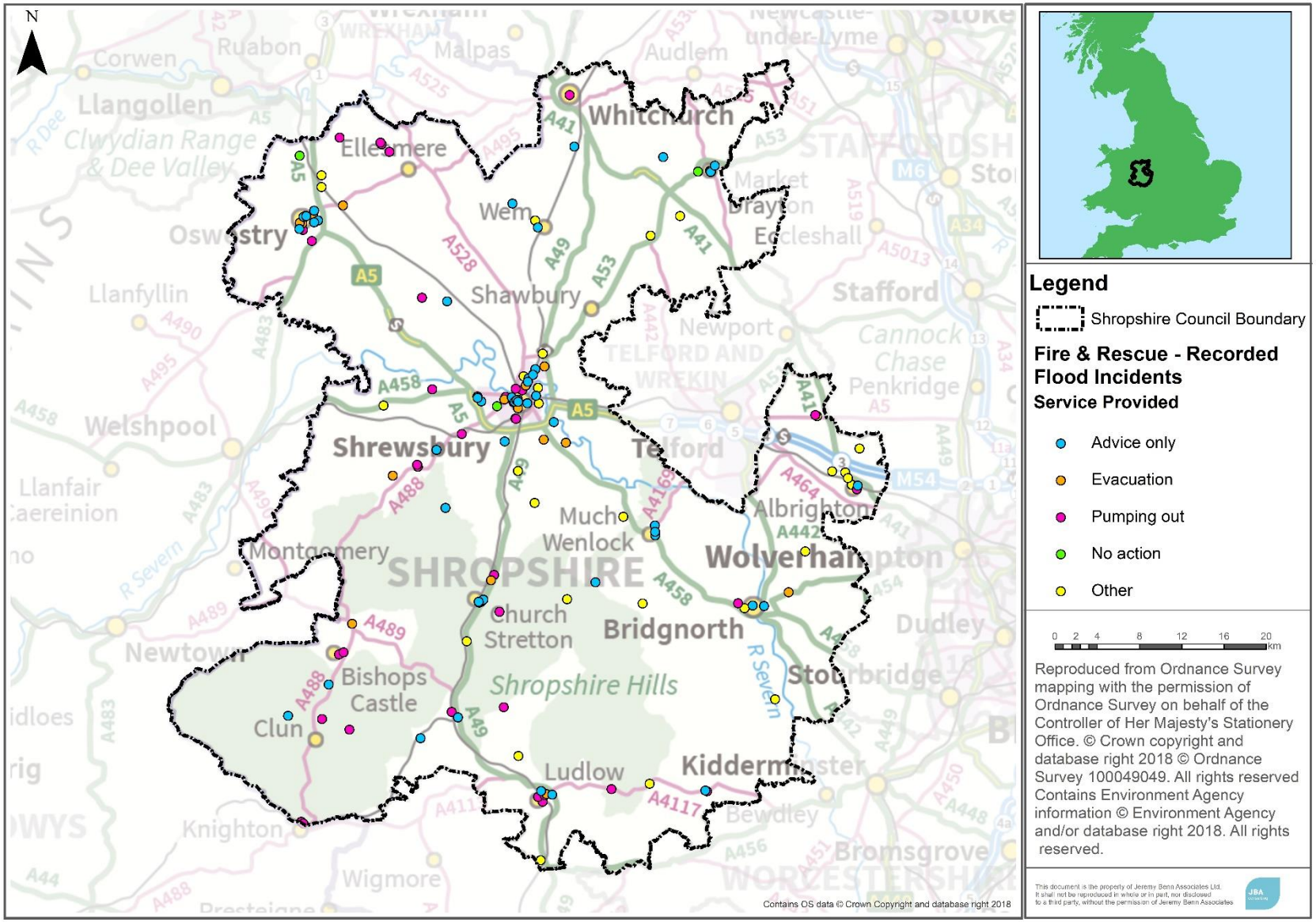
Table 6-1 Documented Historic Flood Records in Shropshire

	Date	Record Source	Additional Information
Upper Severn	1947	Historic Flood Map/2012 SFRA	Flooding triggered by melting of heavy snow, largely affected the upper Severn catchment
Upper Severn	January 1948	Historic Flood Map	Source of flooding: fluvial. Affected areas around the River Severn included Maesbrook and Shrewsbury.
Upper Severn	December 1960	Historic Flood Map	Worst affected areas included Shrewsbury and areas upstream of Shrawardine.
River Severn	October 1998	Historic Flood Map	Source of flooding: fluvial
County-wide	Autumn 2000	Historic Flood Map/2012 SFRA	Prolonged spell of wet weather across the county causing widespread flooding. Flooding in Ludlow occurred as the Rivers Teme and Corve burst their banks. Indicative probabilities of these events ranged between 1.54 and 1.82% in Shrewsbury, and between 4 and 5% in Bridgnorth during this spell.
Whitchurch	October/ November 2000	Historic Flood Map	Source of flooding: fluvial.
River Severn	February 2002	Historic Flood Map/2012 SFRA	Source of flooding: fluvial. Flooding occurred in areas along the Severn, including Shrewsbury and Bridgnorth.
Upper Severn	February 2004	Historic Flood Map	Source of flooding: fluvial.
County-wide	Summer 2007	Historic Flood Map/2012 SFRA	High intensity rainfall in June and July 2007 caused flooding from multiple sources. Key affected areas included Shifnal, Bridgnorth, Shrewsbury and Ludlow. The flooding in Ludlow caused the collapse of the Burway Bridge.
Hopstone, Claverley	28th June 2012	S19 Report	Source of flooding: pluvial. Two properties flooded internally, several detached garages and a number of roads were flooded.
County-wide	June-November 2012	Shropshire Flood Risk Management Strategy Summary	Prolonged spell of wet weather caused numerous local flooding issues across the study area.

Minsterley	July-September 2012	Minsterley Flood Study Technical Report	Source of flooding: fluvial from the Minsterley Brook. Eight properties and the road flooded along The Grove as well as a nearby public footpath.
Severnside, Highley	February 2014	S19 Report	Source of flooding: fluvial from the River Severn. Six terraced properties flooded.
Maesbrook, Melverley and Shrewsbury	December 2015	**BBC News Website**	Source of flooding: fluvial from the River Vyrnwy and Severn. Flood levels at Maesbrook were 1.35m. Closures to Frankwell Riverside Car Park, Gravel Hill Lane and Sydney Avenue in Shrewsbury, with peaks at the Welsh Bridge estimated between 3.3m and 3.7m.
County-wide	May/June 2018	**GeoSmart Information Website**	Source of flooding: pluvial. 20 homes flooded in South Shropshire overnight on the 31st of May, up to 20mm of rain was recorded in one hour causing road closures to the A49. Heavy rain caused flooding to roads and shops in Shrewsbury on the 1st June, with flooding in Coleham around 2ft deep.

Flooding records relating to flooding incidents since 2012, provided by the Fire and Rescue Service, are shown in Figure 6-1. There are notable clusters in the main urban areas in the study area: Shrewsbury, Oswestry, Market Drayton, Ludlow, Bridgnorth and Albrighton. The records do not specify the source of flooding. In this map, only the type of service provided by the Fire and Rescue crew during that incident is provided. The records show that there were 150 related flood incidents since 2012; 21 incidents required evacuation of the premises and 39 incidents required the Fire & Rescue service to pump flood water out of the premises. There are notable dates which have a high frequency of recorded incidents; July 2012 (9 incidents), September 2012 (12 incidents), May 2018 (10 incidents) and June 2018 (11 incidents).

Figure 6-1 Fire and Rescue Service; recorded flood incidents in Shropshire



6.2 Topography, geology, soils and hydrology

6.2.1 Topography

The topography, geology and soil are all important in influencing the way the catchment responds to a rainfall event. The degree to which a material allows water to percolate through it, the permeability, affects the extent of overland flow and therefore the amount of run-off reaching the watercourse. Steep slopes or clay rich (low permeability) soils will promote rapid surface runoff, whereas more permeable rock such as limestone and sandstone may result in a more subdued response.

The topography of Shropshire is mainly characterised by high elevations in the south, with lower elevations in the north and the valley of the River Severn running south-east through the County. The high ground of the Shropshire Hills dominates the southern part of the County, where elevations reach up to 672m AOD. Several rural settlements can be found at these high elevations in the south. Steep river valleys in the south of the County are found in the town of Ludlow, where the River Corve converges with the River Teme. The River Severn flows in a south-easterly direction through the County giving rise to lower elevations in the settlements through which the Severn passes, including Shrewsbury and Bridgnorth. The topography in the northern part of the County is generally flatter than the south; however, there are isolated areas of high elevation in the north, such as Grinshill and Haughmond Hill and the undulating 'Meres and Moses' landscape of North Shropshire. The north-eastern corner of the County is shaped by the valley of the River Tern, which flows through Market Drayton and the River Duckow. The topography of the study area is shown in Figure 6-2.

6.2.2 Geology and Soils

The geology of the catchment can be an important influencing factor on the way that water runs off the ground surface. This is primarily due to variations in the permeability of the surface material and bedrock stratigraphy.

Figure 6-3 shows the bedrock (solid permeable) formations in Shropshire and Figure 6-4 shows the superficial (permeable, unconsolidated (loose)) deposits. These are classified as the following:

- *Principal*: layers of rock or drift deposits with high permeability which, therefore, provide a high level of water storage
- *Secondary A*: rock layers or drift deposits capable of supporting water supplies at a local level and, in some cases, forming an important source of base flow to rivers
- *Secondary B:* lower permeability layers of rock or drift deposits which may store and yield limited amounts of groundwater
- *Secondary undifferentiated:* rock types where it is not possible to attribute either category a or b
- *Unproductive Strata*: rock layers and drift deposits with low permeability and therefore have negligible significance for water supply or river base flow.

In the rural, south-western part of Shropshire, the bedrock is predominantly low permeability Secondary B formations. In the south-east of the County, the bedrock is predominantly Secondary A formations; however, the major urban areas of Bridgnorth and Ludlow in the south-east also straddle Principal and Secondary formations respectively. East of Bridgnorth, the formations are predominantly Principal. The northern part of Shropshire is made up of several different bedrock classifications; the most northern part of the County is made up of unproductive and Secondary B formations, the main urban centre in this area is Whitchurch. Shrewsbury is made up of both Principal and Secondary A deposits, with the urban areas of Ellesmere and Shawbury to the north of Shrewsbury also Principal formations. The superficial deposits in Shropshire are mainly Secondary A types, or Secondary Undifferentiated.

The vast majority of bedrock and superficial deposits in the north-west, central and eastern parts of the County are permeable and therefore capable at providing a level of water storage. The lower permeability of the bedrock found in the south-western and north-eastern parts of the study area will result in higher runoff than in the areas underlain by permeable deposits.

The British Geological Survey provides further information on the nature of groundwater flooding on their **website**.

Figure 6-2 Topography of Shropshire

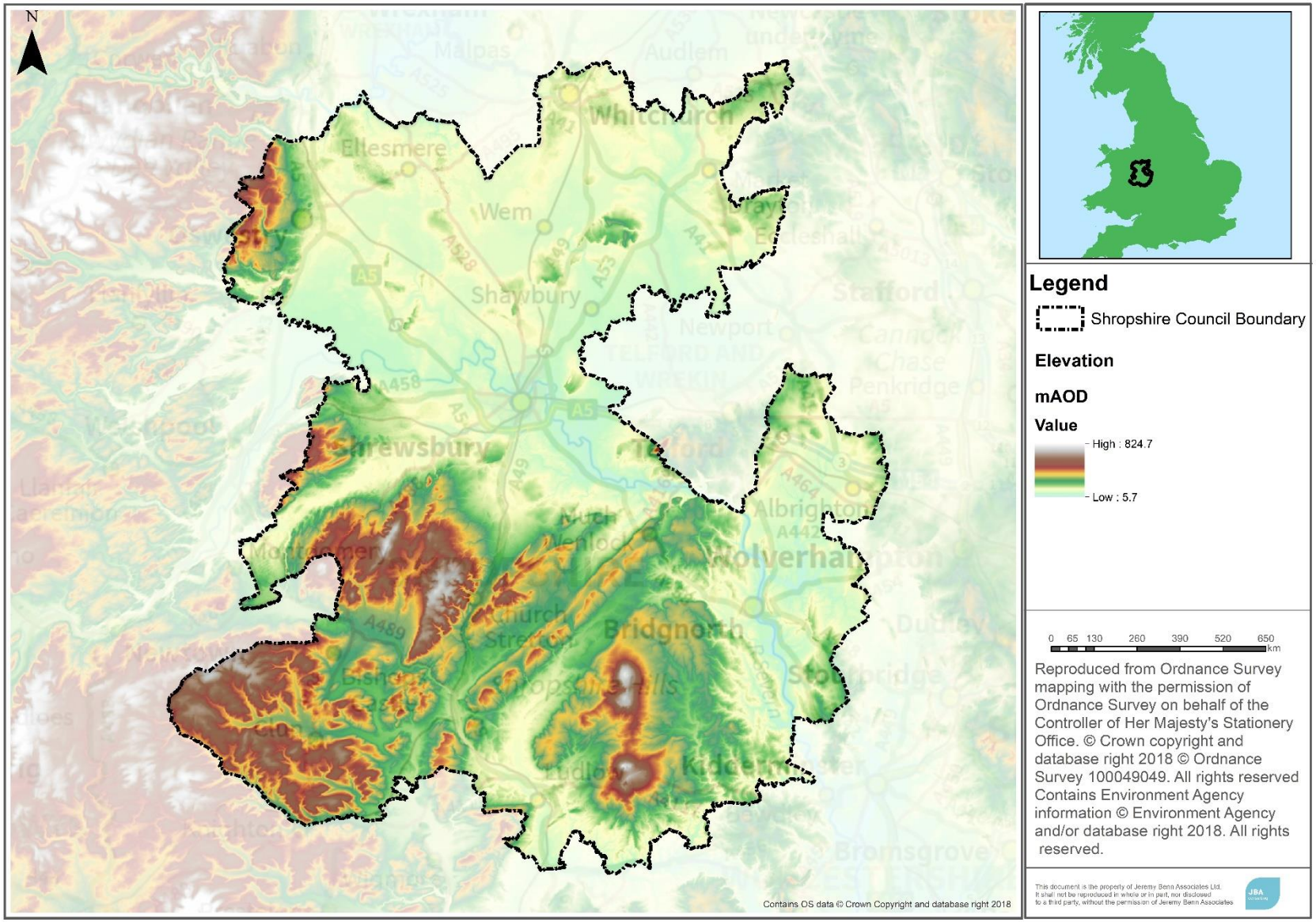


Figure 6-3 Bedrock formations in Shropshire

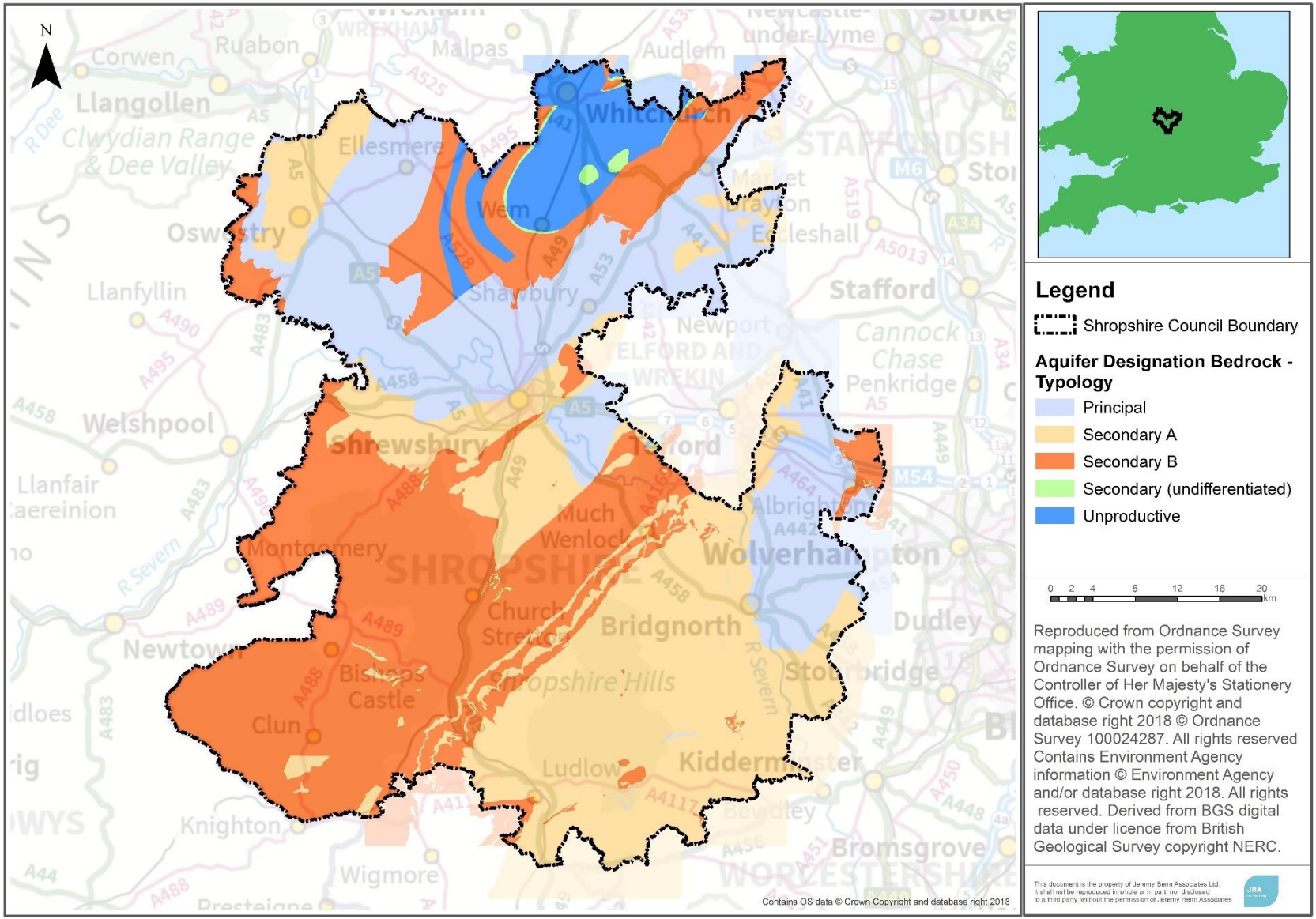
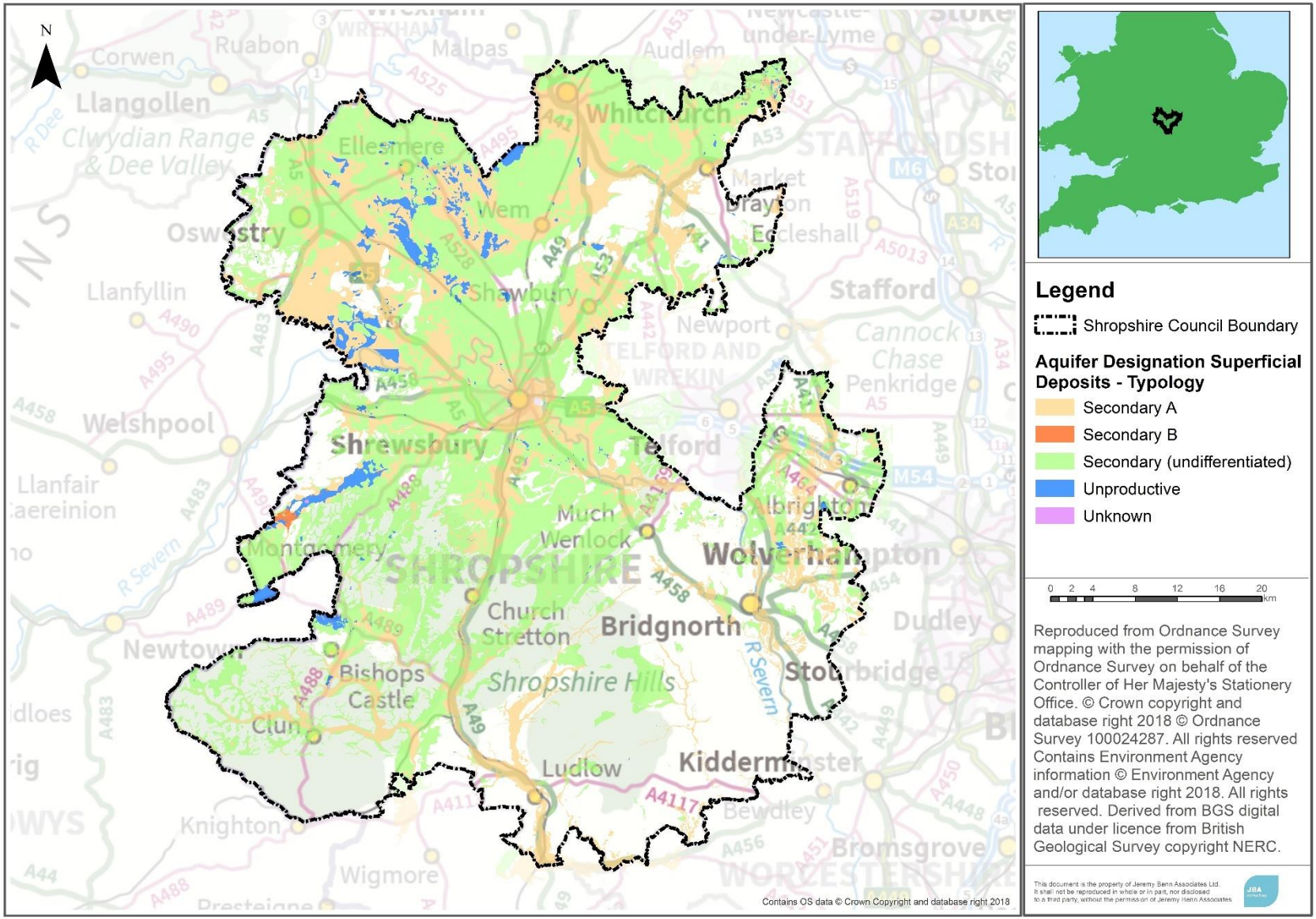


Figure 6-4 Superficial deposits in Shropshire



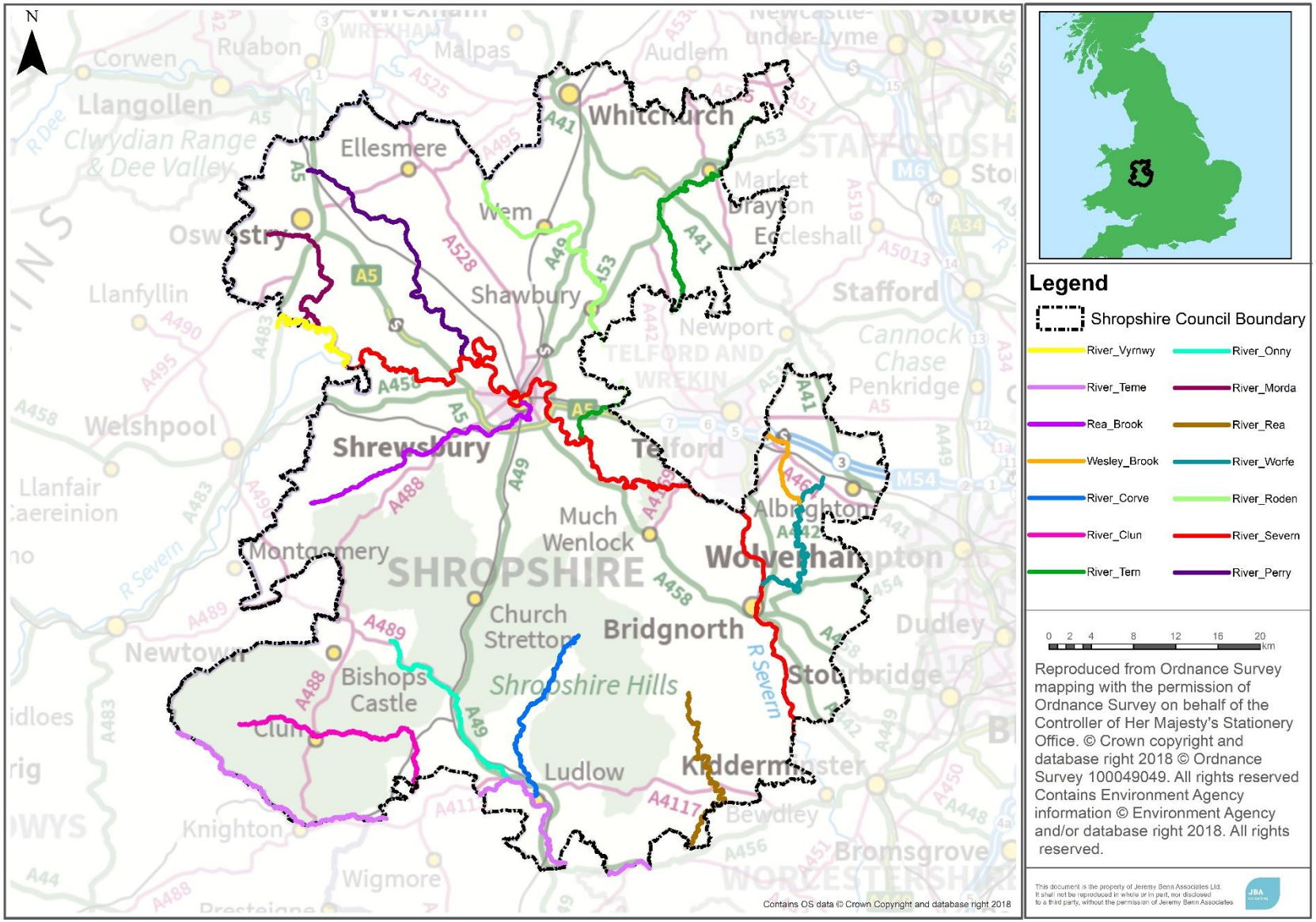
6.2.3 Hydrology

The principal watercourses flowing through the SFRA area are:

- River Severn
- River Vyrnwy
- River Perry
- River Corve
- River Clun
- River Morda
- River Teme
- River Tern
- River Onny
- River Roden
- River Worfe
- River Rea

Tributaries of these watercourses include smaller ordinary watercourses and numerous unnamed drains. There are also a number of ponds and lakes within the study area. A summary of the key watercourses in the SFRA are provided in Figure 6-5. Mapping indicating the location of the key watercourses can be found in Appendix A.

Figure 6-5 Key Watercourses in Shropshire



6.3 Fluvial flood risk

The primary fluvial flood risk is along the River Severn and its main tributaries. These present fluvial flood risk to rural communities as well as some of the main urban centres including, but not exclusively, Shrewsbury, Bridgnorth, Ludlow, Shifnal, Wem, Clun and Ellesmere. On the western side of Shropshire, where the River Severn enters Shropshire at Melverley and where the Rivers Morda and Vyrnwy meet near Maesbrook to the Vyrnwy-Severn confluence, the Flood Zones are wide due to low-lying, flat topography. The Flood Zones along the Severn then begin to narrow around the village of Shrawardine; however, the width of the Flood Zones is still significant along the course of the Severn. As the Severn flows out of Shrewsbury, the Flood Zones widen again due to lower-lying topography before becoming more confined again near Buildwas, where the river enters the Ironbridge Gorge.

The Flood Zone maps for Shropshire are provided in Appendix A: Geo-PDFs, split into Flood Zones 2, 3a and 3b (including an 'indicative 3b' where FZ3a acts as FZ3b in the absence of detailed model data). The locations with the highest fluvial flood risk in Shropshire are detailed in Table 6-4. Please note that this table does not cover all locations at risk and the reader should refer to the mapping for further information on other locations.

6.4 Surface water flooding

Flooding from surface water runoff (or 'pluvial' flooding) is usually caused by intense rainfall that may only last a few hours and usually occurs in lower lying areas, often where the natural (or artificial) drainage system is unable to cope with the volume of water. Surface water flooding problems can be inextricably linked to issues of poor drainage, or drainage blockage by debris, and sewer flooding. This can be made worse by local insufficient drainage capacity. Where discharge is directly to a watercourse, locally high water levels can cause back-up and prevent drainage taking place.

The Risk of Flooding from Surface Water mapping (RoFfSW) provided by the Environment Agency via Shropshire Council shows that a number of communities are at risk of surface water flooding, as discussed in Table 6-4. In general, the RoFfSW shows that surface water predominantly follows topographical flow paths of existing watercourses or dry valleys with some isolated ponding located in low-lying areas. Whilst in the majority of cases the risk is confined to roads, there are notable prominent run-off flow routes around properties, e.g. properties situated at the foot of surrounding hills. The RoFfSW mapping for Shropshire can be found in Appendix A.

Shropshire Council analysed which communities were at risk from surface water flooding when they undertook the Local FRM Strategy in 2015. This information was used to identify the **urban** and **rural** settlements at highest risk of flooding in the County.

6.5 Groundwater flooding

In comparison to fluvial flooding, current understanding of the risks posed by groundwater flooding is limited and mapping of flood risk from groundwater sources is in its infancy. Groundwater level monitoring records are available for areas on Major Aquifers; however, for lower lying valley areas, which can be susceptible to groundwater flooding caused by a high water table in mudstones,

clays and superficial alluvial deposits, very few records are available. Additionally, there is increased risk of groundwater flooding where long reaches of watercourse are culverted as a result of elevated groundwater levels not being able to naturally pass into watercourses and be conveyed to less susceptible areas.

Groundwater susceptibility mapping of Shropshire has been provided in Appendix A. In general, the majority of the south of Shropshire is shown to be within the <25% susceptible classification with higher susceptibilities in north. The locations associated with higher groundwater susceptibility in Shropshire are shown in Table 6-4.

6.6 Flooding from sewers

Sewer flooding occurs when intense rainfall overloads the sewer system capacity (surface water, foul or combined), and/or when sewers cannot discharge properly to watercourses due to high water levels. Sewer flooding can also be caused when problems such as blockages, collapses or equipment failure occur in the sewerage system. Infiltration or entry of soil or groundwater into the sewer system via faults within the fabric of the sewerage system, is another cause of sewer flooding. Infiltration is often related to shallow groundwater and may cause high flows for prolonged periods of time.

Since 1980, the Sewers for Adoption guidelines have meant that the newest surface water sewers have been designed to have capacity for a rainfall event with a 1 in 30 chance of occurring in any given year, although until recently this did not apply to smaller private systems. This means that, even where sewers are built to current specification, they are likely to be overwhelmed by larger events of the magnitude often considered when looking at river or surface water flooding (e.g. a 1 in 100 chance of occurring in a given year). Existing sewers can also become overloaded as new development adds to the discharge to their catchment, or due to incremental increases in roofed and paved surfaces at the individual property scale (urban creep). Sewer flooding is therefore a problem that could occur in many locations across the study area.

Further, sewer flooding is more likely to occur along the routes of main trunk sewers and in particular, if these sewers interact with fluvial systems.

Historical incidents of flooding are detailed by Welsh Water and Severn Trent Water through their list of historic flooding incidents and DG5 register (see Table 6-2). This database records incidents of flooding relating to public foul, combined or surface water sewers and displays which properties suffered flooding. For confidentiality reasons this data has been supplied on a postcode basis. The datasets were supplied on the 13/07/2018 and 13/08/2018 respectively. There were no sewer flooding incidents in Shropshire recorded by United Utilities.

Table 6-2 List of recorded flood incidents from Welsh Water and Severn Trent Water

Post Code	Locality	Recorded Flood Incidents	Post Code	Locality	Recorded Flood Incidents
SY10 7	Weston Rhyn	3	SY7 0	Craven Arms	4
SY11 3	St Martins	36	SY7 8	Clun	3
SY13 1	Whitchurch	42	SY8 1	Ludlow	31
CW3 9	Woore	1	SY8 2	Ludlow	1
DY14 8	Cleobury Mortimer	2	SY8 4	Ludlow	1
SY1 2	Coton Hill	10	SY9 5	Bishops Castle	1
SY1 3	Shrewsbury	1	SY10 8	Oswestry	6
SY1 4	Shrewsbury	50	SY10 9	Oswestry	4
SY2 5	Shrewsbury	3	SY11 1	Oswestry	3
SY2 6	Shrewsbury	2	SY11 2	Oswestry	1
SY3 0	Bayston Hill	3	SY11 4	Oswestry	2
SY3 5	Shrewsbury	1	SY12 9	Criftins	1
SY3 7	Shrewsbury	8	TF9 1	Market Drayton	4
SY3 8	Shrewsbury	15	TF9 3	Market Drayton	2
SY4 2	Shrewsbury	3	TF11 8	Shifnal	3
SY4 3	Shrewsbury	10	TF11 9	Shifnal	1
SY4 4	Shrewsbury	7	TF12 5	Broseley	2

SY4 5	Wem	11	TF13 6	Much Wenlock	14
SY5 0	Minsterley/ Pontesbury	7	WV15 5	Bridgnorth	3
SY5 8	Shrewsbury	5	WV16 4	Bridgnorth	2
SY5 9	Shrewsbury	12	WV16 5	Bridgnorth	1
SY6 6	Church Stretton/ All Stretton	18	WV16 6	Highley	2
SY6 7	Church Stretton	5			**Total=347**

Note: Information combined from Severn Trent Water and Welsh Water

A total of 347 recorded flood incidents in Shropshire were listed in Welsh Water's recorded flood incidents register (from July 1999) and Severn Trent's DG5 register (from 1990). The most frequently flooded localities are: Shrewsbury, Ludlow, St Martins, Whitchurch and Church Stretton.

It is important to recognise the historic flood incident register does not contain information about properties and areas at risk of sewer flooding caused by operational issues such as blockages. Also, the register represents a snapshot in time. As such the sewer flooding flood risk register is not a comprehensive 'at risk register'.

6.7 Flooding from canals

Canals do not generally pose a direct flood risk as they are a regulated waterbody. The residual risk from canals tends to be associated with lower probability events such as overtopping and embankment failure (breach and sudden escape of the water retained in the canal channel).

Breaches or embankment failure may be caused by a number of factors including:

- Culvert collapse
- Overtopping
- Animal burrowing

Flooding from a breach of a canal embankment is largely dictated by canal and ground levels, canal embankment construction, breach characteristics and the volume of water within the canal that can discharge into the lower lying areas behind the embankment. The volume of water released during a breach is dependent on the upstream pound length (i.e. the distance between locks) and how quickly the operating authorities can react to prevent further water loss, for example by the fitting of stop boards to restrict the length of the canal that can empty through the breach, or repair of the breach. The Canal and River Trust monitor embankments at the highest risk of failure.

There are three canals in Shropshire: the Llangollen Canal, the Montgomery Canal and the Shropshire Union Canal. The Canal and River Trust were consulted to identify any instances of breaches and overtopping of each of the canals.

- The **Montgomery Canal** comes into Shropshire from Wales near Pant and Llanymynech. It then travels in a north-easterly direction to join the Llangollen Canal at Lower Frankton. The Montgomery Canal crosses the Rivers Morda and Perry and the Oswestry Brook. There is one recorded incident of overtopping on the Montgomery Canal in Shropshire in 2010, at SJ3071624958, 600m upstream of Maesbury Marsh, when the River Morda overflowed into the canal. It was mainly fields that were flooded from this incident. There has been one recorded incident of breach along the Montgomery Canal in 1937 at the Graham Palmer lock at Frankton.
- The **Llangollen Canal** comes into Shropshire from Wales at Chirk in a south-easterly direction where the Montgomery Canal joins it at Lower Frankton. From there the Llangollen Canal travels north-east and out of Shropshire to the west of Whitchurch in the north of Shropshire. The canal crosses the Tetchill Brook near Ellesmere. There two recorded incidents of overtopping of the canal, once in 2009 at SJ3618232299, when a blocked drain caused towpath flooding and another in 2014 at SJ4981135585 due to unknown causes, again leading to towpath flooding. There have been five incidents of canal breach along the Llangollen, three of which are of unknown dates and causes. In 2007 a lock, sluice and weir failed at Hindford and in 2014 a culvert failed at Grindley Brook.
- The **Shropshire Union Canal** enters Shropshire in the north-east of the County at Knighton. It travels north-west through Market Drayton and out of the northern boundary of Shropshire just north of Adderley. The Shropshire Union canal crosses the River Tern near Market Drayton. There has been one overtopping incident on the Shropshire Union Canal in 1839 due to heavy rain. There have been two breaching incidents, in 1971 due to vandalism at Market Drayton storm weir, and the other in 2000 at Audlem/ Hawkes Moor due to culvert failure.

The flooding incidents from canals in Shropshire have mostly been in largely rural areas. The canals have the potential to interact with other watercourses in the study area including the River Morda, River Perry, Oswestry Brook, Tetchill Brook and the River Tern, which have the potential to become flow paths if these canals were overtopped or breached. Any development proposed adjacent to a canal should include a detailed assessment of how a canal breach would impact the site, as part of a site-specific Flood Risk Assessment. Guidance on development near canals is available from the **Canal and River Trust.**

6.8 Flooding from reservoirs

Reservoirs with an impounded volume greater than 25,000 cubic metres are governed by the Reservoir Act 1975 and are listed on a register held by the Environment Agency. The level and standard of inspection and maintenance required under the Act means that the risk of flooding from reservoirs is very low. Recent changes to legislation under the Flood and Water Management Act require the Environment Agency to designate the risk of flooding from reservoirs over 25,000 cubic metres. Natural Resources Wales (NRW) have a similar legislative role for reservoirs in Wales and this applies to reservoirs over 10,000 cubic metres.

Reservoir failure in Wales could cause flooding downstream on the Severn and Dee and tributaries in Shropshire.

Flooding from reservoirs occurs following partial or complete failure of the control structure designed to retain water in the artificial storage area. Reservoir flooding is very different from other forms of flooding; it may happen with little or no warning and evacuation will need to happen immediately. The likelihood of such flooding is difficult to estimate but is extremely low compared to flooding from rivers of surface water. It may not be possible to seek refuge upstairs from floodwater as buildings could be unsafe or unstable due to the force of water from the reservoir breach or failure.

The risk of inundation to Shropshire as a result of reservoir breach or failure of a number of reservoirs within the area was assessed as part of the National Inundation Reservoir Mapping (NIRIM) study. There are 38 reservoirs shown to affect Shropshire; this includes reservoirs located within Shropshire and a number of reservoirs outside of the area whose inundation mapping is shown to affect Shropshire. The reservoirs inundation extents provided by the Environment Agency are shown in Appendix A.

The Environment Agency maps represent a credible worst-case scenario. In these circumstances it is the time to inundation, the depth of inundation, the duration of flooding and the velocity of flood flows that will be most influential.

Table 6-3 Reservoirs that may potentially affect Shropshire in the event of a breach

Reservoir	Location (grid reference)	Local Authority Area	Is the reservoir located within the study area?
Allscott Settling Lagoons	360118, 313030	Telford and Wrekin	No
Big Pool Shavington	363672, 338191	Shropshire	Yes
Black Dicks Lake	354455, 301813	Shropshire	Yes
Bromfield Pool	346457, 276332	Shropshire	Yes
Chatwell Park Farm Reservoir	379445, 313196	South Staffordshire	No
Chelmarsh	373437, 287543	Shropshire	Yes
Cloverly Pool	361771, 336753	Shropshire	Yes
Devils Dingle	364020, 305527	Shropshire	Yes
Dudmaston Big Pool	374403, 288801	Shropshire	Yes
Hawk Lake	358152, 330700	Shropshire	Yes
Holmer Farm Balancing Lake	370828, 305887	Telford and Wrekin	No
Horsehay Pool	367320, 307340	Telford and Wrekin	No

Ironbridge Cooling Tower Ponds	365852, 303823	Shropshire	Yes
Knighton	373820, 328327	Shropshire/ Stafford	Partially
Knowle Farm Fishing Pool	373385, 308790	Shropshire	Yes
Kyre Pool	363178, 264828	Malvern Hills	No
Lake Clywedog	290663. 288111	Powys	No
Lake Vyrnwy	298947, 321408	Powys	No
Llanforda	327032, 329628	Shropshire	Yes
New Pool	377046, 299764	Shropshire	Yes
Norton Mere	379456, 308546	Shropshire	Yes
Park Pool	380014, 309959	South Staffordshire	No
Patshull Church Pool	379932, 300484	South Staffordshire	No
Patshull Great Pool	380216, 300071	South Staffordshire	No
Pools Farm	348525, 279281	Shropshire	Yes
Priorslee Balancing Lake	372419, 309418	Telford and Wrekin	No
Priorslee Flash	371134, 310294	Telford and Wrekin	No
Roden Pond	359636, 312895	Telford and Wrekin	No
Rosehill Lake	365302, 330375	Shropshire	Yes
Shadwell Pool	354066, 301888	Shropshire	Yes
Shelve Pool	333486, 297892	Shropshire	Yes
Shifnal Reservoir	375201, 306138	Shropshire	Yes
Sunderton Pool	352669, 316296	Shropshire	Yes
Trimpley	377010, 278802	Wyre Forest	No
Upton Park Reservoir	376289, 306911	Shropshire	Yes
Walcot Pool	335261, 285104	Shropshire	Yes
Willey Park Pool	366769, 298798	Shropshire	Yes
Wyldes Quarry	356255, 303754	Shropshire	Yes

As above, the risk of reservoir flooding is extremely low. However, there remains a residual risk to development from reservoirs which developers should consider during the planning stage.

- Developers should seek to contact the reservoir owner to obtain information which may include:
  - reservoir characteristics: type, dam height at outlet, area/volume, overflow location;
  - operation: discharge rates / maximum discharge;
  - discharge during emergency drawdown; and
  - inspection / maintenance regime.
- Developers should apply the sequential approach to locating development within the site.
- Consult with relevant authorities regarding emergency plans in case of reservoir breach.
- The reservoir owners are contacted to confirm the Reservoir Risk Designation (if determined) and the inspection and maintenance regime of the reservoir.
- Consider the impact of a breach and overtopping, particularly for sites proposed to be located immediately downstream of a reservoir. This should consider whether there is sufficient time to respond.
- The EA and NRW online Reservoir Flood Maps contain information on the extents, depths and velocities following a reservoir breach (note: only for those reservoirs with an impounded volume greater than 25,000 cubic metres are governed by the Reservoir Act 1975). For proposed sites located within the extents, consideration should be given to the extent, depths and velocities shown in these online maps.
- In addition to the risk of inundation, those considering development in areas affected by breach events should also assess the potential hydraulic forces imposed by the rapid flood event and check that that the proposed infrastructure fabric can withstand the loads imposed on the structures by a breach event.

6.9 Flood warning and emergency planning

6.9.1 Emergency planning

Emergency planning enables Emergency Responders to respond effectively before, during and after a flood. Emergency Planners also work with local businesses to increase their resilience to flooding through business continuity and local communities on Community Emergency Plans.

The **West Mercia Local Resilience Forum** brings Emergency Responders together in Shropshire to plan for flooding. A Multi Agency Flood Plan has previously been produced for Shropshire and is currently undergoing review. It is recommended that the information in this SFRA is used to inform the review.

Safety is a key consideration for any new development and this includes the residual risk of flooding i.e. behind flood defences, the availability of flood warnings, safe access and egress routes and evacuation procedures. There are currently 19 Flood Alert Areas (FAA) and 55 Flood Warning Areas (FWAs) covering

significant parts of the Shropshire area. These are shown in Appendix A. Flood Warnings are supplied by the Environment Agency for river flooding via the Flood Warning System service, to homes and business within Flood Zones 2 and 3.

The revised 2018 NPPF requires that LPAs assess planning applications to ensure that:

- any residual risk can be safely managed; and
- safe access and escape routes are included where appropriate, as part of an agreed emergency plan.

There are circumstances where a flood warning and evacuation plan is required and / or advised:

- Camping and caravan sites, holiday accommodation and where there are transient occupants e.g. hostels
- Buildings that will be occupied below a design flood level i.e. basements

In addition to the flood warning and evacuation plan considerations in the NPPG, developers should also consider:

- How to manage the consequences of events that are un-foreseen or for which no warnings can be provided e.g. managing the residual risk of a flood defence breach or failure.
- That proposed new development that places additional burden on the existing response capacity of the Council will not normally be considered to be appropriate.
- Developers should encourage those owning or occupying developments, where flood warnings can be provided, to sign up to receive them. This applies even if the development is defended to a high standard.
- The vulnerability of site occupants.
- Situations may arise where occupants cannot be evacuated (e.g. prisons) or where it is safer to remain "in-situ" and / or move to a higher floor or safe refuge area (e.g. developments located immediately behind a defence and at risk of a breach).

In Shrewsbury there are specific plans to mobilise temporary and demountable defences and pumps in the Frankwell and English Bridge areas. Developers in these areas should contact Shropshire Council for further information to inform specific evacuation/ safe access and egress plans for developments in these areas.

Table 6-4 Summary of Flood Risks in Shropshire

Settlement	Fluvial flood risk	Existing or proposed defences	Surface water flood risk	Susceptibility to Groundwater flood risk				Reservoir inundation risk	Historic, recorded flood events
				<25%	>=25% <50%	>=50% <75%	>=75%		
Albrighton	Fluvial flood risk in Albrighton originates from an unnamed watercourse which flows west through Albrighton Pool in the north of the village. The majority of properties are located outside of Flood Zones 2 and 3; however, a few properties are at risk from flooding along Woodland Close.	None	The majority of properties in Albrighton are not located within surface water extents and the majority of surface water risk is confined to the unnamed watercourse. There are however a significant number of overland flow routes via local roads. Most of the roads in the village affected by surface water flooding are only affected by the 1,000-year event; however, isolated areas are affected in the 30-year event, including Charles Avenue, Abney Avenue, Bishton Road, Cross Road, High Street, Station Road and Windsor Road. The surface water extent is wider to the south of the village.	✓	✓			None	
Bishops Castle	Bishops Castle lies entirely within Flood Zone 1; however, an unnamed watercourse runs culverted in a south-easterly direction through the town. The watercourse becomes un-culverted approximately 600m south-east of the town and the immediate area around the watercourse lies within Flood Zones 2 and 3, though this does not affect any properties. Bishops Castle is unlikely to flood from fluvial sources, unless the culvert running through the town became blocked and surcharged.	None	The surface water risk in the town is largely confined to overland flow routes via local roads. The main roads affected in the 30-year event are Brampton Road, Church Street and Union Street. Large isolated pockets of surface water flood extents are present to the east of Love Lane.	✓		✓	✓	None	1 incident of sewer flooding since 1990
Bridgnorth	The River Severn flows south through the eastern part of Bridgnorth and the Cantern Brook joins the Severn to the north. The extents of Flood Zones 2 and 3 along the Severn is quite wide, up to 350m at its maximum through Low Town. Properties adjacent to the Severn are at risk of flooding. Properties in the north of the town along the Cantern Brook are not located within Flood Zones 2 or 3.	None	The surface water flow paths follow the topography in Bridgnorth, flowing via the main local roads in High Town, down the B4373 and into the River Severn and Low Town in the 30-year event, and flowing into the Cantern Brook in the North of the town. The Low Town is largely affected by surface water flooding between the A442 and the Severn due to runoff from higher ground in the east. Properties are largely affected in the 1,000-year event; however, properties along Pale Meadow Road, Washbrook Road and Lavington View are also affected in the 30-year event. Properties around Roundthorn Close, Wenlock Rise and Hazeldine Way are affected by surface water extents largely in the 1,000-year event but also	✓	✓			Bridgnorth is partially located within the reservoir inundation extents of Patshull Pool, Chelmarsh, Devils Dingle, Priorslee Flash and Willey Park Pool	Fluvial events: 2000 6 incidents of sewer flooding since 1990

			from the 100-year and 30-year flowing into a small pond adjacent to the A458.						
Cleobury Mortimer	The majority of Cleobury Mortimer lies within Flood Zone 1; however, there is fluvial flood risk to the town as the catchment is relatively small, and catchments <3km^2 are not included in the EA Flood Zones. Part of the eastern edge of the town lies within Flood Zones 2 and 3 where the River Rea flows south, though no properties are shown to be at risk from flooding. An unnamed watercourse flows east through the south of the town, however given the topography, the town is unlikely to flood from predominantly fluvial sources.	None	As the majority of the town is at high elevations, the majority of surface water flood extents flow along dry valleys from the town to the River Rea. The 30-year and 100-year extents are generally confined to these valleys in the north and south of the town, potentially affecting properties along Pinkham, Lion Lane and Eagle Lane, with a few isolated pockets on the A4117. The 1,000-year event extends further into the high ground of the town, notably along the A4117, Ron Hill Lane and Furlongs Road.	✓				None	2 incidents of sewer flooding since 1990
Clun	Clun lies within a valley in the Shropshire Hills with the River Clun flowing east through the town. The extents of Flood Zones 2 and 3 around the river are quite wide, up to 130m and properties along Bridge Street, Church Street and Waterloo Drive are at risk from flooding. The River Unk flows into the River Clun in the north west of the town, and here flood extents could reach some properties, including the Garden Cottages. Considering the town's low topographical location, it is more likely to flood from predominantly fluvial sources.	None	The surface water extents in Clun are largely confined to runoff towards the various watercourses through the town. The 30-year and 100-year extents are well confined to the watercourses with a few small isolated ponding events in the town, such as along Ford Street. The 1,000-year extent spreads wider across the watercourses and flows down local roads such as Bridge Street and the A488 towards the River Clun. A large surface water flood extent in all events is present in the north east of the town in field, however, this is away from properties.	✓		✓	✓	None	Fluvial events: 2000 4 incidences of sewer flooding since 1990
Church Stretton	Church Stretton lies within the Stretton gap, a narrow valley in the Shropshire Hills. Given the town's topography, it is more likely to flood from predominantly fluvial sources. An unnamed watercourse flows east through the centre of Church Stretton, and the extents of Flood Zones 2 and 3 are quite wide along the watercourse. Many properties located between the B5477 and the A49 west to east, and Springbank Farm to Sandford Avenue north to south are located within Flood Zones 2 and 3. Properties along Carding Mill Valley, as the watercourse flows	None	Due to its topography, Church Stretton is affected by surface water from runoff from surrounding hills and into the town in the 1,000-year event. A large extent in the 1,000-year event is notable to the south of Stretton Farm Road and the east of Ludlow Road; however, this affects a small number of properties. There are also a small number of properties affected by the 30-year flood extent, most notably along Swain's Meadow and Crossways and Hazler Road, The Bridleways and Snatchers Lane are notable overland flow routes. The 1,000-year extent has a greater effect on properties and more local roads are used as flow routes such as the B5477, Central Avenue and Lutwyche Road.		✓	✓		None	23 incidences of sewer flooding since 1990

	into Church Stretton, are also at risk. The drains flowing parallel to the A49 also pose fluvial flood risk to properties, predominantly along Watling Street South, Crossway, Swain's Meadow, Snatchers Lane and Hazler Crescent. The World's End Brook, which flows parallel to the B5477 Ludlow Road, could also be at risk of flooding, though this would be more likely to affect field areas rather than properties. An unnamed watercourse flows north out of Church Stretton into All Stretton adjacent to the railway, the area immediately around the railway line lies within Flood Zones 2 and 3, as well as a small number of properties along Heighways Lane and Farm Lane.								
Craven Arms	Craven Arms is enclosed by the Shropshire Hills to the north, east and west, therefore its low topographical location makes it more likely to flood from predominantly fluvial sources. The main source of fluvial flood risk is from the River Onny which flows south through the eastern side of the town. While the flood extents are wide, there are only a small number of properties that are located within Flood Zones 2 and 3, along Newton Street. Parts of Corvedale Road are located within Flood Zones 2 and 3 where an unnamed watercourse joins the River Onny. Another unnamed watercourse flows east through the town, posing a flood risk to properties along Brook Road, The Crescent, Burnside Close, the B4368, the A49, Fairfield Close and Market Street.	None	Runoff from the surrounding hills towards the River Onny gives rise to the small amount of surface water flooding in the 30-year extent. Small pockets of surface water flooding are present in the 30-year around Coppice Drive and along Watling Street. Notable flow routes in the 1,000-year event are along Brook Road and the B4368. Part of the railway line is shown to be within the 1,000-year extent.			✓	✓	None	4 incidences of sewer flooding since 1990 Pluvial: May/June 2018
Ellesmere	Ellesmere has a varying topography and lower lying areas of the town are at risk from fluvial flooding. Properties along Beech Grove, Cambria Avenue, Oak Drive, Stanham Drive, Trimpley Street, Brownlow Park, Brownlow Court and	None	Ellesmere is affected by very small, isolated pockets of ponded surface water in the 30-year, 100-year and 1,000-year events affecting some roads and properties within the town. The largest areas of ponding in the town are located around Oak Drive, Stanham Drive, Cambria	✓				None	

	Willow Crescent are located within Flood Zones 2 and 3 of the Newnes Brook. Properties along Wharf Road, Scotland Street, Victoria Street, Canal Way and New Wharf Road are located within Flood Zones 2 and 3 near the Llangollen Canal and an unnamed watercourse in the south of the town.		Avenue and around the junction of the A485 with the A528.						
Ludlow	The majority of Ludlow is situated on top of a hill; however, lower lying ground around the Rivers Teme and Corve are at risk of fluvial flooding. Properties along St Marys Lane, Corve Street, Bromfield Road and Linney are located within Flood Zone 2 and 3 of the River Corve. The flood extent of the River Teme in Ludlow is fairly well confined to the channel; however, some properties are within the Flood Zone 2 and 3 extent along Lower Mill Street, Lower Broad Street, St John's Lane, the B4361 and Temeside.	None	The main source of surface water flooding is runoff from higher ground via local roads towards the Teme and Corve. There are predominantly small, isolated pockets of ponding in the 30-year event, with no notable overland flow routes; however, parts of the railway line falls within the extent. Notable overland flow routes in the 1,000-year event are the B4361, Mill Street, Broad Street, Steventon New Road, Sheet Road and Livesey Road. The 1,000-year event largely affects the industrial sites between Weeping Cross Lane and Steventon New Road and the rugby-football club and fields adjacent to the Corve and the Teme.	✓	✓	✓		Ludlow is partially located within the reservoir inundation extents of Pools Farm, Walcot Pool and Bromfield Pool	Fluvial events: 2000, 2007 32 incidences of sewer flooding since 1990 Pluvial: May/June 2018
Market Drayton	The flood extent of the River Tern in Market Drayton is quite wide; however, there are only a few properties located within Flood Zones 2 and 3 of the Tern in the town. Non-residential property around the crossing of the Tern and the A529 are located within Flood Zones 2 and 3. In the north of Market Drayton, an unnamed watercourse poses some fluvial flood risk to the urban area. Flood Zone 3 is mainly confined to the channel in this area, though Flood Zone 2 extends to the industrial estate between Bert Smith Way and the A53.	None	As the majority of the town sits on high ground, most of the surface water risk is areas of isolated ponding, with some overland flow routes in the 1000-year event. The 30-year event only produces a few isolated pockets of ponding with one notable overland flow route along Highfields/Dalelands Estate.	✓	✓	✓		None	6 incidences of sewer flooding since 1990
Much Wenlock	The extent of the fluvial Flood Zones in the town is limited as the catchment of the Shylte Brook is smaller than 3km2 and not shown on national scale mapping. Serious flooding to the town is better represented by the surface water mapping that shows the floodplain of small watercourses and local and	None	The main surface water risk is via overland flow routes to the unnamed watercourse. Flow routes in the 30-year event are the B4378, the A4169 and Shineton Street, there are also isolated pockets of ponding, notably along Station Road and in Much Wenlock Park. The areas of ponding are significantly larger in the 1,000-year event and overland flow routes are also present along Racecourse Road, Barrow Street and the A458.	✓				None	14 incidences of sewer flooding since 1990

	detailed flood modelling available from Shropshire Council.								
Oswestry and Morda	The majority of Oswestry lies within Flood Zone 1 and the topography of the town and the culverted watercourse mean that Oswestry is unlikely to flood from primarily fluvial sources. The village of Morda just to the south of Oswestry is partially located within Flood Zones 2 and 3 of the River Morda; however, due to the topography of Morda, only a small number of properties are affected, immediately to the west and east of Morda Bank, and to land along Weston Lane and Weston Road going out of the village.	None	A large number of roads are affected by surface water flooding flowing from high ground in the west to lower ground in the east where there are large areas of ponding in the 1,000-year event.	✓		✓	✓	None	16 incidences of sewer flooding since 1990
Shawbury	The majority of Shawbury lies to the west of the River Roden at higher elevations, leaving it unlikely to flood from primarily fluvial sources. Through the village, the flood extent of the Roden is fairly confined, and only a small number of properties are located within Flood Zones 2 and 3, primarily along the A53.	None	The surface water flood risk in Shawbury is runoff from the high ground in the west to the River Roden in the east and the unnamed watercourse in the south; however, the runoff and ponding events are isolated and very few, primarily along Bridge Way and Poynton Road in the 1,000-year event. The surface water risk from the 30-year event in Shawbury is relatively minor.	✓	✓		✓	None	
Shifnal	The majority of Shifnal is located within Flood Zone 1, with the area immediately around the Wesley Brook located within Flood Zones 2 and 3. The extent of the Flood Zones is fairly well confined due to the topography of the surrounding areas; however, properties that back onto the Wesley Brook through the town, south of Haughton Road to where the Brook leave Shifnal are located within Flood Zones 2 and 3.	None	There are small, isolated areas of surface water flooding in the 30-year event, notably along Curriers Lane and Barn Road with no notable overland flow routes towards the Wesley Brook. This is similar for the 100-year event, with notable ponding along Aston Road. Overland flow routes are more predominant in the 1,000-year event, with notable overland flow routes being along the B4379 and Victoria Road.	✓		✓	✓	Shifnal is partially located within the extents of Priorslee Flash, Priorslee Balancing Lake, Knowle Farm Fishing Pools and Shifnal Reservoir	4 incidences of sewer flooding since 1990
Shrewsbury	The main fluvial flood risk through Shrewsbury is the River Severn, but fluvial risk is also present from the Bagley Brook, Rad Brook, Rea Brook, Battlefield Brook and other unnamed watercourses. In a severe event, the old course of Severn that runs through the north of the town (and the route of the Bagley Brook) would be affected. Many areas of open space, such as Frankwell car	Existing wall with demountable defences along the Severn in Frankwell along Water Lane, passing	Shrewsbury is affected by surface water flooding with runoff from local roads flowing into the Severn and the Bagely Brook, Rad Brook and Rea Brook. Areas including Monkmoor, Ditherington, Castlefields and Greenfields could be affected by surface water flooding.	✓	✓	✓	✓	Shrewsbury is partially located within the reservoir inundation extents of Sunderton Pool	Fluvial events: 1948, 1960, 1998, 2000, 2004, 2015 >100 incidences of sewer flooding since 1990 Pluvial: May/June 2018

	park and recreation ground and The Quarry park are sacrificial floodplain that flood relatively frequently. Flooding mechanisms are complex at the confluence of the Rea Brook, with water backing up from the Severn affecting low lying properties in the English Bridge area. Many parts of the town are therefore at a high risk of fluvial flooding including parts of but not exclusively: Mountfields, Coleham, Abbey Foregate, Frankwell, Castle Fields, Spring Gardens, Mount Pleasant, Ditherington, Heathgates, Monkmoor, Belle Vue, Sutton, Meole Brace and Coton Hill.	the Welsh Bridge and St George's Bridge. Embankment and flood wall along the Rea Brook from Old Potts Way to the English Bridge.							Historic flood events in Shrewsbury date back beyond 1795, which is one of the largest known events on the River Severn when the Welsh Bridge was washed away.
Wem	The majority of the town of Wem lies north of the River Roden, almost entirely within Flood Zone 1. lower around the River Roden, some properties fall within Flood Zones 2 and 3, predominantly around Roden Grove, Mill Street, Sungrove, Brook Drive and to the east of Wem, parts of Aston Road. An unnamed watercourse flows into Wem in the south to join the River Roden; due to the low topography some properties fall into Flood Zone 2 and 3 of this watercourse, namely Dranwell Lane and Wellgate.		The surface water risk in Wem is mainly runoff from the higher ground of the town towards the River Roden. There are notable large areas of ponding in all events around Thomas Adams School and the fields surrounding it also extending down to Bankhouse Lane and Fothergill Way.			✓	✓	None	11 incidences of sewer flooding since 1990
Whitchurch	Whitchurch has a varying topography. An unnamed watercourse flows south from Blake Mere in the north-east of the town, before flowing north-west through the centre of Whitchurch. Properties that back onto the watercourse are located within Flood Zones 2 and 3, along Rydal Avenue, Edward German Drive, Wayland Close, Edgeley Gardens. At Bridgewater Street, the watercourse flows in and out of culverts, from here only the un-culverted parts of the watercourse lie within Flood Zone 3, which is very well confined to the channel. More properties fall into the Flood Zone 2 extent of this watercourse, along Park Avenue,	None	Due to the topography of Whitchurch, the main surface water flood risk is runoff from the high ground of the town towards the unnamed watercourse which flows into the Grindley Brook. Extents in the 30-year event are predominantly areas of ponding around the B5395, Green End and Jubilee Park. Large extents in the 1,000-year extent are notable around Park Avenue and Sherrymill Hill and between the B5398 and Mare Close.	✓	✓	✓	✓	None	Fluvial events: 2000 42 incidences of sewer flooding since 1999

	Joyca Way, Darwin Court, Mill Street, Castle Hill and Sherrymill Hill. The bus station, supermarket and car park between Bridgewater Street and Green End are also located within Flood Zone 2. Due to the topography and location of watercourses within Whitchurch, the majority of the town is unlikely to flood; however, lower lying land within the vicinity of these watercourses could be more at risk of fluvial flooding.								

7 Flood defences and assets

7.1 Flood defences and standard of protection

The residual risk of flooding in an extreme flood event or from failure of defences should be carefully considered. The condition of existing flood defences and whether they will continue to be maintained and/or improved in the future is a factor that needs to be considered as part of the risk-based sequential approach and, in light of this, whether proposed land allocations are appropriate and sustainable.

Developers should also consider the Standard of Protection (SoP) provided by defences and residual risk as part of a site-specific FRA. Site-specific FRAs will need to thoroughly explore the condition of defences, especially where these defences are informal and demonstrate a wide variation of condition grades. It is important that all of these assets are maintained to a good condition and their function remains unimpaired.

Standard of Protection

Flood defences are designed to give a specific standard of protection, reducing the risk of flooding to people and property in flood prone areas. For example, a flood defence with a 1% AEP standard of protection means that the flood risk in the defended area is reduced to a 1% chance of flooding in any given year.

Although flood defences are designed to a standard of protection it should be noted that, over time, the actual standard of protection provided by the defence may decrease, for example due to deterioration in condition or increases in flood risk due to climate change.

7.1.1 Defence Condition

A broadscale overview of formal flood defences is provided using AIMS data from the Environment Agency and information from the Council, provided in Table 7-2.

Formal structural defences are given a rating based on a grading system for their condition. A summary of the grading system used by the Environment Agency for condition is provided in Table 7-1.

Table 7-1 Defence asset condition rating

Grade	Rating	Description
1	Very good	Cosmetic defects that will have no effect on performance.
2	Good	Minor defects that will not reduce the overall performance of the asset.
3	Fair	Defects that could reduce the performance of the asset.
4	Poor	Defects that would significantly reduce the performance of the asset. Further investigation required.
5	Very Poor	Severe defects resulting in complete performance failure.

Source: Condition Assessment Manual – Environment Agency 2006

Table 7-2 Formal Flood Defences in Shropshire

Watercourse	Location	NGR	Type	Asset Maintained By	Design SoP	Approximate length (m)	Condition rating	Comments
River Roden	Between Loppington and Wem	SJ 48387 29098 to SJ 49640 28028	Embankment	Environment Agency	Up to 5	1632	Fair to good	Both banks
River Severn	Shrewsbury (Welsh Bridge)	SJ 48974 12981 to 48692 12813	Wall/demountable defence	Environment Agency	100	638	Fair to very good	
River Severn/Rea Brook	Coleham, Shrewsbury (English Bridge)	SJ 49669 12300	Wall/embankment/bridge abutment/demountable defence	Environment Agency	100	633	Fair to good	Right bank
River Severn	Near Buckley Farm, Pentre	SJ 36452 16628	Embankment	Environment Agency	5	741	Fair	Left bank
River Severn	Near Pentre Farm	SJ 34293 16562	Embankment	Environment Agency	5	1409	Fair to good	Left bank
River Vyrnwy	Melverley	SJ 32491 17001	Embankment	Environment Agency	5	1521	Fair	Left bank, partially right bank in places
River Vyrnwy	Little Dyffrydd to Lower House	SJ 29389 20514 to 31731 17795	Embankment	Environment Agency	5	4869.6	Fair to good	Left bank, partially right bank in places
River Morda	Station house to Fisherman's Cottage	SJ 30361 20667 to 30415 19446	Embankment	Environment Agency	Up to 10	1922	Fair to good	Left bank

Source: AIMS dataset, Environment Agency

7.2 Major flood alleviation schemes

7.2.1 Shrewsbury

There was major flooding to Shrewsbury Town Centre in 1998 and Autumn 2000. This particularly affected the lowest lying areas of the town, including the Ellesmere Road, Smithfield Road/ Mardol, Frankwell, Town Walls, Longden Coleham and the English Bridge/ Coleham/ Abbey Foregate areas.

Following these major floods, in 2003 the first major scheme was opened to protect the Frankwell area. This is a mixture of permanent flood walls with demountable sections. In the event of a flood warning, Frankwell car park is closed off and the demountable sections put in place to provide a continuous defence. Depending on the forecast flood level, the defences can be further raised adjacent to the footbridge over the Riverside Centre at Frankwell Quay. A Severn Trent pumping station at the entrance to the car park helps to ensure the safe evacuation of surface water from behind the flood defences. This scheme protects over 70 properties, including Theatre Severn and the main entrance to the Town Centre from the west, over Welsh Bridge.

In 2011, a further scheme was completed in the River Severn/ Rea Brook confluence area to protect the English Bridge/ Coleham/ Abbey Foregate area, consisting off a mixture of flood walls and demountable sections. During a flood event, water is temporarily over-pumped into the River Severn in this area. This scheme protects 80 properties including 24 businesses, the Abbey and the gyratory road system that forms the main access to the Town Centre from the east, over the English Bridge.

7.2.2 Much Wenlock

Much Wenlock had notable flooding in 2007 when 64 properties were flooded, and the culverts of the Shylte Brook that run through the town have a limited capacity causing excess flood water to flow over ground when they are full. To alleviate this issue, two ponds, one on the Sytche Brook and the other on the Shylte Brook were constructed to catch and store water in Much Wenlock to reduce flooding to properties and infrastructure in the town. The ponds work as they fill with water during heavy rain and the collected water is then released in a controlled manner. Work on the scheme was completed in July 2017 and reduced flood risk to 171 properties.

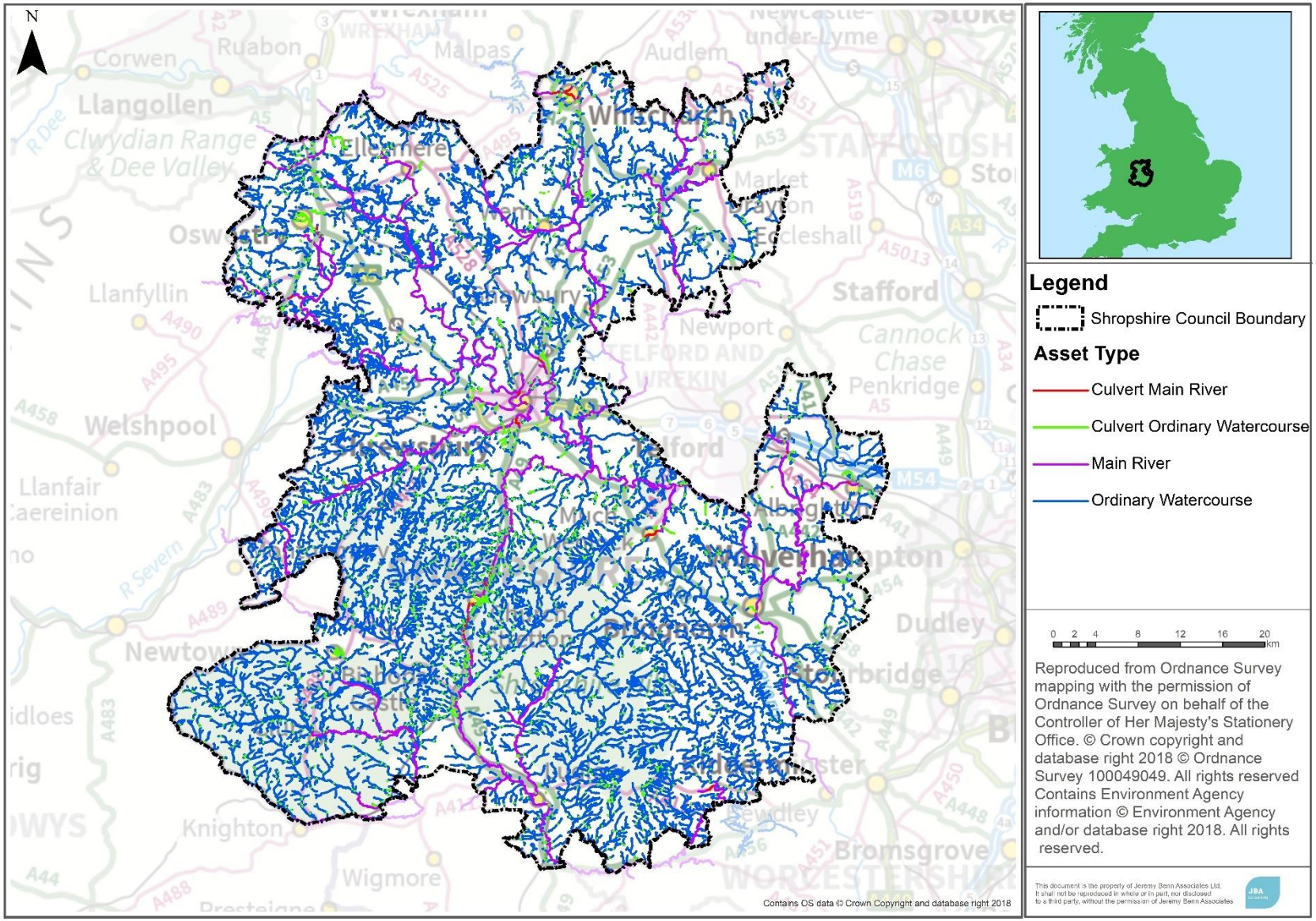
7.2.3 Residual flood risk

The risk of rapid inundation following defence overtopping or breach is limited in Shropshire to areas of Shrewsbury, Much Wenlock and rural areas protected by minor defences.

7.3 LLFA Asset Register

Shropshire Council has compiled a Flood Risk Asset Register for the County under Section 21 of the FWMA (2010). Figure 7-1 shows the assets listed on the Shropshire Council Asset Register located within Shropshire.

Figure 7-1 Map of LLFA Asset Register within Shropshire



8 Cumulative impact of development and cross-boundary issues

8.1 Cumulative impact of development

Under the revised 2018 NPPF, strategic policies and their supporting Strategic Flood Risk Assessments (SFRAs), are required to '*consider cumulative impacts in, or affecting, local areas susceptible to flooding*' (para. 156).

To understand the impact of future development on flood risk in Shropshire, the potential change in developed area and the communities at risk from the 1 in 100-year surface water flooding event within each river catchment have been identified. This identifies the catchments where development may have the greatest impact on flood risk, and where further assessment would be required within a Level 2 Strategic Flood Risk Assessment (SFRA) or site-specific Flood Risk Assessment (FRA).

Where catchments have been identified as sensitive to the cumulative impact of development, the assessment concludes with recommended strategic planning policy suggestions to manage the risk.

8.1.1 Method of assessing cumulative impact

To assess the cumulative impact within Shropshire, the surface water flood risk in each catchment was assessed along with the potential change in developed area of each river catchment to identify the catchments at greatest risk. Figure 8-1 shows the methodology used and Table 8-1 summarises the datasets used within the Shropshire cumulative development scenario.

Figure 8-1 Overview of the method used within the Cumulative Impacts Assessment

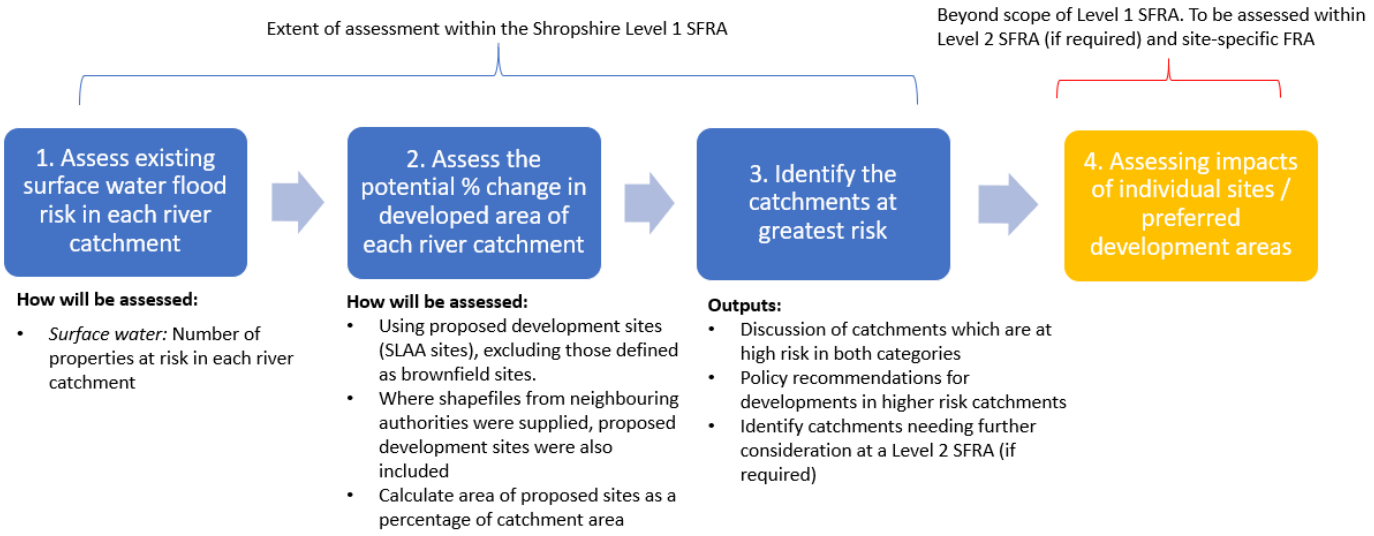


Table 8-1 Summary of datasets used within the Cumulative Impact Assessment

Dataset	Coverage	Source of data	Use of data
Catchment boundaries	Shropshire study area	Water Framework Directive (WFD) catchments	Surface water and development flood risk
Sub-catchment boundaries	Shropshire study area	FEH CD-ROM	Surface water and development flood risk
Shropshire SLAA sites	Shropshire study area	Shropshire Council	Determining % area of catchment where development has been proposed
Neighbouring Local Plan developments	Telford and Wrekin BC	Telford and Wrekin BC	Determining % area of catchment where development has been proposed
Communities at risk from surface water flooding (100-year event)	Shropshire study area	Shropshire Council	Assessing number of properties at risk from surface water flooding in 100-year event

8.1.2 Assessing existing surface water flood risk

To understand the surface water flood risk in each catchment, the 'Communities at risk from surface water' dataset supplied by Shropshire Council was used. This dataset specifies the number of properties that are at risk from surface water flooding in the 100-year event. Water Framework Directive (WFD) catchment data was used to determine the number of properties at risk in each river catchment.

8.1.3 Assessing potential future development

Shropshire Council supplied a list of their Strategic Land Availability Assessment (SLAA) sites, which identifies land that may be used for development. Sites that were specified as brownfield were not included in the assessment. This data was used to determine the area of potential development within each river catchment, as a percentage of the total area of the catchment. Where data regarding potential development in neighbouring authorities was available from the relevant authorities, this was also used in calculating the potential percentage change. This data was then combined with the catchments at highest risk from surface water flooding to determine the catchments with the greatest overall risk.

8.1.4 Assessment assumptions and limitations

The study has been undertaken using the best available data. The assumptions made in assessing and ranking the impacts of cumulative development on catchments within Shropshire are summarised in Table 8-2.

Table 8-2 Assumptions and limitations of the assessment

Assessment aspect	Assumption made	Details of limitation in method	Justification of method used
Development scenarios	Inclusion of all SLAA sites received by Shropshire Council during the Local Plan process, apart from those specifically defined as brownfield sites.	The study assessed the potential impact of all sites received during the Local Plan process. This included sites which may not be suitable for allocation, as well as more strategic development areas which are often developed in phases. As a result, it presents a 'worst case' assessment of growth, which is likely to overestimate the risk within each catchment. Brownfield sites were not included; however, not all sites specified the current land use, so brownfield sites may have been included in the assessment.	Although the method was a very conservative estimate, it identified settlements and catchments with the greatest potential for growth. Sites for development where current land use was specified as brownfield were not included as part of the assessment, as development here is unlikely to impact flood risk.
	Assumption of housing density and impermeable areas	As potential development densities were not known for all of the sites, it was assumed that the entire area of the site would contribute surface water runoff to the wider catchment. In reality, landscaping and requirements for SuDS within sites lessen the impacts of new development.	The assessment considered the 'worst case' development scenario, if surface water runoff was not controlled from new developments. With housing densities and proportions of undeveloped areas not known, the approach was conservative.
	Inclusion of development sites from neighbouring authorities	Development from neighbouring authorities was only considered where GIS data was available and where neighbouring development had a significant impact on the % of proposed development within a catchment.	GIS data provided the most accurate results for the % of a catchment that was covered by proposed development. The majority of development in neighbouring authorities did not have a significant impact on these percentages, i.e. would not make a catchment at highest risk in Shropshire, and therefore neighbouring

			development was considered on this basis. More detail on neighbouring sites with the potential to affect Shropshire is discussed in section 8.
Surface water flood risk	Number of properties flooded	Only areas where >5 properties fall within the 100-year surface water flood extent were included in the assessment.	The communities at risk data supplied by Shropshire Council only included areas where >5 properties were flooded in the 100-year surface water flooding event.

8.1.5 Outcomes

The assessment was initially conducted on the WFD River Catchments as described above; however, some of the catchments seen as 'high risk' were very large catchments which included mostly rural areas. Following the initial assessment, two of the 'high risk' catchments were split into smaller sub-catchments using the FEH CD-ROM to produce more comprehensive results of the cumulative impact of development.

Table 8-3 shows the catchments most at risk from flooding due to the proportion of catchment area covered by proposed development. For the purpose of this assessment only catchments with >5% proposed development has been included. Table 8-4 shows the number of properties at risk from flooding in the 100-year surface water event. For the purpose of this assessment only, catchments with >50 properties at risk have been included.

Table 8-3 Percentage of catchment area covered by proposed development

Catchment	%
East Bridgnorth: Between Bridgnorth and Stanmore*	88.6
Cosford: Neachley Brook - source to confluence Burlington Brook	55.0
Albrighton: Albrighton Brook - source to confluence with River Worfe.	32.4
Shrewsbury North: Bomere Heath to Bagley Brook**	27.8
Shrewsbury: Rad Brook**	17.6
Between Shifnal and Cosford: Burlington Brook - source to confluence with Neachley Brook	16.9
Bicton: tributary of the River Severn**	16.1
Pontesbury to South Shrewsbury: Rea Brook – confluence with Pontesford Brook to confluence with River Severn	14.2

Shifnal: Wesley Brook - source to confluence with River Worfe	13.7***
Bridgnorth West: High Town, tributary of the River Severn*	13.6
Whittington and East Oswestry: Common Brook - source to confluence with River Perry	13.0
Oswestry: Oswestry Brook	10.6
Oldbury (Bridgnorth): Tributary of the River Severn*	10.1
Market Drayton: Tern – confluence with Loggerheads Brook to confluence with Bailey Brook	8.4
Much Wenlock: Shylte Brook - source to confluence with River Severn	6.6
Bishop's Castle: Snakescroft Brook	6.4
Yorton to North Shrewsbury: Sundorne Brook - source to confluence with River Severn	6.1
Swancote to Ryton: River Worfe – confluence with Wesley Brook to confluence with River Severn	5.9
Cound Brook: confluence with unnamed tributary to confluence with Condover Brook	5.5

*Sub-catchment originally part of Severn – confluence with River Worfe to confluence with River Stour WFD catchment

**Sub-catchment originally part of Severn – confluence with Bele Brook to confluence with Sundorne Brook WFD catchment

***Note that percentage for this catchment includes proposed development outside of the Shropshire boundary in Telford and Wrekin.

Table 8-4 Properties at risk from surface water flooding per catchment

Catchment	Number of properties at risk
Oswestry: Oswestry Brook	166
Pontesbury to South Shrewsbury: Rea Brook – confluence with Pontesford Brook to confluence with River Severn	129
Shrewsbury: Rad Brook**	101
South Church Stretton: Quinny Brook - source to confluence with River Onny	97
Much Wenlock: Shylte Brook - source to confluence with River Severn	82
Yorton to North Shrewsbury: Sundorne Brook - source to confluence with River Severn	81
Shifnal: Wesley Brook - source to confluence with River Worfe	74
Shrewsbury North: Bomere Heath to Bagley Brook**	74

South Ludlow: Teme – confluence with River Onny to confluence with River Severn	66
North Oswestry: Perry - source to confluence with Common Brook	61
North Ludlow: Corve – confluence with Seifton Brook to confluence with River Teme	60
Whitchurch: Worthenbury Brook - upper	55

As can be seen from the above tables, there are several catchments that are at high risk in both categories.

Catchments that have >100 properties at risk, or >10% of the area is proposed for potential development are also deemed to be high risk catchments, as well as those are high risk in both categories.

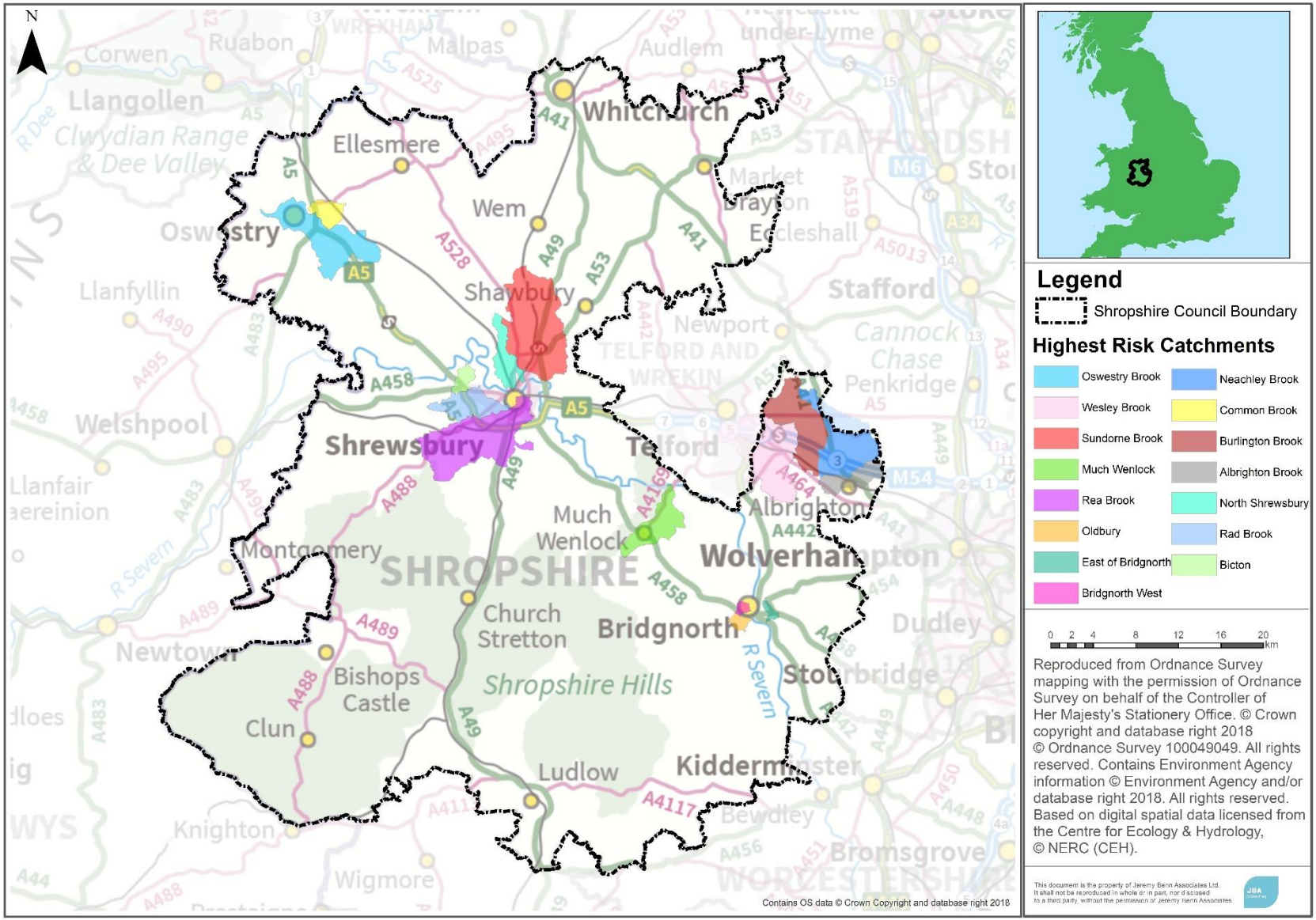
Figure 8-2 shows a map of the 15 highest risk catchments in Shropshire. Appendix B show individual maps of the highest risk catchments with the SLAA sites and communities at risk from surface water flooding used to assess the cumulative impact, and any known flood alleviation schemes within the catchment. A summary of the high-risk catchments is shown in Table 8-5.

Table 8-5 Summary of the cumulative impact assessment high risk catchments

Catchment	Percentage of catchment area covered by proposed development (%)	Number of properties at risk from surface water flooding
East of Bridgnorth: Between Bridgnorth and Stanmore*	88.6	0
Cosford: Neachley Brook - source to confluence Burlington Brook	55.0	0
Albrighton: Albrighton Brook - source to confluence with River Worfe.	32.4	6
Shrewsbury North: Bomere Heath to Bagley Brook**	27.8	74
Shrewsbury: Rad Brook**	17.6	101
Between Shifnal and Cosford: Burlington Brook - source to confluence with Neachley Bk	16.9	0
Bicton: tributary of the River Severn**	16.1	0
Pontesbury to South Shrewsbury: Rea Brook – confluence with Pontesford Brook to confluence with River Severn	14.2	129

Shifnal: Wesley Brook - source to confluence with River Worfe	13.7***	74
Bridgnorth West: High Town, tributary of the River Severn*	13.6	24
Whittington and East Oswestry: Common Brook - source to confluence with River Perry	13.0	22
Oswestry: Oswestry Brook	10.6	166
Oldbury (Bridgnorth): Tributary of the River Severn*	10.1	0
Much Wenlock: Shylte Brook - source to confluence with River Severn	6.6	82
Yorton to North Shrewsbury: Sundorne Brook - source to confluence with River Severn	6.1	81

Figure 8-2 Map showing location of highest risk catchments



8.1.6 Planning Policy Recommendations

The following Planning Policy recommendations have been made for the catchments where cumulative development is likely to have the greatest impact on flood risk:

1. That a Level 2 SFRA or detailed local area Strategic Drainage Study considers further how the cumulative effects of potential peak rates and volumes of water from development sites would impact on peak flows, duration of flooding and timing of flood peaks on receiving watercourses. Such studies could be used to justify greater restrictions/ enforce through Local Planning Policy development site runoff rates and volumes specific to each catchment that are over and above those required by National and Local SuDS Standards. They could also identify where there are opportunities with allocated sites to provide off-site betterment e.g. online/ offline flood storage and where land should be safeguarded within proposed site allocations to fulfil this purpose.
2. Where appropriate, that the opportunity for Natural Flood Management in rural areas, SuDS retrofit in urban areas and river restoration should be maximised in these catchments. In support of policy 6 in the Local FRM Strategy, culverting should be opposed, and day-lighting existing culverts promoted through new developments.
3. Developers should explore through site specific FRAs opportunities to provide wider community flood risk benefit through new developments.
4. Developers should contribute to community flood defences outside of their red line boundary in these catchments to provide wider benefit and help offset the cumulative impact of development.
5. That the LLFA and other RMAs should use this information, alongside the high priority settlement information in the Local FRM Strategy to inform a long-term pipeline of flood alleviation studies and schemes to help inform points 2. to 5. above.
6. That the Environment Agency, in consultation with Shropshire Council, should consider whether to formally designate these catchments as Critical Drainage areas. This would mean that a detailed Flood Risk Assessment would be required for all developments that are proposed, regardless of their size.

8.2 Cross Boundary Issues

Future large-scale development, both within and outside Shropshire can have the potential to affect the flood risk to existing development and surrounding areas. Shropshire has boundaries with the following local authorities:

- South Staffordshire Council
- Powys County Council
- Wyre Forest District Council
- Newcastle-under-Lyme Borough Council
- Telford and Wrekin Council
- Herefordshire Council

- Wrexham County Borough Council
- Stafford Borough Council
- Malvern Hills District Council
- Cheshire East Council
- Cheshire West and Chester Council

The topography of the study area and direction of watercourse flow means that neighbouring authorities which have the most potential to affect flood risk in Shropshire are Telford and Wrekin, Wrexham, Powys and Herefordshire.

A high-level overview of potential cross-boundary flood risk issues is provided in Sections 8.2.1 to 8.2.11 for the 11 neighbouring authorities which have supplied information on their Strategic Site Allocations within their Local Plans. In the vast majority of cases, if appropriate drainage and SuDS are adopted, development in these neighbouring authorities is unlikely to affect flood risk in Shropshire. For the 11 neighbouring authorities, their respective Local Plans are being updated alongside the evidence base (i.e. SFRAs, Sustainability Appraisals etc.) and therefore, their flood risk and drainage policies are not yet formalised. However, it is very likely that to ensure compliance with the NPPF, appropriate sustainable drainage and flood risk policies will be proposed. It is recommended that Shropshire Council consults neighbouring authorities, particularly during the consultation phases of their respective Local Plans, to identify and review potential cross-boundary issues.

8.2.1 Stafford Borough Council

Any developments outlined in Stafford Borough Council's Local Plan are located away from the border with Shropshire on watercourses that flow away from Shropshire, therefore development at these sites are unlikely to impact the fluvial flood risk within the study area.

8.2.2 South Staffordshire District Council

South Staffordshire have identified potential site allocations within its current Local Plan. The potential site allocations are located on watercourses which drain away from Shropshire, therefore development at these sites are unlikely to impact the fluvial flood risk within the study area. There may be a localised effect in increasing flood risk upstream of the sites. If appropriate drainage is adopted at the sites, the likelihood of any significant effect on the level of flood risk in Shropshire is low.

8.2.3 Telford and Wrekin Borough Council

A number of watercourses within Telford and Wrekin flow into the Shropshire via the River Roden, River Severn, River Teme and Wesley Brook. Telford and Wrekin Borough Council supplied data on their potential site allocations for housing and employment within their Local Plan. Numerous site allocations are located near the border with Shropshire, including sites in Ironbridge, Madeley, Dawley, Lawley, Shawbirch and Hortonwood; which, due to the topography and watercourse direction, could drain into Shropshire via the River Tern and River Severn. If appropriate drainage is adopted at the sites, the likelihood of any significant effect on the level of flood risk within Shropshire is low. Further, the increase in impermeable area has the potential to increase runoff entering watercourses that

drain into Shropshire and there may also be a localised effect in increasing flood risk upstream of the sites.

8.2.4 Wrexham Borough Council

Watercourses in Wrexham flow into Shropshire via the River Dee, River Ceriog, Shell Brook and Morlas Brook. Information was supplied on Wrexham's Local Development Plan for 2013-2028. Numerous site allocations are located near the border with Shropshire, including sites in Cefn Mawr, Johnstown, Ruabon, Chirk, Overton and Penley which could drain into Shropshire, primarily via the River Dee and River Ceriog.

8.2.5 Wyre Forest District Council

The majority of watercourses in Wyre Forest do not flow into Shropshire; however, there are several watercourses flowing into Dowles Brook, which forms the border between the two areas. Wyre Forest District Council supplied data on their adopted sites from the 2013 Local Plan and sites which were included in the Local Plan Review Preferred Options consultation in 2017. The majority of sites are located near the River Severn which flows away from Shropshire in Wyre Forest, therefore posing little risk to the study area; however, a number of site allocations are located near the border with Shropshire, including sites in Far Forest and Long Bank which could drain into Shropshire via the River Tern.

8.2.6 Cheshire East Borough Council

The majority of watercourses within Cheshire East Borough Council flow away from Shropshire, therefore potential site allocations within the Local Plan are unlikely to impact the fluvial risk within the study area. There may be a localised effect in increasing flood risk upstream of the sites.

8.2.7 Cheshire and West Chester Borough Council

Shropshire holds a very short border with Cheshire and West Chester. The land near the border is proposed for safeguarding for mineral mining. Watercourses within this area generally flow away from Shropshire, therefore development at these sites are unlikely to impact the fluvial flood risk within the study area.

8.2.8 Malvern Hills District Council

The South Worcestershire Development Plan was supplied showing the locations of proposed housing and development sites. The majority of sites are located away from the border with Shropshire; however, sites at Tenbury Wells and Bayton could drain into the Shropshire border via the River Tern and River Rea.

8.2.9 Powys District Council

Powys forms a large boundary with western Shropshire; the majority of watercourses flow into the Teme, which makes up part of the boundary with Powys. Watercourses originating from Powys also flow into the River Camlad, Rea Brook, River Severn and River Morda. A number of development sites outlined in the Local Plan for Powys are located along the River Severn, which flows into Shropshire from Powys; however, the majority are located away from the border of the two areas. Sites at Churchstoke, Trewern, Four Crosses and Knighton could drain into Shropshire.

8.2.10 Herefordshire Council

A number of watercourses in Herefordshire flow into the River Tern, which flows into Shropshire. Proposed development sites at Adforton, Brampton Bryan, Brimfield, Leintwardine, Little Hereford, Orleton, Richards Castle and Walford could drain into Shropshire.

8.2.11 Newcastle-under-Lyme Borough Council

A number of watercourses in Newcastle-under-Lyme that could affect Shropshire flow into the River Tern, which forms part of the border between Shropshire and Newcastle. The Stoke-on-Trent City Council and Newcastle-under-Lyme Borough Council Joint Local Plan Preferred Options Consultation document outlines preferred housing and employment sites within Newcastle. The sites proposed in the plan are not located on watercourse that flow into Shropshire, therefore development at these sites are unlikely to impact the fluvial flood risk within the study area.

8.3 Water quality considerations

In addition to cross-boundary issues regarding flood risk, there are also cross-boundary issues relating to water quality. Development or changes to land management practises in the upper catchments of watercourses that flow across boundaries into Shropshire can potentially impact on the quality of watercourses within the study area. Development should consider the quality of the water that is released from sites and the impact it may have on the water quality on any receiving waterbodies. Future development should ensure there is no adverse impact on the quality of watercourses within the Council administrative area. Any impacts identified should then be considered in relation to the WFD Ecological, Hydromorphological and Chemical Status of the waterbody and the status objectives. Opportunities to improve the status of watercourses should also be considered. This is particularly important for Shropshire as there are several watercourses within the area which have not achieved a good status, primarily due to diffuse pollution and phosphate levels.

9 FRA requirements and guidance for developers

9.1 Over-arching principles

This SFRA focuses on delivering a strategic assessment of flood risk within Shropshire. Prior to any construction or development, site-specific assessments will need to be undertaken so all forms of flood risk at a site are fully addressed. It should be acknowledged that a detailed FRA may show that a site is not appropriate for development of a particular vulnerability or even at all. Where the FRA shows that a site is not appropriate for a particular usage, a lower vulnerability classification may be appropriate.

9.1.1 Planning consultees

There are a number of statutory consultees for planning matters; key stakeholders are listed below (note, this list is not exhaustive):

- Shropshire Council decides all planning matters, including those related to flood risk, in their decision whether or not to grant planning permission. The Council being a Unitary Authority is also the Lead Local Flood Authority, providing technical advice on surface water drainage strategies and designs put forward for 'major' developments.
- The Environment Agency is a statutory consultee for applications in Flood Zones 2 and 3

9.2 Requirements for site-specific Flood Risk Assessments

9.2.1 What are site specific FRAs?

Site-specific FRAs are carried out by (or on behalf of) developers to assess flood risk to and from a site. They are submitted with planning applications and should demonstrate how flood risk will be managed over the development's lifetime, taking into account climate change and vulnerability of users.

9.2.2 When is a FRA required?

Site-specific FRAs are required in the following circumstances:

- Proposals of 1 hectare or greater in Flood Zone 1.
- Proposals for new development (including minor development and change of use) in Flood Zones 2 and 3.
- Proposals for new development (including minor development and change of use) in an area within Flood Zone 1 which has critical drainage problems (as notified to the LPA by the Environment Agency).
- Where proposed development or a change of use to a more vulnerable class may be subject to other sources of flooding.

A FRA may also be required for some specific situations:

- If the site may be at risk from the breach of a local defence (even if the site is actually in Flood Zone 1)
- Where the site is intended to discharge to the catchment or assets of a water management authority which requires a site-specific FRA
- Where the site's drainage system may have an impact on an IDB's system

- Where evidence of historical or recent flood events have been passed to the LPA
- In an area of significant surface water flood risk.

9.2.3 Objectives of site-specific FRAs

Site-specific FRAs should be proportionate to the degree of flood risk, as well as appropriate to the scale, nature and location of the development. Site-specific FRAs should establish:

- whether a proposed development is likely to be affected by current or future flooding from any source;
- whether a proposed development will increase flood risk elsewhere;
- whether the measures proposed to deal with the effects and risks are appropriate;
- the evidence, if necessary, for the local planning authority to apply the Sequential Test; and
- whether, if applicable, the development will be safe and pass the Exception Test.

FRAs should follow the approach recommended by the NPPF (and associated guidance) and guidance provided by the Environment Agency and Shropshire Council. Guidance and advice for developers on the preparation of site-specific FRAs include:

- **Standing Advice on Flood Risk** (Environment Agency);
- **Flood Risk Assessment for Planning Applications** (Environment Agency);
- **FRA Guidance Notes (Environment Agency SHWG Area Sustainable Places Team)**;
- **Shropshire Council flood risk advice to developers** and
- **Site-specific Flood Risk Assessment: CHECKLIST** (NPPF PPG, Defra)

Guidance for local planning authorities for reviewing flood risk assessments submitted as part of planning applications has been published by Defra in 2015 – **Flood Risk Assessment: Local Planning Authorities.**

9.3 Flood risk management guidance - Mitigation measures

Mitigation measures should be seen as a last resort to address flood risk issues. Consideration should first be given to minimising risk by planning sequentially across a site. Once risk has been minimised as far as possible, only then should mitigation measures be considered.

9.3.1 Site layout and design

Flood risk should be considered at an early stage in deciding the layout and design of a site to provide an opportunity to reduce flood risk within the development.

The NPPF states that a sequential, risk-based approach should be applied to try to locate more vulnerable land use away from flood zones, to higher ground, while more flood-compatible development (e.g. vehicular parking, recreational space)

can be located in higher risk areas. However, vehicular parking in floodplains should be based on the nature of parking, flood depths and hazard including evacuation procedures and flood warning.

Waterside areas, or areas along known flow routes, can act as Green Infrastructure, being used for recreation, amenity and environmental purposes, allowing the preservation of flow routes and flood storage, and at the same time providing valuable social and environmental benefits contributing to other sustainability objectives. Landscaping should ensure safe access to higher ground from these areas and avoid the creation of isolated islands as water levels rise.

Making space for water

All new development close to rivers should consider the opportunity presented to improve and enhance the river environment. Developments should look at opportunities for river restoration and enhancement as part of the development. Options include backwater creation, de-silting, in-channel habitat enhancement and removal of structures. When designed properly, such measures can have benefits such as reducing the costs of maintaining hard engineering structures, reducing flood risk, improving water quality and increasing biodiversity. Social benefits are also gained by increasing green space and access to the river.

The provision of a buffer strip can 'make space for water', allow additional capacity to accommodate climate change and ensure access to the watercourse, structures and defences is maintained for future maintenance purposes. It also enables the avoidance of disturbing riverbanks, adversely impacting ecology and having to construct engineered riverbank protection. Building adjacent to riverbanks can also cause problems to the structural integrity of the riverbanks and the building itself, making future maintenance of the river much more difficult.

9.3.2 Raised floor levels

The raising of floor levels within a development avoids damage occurring to the interior, furnishings and electrics in times of flood. If it has been agreed with the Environment Agency that, in a particular instance, the raising of floor levels is acceptable, the floor levels should be raised to a minimum of 600mm above the maximum water level caused by a 1 in 100-year fluvial flood event including an appropriate allowance for climate change. The additional height that the floor level is raised above the maximum water level is referred to as the "freeboard". Additional freeboard may be required because of risks relating to blockages to the channel, culvert or bridge and should be considered as part of an FRA.

If raised floor levels are proposed, these should be agreed with Shropshire Council and the Environment Agency. The minimum Finished Floor Level (FFL) may change depended on the vulnerability and flood risk of the development.

Reference to the latest climate change guidance will be made when considering the FFL. Many areas currently situated within Flood Zone 2 may become part of Flood Zone 3a in the future because of climate change, therefore it is essential that the potential risk of flooding in the future is considered when planning development.

Allocating the ground floor of a building for less vulnerable, non-residential, use is an effective way of raising living space above flood levels.

Single storey buildings such as ground floor flats or bungalows are especially vulnerable to rapid rise of water (such as that experienced during a breach). This risk can be reduced by use of multiple storey construction and raised areas that provide an escape route. However, access and egress would still be an issue, particularly when flood duration covers many days. All sleeping accommodation in Flood Zone 2 and 3a should be located above the recommended flood level. No sleeping accommodation should be located in Flood Zone 3b.

Similarly, the use of basements should be avoided. Habitable uses of basements within Flood Zone 3 should not be permitted, whilst basement dwellings in Flood Zones will be required to pass the Exception Test.

9.3.3 Flood Resilient Design

Many of the recent developments in flood risk areas in Shrewsbury serve as examples of flood resilient design, where habitable floor levels have been raised above design flood levels and developments have been designed to provide an element of flood storage and allow flood water to flow through and around the development. These include Benbow Quay on the Ellesmere Road, the former Shrewsbury Town Football Club site downstream of the English Bridge on the right bank as shown in Figure 9-1 and Stiperstones Court Retirement Living on Abbey Foregate fronting the Rea Brook, which is shown in Figure 9-2.

Figure 9-1 Riverside Meadow apartments from the River Severn

Source: Environment Agency

Figure 9-2 Stiperstones Court retirement apartments from the Rea Brook

Source: Environment Agency

9.3.4 Access and egress

Safe access and egress will need to be demonstrated at all development sites. For residential developments, a minimum dry pedestrian access should be provided to and from the development without crossing through the 1 in 100-year plus climate change floodplain. Vehicular access to the site should be achievable, taking into account extreme events.

If safe access and egress cannot be achieved, the Defra/EA Technical Report: **FD2320: Flood Risk Assessment Guidance for New Development** should be referred to, to determine the hazard to people posed along the access route. This can also be used to inform a Flood Warning and Evacuation Plan for the site in consultation with Emergency Planners.

Emergency vehicular access should be possible during times of flood.

9.3.5 Modification of ground levels

Modifying ground levels to raise the land above the required flood level is an effective way of reducing flood risk to a particular site in circumstances where the land does not act as conveyance for flood waters. However, care must be taken at locations where raising ground levels could adversely affect existing communities and property; in most areas of fluvial flood risk, raising land above the floodplain

would reduce conveyance or flood storage in the floodplain and could adversely impact flood risk downstream or on neighbouring land.

Where proposed development results in a change in building footprint, the developer should ensure that it does not impact upon the ability of the floodplain to store or convey water and seek opportunities to provide floodplain betterment. Similarly, where ground levels are elevated to raise the development out of the floodplain, compensatory floodplain storage within areas that currently lie outside the floodplain should be provided to ensure that the total volume of the floodplain storage is not reduced.

For compensatory flood storage to be effective and not require hydraulic modelling, it must be provided on a level for level, volume for volume basis on land which does not already flood and is within the site boundary. Where land is not within the site boundary, it must be in the immediate vicinity, in the applicant's ownership/control and linked to the site. Floodplain compensation should be considered in the context of the 1% annual probability (1 in 100 year) flood level including an allowance for climate change. When designing a scheme flood water must be able to flow in and out unaided. An FRA should demonstrate that there is no loss of flood storage capacity and include details of an appropriate maintenance regime to ensure mitigation continues to function for the life of the development. Guidance on how to address floodplain compensation is provided in Appendix A3 of the CIRIA Publication C62430.

Raising levels can also create areas where surface water might pond during significant rainfall events. Any proposals to raise ground levels should be tested to ensure that it would not cause increased ponding or build-up of surface runoff on third party land.

9.3.6 Development and raised defences

Construction of localised raised floodwalls or embankments to protect new development is not a preferred option, as a residual risk of flooding will remain. Compensatory storage must be provided where raised defences remove storage from the floodplain. It would be preferable for schemes to involve an integrated flood risk management solution.

Temporary or demountable defences are normally not acceptable forms of flood protection for a new development but might be appropriate to address circumstances where the consequences of residual risk are severe but the time required to install the defences, for example in an overtopping scenario, would be realistic. In addition to the technical measures the proposals must include details of how the temporary measures will be erected and decommissioned, responsibility for maintenance and the cost of replacement when they deteriorate. The storage and accessibility of such structures must be considered.

Where development is located behind, or in an area benefitting from defences, consideration should be given to the potential safety of the development, finished floor levels and the potential for safe access and egress in the event of rapid inundation of water due to a defence breach with little warning.

9.3.7 Developer contributions

In some cases and following the application of the Sequential Test, it may be appropriate for the developer to contribute to the improvement of flood defence provision that would benefit both proposed new development and the existing local

community. Developer contributions can also be made to maintenance and provision of flood risk management assets, flood warning and the reduction of surface water flooding (i.e. SuDS).

DEFRA's Flood and Coastal Risk Management Grant in Aid (FCRMGiA)[5] can be obtained by operating authorities to contribute towards the cost of a range of activities including flood risk management schemes that help reduce the risk of flooding and coastal erosion. Some schemes are only partly funded by FCRMGiA and therefore any shortfall in funds will need to be found from elsewhere when using Resilience Partnership Funding, for example local levy funding, local businesses or other parties benefitting from the scheme.

For new development in locations without existing defences, or where the development is the only beneficiary, the full costs of appropriate risk management measures for the life of the assets proposed must be funded by the developer.

Information on current and future flood alleviation schemes can be obtained from the Environment Agency and Shropshire Council as LLFA.

9.4 Flood risk management guidance - Resistance measures

There may be instances where flood risk to a development remains despite implementation of such planning measures as those outlined above. For example, where the use is water compatible, where an existing building is being changed, where residual risk remains behind defences, or where floor levels have been raised but there is still a risk at the 1 in 1,000-year scenario. In these cases, (and for existing development in the floodplain), additional measures can be put in place to reduce damage in a flood and increase the speed of recovery.

These measures should not normally be relied on for new development as a mitigation method. Most of the measures should be regarded as reducing the rate at which flood water can enter a property during an event and considered an improvement on what could be achieved with sand bags. They are often deployed with small-scale pumping equipment to control the flood water that does seep through these systems. The effectiveness of these forms of measures are often dependant on the availability of a reliable forecasting and warning system to user the measures are deployed in advance of an event. The following measures are often deployed:

Permanent barriers

Permanent barriers can include built up doorsteps, rendered brick walls and toughened glass barriers.

Temporary barriers

Temporary barriers consist of moveable flood defences which can be fitted into doorways and/or windows. The permanent fixings required to install these temporary defences should be discrete and keep architectural impact to a minimum. On a smaller scale, temporary snap on covers for airbricks and air vents can also be fitted to prevent the entrance of flood water.

Community resistance measures

These include demountable defences that can be deployed by local communities to reduce the risk of water ingress to a number of properties. The methods require

[5] Environment Agency (2012) Principles for implementing flood and coastal resilience funding partnerships

the deployment of inflatable (usually with water) or temporary quick assembly barriers in conjunction with pumps to collect water that seeps through the systems during a flood.

Non-return valves

Non-return valves can be installed to prevent waste water from being forced up appliances e.g. lavatories, washing machines, sinks etc.

9.5 Flood risk management guidance - Resilience measures

Flood-resilient buildings are designed and constructed to reduce the impact of flood water entering the building. These measures aim to ensure no permanent damage is caused, the structural integrity of the building is not compromised and the clean up after the flood is easier. Interior design measures to reduce damage caused by flooding include:

- electrical circuitry installed at a higher level with power cables being carried down from the ceiling rather than up from the floor level;
- water-resistant materials for floors, walls and fixtures.

The consideration of resistance and resilience measures should not be used to justify development in inappropriate locations.

9.6 Reducing flood risk from other sources

9.6.1 Groundwater

Groundwater flooding has a very different flood mechanism to any other and for this reason many conventional flood defence and mitigation methods are not suitable. The only way to fully reduce flood risk would be through building design (development form), ensuring floor levels are raised above the water levels caused by a 1 in 100-year plus climate change event. Site design would also need to preserve any flow routes followed by the groundwater overland to ensure flood risk is not increased downstream.

Infiltration SuDS can cause increased groundwater levels and subsequently may increase flood risk on or off of the site. Developers should provide evidence and ensure that this will not be a significant risk. When redeveloping existing buildings, it may be acceptable to install pumps in basements as a resilience measure. However, for new development this is not considered an acceptable solution.

9.6.2 Surface water and sewer flooding

Developers should discuss public sewerage capacity with the water utility company at the earliest possible stage. The development must improve the on-site drainage infrastructure to reduce flood risk on the site and the wider area. It is important that a drainage impact assessment shows that this will not increase flood risk elsewhere, and that the drainage requirements regarding runoff rates and SuDS for new development are met.

If residual surface water flood risk remains, the likely flow routes and depths across the site should be modelled. The site should be designed so that these flow routes are preserved and building design should provide resilience against this residual risk.

Developers should refer to the Shropshire Council SuDS Handbook for guidance on how to design new developments to take surface water flood risk into account.

9.6.3 Sustainable Drainage Systems

Sustainable Drainage Systems (SuDS) aim to mimic the natural processes of Greenfield surface water drainage by encouraging water to flow along natural flow routes and thereby reduce runoff rates and volumes during storm events while providing some water treatment benefits. SuDS also have the advantage of providing effective Blue and Green infrastructure and ecological and public amenity benefits when designed and maintained properly.

Developers should refer to the Shropshire Council SuDS Handbook for guidance on how to design SuDS systems on new developments to meet Local SuDS standards.

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10 Surface water management and SuDS

10.1 What is meant by surface water flooding?

Surface water flooding describes flooding from sewers, drains, and ditches that occurs during heavy rainfall.

Surface water flooding includes:

- **pluvial flooding**: flooding as a result of high intensity rainfall when water is ponding or flowing over the ground surface (overland surface runoff) before it either enters the underground drainage network or watercourse or cannot enter it because the network is full to capacity;
- **sewer flooding**: flooding that occurs when the capacity of underground water conveyance systems is exceeded, resulting in flooding inside and outside of buildings. Normal discharge of sewers and drains through outfalls may be impeded by high water levels in receiving waters which may cause water to back up and flood around buildings or in built up areas. Sewer flooding can also arise from operational issues such as blockages or collapses of parts of the sewer network; and
- **overland flows entering the built-up area from the rural/urban fringe**: includes overland flows originating from groundwater springs.

10.2 Role of the LLFA and Local Planning Authority in surface water management

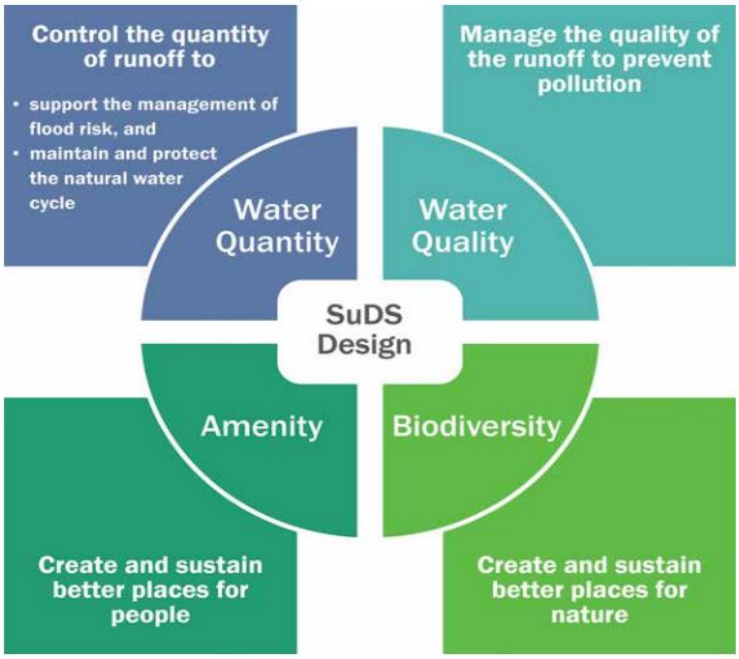
In April 2015 Shropshire Council was made a statutory consultee on the management of surface water and, as a result, provide technical advice on surface water drainage strategies and designs put forward for major development proposals.

When considering planning applications, the Flood and Water Team at Shropshire Council will provide advice to the Planning Department on the management of surface water. As LPA, Shropshire Council should satisfy themselves that the development's proposed minimum standards of operation are appropriate and ensure through the use of planning conditions or planning obligations, that there are clear arrangements for on-going maintenance over the lifetime of the development.

Judgement on what SuDS system would be reasonably practicable is through reference to **Defra's Non-Statutory Technical Standards for SuDS** and the Local SuDS Standards in the Shropshire SuDS Handbook.

It is essential that developers consider sustainable drainage at an early stage of the development process – ideally at the master-planning stage. This will assist with the delivery of well designed, appropriate and effective SuDS. Proposals should also comply with the key SuDS principles regarding solutions that deliver multiple long-term benefits. These four principles are shown in Figure 10-1.

Figure 10-1 Four pillars of SuDS design



Source: The SuDS Manual (C753)

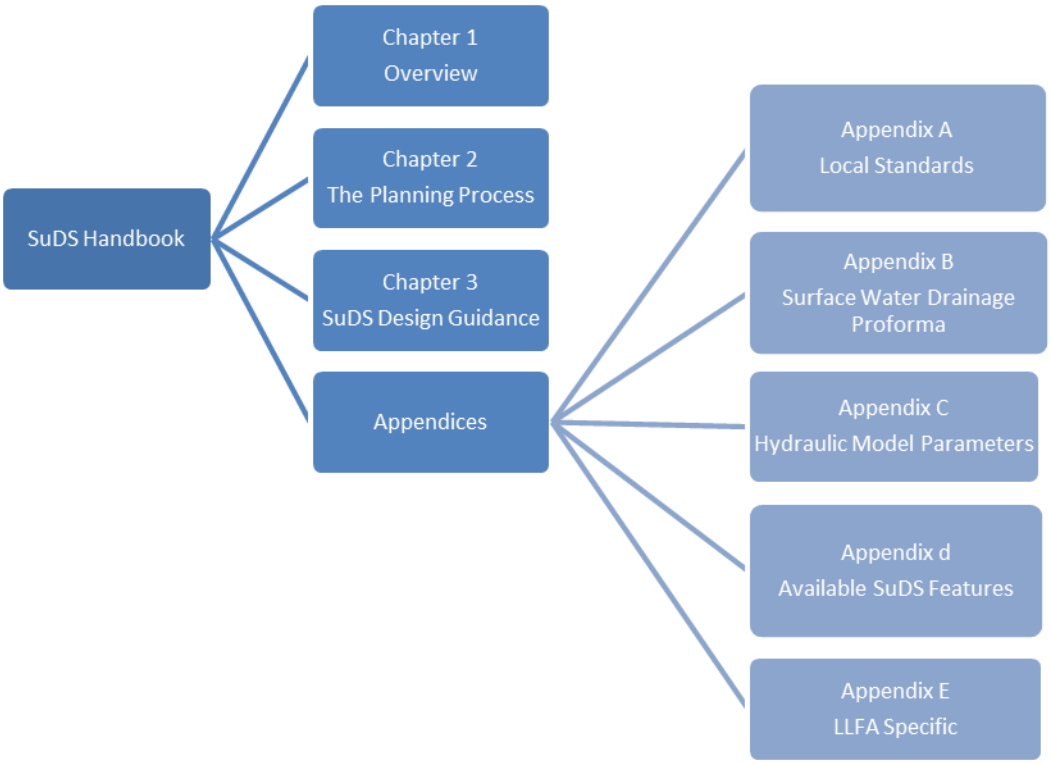
10.3 Shropshire Council SuDS Handbook

This section is based on the 2018 consultation version of the SuDS Handbook. The reader should check the **Shropshire Council website** for the latest version.

Shropshire Council have worked in partnership with seven other West Midlands LLFA to produce the SuDS Handbook. The front end of the document is identical across LLFAs and each LLFA has a specific appendix in their version setting out local design considerations, constraints, case studies and arrangements for SuDS maintenance. Shropshire Council have widely consulted with other RMAs when preparing the document to ensure their views have been taken into account.

Figure 10-2 shows how the SuDS Handbook has been presented. The Handbook contains a proforma that a developer should submit alongside a Flood Risk Assessment/ Surface Water Drainage Strategy.

Figure 10-2 Contents of the Shropshire SuDS Handbook



The SuDS Handbook presents design guidance alongside Local SuDS Standards that developers should meet when proposing SuDS systems on new developments.

The Local Standards are that:

Design Principles

Local Standard A – Phased Development and Drainage Strategies

For phased developments, the LLFA will expect planning applications to be accompanied by a Drainage Strategy which takes a strategic approach to drainage provision across the entire site and incorporates adequate provision for SuDS within each phase.

Local Standard B – Pollution Prevention and Control

The LLFA will expect the SuDS to demonstrate how pollutants are prevented or controlled as part of the SuDS scheme. This should include consideration of the sensitivity of receiving waterbodies and particular attention should be given to the first 5mm of rainfall ('first flush' that mobilises the most pollutants).

Local Standard C – Conformity with the SuDS Management Train Principles

The LLFA will expect the SuDS design to demonstrate how the principles of the SuDS Management Train have been taken into account.

Local Standard D – Multiple Benefits

The LLFA will expect the SuDS design to demonstrate, where appropriate, how environmental site constraints have been considered and how the features design will provide multiple benefits e.g. landscape enhancement, biodiversity, recreation, amenity, leisure and the enhancement of historical features.

Volume Control

Local Standard E – Climate Change

The LLFA will expect SuDS design to include an allowance for a 30%* increase in rainfall for a 1% Annual Exceedance Probability rainfall event in order to accommodate climate change. (*note that guidance may be subject to change and therefore the most up to date information should be referenced).

Local Standard F – Urban Creep

The LLFA will expect the SuDS design to include an allowance for an increase in impermeable area to accommodate urban creep.

Local Standard G – Emergency Overflows

The LLFA will expect an emergency overflow to be provided for piped and storage features above the predicted water level in a 1% Annual Exceedance Probability rainfall event, with an allowance for climate change.

Local Standard H – Freeboard Levels

The LLFA will expect all surface water storage ponds to provide a 300mm freeboard above the predicted water level arising from a 1% Annual Exceedance Probability rainfall event inclusive of an allowance for climate change. Care must be taken to ensure that excavations do not take place below the ground water level.

Flood Risk Within the Development

Local Standard I – Exceedance Flows

The LLFA will expect exceedance flows, originating from both within and outside of the development site, must be directed through areas where the risks to both people and property are minimised.

When considering exceedance routes, particular attention should be paid to:

i. The position of walls, bunds and other obstructions that may direct water but must not cause ponding

ii. The location and form of buildings (e.g. terraces and linked detached properties) that must not impede flows or cause ponding

Submitted drawings and calculations must identify sources of water entering a site pre-development, how flows will be routed through a site, where flows leave the site pre-development and where they leave the site post development.

Local Standard J – Watercourse Floodplains

The LLFA will expect the floodplains of ordinary watercourses to be mapped to an appropriate level of detail considering the nature of the application (i.e. detailed flood modelling should be undertaken to support full planning applications). The layout of the development will then take a sequential approach, siting the least vulnerable parts of that development in the highest flood risk areas.

Local Standard K – Retention of Natural Drainage Features

The LLFA will expect natural drainage features on a site should be maintained and enhanced. Culverting of open watercourses will not normally be permitted except where essential to allow highways and / or other infrastructure to cross. In such cases culverts should be designed in accordance with CIRIA's Culvert design and operation guide, (C689).

Where a culverted watercourse crosses a development site, it should be reverted back to open channel. In such a case the natural conditions deemed to have existed prior to the culverting taking place should be re-instated.

Local Standard L – Impact of Downstream Water Levels

If high water levels within a receiving watercourse into which a SuDS scheme discharges are anticipated, the LLFA will expect that they will not adversely affect the function of that SuDS system.

Designing for Maintenance Considerations

Local Standard M – Maintenance Requirements

The LLFA will expect SuDS to be designed so that they are easy to maintain. Proper use of the SuDS management train, including surface features, is one way to achieve this.

The developer must set out who will maintain the system, how the maintenance will be funded and provide a maintenance and operation manual.

Local Standard N – Minimising the Risk of Blockages

The LLFA will expect the SuDS design to minimise the risk of blockage as far as is reasonably possible e.g. by using suitable pipe sizes and making underground assets as visible and accessible as possible.

Local Standard O – Use of Pumped Systems

If it can be demonstrated that a partial or completely pumped drainage system is the only viable option, the LLFA will expect the residual risk of flooding due to the failure of the pumps to be assessed. The design flood level must be determined under the following conditions:

- If the pumps were to fail
- If the attenuation storage was full, and
- If a design storm occurred.

The finished floor levels of the affected properties should be raised above this level and all flooding should be safely stored onsite.

An emergency overflow must be provided for piped and storage features above the predicted water level arising from a 1% Annual Exceedance Probability rainfall event inclusive of allowances for climate change and urban creep.

10.3.1 C753 CIRIA SuDS Manual (2015)

The **C753 CIRIA SuDS Manual** (2015)[6] replaces and updates the previous version (C697) providing up to date guidance on planning, design, construction and maintenance of SuDS. The document is designed to help the implementation of these features into new and existing developments, whilst maximising the key benefits regarding flood risk and water quality. The manual is divided into five sections ranging from a high-level overview of SuDS, progressing to more detailed guidance with progression through the document. It is recommended that developers and the LPA utilise the information within the manual to help design SuDS which are appropriate for a development.

10.3.2 Non-Statutory Technical Guidance, Defra (March 2015)

Non-Statutory Technical guidance has been developed by Defra to sit alongside PPG to provide non-statutory standards as to the expected design and performance for SuDS.

In March 2015, the latest guidance was released providing amendments as to what is expected by the LPA to meet the National standards. The guidance provides a valuable resource for developers and designers outlining peak flow control, volume control, structural integrity of the SuDS, and flood considerations both within and outside the development as well as maintenance and construction considerations. It considers the following: flood risk inside and outside the development, peak flow, volume control, structural integrity, designing for maintenance considerations and construction.

The LPA will make reference to these standards when determining whether proposed SuDS are considered reasonably practicable.

10.4 Other surface water considerations

10.4.1 Groundwater Vulnerability Zones

The Environment Agency published new groundwater vulnerability maps in 2015. These maps provide a separate assessment of the vulnerability of groundwater in overlying superficial rocks and those that comprise the underlying bedrock. The maps show the vulnerability of groundwater at a location based on the hydrological, hydrogeological and soil properties within a one-kilometre grid square.

Two maps are available:

- **Basic groundwater vulnerability map:** this shows the likelihood of a pollutant discharged at ground level (above the soil zone) reaching groundwater for superficial and bedrock aquifers and is expressed as high, medium and low vulnerability
- **Combined groundwater vulnerability map:** this map displays both the vulnerability and aquifer designation status (principal or secondary). The

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[6] C753 CIRIA SuDS Manual (2015):

http://www.ciria.org/Memberships/The_SuDS_Manual_C753_Chapters.aspx

aquifer designation status is an indication of the importance of the aquifer for drinking water supply.

The groundwater vulnerability maps should be considered when designing SuDS. Depending on the height of the water table at the location of the proposed development site, restrictions may be placed on the type of SuDS appropriate to certain areas.

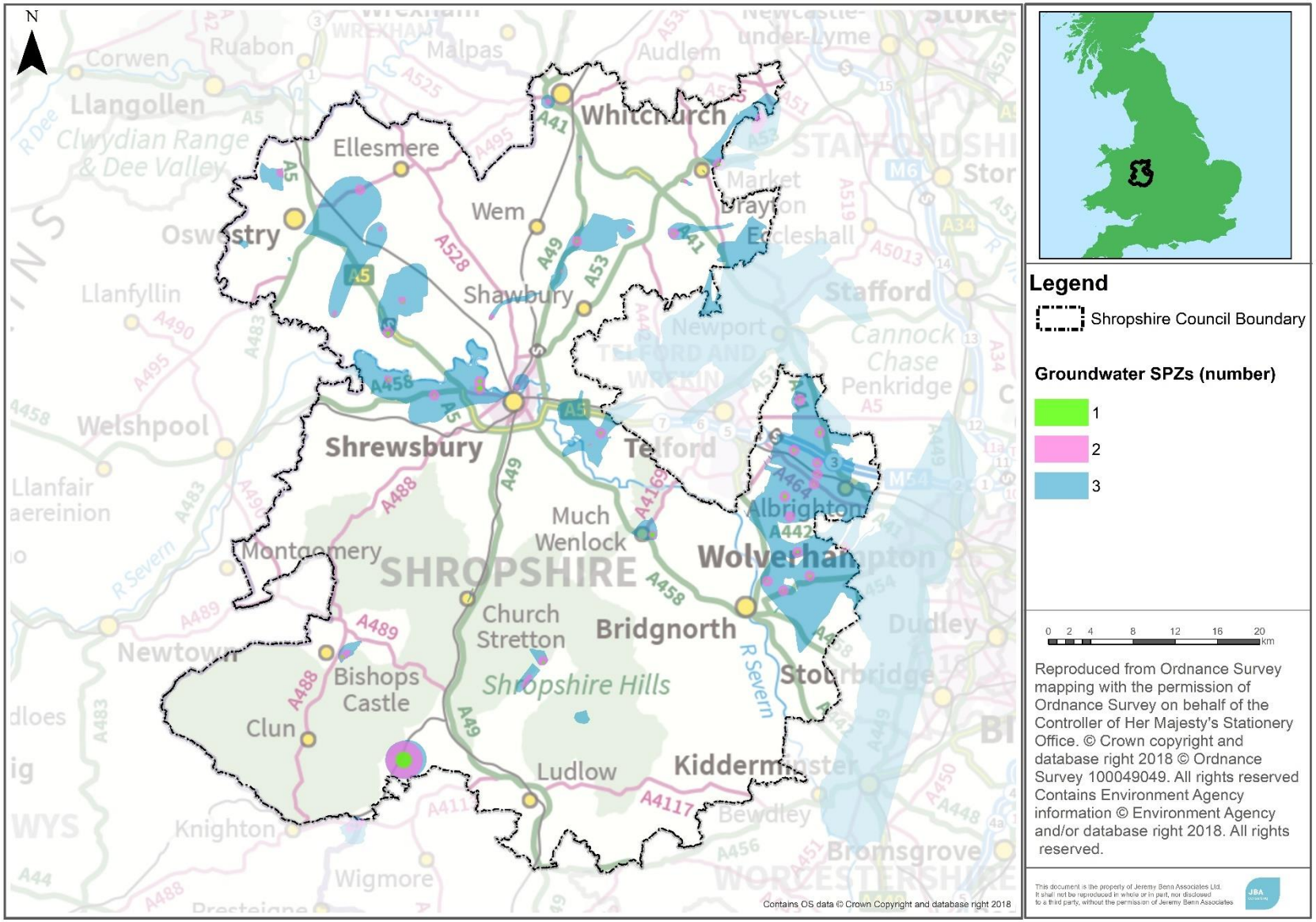
10.4.2 Groundwater Source Protection Zones (GSPZ)

In addition to the AStGWF data the Environment Agency also defines Groundwater Source Protection Zones in the vicinity of groundwater abstraction points. These areas are defined to protect areas of groundwater that are used for potable supply, including public/private potable supply, (including mineral and bottled water) or for use in the production of commercial food and drinks. The Groundwater SPZ requires attenuated storage of runoff to prevent infiltration and contamination. The definition of each zone is shown below:

- **Zone 1 (Inner Protection Zone)** – Most sensitive zone: defined as the 50-day travel time from any point below the water table to the source. This zone has a minimum radius of 50 metres
- **Zone 1c (Inner Protection Zone) –** Same as Zone 1 but subsurface activity only.
- **Zone 2 (Outer Protection Zone)** – Also sensitive to contamination: defined by a 400-day travel time from a point below the water table. This zone has a minimum radius around the source, depending on the size of the abstraction
- **Zone 2c (Outer Protection Zone) –** Same as Zone 2 but subsurface activity only.
- **Zone 3 (Total Catchment)** - Defined as the area around a source within which all groundwater recharge is presumed to be discharged at the source. In confined aquifers, the source catchment may be displaced some distance from the source. For heavily exploited aquifers, the final Source Catchment Protection Zone can be defined as the whole aquifer recharge area where the ratio of groundwater abstraction to aquifer recharge (average recharge multiplied by outcrop area) is >0.75. Individual source protection areas will still be assigned to assist operators in catchment management
- **Zone 4 (Zone of special interest)** – A fourth zone SPZ4 or 'Zone of Special Interest' usually represents a surface water catchment which drains into the aquifer feeding the groundwater supply (i.e. catchment draining to a disappearing stream). In the future this zone will be incorporated into one of the other zones, SPZ 1, 2 or 3, whichever is appropriate in the particular case, or become a safeguard zone

The location of the Groundwater SPZs in relation to Shropshire are shown in Figure 10-3.

Figure 10-3 Groundwater Source Protection Zones



The vast majority of Shropshire is not located within a Groundwater SPZ. Areas within a Groundwater SPZ are predominantly located along the Severn towards Shrewsbury, to the east of Shropshire near Shifnal, Albrighton and east of Bridgnorth, and isolated areas in the north.

The east and parts of the northern areas of Shropshire are underlain by a bedrock classified as Principal and due to the permeable nature of this bedrock, infiltration may not be a suitable SuDS technique in this area. For SuDS techniques that are designed to encourage infiltration, it is imperative that the water table is low enough and a site-specific infiltration test is conducted early on as part of the design of the development. Infiltration should be considered with caution within areas of possible subsidence or sinkholes. Where sites lie within or close to groundwater protection zones (GSPZs) or aquifers or near areas of contaminated land / areas of former mining works, further restrictions may be applicable, and guidance should be sought from the LLFA.

10.5 Nitrate Vulnerable Zones

Nitrate Vulnerable Zones (NVZs) are areas designated as being at risk from agricultural nitrate pollution. Nitrate levels in waterbodies are affected by surface water runoff from surrounding agricultural land entering receiving waterbodies.

The level of nitrate contamination will potential influence the choice of SuDS and should be assessed as part of the design process.

Parts of Shropshire are located within surface water NVZ, mainly in the north and east, covering the urban centres of Whitchurch, Wem, Market Drayton, Ellesmere, Bridgnorth and Much Wenlock. The north-eastern and eastern parts of Shropshire are also located within groundwater NVZ, covering the urban centres of Market Drayton, Newport and Bridgnorth. There are a few isolated areas of eutrophic water NVZ, notably around the Meres in Shropshire; Colemere, Ellesmere, White Mere and Crose Mere in the north-west of the county.

The NVZ coverage can be viewed on the **Environment Agency's online maps**.

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11 Strategic flood risk solutions

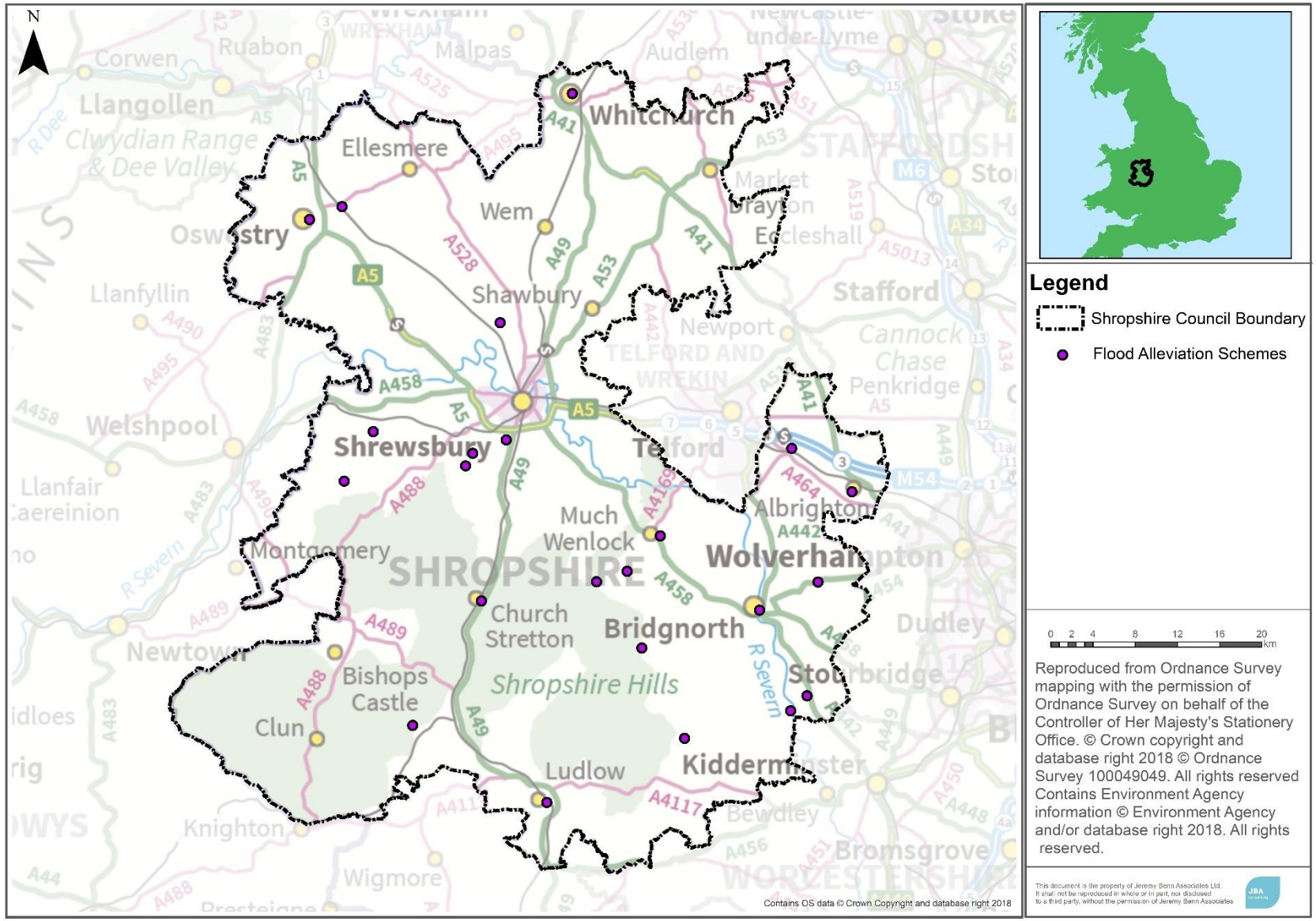
11.1 Introduction

Strategic flood risk solutions offer the opportunity to reduce flood risk in Shropshire. The Local FRM Strategy and Severn Flood Risk Management Plan set out specific actions for the County. New development has the potential to contribute towards such solutions, either by the provision of on-site measures that contribute towards a wider strategic approach or by financially contributing to offsite measures that can reduce flood risk to developments and/ or help to offset the cumulative impact of development.

11.2 Current programme of Flood Alleviation Schemes

Figure 11-1 shows the current programme of flood alleviation schemes in Shropshire. These include those currently progressing, such as the Wesley Brook Flood Alleviation Scheme in Shifnal and longer-term pipeline schemes. Shropshire Council are proposing studies to investigate flood mitigation measures for the highest priority urban and rural locations at risk of surface water flooding in the Local FRM Strategy. These studies will involve working with other RMAs and local communities to investigate the potential for flood mitigation measures including where they might be needed, what they might look like, how much they would cost, what they would benefit and how they would be funded. They could also consider how new development in the area of interest could contribute towards flood mitigation, either by providing measures on site or by requesting developer contributions towards offsite works.

Figure 11-1 Flood Alleviation Schemes



11.3 Natural flood management

Natural Flood Management (NFM) is used to protect, restore and re-naturalise the function of catchments and rivers to reduce flood risk. A wide range of techniques can be used that aim to reduce flooding by working with natural features and processes in order to store or slow down flood waters before they can damage flood risk receptors (e.g. people, property, infrastructure, etc.). NFM involves taking action to manage flood and coastal erosion risk by protecting, restoring and emulating the natural regulating functions of catchments, rivers, floodplains and coasts. Techniques and measures, which could be applied in Shropshire include:

- Peatland and moorland restoration in upland catchments
- Offline storage areas
- Re-meandering streams
- Targeted woodland planting
- Reconnection and restoration of functional floodplains
- Restoration of rivers and removal of redundant structures
- Installation or retainment of large woody material in river channels
- Improvements in management of soil and land use
- Creation of rural and urban SuDS

In 2017, the Environment Agency published on **online evidence base** to support the implementation of NFM and maps showing locations with the potential for NFM measures. Mapping showing the potential for NFM in Shropshire is shown in Appendix A. These maps are intended to be used alongside the evidence directory to help practitioners think about the types of measure that may work in a catchment and the best places in which to locate them. There are limitations with the maps; however, it is a useful tool to help start dialogue with key partners.

There are areas within Shropshire where by removing existing defences and reconnecting the floodplain could create areas for potential without causing risk to properties. These areas are spread throughout Shropshire, with the largest areas present along the River Severn upstream of Shrewsbury. Reconnecting the river with its floodplain and naturalising the river itself should lead to reduced peak flood levels which will protect properties and infrastructure in settlements downstream.

NFM measures are designed to reduce the flow of floodwater to minimise the risk of flooding to areas downstream. Tree planting can play a vital role in reducing flood risk within an area. Increased rainfall interception and infiltration may reduce surface water runoff and therefore increase the potential of NFM in the area. There are many areas within Shropshire where tree planting could be implemented, most notably along the River Severn, with the potential for vast expanses from where the River Vyrnwy enters Shropshire to its confluence with the Severn.

Shropshire Council has received national FCERM Grant in Aid funding for the 'Slow the Flow' Project. Working in partnership with Shropshire Wildlife Trust, the Environment Agency, English Severn and Wye RFCC, landowners and community flood action groups, the aim of the project is to use natural methods to 'slow the flow' in a number of catchments and reduce flood risk to communities downstream.

The six-year project seeks to take an alternative approach to the management of flood risk, rather than the construction of traditional flood defences, considering

catchments as a whole, and looking to reduce or slow flows nearer to their source. This will be done in a number of ways.

- Increasing infiltration into the soil: Allowing more water to soak away means less water travels quickly downstream where it may cause flooding problems.
- Slowing water down as it flows through the catchment: By constructing features such as "leaky dams" or putting other obstructions across the flood plain and in channels, heavier flows can be held back, and flood levels downstream reduced.
- Storing water upstream: By using existing storage areas and creating new ponds and basins, flood water can be stored upstream and released slowly, rather than rushing downstream.

So far, measures have been installed at Battlefield in Shrewsbury and upstream of Culmington in South Shropshire. The Council are currently considering the wider implementation of NFM across the Corvedale Catchment though the Project. This will help reduce flood risk to Ludlow and local rural communities

11.4 Flood storage

Flood storage schemes aim to reduce the flows passed downriver to mitigate downstream flooding and detain additional runoff from increased impermeable areas in the catchment due to development by releasing it downstream at a slower rate, to avoid any increase in flood depths and/or frequency downstream. Methods to provide these schemes include:

- enlarging the river channel;
- raising the riverbanks; and/or
- constructing flood banks set back from the river.

Flood storage schemes have the advantage that they generally benefit areas downstream, not just the local area. The Much Wenlock Flood Alleviation Scheme was completed in July 2017 and reduces flood risk to 171 properties in the town, which flooded in 2007 and has the potential of flooding from culvert blockages.

The construction of new upstream storage schemes as part of upstream catchment-based approaches on watercourses could provide one potential strategic solution to flood risk. Watercourses which are rural in their upper reaches but have high levels of flood risk to urban areas in the downstream reaches are potential candidates, as the open land in the upper reaches can potentially provide the space for an attenuation area, providing benefit to the urban area downstream.

11.5 Catchment and floodplain and river restoration

Floodplain and river restoration represent the most sustainable form of strategic flood risk solution, by allowing watercourses to return to a more naturalised state. The following measures could be adopted:

- return existing and future brownfield sites that are adjacent to watercourses back to floodplain, rather than allowing new development;
- Restoring watercourses and allowing them to act as green corridors/ infrastructure
- removal of redundant structures to reconnect the river and the floodplain; and

- apply the Sequential Approach to avoid new development within currently undefended floodplain

There is potential to re-naturalise a watercourse by re-profiling the channel, removing hard defences, re-connecting the channel with its floodplain and introducing a more natural morphology (particularly in instances where a watercourse has historically been modified through hard bed modification). Detailed assessments and planning would need to be undertaken to gain a greater understanding of the response to any proposed channel modification.

By using the Sequential approach and by locating development away from these watercourses it will ensure the watercourse retains connectivity to its floodplain. Loss of floodplain connectivity in the upper reaches of watercourses could potentially increase flooding downstream. This could help to negate any need to build flood defences for proposed development downstream.

11.6 Culverts

Culverted watercourses were often constructed to enable the efficient drainage of an area and allow land to become developable. However, culverted watercourses require regular maintenance to ensure that they function correctly. In most cases they also require trash screens at their entrance to ensure they do not become blocked by large debris, further adding to the maintenance requirements.

Policy 6 of the Local FRM Strategy states that the Council will generally be opposed to the culverting of watercourses and the construction of in channel structures unless there is no reasonable alternative, e.g. where a new road or railway embankment is to cross a watercourse, the use of a culvert may be approved.

Where practical, the Shropshire Council FRM team encourage the de-culverting and re-naturalisation of watercourses restoring to open channel in Shropshire. De-culverting can bring many benefits including; reducing the need for regular maintenance and trash screens, reducing blockages and enhancing the river environment by providing a more varied habitat. In some cases, small sections of open channel can be beneficial for flood risk management allowing for flood water to disperse naturally and thus slowing the movement of flood water downstream.

Further information is provided in the '**Trash and Security Screen Guide 2009',** published by the Environment Agency/ Defra, which should be used as evidence for any culvert assessment, improvement or structure retention. The reader should refer to the CIRIA website, as this document is currently being updated.

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12 Summary

This Level 1 SFRA delivers a strategic assessment of risk from all sources of flooding in Shropshire. It also provides an overview of policy and provides guidance for planners and developers.

12.1 Sources of flood risk

Parts of Shropshire are at risk from the following sources; fluvial, surface water, groundwater, sewers, reservoir inundation, canal overtopping / breaches. This study has shown that the most significant sources of flood risk in Shropshire are fluvial and surface water.

- *Fluvial flooding*: The primary fluvial flood risk is along the River Severn and its tributaries. These present fluvial flood risk to rural communities as well as to the main urban centres in Shropshire. The floodplain of the Severn is extensive through Shrewsbury and Bridgnorth (Low Town), with less extensive floodplains in the north-west and south of the County, where higher ground constrains the river.
- *Surface water:* The Risk of Flooding from Surface Water map shows a number of prominent overland flow routes; these predominantly follow topographical flow paths of existing watercourses or dry valleys with some isolated ponding located in low lying areas. There are notable areas of risk driven by the topography e.g. at the bottom of hills in the south of the County.
- *Sewer*: The majority of sewers in Shropshire are managed by Severn Trent Water with Welsh Water and United Utilities managing sewers in some areas. The combined DG5 registers of recorded historical sewer flooding was supplied and indicates a total of 347 recorded incidences of sewer flooding in Shropshire from 1990 (Severn Trent record) and 1999 (Welsh Water record). The settlements with the most recorded incidents include Shrewsbury, Ludlow, St Martins, Whitchurch and Church Stretton.
- *Groundwater:* The Areas Susceptible to Groundwater Flooding map shows that in general, the south of Shropshire is within the <25% susceptible classification, therefore is at a lower risk of groundwater flooding. Parts of the north of Shropshire fall within higher susceptibility classifications and are therefore at higher risk from groundwater flooding.
- *Canals*: There are three canals in Shropshire the Llangollen Canal, the Montgomery Canal, and the Shropshire Union Canal. These have the potential to interact with other watercourses and become flow paths during flood events or in a breach scenario. There has been one recent incident of overtopping in Shropshire, in 2014 on the Llangollen Canal near Fenn's Moss in north Shropshire.
- *Reservoirs:* There is a potential risk of flooding from reservoirs both within the County and those outside, such as Llyn (Lake) Clywedog and Llyn Vyrnwy in Wales. There are no records of flooding from reservoirs in the study area. The level and standard of inspection and maintenance required under the Reservoirs Act means that the risk of flooding from reservoirs is relatively low. However; there is a residual risk of a reservoir breach and this risk should be considered in any site-specific Flood Risk Assessments (where relevant).

12.2 Defences

The main flood defences are in Shrewsbury, including the Frankwell and English Bridge areas. Water levels on the Severn in Shrewsbury are highly dependent on

the operation of an 'argae' system upstream at the Severn and Vyrnwy confluence in Wales. These are agricultural flood embankments that act as an interconnected flood storage area. In rural areas there are defences in Much Wenlock, Walcot, Wem, Pentre and Melverley, comparing of flood walls and embankments. The level of protection these offer against flooding varies.

Shropshire Council are taking forward a scheme for Shifnal and investigating where future works might be needed in priority urban and rural locations identified in their Local Flood Risk Management Strategy (2015).

12.3 Development and flood risk

The Sequential and Exception Test procedures for both Local Plans and Flood Risk Assessments have been documented, along with guidance for planners and developers. Links have been provided for various guidance documents and policies published by other Flood Risk Management Authorities such as the Lead Local Flood Authority and the Environment Agency.

When necessary, development and redevelopment within Shropshire will require a Flood Risk Assessment appropriate to the scale of the development and to the scope as agreed with the Lead Local Flood Authority and/ or Environment Agency. Flood Risk Assessments should consider flood risk from all sources including residual risk, along with promotion of Sustainable Drainage Systems to create a conceptual drainage strategy and safe access/egress at the development in the event of a flood. Latest climate change guidance (published in February 2016) should also be taken into account, for the lifetime of developments.

12.4 Surface water and SuDS

All new major development proposals should ensure that sustainable drainage systems for management of run-off are put in place. The developer is responsible for ensuring the design, construction and future/ongoing maintenance of such a scheme is carefully and clearly defined and that the SuDS system is designed in accordance with national and local SuDS Standards.

12.5 Cross boundary and cumulative impacts

The cumulative impact of development has been considered by identifying those catchments likely to see the most development and those catchments with the highest surface water flood risk. The following catchments were identified at the most vulnerable to cumulative increases in flood risk due to new development:

- **Oswestry:** Oswestry Brook
- **East of Bridgnorth:** Between Bridgnorth and Stanmore
- **Shrewsbury North:** Bomere Heath to Bagley Brook
- **Shrewsbury:** Rad Brook
- **Bicton:** Tributary of the River Severn
- **Pontesbury to South Shrewsbury:** Rea Brook – confluence with Pontesford Brook to confluence with River Severn
- **Bridgnorth West:** High Town, tributary of the River Severn
- **Oldbury (Bridgnorth):** Tributary of the River Severn
- **Much Wenlock**: Shlyte Brook to confluence with River Severn
- **Yorton to North Shrewsbury:** Sundorne Brook – source to confluence with River Severn
- **Shifnal:** Wesley Brook – source to confluence with River Worfe
- **Cosford:** Neachley Brook – source to confluence with Burlington Brook
- **Albrighton:** Albrighton Brook – source to confluence with River Worfe

- **Between Shifnal and Cosford:** Burlington Brook – source to confluence with Neachley Brook
- **Whittington and East Oswestry:** Common Brook – source to confluence with River Perry

12.6 Status of the SFRA

It is important to recognise that the SFRA has been developed using the best available information at the time of preparation. This relates both to the current risk of flooding from rivers, and the potential impacts of future climate change. The Environment Agency regularly reviews their flood risk mapping, and it is important that they are approached to determine whether updated (more accurate) information is available prior to commencing a site-specific FRA.

It is recommended that the SFRA is reviewed internally on a quarterly basis, in line with the Environment Agency's Flood Zone map updates to ensure latest data is still represented in the SFRA, allowing a cycle of review and a review of any updated data by checking with Shropshire Council, the Highways Authority, Severn Trent Water and the Environment Agency for any new information.

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13 Recommendations

The following recommendations are made for the Council to consider as part of their planning policy and flood risk management.

13.1 Development Sequential and Exception tests

Areas of the County are at high risk from river and/ or surface water flooding. Shropshire Council should use the information in this SFRA when deciding which development sites to take forward in their Local Plan by applying the Sequential Test. Developers should consult Shropshire Council and the Environment Agency (where relevant), at an early stage to discuss flood risk including requirements for site-specific FRAs, detailed hydraulic modelling, and drainage assessment and design.

A Level 2 SFRA is recommended, which will explore flood hazard in greater detail should sites be allocated in high flood risk areas and the Exception Test required.

13.1.1 Site-specific Flood Risk Assessments

Developers should, where required, undertake more detailed hydrological and hydraulic assessments of the watercourses to verify flood extent (including latest climate change allowances), inform development zoning within the site and prove, if required, whether the Exception Test can be passed. Developers should include an assessment of the residual risk where developments are located in areas benefitting from defences. They should consider both the impact of breach, including the effect on safe access and egress, as well as potential for flood risk to increase in the future due to overtopping. Any improvements to defences should ensure they are in keeping with wider catchment policy.

The assessment should also identify the risk of existing flooding to adjacent land and properties to establish whether there is a requirement to secure land to implement strategic flood risk management measures to alleviate existing and future flood risk.

13.2 Windfall sites

Windfall sites are sites that have not been specifically identified in the Local Plan, that do not have planning permission and have unexpectedly become available. Local authorities are expected to make a realistic allowance for windfall development based on past trends. The acceptability of windfall applications in flood risk areas should be considered at the strategic level through a policy setting out broad locations and quantities of windfall development that would be acceptable or not in Sequential Test terms. In the event of there being no windfall policy, it may be possible for the local authority to apply the Sequential Test, taking into account reasonably available sites, historic windfall rates and their distribution across Shropshire relative to Flood Zones.

13.3 Drainage assessments and promotion of SuDS

Planners should be aware of the role of the Flood and Water Team as a Statutory Consultee and refer to the guidance and standards in the Shropshire SuDS Handbook when assessing planning applications. The developer should submit the proforma in the SuDS Handbook alongside a Flood Risk Assessment/ Surface Water Drainage Strategy to demonstrate how the Local SuDS Standards have been met.

13.4 Strategic solutions

Developers should consult with Shropshire Council at pre-application stage to determine the latest progress with the programme of flood alleviation schemes and opportunities for NFM, culvert day lighting and river restoration on/ off site. RMAs should work together through flood risk studies for high priority locations to determine where land should be safe guarded for future flood alleviation works, such as flood storage, SuDS retrofit or NFM.

13.5 Cumulative Impacts

The following Planning Policy recommendations have been made for the catchments where cumulative development is likely to have the greatest impact on flood risk:

1. That a Level 2 SFRA or detailed local area Strategic Drainage Study considers further how the cumulative effects of potential peak rates and volumes of water from development sites would impact on peak flows, duration of flooding and timing of flood peaks on receiving watercourses. Such studies could be used to justify greater restrictions/ enforce through Local Planning Policy development site runoff rates and volumes specific to each catchment that are over and above those required by National and Local SuDS Standards. They could also identify where there are opportunities with allocated sites to provide off-site betterment e.g. online/ offline flood storage and where land should be safeguarded within proposed site allocations to fulfil this purpose.
2. Where appropriate, that the opportunity for Natural Flood Management in rural areas, SuDS retrofit in urban areas and river restoration should be maximised in these catchments. In support of policy 6 in the Local FRM Strategy, culverting should be opposed, and day-lighting existing culverts promoted through new developments.
3. Developers should explore through site specific FRAs opportunities to provide wider community flood risk benefit through new developments.
4. Developers should contribute to community flood defences outside of their red line boundary in these catchments to provide wider benefit and help offset the cumulative impact of development.
5. That the LLFA and other RMAs should use this information, alongside the high priority settlement information in the Local FRM Strategy to inform a long-term pipeline of flood alleviation studies and schemes to help inform points 2. to 5. above.
6. That the Environment Agency, in consultation with Shropshire Council, should consider whether to formally designate these catchments as Critical Drainage areas. This would mean that a detailed Flood Risk Assessment would be required for all developments that are proposed, regardless of their size.

Appendices

A Shropshire Level 1 SFRA - Geo-PDF Mapping

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B Cumulative Impact Assessment - High Risk Catchments Maps

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