Shropshire Outline Water Cycle Study

Final report

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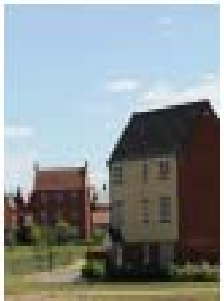
http://www.halcrow.com/html/our_markets/watercycleplanning.htm

June 2010



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Revision schedule

Date	Document reference	Stage	Author	Approver
30/11/2009	WUSHWC	Draft	Ali Cotton	Andy McConkey
14/05/2010	WUSHWC	Draft Final	Ali Cotton	Andy McConkey
23/06/2010	WUSHWC	Final	Ali Cotton / Emma Smith	Ali Cotton

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Halcrow

1 Introduction

1.1 Background to the water cycle study

The Panel Report following the Phase 2 examination of the Regional Spatial Strategy (RSS) for the West Midlands has increased the number of new homes proposed in Shropshire over the next 20 years, from 25,700 to 27,500. The RSS sets out a settlement strategy that identifies the sub regional role of Shrewsbury as a Settlement of Significant Development and Growth Point. Given this role, the RSS proposes that Shrewsbury should accommodate 6,500 dwellings up to 2026 and that development should be of a smaller scale in the market towns and focused on catering for local needs and local regeneration in the villages.

Building new homes is not simply a matter of constructing the buildings themselves. To operate effectively as a home, and as part of a wider community, each building is also dependant on a range of services, and the infrastructure necessary to provide these. A critical component of this infrastructure is associated with water; the provision of clean water for drinking and washing; the safe disposal of waste water; and protection from flooding.

The addition of a small number of new homes may not represent a significant additional burden on existing water infrastructure. However when large numbers of houses are built, there is a risk that existing infrastructure will be overwhelmed, and both the environment and people's quality of life, will suffer.

There is a finite capacity within the environment, and it cannot simply provide more and more water to serve new development. Equally, there is a limit to the amount of waste water that can be safely returned to our rivers and the sea without having a detrimental impact on the environment. Furthermore, we know that extreme rainfall can overwhelm drains and overtop flood defences. Climate change is bringing fresh challenges as patterns of rainfall are predicted to change, with more intense rainfall events. We must also make sure that water infrastructure contributes to the shift to a low carbon economy that is essential if greenhouse gas emissions are to be reduced. Planning for water has to take into account these natural constraints, and factors such as the timing and location imposed by the development itself.

Shropshire Council is currently preparing its Core Strategy, as part of the LDF process. LDF documents submitted to the Secretary of State must include an evidence base to support the proposed strategic approach. Shropshire Council commissioned a water cycle study, as part of this evidence base to ensure that development will not have a detrimental impact on the environment and that the necessary water infrastructure can be provided in a timely manner to support growth.

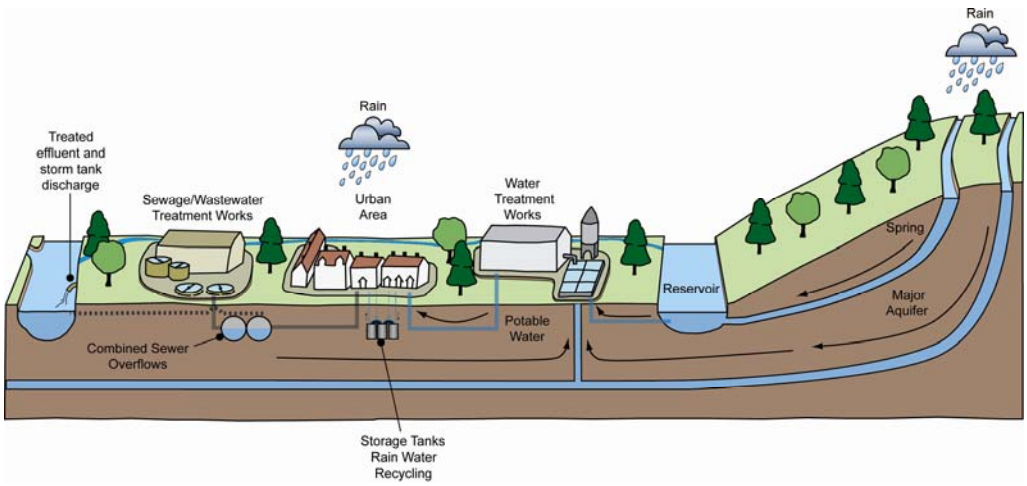
Halcrow Group Ltd were commissioned to undertake a WCS for Shropshire Council, in partnership with the Environment Agency, Natural England, Severn Trent Water and Welsh Water

1.2 Water cycle processes

The water cycle includes the processes and systems that collect, store, or transport water in the environment. Water cycle processes are both above and below ground level, and can be either natural or man-made. In an undeveloped area, the water cycle includes rainfall landing on the ground, where it is either transferred into above ground streams, rivers, wetlands, floodplains, and estuaries to the sea, or is absorbed into the soil, ending up in groundwater storage aquifers. The cycle is completed by evaporation from these systems back into the atmosphere.

In a developed area, the natural processes and systems are sometimes adapted for development or public health reasons. For example, water is taken from rivers, treated, and piped via water supply systems into urban areas. Wastewater produced by houses is collected in a below ground sewerage system, where it is transported to a wastewater treatment works before being discharged to the sea, rivers or to groundwater.

The natural processes are extremely important for wildlife and ecology, and even man made systems can have biodiversity and wildlife interest. It is important that when building new homes, or even redeveloping existing areas we understand the impact on the natural environment.



1.3 Objectives of the water cycle study

As defined in the brief the objectives of the WCS are to:

- Undertake a strategic level assessment of infrastructure and environmental capacity in relation to proposed housing and employment development within Shrewsbury, the market towns, key centres and local

centres, as defined in the Core Strategy Policy Directions document. This assessment should focus on water demand and supply, water quality, and wastewater collection and treatment, flood risk and drainage.

- Undertake a detailed assessment of the strategic urban extensions for development in Shrewsbury and Oswestry, to assist understanding of whether there are viable and deliverable options for these settlements and to identify a viable and deliverable infrastructure solution for these locations, identifying likely timescales for provision and the impact this may have on the phasing of development.
- Undertake an initial assessment of the Ironbridge Power Station site to provide an understanding of the existing water cycle processes affecting the site and consider strategic water services infrastructure requirements and options.
- Provide advice on the effective management of surface water, including setting out design standards for sustainable drainage and providing policy recommendations to ensure the coordinated preparation of Surface Water Management Plans by developers for major site allocations. This should take into account local geology, Source Protection Zones and Nitrate Vulnerable Zones, as well as explore the wider benefits of sustainable drainage systems in terms of Green Infrastructure. It should also support the work being undertaken by the drainage department at Shropshire Council in terms of developing a Surface Water Asset Management Plan.
- Provide policy recommendations for improving water efficiency within new developments.
- Provide a coordinated approach to development and water management between Shropshire and neighbouring authorities, particularly in relation to the towns of Tenbury, Knighton and Telford.
- Produce a study that can be defended at examination and provides evidence to inform the development of the Core Strategy, and where possible Site Allocations and Management of Development DPD and LDF Implementation Plan. Where further detailed evidence is required to inform Site Allocations and Management of Development DPD and LDF Implementation Plan, the WCS will identify what further information is required and when it is required to support the development of the DPDs.

The water cycle strategy will be used to inform the Shropshire Council's LDF documents, sustainability appraisals, and appropriate assessments, which are subject to inspection by an independent inspector. Therefore, the water cycle strategy must provide the evidence base to ensure that development does not have a detrimental impact on the environment, and that water services infrastructure is provided in a timely manner.

2 Development scenario for WCS

2.1 *Overview*

The Panel Report following the Phase 2 examination of the Regional Spatial Strategy (RSS) for the West Midlands has increased the number of new homes proposed in Shropshire over the next 20 years, from 25,700 to 27,500. The RSS sets out a settlement strategy that identifies the sub regional role of Shrewsbury as a Settlement of Significant Development and Growth Point. Given this role, the RSS proposes that Shrewsbury should accommodate 6,500 dwellings up to 2026 and that development should be of a smaller scale in the market towns and focused on catering for local needs and local regeneration in the villages.

The Council published a Core Strategy Policy Directions document in August 2009 which was followed by the Core Strategy Final Plan publication in February 2010. This expands on the settlement strategy within the RSS, identifying the proposed approach for Shropshire. It proposes that the main locations for development should be in Shrewsbury and Oswestry, given that they are the largest settlements within the county. Development will then be focused on the market towns and key centres, which provide sustainable locations for development, as focal points for local transport networks, employment opportunities and services. Some land allocations may also be appropriate in some larger villages which have the potential to act as community hubs or clusters. The document also recognises the role of key centres adjoining Shropshire, such as Tenbury and Knighton and the need for cross boundary working.

In terms of employment land provision, the RSS requires the provision of 288 hectares in Shropshire up to 2016, subject to local review. Site specific allocations for this employment land provision will be focused in Shrewsbury, the market towns and key centres.

In addition to proposed housing and employment development, the Policy Directions document explored options for the redevelopment of the Ironbridge Power Station, which adjoins the Telford and Wrekin Local Authority Boundary. Although this has not been pursued as a policy within the Core Strategy Final Plan, the power station is expected to come to the end of its life by 2016 and the future use of the 122 hectare site therefore raises strategic issues for both Shropshire Council and Telford and Wrekin Council.

2.2 *Shrewsbury and Oswestry*

In its role as a Settlement of Significant Development and a Growth Point, Shrewsbury should accommodate 6,500 new homes by 2026. The 2009 Strategic Housing Land Availability Assessment identified capacity for some 3,800 dwellings within the existing town development boundary, but with some

greenfield areas within the Shrewsbury bypasses with scope to provide the balance required to meet the total RSS development numbers. Two sustainable urban extensions have been proposed in the Core Strategy Final Plan publication; one to the south of Shrewsbury (land off Thieves Lane/Oteley Road/Hereford Road) and one to the west of Shrewsbury (land in the Bicton Heath direction). The remainder of growth in Shrewsbury will be through existing allocations and permissions, SHLAA sites, and windfall development. The majority of this development is likely to occur within Shrewsbury urban area, on existing brownfield sites. Table 2-1 provides an indicative level of housing development for Shrewsbury based on information on past development trends provided by Shropshire Council.

Location	Development no's for WCS
Completions 2006-2009	624
Existing Permissions 2009	1454
Allocations from local plan	260
SHLAA sites within development boundaries	1480
Windfall development	930
Sustainable urban extension (south)	1070
Sustainable urban extension (west)	700
Total (including completions)	**6518**
Total (excluding completions)	**5894**

Table 2-1 Indicative levels of development in Shrewsbury for testing by the Water Cycle Study

In addition to the new homes, the two urban extensions will also include employment land, which is also assessed as part of the WCS. For the urban extension to the south, 40 hectares (ha) of employment land has been tested in the WCS and 12ha for the west area. An estimate of the employment types to be considered and their location is shown in Table 2-2.

Location	Employment land area (ha)	Employment type
Land at Thieves Lane (South of Shrewsbury)	10	B1
Land at Oteley Road (South of Shrewsbury	25	B1/B2/B8
Land at Meole Brace Retail Park (South of Shrewsbury)	5	A1/B1/D1
Total employment land for south of Shrewsbury	**40**	
Land at Bicton Heath (West of Shrewsbury)	12	B1
Other proposed employment land in Shrewsbury	43	

Table 2-2 Indicative levels of employment land for sustainable urban extensions in Shrewsbury, for testing by the WCS

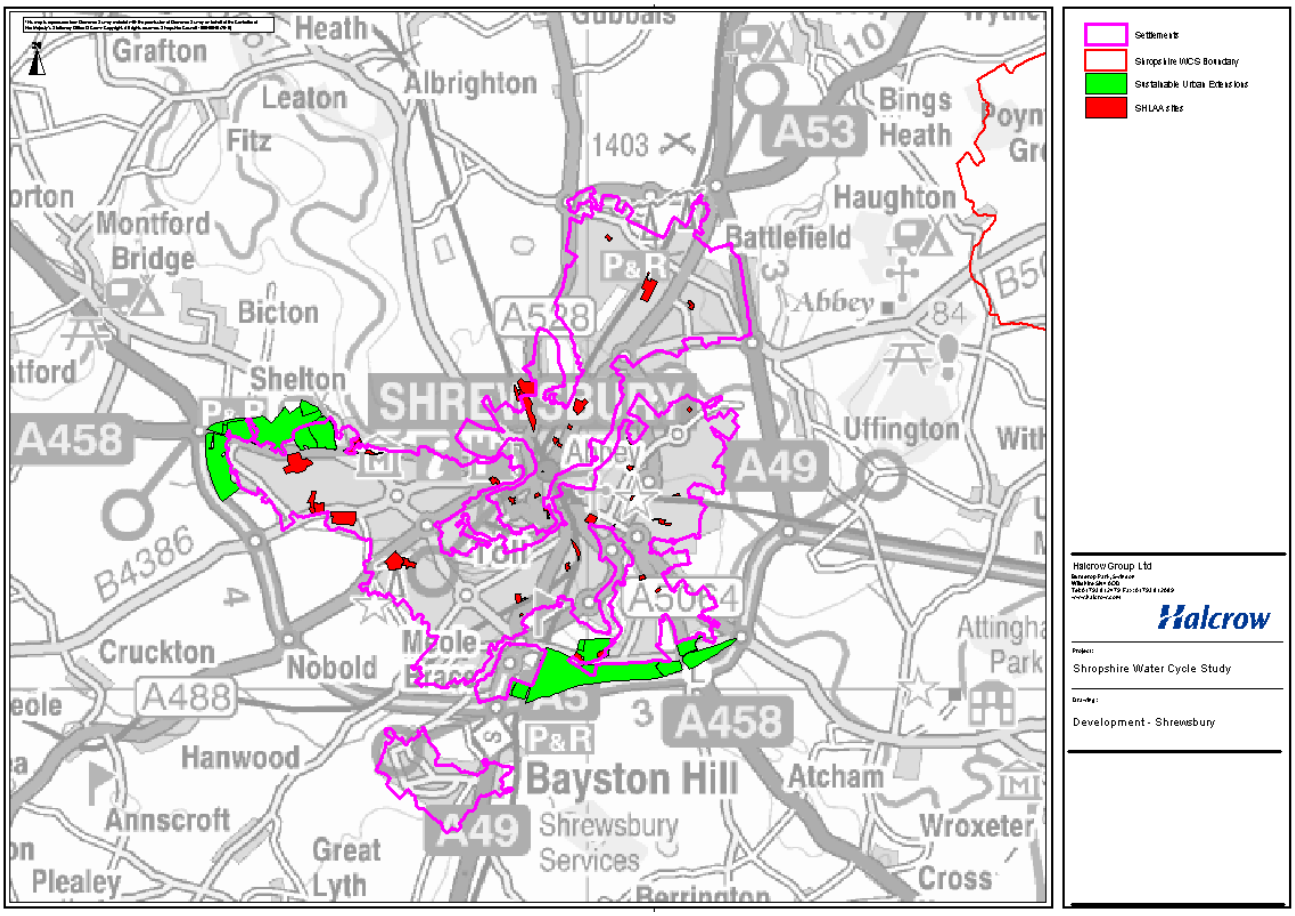


Figure 2-1 Potential areas for housing development in Shrewsbury based on the Strategic Housing Land Availability Assessment

Oswestry, as the county's second largest town, will accommodate significant growth, and as part of the WCS a total of 2,805 homes are to be tested. Of this, 423 homes have already been completed as of March 2009 and can be excluded from the capacity assessment for Oswestry. As in Shrewsbury, all of the proposed development cannot be accommodated within the existing settlement, and thus a sustainable urban extension has been proposed to the south east of the town (on land between Shrewsbury Road, Middleton Road and the A5/A483 Oswestry bypass). The remainder of development will occur through existing allocations and permissions, SHLAA sites and windfall development. Table 2-3 provides an indicative level of housing development for Oswestry based on information on past development trends, for testing by the WCS.

Location	Development no's for WCS
Completions 2006-2009	423
Existing Permissions 2009	287
Allocations from local plan	5
SHLAA sites within development boundaries	490
Windfall development	850
Sustainable urban extension (south east)	750
Total (including completions)	**2805**
Total (excluding completions)	**2382**

Table 2-3 Indicative levels of development in Oswestry for testing by the WCS

Oswestry will also be required to accommodate employment land, and the WCS will test the provision of 6 ha of employment land as part of the sustainable urban extension to the south east. The employment land is proposed to be entirely offices (one office block). There is a further 21.5 ha of employment land which are outstanding commitments and allocations, and another 14 ha of proposed employment land in Oswestry. In total, a further 41 ha of employment land is forecast, at this stage, for Oswestry up to 2026.

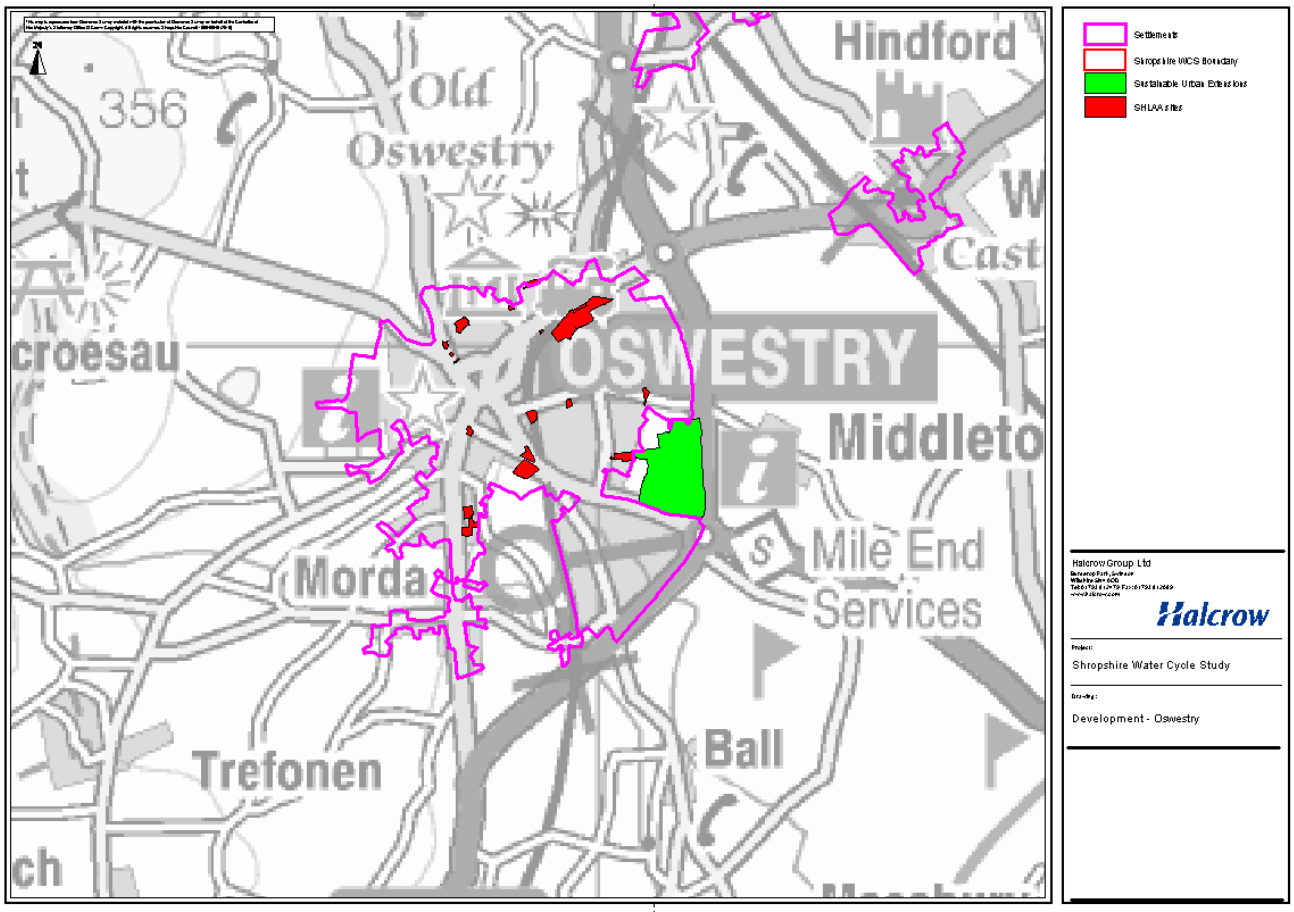


Figure 2-2 Potential areas for housing development in Shrewsbury based on the Strategic Housing Land Availability Assessment

2.3 Ironbridge power station

Ironbridge power station is predicted to come to the end of its life in 2016, although E.ON have indicated there will still be some power generation on site. However, the future power generation will use considerably less land, and it is understood that 122 ha could come forward for development. At this stage it is understood that the land will be used as large-scale employment land, although there is no indication of the employment type.

2.4 Market towns, local centres and key local centres

The Core Strategy Final Plan publication identifies that the market towns and key centres will continue to play a key role in the county and will provide locations for both new residential development and employment land. A list of market towns, key centres and local centres assessed as part of the WCS, alongside the indicative levels of development for testing in the WCS are outlined in Table 2-4.

Settlement	Completions 2006-2009	Permissions in 2009	Allocations from the local plan	Potential new dwellings as identified by information on past trends	Total development (excluding completions)	Total employment land (ha)
2. Large market towns						
Whitchurch	110	191	371	860	1422	25
Market Drayton	210	221	45	674	940	25
Ludlow	145	239	0	484	723	13
Bridgnorth	130	509	0	250	759	18
3. Market towns & key centres						
Wem	83	245	0	216	461	3
Ellesmere	56	424	0	268	692	8
Minsterley / Pontesbury	45	22	0	152	174	2
Bishops Castle	19	29	0	212	241	5
Church Stretton	36	36	0	237	273	2
Cleobury Mortimer	104	62	0	146	208	2
Clun	5	11	0	65	76	1
Craven Arms	60	44	80	255	379	7
Highley	72	18	51	107	176	2
Much Wenlock	9	33	0	177	210	4
Shifnal	121	93	190	151	434	4
4. Local Centres						
Prees	14	10	0	70	80	2
Shawbury	27	3	0	90	93	1
Woore	14	55	0	30	85	1
Baschurch	52	33	40	110	183	1
Gobowen	23	143	95	109	347	2
St. Martins	10	102	0	138	240	3
Whittington	3	5	0	100	105	1
Bayston Hill	10	10	0	108	118	1
Dorrington	5	6	0	85	91	1
Albrighton*	12	24	80	170	274	1
Broseley	21	58	90	136	284	2

Table 2-4 Indicative levels of development in market towns, key centres and local centres for testing in the WCS

* Plus potential 1000 new dwellings for MOD personnel

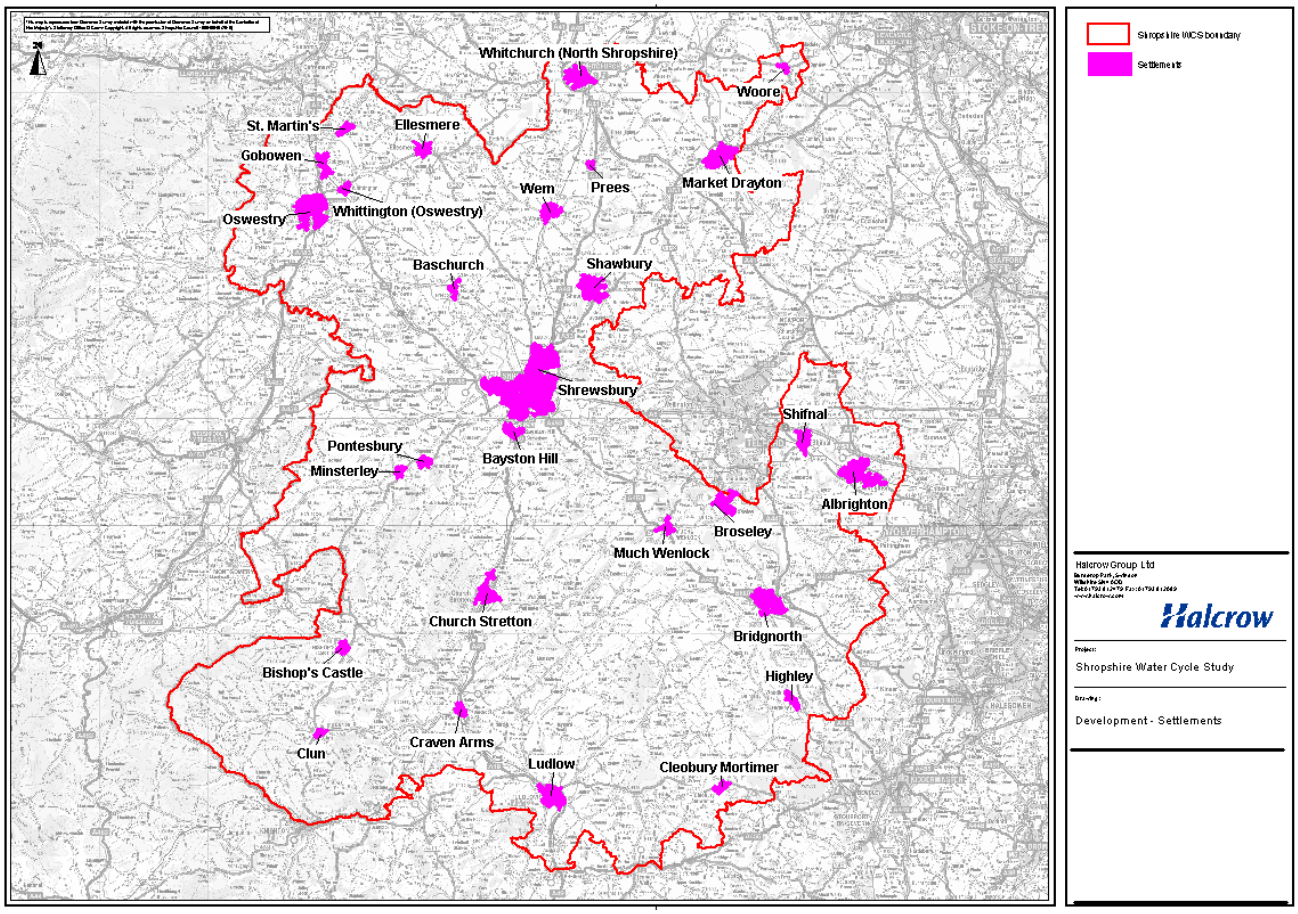


Figure 2-3 Market towns, key centres and local centres included in WCS

2.5 Additional dwellings to be accommodated in spatial zones

In the Core Strategy Final Plan publication, Shropshire Council has divided the county into five spatial zones, as illustrated in Figure 2-4. Within these five spatial zones, ranges for the provision of housing and employment needs have been identified. Whilst some of the needs have already been met with development from 2006, the WCS will provide the evidence base to identify where additional development would be more sustainable.

Spatial zone	Range of housing needs by spatial zone (No of dwellings)	Range of employment needs by spatial zone (area – ha)
North east	5500 - 6050	50 - 60
North west	5775 - 6325	55 - 65
Central	8250 - 8800	95 - 105
South	3575 - 4125	35 - 45
East	3025 - 3850	30 - 40

Table 2-5 Housing and employment ranges based on spatial zones

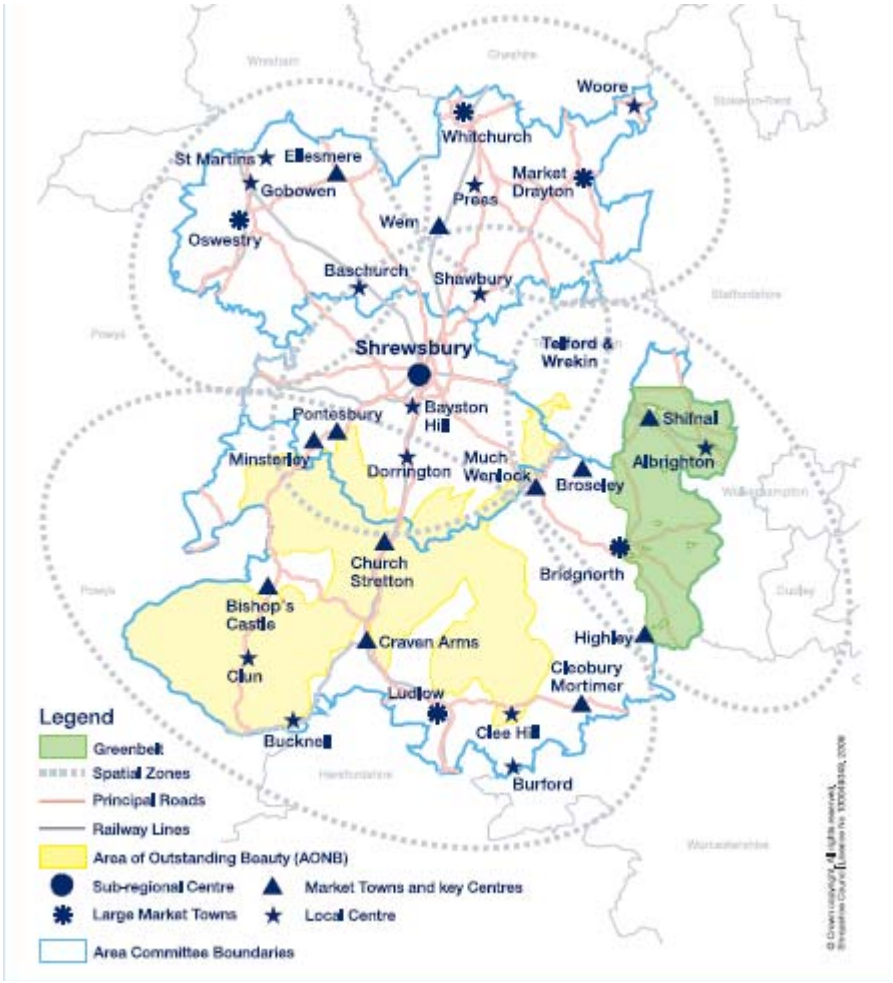


Figure 2-4 Spatial zones taken from the Shropshire Core Strategy Final Plan Publication

3 Water resources & water supply

3.1 Overview

The Water Cycle Study (WCS) has collated information on water resources from Severn Trent Water's draft Water Resource Management Plan 2009 (dWRMP09) and other sources to identify significant water resource constraints across the study area. A number of demand scenarios have been examined, and options identified leading to more sustainable use of water resources. The WCS has not sought to repeat the extensive work undertaken by Severn Trent Water for their dWRMP09, which is subject to scrutiny by Defra, Ofwat and the Environment Agency.

3.2 Data and References

The data used for this section of the WCS has been sourced from the following locations:

- http://www.statistics.gov.uk
- Shropshire Core Strategy: Policy Directions (Shropshire Council, 2009)
- West Midlands Regional Spatial Strategy (Government Office for the West Midlands, 2008)
- Draft Water Resources Management Plan 2009 (Severn Trent Water, 2008)
- Draft Water Resources Management Plan 2009 – Statement of Response Parts 1 to 5 (Severn Trent Water, 2009)
- The Severn Corridor CAMS
- The Severn Uplands CAMS (Environment Agency, 2005)
- The Teme CAMS (Environment Agency, 2005)
- The Worcestershire Middle Severn CAMS (Environment Agency, 2006)
- The Shropshire Middle Severn CAMS (Environment Agency, 2007)
- Code for Sustainable Homes – A Step Change in Sustainable Home Building. Crown copyright, 2006.
- Future Water: The Government's water strategy for England (Department for Environment Food and Rural Affairs, 2008)

3.2.1 Draft Water Resource Management Plan and Statement of Response

STW released their dWRMP for public consultation in 2008. Subsequent to comments received on the draft, STW released a Statement of Response (SoR), which summarises proposed changes to be made for the final WRMP09 due to be published in 2010.

The information within this WCS and the Demand Scenarios examined are based upon the information provided within the dWRMP09. Detailed data concerning the final planning approach for the final WRMP09 was not available at the time of

writing and thus the demand scenarios tested are based upon final planning tables from the dWRMP09 and do not include proposals from the SoR.

Where updated information has been provided by the SoR this has been included within Section 3.9, and conclusions have been formed around any effect of such changes on the Demand Scenario results from the dWRMP09. It should be noted that as information remains subject to change, strategies and conclusions may vary from the draft to final submission version of the WRMP09.

3.3 Water Company Overview

Public water supply to Shropshire is provided by Severn Trent Water (STW). The Severn Trent Water supply area is divided into six Water Resource Zones (WRZs) defined as the largest possible zone in which all water resources can be shared, excluding external transfers. Shropshire is split between three of these zones. The Severn Resource Zone (WRZ3) covers the majority of central and southern Shropshire serving 59% of the study area population. The Oswestry Resource Zone (WRZ1) covers north western Shropshire (18%) and Staffs and East Shropshire Resource Zone (WRZ2) covers the north east and part of the central eastern area (23%).

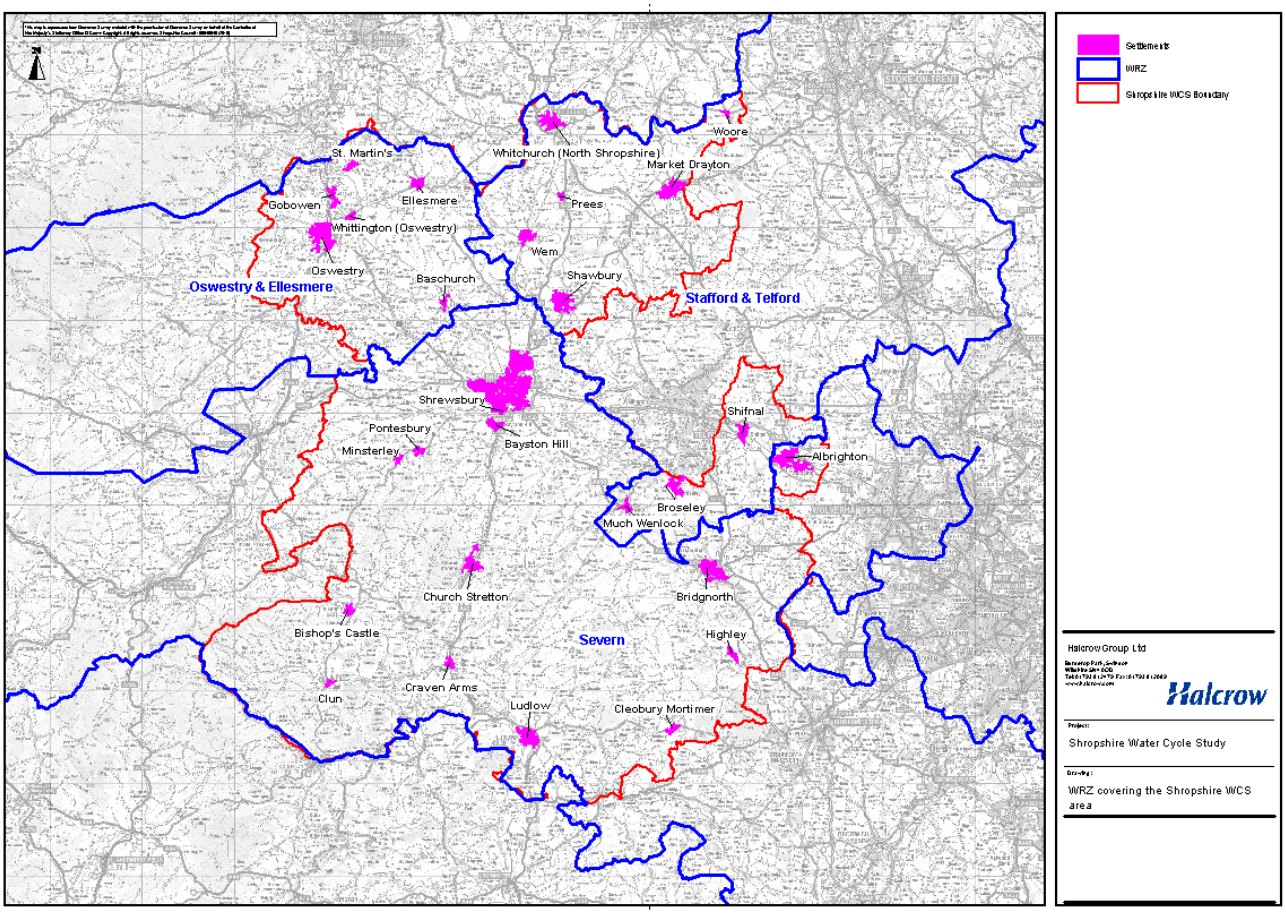


Figure 3-1 WRZs in the study area

STW supplies water to 7.4 million people, around 3.1 million households. It also supplies 220,000 commercial and non domestic properties. 40% of water is supplied from river abstraction, 30% from groundwater boreholes or wells, and 30% from surface water reservoirs. We have assumed that the status quo will be maintained and that STW will remain responsible for the provision of water resources for the development areas within the study area. Other companies may supply water to development sites via Inset Appointments[1], but this has not been included as part of the WCS assessment.

3.3.1 Existing Resource Summary

STW currently has a raw water reservoir capacity of 24,800 Megalitres (Ml) full, over 180 borehole sites ranging from 1 Ml/d to 30 Ml/d, and imports up to 345 Ml/d from the Elan Valley Reservoirs and exports up to 60Ml/d to Yorkshire Water Services Ltd. Treated water is provided by 17 major treatment works in the region of 2,400 Ml/d, with agreements with neighbouring undertakers to import up to 65 Ml/d and export up to 12 Ml/d of treated water. Resources statistics for each WRZ are shown in Table 3-1.

Water Resource Zone	Population	Deployable Output[2] (Ml/d)	WaterAvailable for Use (Ml/d)	Distribution Input[3] (Ml/d)
Severn	2,377,000	648.5	611.8	641.9
Staffs and East Shropshire	801,500	228.3	222.9	206.0
Oswestry	66,500	21.5	21.2	24.9

Table 3-1 Resource Zone 1, 2 & 3 Statistics 2006-07 [4]

In their WRMP04 STW demonstrated a significant risk that supply would not meet demand within the Severn WRZ, with the Oswestry and Staffs and East Shropshire WRZs at borderline deficit. A number of schemes were promoted and have been implemented to various extents to improve supply-demand headroom. The baseline supply-demand balance and short term projections from the draft WRMP09 data tables are shown in Figure 3-2.

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[1] The inset appointment process is the route by which one company replaces the incumbent as the appointed water and/or sewerage company for a specified area. As such the replacement appointed water company will have all of the same duties and responsibilities as the previous statutory water company for the specified area. More information is available at http://www.ofwat.gov.uk/legacy/aptrix/ofwat/publish.nsf/content/insetappointments1205.html

[2] Deployable Output is the maximum demand that can be met over the course of a year from the indigenous water resources of a WRZ, plus and minus the water transferred into and out of the WRZ and subject to all operating constraints.

[3] Distribution Input is the amount of treated water entering the distribution system at the WRZ point of production.

[4] Data from Table 2.1 of STW draft WRMP09, 2008.

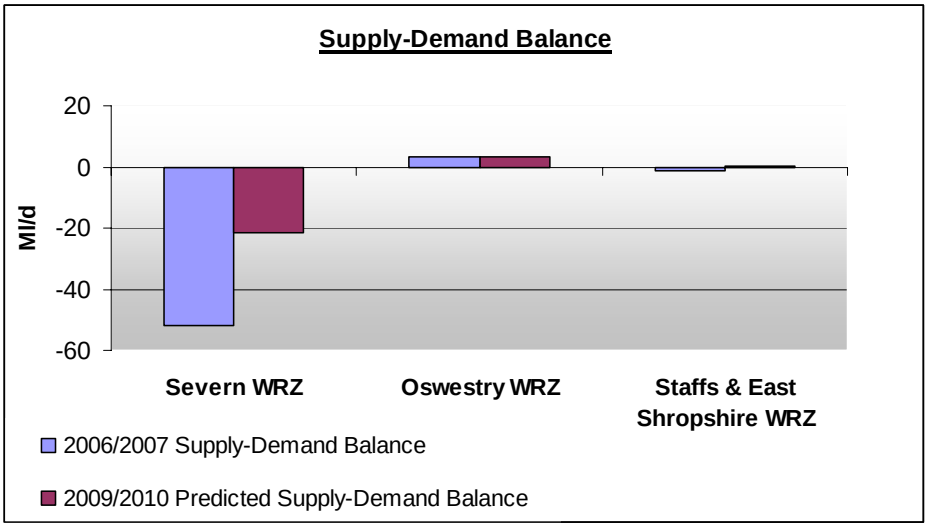


Figure 3-2 WRZ Supply-Demand Balance

Water abstraction resources in Shropshire are split between four catchment areas with the southern and western areas of the county reliant mainly upon surface water abstraction, whilst northern and eastern areas benefit from large aquifer resources. The River Severn traverses the county supporting major abstractions for navigation, agriculture and industry.

Although the STW Resource Zones may be treated as separate entities, there are a number of water connections between these zones. This Strategic Water Grid provides flexibility, enabling water to be moved around the STW region dependant upon supply and demand.

3.4 Environment Agency Water Resource Management

The Environment Agency manages water resources at a local level through Catchment Abstraction Management Strategies (CAMS), which are prepared on a 6 yearly cycle. The second cycle of CAMS will be available by 31 December 2010, and will include the Severn Corridor, Teme, Worcestershire Middle Severn and Shropshire Middle Severn

Within the CAMS, the Environment Agency's assessment of the availability of water resources is based on a classification system which states the perceived resource availability status, indicating:

- the relative balance between the environmental requirements for water and how much is licensed for abstraction;
- whether water is available for further abstraction, and;
- areas where abstraction needs to be reduced.

The categories of resource availability status are shown in Table 3-2. The classification is based on an assessment of a river system's ecological sensitivity to abstraction-related flow reduction.

Indicative Resource Availability Status	Licence Availability
Water available	Water is likely to be available at all flows including low flows. Restrictions may apply.
No water available	No water is available for further licensing at low flows. Water may be available at high flows with appropriate restrictions.
Over-licensed	Current actual abstraction is such that no water is available at low flows. If existing licences were used to their full allocation they could cause unacceptable environmental damage at low flows. Water may be available at high flows with appropriate restrictions.
Over-abstracted	Existing abstraction is causing unacceptable damage to the environment at low flows. Water may still be available at high flows with appropriate restrictions.

Table 3-2 CAMS Resource Availability Status Categories

This classification can be used to help assess the potential for additional water resource abstraction opportunities.

Figure 3-3 shows the Environment Agency's assessment of the relative water stress throughout England, and it can be seen that the water resources in the Shropshire area are under moderate stress. The effects of climate change are likely to further reduce supply and could increase demand.

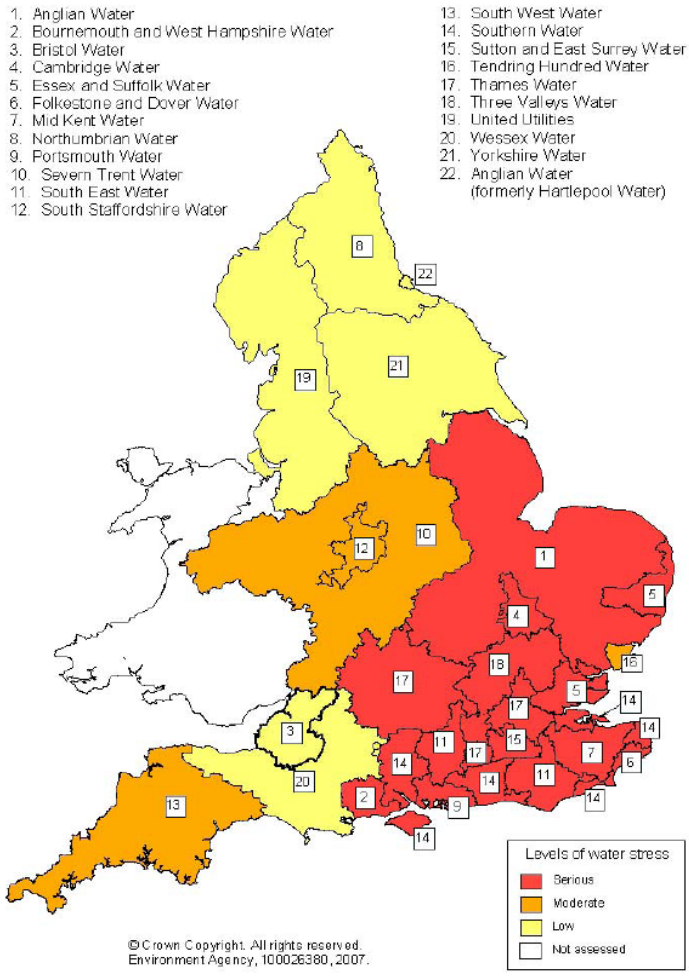


Figure 3-3 Map of Areas of Relative Water Stress (source: Areas of Water Stress, Final Classification; Environment Agency)

3.5 Shropshire Catchment Abstraction Management

The Shropshire water cycle study area can be roughly split equally between four main abstraction catchments: Shropshire Middle Severn, Worcestershire Middle Severn, Teme, and Severn Uplands. Though these CAMS documents include its tributaries they omit the River Severn as the Severn Corridor is examined under its own CAMS.

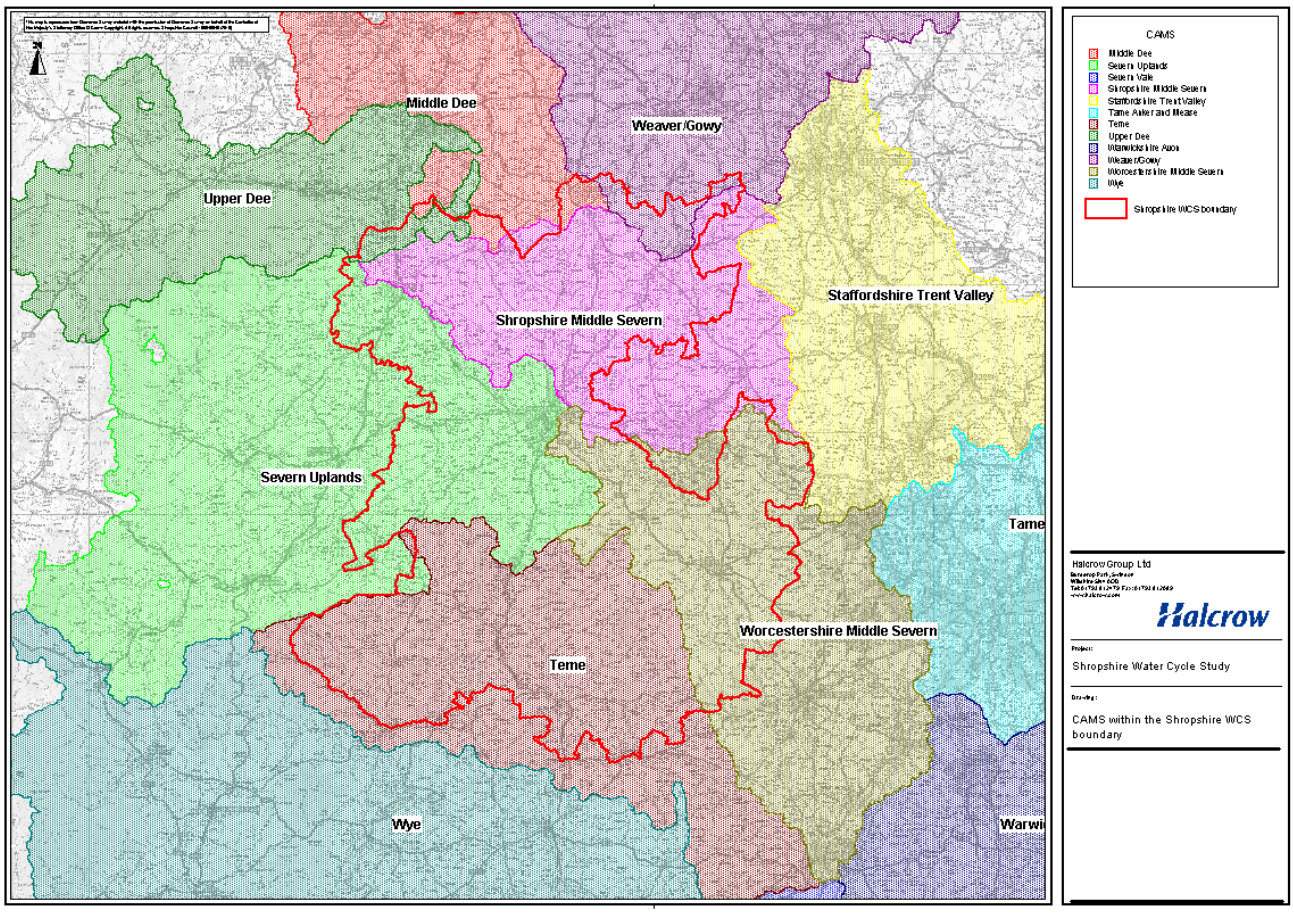


Figure 3-4 CAMS within study area

3.5.1 Severn Corridor

The River Severn flows from the Welsh hills to its mouth in the Severn Estuary and passes through Shropshire including the towns of Shrewsbury and Bridgnorth. The river provides public water to six million people inclusive of exports to other catchments. The river also supports abstractions for navigation, agriculture and industry with the main industrial abstraction at Ironbridge power station. Abstraction demands on the river are regulated to maintain an acceptable flow. During prolonged low flow events this regulation is aided by the Shropshire Groundwater Scheme, which pumps groundwater to the river from the Sherwood Sandstone aquifer in Shropshire. The Severn Corridor CAMS resource assessment has determined that the River Severn Corridor within Shropshire, upstream of the confluence with the River Worfe at Bridgnorth had a status of "Water Available". However, the status of the river after the confluence was "No Water Available, thus the status for the whole corridor is classed as "No Water Available". The result is that a system of abstraction restrictions is in place with time limits applied to new or increased licences.

3.5.2 Shropshire Middle Severn

Northern Shropshire is covered by the Shropshire Middle Severn CAMS area. Main watercourses are tributaries to the River Severn, the Rivers Perry, Roden,

Tem, Meese, Strine; Rea Brook, Coley Brook and Cound Brook. The area contains significant quantities of groundwater within its Permo-Triassic Sandstone aquifer. The catchment also includes several boreholes used as part of the Shropshire Groundwater Scheme devised to work in conjunction with the Clywedog and Vyrnwy reservoirs to meet environmental flow requirements of the River Severn and help meet rising water demand. The main Shropshire population centres covered by the CAMS area are Shrewsbury, Church Stretton, Pontesbury, Wem and Market Drayton. The area is mainly rural in nature which can have a major impact on water resources due to agricultural demands. The CAMS resource assessment determined that the majority of resources were either "Over Licensed" (e.g. River Perry and Tern), "Over Abstracted" (e.g. Coley Brook, although AMP4 investigation in place) or had "No Water Available". This has resulted in a number of groundwater management units (GWMU) being closed to further abstraction. Surface water licences for a number of resources will only be considered in medium to high flows. Rea Brook was the only resource found as "Water Available" however as Rea Brook flows to the River Severn which has a status of "No Water Available" this area must also be considered as "No Water Available" to protect flows in the Severn Corridor CAMS area.

3.5.3 Worcestershire Middle Severn

Central eastern Shropshire is covered by the Worcestershire Middle Severn CAMS area. Main watercourses are tributaries to the River Severn, the Rivers Worfe, Stour and Salwarpe. The area also contains significant quantities of groundwater contained within the Permo-Triassic Sandstone aquifer. The main Shropshire population centres covered by the CAMS are Bridgnorth, Broseley and Much Wenlock. The majority of water abstracted (92%) is groundwater for public water supply by South Staffordshire Water and Severn Trent Water. Most of these abstractions are made by historic licences and no new licences have been granted for many years. The CAMS resource assessment determined that the GWMU was "Over Abstracted" and no further licences would be granted. For existing licences no additional water would be granted and renewals must be justified. Most major watercourses were also found to be "Over Abstracted" due to abstractions from groundwater. As all of the water in this catchment contributes to the Severn Corridor CAMS area which has a status of "No Water Available" the few water courses found as "Water Available" must also be over ridden to "No Water Available", to protect flows in the Severn Corridor.

3.5.4 Teme

Southern Shropshire is covered by the Teme CAMS area which comprises the entire River Teme catchment to its confluence with the River Severn at Worcester. The catchment is largely natural. Key Shropshire populations within the CAMS area are at Ludlow and Craven Arms. The Teme is the second largest tributary of the River Severn and is classed as a SSSI. There are no major aquifers or GWMUs in the area and of over 125 licensed abstractions in the Teme catchment only 16% are from groundwater. Whilst there is an adequate supply of surface water

resources during the winter period, in the summer the River Teme often experiences low flows with corresponding imposed abstraction restrictions (low flows are a natural occurrence). The main uses of water are for public water supply and agriculture and whilst the majority of abstraction licences are for agricultural purposes, the small number of public water abstractions account for over 50% of the total quantity. The CAMS resource assessment determined that the catchment is designated as "Water Available". However as all of the water in this catchment contributes to the Severn Corridor CAMS area which has a status of "No Water Available" this area must also be considered as "No Water Available" to protect flows in the Severn Corridor.

3.5.5 Severn Uplands

Central western Shropshire and Oswestry are covered by the Severn Uplands CAMS area which is a collection of mainly small tributaries of the River Severn and Vyrnwy. There are plentiful surface water resources in the catchment such as the Clywedog and Vyrnwy reservoirs in the west with surface water abstraction licences four times those for groundwater. Many abstractions are small and from minor aquifers and most of the catchment is exempt from groundwater licensing, with the only licences being for the Knockin GWMU south of Oswestry and from sands and gravels around the main rivers. 68% of water licensed for abstraction is for agricultural purposes reflecting the catchments rural nature. The CAMS resource assessment determined that most of the catchment is designated as "Water Available". However as all of the water in this catchment contributes to the Severn Corridor CAMS area which has a status of "No Water Available" all units in this area must also be considered as "No Water Available" to protect flows in the Severn Corridor.

There are three other CAMS areas located on the northern fringes of the Shropshire boundary, namely Upper Dee, Middle Dee and Weaver Gowy. Due to their small areas of influence these have been omitted from this study.

The indigenous water resources within the WCS area have limited abstraction potential. Availability of groundwater varies throughout the WCS area, with a number of groundwater resources closed to further abstraction licensing with possible reductions in existing licences. Surface water is more widely available, though due to the "No Water Available" status of the Severn Corridor, into which all the Shropshire CAMS areas feed, these resources will have "Hands Off" flow restrictions applied to any new and existing licences, limiting abstraction times and quantities in order to maintain adequate flows downstream. The Environment Agency will also use its Restoring Sustainable Abstraction (RSA) programme to reclaim water in severely stressed areas.

The flexible nature of the Strategic Water Grid and its import/export capability between WRZs show that water supply within the study area is not wholly dependant upon abstractions within the local CAMS areas, and is a product of the

overall WRZs deployable output and supply links between WRZs. This is further detailed within the STW dWRMP09.

3.6 Summary of water company overview

A full summary of STW's baseline situation and strategy from the dWRMP09 is presented in Appendix B; this section provides an overview of the key findings from the assessment of STWs existing strategy.

The Severn WRZ, which covers 59% of the Shropshire population, already has supply-demand deficit which only becomes positive in AMP6 under dWRMP09 proposals and maintains borderline headroom to 2035. The Staffordshire and East Shropshire WRZ covering 23% of the Shropshire population will also have a deficit at the end of AMP5 unless draft WRMP09 proposals are agreed with the Environment Agency. Oswestry WRZ at 19% of the population is expected to maintain positive supply to the end of the planning period upon completion of WRP04 works in 2009/2010.

The majority of water resources within the area are classed as "No Water Available", "Over Abstracted" or "Over Licensed" by the Environment Agency within the CAMS studies, with restricted abstraction potential which is unlikely to be relaxed in future years. Those which are initially designated as "Water Available" have been over-ridden to "No Water Available" to protect the Severn Corridor into which they eventually feed. The region is a net importer from other WRZ areas via STW's strategic grid, and this is set to expand with proposed future investment schemes based on improvements to the strategic grid that will allow increased transfer of flows around the WRZs. Some WRZs cannot support current demand and/or will not be able to support future demand unless abstraction licences are increased. Capital investment works have been proposed and leakage management and water efficiency measures have been promoted in all areas.

The predicted supply-demand balance for STWs preferred plan within the respective WRZs covering the Shropshire WCS area are shown in Figures 5-6 to 5-8[5] and include STW's confidence limits.

[5] Figures are taken from Section 17 of the STW draft WRMP09.

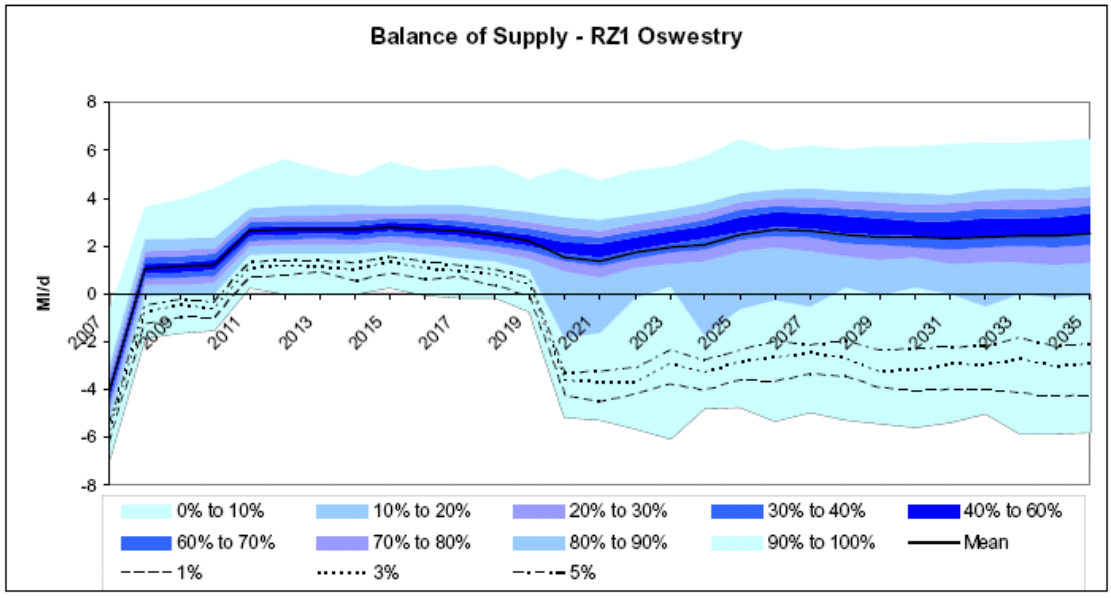


Figure 3-5 Preferred Plan for Oswestry WRZ Supply-Demand Balance to 2035

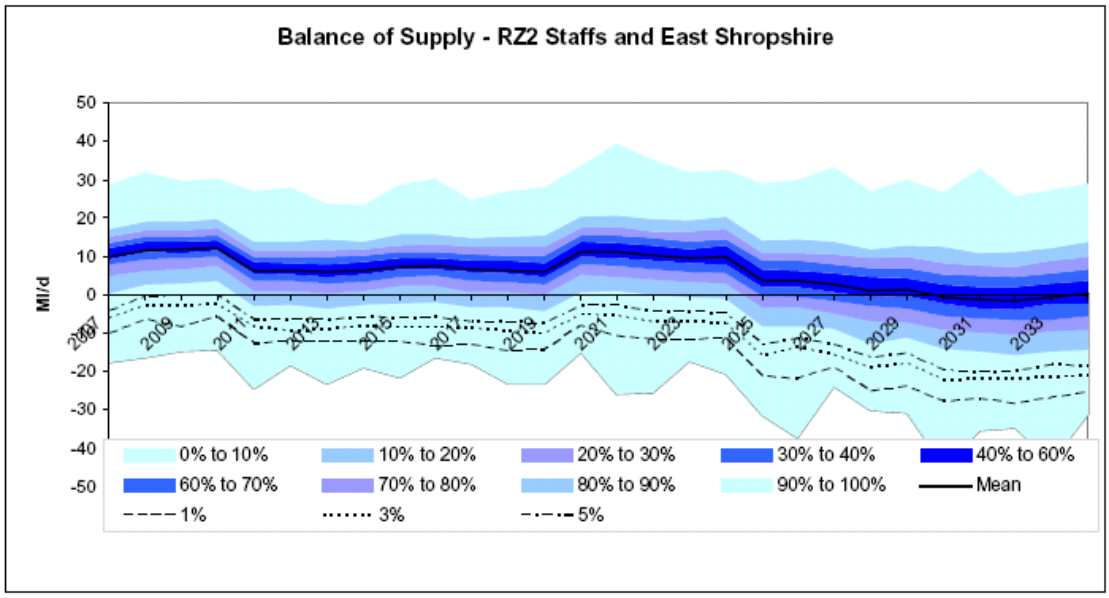


Figure 3-6 Preferred Plan for Staffs and East Shropshire WRZ Supply-Demand Balance to 2035

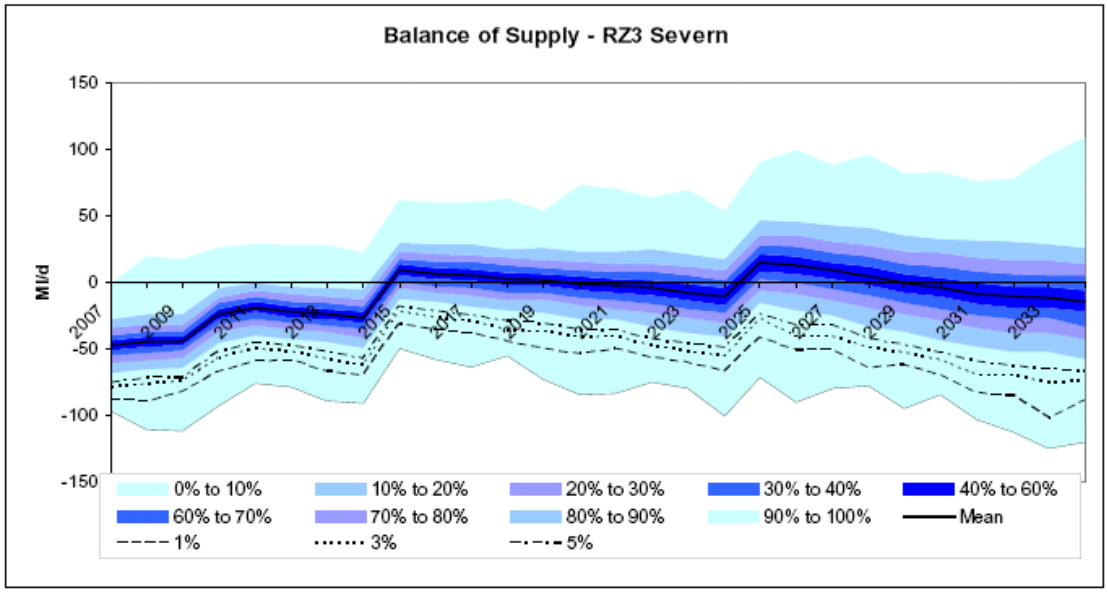


Figure 3-7 Preferred Plan for Severn WRZ Supply-Demand Balance to 2035

3.7 Demand Management

3.7.1 National Policy

The Government's new water strategy for England, *Future Water* was published February 2008. *Future Water* outlines a strategic and integrated approach to the sustainable management of our water resources to 2030, for the public water supply as well as for the provision of healthy ecosystems and the services they provide.

The Vision by 2030 includes the following measures:

- Reduced per capita consumption of water through cost effective measures, to an average of 130 litres per person per day (l/p/d) by 2030 or possibly even 120 litres per person per day depending on new technological developments and innovation
- Amend the Building Regulations to include a requirement for a minimum standard of water efficiency in new homes. The requirement will be in the form of a calculated whole building performance standard set at 125 litres per day (l/p/d).
- In areas of serious water stress it is believed that near universal metering will be needed by 2030.

In response to the Strategy, the Environment Agency have stated that in water stressed areas the introduction of universal metering needs to be undertaken earlier. The Environment Agency would like to see the majority of households in areas where water is scarce to be metered by 2015 with the remainder in water scarce areas being metered by 2020. The Environment Agency also wish to promote the metering of all new properties, including flats.

3.7.2 Code for Sustainable Homes (CSH)

The Code for Sustainable Homes introduces a step-change in sustainable development and forms a basis for future developments to the Building Regulations. As of May, 2008 the Government has made it mandatory that all new homes have a rating against the Code for Sustainable Homes. The Code measures the sustainability of a new home against nine categories of sustainable design, rating the 'whole home' as a complete package. The Code uses a 1 to 6 star rating system to communicate the overall sustainability performance of a new home. The Code sets minimum standards for energy and water use at each level.

The relevant sections in relation to the Water Cycle Strategy are:

- Water Efficiency;
- Surface Water Run-off; and
- Energy / CO_2 (relating to heating water).

A minimum requirement for each of the nine categories is necessary to achieve the base rating of Level 1. Beyond this, threshold values must be attained for both 'Water' and 'Energy' to achieve higher code levels. Hence to achieve for example Code Level 3, the requirements for both carbon and water efficiency must be achieved in addition to the minimum points system requirement. Points may be awarded in the other sustainability categories for initiatives and measures implemented beyond the base level requirement for Code Level 1.

Table 3-3 defines the Carbon and Water Efficiency requirements for each Code Level rating. This assumes the basic entry requirements are met for the other six categories.

Achieving a sustainability rating

	Minimum Standards				
	Energy		Water		
Code Level	Standard (Percentage better than Part L' 2006)	Points Awarded	Standard (litres per person per day)	Points Awarded	Other Points[4] Required
1(★)	10	1.2	120	1.5	33.3
2(★★)	18	3.5	120	1.5	43.0
3(★★★)	25	5.8	105	4.5	46.7
4(★★★★)	44	9.4	105	4.5	54.1
5(★★★★★)	100[2]	16.4	80	7.5	60.1
6(★★★★★★)	A zero carbon home[3]	17.6	80	7.5	64.9

Notes
1. Building Regulations: Approved Document L (2006) – 'Conservation of Fuel and Power.'
2. Zero emissions in relation to Building Regulations issues (i.e. zero emissions from heating, hot water, ventilation and lighting).
3. A completely zero carbon home (i.e. zero net emissions of carbon dioxide (CO_2) from all energy use in the home).
4. All points in this document are rounded to one decimal place.

Table 3-3 Code Level requirements for energy and water efficiency[6]

All new social housing already has to be built to CSH level 2, and the Water Act 2003 places a requirement on LPAs to take steps wherever practicable to encourage the conservation of water. It should be noted that to attain Code Level 3, a home must satisfy the criteria for carbon AND water efficiency. The reduction in use of heated water can therefore contribute towards achieving higher targets for both carbon and water efficiency.

The Environment Agency recommends that measures are adopted to allow the efficient use of water in all new homes with water efficiency set at 105 litres per head per day (i.e. level 3/4 for water within Code for Sustainable Homes) or better.

3.7.3 Regional Policy

Under the Water Act 2003, (part 3 sections 81 & 83), relevant authorities must, where appropriate, take steps to encourage the conservation of water'. Shropshire is covered by the West Midlands Regional Spatial Strategy (RSS) which will guide

[6] Source: Code for Sustainable Homes – A Step Change in Sustainable Home Building Practice. Crown Copyright, 2006.

policy until 2021. The initial strategy (formerly RPG11) published in 2004 has undergone public examination and is awaiting the secretary of state proposed changes. The draft RSS policy relating to water resources is as follows, subject to amendment within the RSS phase 2 revision:

Policy

Policy QE9: The Water Environment.

A. Development plan policies and plans of the Environment Agency and other agencies should be coordinated, where necessary across local authority and Regional boundaries, to:

i) protect or improve water quality and where necessary significantly reduce the risk of pollution especially to vulnerable surface and groundwater in order to improve health and well-being;

ii) manage demand, conserve supply, promote local recycling of water and the multiple use of water resources;

iii) protect and enhance wetland species and habitats, particularly those subject to local biodiversity partnerships;

iv) ensure that abstraction from watercourses and aquifers does not exceed sustainable levels;

v) reduce any adverse effects of development on the water environment by encouraging consideration of sustainable drainage systems where appropriate at an early stage in the design process;

vi) ensure the timing and location of development respects potential economic and environmental constraints on water resources; and

vii) maintain and enhance river and inland waterway corridors as key strategic resources, particularly helping to secure the wider regional aims of regeneration, tourism and the conservation of the natural, built and historic environment.

B. Development that poses an unacceptable risk to the quality of groundwater or surface water in this or other regions should therefore be avoided.

The RSS continues to state that in preparing development plans, local authorities should take advice from the Environment Agency, at the earliest possible stage, on the implications for their plans of the Water Framework Directive, which is being implemented progressively from 2003. In particular they should seek advice from the Environment Agency on those areas in the Region most at risk from over abstraction and pollution and where these are already detrimental to the environment. Development plans should also promote the efficient use of water in order to maximise the use of existing supplies.

3.7.4 Local Authority Policy

The draft West Midlands RSS phase 2 revision sets out sustainable design and construction policy (policy SR3) for LPAs to ensure that all new buildings are designed and constructed to the highest possible environmental standards. It requires that all new homes meet the Code for Sustainable Homes level 3, of 105

litres per head per day, with consideration given to meeting level 6, 80 litres per head per day, by 2016.

3.8 Future Demand Scenario Testing

The water company has a statutory requirement to supply water to a specific level of service. The way that it is regulated means that it cannot rely on promises by developers or local authorities to manage demand. Hence, the per capita consumption (PCC) scenarios used by STW in its demand assessment does not look at more aspirational demand management scenarios that can only be achieved with strong planning policies. This study has therefore considered demand management scenarios that go beyond STWs plans.

All the analysis within the STW dWRMP09 undergoes a rigorous testing and review process with Defra, Ofwat and the Environment Agency, as well as public consultation. The assumptions made by STW have been previously stated and the dWRMP09 final planning component information provided by STW has been accepted for use within the future demand scenario testing undertaken for the WCS.

The demand management scenarios considered are based upon information provided in the STW draft WRMP09 and use a simplification of the draft WRMP09 Final Planning Supply Demand Components[7] for each WRZ as a "baseline" for the assessment of more ambitious consumption reduction scenarios. They show how various demand management strategies can affect the requirement for additional water resources in the study area due to increases in housing from new development; and what would need to be done to achieve demand reductions in the existing urban areas and the new development sites.

Proposed changes for the final WRMP09 as stated in STW's SoR are summarised in Section 3.9, and conclusions are formed around what effect these changes would likely have on the scenario test results.

The proportion of current WCS area populations within each WRZ has been estimated using the Office of National Statistics (ONS) lower-layer super output area (LSOA) population data. The LSOA data, which is consistent with the ONS published district population totals, allows a population-based determination of the proportion of a district that lies within a specific water resource zone. The most recent LSOA data, for 2006, has been used to assess the proportions of the 2006 local authority area populations within a resource zone; the same proportions are then assumed to apply to the more recent 2007 mid-year estimate population data.

[7] Data from the Final Planning data tables WRP4-FP of STW draft WRMP09, 2008

The 2006/07 populations for each WRZ are identified by STW as 66,539 for the Oswestry zone, 801,525 for the Staffs and East Shropshire zone and 2,376,993 for the Severn zone. Data from the Office of National Statistics (ONS) records a population of 70,445 for the Oswestry zone, 811,439 for the Staffs and East Shropshire zone and 2,407,011 for the Severn WRZ. Where there is less than 5% difference between these two sets of data population figures provided from STW are considered to be correct and have been used in the demand scenario testing.

Assumptions have been made in developing the demand scenarios and are listed below. A number of these detail differences from the dWRMP09 final planning data tables. The data tables amalgamate information such as the PCC for new and existing metered housing into "Measured Household PCC". Assumptions have therefore been made to simplify the data and enable a distinction between new housing and existing housing stock, their relative effects on water demand, and how demand can be managed by different strategies. Though this approach may produce some differences in final demand for the WCS area than that from the dWRMP09 baseline, it does indicate the relative effects that the various demand management approached tested may produce in the WCS area.

- We have calculated the current total potable water demand for the WCS area by factoring the current demands within each of the three WRZs to the percentage of the WCS area domestic population they cover.
- We have assumed that new household PCC rates are as per STW metered household PCC rates forecast over the planning period.
- We have assumed that water consumption for existing metered and unmetered properties remains constant during the plan period. This differs from STW assumption in the draft WRMP09 that PCC for these properties varies throughout the planning period.
- We have used STW forecast occupancy rates for new properties provided in their draft WRMP09. We have assumed the occupancy rate in the existing housing remains constant throughout the planning period at the average of baseline unmeasured and measured household rates. The STW draft WRMP09 assumes that the occupancy rate varies for measured households and unmeasured households during the planning period.
- Within the assessment we have used the new development figures provided in the RSS up to 2026. These may differ from the values used in the draft WRMP09. As mentioned earlier, the draft WRMP09 undergoes a rigorous testing and review process with Defra, Ofwat and the Environment Agency, as well as public consultation. One of the key areas for scrutiny in this process is the forecast dwelling and population assumptions; therefore we are not undertaking any additional review of the accuracy of STW forecast population or dwelling numbers.

3.8.1 Scenarios and Results

The list of scenarios below provides detail of the components of each scenario tested for the Shropshire WCS area and is a summation of the results of scenario testing on each of the three water resource zones. This allows an assessment to be made of the total impact of demand management scenarios on the area. A summary of the scenarios can be found in Table 3-4 and the outcomes of the WCS area demand management scenarios are shown in Figure 3-8.

It is important to note that the intent of the results is not to show an overall position for supply-demand balance, as this is mentioned previously and well covered within STW's draft WRMP09. The intent is to show how differing demand management strategies may mitigate the increase in water demand associated with new housing development in the WCS area.

Scenario 1: Business as usual.

This scenario looks at how household potable demand would increase should new development occur in-line with the RSS levels of development and that STW draft WRMP09 forecast PCC rates be realised in the new development areas, assuming that all new properties are metered. The PCC for existing homes (metered and unmetered) is assumed to remain constant throughout the planning period. The meter penetration ratio of metered to unmetered homes is assumed to be in agreement with the SWW draft WRMP09 forecast. This scenario has been used as the basis against which all other scenarios have been derived.

Scenario 2: New homes built to Code for Sustainable Homes Level 3.

This scenario looks at how the implementation of CSH water efficiency targets to CHS level 3 would affect potable demand. All new homes built after 2009 will be required to achieve CSH level 3 (105 l/h/d). We have assumed that all other variables are as detailed in Scenario 1.

Scenario 3: New homes built to Code for Sustainable Homes Level 5.

This scenario looks at how the implementation of CSH water efficiency targets to CHS level 5 would affect potable demand. All new homes built after 2009 will be required to achieve CSH level 5 (80 l/h/d). We have assumed that all other variables are as detailed in Scenario 1.

Scenario 4: New homes built to Code for Sustainable Homes Level 5 and increased meter penetration.

This scenario looks at how the implementation of water efficiency targets to CHS level 5 and increased meter penetration to 90% by 2020 would affect potable demand. All new homes built after 2009 will be required to achieve CSH level 5

(80 l/h/d) with all new properties metered and plans implemented to increase total meter penetration to 90% by 2020, which is a corresponding uptake of meters by around 7,300 existing homes each year from 2010 to 2020.

Scenario 5: New homes built to Sustainable Homes Level 3 and reduced existing PCC.

This scenario is as Scenario 2 with the addition of a reduction in PCC for existing metered properties of 2 litres per head per day each year from 2009 to the end of the planning period, equating to a total reduction in PCC of 32 l/h/d for existing metered properties. Existing unmetered PCC remains constant at the 2006 baseline. All new homes built after 2009 will be also be required to achieve CSH level 3 (105 l/h/d).

Scenario 6: New homes built to Sustainable Homes Level 5 with reduced existing PCC and increased meter penetration.

This scenario is as Scenario 3 with the addition of a reduction in PCC for existing metered properties of 1 litre per head per day each year from 2009 to the end of the planning period, which equates to 16 l/h/d, and increased meter penetration to 90% by 2020. All new homes built after 2009 will be required to achieve CSH level 5 (80 l/h/d).

Scenario	66% Metering by 2035	90% Metering by 2020	All New Homes Built to CSH 3	All New Homes Built to CSH 5	Yearly Reduction in Existing PCC	Variance from 2006 Baseline Demand (Ml/d)
1	✓	×	×	×	×	+7.12
2	✓	×	✓	×	×	+5.44
3	×	×	×	✓	×	+4.22
4	×	✓	×	✓	×	+2.88
5	×	✓	✓	×	2 l/h/d from 2010	+0.20
6	×	✓	✓	×	1 l/h/d from 2010	-1.59

Table 3-4 Water resources scenarios assessed

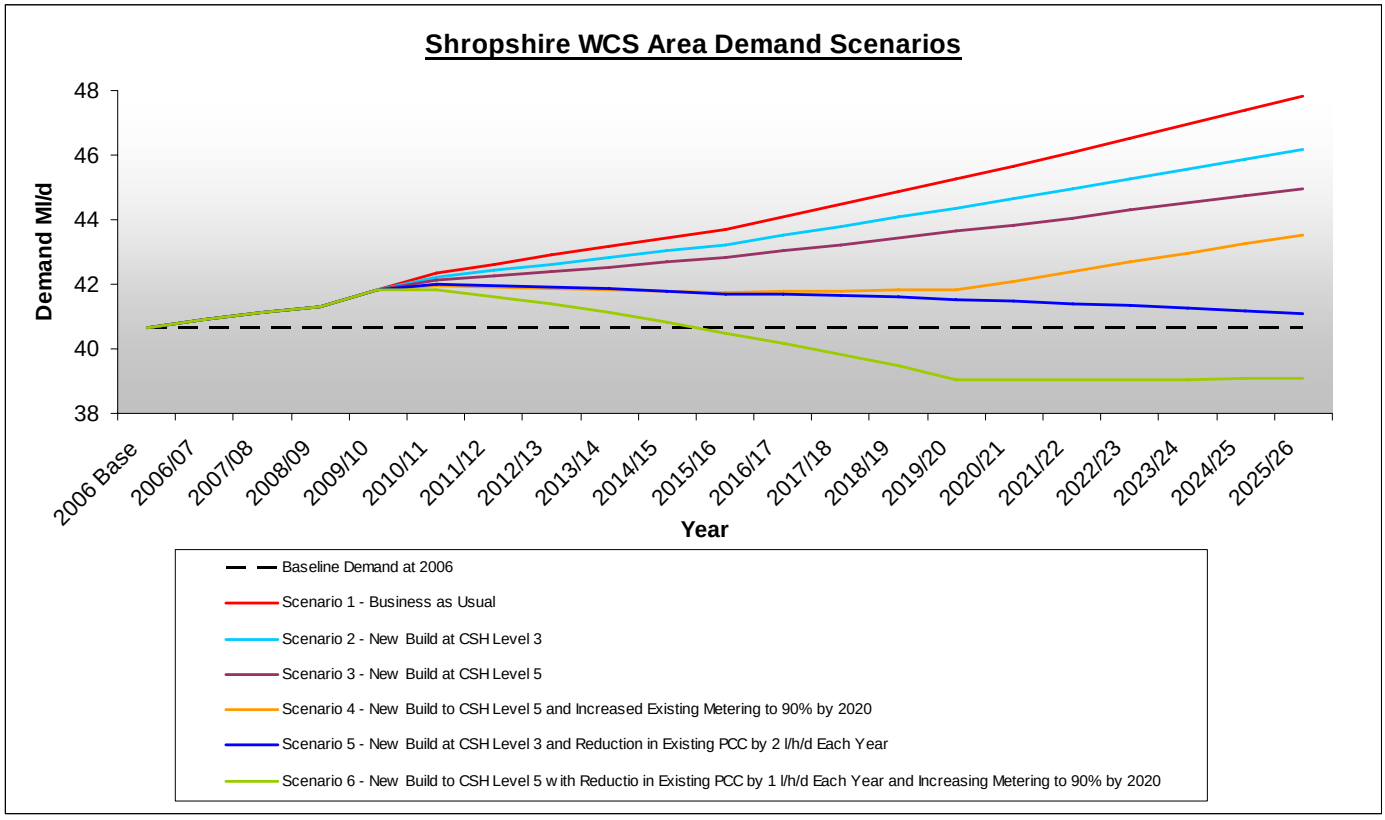


Figure 3-8 Shropshire WCS Area, Demand Scenario Results

The information in Figure 3-8 shows the increase in household water demand from 2006 levels due to proposed increasing development over the planning period and the effect the demand management scenarios may have on this increase.

Baseline potable water demand due to existing housing in the WCS area in 2006/07 was 40.64 Ml/d. The business as usual case (scenario 1) based upon constant existing PCC rates and varying new PCC rates is the worst case scenario tested and shows that if no demand management measures were implemented other than the increased meter penetration proposed by STW, an additional 7.21 Ml/d of potable water will be required in the study area by 2026. This is approximately equivalent to almost three Olympic size swimming pools on a daily basis, or an increase in household demand of 17.5 % between now and 2026. Severn Trent Water's proposals for meter penetration are to meet 66% metering by 2035 which is behind the Environment Agency's proposals on 95% meter penetration of the existing population by 2016, though other demand management procedures are prescribed in the draft WRMP09.

The implementation of various levels of the CSH has been tested alongside STW's proposals on metering (Scenarios 2 and 3). It can be seen that the introduction of increasing levels of the CSH in homes built from 2009 onwards reduces the impact of additional demand from new development. The introduction of increased water meter penetration reduces demand even further, as seen in the comparison between Scenarios 3 and 4 producing a saving of 1.34 Ml/d. Scenario 5 shows that a reduction in PCC demand from existing metered households in conjunction with a suitable level of CSH can create a near water neutral position at the end of the planning period within the study area. Scenario 6 shows that combining increased CSH levels, meter penetration and reducing existing metered household PCC can dramatically reduce demand to levels below the baseline 2006 figure, creating a saving of 1.57 Ml/d on 2006 levels by 2026.

The analysis shows that the greatest reduction in water demand can be achieved by reducing demand in the existing population. This is because the existing population account for a larger proportion of the total population than the population from new development. Therefore although measures such as CSH targeted at new developments have a positive impact upon total demand, they should be used in conjunction with proposals for the existing population in order to achieve maximum reductions in total demand. Comparing the scenarios it can be seen that the increase in demand is not as steep over the planning period with the use of CSH measures and reduces further with the use of increased meter penetration. However a reduction in PCC for the existing population can have a dramatic effect. Scenario 5 details reductions in PCC each year for existing metered houses of 2 l/h/d which actually reduces the overall demand for the period. This results in existing metered properties with a PCC of between 95 and 100 l/h/d by 2026 dependant on WRZ, the equivalent of a PCC in excess of CSH

level 4. However, it must be accepted that reducing existing PCC each year cannot be sustained over the long-term and will be constrained by technology at some point. In addition, to reduce demand in the existing housing stock will require behavioural change, which increases the uncertainty over the potential success of any measures.

Water neutrality (Scenario 5) can be achieved from 2009 to 2026 by implementing a variety of measures. This includes STW proposals for meter penetration, though aims should be to reach the Environment Agency's proposals on compulsory metering of 95% of existing properties by 2016; the implementation of the CSH level 5 and a reduction in the existing PCC of the existing population of 2 l/h/d each year. This would need to be achieved through the implementation of water efficiency measures such as retrofitting, education and encouraging water efficient devices.

3.9 Statement of Response and Variance from the draft WRMP09

Following responses received from the publication of the draft WRMP09 in 2008, STW released a SoR to highlight resultant changes and likely impact for the final WRMP09. Main changes are summarised below:

- Alterations have been made to WRZs' DO as at 2010. The DO for Staffs and East Shropshire has been increased by 15.43 Ml/d and that for the Severn has been decreased by 9.72 Ml/d.
- Projections on average normal year household usage have been revised down from 138 l/h/d to 133 l/h/d by 2035.
- Unmeasured household PCC is revised from having a downwards trend to remaining fairly static.
- Measured household PCC is revised to remain as an upwards trend but with a lower overall PCC than that in the draft.
- Metering is revised upwards to a penetration of 72% of households by 2035.
- The policy of metering upon change of occupancy is no longer restricted to the Staffs and South Shropshire WRZ.
- Non-household consumption has been revised downwards.
- Restoring Sustainable Abstraction reductions of 10 Ml/d in the Staffs and East Shropshire WRZ are no longer included.
- Overall leakage target is revised down to 453 Ml/d by 2014/15.
- Revised proposals for water efficiency producing 16.35 Ml/d of savings by 2015.
- The adverse effect on DO due to climate change has been increased for the three WRZs of interest.
- There have been a number of revisions to proposed capital schemes. The Severn WRZ sees the removal of Ombersley Treatment Works and Mill End GAC but includes new proposed resilience schemes. The Staffs and East Shropshire sees the removal of all schemes.

- Target headroom is revised to be achieved and maintained throughout all years within the planning period.

Changes within the SoR indicate that a supply-demand balance will be now be maintained throughout the WCS area over the planning period. However, increasing housing development will still increase water demand. Therefore adequate DO should not be seen as a barrier to promote reductions in water consumption within this area of water stress.

The above changes likely to enhance demand management within the WCS area which are over and above those set out in the draft WRMP09 are:

- Reduction in average household consumption to 133 l/h/d by 2035 including reduction of measured household PCC due to water efficiency savings and metering.
- Increased metering to 72% by 2035 and extended policy of metering upon change of occupancy.

The result of these actions on the demand scenarios is a reduced baseline demand. Though these measures are a positive action in respect to the draft WRMP09 baseline, they do not cover the more aspirational strategies as prescribed in the demand scenarios.

3.10 Conclusions and Recommendations

Severn Trent Water's draft WRMP09 details a plan to continue with a twin-track approach to supply-demand management. The WCS region is in a state of moderate water stress with an overall status of "No Water Available", which will result in a tightening of abstraction licences and decreased future licensing when viewed in conjunction with required programs such as the Environment Agency's Restoring Sustainable Abstraction.

The draft WRMP09 detailed demand currently outstripping supply in the Severn WRZ, predicted increases in demand from the Oswestry and Staffs and East Shropshire zones and a number of planned capital schemes to meet these demands in order to balance supply. With little if any headroom available the effect of increased development levels or problems with the implementation of capital projects could have resulted in supply-demand shortfalls as seen in previous years.

The subsequent release of the SoR by STW repeals a number of the problems presented within the draft WRMP09. Through the proposed changes target headroom is now achieved across the WCS area and maintained throughout all years in the planning period. Proactive steps have been taken to reduce water demand in existing homes through greater water efficiency savings and increased metering. Though these changes go someway to reducing demand in the WCS

area, further and sustained measures are required to mitigate the increase in demand from new development.

The scenarios tested have attempted to predict future demand with various demand reduction measures in place. Water neutrality can be considered possible (in principle) but requires immediate implementation of CSH Level 3 or above, with new tariff structures and water efficiency projects to produce the 2 l/h/d existing PCC reductions. This is over and above the reduction targets set by Ofwat of 1 l/h/d per property to 2015 and is required in order to achieve the demand scenarios tested. This shows the effect that the implementation of CSH Levels and intensive efficiency targeting and tighter policies for meter penetration can have.

The demand analysis shows how the application of higher levels of the Code for Sustainable Homes and increasing the proportion of the metered population can help reduce water demand. It also demonstrates that a reduction in the PCC of existing properties and population is likely to have a greater impact than targeting new developments alone. It is recommended that continued support is given to measures currently in place and that new measures and technologies are supported at a national and local level.

Overall, whilst STW have plans in place to increase the amount of water available, it must be recognised that water availability is finite and good practice should be adopted now to avoid adverse environmental consequences at a later date. In addition to STWs proposed schemes to increase the amount of water available, it is critical that planning policies are adopted by Shropshire Council to ensure that all new developments (including greenfield and brownfield) are built to a minimum of CSH level 3 (105 l/h/d), and preferably CSH level 5 (80 l/h/d)[8]. Furthermore, the evidence from the demand management scenarios indicates the importance of reducing demand in the existing housing stock. This needs to be achieved through an ongoing partnership approach by Shropshire County Council, the Environment Agency and Severn Trent Water, to identify and implement the optimal mechanism for reducing demand in the existing housing stock.

An indicative action plan is provide below in Section 3.11.

3.11 Indicative Action Plan

A possible future action plan could include:

[8] Government policy "Building a Greener Future, 2007" targets all news homes built after 2016 to be at CSH level 6 (80 l/h/d)

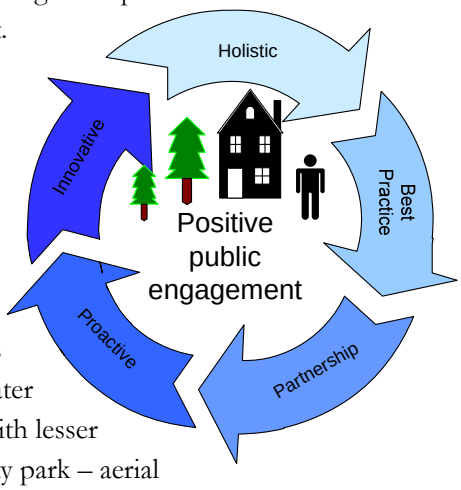
Council Led

Local Development Framework policies:

- Given the well developed evidence base and clear policy at the regional level, Shropshire could include more stringent policy in their Local Development Framework requiring new development to be increasingly water efficient, inclusive of high levels of CSH and water resource augmentation such as rain water and stormwater harvesting. Core Strategy Final Plan: CS6 outlines that all proposals will be required to complete a water audit as part of the sustainability checklist and incorporate water efficiency measures.

Pride in our community campaign:

- **Objective:** engaging existing residents, making them proud of Shropshire's natural and built environment.
- **Target:** raising public awareness of their environment.
- **Action:** review existing community facilities, are they good enough can they be improved? Brain storm additional facilities and events to improve quality of life.
- **Examples:** make sure all community areas are attractive, well maintained, with low water requirement. Identify areas of woodland with lesser ecological value, construct attractive activity park – aerial runway, mountain bike tracks, café etc. Introduce regular events to shout about Shropshire's natural environment, kids after school activities e.g. green gym. Local competition for best wildlife or natural environment photo.



Importance of water campaign:

- **Objective:** engage existing residents on need to conserve water.
- **Action:** review existing community facilities and implement measures to reduce water e.g. spray taps, grey water recycling, rainwater harvesting, advertise action taken and results achieved.
- Education programmes in school. Public exhibition, water audit for typical household, water saving devices, details of cost and expected savings, make spray taps, flow restrictors, water butts etc available at subsidised cost. Provide details (with model?) of underlying aquifers. Public visits to headworks and treatment facilities. Articles in local papers.

Lorry-side advertisement with volume of water consumed by typical households.

Reduction of water consumption in Social Housing:

- **Objective:** deliver significant water savings and catalyse residents of social housing to make pro-environmental changes.
- **Action:** appoint a facilitator to work with STW, housing authorities and other partners to support residents in green lifestyle changes through technological and behavioural change. Investigate options for joint water and power audit/saving campaign.

Note: Waterwise (www.waterwise.org.uk) are in the process of appointing a number of such facilitators and may be able to provide assistance.

Water use audit of all public buildings:

- **Objective:** reduce water consumption.
- **Action:** structured audit of all public buildings. Measures implemented where appropriate to reduce consumption. Advertise successes in local paper etc.

Use of water efficient devices:

- **Objective:** raise awareness people's choices.
- **Action:** encourage all retailers to stock water efficient devices and prominently display water consumption ratings. Maintain and actively promote a register of green plumbers. Show house where water saving devices such as simple bath waste diverters, green walls, etc can be seen in action by the public.

Water Company Led

Increased metering:

- **Objective:** to provide economic incentive to conserve water and better data on system performance
- **Action:** progress enhanced metering scheme throughout the region with targeted advertising campaigns addressing the economic and environmental benefits of water metering.

Leakage reduction programme:

- **Objective:** reduce water abstraction and also increase acceptability of meters.
- **Action:** use improved data provided by universal metering to target areas of higher than average losses. Advertise successes in local paper etc.

Promotion of water efficiency devices:

- **Objective:** further general promotion of water efficiency devices.
- **Action:** subsidy and retrofit of water efficient devices for existing homes.

4 Wastewater infrastructure assessment

4.1 Introduction

This section of the report discusses the existing wastewater treatment infrastructure within Shropshire. The wastewater assessment has been undertaken in close consultation with Severn Trent Water and Welsh Water. The purpose of the wastewater assessment is to identify whether there is sufficient hydraulic infrastructure capacity[9] at the wastewater treatment works (WwTW) and within the drainage network to accommodate planned growth. The assessment focuses on strategic wastewater infrastructure (e.g. trunk sewers or pumping stations) and does not consider local network issues. If there is not sufficient capacity the analysis has identified whether capacity can be built in a timely manner to support growth.

4.1.1 Background

The wastewater that we produce from our homes and our businesses is collected by the drainage system below ground from where it is transported by gravity or via pumping to wastewater treatment works. This drainage system is known as the sewerage system, and can be either a separate or combined sewerage system.

A separate system comprises a foul system which conveys wastewater or foul drainage only to the wastewater treatment works, and a surface water system that collects roof and highway runoff and discharges the clean runoff into rivers and coastal waters. Combined systems collect both rainfall runoff and foul water, and in times of very heavy rainfall can be at risk of being overwhelmed and causing dilute sewage to flood above ground. Where this is the case, the combined system will have what is known as a combined sewer overflow (CSO).

A CSO acts as a relief valve during times of very heavy rainfall and allows dilute storm sewage to be discharged into river and coastal waters. The design of such overflows ensures that discharges only occur during times of very heavy rainfall when there is sufficient dilution in the receiving water to ensure the discharge does not cause pollution or environmental damage.

New residential developments and new employment areas that connect to the existing sewerage system can cause an increase in foul flooding and surface water flooding, and an increase in discharges from combined sewer overflows in combined sewerage systems. Therefore it is important to understand the nature

[9] Hydraulic capacity is defined as the ability of a WwTW to accept additional foul flows; this is not related to the performance of the WwTW *per se*, but is a reflection of the physical infrastructure in place to accept additional foul flows

and capacity of the downstream sewerage system when allocating land for development.

Incapacity in the sewerage system is unlikely to be an absolute showstopper to development; upgrades to the existing sewerage system or new strategic sewer mains can provide additional capacity, subject to funding being provided. However, the time required to plan, finance and deliver sewerage upgrades depends on the length of upgrade required, and the land use below which the existing or new system would drain. Major upgrades through the existing urban area can cause significant disruption within the existing urban area and hence take longer to plan and deliver than new systems through greenfield land. However, new systems through greenfield land can be significantly more costly.

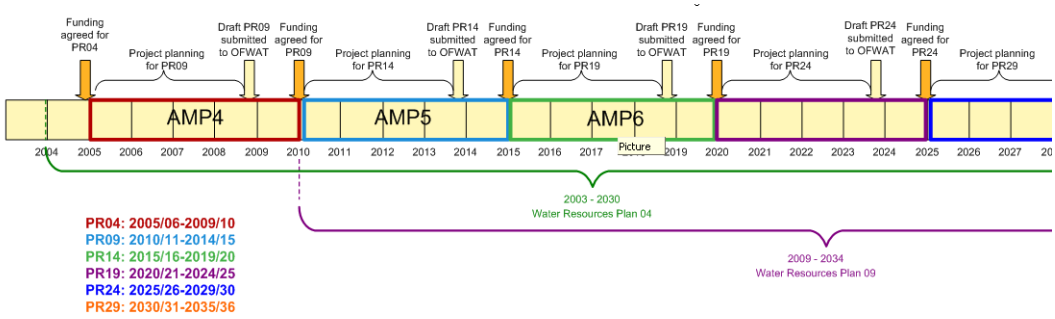
Severn Trent Water and Welsh Water are responsible for the operation and maintenance of the existing foul drainage network and wastewater treatment facilities within the study area. Water companies have a legal obligation under Section 94 of the Water Industry Act 1991 to provide additional capacity as and when required. Nevertheless it is important that development proposals are discussed with the relevant water company at the earliest possible opportunity to ensure that the appropriate wastewater infrastructure is in place in a timely manner.

Assessing the available headroom at any particular treatment works is problematical. This is because, typically, flows to the works vary with time, particularly in relation to changes in trade discharges. Thus, an exact evaluation of spare capacity at any particular works is not possible. In addition to this, the forthcoming introduction of the Water Framework Directive may lead to a tightening of discharge consents.

The availability and certainty of information has provided a limitation on the wastewater assessment for Shropshire WCS. It has been possible to identify where further, more detailed wastewater capacity assessments might be required. It is critical that early consultation between the local planning authority and the sewerage undertaker occurs, to ensure timely and adequate provision of wastewater infrastructure.

Any improvements to the treatment works will be programmed into the water companies' capital programme, which runs in five year Asset Management Plan (AMP) cycles. At the time of writing the final report, water companies have begun their AMP5 programmes, which runs from 2010-2015. This funding cycle and its associated constraints may have implications for the phasing of development. Early consultation with water companies is required to support their capital expenditure programme for AMP6 and beyond. If required, investment which has not been included in the capital expenditure programme can occur (e.g. investment in AMP5 which has not been planned for), and the water companies

can reclaim the expenditure as part of their AMP6 programme. This process is formally known as 'logging up'.



4.2 Overview of methodology

STW carried out the strategic assessment of WwTW and wastewater network hydraulic and to accommodate the proposed level of growth. For the WwTW, STW has commented on:

- the current available hydraulic capacity at each WwTW (including an estimate of the population equivalent [PE] and number of dwellings that could be accommodated before hydraulic capacity is reached);
- the current process capacity at each WwTW, and;
- the availability of land to expand the WwTW, where required.

Subsequently, Halcrow Group Ltd has identified whether the proposed levels of housing and employment growth will result in hydraulic capacity being reached at the WwTW. Where hydraulic capacity will be reached, we have identified during which AMP period this may occur, which can be used to help plan the phasing of development.

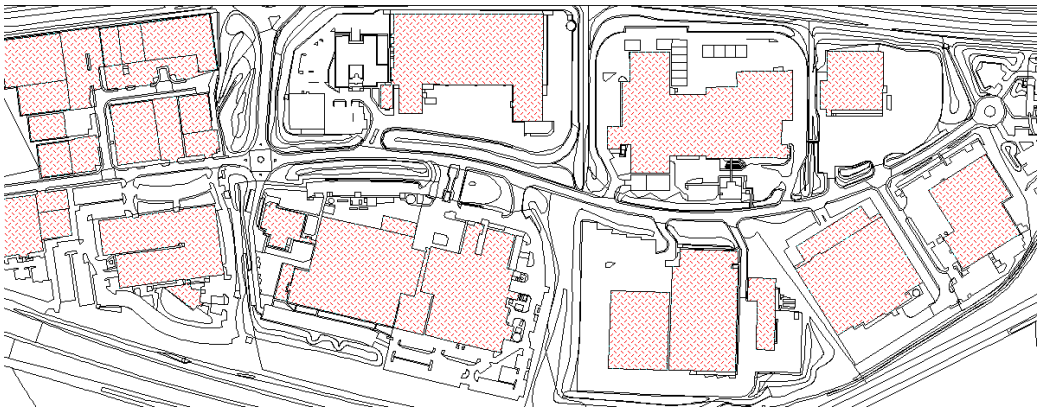
For all new developments, it has been assumed that foul flows only will be connected to the sewer system; this assumes that all surface water is not connected to the sewer system and is managed though separate systems (e.g. SUDS). It is recommended that foul flows and surface water flows are kept separate for all new developments, although it is recognised that in some brownfield locations there may be no alternatives other than to discharge surface water to the sewer network.

The assessment of WwTW has assumed that consumption in new development will be 160 l/head/day, which is made up of 140 l/h/d of domestic consumption, 10% allowance for infiltration and a small allowance for commercial flows. These assumptions are considered to be conservative, and water efficiency measures which reduce domestic consumption would reduce the new net burden on flows arriving at the WwTW.

Foul flows from employment land are highly uncertain and depend largely on the nature of the employment on site. For example, the additional foul flow from a

multi-storey office would be significantly greater than foul flows generated from a warehouse unit. The process for estimating the additional flows from employment land for the outline WCS are assumption-heavy and will need to be confirmed as and when employment sites come forward for development. To estimate the foul flow generated from employment land the following assumptions have been made:

- foul flow has been estimated at 0.5 l/s/ha - STW has carried out flow monitoring from employment land and has estimated that the average foul flow is less than 1 l/s/ha, and more likely to be in the region of 0.5 l/s/ha. This is reasonable when compared to evidence from Halcrow's experience of working for other water companies in England. No variation has been made for different types of employment land at this stage.
- % of developed site which will contribute to additional foul flows is 30% - in an employment site not all of the developed land would contribute towards additional foul flow, as there needs to be an allowance for roads, car parking and open space. From analysis of GIS layers of a mixed employment site, it is estimated that 30% of an employment site may be "populated" and thus contribute to additional foul flows.



Thus, for a 10 ha employment site the estimated dry weather flow (foul flow only) can be calculated by:

10 ha * 0.5 l/s/ha * 30% * (3600 * 24[10]) = 129600 l/d

To calculate the PE from employment land, the flow in l/d should be divided by the assumed per capita consumption (in this case 160 l/h/d). Therefore the PE from the employment land for the worked example would be 129600 l/d / 160 l/h/d = 810 PE.

[10] 3600 * 24 converts the flow from l/s to l/day.

The calculated PE from employment land can be added to the residential PE (which is calculated by number of dwellings * assumed occupancy rate of 2.4 persons per dwelling).

With regards to the wastewater infrastructure network capacity, STW has undertaken a strategic assessment of the key constraints to development. This has included an assessment of known flooding problems, existing combined sewer overflows, and strategic trunk sewer and pumping station capacity, which may be affected by growth. STW has also identified locations where capital investment schemes are likely to occur over the next 2-3 years, and which may resolve existing capacity issues in the identified catchment.

4.3 WwTWs affected by growth

Table 4-1 illustrates the WwTW affected by growth and the indicative new dwellings draining to these WwTW for testing in the WCS.

WwTW name	Locations affected by growth which drain to the WwTW	Indicative number of dwellings to drain to WwTW	Indicative level of employment land to drain to WwTW (ha)
Monkmoor Shrewsbury	Shrewsbury, Bayston Hill	6102	96
Mile-Oak Oswestry	Oswestry, Gobowen, Whittington	2382	41
Whitchurch	Whitchurch	1422	25
Market Drayton	Market Drayton	940	25
Bridgnorth - Slads	Bridgnorth	759	18
Ludlow	Ludlow	723	13
Ellesmere - Wharf Meadow	Ellesmere	692	8
Wem - Aston Road	Wem	461	3
Drenewydd-Oswestry	Gobowen, Whittington	452	3
Shifnal	Shifnal	434	4
Craven Arms	Craven Arms	379	7
Coalport	Broseley	284	2
Albrighton	Albrighton	274	1
Church Stretton	Church Stretton	273	2
Bishops Castle	Bishops Castle	241	5
Five Fords (Wrexham)	St. Martins	240	3
Much Wenlock	Much Wenlock	210	4
Cleobury Mortimer	Cleobury Mortimer	208	2
Baschurch	Baschurch	183	1
Highley	Highley	176	2
Minsterley/Pontesbury	Minsterley / Pontesbury	174	2
Shawbury	Shawbury	93	1

WwTW name	Locations affected by growth which drain to the WwTW	Indicative number of dwellings to drain to WwTW	Indicative level of employment land to drain to WwTW (ha)
Dorrington	Dorrington	91	
Woore	Woore	85	1
Prees - Higher Heath	Prees	80	2
Clun	Clun	76	1

Table 4-1 WwTW affected by growth

4.4 WwTW infrastructure capacity

4.4.1 Monkmoor Shrewsbury WwTW

Monkmoor WwTW lies to the east of Shrewsbury, and treats flows from Shrewsbury urban area and Bayston Hill. It is an activated sludge plant works. STW have commented that there is sufficient hydraulic capacity at Monkmoor WwTW to accommodate the proposed level of growth in Shrewsbury and Bayston Hill. STW have also indicated that "currently the works is performing well within the required quality parameters, indicating that there is significant headroom from a quality performance perspective."

4.4.2 Mile Oak WwTW (which drains Oswestry settlement)

Mile Oak WwTW lies to the south east of Oswestry, and treats flows from Oswestry urban area, Gobowen and Whittington.

STW has indicated that there is no current hydraulic capacity at the WwTW to accommodate additional growth. Although the WwTW is located close to a residential area there is considered to be sufficient land available to extend the physical infrastructure at the WwTW to create additional hydraulic capacity. In addition, sewerage undertakers have a legal obligation under Section 94 of the Water Industry Act 1991 to provide additional treatment capacity as and when required (subject to agreement over discharge with the Environment Agency). Therefore there are no showstoppers to providing additional capacity at Mile Oak WwTW to accommodate growth.

Whilst there are no showstoppers to accommodating growth at Mile Oak WwTW, it is important that the phasing of development is aligned with the provision of additional capacity at the WwTW. STW have indicated that they would not normally start to look at specific options for providing additional capacity at the WwTW until planning applications come forward and provide a level of development certainty. However, STW have confirmed that there are sufficient finances in AMP5 to provide hydraulic capacity to accommodate growth, and that a capital investment project has been promoted by STW to address the capacity issues at this WwTW. In the short-term and prior to capacity improvements being provided, Shropshire Council should continue to liaise with STW to identify whether development applications will cause further hydraulic capacity constraints.

As in Shrewsbury, the urban extension to the east of Oswestry is not proposed to come forward until 2014. As a result there is considered sufficient lead in time to ensure that the appropriate infrastructure is built at the WwTW to serve additional foul flows from this urban extension. It is critical that ongoing consultation occurs between Shropshire Council and STW, to discuss the timing and nature of the proposed development at the urban extensions and to ensure the appropriate infrastructure is accommodated prior to the urban extensions being built.

There is another WwTW to the north east of Oswestry, called Drenewydd-Oswestry WwTW. This works currently drains flows from the settlements of Gobowen and Whittington, and has an existing hydraulic capacity of just over 8000 PE. Given the existing hydraulic capacity at this works, it would be possible to drain all new development from Oswestry to Drenewydd without breaching the current hydraulic capacity. The outline WCS has not investigated the feasibility or costs of diverting new development to Drenewydd-Oswestry WwTW in comparison to upgrading Mile Oak WwTW. The feasibility of draining additional flows from Oswestry to Drenewydd-Oswestry WwTW will need to be investigated by STW as development sites come forward. This WwTW is likely to be less feasible from a water quality perspective, which is further discussed in chapter 5.

4.4.3 WwTW which serve market towns, key centres and local centres

Development from the market towns, key centres and local centres assessed as part of the WCS will drain to 22 different WwTW, as identified in Table 4-1. STW has identified that the following WwTW all have no current hydraulic capacity to accept proposed growth (in order of proposed growth from most to least):

- Ludlow;
- Wem-Aston Road;
- Coalport;
- Albrighton;
- Baschurch;
- Minsterley;
- Shawbury, and;
- Dorrington.

At all of these WwTW there is considered to be sufficient land available to provide the additional physical infrastructure required. It should be noted that Wem-Aston Road, Albrighton and Minsterley WwTW are located close to residential areas and may therefore be constrained to some parts of the site, but overall there is sufficient land available to accommodate the likely required expansion of the works. Similarly, Coalport WwTW is partially constrained to the east by the River Severn and to the west by the railway line. Whilst this is not considered to be a showstopper to development in these settlements, careful planning and consultation will be required between Shropshire Council and STW

at these WwTW, to ensure that development occurs in a timely manner to coincide with infrastructure improvements at the WwTW.

Based on the analysis of proposed housing growth and employment land, the following WwTW are predicted to breach current hydraulic capacity due to growth:

- Bridgnorth-Slads – this will probably require upgrading in AMP7;
- Shifnal – this will probably require upgrading in AMP6;
- Craven Arms – this will probably require upgrading in AMP6;
- Much Wenlock – this will probably require upgrading in AMP7;
- Cleobury Mortimer – this will probably require upgrading in AMP6, and;
- Clun – this will probably require upgrading in AMP6.

It should be noted that all of these WwTW are predicted to exceed their current hydraulic capacity based on the assumptions made in the analysis for the outline WCS; however, infrastructure upgrades would not be required for at least the next 5 years. In particular, the per capita consumption has been assumed to be 160 l/h/d, which is considered to be conservative, and implementation of water efficiency measures in these settlements to reduce foul flows from new development may negate the need to upgrade these WwTW.

Two of the settlements considered as part of this WCS drain to WwTW which are operated and maintained by Welsh Water; St Martins and Whitchurch. St Martins drains to Five Fords WwTW which is located to the south east of Wrexham, and Whitchurch drains to Whitchurch WwTw which is located to the west of the settlement. Welsh Water have indicated that the proposed development numbers from both settlements would not be expected to create capacity issues at the WwTW.

WwTW Name	Estimated spare hydraulic capacity		Total housing growth excl. completions	Total employment land (ha)	Hydraulic capacity assessment	AMP period when hydraulic capacity might be breached	Estimate headroom based on current quality performance (RAG)	Future quality issues (RAG)	Physical constraints regarding provision of additional treatment capacity (RAG)	Any other comments
	PE	Dwellings (@ 2.4hd/dwelling)								
Market Drayton	5424	2260	940	25	Capacity will not be breached		Significant	Not expected to be an issue	No land or other constraints preventing expansion	As part of the EA's National Environment Programme we are expecting to meet a 2mg/l P consent by Sept 2014.
Bridgnorth - Slads	2881	1200	759	18	Capacity will be breached due to growth	AMP7	Limited	Not expected to be an issue	No land or other constraints preventing expansion	
Ludlow	0	0	723	13	No current capacity		Significant	Not expected to be an issue	No land or other constraints preventing expansion	
Ellesmere - Wharf Meadow	See comment	See comment	692	8	No data		Limited	Not expected to be an issue	No land or other constraints preventing expansion	There are data issues relating to current dry weather flow which are subject to further analysis. Should there be insufficient

										hydraulic spare capacity at this works there are no known physical constraints that would prevent additional capacity being provided at this treatment works.
Wem - Aston Road	0	0	461	3	No current capacity		Significant	Not expected to be an issue	No land or other constraints preventing expansion	This treatment works is located to close to a residential area but there is land available should additional treatment capacity be required.
Drenewydd-Oswestry	8086	3370	452	3	Capacity will not be breached		Significant	Not expected to be an issue	No land or other constraints preventing expansion	As part of the EA's National Environment Programme we are expecting to meet a 3mg/l Ammonia by Dec 2012.
Shifnal	790	330	434	4	Capacity will be breached due to growth	AMP6	Significant	Not expected to be an issue	No land or other constraints preventing expansion	
Craven Arms	970	400	379	7	Capacity will be breached due to growth	AMP6	Minimal	Not expected to be an issue	No land or other constraints preventing expansion	Whilst there is minimal spare capacity in terms of current quality performance there are no known

										physical constraints that would prevent additional capacity being provided at this treatment works.
Coalport	0	0	284	2	No current capacity		Significant	Not expected to be an issue	No land or other constraints preventing expansion	There is no hydraulic spare capacity at this works but whilst the works is located between the River Severn to the east and a railway line to the west there is spare land available for expansion should additional treatment capacity be required
Albrighton	0	0	274 (excluding 1,000 additional MoD development)	1	No current capacity		Limited	Not expected to be an issue	No land or other constraints preventing expansion	Whilst there is no hydraulic spare capacity at this works and it is close to an existing residential development there are no known physical constraints that would prevent additional capacity being provided at this treatment works.
Church Stretton	2090	870	273	2	Capacity will not be breached		Limited	Not expected to be an issue	No land or other constraints preventing	

									expansion	
Bishops Castle	1320	550	241	5	Capacity will not be breached		Limited	Not expected to be an issue	No land or other constraints preventing expansion	
Much Wenlock	669	280	210	4	Capacity will be breached due to growth	AMP7	Significant	Not expected to be an issue	No land or other constraints preventing expansion	
Cleobury Mortimer	272	110	208	2	Capacity will be breached due to growth	AMP6	Limited	Not expected to be an issue	No land or other constraints preventing expansion	
Baschurch	0	0	183	1	No current capacity		Limited	Not expected to be an issue	No land or other constraints preventing expansion	
Highley	1119	470	176	2	Capacity will not be breached		Significant	Not expected to be an issue	No land or other constraints preventing expansion	
Minsterley	0	0	174	2	No current capacity		Significant	Not expected to be an issue	No land or other constraints preventing expansion	This treatment works is located close to a residential area but there is land available should

										additional treatment capacity be required.
Shawbury	0	0	93	1	No current capacity		Limited	Not expected to be an issue	No land or other constraints preventing expansion	
Dorrington	0	0	91	0	No current capacity		Limited	Not expected to be an issue	No land or other constraints preventing expansion	
Woore	1618	670	85	1	Capacity will not be breached		No data	Not expected to be an issue	No land or other constraints preventing expansion	
Prees - Higher Heath	583	240	80	2	Capacity will not be breached		Significant	Not expected to be an issue	No land or other constraints preventing expansion	
Clun	159	70	76	1	Capacity will be breached due to growth	AMP6	Significant	Not expected to be an issue	No land or other constraints preventing expansion	

Table 4-2 Assessment of WwTW hydraulic and process capacity

4.5 Wastewater network infrastructure capacity

Severn Trent Water has carried out a high level assessment of the implications of development on the strategic wastewater network infrastructure. No modelling has been undertaken, and the review has been based on a desktop assessment on wastewater network capacity. STW should be consulted as early as possible, once development sites come forward by developers, which will allow them to undertake a detailed assessment of the wastewater network infrastructure required to support the development and whether any upgrades are required. During AMP5, STW will be undertaking Sewerage Management Planning (SMPs)[11] to plan the management of their assets, and STW have indicated that SMPs will be reviewed on a 6-12 month basis. The frequent review of the plans will enable STW to provide ongoing and up to date information on the performance and capacity of the wastewater network.

4.5.1 Shrewsbury

At the outline stage, STW have not identified any major wastewater network infrastructure constraints to development in Shrewsbury. Development within Shrewsbury urban area will comprise of existing permissions, allocations, SHLAA sites and windfall development. STW has identified at the outline stage, that it is unlikely that these developments would cause capacity issues. This is subject to detailed modelling. In addition, the removal of surface water from the network should be promoted by Shropshire Council, where possible. This would serve to reduce runoff entering the sewers and would reduce the risk of development causing capacity issues.

The proposed sustainable urban extension to the west of Shrewsbury is located on the opposite side of Shrewsbury to Monkmoor WwTW. Development in this area will drain through the Rad Brook Valley trunk sewer (which drains through the town centre). There are no known flooding problems in the sub-catchment immediately downstream of the proposed development site, although there are some known sewer flooding problems in the town centre. Options to resolve the flooding problems in the town centre are currently being appraised by STW as part of their capital investment programme. Subject to this scheme going ahead, there are not considered to be any constraints to this development.

The sustainable urban extension to the south of Shrewsbury is not envisaged to cause any wastewater network capacity issues. STW has commented that downstream of the proposed development there are no known flooding problems and there is reasonable hydraulic performance draining to Monkmoor WwTW.

[11] In AMP4 STW used Drainage Area Plans (DAPs) to plan the management of their assets, which were typically reviewed on a 3-yearly basis.

4.5.2 Oswestry

At the outline stage, no major constraints have been identified with regards to wastewater network capacity. Development within Oswestry urban area will comprise of existing permissions, allocations, SHLAA sites, and windfall development. Although each site would need to be evaluated in further detail, it is not envisaged that this development would cause major capacity issues in the wastewater network, provided that surface water is not connected to the foul sewers. STW has identified flooding problems along Victoria Road, and any development to the west of Victoria Road has the potential to exacerbate these flooding problems.

The urban extension to the east of Oswestry is located 1.5km north of Mile Oak WwTW. Development in this area could be connected to the 600mm diameter sewer which runs alongside the western boundary of the site. There are no flooding problems identified downstream of the development, and therefore at the outline stage there are no wastewater network constraints identified for this urban extension.

4.5.3 Market towns, local centres and key centres

The analysis for wastewater network infrastructure capacity in the market towns, local centres and key centres has been used to identify where constraints to development may exist, or where development has the potential to create or exacerbate capacity issues. At this stage, the analysis has not included any site specific information; rather it has been undertaken at the settlement scale. Necessarily, as specific development sites come forward in these settlements they will need to be subject to more detailed assessment, but the findings of the outline WCS can be used to identify high level issues and identify preferred locations for development. As a general rule of thumb, development which is located closer to the WwTW will require shorter flow pathways to the WwTW, and hence are less likely to create or exacerbate capacity issues.

Table 4-3 provides the outputs from the wastewater network infrastructure assessment for the outline WCS and identifies the key constraints to development.

Settlement Name	WwTW Catchment	Sewerage Comment	Potential impact on sewerage infrastructure
Whitchurch	Whitchurch	There are some existing capacity issues in the Whitchurch area, and upgrades might be required to serve growth depending on the locations of development	Medium
Market Drayton	Market Drayton	There is generally good hydraulic performance in Market Drayton with only a few isolated low priority known external flooding problems	Low
Ludlow	Ludlow	All flows from the north of Ludlow are pumped south under the river to a gravity sewer upstream of Ludlow STW by a 300mm diameter rising main approx 420m long. There are isolated flooding problems on a small sub catchment to in the centre of Ludlow (east of the railway) but this problem has recently been deferred due to its high cost. However this flooding problem should not be affected by future development locations although detailed modelling would be required for once specific development locations are available. There are also known hydraulic restrictions to the south east of Ludlow (south of Sheet Road) which may be susceptible to additional development flows. To the east of Ludlow there are several combined sewer overflows which could be affected by development to the north west of Ludlow. Once specific development locations are known it is recommended that further assessments be undertaken	Medium
Bridgnorth	Bridgnorth - Slads	All flows are pumped to the treatment works by a single 450mm diameter 2.7km rising main by Underhill Street SPS located to the west of the River Severn. Flows to the east of the river pass through twin 300mm diameter syphon which are protected upstream by a combined sewer overflow. Any development upstream of this CSO would require modelling to determine whether its performance would be unduly affected. There are three known isolated flooding problems in the catchment but these are currently being appraised by capital projects for resolution in the next 2-3 years.	Medium
Wem	Wem - Aston Road	Wem STW is located to the east of the railway and generally there is good hydraulic performance in the catchment. There are known internal flooding problems to the south of the River Roden.	Low
Ellesmere	Ellesmere - Wharf Meads	There are no known flooding problems in the catchment and there is generally good hydraulic performance. Any development to the west of Ellesmere will need to be pumped to the sewage works	Low

Settlement Name	WwTW Catchment	Sewerage Comment	Potential impact on sewerage infrastructure
Minsterley / Pontesbury	Minsterley	There are no known flooding problems in the catchment and there is generally good hydraulic performance. All flows are pumped to Minsterley STW via The Grove Sewage Pumping Station (SPS) through a 150mm diameter rising main 500m long. Capacity checks will be required to determine if additional pumping capacity is required. There are no combined sewer overflows in the catchment.	Medium due to pumping station
Bishops Castle	Bishops Castle	There are isolated hydraulic issues in the catchment with a single isolated flooding problem to the north. The STW is located to the south east of the catchment. There are two combined sewer overflows in the catchment. Any development to the west will need to be pumped to the sewage works	Low
Church Stretton	Church Stretton	Church Stretton STW is located approximately 3.8km downstream of the main town via 525mm diameter outfall sewer. There are localised hydraulic capacity issues at the upstream end of this outfall sewer but there is no known reported flooding. Detailed hydraulic analysis would be required to determine if localised reinforcement work is required to cater for upstream development. There is a single combined sewer overflow in the centre of Church Stretton which will be affected by any development to the north or north/west.	Medium
Cleobury Mortimer	Cleobury Mortimer	There are some hydraulic performance problems in this catchment and there is a known flooding problem in the vicinity of St Mary's Church. The main 225/375mm diameter main foul outfall sewer is known to have limited spare capacity and as it runs through rear gardens it may be difficult to upsize. Any development to north west, west or south west would need detailed hydraulic modelling assessments	Potentially high due to the location of sewers if they need upsizing
Clun	Clun	There are no known flooding problems in the catchment and there is generally good hydraulic performance. Any development to the south of the River Clun would need to pass under the river via a 225mm diameter syphon.	Low
Craven Arms	Craven Arms	Craven Arms STW is located 1.3km south of the main village via a 600mm outfall sewer although their is a combined sewer to halfway down. Whilst there are localised hydraulic restrictions in the catchment there are no known flooding problems but any development to the west of the railway would pass through a sewer currently modelled to have a 1 year flooding frequency and so this sewer may need to be upsized.	Medium due to potential upsize required under railway

Settlement Name	WwTW Catchment	Sewerage Comment	Potential impact on sewerage infrastructure
Highley	Highley	There are no known flooding problems in the catchment. Development to the north west of the sewage treatment works is not expected to cause a problem (subject to detailed hydraulic modelling)	Low
Much Wenlock	Much Wenlock	There is a known flooding problem immediately upstream of the main outfall sewer to the treatment works. There is a combined sewer overflow on the main outfall sewer. Based on the initial desk-top assessment by STW there is a potential impact of additional foul flows from development on the sewerage network due to the known flooding problem and CSO on the main outfall sewer. If development comes forward in Much Wenlock this would need to be confirmed by detailed modelling, and any options identified and appraised by STW.	Medium due to known problem on outfall sewer
Shifnal	Shifnal	Other than isolated hydraulic restrictions in the catchment there appears to be reasonable hydraulic performance in the catchment. All flows are pumped to Shifnal STW by a 250mm diameter 1.2km rising main. Development locations to the south of the railway would be preferable.	Medium due to fact that 434 new dwelling need to be pumped to STW
Prees	Higher Heath - Prees	All flows drain to Mill Street SPS located in the centre of the catchment (adjacent to the watercourse) before being pumped 2.7km to Higher Heath STW. There are no known flooding problems in the catchment although there is a combined sewer overflow on the 300mm diameter foul sewer draining the catchment to the east of Mill Street SPS	Low
Shawbury	Shawbury	All flows drain to Shawbury SPS before being pumped 900m to Shawbury STW. There is a known flooding problems in the catchment to the south west of the pumping station but this is currently being appraised for resolution in the next 2/3 years. This is a small catchment of 225mm diameter sewers but there are no combined sewer overflows	Medium
Woore	Woore	There are no known flooding problems in the catchment. The village drains via a 2.5km 225mm diameter outfall sewer to Woore STW located to the south.	Low

Settlement Name	WwTW Catchment	Sewerage Comment	Potential impact on sewerage infrastructure
Baschurch	Baschurch	There are no known flooding problems in the catchment. The village drains via a 1.6km 375mm diameter outfall sewer to Baschurch STW located to the south.	Low
Gobowen	Drenewydd-Oswestry	All flows drain to Gobowen SPS before being pumped south to Drenewydd STW to the south. There is a known flooding problems in the catchment along Old Whittington Road although this only an isolated problem currently being assessed for a localised fix.	Medium
St Martins	Five Fords (Wrexham)	Localised hydraulic capacity issues and detailed hydraulic analysis would be required to determine if localised reinforcement work is required	Medium
Whittington	Drenewydd-Oswestry	All flows drain to Whittington SPS before being pumped 1.9km to Drenewydd STW to the south. There are no known flooding problems in the catchment and no combined sewer overflows	Low
Bayston Hill	Monkmoor Shrewsbury	The catchment gravitates north into Shrewsbury before eventually reaching Monkmoor STW. There are isolated hydraulic performance issues in the catchment with known flooding problems (PA 4291) in Pulley Lane which could be exacerbated by development to the north west. The central and east of the catchment drains to a combined sewer overflow but whilst their are isolated hydraulic performance issues there is only a single known external flooding problem in this catchment but it is unlikely to be affected by development.	Medium
Dorrington	Dorrington	This is a small catchment consisting of 150/225mm diameter sewers draining to Dorrington STW to the south. There are no known flooding problems in this catchment nor any combined sewer overflows	Low
Albrighton*	Albrighton	Work is currently under construction/nearing completion to address known flooding problems in Albrighton. We are aware of other known external flooding problems immediately upstream of the STW and we will need to undertake hydraulic modelling in due course to ensure new development does not exacerbate this localised problem. The MOD site would need to be pumped directly to Albrighton STW as there are no gravity sewers to the north or west of the STW	Low

Settlement Name	WwTW Catchment	Sewerage Comment	Potential impact on sewerage infrastructure
Broseley	Coalport	There are no known flooding problems in the catchment.. This catchment drains northwards towards the River Severn valley to a sewage pumping station which then pumps flows parallel to the River Severn 3.6km to Coalport STW. There are combined sewer overflows on each sewer catchment draining to the pumping station.	Medium due to need to check pumping and overflow impacts

Table 4-3 Wastewater network infrastructure capacity assessment for market towns, local centres and key centres

4.6 Ironbridge power station

At the time of writing the Shropshire WCS, no information had been provided by Severn Trent Water on the likely WwTW and wastewater network options for the Ironbridge power station site. Under section 94 of the Water Industry Act 1991, sewerage undertakers have a duty to provide treatment capacity for future development. As the Ironbridge power station is unlikely to come forward prior to 2015, there is considered to be sufficient time to plan the necessary infrastructure provision during the AMP5 process (2010-2015). Severn Trent has indicated they would usually require 3-4 years of 'lead-in' time to plan for infrastructure upgrades; therefore during AMP5 Shropshire Council should confirm with Severn Trent the exact timing and nature of future development at the Ironbridge power station.

4.7 Conclusions and recommendations

The analysis of existing hydraulic capacity both at WwTW and within wastewater networks has shown there are no showstoppers to growth in Shropshire. There are 9 WwTWs which are considered to have no current hydraulic capacity; at all these locations there are no physical constraints to providing additional capacity. In addition, STW have confirmed there are available finances during AMP5 to upgrade WwTWs to accommodate growth.

In Oswestry, there is no current hydraulic capacity to accommodate additional growth to the WwTW. It should be noted that STW have indicated that there are budgets available in AMP5 to undertake growth-related schemes and a capital investment project has been promoted by STW. In Oswestry, the proposed urban extensions will not come forward for development until 2014. There is considered to be sufficient lead in time to ensure there is adequate capacity at the WwTW to accommodate the urban extensions. In the short-term (and prior to upgrades being completed at Mile Oak WwTW) it is recommended that there are ongoing discussions between Shropshire Council and STW, to confirm there is adequate capacity to accommodate the proposed growth as development applications come forward.

The following wastewater recommendations are based on the findings of the outline WCS:

- Surface water should be kept out of the sewerage network, where possible. The removal of the automatic right to connect surface water in the Floods and Water Management Act, will help sewerage undertakers reduce surface water connections to the sewerage network. It is recognised that in some locations there will be no practicable alternative other than connecting surface water to the sewerage network, but it is the responsibility of the developer to demonstrate that all other possible drainage alternatives have been explored in the first instance.

- Foul flows from new developments can be reduced through implementation of water efficiency measures and metering of all new development. This will reduce the new net burden on the wastewater network and at the WwTW.
- Where proposed development will drain through existing Combined Sewer Overflows (CSOs) or Emergency Overflows (EOs) an Urban Pollution Management (UPM) assessment will be required to ensure that there is no impact on receiving water quality.[12] The Environment Agency's position is to avoid new or increased CSO discharges. This is in line with their "No Deterioration" policy which does not allow any breach of statutory standards due to growth and minimises deterioration to water quality.
- Where there is no existing hydraulic capacity at the WwTW, sites which may result in a net reduction in foul flows draining to the WwTW should be prioritised, where possible (e.g. change of use on brownfield land).
- All development proposals should be discussed with STW at the earliest possible opportunity, to understand the constraints for development and potential upgrades required.

[12] The UPM procedure follows a risk-based approach, and therefore allows different levels of investigation depending on the nature of the 'risk'. Therefore, in some cases a simple UPM assessment may be adequate to confirm development will not adversely impact on the operation of the CSOs/EOs or quality of the receiving watercourse.

5 Water quality

5.1 Introduction

A review of water quality is required during the development process to ensure that development does not adversely affect water quality, and does not hinder the ability of a water body to meet the WFD. More detailed information on the WFD is provided in Appendix A of this report, but this overview outlines the process to assess water quality as part of the WCS.

Development can adversely affect water quality in two principal ways:

- increases in final treated wastewater (or effluent) load from WwTW which causes a deterioration of water quality, and;
- increases in intermittent discharges from combined sewer overflows (CSOs), pumping stations, and storm tanks at WwTW – the potential for development to affect the operation of overflows has been assessed as part of the wastewater assessment.

The future expansion potential of a wastewater treatment works with respect to water quality is determined by assessing the discharge consent, set by the Environment Agency. This consent is based on the ecological sensitivity of the receiving watercourse and specifies a maximum flow and a minimum effluent quality that the WwTW has to achieve to meet water quality targets without causing environmental damage.

As the population connected to a sewage treatment works increases, the amount of treated wastewater being discharged to the receiving water generally increases in proportion to the population increase. When this increased population causes the treatment works to exceed the consented maximum discharge volume allowed by the existing Environment Agency consent, improvements are likely to be required to the treatment works to improve the standard of treatment and to ensure river quality does not deteriorate.

The quantity of treated effluent discharged from each treatment works and its quality is specified by the legal discharge consent, issued by the Environment Agency under the Water Resources Act 1991. The consent is normally based upon the dry weather flow (DWF) of the treated effluent, and stipulates limits for the concentration of biochemical oxygen demand (BOD), total suspended solids (TSS) and ammoniacal nitrogen (NH3). Compliance is determined by means of statistical analysis of effluent quality data. To this end the DWF and quality of discharge from a WwTW forms the "planned water quality"; that is the water quality the Environment Agency would expect if the WwTW was discharging at

its DWF and discharge consent. The planned water quality has typically been based on the River Ecosystem Classification of a river reach.

In the foreseeable future, consent limits will be set with a view to meeting the requirements of the Water Framework Directive (WFD) whose aim is to ensure that good river quality standards are met throughout each waterbody. The intention is to set the discharge consent limits based upon the quality and volume of the receiving watercourse and the volume of wastewater effluent at the point of discharge. However, the means of applying these principles to an individual discharge when upstream quality is already unsatisfactory, or when upstream flow provides inadequate dilution to maintain "good" quality status using best available techniques for treatment, is presently unclear.

5.2 Data and References

The data used for this section of the WCS has been sourced from the following locations:

- Receiving water – Severn Trent Water and Environment Agency
- Current WwTW quality consents – Severn Trent Water and Environment Agency
- Measured DWF – Severn Trent Water and Environment Agency
- Consented DWF – Severn Trent Water and Environment Agency
- Housing numbers/employment land info – Shropshire County Council
- WFD classifications – Environment Agency website – "What's in my backyard?"
- PCC, infiltration, people per dwelling – Severn Trent Water
- Consumption per hectare (l/s), % of land developed

5.3 Methodology

To assess the impact of growth on water quality downstream of WwTW discharges, we have assessed the maximum number of houses likely to be connected to each WwTW. This has been used to identify whether a new consent would be required at the WwTW to accommodate proposed growth. If growth will not cause a breach of the current consented DWF then it is fair to assume that there will not be deterioration of planned water quality (that is the water quality the Environment Agency expects if a WwTW was discharging at its DWF and discharge consent).[13]

For the WwTWs which will require a new DWF consent to accommodate growth, two distinct types of assessment have been undertaken:

[13] It is worth noting that even if growth will not cause breach of consented DWF at the WwTWs there may need to be tightening of discharge consents at the WwTWs to help meet the more stringent environmental standards required by the WFD. However, the purpose of the water quality assessment in a WCS is to identify where development may cause deterioration of water quality; the WCS does not consider the wider implications of meeting the WFD, which is beyond the scope and purpose of a WCS

- No deterioration – this identifies whether a new discharge consent can be set at a WwTW to ensure no deterioration in water quality downstream of the works (within the limits of conventional treatment).
- WFD assessment – this identifies whether growth will make it more difficult for the receiving watercourse to achieve good status under the WFD.

To undertake an assessment of no deterioration, there are two principal approaches which can be adopted:

- No deterioration of class – this identifies the current WFD classification (to the 95% confidence) downstream of the WwTW and assesses the discharge consent required to ensure that there is no deterioration in WFD class. The fist principle of the WFD is to ensure no deterioration of current class (for individual parameters), and it is important that growth does not cause a deterioration in current WFD status downstream of discharge from the WwTW. For example, if ammonia is currently classified as good status, then the first principle of the WFD would be to ensure no deterioration.
- Load standstill - the load standstill calculation identifies the consents required at the WwTW to ensure no overall increase in load to the receiving watercourse with growth (where load = flow * concentration). These calculations provide an estimate of the quality consent required to prevent a deterioration of the WwTW discharge. They are not based on the requirements of the river (also known as "river needs consent" or RNC), but will ensure that there will be no deterioration of water quality. They represent a worst-case scenario and will result in more stringent discharge consents than the 95% confidence assessment

At the time of writing the final report (June 2010) there is some uncertainty as to which of the above assessment approaches will be applied and therefore how no deterioration should be assessed in the context of growth. The Environment Agency has drafted a policy, which is awaiting sign off from Defra.

For the purposes of this study, we have undertaken a load standstill calculation where there is an existing BOD, ammonia or phosphate consent. Where there is no existing phosphate consent, we have undertaken a 95% confidence assessment. Similarly, where a proposed consent using load standstill is beyond the limits of conventional treatment[14], we have undertaken a 95% confidence assessment to identify the potential differences between the proposed load standstill and 95% confidence consents

[14] In the Midlands region the limits of conventional treatment are considered to be 3 mg/l for ammonia as a 95%ile, and 1 mg/l for phosphate as an annual average. In other parts of England, the limit of conventional treatment for ammonia is considered to be 1 mg/l as a 95%ile

The 95% confidence assessment has been undertaken using the Environment Agency River Quality Planning (RQP) toolkit. This calculates the WwTW discharge consent to meet a specified target, in this case, the current phosphate status of the river. The following information has been input into the RQP calculations:

- river flow upstream of the WwTW has been taken from the Environment Agency regional SIMCAT models (mean and low flow);
- river quality upstream of the WwTW has been taken from the sample data provided by the Environment Agency, where this was not available, midpoint of WFD good status has been used;
- future DWF from the WwTW (2026) is the sum of the current measured DWF and the future calculated DWF;
- WFD no deterioration targets – the Environment Agency have provided the water quality targets to be used for the assessment (as shown in Table 5-1)

WwTW	No deterioration targets	
	Current WFD Phosphate status downstream of WwTW	Mean quality target for phosphate (mg/l)
Monkmoor Shrewsbury	Good	0.12
Mile Oak-Oswestry	Poor	1.00
Ludlow	Good	0.12
Bridgnorth - Slads	Moderate	0.25
Wem - Aston Road	Poor	1.00
Minsterley	Poor	1.00
Cleobury Mortimer	Moderate	0.25
Clun	Good	0.12
Craven Arms	Moderate	0.25
Much Wenlock	Poor	1.00
Baschurch	Poor	1.00
Dorrington	Good	0.12
Coalport	Moderate	0.25
Albrighton (with MoD)	Poor	0.50

Table 5-1 No deterioration targets for 95% confidence assessment

The WFD assessment seeks to ensure that growth will not hinder the ability of a watercourse to meet good ecological status. This analysis has been done using the Environment Agency River Quality Planning (RQP) toolkit), which is used to calculate the WwTW discharge consent to meet a specified target (in this case good status). The following information has been inputted to the RQP calculations:

- river flow upstream of the WwTW has been taken from the Environment Agency regional SIMCAT models (mean and low flow);
- river quality upstream of the WwTW has been assumed to be at mid-point of 'good status' – this assumes that all sources of pollution upstream of the WwTW have been addressed and this allows an assessment to be made of the discharge consents from the WwTW to 'play its part' in meeting WFD good status;
- future DWF from the WwTW (2026) is the sum of the current measured DWF and the additional DWF due to growth, and;
- WFD good status targets have been taken from the UKTAG standards (http://www.wfduk.org/UK_Environmental_Standards/LibraryPublicDocs/UKTAG%20ReportAug%202006UKEnvironmentalStandardsandConditionsFinalReport).

Where a proposed discharge consent is beyond the limits of conventional treatment with growth, a further assessment has been undertaken to identify the proposed discharge consent assuming no growth. This assessment makes it possible to identify whether growth will make it more difficult to achieve good ecological status.

Increases in DWF to the WwTW due to growth (residential and employment) has been calculated using the same assumptions used in the wastewater infrastructure capacity assessment (see chapter 6).

5.4 Water quality assessment

5.4.1 Current water quality

The current WFD status has been assessed for each water body, which the WwTW discharge into. As shown in Table 5-2 only 4 of the water bodies assessed are currently meeting good ecological status. The WFD states that all water bodies must reach good ecological status by 2027 at the latest.

Historically, discharge consents at WwTW have been set to hit a target known as the River Quality Objectives (RQOs). Where a waterbody has been specified with a RQO of 1 or 2 (scale goes from 1-5), the 90%ile targets for BOD and ammonia are better than WFD good status. Therefore, a waterbody which is classified as RQO 1 or 2 is likely to be meeting WFD good status for BOD and ammonia. Only 5 of the 26 receiving waters are not RQO 1 or 2 reaches.

However, unlike the WFD, there were no phosphate standards in RQOs. Therefore, to meet the WFD good status for phosphate will probably require the application of quite stringent discharge consents at many WwTW. Under the Urban Waste Water Treatment Directive (UWWTD) phosphate consents are set to 2 mg/l (when population equivalent is >10,000) or 1 mg/l (where PE is >100,000) and a WwTW discharges to a sensitive water.

Waterbody Name	Existing RQO	Overall Physico-chemical Status (EcoGen)	Overall Biological Status (EcoBio)	Overall HM Status (EcoHM)	Overall Ecological Status (EcoClass)	Status Objective
R Severn - Sundorne Bk to conf M Wenlock-Farley Bk	2					Good Ecological Potential by 2027, Good Chemical Status by 2015
River Morda - source to conf unnamed trib	1					Good Ecological Status by 2027
Common Bk - source to conf R Perry	4					Good Ecological Status by 2027
R Tern - conf Coal Bk to conf Bailey Bk	2					Good Ecological Status by 2027
R Teme - conf R Onny to conf R Severn	2					Good Ecological Status by 2015, Good Chemical Status by 2027
R Severn - conf R Worfe to conf R Stour	2					Good Ecological Potential by 2027
R Roden - conf Sleap Bk to conf R Tern	2					Good Ecological Status by 2027, Good Chemical Status by 2015
Tetchill Bk - source to conf R Perry	5					Good Ecological Status by 2027
Rea Bk - conf Rowley Bk to conf Minsterley Bk	2					Good Ecological Status by 2027
Snakescroft Brook - R Kemp	4					Good Ecological Status by 2015, Good Chemical Status by 2015
Quinny Bk - source to conf Byne Bk	2					Good Ecological Status by 2027
R Rea - conf Farlow Bk to conf R Teme	2					Good Ecological Status by 2027
R Clun - conf R Unk to conf R Teme	1					Good Ecological Status by 2015
R Onny - conf R E Onny to conf R Teme	2					Good Ecological Status by 2015
Borle Bk - conf unnamed trib to conf R Severn	2					Good Ecological Status by 2027
Much Wenlock-Farley Bk - source to conf R Severn	4					Good Ecological Status by 2027
Wesley Bk - source to conf R Worfe	2					Good Ecological Status by 2027
Bailey Bk - source to conf R Tern	3					Good Ecological Status by 2027
R Roden - conf Sleap Bk to conf R Tern	2					Good Ecological Status by 2027, Good Chemical Status by 2015
R Tern - source to conf Loggerheads Bk	2					Good Ecological Status by 2027
R Perry - conf Tetchill Bk to conf R Severn	2					Good Ecological Status by 2027, Good Chemical Status by 2015

Waterbody Name	Existing RQO	Overall Physico-chemical Status (EcoGen)	Overall Biological Status (EcoBio)	Overall HM Status (EcoHM)	Overall Ecological Status (EcoClass)	Status Objective
Cound Bk - conf unnamed trib to conf unnamed trib	1					Good Ecological Status by 2015
R Severn conf M Wenlock-Farley Bk to conf R Worfe	2					Good Ecological Potential by 2027, Good Chemical Status by 2015
Albrighton Bk/R Worfe to conf Wesley Bk	2					Good Ecological Status by 2027
Albrighton Bk/R Worfe to conf Wesley Bk	2					Good Ecological Status by 2027

Symbol	Status
	High
	Good
	Moderate
	Poor
	Bad
	Not yet assessed
	Other

Table 5-2 Current WFD status of waterbodies with WwTW affected by growth

Table 5-3 shows the relative dilution of the effluent flow in the receiving waterbodies for the WwTWs which are due to receive growth. This is based on the current measured DWF and the upstream river flows taken from the National SIMCAT model. The relative dilution of the receiving watercourse to effluent indicates which watercourses are more likely to be affected by effluent discharges. Watercourses with low percentages (e.g. Ludlow) will have a small effluent discharge in relation to the upstream river flows and therefore the quality and quantity of effluent discharge will have a lower impact on quality in the receiving watercourses. On the contrary those WwTWs which have a higher percentage (e.g. Albrighton) will have a large effluent discharge in relation to the upstream river flows and effluent quality and quantity would therefore play a more important role in determining water quality in the receiving watercourse.

Table 5-3 also shows current phosphate compliance against WFD good status at the sample point downstream of each WwTW, and a comment on whether the failure is likely to be due to point or rural diffuse sources, or a combination of both. It should be noted that these comments have been provided by the Environment Agency.

WwTW	Waterbody Name	Waterbody ID	Effluent flow as a % total flow d/s of WwTW (Mean)	Effluent flow as a % total flow d/s of WwTW (Q95)	Phosphate compliance	Reason for failure
Monkmoor Shrewsbury	R Severn - Sundorne Bk to conf M Wenlock-Farley Bk	GB109054049141	0.48	1.83	Significant fail	Suspect reason for elevated phosphate is point source discharges
Mile Oak-Oswestry	River Morda - source to conf unnamed trib	GB109054055070	11.88	14.76	Not currently failing	-
Drenewydd-Oswestry	Common Bk - source to conf R Perry	GB109054054960	21.50	37.45	Significant fail	Suspect phosphate enrichment is a result of a combination of point and rural diffuse pollution sources
Market Drayton	R Tern - conf Coal Bk to conf Bailey Bk	GB109054055100	6.33	7.65	Not currently failing	-
Ludlow	R Teme - conf R Onny to conf R Severn	GB109054044510	0.36	1.74	Not currently failing	-
Bridgnorth - Slads	R Severn - conf R Worfe to conf R Stour	GB109054049145	0.05	0.17	Significant fail	Suspect phosphate enrichment is a result of a combination of point and rural diffuse pollution sources
Wem - Aston Road	R Roden - conf Sleap Bk to conf R Tern	GB109054049190	4.94	13.86	Significant fail	Suspect phosphate enrichment is a result of a combination of point and rural diffuse pollution sources
Ellesmere - Wharf Meadow	Tetchill Bk - source to conf R Perry	GB109054055000	-	-	Significant fail	Suspect phosphate enrichment is a result of a combination of point and rural diffuse pollution sources

WwTW	Waterbody Name	Waterbody ID	Effluent flow as a % total flow d/s of WwTW (Mean)	Effluent flow as a % total flow d/s of WwTW (Q95)	Phosphate compliance	Reason for failure
Minsterley	Rea Bk - conf Rowley Bk to conf Minsterley Bk	GB109054049540	0.92	4.35	Significant fail	Suspect phosphate enrichment is a result of a combination of point and rural diffuse pollution sources
Bishops Castle	Snakescroft Brook - R Kemp	GB109054044060	4.80	16.42	Significant fail	Suspect phosphate source is predominantly due to rural diffuse pollution
Church Stretton	Quinny Bk - source to conf Byne Bk	GB109054044350	11.44	26.29	Significant fail	Suspect phosphate enrichment is a result of a combination of point and rural diffuse pollution sources
Cleobury Mortimer	R Rea - conf Farlow Bk to conf R Teme	GB109054044260	0.67	3.74	Not currently failing	-
Clun	R Clun - conf R Unk to conf R Teme	GB109054043990	0.13	0.75	Not currently failing	-
Craven Arms	R Onny - conf R E Onny to conf R Teme	GB109054044330	0.37	1.01	Significant fail	Suspect reason for elevated phosphate is point source discharges
Highley	Borle Bk - conf unnamed trib to conf R Severn	GB109054044670	1.52	6.47	Marginal fail	Suspect phosphate source is predominantly due to rural diffuse pollution
Much Wenlock	Much Wenlock-Farley Bk - source to conf R Severn	GB109054049390	8.78	39.95	Significant fail	Suspect reason for elevated phosphate is point source discharges
Shifnal	Wesley Bk - source to conf R Worfe	GB109054050060	10.32	25.01	Significant fail	Suspect reason for elevated phosphate is point source discharges

WwTW	Waterbody Name	Waterbody ID	Effluent flow as a % total flow d/s of WwTW (Mean)	Effluent flow as a % total flow d/s of WwTW (Q95)	Phosphate compliance	Reason for failure
Prees - Higher Heath	Bailey Bk - source to conf R Tern	GB109054055140	8.45	17.05	Not currently failing	-
Shawbury	R Roden - conf Sleap Bk to conf R Tern	GB109054049190	0.64	1.69	Not currently failing	-
Woore	R Tern - source to conf Loggerheads Bk	GB109054055150	0.42	0.51	Not currently failing	-
Baschurch	R Perry - conf Tetchill Bk to conf R Severn	GB109054050030	1.12	2.51	Significant fail	Suspect phosphate enrichment is a result of a combination of point and rural diffuse pollution sources
Dorrington	Cound Bk - conf unnamed trib to conf unnamed trib	GB109054049400	0.15	0.47	Not currently failing	-
Coalport	R Severn conf M Wenlock-Farley Bk to conf R Worfe	GB109054049143	0.37	1.15	Significant fail	Suspect reason for elevated phosphate is point source discharges
Albrighton	Albrighton Bk/R Worfe to conf Wesley Bk	GB109054050270	48.16	56.37	Significant fail	Suspect phosphate enrichment is a result of a combination of point and rural diffuse pollution sources
Whitchurch (Welsh Water)	No information available		-	-	Not currently failing	-
St Martins - Wrexham	No information available		-	-	Not currently failing	-

Table 5-3 Current relative dilution of effluent and phosphate compliance

5.4.2 Initial assessment

Table 5-4 shows the results of the initial environmental impact assessment. Where a WwTW will exceed its DWF consent the cells have been highlighted in red. At Mile Oak-Oswestry, Coalport, Baschurch, Ludlow and Wem WwTW the consented DWF is already exceeded. A further 9 works are predicted to breach their consented flow consent by 2026.

Growth up to 2026 at Drenewydd-Oswestry, Market Drayton, Bishops Castle, Church Stretton, Highley, Shifnal, Prees – Higher Heath, Shawbury, Woore and Albrighton (without the additional MoD growth) WwTW can all be accommodated without breaching their flow consent. Although the growth at these WwTWs will not cause a breach of consented DWF there may need to be tightening of discharge consents at the WwTWs to help meet the more stringent environmental standards required by the WFD.

Relevant WwTW	Current BOD 95%ile consent	Current Amm 95%ile consent	Current P consent (mean)	Measured DWF	Consented DWF	Max Dwelling Forecast to Test (to 2026)	2011 DWF	2016 DWF	2021 DWF	2026 DWF
Monkmoor Shrewsbury*	25	10	-	17,770	20838	**5,894**	18,647	19,524	20,401	21,277
Mile Oak-Oswestry	20	3	-	4,958	4890	**2,382**	5,320	5,681	6,043	6,404
Monkmoor Shrewsbury**	25	10	-	17,770	20838	**6,012**	18,658	19,546	20,435	21,323
Drenewydd-Oswestry	10	5	-	1,159	2484	**452**	1,212	1,265	1,318	1,371
Market Drayton	10	5	-	2,532	3400	**940**	2,703	2,874	3,046	3,217
Ludlow	30	12	1	3,236	2900	**723**	3,348	3,459	3,571	3,682
Bridgnorth - Slads	30	-	-	2,493	2954	**759**	2,624	2,755	2,887	3,018
Wem - Aston Road	15	5	-	1,580	1437	**461**	1,634	1,688	1,742	1,796
Ellesmere - Wharf Meadow	25	7	-	No data received	1280	**692**				
Minsterley	15	5 (10)	-	447	450	**174**	470	493	517	540
Bishops Castle	15	5 (10)	1	326	546	**241**	365	405	444	483
Church Stretton	15	5	-	1,332	1800	**273**	1,365	1,397	1,430	1,463
Cleobury Mortimer	45	-	-	500	500	**208**	526	553	579	606
Clun	25	20	-	89	119	**76**	100	110	121	131
Craven Arms	25	15	-	688	750	**379**	747	806	865	924
Highley	25	10	-	660	781	**176**	683	707	730	754
Much Wenlock	15	5	-	644	680	**210**	677	710	743	776
Shifnal	10	3 (5)	-	1,522	2082	**434**	1,577	1,631	1,686	1,740
Prees - Higher Heath	40	15	-	341	443	**80**	355	369	383	398
Shawbury	20	10	-	709	1433	**93**	721	733	746	758
Woore	25	15	-	95	295	**85**	106	118	129	141

Relevant WwTW	Current BOD 95%ile consent	Current Amm 95%ile consent	Current P consent (mean)	Measured DWF	Consented DWF	Max Dwelling Forecast to Test (to 2026)	2011 DWF	2016 DWF	2021 DWF	2026 DWF
Baschurch	20	5	-	1,259	1000	**183**	1,280	1,301	1,321	1,342
Dorrington	45	20	-	75	110	**91**	87	99	111	123
Coalport	25	10 (15)	-	16,394	16000	**284**	16,428	16,461	16,495	16,529
Albrighton	15	5	-	1,072	1280	**274**	1,102	1,131	1,161	1,190
Albrighton (with MoD)	15	5	-	1,072	1280	**1,274**	1,198	1,323	1,449	1,574
Whitchurch (Welsh Water)	No information available					**1,422**	Assessment cannot be completed due to lack of available information			
Five Fords (drains St Martins) – (Welsh Water)	20	10	-	No information available	27720	**240**	No information on current measured DWF			

Table 5-4 Initial assessment of developments up to 2026

* including growth from Shrewsbury urban area only, ** including growth from Shrewsbury & Bayston Hill. It should be noted that in April 2010 STW revised the measured DWF (80%ile) at Monkmoor WwTW to 16,514 m^3/d; in this case the DWF consent would not be exceeded up to 2026. However, there is inherent uncertainty in measured DWF and a worst-case was used for this assessment to demonstrate that should a new consent be required to serve growth this would not present a constraint to development.

Note, Ellesmere – Wharf Meadow has not been assessed due to data issues relating to current dry weather flow which are subject to further analysis by Severn Trent Water. Severn Trent Water have commented that should there be insufficient hydraulic spare capacity at this works there are no known physical constraints that would prevent additional capacity being provided at this treatment works.

Whitchurch and St Martins are both within the Welsh Water catchment – no data is currently available on measured DWF, and therefore it has not been possible to undertake an assessment. Further assessment will be necessary, in consultation with Welsh Water, as part of the appraisal of sites within the Site Allocations and Management of Development document.

5.4.3 Consents to achieve no deterioration

Table 5-5 illustrates the results of the no deterioration assessment for the 14 WwTWs which would breach the flow consents with the proposed growth up to 2026. Where the indicative consents need to be set beyond the limits of conventional treatment, this is highlighted in the table in red. For the majority of WwTWs, the results indicate that some tightening of consents would be needed to ensure no deterioration of downstream water quality. However, for the most part the required tightening of consents would remain within the limit of conventional treatment, and hence would not be considered as a barrier to growth.

At Albrighton WwTW with 274 new homes, there is no breach of the flow consent up to 2026 and it is therefore fair to assume that there will not be deterioration of planned water quality (that is the water quality the Environment Agency expects if a WwTW was discharging at its DWF and discharge consent). and therefore the no deterioration assessment has not been undertaken. However, at Albrighton WwTW with the additional MoD growth, the no deterioration assessment has indicated the potential for consents to be tightened beyond the limits of conventional treatment. A phosphate consent of <1 mg/l would be required to ensure no deterioration of current class. This is beyond the limits of conventional treatment and in this instance the proposed level of development may not be achievable within environmental capacity limits. The sustainable levels of growth would need to be confirmed through the site allocations Development Plan Document (DPD).

In the case of Mile Oak WwTW, the assessment has indicated that there is a potential for the ammonia consent to be tightened to 2 mg/l to ensure no deterioration of class and to maintain current load (it should be noted that maintenance of current load guarantees no deterioration in the quality of the final effluent, but is based on a worst-case scenario and goes beyond no deterioration of current WFD class). Although 3mg/l is classed as the limit of conventional treatment by Severn Trent Water Ltd and the Midlands Region of the Environment Agency, consents below 3 mg/l are in common usage elsewhere in England, and we do not consider that a consent tighter than 3 mg/l should be material constraint to development in Oswestry. Any further tightening of consents which would be required to ensure good ecological status would need to be subject to environmental benefit-cost, be promoted through the National Environment Programme and funded through the AMP process. In light of these findings we consider that growth at Oswestry, to the levels considered by this WCS, is not constrained by environmental capacity.

At Ludlow, a similar situation is evident for phosphate. The phosphate consent does not need to be tightened to ensure no deterioration of current phosphate WFD class (good status). However, the load standstill suggests a phosphate consent of < 1mg/l would be needed. In light of these findings we consider that

growth at Ludlow, to the levels considered by this WCS, is not constrained by environmental capacity.

WwTW	Current consent information				2026 indicative consents to ensure no deterioration					Comments
	DWF (m3/d)	BOD 95%ile (mg/l)	Ammonia 95%ile (mg/l)	Phosphate mean (mg/l)	DWF (m3/d)	Load standstill - BOD 95%ile (mg/l)	Load standstill - Ammonia 95%ile (mg/l)	Phosphate mean (mg/l)		
								Load standstill	95% confidence	
Monkmoor Shrewsbury (Shrewsbury growth only)	20,838	25	10	-	21,277	24	10	-	6.2	
Mile Oak-Oswestry	4,890	20	3	-	6,404	15	2	-	6.0	Ammonia consent may need to be tightened to 2 mg/l to meet no deterioration of current class (at 50% confidence).
Monkmoor Shrewsbury (with additional market towns growth)	20,838	25	10	-	21,323	24	10	-	6.2	
Ludlow	2,900	30	12	1	3,682	24	9	0.8	8.1	No tightening of consent required to ensure no deterioration of current class
Bridgnorth - Slads	2,954	30	-	-	3,018	29	-	-	104.4	
Wem - Aston Road	1,437	15	5	-	1,796	12	4	-	9.7	

Minsterley	450	15	5	-	540	13	4	-	36.3	
Cleobury Mortimer	500	45	-	-	606	37	-	-	7.5	
Clun	119	25	20	-	131	23	18	-	20.4	Phosphate consent of 8 mg/l needed to achieve Habitats Directive phosphate standard of 0.06 mg/l as an annual average
Craven Arms	750	25	15	-	924	20	12	-	28.9	
Much Wenlock	680	15	5	-	776	13	4	-	4.4	
Baschurch	1,000	20	5	-	1,342	15	4	-	47.9	
Dorrington	110	45	20	-	123	40	18	-	21.4	
Coalport	16,000	25	10	-	16,529	24	10	-	18.5	
Albrighton (with MoD)	1,280	15	5	-	1,574	12	4	-	0.8	Discharge consent beyond limit of conventional treatment needed for phosphate

Table 5-5 Indicative consents to achieve no deterioration of water quality downstream of the WwTW

5.4.4 Consents to achieve 'good status'

Further analysis has been undertaken to establish likely consents required to meet WFD good status. These calculations are based on the assumption that the river upstream of the works is currently meeting WFD good status. The objective of this assessment is to ensure that growth does not make it more difficult to achieve good ecological status. In line with draft Environment Agency policy, there are three principal outputs from the WFD assessment:

1. indicative consents are within the limits of conventional treatment with **and** without growth – no issue for growth, although there is a potential cost implications to upgrade the works to meet tighter consents with growth;
2. indicative consents are **beyond** the limits of conventional treatment with **and** without growth – achieving good status may be more difficult after growth, but this should not be viewed as a barrier to growth, and;
3. indicative consent **without** growth is **within** limits of conventional treatment, **but beyond** the limits of conventional treatment **with growth –** this should be viewed as a potential barrier to growth.

The results of the assessment are presented in Table 5-6, and the red shading shows where consents would require tightening beyond the limits of conventional treatment.

At the majority of WwTW consents can be set within the limit of conventional treatment to ensure good status is achieved downstream of the discharge with and without growth At these WwTW, the evidence indicates that growth will not make it more difficult to achieve good status, and therefore is not a barrier to growth.

However, the evidence indicates that at Mile Oak, Wem-Aston Road, Much Wenlock and Albrighton WwTWs, consents would need to be set beyond the limit of conventional treatment to achieve good ecological status. A further assessment has been carried out at these WwTWs to identify the indicative consents without any growth, and the results of this assessment are illustrated in the final two columns of Table 5-6. At all WwTWs, the indicative consents would need to be set beyond the limits of conventional treatment with **and** without growth; therefore the requirement to set consents beyond conventional treatment is not merely as a result of growth but due to other contributing factors such as diffuse pollution. Actions will therefore be required as part of the River Basin Management Plan and should not be seen as a barrier to growth.

It is noted that Mile Oak-Oswestry, Much Wenlock and Albrighton WwTW also require ammonia consents of 2 mg/l or less to meet good status. Where a WwTW has ammonia discharge consent of > 3mg/l the distribution of effluent quality typically follows a log-normal distribution. However, when a WwTW discharges at

low ammonia concentrations (less than 3 mg/l) the log-normal distribution is not appropriate to represent the distribution of ammonia. This is because when a WwTW has a stringent ammonia consent the majority of final effluent samples will be at low concentrations, with a few samples taken when the WwTW discharges at higher concentrations. The distribution does not therefore fit a parameterised distribution, and as a result the log-normal distribution which is normally used for water quality planning is no longer appropriate to represent final effluent discharge. In such cases a non-parametric data file is used in the modelling. In most cases, using a non-parametric data file in the modelling will result in a less stringent consent than that calculated using the log-normal distribution. This additional modelling has not been undertaken for this study, but would be required to be undertaken by the Environment Agency when assessing the requirements for new consents at WwTW.

WwTW	Current consented discharge consents			Consents with **2026 flows** and upstream sources of pollution addressed			Consents with **current consented flows** and upstream sources of pollution addressed	
	BOD consent mg/l (95%ile)	Ammonia consent mg/l (95%ile)	Phosphate consent mg/l (annual average)	BOD consent mg/l (95%ile)	Ammonia consent mg/l (95%ile)	Phosphate consent mg/l (annual average	Ammonia consent required mg/l (95%ile)	P consent required (mean) mg/l
Monkmoor Shrewsbury	25	10	-	> current consent	9	3	-	-
Mile Oak-Oswestry	20	3	-	13	2.4	0.3	2.8	0.3
Monkmoor Shrewsbury (with additional market towns growth)	25	10	-	> current consent	9	3	-	-
Ludlow	30	12	1	> current consent	> current consent	> current consent	-	-
Bridgnorth - Slads	30	-	-	> current consent	86	27	-	-
Wem - Aston Road	15	5	-	> current consent	4	0.4	-	0.5
Minsterley	15	5 (10)	-	> current consent	4	1	-	-
Cleobury Mortimer	45	-	-	43	13	2	-	-

WwTW	Current consented discharge consents			Consents with **2026 flows** and upstream sources of pollution addressed			Consents with **current consented flows** and upstream sources of pollution addressed	
	BOD consent mg/l (95%ile)	Ammonia consent mg/l (95%ile)	Phosphate consent mg/l (annual average)	BOD consent mg/l (95%ile)	Ammonia consent mg/l (95%ile)	Phosphate consent mg/l (annual average	Ammonia consent required mg/l (95%ile)	P consent required (mean) mg/l
Clun	25	20	-	> current consent	19	6	-	-
Craven Arms	25	15	-	> current consent	13	4	-	-
Much Wenlock	15	5	-	10	2	0.2	2	0.2
Baschurch	20	5	-	> current consent	> current consent	2	-	-
Dorrington	45	20	-	> current consent	> current consent	2	-	-
Coalport	25	10 (15)	-	> current consent	> current consent	5	-	-
Albrighton (with MoD)	15	5	-	7	1	0.1	1	0.1

Table 5-6 Indicative consents to achieve good ecological status, assuming upstream sources of pollution have been addressed

5.4.5 Ironbridge

Effluent flows from development in Ironbridge are likely to discharge to the River Severn, although this will depend on the drainage options which are considered most feasible by STW. The waterbody (GB109054049143) which the Ironbridge site currently lies within, is currently in moderate ecological status. The target is to meet good ecological potential by 2027, and good chemical status by 2015. Ammonia and Dissolved Oxygen are currently in high status, and phosphate is currently in moderate status. The River Severn has a very high dilutive capacity, and therefore it is likely that the additional effluent flows could be accommodated. Once the development locations are known, and STW confirm the preferred treatment options, the Environment Agency will need to assess the water quality discharge consents required to ensure no deterioration of current class in the first instance, and good chemical status.

5.5 Conclusions and recommendations

The outline WCS has assessed where growth is forecast to cause a breach of current environmental capacity (a breach of current consented DWF at the WwTW). Where a WwTW will not breach its current consented DWF, then it is unlikely that growth will cause deterioration of planned water quality. Tighter discharge consents may be required to meet the requirements of the WFD, but more stringent discharge consents will need to be assessed by the Environment Agency as part of its river basin management planning role, rather than being driven by growth

Where a WwTW will exceed its DWF consent due to growth, further work has been undertaken:

- first to demonstrate whether discharge consents can be tightened within the limits of conventional treatment to achieve no deterioration of downstream water quality, and;
- secondly to demonstrate whether growth will make it more difficult to achieve the requirements of the Water Framework Directive downstream of the WwTW.

For the majority of WwTWs which will require a new discharge consent due to growth, a new consent can be set within the limits of conventional treatment, and therefore growth which drains to these WwTW should not be constrained by water quality. However, at Albrighton (with MoD growth), the assessment has shown that a phosphate consent beyond the limits of conventional treatment would be required to achieve no deterioration of current phosphate WFD class. This represents a potential barrier to the level of growth modelled, and further work will be needed during the site allocations document, to confirm the sustainable levels of growth without causing deterioration of water quality, or requiring discharge consents beyond the limit of conventional treatment.

In the case of Mile Oak, there is some potential for the ammonia consent to be tightened to 2 mg/l to ensure no deterioration of current class or to maintain current load; however, this is not considered to be a barrier to growth. At Ludlow, no deterioration of current phosphate WFD class can be achieved without tightening of the current phosphate consent, although it should be noted that to achieve 'load standstill' would require a consent beyond 1 mg/l.

With respect to ensuring growth does not make it more difficult to achieve good ecological status under the WFD, the assessment has shown the majority of works would require discharge consents within the limits of conventional treatment, with and without growth. At these WwTW, there are no known barriers to achieving good WFD status, although there is a potential that growth may trigger fresh investment at a WwTW.

At Mile-Oak, Wem-Aston Road, Much Wenlock and Albrighton (with MoD growth), discharge consents would need to be set beyond the limits of conventional treatment, **with** and **without** growth; therefore, this is not considered a barrier to growth as there is an issue to meeting good WFD status irrespective of growth. Actions will be required as part of the River Basin Management Plan to tackle other contributing factors such as diffuse pollution.

Overall, the evidence indicates that there are some potential water quality constraints to growth at Mile-Oak and Albrighton (with MoD growth). Further work is needed outside of the WCS to confirm growth is sustainable in the context of environmental capacity.

- Mile-Oak – the Environment Agency will need to confirm whether consents to ensure no deterioration will be set using load standstill or no deterioration of WFD class. In addition, STW should confirm, in principle, whether a 2 mg/l ammonia consent would be achievable at Mile-Oak WwTW.
- Albrighton (with MoD growth) – further investigations will be required during the site allocations, to determine the level of housing growth which would be sustainable, without going beyond environmental capacity.

6 Flood risk management

6.1 Introduction

This chapter presents the findings from the assessment of flood risk in Shropshire. The analysis has identified where proposed developments might lie in areas of high flood risk to ensure that development is located away from high flood risk areas, in accordance with PPS25. The assessment builds upon existing work already carried out through the Strategic Flood Risk Assessments (SFRAs) and Catchment Flood Management Plan (CFMP), and applies the principles and recommendations from these to specific development proposals.

A review of flood risk management options during the early phases of a Water Cycle Strategy is essential to ensure that:

- the risk of flooding from all sources to the development areas is considered and development is steered away from high risk areas (in particular, Flood Risk Zones 2 and 3);
- the potential impact of development proposals on catchment flood response is considered;
- any flood risk mitigation measures are planned in a strategic, rather than unplanned fashion, and;
- there is no deterioration to existing communities' standard of protection.

The Water Cycle Study Guidance (Environment Agency, 2008) states that the output of an Outline Water Cycle Study should answer the following question:

"Is there enough land available for development – without increasing flood risk or building vulnerable properties in flood risk areas."

The Water Cycle Sudy is not intended to replace site-specific flood risk assessments by developers. Instead, it identifies the potential for developers, local planning authorities and the Environment Agency to work together in providing strategic solutions that benefit the catchment as a whole.

The aims and scope of this flood risk and surface water assessment are therefore as follows:

- to review the findings of recent studies into flood risk in Shropshire;
- to determine existing flood risk to the proposed development areas from all sources of flooding, in order to aid the local planning authority in selecting preferred areas;

- to identify the potential for strategic solutions to mitigate the effects of development and improve flood risk protection standards in the study area; and
- to identify where a Phase 2 (detailed) Water Cycle Strategy may be required.

6.2 Methodology

For urban extensions in Shrewsbury and Oswestry the hydrological analysis considered the existing flood risk to the development through an analysis of the Environment Agency's Flood Zone 2 and 3 maps and other sources of flood risk. The combined area of Flood Zones 2 and 3 within each proposed site allocation was calculated to determine the level of fluvial flood risk. For each proposed site allocation, an assessment was then undertaken to determine whether there is sufficient land at low level flood risk to accommodate the proposed housing allocation. The assumption was made that housing density would be 40 properties per hectare and a further 15% of the site will remain as open space. The SFRA was used to identify flooding from other sources at the strategic locations. The SFRA was supplemented by the surface water mapping carried out as part of the WCS (discussed in chapter 9).

For the SHLAA sites in Shrewsbury and Oswestry, and the market towns, key centres and local centres, a more strategic approach to the assessment has been undertaken, focusing on the key constraints and opportunities to development in relation to flood risk to help identify preferred settlements for development on the basis of flood risk and surface water management. A high level review of the Environment Agency's Flood Zone maps has been undertaken in relation to each settlement and its surrounding area to identify any major constraints to development. The Level 1 SFRA data has also been used to identify flood risk from other sources including surface water, groundwater and impounded water bodies (e.g. canals and reservoirs), alongside the outputs from the surface water mapping undertaken for the WCS.

It should be noted that further background information and context on flood risk in Shropshire is provided in Appendix D.

6.3 Shrewsbury

Shrewsbury lies within the River Severn catchment. The River Severn flows from the north west across the area, meandering through rural landscape before flowing through Shrewsbury town, where it is fed by the Rad Brook and the Rea Brook. The main fluvial risk of flooding is at Shrewsbury itself from the River Severn, where large parts of the town have been affected including Frankwell, Castlefield and Monkmoor. Recent flood events have included 1998, 2000, 2002, 2003, 2004, 2006 and 2007. In the autumn of 2000, the worst flooding for over 50 years caused widespread damage along the length of the River Severn. Shrewsbury was badly affected and the town was extensively flooded three times in the space of six

weeks. As a result, the Environment Agency accelerated a feasibility study to investigate the provision of flood defences for the town. Defences now exist in Frankwell and Coleham (with further flood defence works planned for Coleham in the near future). As with other parts of Shropshire, surface water flooding has been identified as an issue, particularly within Shreswbury town itself.

6.3.1 Sustainable Urban Extensions

The assessment of flood risk in Shrewsbury has focused primarily on the two urban extensions (Shrewsbury South and Shrewsbury West). A detailed assessment of the proposed strategic locations has been undertaken, taking into consideration flood risk from all sources and outlining the overriding constraints to development. Table 6-1 below summarises the key findings.

Site name	Total site area (ha)	Total housing allocation	Total employment land (ha)	Total developable area (ha)	Combined FZ2 and 3 Area (ha)	Percentage of development site in Flood Zone 2 & 3	Is there sufficient land at low flood risk (Flood Zone 1) for development to occur?
Shrewsbury South	94.95	1070	40	66.75	3.8	4.0%	Y
Shrewsbury West	88.49	700	12	29.5	0.002	0.002%	Y

Table 6-1 Summary of flood risk for urban extensions in Shrewsbury

For the urban extension at Shrewsbury South, few constraints to development have been identified. Only 4% of the total area is affected by the combined Flood Zones 2 and 3. The main fluvial flood risk from the Money Brook, affecting the south western part of the site. Whilst the fluvial flood risk is considered low, the Level 2 SFRA for Shrewsbury indicated that the Flood Zone maps in this area require refinement. A detailed FRA will therefore be required prior to development in the vicinity of this watercourse, to verify the extents and levels of Flood Zones 2, 3a, 3b and 3a plus climate change. It is also apparent that there may be a residual risk to parts of the site from blockage of the railway culvert. This should also be assessed within a site-specific FRA. It is recommended that resultant flood risk areas are left as open space and the site should be developed sequentially, with the most vulnerable aspects of development located in low risk areas.

The Environment Agency has indicated that surface water is a known issue within the Money Brook catchment. Any increase in run-off into the Money Brook is likely to impact on the Rea Brook in Shrewsbury, which currently has capacity problems. Provided guidance within PPS25 is followed, and surface water is managed appropriately, the risk of flooding in downstream catchments should not present a problem or constraint to future development in this area.

As with the Shrewsbury South extension area, there are few constraints to development within the Shrewsbury West site from fluvial sources. The assessment has indicated that less than 1% of the site is shown to be affected by the combined Flood Zones 2 and 3. The part of the site affected is the land at Oak Farm (Gains Park) where the Rad Brook and an unnamed watercourse flow through area. Whilst the fluvial flood risk is limited to this area, the Shrewsbury Level 2 SFRA indicated that the Flood Zones for this watercourse require verification prior to any development in this area. As such, a site-specific FRA will be required to verify the extents and levels of flooding for Flood zones 2, 3a, 3a plus climate change and 3b. It is recommended that the resultant flood risk areas are left as open space which should be achievable given the overall availability of land within the urban extension.

Taking into account the extent of fluvial flood risk, requirements for open space and storage of runoff from the site, there should be sufficient developable land for the proposed number of dwellings within the Shrewsbury West allocation.

For both of the sites, it must be ensured that any proposed development does not increase flood risk elsewhere. The Severn CFMP highlights that the use of SUDS and land management techniques should allow the housing growth to take place without any increase in flooding as a direct result of development. Further details of appropriate SUDS and surface water management are outlined within chapters 7 and 8.

It is recommended that an integrated surface water management strategy is undertaken for the urban extensions. Instances of surface water flooding and flooding from artificial drainage have been identified as a problem, particularly at times of heavy and prolonged rainfall. Future development proposed in locations known to be at risk from surface water flooding is avoided and appropriate surface water management plans should be developed to ensure that flood risk is not increased within the site or to locations downstream.

6.3.2 SHLAA Sites

Other development within Shrewsbury could come from SHLAA sites. For the remainder of the proposed growth within Shrewsbury, a high level review of accepted SHLAA sites has been undertaken. This has taken into consideration the risk of fluvial flooding, considered the information within the Level 1 SFRA and Severn CFMP to establish whether there is a risk of flooding from other sources

Of the 39 sites assessed, 13 have been identified as at risk from flooding, with the predominant constraint to development being fluvial flood risk from the River Severn, Rea Brook and Bagley Brook.

Many potential development locations are in otherwise sustainable locations, but are shown to be at risk of flooding posed by the River Severn and the Rea Brook in the Abbey Foregate area). A number of the proposed SHLAA sites are shown to be located within the Environment Agency's Flood Zones 2 and 3. Modelling work undertaken as part of the Shrewsbury Level 2 SFRA has however indicated that a number of sites shown to be affected by the Environment Agency's Flood Zone map are at a lower risk from fluvial flooding. Land off Underdale Road, Barker Street/ St Austins Street, Ditherington Flax Mill, New Park Road/ St Micheals Street and Salop Music Centre, St Michaels Street, have been shown to be located within Flood Zone 1, and should ideally be developed in preference to sites shown to be affected by Flood Zones 2 and 3.

However, for sites, Chronicle House - 6 Castle Foregate, Ellesmere Road (East), Wyle Cop, land at Silkmoor, New Zealand House, Abbey Foregate, land at Ellesmere Road and land at Old Coleham there is likely to be some constraint to development, with part of the site shown to be affected by the combined Flood Zone 2 and 3. Whilst for most of these sites, the fluvial flood risk is to a lesser extent than that shown by the Environment Agency's Flood Zone maps, there is still some risk. For any development in this area, the Shrewsbury Level 2 modelled flood outlines should be considered to determine the extent of flooding and determine that future development will be 'safe.' Application of the Sequential Test will be required to all of the sites located within Flood Zones 2 and 3, to ensure development is located towards the areas of lowest risk in the first instance. This should take into consideration flooding from all sources. Prior to allocating any of the above sites for development, the LPA should also consider whether the sites are likely to pass the Exception Test. Both the LPA Land Drainage team and the Environment Agency should be consulted as part of this process.

In the autumn of 2000, the worst flooding for over 50 years caused widespread damage along the length of the River Severn. Shrewsbury was badly affected and the town was extensively flooded three times in the space of six weeks. As a result, the Environment Agency accelerated a feasibility study to investigate the provision of flood defences for the town. Defences now exist in Frankwell and Coleham (with further flood defence works planned for Coleham in the near future). Whilst the majority of the SHLAA sites are not located behind these defences, the land at Silkmoor is located behind the defence at Frankwell. It is recommended that the findings of the Shrewsbury L2 SFRA are used to inform any proposed development within this site, to ensure that development is located in the areas at lowest risk from flooding and from any potential breach or overtopping of the defence. It is also recommended that for any further site allocations that may come forward in Shrewsbury, the Level 2 SFRA is consulted, particularly for sites located behind defences. The findings of the Level 1 SFRA have indicated that incidents of surface water flooding have been recorded within some of the SHLAA sites (Shrewsbury Training and Development Centre and land off

Underdale Road). Surface water flooding may therefore be a constraint within Shrewsbury. The management of surface water within Shrewsbury as a whole is therefore important and should be considered for all sites as part of a detailed FRA.

6.4 Oswestry

Oswestry lies towards the north of the county, predominantly within the Severn catchment. The main risk of fluvial flooding is from the River Severn, however, this has affected mainly agricultural land. Historic flood records indicate that flooding has also occurred along the River Vyrnwy at Llanmyneach and Pontrobert. As with other parts of the county, surface water flooding has been an issue in Oswestry, particularly at times of heavy and prolonged rainfall, with land in both Oswestry town and more rural areas affected.

6.4.1 Sustainable urban extensions

The assessment of flood risk in Oswestry has focused primarily on the sustainable urban extension area at Oswestry south east. A detailed assessment has been undertaken, taking into consideration flood risk from all sources and outlining the overriding constraints to development. Table 6-2 below summarises the key findings.

Site name	Total site area (ha)	Total housing allocation	Total employment land (ha)	Total developable area (ha)	Combined FZ2 and 3 Area (ha)	Percentage of development site in Flood Zone 2 & 3	Is there sufficient land at low flood risk (Flood Zone 1) for development to occur?
Oswestry East	32.59	750	6	24.75	0.0	0.0%	Y

Table 6-2 Summary of flood risk for urban extension in Oswestry

For Oswestry East, few major constraints to development from flood risk have been identified. The site is not shown to be affected by fluvial flooding and lies fully in Flood Zone 1. It should however be noted that the nearest watercourse (Oswestry Brook) is approximately 0.5km to the west. Whilst the existing Environment Agency Flood Zone Maps do not demonstrate a flood risk within the site itself, consultation with the Environment Agency has indicated that the Oswestry Brook runs adjacent to the site, and therefore there is likely to be a risk of flooding from run-off from existing development draining into the Brook. A site-specific FRA should therefore be undertaken to determine the extent of flooding from the Oswestry Brook and any potential impacts future development may have on flood risk downstream. Consultation of the Level 1 SFRA indicates that there are no observed incidents of flooding from other sources; however, local knowledge has indicated that surface water flooding is an issue, particularly within the town itself.

Taking into account all of the constraints to development, the assessment has indicated that there is sufficient developable land for the proposed number of dwellings provided that a site-specific FRA can demonstrate future development will not increase flood risk elsewhere.

6.4.2 SHLAA Sites

Other development within Oswestry could come from SHLAA sites. For the remainder of the proposed growth within Oswestry, a high level review of accepted SHLAA sites has been undertaken. This has taken into consideration the risk of fluvial flooding, considered the information within the Level 1 SFRA and Severn CFMP to establish whether there is a risk of flooding from other sources and has also included an assessment of the suitability of SUDS based on the Environment Agency's groundwater vulnerability maps and source protection zones.

Of the sites assessed, there were no major constraints to development from fluvial flood risk. All of the sites were located within Flood Zone 1, with the average distance to the nearest watercourse being 1 –1.5km. The assessment did not uncover any recorded incidents of flood risk from other sources within Oswestry. This does not however mean that there is no risk. In particular, it has been noted that surface water flooding has been an issue, particularly within the town itself. As a number of the SHLAA sites are on existing brownfield sites, the sustainable management of surface water is therefore important through the use of SUDS. This is discussed in more detail in Chapter 10. In line with the recommendations in the Severn CFMP, there are opportunities to implement SUDS within sites as is the promotion of PPS25, which will help to reduce risk to any new and existing development within the vicinity of the proposed sites.

6.5 Ironbridge power station

In addition to the proposed housing and employment development, Shropshire Policy Directions document explores options for the redevelopment of the Ironbridge Power Station site, which adjoins the Telford and Wrekin Local Authority Boundary. This power station is expected to come to the end of its life by 2016 and the future use of the 122ha site raises strategic issues for both Shropshire Council and Telford and Wrekin Council.

A preliminary assessment of the Ironbridge site has been undertaken, taking into consideration flood risk from all sources and outlining the overriding constraints to development.

The assessment has indicated that the main constraint to development to this site will be from fluvial flood risk. The River Severn is located along the northern boundary of the site and flows in an easterly direction. A further unnamed minor watercourse is located to the west of the site and forms a tributary of the River Severn.

The existing Flood Zone maps indicate that approximately 20% of the site is located within the combined Flood Zones 2 and 3, with the predominant risk of flooding from the River Severn towards the northern extent of the site. In addition, there is a risk of fluvial flooding through the western extent of the site from the unnamed minor watercourse. It should be noted that the Flood Zone maps for this watercourse are currently misaligned in places, and therefore, prior to any development, detailed modelling should be undertaken to verify the extent and depth of flooding to the site from Flood Zones 2, 3a, 3b and the future climate change scenario.

A review of the Level 1 SFRA has indicated that there are no observed incidents of flooding from other sources within the site itself. There is however one observed incident of flooding from surface water to the north of the site by Buildwas. This indicates that surface water flooding may be an issue in this area. As such, this may present some constraint to future development and surface water management through the use of SUDS should be investigated as part of a FRA. This is discussed in more detail in Chapter 10. In line with the recommendations in the Severn CFMP, there are opportunities to implement SUDS within the site as is the promotion of PPS25, which will help to reduce risk to any new and existing development within the vicinity of the proposed sites.

6.5.1 Recommendations for future work & policies for future development

Based on the findings of the detailed assessment, it is recommended that a site-specific detailed FRA is undertaken prior to development of the site. The key recommendations for the Ironbridge site are outlined below.

- The FRA should undertake detailed modelling to determine the extent and depth of flooding for Flood Zones 2, 3a, 3b and the future climate change scenario from the unnamed watercourse to the west of the site. The results of this modelling work should be used in combination with those from the existing River Severn model to determine the overall flood risk and flood hazard to the site.
- It is also evident that there may be a residual risk to the site from the blockage of culverted sections of watercourse. It is recommended that as part of a detailed FRA for the site, further modelling is undertaken to establish the residual risk to the site. A small 1D-2D model of the site could be developed to allow the creation of depth, velocity and hazard maps for the site. This will enable the Council to inform the application of the Sequential Test and Sequential Approach.
- For any culverted sections of watercourse, options for de-culverting should be explored wherever possible. In the event that this is not possible, an assessment of the structural integrity of the culverts should be carried out prior to any development in the vicinity. Any remedial works to ensure the culverts' longevity (commensurate with the lifetime of the development) should be carried out. Developer contributions

should be sought for this purpose. In addition, the Council should develop a culvert maintenance schedule, to periodically clear culverts of debris, which will reduce the risk of blockage during flood events.

- The detailed FRA must ensure that the development will not increase flood risk for the site itself, or for areas downstream (e.g. Ironbridge). This is particularly important for this site as the Level 1 SFRA for Telford and Wrekin has indicated that there are a number of surface water and drainage system problems within the Local Authority area. It must therefore be ensured that the overall risk of flooding to Ironbridge is not increased by any development at the Power Station Site. There may be opportunities for Shropshire Council to work in conjunction with Telford and Wrekin to develop a surface water management strategy for the area.
- The detailed FRA should demonstrate that runoff from the site is reduced, thereby reducing surface water flood risk. This will involve the use of SUDS techniques which should take into account the local geological and groundwater conditions. For all sites, the post development runoff volumes and peak flow rates should be attenuated (1 in 100 year + climate change) to the Greenfield (pre-development) condition with a minimum reduction of 20%, and mimic the surface water flows arising from the site prior to the proposed development.
- The detailed FRA should ensure that all new development is 'safe,' meaning that dry pedestrian access to and from the development is possible without passing through the 1 in 100 year plus climate change floodplain, and emergency vehicular access is possible.
- There should be no inappropriate development located within the floodplain using the methods outlined in PPS25. The Council should adopt the principle of avoidance by ensuring, where possible, that areas of a site affected by Flood Zones 2, 3a, 3a plus climate change and 3b remain as open space. The avoidance of flood risk is important in the development of sustainable communities and will deliver a positive reduction in flood risk by reducing the impact that flooding may have on the community (by reducing the number of people within the site that would otherwise be at risk) and reducing flood risk elsewhere. It can also help the Council to achieve green space targets.
- The Council should also adopt a policy of managed retreat, particularly if and future flood hazard mapping indicates a high hazard within the flood risk areas. The existing Flood Zone maps indicate that the northern and western parts of the site are located within Flood Zones 2 and 3; however, the southern part of the site is located within Flood Zone 1. Development should therefore be located in the lower risk parts of the site; with those at high risk kept as open space.
- Developments should seek to reduce the overall level of flood risk in the area and beyond through the layout and form of the development.

6.6 Market towns, key centres and local centres

The Council's Core Strategy Policy Directions document indicates that after the Urban extensions in Shrewsbury and Oswestry, development will then be focused on the 26 market towns, key centres and local centres, which provide sustainable locations for development. A more strategic approach to the assessment has been undertaken for these areas, focusing on the key constraints and opportunities to development in relation to fluvial flood risk to help identify preferred settlements for development on the basis of flood risk and surface water management. A high level review of the Environment Agency's Flood Zone maps has been undertaken in relation to each settlement and its surrounding area to identify any major constraints to development. The assessment of flood risk in the Borough is summarised below, by a red, amber, green assessment which identifies where fluvial flood risk may provide more of a constraint in settlements. The criteria for the assessment are shown in Table 6-3.

Flood risk drop down menu	Description
RED	Concerns that there is not sufficient land at low flood risk to accommodate development
AMBER	Flood risk may be a constraint in some parts of the settlements (either within the existing settlement, or on potentially developable land)
GREEN	Flood risk not considered to be a constraint

Table 6-3 Criteria for assessment of flood risk – Shropshire

It should be noted that the assessment has focussed predominantly on risk from fluvial flooding. In some instances, whilst the assessment may indicate that fluvial flood risk may not be a barrier to development, it should be ensured that there is sufficient land available at lower risk (e.g. in Flood Zone 1). In addition, some site may be only marginally affected by fluvial flooding. In all cases, an FRA will be required to determine the detailed extent and depth of flooding and, assess flood risk from all sources, in order to inform development.

Table 8-3 provides a summary of the constraints from flood risk for the settlements within Shropshire.

Settlement name	Red, amber, green	Comments
Whitchurch	**GREEN**	Fluvial flooding presents a minor risk through the centre of the settlement although only a small percentage of the settlement affected

Settlement name	Red, amber, green	Comments
Market Drayton	**AMBER**	Flood risk may present some constraint to the north (unnamed watercourse) and south (River Tern). Development to East and West less constrained by flood risk. Some recorded incidents of surface water flooding in Level 1 SFRA
Ludlow	**AMBER**	Development significantly constrained by flood risk to north (unnamed watercourse), south and west (River Corve and River Teme). Also some constraints to development to the south east
Bridgnorth	**AMBER**	River Severn flows through the centre of the existing settlement. Some constraint to development to the north from unnamed watercourse
Wem	**AMBER**	Some constraint to development to north. River Roden flows through the southern side of the settlement
Ellesmere	**AMBER**	May be some constraint to development from Tetchill Brook to south and west. No constraints exist to the north of existing settlement
Minsterley/Pontesbury	**RED**	Some flood risk exists through centre of existing settlement and to north of Pontesbury from the Rea Brook. Some risk of surface water flooding with Level 1 SFRA indicating recent development has led to overloading of drains
Bishops Castle	**GREEN**	Settlement fully located in flood zone 1 and no minor/major watercourses identified
Church Stretton	**RED**	Constraints identified to the east from the Cound Brook. Large parts of the valley floor especially to the south of the town are covered by water during the Winter due to surface water flooding. Given that Church Stretton is at the head of two catchments, the Onny and the Cound Brook, the flat lying areas of the valley floor suffer from overland/ surface water flooding problems. Current flood mapping does not identify the full extent of the affected area. Combination of pluvial and fluvial flooding problems exists.
Cleobury Mortimer	**GREEN**	Some constraint to development to the east and south (River Rea) although only small percentage of existing settlement currently at risk
Clun	**GREEN**	No major constraints to development identified. Some fluvial flood risk through centre of existing settlement
Craven Arms	**AMBER**	River Onny presents some constraint to development along eastern boundary. High percentage of existing settlement affected by fluvial flooding (32%)
Highley	**GREEN**	Settlement fully located in flood zone 1 and no minor/major watercourses identified

Settlement name	Red, amber, green	Comments
Much Wenlock	**RED**	Part of the existing settlement at risk from fluvial flooding from Farley Brook. significant flooding from both fluvial and pluvial sources. A number of locations within the settlement and adjacent area of Farley affected during summer 2007 and November 2008 (approx. 64 properties). Flash flooding resulting in runoff from the surrounding area and an inadequate draining system that cannot cope with the volume of water is a particular issue, causing disruption to many parts of the town.
Shifnal	**AMBER**	Settlement affected by Flood Zones 2 and 3. The Wesley Brook flows through the centre of the settlement. Some further constraint to development along eastern boundary from unnamed watercourse
Prees	**GREEN**	Settlement affected by Flood Zones 2 and 3 from the Strine Brook, however, only a small percentage affected. No other constraints to development identified
Shawbury	**GREEN**	Some constraints identified to east from River Roden. Only a small percentage of the settlement affected. Sundorne Brook approximately 1.5km to west of settlement but does not present a major constraint
Woore	**GREEN**	Settlement fully located in flood zone 1 and no minor/major watercourses identified
Baschurch	**GREEN**	Settlement fully located in flood zone 1 and no minor/major watercourses identified
Gobowen	**AMBER**	Parts of the settlement affected by Flood Zones 2 and 3 from the River Perry which also presents constraints to development to the north west and east. An unnamed watercourse presents some constraint to development to the south west and east
St Martins	**GREEN**	Settlement fully located in flood zone 1 and no minor/major watercourses identified. The nearest watercourse is the Morlas Brook approximately 1km to the west, and an unnamed watercourse to the north-east (1.7km from existing settlement)
Whittington	**AMBER**	Some constraint to development to the south east and east from unnamed watercourses. A further unnamed watercourse exists to the north east and flows through the centre of the existing settlement. The flood risk from this watercourse is currently unknown and should be considered as part of a FRA
Bayston Hill	**AMBER**	Settlement located fully in Flood Zone 1. Some constraint to the east from Money Brook. An unnamed watercourse is also located along the western boundary. The risk from this watercourse is unknown and should be verified as part of a FRA
Dorrington	**AMBER**	Settlement affected by Flood Zones 2 and 3 from the Cound Brook
Albrighton	**RED**	Settlement affected by Flood Zones 2 and 3 from the Albrighton Brook. Level 1 SFRA indicates that flooding from both pluvial and fluvial sources is an issue.
Broseley	**AMBER**	Some constraint to development to the north of the settlement from the River Severn. A minor watercourse is located to the south of the settlement

Table 6-4 Summary of flood risk analysis - Shropshire

The flood risk analysis has identified where fluvial flood risk may present some constraint to development within the county. It is not considered that flood risk

will be a barrier to development, because there is sufficient land at low flood risk to allow development to occur outside of flood risk areas.

For ten of the settlements assessed, flood risk is not considered a major constraint to development and therefore, should be considered in the first instance (from the perspective of flood risk). These include Whitchurch, Bishops Castle, Cleobury Mortimer, Clun, Highley, Prees, Shawbury, Woore, Baschurch and St Martins. The majority of these settlements are located fully in Flood Zone 1 or are only marginally affected by fluvial flood risk. It should be noted that for sites that come forward in these areas, an FRA will be required to assess flood risk from other sources; however, the findings of this WCS have not identified any major constraints to development at this stage.

For fourteen of the settlements assessed, some constraints to development were identified. For Bridgnorth, Wem, Ellesmere, Craven Arms, Shifnal and Gobowen, a relatively high percentage of the existing settlements were affected by fluvial flooding, with Flood Zones 2 and 3 extending into the settlements. Table 8-3 above outlines the main constraints to development within or adjacent to these settlements. In some instances, flood risk from other sources was identified as a constraint (Market Drayton, Ludlow, Church Stretton, Gobowen, Bayston Hill and Broseley). In the majority of cases, surface water was identified as a potential constraint to development. This is discussed in more detail in Chapter 9.

Four settlements were identified as having significant constraints to development. These were Minsterley/Pontesbury, Albrighton, Church Stretton and Much Wenlock. For Minsterley/Pontesbury, the Rea Brook presents an existing risk to the central parts of the settlement, affecting just over 7% of the total area. In addition, the Level 1 SFRA has identified potential surface water flooding where it is believed that increased development within the area has caused flooding from overloaded drains. Further development in this area may contribute to the problem and careful management of surface water flood risk will be required (Section 9).

At Albrighton, some constraint to development has been identified from the Albrighton Brook which flows through the centre of the settlement. When this watercourse is in flood, it restricts the ability of the area to drain. In addition, further constraints have been identified from the Neachley Brook which flows from north to west of the settlement and, two unnamed minor watercourses to the north and south of the settlement. In addition, the Level 1 SFRA indicated that historically, Albrighton has suffered from extensive flooding from both pluvial and fluvial sources. It is understood that Severn Trent Water (STW) are undertaking studies of the foul/combined sewer system in the area. Any future development within or adjacent to Albrighton will therefore require a detailed assessment of the overall management of both fluvial and pluvial forms of

flooding and must ensure that flood risk is not increased within the settlement itself or the surrounding area.

Within the Church Stretton area, there is a risk of fluvial flooding from a combination of both fluvial flooding (Cound Brook) and surface water flooding. Consultation with the Environment Agency has indicated that large parts of the valley floor, especially to the south of the town, have been affected by surface water flooding, particularly during Winter months. Church Stretton itself is located at the head of two catchments, the Onny and the Cound Brook. The flat lying areas of the valley floor suffer from overland/ surface water flooding problems. It is evident that current flood mapping within the settlement does not identify the full extent of the affected area. This should be investigated as part of a strategic surface water management plan. Future development within or adjacent to Church Stretton may impact on future flood risk. It is recommended that a detailed assessment of the overall management of both fluvial and pluvial forms of flooding is undertaken to ensure that flood risk is not increased within the settlement itself or the surrounding area.

Much Wenlock has experienced significant flooding from both fluvial and pluvial sources (Section 9). Recently, a number of locations within the settlement and the adjacent area of Farley were affected during both summer 2007 and November 2008. Shropshire Council has undertaken a detailed review into the sources and mechanisms of flooding within and adjacent to the settlement (Much Wenlock Flood Investigation, September 2009). Anecdotal evidence from the Environment Agency has indicated that there is a significant risk of surface water flooding in Much Wenlock, with approximately 64 properties reported as being affected within Much Wenlock and Farley in June 2007 (Bridgnorth Journal). In particular, flash flooding resulting in runoff from the surrounding area and an inadequate draining system that cannot cope with the volume of water is a particular issue, causing disruption to many parts of the town. There are also issues of capacity with the drainage infrastructure. It is strongly recommended that a detailed assessment of flood risk within Much Wenlock and Farley is undertaken through a SWMP, to ensure the interactions between the different sources of flooding are fully understood and that flood risk is appropriately managed in the future.

6.7 Windfall development

For the purposes of development management, detailed policies will need to be set out to ensure that flood risk is taken account of appropriately for both allocated and non-allocated 'windfall' sites. The following reflects the minimum requirements under PPS25 (reference should be made to Tables D.1-D.3 in PPS25).

6.7.1 Future Development within Flood Zone 1

In this zone, developers and local authorities should realise opportunities to reduce the overall level of flood risk in the area and beyond through the layout and form of the development. There is no significant flood risk constraint placed upon future developments within the Low Probability Flood Zone 1, although for sites larger than one hectare, the vulnerability from other sources of flooding should be considered as well as the effect of the new development on surface water runoff.

Where watercourses are located within the site, the proposed development should be set-back from the watercourse with a minimum 8m wide undeveloped buffer zone, to allow appropriate access for routine maintenance and emergency clearance. This is an Environment Agency requirement for Main Rivers. For sites adjacent to 'Ordinary Watercourses,' under the jurisdiction of the Local Authority, a similar buffer strip of 8m would be required and should be determined in conjunction with the Local Authority Land Drainage Officer.

Typically, a Drainage Impact Assessment will be required to demonstrate that runoff from the site is reduced, thereby reducing surface water flood risk. This will involve the use of SUDS techniques which should take into account the local geological and groundwater conditions. For all sites, the post development runoff volumes and peak flow rates should be attenuated to the Greenfield discharge rates with a minimum reduction of 20%, as required by the Environment Agency.

6.7.2 Future Development within Flood Zone 2

Land use within Medium Probability Flood Zone 2 should be restricted to the 'water compatible', 'less vulnerable' and 'more vulnerable' category, with preference given to the lowest flood risk / vulnerability uses. Where other planning pressures dictate that 'highly vulnerable' land uses should proceed, it will be necessary to ensure that the requirements of the Exception Test are satisfied. The following should be considered:

- A detailed site-specific FRA should be prepared in accordance with PPS25 and Council planning policies.
- Floor levels should be situated above the 1000 year predicted maximum level plus a minimum freeboard of 600mm.
- The development should be safe, meaning that dry pedestrian access to and from the development should be possible above the 1 in 1000 year flood level and emergency vehicular access should be possible during times of flood.
- SUDS should be implemented to ensure that runoff from the site (post development) is reduced. For all sites, the post development runoff volumes and peak flow rates should be attenuated to the Greenfield discharge rates with a minimum reduction of 20%, as required by the

Environment Agency, for both Greenfield and Brownfield sites. Space should be set-aside for SUDS.

- The proposed development should be set-back from the watercourse with a minimum 8m wide undeveloped buffer zone, to allow appropriate access for routine maintenance and emergency clearance. This is an Environment Agency requirement for Main Rivers. For sites adjacent to 'Ordinary Watercourses,' under the jurisdiction of the Local Authority, a similar buffer strip of 8m would be required and should be determined in conjunction with the Local Authority Land Drainage Officer.

6.7.3 Future development within High Probability Flood Zone 3a

Land-use with High Probability Flood Zone 3a should be restricted to the water compatible or 'less vulnerable' uses to satisfy the requirements of the Sequential Test. For 'more vulnerable' uses it is necessary to ensure that the requirements of the Exception Test are satisfied. The following should be considered:

- A detailed site-specific FRA should be prepared in accordance with PPS25 and Council planning policies. Properties situated within close proximity to formal defences or water retaining structures (reservoirs/canals) will require a detailed breach and overtopping assessment to ensure that the potential risk to life can be safely managed throughout the lifetime of the development. The nature of any breach failure analysis should be agreed with the Environment Agency.
- The development should not increase flood risk elsewhere, and opportunities should be taken to decrease overall flood risk (such as use of SUDS and de-culverting). This can be achieved by developing land sequentially, with areas at risk of flooding favoured for green space.
- Floor levels should be situated above the 1000 year predicted maximum level plus a minimum freeboard of 600mm. Within defended areas the maximum water level should be assessed from a breach analysis.
- The development should allow dry pedestrian access to and from the development above the 1 in 1000 year flood level and emergency vehicular access should be possible during times of flood. A flood management plan should be prepared where evacuation and rescue during a flood event is an issue, and managing flood risk is a factor. Those proposing developments should take advice from Shropshire Council's Emergency Planning Officer when producing a flood management plan as part of a FRA, in consultation with the Environment Agency. Reference should be made to Section 7.25 to 7.33 of the PPS25 Practice Guide (December 2009).
- Basements should not be used for habitable purposes. Where basements are permitted for commercial use, it is necessary to ensure that the basement access points are situated 600 mm above the 1 in 1000 year flood level.

- SUDS should be implemented to ensure that runoff from the site (post development) is reduced. For all sites, the post development runoff volumes and peak flow rates should be attenuated to the Greenfield discharge rates with a minimum reduction of 20%, as required by the Environment Agency, for both Greenfield and Brownfield sites. Space should be set aside for SUDS.
- The proposed development should be set-back from the watercourse with a minimum 8m wide undeveloped buffer zone, to allow appropriate access for routine maintenance and emergency clearance. This is an Environment Agency requirement for Main Rivers. For sites adjacent to 'Ordinary Watercourses,' under the jurisdiction of the Local Authority, a similar buffer strip of 8m would be required and should be determined in conjunction with the Local Authority Land Drainage Officer.

6.7.4 Future development within Functional Floodplain Zone 3b

Prior to development within Flood Zone 3, the LPA must demonstrate that the Sequential Test has been applied and that there are no reasonably available sites in areas with a lower probability of flooding that would be appropriate to the type of development or land use proposed. A sequential approach should be used in areas known to be at risk of flooding from other sources.

Within Flood Zone 3b, development should be restricted to 'water-compatible uses' and 'essential infrastructure' that has to be there. Table D2 from PPS 25 (reproduced in Section 1.5.1 of this report) outlines the types of development included within this classification. It should be noted that 'essential infrastructure' includes essential transport infrastructure (including mass evacuation routes) which may have to cross the area at risk as well as strategic utility infrastructure such as electricity generating power station and grid and primary substations. Reference should be made to Table D2 of PPS 25 when considering development within Flood Zone 3b to ensure only appropriate development is considered. 'Essential infrastructure' in this zone must pass the Exception Test and be designed and constructed to remain operational in times of flood and not impede water flow.

6.8 Conclusions and recommendations

6.8.1 Shropshire-wide recommendations

Flood risk management is an important consideration within Shropshire. Within Shropshire the main rivers include the River Severn and its tributaries (River Vyrnwy, River Perry, Rad Brook, Rea Brook, River Tern and River Teme).

Parts of some development sites and existing settlements are situated within existing Flood Zones 2 and 3 (as defined by the Environment Agency) and are therefore already at risk from fluvial flooding. In addition, there are a number of

locations at risk of flooding from other sources. Key recommendations that apply throughout the sub-region are outlined below.

It is recommended that LDFs include policies to prevent inappropriate development within the floodplain using the methods outlined in PPS25. Any new development should be located in the areas of lowest flood risk and must not increase risk to existing development and areas identified as functional floodplain should be protected from development. Where parts of development sites are proposed within Flood Zones 2 and 3, developers should undertake a site-specific Flood Risk Assessment (FRA) to establish the extent of Flood Zones 2, 3a and 3b, and the future risk of climate change. Further modelling may be required to establish these risk areas. Land use within these sectors should be allocated according to the appropriate use as outlined in PPS25, taking into consideration the vulnerability of the development, with preference given to the lowest flood risk / vulnerability uses.

For a number of locations within the county, instances of surface water flooding from artificial drainage and surface water have also been identified as a problem, particularly at times of heavy and prolonged rainfall. It is therefore recommended that future development proposed in locations known to be at risk from surface water flooding is avoided. Appropriate surface water management plans should be developed to ensure that flood risk is not increased within the site or to locations downstream.

It must be ensured that all new development is 'safe,' meaning that dry pedestrian access to and from the development is possible without passing through the 1 in 1000 year plus climate change floodplain, and emergency vehicular access is possible. For major and vulnerable development, an evacuation plan for the 1 in 1000 year event should be prepared in conjunction with the Local Authority emergency planning officer.

A number of flood defences are located within the WCS area which provide benefit to a number of residential and commercial properties. These are predominantly located in the Frankwell area of Shrewsbury and parts of the Severn-Vyrnwy confluence. The defences at Frankwell were designed to a 100-year return period standard and rely on a system of demountable barriers that tie into permanent defence structures. Future development within existing urban areas may be required behind these defences. A Level 2 SFRA has been undertaken for Shrewsbury to determine the residual risk to areas behind the existing defences. This information should be considered for all development proposed behind the existing defences.

The Level 1 SFRA identified further defences within Shropshire, namely those on the River Severn. Demountable defences, with permanent civil engineering works, have recently been used to protect areas in Shrewsbury and Ironbridge.

Both temporary and demountable defences are not considered permanent and PPS 25 differentiates between temporary and demountable defences as the latter is associated with a particularly high risk of failure (as they may not be deployed rapidly enough). Any development behind such defences will therefore require an FRA to determine the risk to the site.

Low lying agricultural land at the confluence of the Severn and the Vyrnwy is frequently flooded and a series of low earth embankments, known locally as argaes, have been constructed to provide some protection. These banks prevent flooding at low return periods, typically protecting properties and agricultural land up to the events with between 10 and 20% chance of occurrence. A series of outfall structures release water back to the Severn and the Vyrnwy once river water levels have decreased but the argaes can prolong localised flooding by retaining floodwater trapped behind them after an event has passed. Previous studies have shown that the argae system provides significant protection to downstream communities, such as Shrewsbury, by storing substantial volumes of floodwater and releasing it back to the Severn after the event. As such, these areas should be protected from future development to ensure that the risk of flooding is not increased downstream.

For proposed sites outside of the existing Level 2 SFRA, where development is proposed behind defences, a site-specific FRA will be required to assess the residual risk to the site from breach or overtopping and to properly inform new development in the area. In some instances, development behind defences may not be considered appropriate and / or safe. For example, inundation of potential development sites in defended areas may pose significant problems and a greater risk than undefended sites located in Flood Zone 3. Windfall sites that come forward for development should be subject to the Sequential Test. For any new development, it is preferable for flood risk to be managed in the first instance through the selection of safe locations through appropriate land use planning and the application of the Sequential Test.

In line with the recommendations outlined in the Severn CFMP, defences must be properly maintained to ensure the required protection is provided in the future. Account must be taken of storage areas within the sub-region, with support given to flood alleviation measures under consideration by the Environment Agency by safeguarding possible sites for flood storage and other channel works. Opportunities should be identified for setting back defences which will increase localised storage and could in turn allow for the creation of a more natural channel.

It may be possible to cluster potential development areas together to consider strategic flood risk management activities that would provide a strategic benefit and bring benefit to the wider community.

6.8.2 Shrewsbury

Flood risk is relatively high for existing properties in Shrewsbury that are based close to the River Severn and its tributaries. Existing studies have indicated that important flood flow routes and high-hazard informal flood storage areas have been identified through Shrewsbury. These areas must be safeguarded from future development, and maintained and operated as such (by the Council). Whilst a high level of development has been proposed for Shrewsbury, despite the existing risk, as long as development is suitably located within the area, through the application of the Sequential Test, flood risk should not be increased by development.

The two proposed urban extensions are not in areas of high flood risk. Some parts of the extension area may be affected by flood risk, and these should be confirmed through site-specific FRA's. There is sufficient land at low flood risk to ensure that development is steered away from areas at higher risk.

The Shrewsbury Level 2 SFRA has indicated that there is a residual risk of breach or overtopping to development proposed behind the flood defences through the town. Therefore, prior to any development of areas behind defences, the Sequential and Exception Tests must be undertaken in the first instance in accordance with Table D3 of PPS25. In some instances, development behind these defences may be required in order to meet the wider aims of sustainable development. Where the need to apply the Exception Test is identified, the results of the Shrewsbury Level 2 SFRA must be utilised. Where the relevant tests are passed, development should be set back from the defence and the identified 'significant' and 'extreme' hazard areas avoided; with development steered towards the identified low and moderate hazard areas, where flood resistance and resilience measures can sufficiently mitigate the risk. A site-specific FRA should be undertaken to ensure the development is safe and appropriate mitigation measures are in place to reduce the risk of flooding. Where the provision of flood risk management (including defence and mitigation works) may be required, developer contributions may be sought towards the proportionate increase towards flood warning provision and/or maintenance and operational costs. This is one aspect that could be identified within a SPD for planning contributions.

In some instances, development behind defences may not be considered appropriate and / or safe. Inundation of potential development sites in defended areas may pose significant problems and greater risk than the undefended Flood Zone 3 sites. For Windfall sites that come forward for development, the Sequential Test should be undertaken to determine whether there are sites available which are located in lower risk areas. For any new development, it is preferable for flood risk to be managed through the selection of safe locations in the first instance through land use planning and the application of the Sequential Test.

The River Severn CFMP policy unit for this area is to 'take further actions to sustain the current level of risk into the future (responding to the potential increase in risk from urban development, land-use change and climate change). However, developer contributions may still be sought to increase the level of the defences to mitigate the effects of climate change on flood risk in the area. Finally, the cumulative impact of loss of storage at the allocation site on flood risk elsewhere within the flood cell must be assessed, and suitable methods employed to ensure no loss of storage (this may have to be facilitated by vacant ground floors).

Many urban areas in Shrewsbury also experience problems from surface water flooding. The sustainable management of surface water is therefore important through the used of SUDS. This is discussed in more detail in Chapter 10. In line with the recommendations in the Severn CFMP, there are opportunities to implement SUDS within both urban extension areas, as promoted in PPS25, which will help to reduce risk to any new and existing development within the vicinity of the urban extension area.

6.8.3 Oswestry

Fluvial flood risk is relatively low in Oswestry, with no Main Rivers being located within the town itself. The greatest constraint to development will be from the River Morda to the south of the town.

The Oswestry Brook, located towards the south eastern extent may also present some constraint to development. Current Flood Zone maps do not exist for this watercourse however and therefore, prior to any development adjacent to this watercourse, an FRA will be required to establish the extent of Flood Zones 2, 3a and 3b, and the future risk of climate change. Further modelling may be required to establish these risk areas. Land use within these sectors should be allocated according to the appropriate use as outlined in PPS25.

As with other parts of Shropshire, Oswestry is known to experience problems from surface water flooding. Whilst no recorded incidents were identified within the Level 1 SFRA, the sustainable management of surface water is important through the use of SUDS. This is discussed in more detail in Chapter 10. In line with the recommendations in the Severn CFMP, there are opportunities to implement SUDS within the sustainable urban extension area, as promoted by PPS25, which will help to reduce risk to any new development within the vicinity of the proposed development.

Overall, however, it is not considered that flood risk will be a barrier to development within Oswestry, because there is sufficient land at low flood risk to allow development to occur outside of flood risk areas.


Halcrow

7 Surface water management & mapping

7.1 Introduction

The purpose of this chapter in the report is to provide a regional context for surface water management and mapping. A key requirement of the Shropshire WCS is to identify locations at a greater risk of surface water flooding in order to inform the development of a surface water policy for the county.

Surface water mapping is in its infancy in comparison to fluvial flood risk mapping. As such, surface water flood maps of Shropshire do not currently exist. Whilst the Level 1 SFRAs for the Districts and Boroughs of Shropshire identified recorded incidents of surface water flooding within Shropshire, no detailed mapping was undertaken. This WCS has therefore built upon the work undertaken within the Level 1 SFRA to produce a series of surface water risk maps for Shropshire to help inform the Council's development of a sustainable surface water policy for the county, and help identify areas where a more detailed assessment of surface water flood risk may be required. The following sections outline the methodology undertaken and the key findings.

7.2 Background

Surface water maps do not currently exist for Shropshire at a detailed level. Following the summer 2007 floods, one of the key recommendations of the Pitt Review was that the Environment Agency, supported by Local Authorities and water companies, should identify areas that are at highest risk from surface water flooding. As part of this process, a series of broad scale maps were produced identifying areas susceptible to surface water flooding (ASTSWF) as a preliminary national output. The main objective of these maps was to provide Local Resilience Forums (LRFs) with an initial indication of areas that may be susceptible to surface water flooding with the purpose that they may be used in combination with local knowledge to plan their emergency response to surface water flooding.

The initial phase of surface water mapping undertaken by the Environment Agency utilised a simplified method that excludes urban sewerage and drainage systems, excludes buildings, and uses a single rainfall event. The maps therefore only provide a general indication of areas which may be more likely to suffer from surface water flooding. Due to the coarse nature of the maps, it is not possible to reproduce them directly for release to the public. As such, they cannot be used as a form of surface water mapping in their own right. The maps have therefore been used in conjunction with the information contained within the Level 1 SFRA, as a tool to help assist in the identification of areas that may be susceptible to surface water flooding within Shropshire. Section 9.3 outlines the methodology

undertaken to produce maps identifying areas that may be at risk from surface water flooding in Shropshire.

7.3 Overview of Methodology

7.3.1 County wide mapping

Mapping has been carried out across the county to identify locations at risk from surface water flooding. The mapping has built upon the work undertaken as part of the Level 1 SFRA, identifying locations that may be susceptible to surface water flooding. The methodology undertaken is outlined below.

Existing GIS information has been utilised to map settlements within the county that may be susceptible to surface water flooding. The following information has been used:

- Environment Agency ASTSWF maps
- Anecdotal evidence obtained during the Shropshire Level 1 SFRAs and the Shrewsbury Level 2 SFRA
- River Severn CFMP
- Severn Trent Water DG5 Data (obtained during the Level 1 SFRA).

An initial assessment was undertaken of the key settlements identified for future growth within Shropshire. These settlements include sub-regional centres, large market towns, market towns and key centres and local centres. Appendix C outlines the key settlements assessed.

For each settlement the percentage area affected by the Environment Agency's ASTSWF was calculated and a classification as to the level of risk was made according to the percentage of affected area. It should be noted that the Environment Agency's surface water maps are split into three bandings, indicating 'Less' to 'More' susceptible to surface water flooding. The 'More' band is useful to help identify areas which have a natural vulnerability to flood first, flood deepest and / or flood for more frequent, less severe events (when compared to other bands). For this WCS assessment, the 'More' and 'Intermediate' bandings have been utilised to determine which areas may be at greatest risk of surface water flooding. The settlements were categorised into 'High', 'medium' or 'low' susceptibility based on the percentage area of the ASTSWF within the settlement. Table 7-1outlines the bandings adopted.

Susceptibility to surface water flooding	Percentage of settlement affected by the combined 'More' & 'Intermediate' ASTSWF maps
High	>15
Medium	5-15
Low	<5.0

Table 7-1 Categorisation of susceptibility to surface water flooding for Settlements within Shropshire

A further assessment was then undertaken utilising the information contained within the Level 1 SFRA and the River Severn CFMP. Available anecdotal evidence was reviewed to determine whether there were recorded incidents of surface water flooding within the key settlements. Table 7-2 below outlines the categorisation of susceptibility to surface water flood risk based on the existing information. Where there was evidence of surface water flood risk from a number of sources (e.g. Level 1 SFRA, DG5 data, CFMP); the susceptibility to surface water flooding was classified as high. Where there was evidence of surface water flood risk but this was limited to only one source of information or the records indicated the risk was restricted to an individual location, the susceptibility to surface water flooding was classified as medium. For settlements within the county where there were no recorded incidents of surface water flooding, the susceptibility to surface water flooding was classified as low.

Flood risk drop down menu	Description
HIGH	Level 1 SFRA and anecdotal evidence indicate a high susceptibility to surface water flooding. Multiple recorded incidents or records from numerous sources (e.g. Level 1 SFRA, STW DG5 register, CFMP)
MEDIUM	Level 1 SFRA and anecdotal evidence indicate some recorded incidents of surface water flooding
LOW	Surface water flood risk is not considered to be a significant constraint to development

Table 7-2 Categorisation of susceptibility of settlements to surface water flooding based on the assessment of the Level 1 SFRA, DG5 and Severn CFMP data

An overall assessment of surface water flood risk was then undertaken, taking into consideration all of the available sources of information. The findings of this assessment are outlined in Appendix F and outline the overall susceptibility and the justification for the selected classification.

7.4 Assessment of surface water flooding

Figure 7-1 demonstrates the defined settlements that may be susceptible to surface water flood risk, based on the overall assessment.

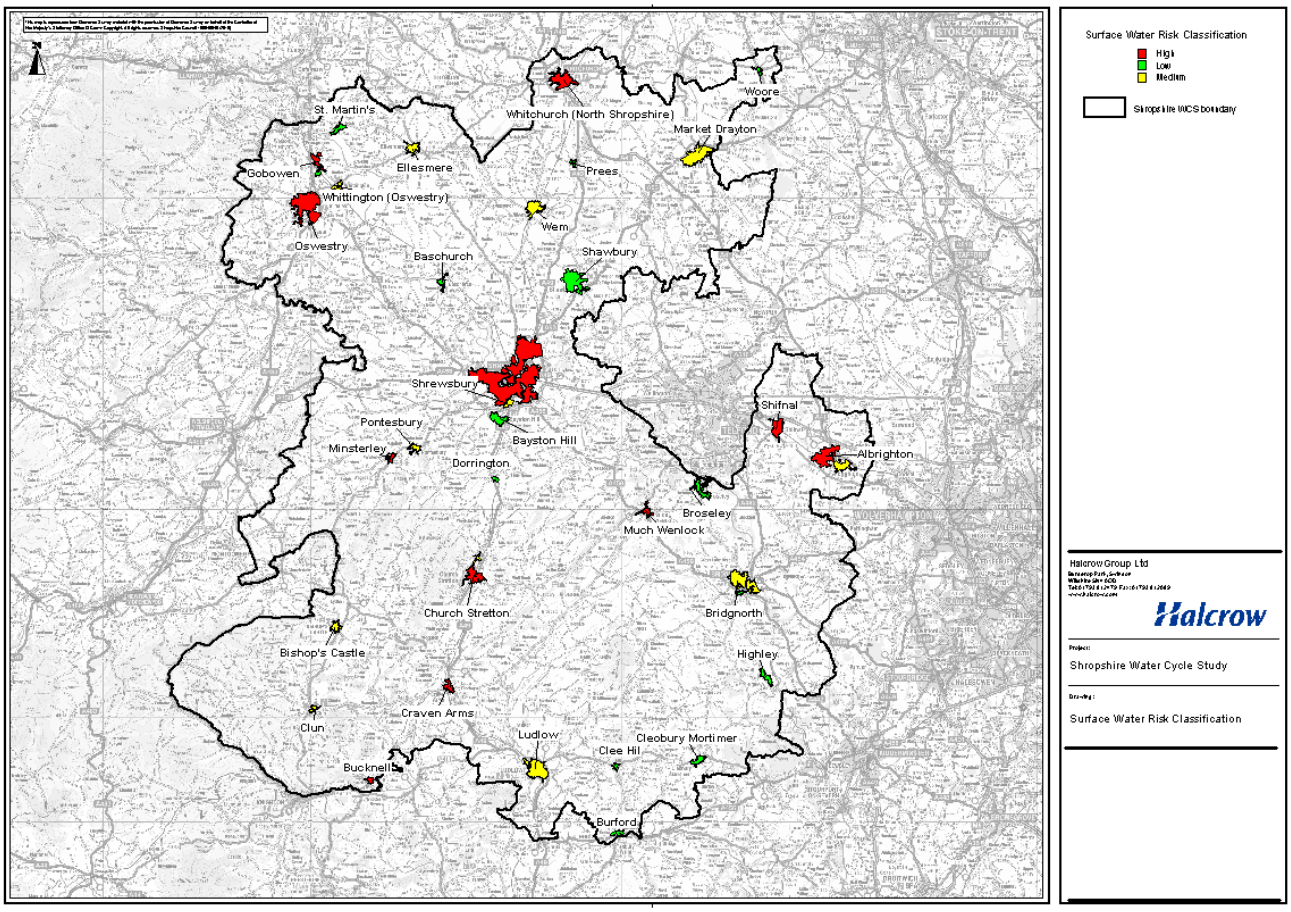


Figure 7-1 County wide surface water flood mapping

The settlements identified with the highest susceptibility to surface water flood risk include: Whitchurch (North Shropshire), Gobowen, Oswestry, Shrewsbury, Shifnal, Church Stretton, Much Wenlock, Albrighton, Minsterley, Craven Arms and Bucknell. For these areas, the ASTSWF maps indicated that a relatively high percentage of the existing settlement may be susceptible to surface water flooding and this was supported by the anecdotal evidence contained within the Level 1 SFRA.

Towards the northern extent of the county, Whitchurch, Gobowen and Oswestry have been identified as settlements that may be at a high susceptibility to surface water flooding and, Craven Arms and Bucknell towards the southern extent of the county. For these settlements, the Level 1 SFRA identified a number of recorded incidents of flooding within STW's DG5 database in addition to a large percentage of the settlement being affected by the ASTSWF maps. At Gobowen, there were also reports of insufficient capacity of culverts. Development within this area may therefore increase the risk and a detailed assessment should be

undertaken of any locations identified for future development within or adjacent to these areas.

Towards the centre of the county, Shrewsbury has been identified as an area that may be susceptible to surface water flooding. Over 10% of the existing settlement was shown to be affected by the ASTSWF maps and many areas within Shrewsbury have also been reported as experiencing problems from surface water flooding within the Level 1 SFRA and Severn CFMP. The sustainable management of surface water is therefore important through the use of SUDS. This is discussed in more detail in Chapter 10. In line with the recommendations in the Severn CFMP, there are opportunities to implement SUDS within both sites which will help to reduce risk to any new and existing development within the vicinity of the urban extensions. This area may also benefit from a Surface Water Management Plan (SWMP) in order to ensure the future management of surface water risk is managed in a sustainable way.

The settlement of Shifnal has been identified as at high susceptibility from surface water flooding with over 20% of the settlement shown to be affected by the ASTSWF maps. A number of surface water flood risk issues were identified within the Level 1 SFRA. In particular, it was outlined that the settlement could be affected by flooding from the Telford and Wrekin area through any increased discharges into the Wesley Brook. The Environment Agency has advised that surface water drainage policies need to be developed in order to prevent an overall increase in risk from future development. It is therefore recommended that prior to development within or adjacent to this settlement, a SWMP is undertaken in conjunction with Telford and Wrekin Council to determine the main flood risks and formulate a surface water management plan to ensure the sustainable management of flood risk in the future.

Within the settlement of Albrighton, the percentage of the settlement affected by the ASTSWF maps was approximately 9%. However, the Level 1 SFRA indicated that the STW DG5 register identified Albrighton as one of the most problematic postcode areas within the county. Information received from the Environment Agency supports this and outlines how the area suffered extensive flooding from both fluvial and pluvial sources in the summer of 2006. The area would therefore benefit from further assessment through a SWMP in order to determine the interactions between the various sources of flooding and how they may be effectively managed in the future.

Towards the western extent of the county, the settlement of Minsterley has also been identified as an area that may be at higher risk of surface water flooding. Over 10% of the settlement is shown to be affected by the ASTSWF maps and anecdotal evidence from the Level 1 SFRA has indicated that flooding has been experienced from overloaded drains. This was thought to be a result of increased development in the area. Future development within this area may exacerbate the

problems further and therefore, a further assessment as to the main issues should be undertaken to ensure that surface water is appropriately managed in the future.

The settlement of Church Stretton has also been identified as an area that may be at a higher risk of flooding from surface water flooding. Consultation with the Environment Agency has indicated that during the winter, large parts of the valley floor especially to the south of the town are covered by water due to surface water flooding. In addition, Church Stretton is located at the head of two catchments: the Onny and the Cound Brook, and is therefore also at risk from fluvial flooding. However, it is thought that the current flood mapping does not identify the full extent of the affected area. Future development within this area may exacerbate the problems. Further assessment as to the main issues should be undertaken, in particular the interactions between the fluvial and pluvial flooding, to ensure that surface water is appropriately managed in the future.

Anecdotal evidence received from the Environment Agency has indicated that there is a significant risk of both surface water flooding and fluvial flooding in Much Wenlock. Recently, a number of locations within the settlement and the adjacent area of Farley were affected during both summer 2007 and November 2008. Shropshire Council has undertaken a detailed review into the sources and mechanisms of flooding within and adjacent to the settlement (Much Wenlock Flood Investigation, September 2009). According to the Bridgnorth Journal, approximately 64 properties were reported as being affected by flooding within Much Wenlock and Farley in June 2007. In particular, flash flooding resulting in runoff from the surrounding area and an inadequate draining system that cannot cope with the volume of water is a particular issue, causing disruption to many parts of the town. There are also issues of capacity with the drainage infrastructure. It is strongly recommended that a detailed assessment of flood risk within Much Wenlock and Farley is undertaken through a SWMP, to ensure the interactions between the different sources of flooding are fully understood and that flood risk is appropriately managed in the future.

For a number of the settlements, a medium susceptibility to surface water flood risk was identified. These included: Ellesmere, Market Drayton, Whittington (Oswestry), Wem, the area to the south of Shrewsbury, Pontesbury, Bridgnorth (areas to the south west of the town is classified at low susceptibility), Bishop's Castle, Clun and Ludlow. Whilst the risk in these areas is not considered as high as for the settlements outlined above, surface water flooding has been reported as an issue. Whilst these areas should be considered in preference to those classified at high susceptibility, further assessment as to the potential surface water flooding issues should be considered prior to development.

The remainder of the defined settlements within Shropshire were classified with a low susceptibility to surface water flood risk. These included: Woore, St Martin's, Prees, Gobowen, Shawbury, Baschurch, Bayston Hill, Broseley, the south western

extent of Bridgnorth, Highley, Cleobury Mortimer, Clee Hill, Dorrington and Burford. Based on the assessment undertaken, the perceived susceptibility to surface water flood risk is lower than for the settlements outlined above and development of these areas should not be constrained significantly by surface water flood risk.

It should be noted that the assessment undertaken has focused primarily on the settlements identified for growth. For areas outside of these settlements, it does not mean that there is no risk of surface water flooding. As such, the Level 1 SFRA recorded incidents of flooding from surface water sources have also been presented on the map. As and when proposed sites are identified, further assessment should be undertaken to asses the risk of surface water flooding within the county. Site-specific FRAs should be undertaken as part of the planning application process to determine the overall risk to the site.

7.5 Additional surface water flooding evidence

Shropshire Council land drainage department currently hold GIS records of reported flooding incidents. Each reported flooding incident is categorised into one of the following categories:

- Ditch: blocked – a roadside ditch is blocked
- Drain: blocked – pipes are blocked (could be highway drainage, or public or private sewerage)
- Flood – a report of flood water (could be from either of the above sources)
- Water: standing – a report of flood water (could be from either of the above sources)

These historic flooding incidents are most likely to be indicative of 'operational' issues with a settlement. After discussion with Shropshire Council it was decided to use the Ditch: blocked and Drain: blocked records as the basis to identify 'operational' issues within an area. The latter two categories are linked to the Ditch: blocked and Drain: blocked categories, and would therefore likely lead to a double-counting of flooding incidents. For each settlement, the number of Ditch: blocked and Drain: blocked records were summed, and then divided by the settlement area to give a density of flooding incidents per settlement. Although the densities were very low, this analysis provided a consistent method to understand the settlements which had a higher proportion of 'operational' issues[15]. It should be noted that this analysis has been based on a sparse and incomplete dataset, and should only be used to provide an indication of likely 'operational' issues which might require further investigation.

[15] If a simple sum of the number of historical records had been calculated, then larger settlements would have been ranked higher (due to higher number of incidents), which would not allow a comparative analysis to be undertaken between settlements.

Name	Area (ha)	Ditch: blocked (no)	Drain: blocked (no)	Sum of ditch and drain:blocked	Density (no./ha)	Rank
Clun	28.96	1	12	13	0.4	1
Much Wenlock	62.67	0	26	26	0.4	2
Bridgnorth	331.82	7	99	106	0.3	3
Highley	73.70	0	22	22	0.3	4
Prees	22.45	0	6	6	0.3	5
Shifnal	147.72	2	33	35	0.2	6
Ludlow	289.81	0	65	65	0.2	7
Whitchurch (North Shropshire)	244.37	4	50	54	0.2	8
Church Stretton	191.92	3	39	42	0.2	9
Cleobury Mortimer	65.54	1	13	14	0.2	10
Craven Arms	66.37	2	12	14	0.2	11
Whittington (Oswestry)	47.53	0	10	10	0.2	12
Broseley	142.52	3	26	29	0.2	13
Wem	157.86	3	29	32	0.2	14
Bishop's Castle	63.35	0	12	12	0.2	15
St. Martin's	62.55	1	10	11	0.2	16
Woore	29.58	1	4	5	0.2	17
Pontesbury	59.26	1	9	10	0.2	18
Ellesmere	100.31	0	15	15	0.1	19
Shrewsbury	1950.83	7	278	285	0.1	20
Market Drayton	314.89	5	39	44	0.1	21
Bayston Hill	116.82	0	16	16	0.1	22
Oswestry	519.78	1	60	61	0.1	23
Albrighton	409.41	1	46	47	0.1	24
Gobowen	108.48	0	8	8	0.1	25
Baschurch	53.61	0	3	3	0.1	26
Minsterley	45.65	0	1	1	0.0	27
Shawbury	336.15	1	5	6	0.0	28

Table 7-3 Historic incidents of ditch and drain: blocked

It is understood that Shropshire Council are undergoing a process to improve future flooding incident data collected, and therefore this analysis should be reviewed in light of the improved data.

7.6 Conclusions and recommendations

The surface water maps produced as part of this WCS has provided a tool to help identify areas within the county that may be susceptible to a higher risk of surface water flooding. This is based on evidence gained from the Environment Agency ASTSWF maps and other sources of evidence (including DG5, SFRA, CFMPs).

7.6.1 Areas classified as low surface water flood risk

For areas identified as being at low surface water flood risk the following recommendations are made:

- Development should not result in an increase in surface water flood risk downstream of the proposed development. This can be achieved through site-specific FRAs which ensure surface water runoff rates and volumes from proposed development sites are no greater than existing (betterment should be sought for brownfield sites in agreements with the Environment Agency).
- Consideration should be given to any surface water runoff entering the development site, which could result in flooding. This should be done during the master planning of proposed development and land should be allocated in areas of lower flood risk initially, in accordance with PPS25.
- Within the development boundary surface water runoff should be managed to ensure no flooding of properties up to the 100 year rainfall event (including an allowance for climate change). This can be done during the master planning of the site, and is likely to require effective planning of exceedance flow pathways.

7.6.2 Areas classified at medium surface water flood risk

For areas identified as being at 'medium' risk from surface water flooding, the following recommendations are made:

- it is important that new development does not exacerbate existing surface water flooding, and that new development is effectively planned to ensure development itself is not at risk from surface water flooding.
- The requirements for the new development are similar to those for areas identified as being at low surface water flood risk, but it is recommended that further analysis is undertaken to confirm the nature of existing risk and how development may affect this risk.
- In the absence of a strategy and/or Surface Water Management Plan, development should seek opportunities to reduce the surface water flooding in the wider area. A full Surface Water Management Plan (SWMP) is probably not required, but further assessment of surface water flooding should be carried out to develop surface water drainage strategies for these areas.

7.6.3 Areas classified as high surface water flood risk

For areas identified as being at high risk the following recommendations are made:

- further assessment is to be undertaken in order to determine overall risk of flooding and to identify options for mitigating this risk, taking into consideration future development.
- It is recommended that Surface Water Management Plans (SWMPs) are undertaken for areas identified at a high susceptibility to surface water

flooding within or adjacent to the key settlements within Shropshire. These SWMPs should assess existing surface water flood risk in the key settlements and they should seek to strategically plan the provision of drainage for all new development.

- All new development should make allowance for climate change by designing safe and sustainable homes.
- Surface Water Management Plans (SWMPs) should focus on risk management and optimising the provision of strategic and sustainable surface water drainage infrastructure (i.e. SUDS). They should also take account of the risks of surface water and sewer flooding and how these might affect an area in combination with flooding from rivers and (where relevant) canals, reservoirs, or groundwater.
- A SWMP will enable key local partners with responsibility for surface water and drainage in the high risk area work together to understand the causes of surface water flooding and agree the most cost effective way of managing surface water flood risk.

Recent SWMP Technical Guidance has been produced by Defra (updated March 2010), and is available at: http://www.defra.gov.uk/environment/flooding/manage/surfacewater/plans.htm

8 Surface water drainage

8.1 Introduction

The surface water drainage assessment for the Shropshire outline WCS has been carried out to:

- identify the types of Sustainable Drainage Systems (SUDS) which may be applicable across the county;
- make policy recommendations about the use of sustainable surface water drainage techniques across the county, and;
- identify the runoff rates and volumes required from urban extensions to ensure that runoff rate and volume from the development site does not exceed greenfield runoff rates and volumes up to the 1 in 100 year rainfall event, plus an allowance for climate change.

8.1.1 Overview of sustainable surface water drainage

The effect of development is generally to reduce the permeability of a site. The consequence of this, if no measures are put in place, is to increase the volume of water and the peak flow rate from the developed site during and after rainfall event. Increases in the volume of water and the peak flow rate can cause flooding to occur both within a development site, and can increase flood risk downstream of the development.

The ethos of sustainable surface water drainage is to mimic, as far as possible, the surface water flows (volume and peak flow rate) from the site prior to development. This can be achieved through drainage infrastructure which can reduce the volume of water and peak flow rate from the development site; this drainage infrastructure has become commonly known as Sustainable Drainage Systems (SUDS). SUDS are used to reduce the peak flow rate and volume of water from a development site, and SUDS techniques can be used to improve the quality of surface water runoff and provide amenity and biodiversity benefits.

A SUDS management train should be adopted to manage surface water drainage sustainably and to mimic natural catchment processes as closely as possible. As a general rule, surface water should be managed as close to source as is practicable. Source control, reducing surface water runoff, and recycling should be prioritised for all developments, particularly the urban extensions. The SUDS management train, illustrated in Figure 8-1 has four principle components (Source: SUDS manual C697, CIRIA 2007):

- **Prevention -** The use of good site design and site housekeeping measures to prevent runoff and pollution (e.g. sweeping to remove surface dust and

detritus from car parks), and rainwater harvesting. Prevention policies should generally be included within the site management plan.

- **Source control -** Control of runoff at or very near its source (e.g. soakaways, other infiltration methods, green roofs, pervious pavements).
- **Site control -** Management of water in a local area or site (e.g. routing water from building roofs and car parks to a large soakaway, infiltration or detention basin).
- **Regional control -** Management of runoff from a site or several sites, typically in balancing ponds or wetland.

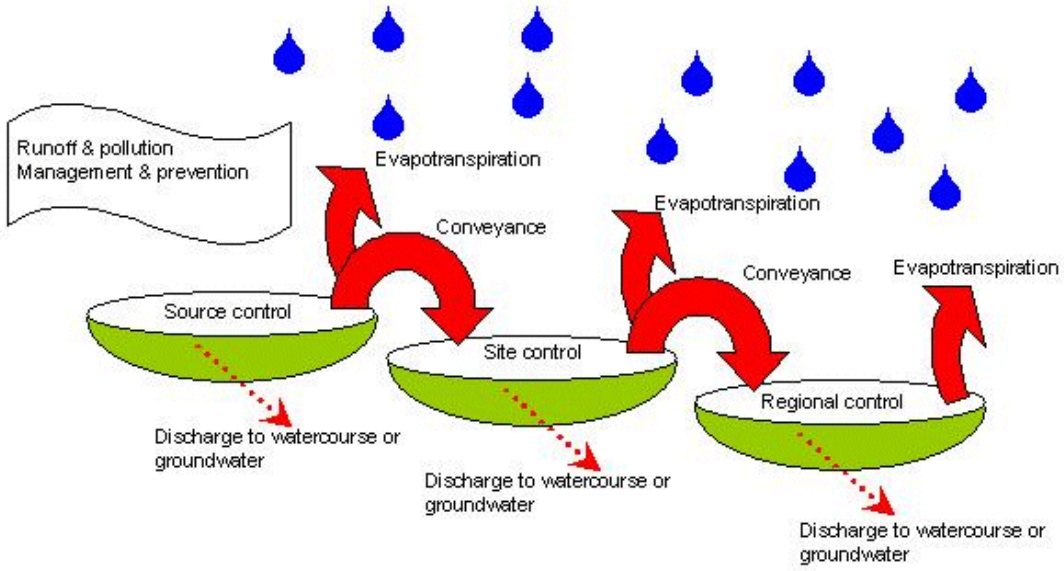


Figure 8-1 SUDS management train (http://www.ciria.com/suds/suds_management_train.htm)

Different sustainable drainage techniques should be applied at different scales and for performing different functions. For small developments or extensions to the curtilages of existing properties, source control sustainable drainage approaches will be more applicable and should be adopted to mitigate surface water runoff rate and volume. Evidence from the Integrated Urban Drainage pilot studies indicated that extensions to existing properties (also known as 'urban creep') can increase surface water flood damages as significantly as climate change. It is therefore critical to manage additional surface water runoff from urban creep. It is particularly challenging to manage urban creep effectively; this is often due to the lack of available space in high density urban areas to attenuate or infiltrate surface water runoff. The techniques which might work to reduce surface water runoff from 'urban creep' include:

- soakaways;
- pervious pavements, and;
- rainwater harvesting or water butts (which perform a limited function to reduce runoff).

In general, the policy to deal with urban creep requires runoff to be reduced, where possible using sustainable drainage techniques. Any additional surface water which is discharged to watercourse or sewer should be discussed with the Environment Agency and the sewerage company, respectively.

In larger development sites, the SUDS management train will be more applicable, and a series of source, site and regional drainage structures will be more applicable. Even in larger developments, source control measures should be encouraged and adopted where practicable.

Table 8-1 summarises the different SUDS techniques and their applicability to reduce flow rate, volume and provide water quality, amenity or biodiversity benefits. The table also summarises the scale at which the SUDS techniques can generally be applied.

General information					Performance						Site suitability	
SUDS technique	Description	Applicable scale	Highly suitable for	Suitable for urban creep / household extensions	Design return period	Peak flow reduction	Volume reduction	WQ treatment	Amenity potential	Ecology potential	Retrofit potential	Contaminated land above vulnerable groundwater (with liner)
Green roofs	Systems which cover a building's roof with vegetation (laid over a drainage layer)	Source	Large buildings with flat roofs Industrial / commercial areas	Possibly	1 in 2 years	Medium	Medium	Good	Good	Good	Yes	Yes
Soakaways	Square or circular excavations filled withy rubble or lined, and can be used to store and infiltrate runoff	Source / Site	Low-medium density housing Large buildings with land available	Yes	1 in 10 years	Good	Good	Good	Poor	Poor	Yes	No
Water butts	Offline storage devices used for capturing and storing roof runoff	Source	All scales of development	Yes	N/A	Low	Low	Low	Poor	Poor	Yes	Yes
Rainwater harvesting	Rainwater from roofs and hard surfaces can be stored and used	Source	Low and high density residential areas Large single-ownership building with land	Yes	N/A	High	High	Poor	Poor	Poor	Yes	Yes

General information					Performance						Site suitability	
SUDS technique	Description	Applicable scale	Highly suitable for	Suitable for urban creep / household extensions	Design return period	Peak flow reduction	Volume reduction	WQ treatment	Amenity potential	Ecology potential	Retrofit potential	Contaminated land above vulnerable groundwater (with liner)
			available									
Filter strips	Wide, sloping areas of grass that treat runoff from adjacent impermeable areas	Source / Site	Low-medium density residential areas Open green space Roads and footpaths with ample space available		N/A	Poor	Poor	Medium	Medium	Medium	Yes	No
Trenches (Infiltration)	Trenches filled with stone designed to convey +/or store runoff (they can infiltrate)	Source (Conveyance)	Hard standing areas Car parks		1 in 5 years	Medium	High	High	Low	Low	Yes	No

General information					Performance						Site suitability	
SUDS technique	Description	Applicable scale	Highly suitable for	Suitable for urban creep / household extensions	Design return period	Peak flow reduction	Volume reduction	WQ treatment	Amenity potential	Ecology potential	Retrofit potential	Contaminated land above vulnerable groundwater (with liner)
Trenches (Filter)	Trenches filled with stone designed to convey +/or store runoff	Conveyance	Highway drainage Conveying surface water to other storage areas		1 in 5 years	Medium	Low	High	Low	Low	Yes	Yes
Swales	Shallow channels designed to convey runoff and reduce pollutants	Source / Site (Conveyance)			1 in 10 years	Medium	Medium	Good	Medium	Medium	Limited	Yes
Bio-retention	Shallow depression on surface that are under drained and remove pollution and reduce runoff volumes	Source / Site	Large open green space		Max. 1 in 10 years	Medium	Medium-High with infiltration	Good	Good	Medium	Yes	Yes
Pervious pavements	Allow rainwater to infiltrate through the surface to an underlying storage area	Source / Site	Residential roads (e.g. estates) Car parks Hard standing areas, e.g. shopping areas	Yes	1 in 100 years	Good	Good	Good	Poor	Poor	Yes	Yes

General information					Performance						Site suitability	
SUDS technique	Description	Applicable scale	Highly suitable for	Suitable for urban creep / household extensions	Design return period	Peak flow reduction	Volume reduction	WQ treatment	Amenity potential	Ecology potential	Retrofit potential	Contaminated land above vulnerable groundwater (with liner)
Geo-cellular / modular systems	Modular plastic geocellular systems with a high void ratio that can be used to create a below ground soakaway or storage structure	Source / Site / Regional (Conveyance possible)			1 in 100 years	Good	Poor - Good with infiltration	Poor	Poor	Poor	Yes	Yes
Sand filters	Single or multi-chambered structures to treat surface water runoff through filtration using a sand bed as the primary filter medium.	Site / Regional	SW and highway drainage Low-medium density housing Large buildings with land available		N/A	Poor	Poor	Good	Poor	Poor	Yes	Yes
Infiltration basins	Depressions designed to store and infiltrate runoff	Site	Large open green space		1 in 100 years	Average	Good	Good	Good	Good	No	No
Detention basins	Dry basins which are designed to store a certain volume of runoff and provide some WQ treatment	Site / Regional			1 in 100 years	Good	Poor	Medium	Good	Medium	Yes	Yes

General information					Performance						Site suitability	
SUDS technique	Description	Applicable scale	Highly suitable for	Suitable for urban creep / household extensions	Design return period	Peak flow reduction	Volume reduction	WQ treatment	Amenity potential	Ecology potential	Retrofit potential	Contaminated land above vulnerable groundwater (with liner)
Ponds	Basins with a permanent pool of water for WQ treatment. Provide temporary storage for storm runoff	Site / Regional			1 in 100 years	Good	Poor	Good	Good	Good	Unlikely	Yes
Stormwater wetlands	Comprise of shallow ponds and marshy areas providing stormwater attenuation and treatment	Site / Regional (Conveyance)			1 in 100 years	Good	Poor	Good	Good	Good	Unlikely	Yes

Table 8-1 Summary of SUDS techniques and their applicability (based on information derived from CIRIA manuals C609 and C697)

NB: The design return period in this table has been provided to illustrate suitable rainfall probabilities which different SUDS can be designed for. The values quoted are not specifying design standards. It should be noted that during design of SUDS, an allowance should be made for climate change (either 20% or 30% peak rainfall intensity increases).

Sustainable surface water drainage should be adopted for all new developments (including redevelopment of brownfield land). Surface water runoff volume and peak flow rate from the development sites should not exceed greenfield runoff rate and volume up to and including the 100 year, 6 hour rainfall event (including an allowance for climate change). In brownfield developments, it may not be possible to achieve greenfield runoff rate and volume, but a reduction in surface water runoff should be achieved after the redevelopment and developers should agree the surface water drainage requirements with Shropshire Council and the Environment Agency early on in the development application process.

The Floods and Water Management Act has brought about significant legislative changes to the management of surface water. In the meantime Shropshire Council can ensure it adopts policies which are in line with the clauses outlined in the Bill. A summary of the key clauses in the Act related to sustainable drainage is outlined.

- Upper tier and unitary authorities will become responsible for the adoption and maintenance of new build SUDS; new build includes all new development and redevelopment.
- Upper tier and unitary authorities will become the approving body (SAB) for all new build SUDS. The requirements for approving new build SUDS will be outlined in forthcoming national standards on the construction and operation of surface water drainage.
- There will be a removal of the automatic 'right to connect' surface water drainage to the public sewerage network. New surface water drainage systems will need to be approved in line with the National Standards before any connection to the public sewerage network is made.
- Where possible, runoff should be infiltrated to the ground. Surface water drainage to a watercourse or public sewer is considered to provide successively less desirable solutions.

Should surface water runoff be required to be connected to a watercourse consideration needs to be given to the location of the development site in relation to the nearest watercourse. There will be cases where surface water runoff will need to be routed through private land in order to connect to the watercourse. Under the Floods and Water Management Act, upper tier and unitary authorities will become the SAB, and would therefore be responsible for purchasing land or compensating land owners to allow surface water runoff to be routed through land, and connect to a watercourse. Given these considerations, development may be more suitable in locations which are closer to watercourses, and hence reduce the potential costs and difficulties of routing surface water through private land.

8.1.2 Costs of sustainable surface water drainage

The CIRIA SUDS manual (C697) provided indicative construction costs, and operation and maintenance costs for various elements of sustainable drainage

systems. Inevitably, the costs are influenced by multiple factors, but the SUDS manual does indicate that the "total volume or area of a component is likely to be a strong predictor of cost." Indicative capital costs, and operation and maintenance costs, are provided in Table 8-2 (it should be noted that these are 2004 prices).

Component	Capital cost		Operation and maintenance cost	
	Cost (£)	Unit	Annual Cost* (£)	Unit
Filter drain	£100-£140	/m³ stored volume	£0.2-£1	/m² of filter surface area
Infiltration trench	£55-£65	/m³ stored volume		
Soakaway	>£100	/m³ stored volume	£0.1	/m² of treated area
Permeable pavement	£30-£40	/m² permeable surface	£0.5-£1	/m³ of storage volume
Infiltration basin	£10-£15	/m³ detention volume	£0.1-£0.3	/m² detention basin area
Detention basin	£15-£20	/m³ detention volume		
Wetland	£25-£30	/m³ treatment volume	£0.1	/m² of wetland surface area
Retention Pond	£15-£25	/m³ treatment volume	£0.5-£1.5	/m² of retention pond surface area
Swale	£10-£15	/m² swale area	£0.1	/m² of swale surface area
Filter strip	£2-£4	/m² filter strip area	£0.1	/m² of filter surface area

Table 8-2 Capital costs and operation and maintenance costs (from SUDS manual)

* Annual cost (for regular maintenance only)

8.2 Data and references

The data and information used for this section of the outline WCS is outlined below:

- Environment Agency Groundwater Vulnerability maps (GIS);

- Environment Agency Source Protection Zones (GIS);
- British Geological Survey drift and bedrock geology (GIS) – this was sourced under a complementary licence from Shropshire Council);
- Nitrate Vulnerable Zones (GIS);
- Defra/EA Preliminary Rainfall Runoff Management for New Developments, R&D Technical Report W5-074/A/TR/1

8.3 Methodology

8.3.1 County wide mapping

Mapping has been carried out across the county to identify the types of SUDS that are likely to be more appropriate in different locations in Shropshire. The mapping identifies the locations, at a coarse scale, which will be suitable for infiltration, attenuation or combination (infiltration / attenuation).

The Environment Agency has classified aquifers in England and Wales as Major or Minor[16], dependent on their permeability and importance for water supply. This classification, in conjunction with the pollution attenuation properties of the soil, has been used to define groundwater vulnerability ratings, which can be used to asses the potential impacts of new developments. The soil classes are summarised below, in Table 8-3.

Leaching Potential	Soil Classes
High – soils with little ability to attenuate diffuse source pollutants and in which non-adsorbed diffuse source pollutants have the potential to move rapidly to underlying strata or to shallow groundwater.	**H1** – soils which readily transmit liquid discharges
	H2 – soils which readily transmit a wide range of pollutants
	H3 – soils which readily transmit non-adsorbed pollutants and liquids but which have some attenuation ability
	HU – soil information for urban areas is less reliable so the worst case is assumed
Intermediate – soils with a moderate ability to attenuate diffuse source pollutants or in which it is possible to that some non-adsorbed diffuse source pollutants and liquids cold penetrate the soil layer.	**I1** – soils which can possibly transmit a wide range of pollutants
	I2 – soils which can possibly transmit non- or weakly adsorbed pollutants or liquids, but are unlikely to transmit adsorbed pollutants
Low – soils in which pollutants are unlikely to penetrate the soil layer.	**L**

Table 8-3 Environment Agency groundwater vulnerability classification

16) The Environment Agency's aquifer classification system is currently being revised. In future, geological units will be referred to as 'Principle' or 'Secondary' aquifers and 'Unproductive Strata'. However, no mapping has yet been published showing their distribution, therefore the current 'Major', 'Minor' and 'Non-aquifer' classifications, which are roughly equivalent, have been used in this assessment.

The Environment Agency has also defined groundwater source protection zones (SPZs) around groundwater sources which are abstracted for potable use (which includes public water supply and food/drinks production). Three zones are defined, based on the time taken for pollutants entering the ground to reach the abstraction point. These are summarised in Table 8-4 below.

SPZ	Definition
Zone 1 (Inner Protection Zone)	'Any pollution that can travel to the borehole within 50 days from any point within the zone'
Zone 2 (Outer Protection zone)	'pollution that takes up to 400 days to travel to the borehole, or 25% of the total catchment area'
Zone 3 (Total Catchment)	'the total area needed to support removal of water from the borehole, and to support any discharge from the borehole'

Table 8-4 - Definition of groundwater source protection zones

The methodology adopted for the county wide assessment of the suitability of SUDS is outlined below:

- The groundwater vulnerability (GWV) maps are used to identify the potential to infiltrate surface water runoff into the ground. The GWV maps are appropriate for the initial assessment because they include an assessment soil leachability, aquifer permeability and classification of the aquifer. The GWV maps were used to create the following classification
- major aquifer = good potential for infiltration SUDS;
- minor aquifer = moderate potential for infiltration SUDS, and;
- no aquifer = poor potential for infiltration SUDS.
- The classification derived from the GWV maps were subsequently checked against both solid and drift geology information, and any anomalies were adjusted at this stage.
- To ensure a groundwater quality element was included in the analysis, Source Protection Zones (SPZs) were used to identify where groundwater may be particularly vulnerable to pollution. The SPZ maps were used to create the following classification
- SPZ 1 = high risk of groundwater pollution;
- SPZ 2 = moderate risk of groundwater pollution, and;
- SPZ 3 / None = low / no risk of groundwater pollution.
- The information from the GWV and SPZ maps were subsequently combined to create an assessment matrix, which could identify the potential suitability of SUDS approaches. The assessment matrix is shown in Table 8-5, and a more detailed breakdown of the criteria is shown in Table 8-6.

		Risk to groundwater pollution (based on SPZ)		
		1	**2**	**3 / None**
Drainage potential for infiltration SUDS	**Good**	G1	G2	G3 / G4
	Medium	M1	M2	M3 / M4
	Poor	Poor		

Table 8-5 Assessment matrix for county wide mapping of SUDS

Category	Suitable SUDS	Description
G1	Attenuation	Although the geology is highly permeable the site is in Source Protection Zone 1 and therefore there is a presumption away from infiltration techniques. Depending on site specific characteristics some infiltration might be possible, but would need to be determined through site investigations
G2	Infiltration + treatment	Highly permeable geology makes infiltration SUDS applicable. Some consideration will need to be given to the treatment of runoff to protect groundwater
G3 / G4	Infiltration	Highly permeable geology makes infiltration SUDS applicable. Unlikely to be an issue with pollution of groundwater
M1	Attenuation	Although the geology is generally permeable the site is in Source Protection Zone 1 and therefore there is a presumption away from infiltration techniques. Depending on site specific characteristics some infiltration might be possible, but would need to be determined through site investigations
M2	Infiltration or attenuation + treatment	Suitable for infiltration or attenuation depending on the site specific characteristics. Some consideration will need to be given to the treatment of runoff to protect groundwater if infiltration is used
M3 / M4	Infiltration or attenuation	Suitable for infiltration or attenuation depending on the site specific characteristics. Unlikely to be an issue with pollution of groundwater
Poor	Attenuation	Low permeability geology means that infiltration SUDS are less likely to be applicable although this should be confirmed by site investigations

Table 8-6 Detailed information on assessment matrix for SUDS suitability

Whilst a high level assessment has been undertaken, it should be noted that detailed site geological surveys should be undertaken by developers as required, as a part of the planning application process to define the most suitable SUDS options. It is important to note that *a groundwater risk assessment will be required for any site where infiltration SUDS are proposed.* SUDS infiltration for discharges to ground, from surface water from roads, vehicle parking and amenity areas are subject to agreement by the SUDS Approval Board and should demonstrate compliance with the criteria set out in the forthcoming National SUDS Standards, including water quality, design and maintenance. The EA should be consulted regarding the risks to groundwater at an early stage, as it is likely that more detailed risk

assessments would be required for those sites located in, or near to, source protection zones, or where groundwater is found at shallow depths. Reference should be made to the Environment Agency Groundwater Protection: Policy and Practice (GP3) Part 4, 2008 edition 1 (http://www.environment-agency.gov.uk/research/library/publications/40741.aspx).

8.3.2 Sustainable urban extensions

For the urban extension areas in Shrewsbury and Oswestry a detailed surface water drainage assessment has been carried out, which builds upon the county wide mapping. Approximate storage volumes and allowable runoff rates have been calculated for strategic development sites which should be taking into account for SUDS design at an early stage. The calculation method is outlined in the joint Defra / Environment agency R&D technical Report "Preliminary rainfall runoff management for developments" (Environment Agency 2007)[17]. This method provides initial, conservative estimates of the increase in peak flow and volume of runoff from proposed developments. For this assessment it should be noted the assumed housing density was 40 houses/ha, and 75% of the developable area would become impermeable.

For each site required, storage volumes are broken down into attenuation storage which is provided to reduce the rate of runoff to the equivalent predevelopment runoff volume, and, long term storage is provided to reduce the volume of runoff to the predevelopment runoff volume. Developers will be required to provide sufficient storage to meet the combined total on the long term and attenuation storage. Where relevant, results of the hydrological analyses have been included for the LPAs which have identified urban extensions.

In addition, Nitrate Vulnerable Zones (NVZs), local groundwater policy and groundwater emergence maps were checked to provide a more detailed assessment of the urban extensions.

It should be stressed that developers should only use the outline WCS figures as indicative. Developers should devise their own strategy and include the appropriate level of detail within outline planning application.

8.3.3 Market towns, key centres and local centres

For the remainder of proposed development in Shrewsbury and Oswestry, and proposed developments in the market towns, key centres and local centres, a more strategic approach to the assessment has been undertaken, focusing on the key

[17] The Defra/EA technical report outlines three stormwater drainage design stages; 1) prior to or during Master Plan development, 2) At Master Plan / Environmental Impact Assessment, and 3) detailed planning of the site drainage. The calculations undertaken for the WCS are in line with the Defra/EA methodology, and are suitable for stage 1 of the stormwater drainage design. Stage 1 provides an initial estimate of storage volumes to assist initial discussions between local authorities and the Environment Agency.

constraints and opportunities for surface water drainage. The appropriateness of SUDS for each settlement has been based on the county wide mapping undertaken. It should be noted that whilst an indication of suitable SUDS has been provided, the settlement approach has considered relatively large geographic areas within the study. As such, a definitive assessment can not be made. As allocations become available, developers should undertake a more detailed assessment based on specific site areas.

8.4 County wide mapping

Shropshire has a mixture of soil types, ranging from slowly permeable and freely draining, slightly acidic, loamy and clayey soils. The more permeable sites should have priority given to infiltration drainage techniques, as opposed to discharging surface water to watercourses. Where less permeability is found and infiltration techniques that rely on discharge into the existing soils are not viable (also due to a high water table, source protection zones, contamination etc), discharging site runoff to watercourses is preferable to the use of sewers. Integrated urban drainage should also be used throughout the design process and early consultation with Shropshire Council and the Environment Agency is essential for all development sites to identify the types of SUDS likely to be applicable.

An assessment of the major and minor aquifers in Shropshire is illustrated in Table 8-7. Major aquifers are more permeable and are much more likely to be suitable for infiltration SUDS approaches.

Major Aquifers	Minor Aquifers (solid)	Minor Aquifers (superficial)	Non-aquifers
Sherwood Sandstone Group, Bridgenorth Sandstone, Carboniferous Limestone	Alberbury Breccia, Coal Measures, Millstone Grit, Old Red Sandstone, Silurian limestones, Uriconian rhyolite and tuffs.	Scree, head (sandy), alluvium, alluvial fan deposits, river terrace deposits, glaciofluvial sand and gravel deposits, morainic drift.	Middle Lias, Lower Lias, Penarth Group, Mercia Mudstone Group, Silurian (exc. limestones), Ordovician, Cambrian, Precambrian (exc. Uriconian rhyolite and tuffs), intrusive igneous rocks.

Table 8-7 Aquifer Units of West Shropshire

Large parts of the northern and eastern edge of Shropshire is underlain by Permo-Triassic Sandstone, which is highly permeable and therefore deemed to have a higher potential for infiltration SUDS. As Permo-Triassic sandstone is highly permeable, the northern and eastern edge of Shropshire has major aquifers, and there are large numbers of boreholes (and hence SPZs) need to be protected. Therefore, whilst infiltration SUDS should be largely applicable, due consideration should be given to the presence of SPZs when determining whether infiltration SUDS are likely to be applicable. Table 8-8 illustrates EA policy on SPZs.

	Within SPZ1	Outside SPZ1
Environment Agency Policy	Only clean roof drainage may be infiltrated, with the following conditions: - drains must be sealed to prevent ingress of surface drainage; - pathways for contaminant migration must not be created and in-ground contamination must not be mobilised; - hydrogeological risk assessment demonstrates insignificant risk.	Infiltration of potentially contaminated runoff is prohibited. However, infiltration of SuDS (and STW) discharges is permitted, provided that: - a hydrogeological risk assessment can demonstrate adequate protection for groundwater; - arrangements for effective management and maintenance of the SUDS are in place. There is a presumption against the use of deep soakaways, bypassing the soil zone, unless: - there is no viable alternative; - treatment is in place; - a hydrogeological risk assessment demonstrates insignificant risk.

Table 8-8 Environment Agency policy on SPZs (Environment Agency Groundwater Protection: Policy and Practice (GP3) Part 4, 2008 edition 1 - http://www.environment-agency.gov.uk/research/library/publications/40741.aspx)

Much of south eastern and central Shropshire, and a small part to the north west, is underlain by minor aquifer, which is considered to be relatively permeable. The suitability for SUDS will be highly dependant on local groundwater conditions, such as depth to groundwater.

South west Shropshire and parts of the north of Shropshire are underlain by solid bedrock geology, which is considered to be non-aquifer and therefore has low permeability. Due to the low permeability of the soil and geology, attenuation based SUDS will generally be more applicable. Within the non-aquifer zones there are some locations where the drift geology indicates a slightly higher permeability, and therefore infiltration SUDS may be applicable depending on depth to groundwater. In some of these locations the drift geology is alluvium, which frequently lies within flood zone 3. As a general rule, SUDS should be built outside of flood zone 2 & 3 as a preference, or up to the 100 year event plus climate change as a minimum. If SUDS are constructed in areas of flood risk there is a possibility the river could flood the SUDS features, thus reducing their capacity and ability to perform their drainage function properly.

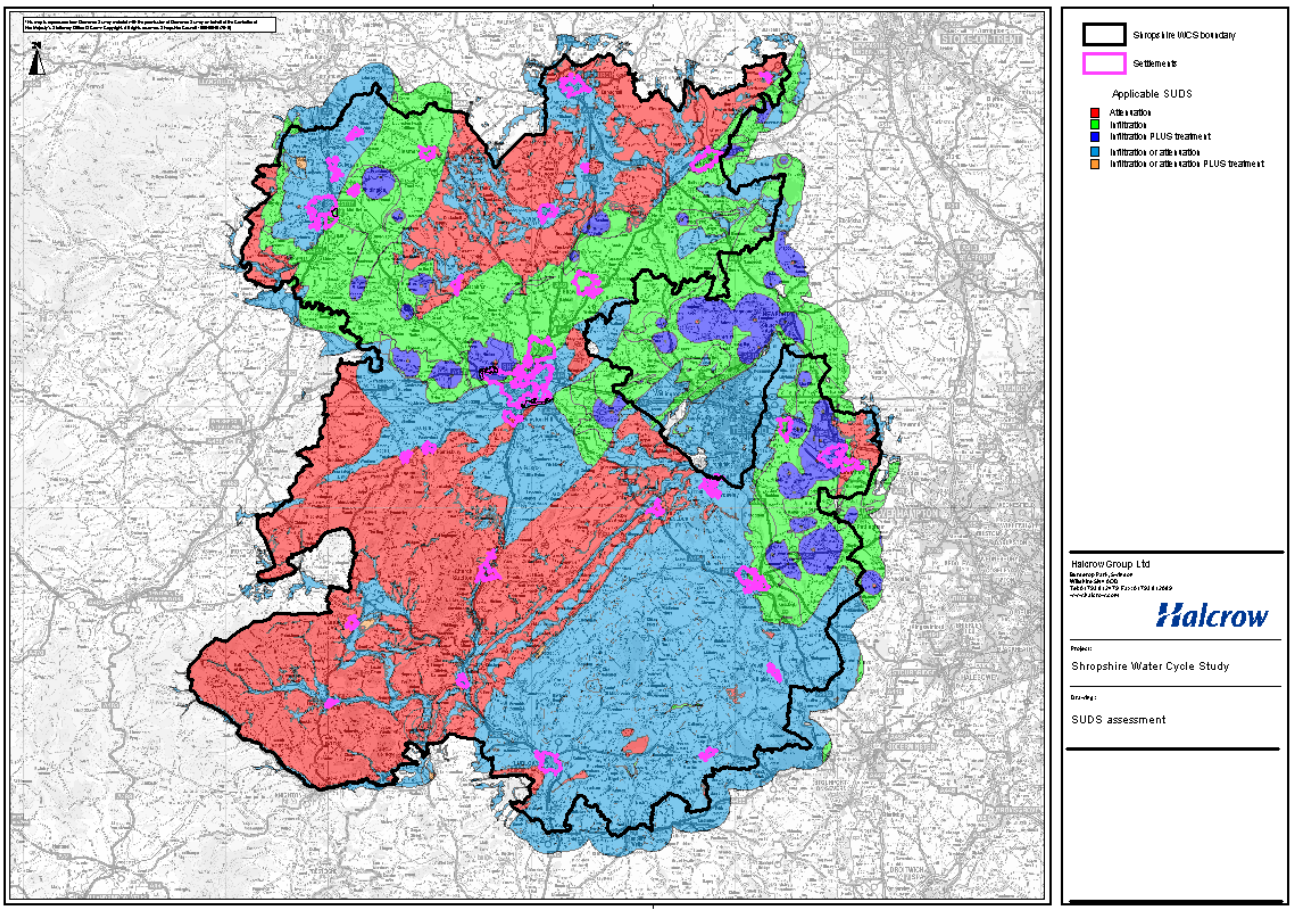


Figure 8-2 Outputs from county wide SUDS assessment

8.5 *Shrewsbury*

The majority of the urban extension area to the south of Shrewsbury is underlain by Westphalian and Stephanian coal measures, which is relatively permeable geology and may be suitable for infiltration SUDS approaches depending on the depth to groundwater. The Land at Weeping Cross and the Land off Thieves Lane are underlain by impermeable rocks of Anglesey, although the eastern edge of the Land off Thieves Lane is underlain by highly permeable Triassic sandstone.

Due to the varying permeability of the site, a range of infiltration and attenuation SUDS will be applicable, and this will need to be confirmed by site specific investigations. There are no SPZs or NVZs which will affect the urban extension and infiltration of runoff should be promoted where practicable. Where discharge to a watercourse is required, this should be carefully managed to ensure peak flow rate is not greater than greenfield. There are several watercourses which run in parallel to the site, where surface water could discharge to, subject to agreement with the Environment Agency. Discharges to watercourses may require additional SUDS treatment stages to reduce the risk of pollutants entering the watercourse.

The Defra/EA rainfall runoff methodology indicates that approximately 4% of the development site will need to be taken up to ensure surface water peak flow

and runoff volumes are no greater than greenfield rates and volumes (assuming no infiltration). This is not considered to represent a constraint to development and there will be sufficient land availability to provide the surface water drainage.

General site information					Surface water drainage requirements			
Site name	**Total site area (ha)**	**Total housing allocation**	**Total employment land (ha)**	**Total developable area (ha)**	**Total storage required assuming no infiltration occurs assuming 1m depth of storage- worst case (ha)***	**Annual peak flow rate - QBAR (l/s/ha)**	**100 yr runoff rate from developed site - Q100yr (l/s/ha)**	**% of development site required by storage - assuming no infiltration**
Shrewsbury South	94.95	1070	40	66.75	3.5	4.48	11.56	4%
Shrewsbury West	88.49	700	12	29.5	1.6	4.63	11.94	2%

Table 8-9 Surface water volume and peak flow requirements for Shrewsbury urban extension areas

* the volume and peak flow rate are those required for a 100 year, 6 hour storm (including 30% allowance for climate change). These values do not include an allowance for water quality treatment, and hence the actual storage requirements on site may be greater depending on the need to improve the quality of runoff discharging to groundwater or watercourses.

To the west of Shrewsbury, the proposed urban extension area is underlain by highly permeable Triassic sandstone, which has well drained soils. As a result the majority of the site is considered to be suitable for infiltration based SUDS approaches. However, the entire site is within SPZ 2, and the eastern edge of the proposed allocation (most of Land off Holyhead Road, 'additional site' identified by Shropshire Council, and eastern edge of Land at Oxen) is within SPZ 1. As a general rule, infiltration SUDS will not be applicable within SPZ 1 because of the risk of groundwater pollution. Some infiltration of roof runoff may be possible, subject to the constraints identified in Table 8-8. The area in SPZ 2 is at lower risk of polluting groundwater sources, but some additional SUDS treatment might be required where infiltration approaches are used. All of the proposed allocation is within a NVZ, which is classified as NVZ for surface water. Therefore, if surface water drainage is discharged to a watercourse the developer should assess the risk of nitrates in surface water entering the watercourse[18]. Should surface water runoff need to be discharged to a watercourse, there are watercourses in the near vicinity of the site (e.g. Rad Brook, Severn) which could act as locations for outfalls.

[18] It is unlikely that there will be high level of nitrates in surface water runoff, but there can be there can be nitrogenous waste in plants (e.g. leaves) which can be nitrified into nitrates. This is considered a low risk, and well designed SUDS, which include a treatment element, should mitigate this risk.

The Defra/EA rainfall runoff methodology indicates that approximately 2% of the development site will need to be taken up to ensure surface water peak flow and runoff volumes are no greater than greenfield rates and volumes (assuming no infiltration). This is not considered to represent a constraint to development and there will be sufficient land availability to provide the surface water drainage.

The majority of existing allocations, permissions, SHLAA sites and windfall development will occur on brownfield land within Shrewsbury urban area. The high level assessment of Shrewsbury urban area indicates that:

- to the north and west of the town infiltration SUDS may be more applicable, subject to the presence of SPZ 1 at SHLAA site SHREW198 (Ditherington Flax Mill);
- in central Shrewsbury, and to the south and east of the town, a combination of attenuation and infiltration SUDS will be more applicable, depending on the depth to groundwater;
- as the majority of developments will be smaller scale, source and site control measures are more likely to be applicable at these sites;
- the majority of SHLAA sites (as provided on a GIS layer) are within 0.5km of a watercourse, which is useful should surface water runoff need to be discharged to a watercourse, and;
- the north and west of the town lie within a NVZ (surface water) which should be considered if surface water is discharged to watercourses.

8.6 Oswestry

The proposed urban extension area to the east of Oswestry is underlain by highly permeable Triassic sandstone, which has well drained soils. The site does not lie within a SPZ 1 or 2, and therefore infiltration SUDS are likely to be highly suitable to manage surface water runoff from this site. However, the entire site is within a NVZ, which has been classified as a NVZ for groundwater. There is a risk that infiltration SUDS could mobilise existing pollutants within the soil and increase nitrate levels within groundwater. A more detailed assessment of the risk of nitrate pollution of the groundwater should be undertaken as part of any development proposals. Where there is demonstrated to be a minimal risk to groundwater infiltration SUDS should be promoted. If discharge to a watercourse is required the nearest watercourse runs parallel to the western boundary of the site.

The Defra/EA rainfall runoff methodology indicates that approximately 4% of the development site will need to be taken up to ensure surface water peak flow and runoff volumes are no greater than greenfield rates and volumes (assuming no infiltration). This is not considered to represent a constraint to development and there will be sufficient land availability to provide the surface water drainage.

General site information					Surface water drainage requirements			
Site name	**Total site area (ha)**	**Total housing allocation**	**Total employment land (ha)**	**Total developable area (ha)**	**Total storage required assuming no infiltration occurs assuming 1m depth of storage- worst case (ha)***	**Annual peak flow rate - QBAR (l/s/ha)**	**100 yr runoff rate from developed site - Q100yr (l/s/ha)**	**% of development site required by storage - assuming no infiltration**
Oswestry East	32.59	750	6	24.75	1.1	6.48	16.71	4%

Table 8-10 Surface water volume and peak flow requiremens for Oswestry urban extension area

* the volume and peak flow rate are those required for a 100 year, 6 hour storm (including 30% allowance for climate change). These values do not include an allowance for water quality treatment, and hence the actual storage requirements on site may be greater depending on the need to improve the quality of runoff discharging to groundwater or watercourses.

The majority of existing allocations, permissions, SHLAA sites and windfall development will occur on brownfield land within Oswestry urban area. The high level assessment of Oswestry urban area indicates that:

- the majority of Oswestry urban area is underlain by relatively permeable Westphalian or Stephanian coal measures, and a combination of attenuation and infiltration SUDS will be applicable, depending on geological investigations as part of the development applications;
- the south east of Oswestry is underlain by highly permeable Triassic sandstone, and is likely to be more suitable for infiltration SUDS;
- the northern extent of Oswestry lies within a NVZ for surface water, and any surface water drainage connections to watercourses should be assessed to understand the risk of nitrate pollution of watercourses
- the south east of Oswestry lies within a NVZ for groundwater and any proposed infiltration SUDS should include an assessment of the risk of mobilising pollutants in the soil and the risk of groundwater pollution;
- as the majority of developments will be smaller scale, source and site control measures are more likely to be applicable at these sites, and;

- a large number of the proposed SHLAA sites are over 1km from the nearest watercourse[19], which may present a constraint should surface water runoff need to discharge to a watercourse.

8.7 Ironbridge power station

As there is uncertainty over the nature of the proposed development at the Ironbridge power station, the outline WCS has provided an overview of the surface water drainage considerations which should be assessed as part of the development process.

- Surface water runoff rates and volumes from the development site should be agreed with the EA at an early stage of the planning applications. Betterment of existing runoff rates and volumes should be sought.
- Infiltration SUDS should be prioritised, where practicable. It is recognised that because of the impermeable nature of the underlying geology, infiltration SUDS may not be applicable in all cases. In addition, the nature of the existing land use may result in contaminated land which must be assessed where infiltration SUDS are proposed.
- Surface water runoff should not be connected to the public sewerage system. As this is a large site there is considerable land available to store runoff, and discharge it to a watercourse where necessary.
- SUDS should not be built within flood zone 3, because there is a risk they will not operate efficiently up to and including the 100 year flood event.
- Due to the large nature of the site a regional approach to managing surface water is recommended. Under the forthcoming Floods and Water Management Bill Shropshire Council will be responsible for the approval, adoption and maintenance of new build SUDS. It is considered that cost-savings and efficiencies can be gained through larger SUDS features, rather than a series of smaller scale features.

8.8 Market towns, key centres and local centres

For the market towns, key centres and local centres the outline WCS has carried out a high level assessment of the surface water drainage requirements. At this stage, the assessment has included the location of nearest watercourses (which is important for assessing the potential to discharge to a watercourse if required), SPZs, and an overall assessment of the suitability of different SUDS approaches

[19] This assessment has been made using a major and minor watercourse GIS layer, and it is possible that there are missing watercourses, ditches or surface water culverts which could be used for surface water drainage if required.

(based on the county-wide mapping). The results from this assessment are presented in Table 8-11.

Settlement	Approximate distance to nearest watercourse (km)	SPZ	SUDS likely to be suitable
Whitchurch	An unnamed watercourse flows to the western boundary of the settlement. Flood zones 2 and 3 extend across the centre of the settlement which suggests there may be an unknown watercourse flowing through the settlement.	None	Infiltration or attenuation, but to the north of the existing settlement attenuation is more likely to be suitable in places
Market Drayton	This settlement has an unnamed watercourse which flows along the north western boundary and the River Tern which flows along the south eastern boundary. All areas of the catchment are within 0.7 km of a watercourse	1, 2 and 3	Largely suitable for infiltration although presence of SPZ 1 in existing settlement and to the west and east should be noted
Ludlow	There are rivers directly adjacent to the northern, western and southern areas of the settlement. Growth in the east of the settlement would be 1km away from a watercourse.	None	Infiltration or attenuation, although to the south west of the settlement attenuation only will be more applicable
Bridgnorth	River Severn flows through the centre of the settlement and there is also a minor watercourse which flows parallel to the northern boundary of the settlement. All areas of the catchment are within 1 km of a watercourse	None	Eastern half of settlement more suitable for infiltration SUDS, but to the western half of the settlement a combination may be required
Wem	The River Roden flows through the southern part of the settlement. There are two unnamed watercourses to the north of the settlement and it may be possible to drain surface water to these 2 watercourses, if required. Growth in the north of the settlement would be 1 km away from the nearest watercourse	None	Infiltration or attenuation, but to the north of the existing settlement attenuation is more likely to be suitable
Ellesmere	Tetchill Brook flows around the southern and western boundary directly adjacent to this settlement. The north eastern area of the settlement is approximately 1.5 km from this watercourse. There are no known watercourses to the north of the settlement.	None	Infiltration, although development to the east of the settlement might be more suitable for attenuation
Minsterley / Pontesbury	Minsterley Brook flows through the centre of Minsterley. All growth to Minsterley is within 0.4 km of a watercourse. There are no watercourses within the Pontesbury settlement. There is a minor watercourse 1 km to the east and Rea Brook 1 km to the north of the Pontesbury settlement.	None	Infiltration or attenuation

Settlement	Approximate distance to nearest watercourse (km)	SPZ	SUDS likely to be suitable
Bishop's Castle	There are no known watercourses within the settlement boundary. The River Kemp flows approximately 0.8 km south of the settlement.. Development to the north would be >1km to the nearest known watercourse	None	Largely suitable for attenuation, although some infiltration may be possible to the south east of settlement
Church Stretton	Cound Brook flows along the eastern boundary and through the centre of this settlement. There is also a minor unnamed waterourse in the south of the settlement. All areas of the settlement are within 1km of a watercourse.	1,2 and 3	Highly varied permeability, and presence of SPZ 1 to the west of the settlement means the types of SUDS will depend heavily on development location
Cleobury Mortimer	River Rea and an unnamed watercourse flow along the eastern and southern boundaries respectively. All areas of the settlement are within 0.5km of a watercourse	None	Infiltration or attenuation
Clun	River Clun flows through the centre of the settlement. All areas of the settlement are within 0.3km of a watercourse	None	Infiltration or attenuation, depending on depth to groundwater (drift geology is relatively permeable, but solid geology is impermeable)
Craven Arms	The River Onny flows along the eastern boundary of the settlement. Growth in the west of the settlement would be 0.9 km from a watercourse.	None	Infiltration or attenuation
Highley	There are no major or minor watercourses within the settlement. Borle Brook flows parallel, 0.7 km from the western boundary of the settlement and River Severn flows parallel, 0.6km from the eastern boundary of the settlement.	None	Infiltration or attenuation
Much Wenlock	Farley Brook flows through the centre of the settlement. All areas of the settlement are within 0.5km of this watercourse	1, 2 and 3	Attenuation
Shifnal	Wesley Brook flows through the centre of the settlement. There is also a minor water course which flows along the eastern boundary of the settlement. All areas of the settlement are within 0.5km of one of these watercourses.	2 and 3	Infiltration more suitable but must consider presence of SPZ 2 in the east of the settlement

Settlement	Approximate distance to nearest watercourse (km)	SPZ	SUDS likely to be suitable
Prees	Strine Brook flows through the centre of the settlement. All areas of the settlement are within 0.3 km of this watercourse.	None	Infiltration or attenuation, but to the east of the existing settlement attenuation is more likely to be suitable
Shawbury	The River Roden flows through the south eastern area of the catchment - this is approximately 2 km from the north western area of the settlement. Areas to the west of the settlement are closer to Sundorne Brook approximately 1.5 km to the west of the settlement.	None	Infiltration
Woore	There are no known watercourses within the settlement boundary. There are unnamed watercourses approximately 1km to the east and 1.5km to the west of the settlement.	None	Infiltration or attenuation
Baschurch	There are no known watercourses within the settlement boundary. The nearest watercourse is the River Perry 1km to the west of the settlement and War Brook 1 km to the north east of the settlement.	None	Highly varied permeability, and presence of SPZ 1 to the west of the settlement means the types of SUDS will depend heavily on development location
Gobowen	The River Perry flows through the northern part of the settlement. There are flood zones 2 and 3 across the centre and southern areas of the settlement which suggests there is also a watercourse flowing through these areas.	None	Infiltration or attenuation
St. Martin's	The nearest watercourse is Morlas Brook, approximately 1km to the west of the settlement, and there is an unnamed watercourse to the north-east of the settlement (1.7km from existing settlement)	None	Infiltration or attenuation
Whittington	Common Brook flows 0.3km to the south of this settlement. Growth in the north of the settlement would be 1 km away from this watercourse	3	Infiltration
Bayston Hill	There are no known major or minor watercourses within the settlement. There is a minor watercourse 0.2 km to the east and Rea Brook 0.4 km to the north of the settlement. Growth in the south of the settlement would be 1.5 km from a watercourse.	None	Majority of existing settlement is more suitable for attenuation SUDS, but to the north west of the settlement infiltration may be possible

Settlement	Approximate distance to nearest watercourse (km)	SPZ	SUDS likely to be suitable
Dorrington	Cound Brook and an unnamed watercourse flow through the settlement. Therefore all growth in this settlement will be within 1 km of a watercourse	None	Infiltration or attenuation
Albrighton	Albrighton Brook flows through the centre of the settlement. Neachley Brook is adjacent to the settlement and flows from north to west of the settlement. There are also 2 minor watercourses to the north and south of the settlement. All areas of the settlement are within approximately 0.7km of one of these watercourses	3	Highly varied permeability, and presence of SPZ 1 to the west of the settlement means the types of SUDS will depend heavily on development location
Broseley	River Severn flows along the northern boundary of the settlement. A minor watercourse lies to the south of the settlement. All areas of the settlement are within 1km of one of these watercourses	None	Infiltration or attenuation

Table 8-11 Strategic assessment of surface water drainage for market towns, key centres and local centres

8.9 Windfall development

Due to the nature of windfall development, there is no indication of specific locations which might come forward for windfall development at this stage, and thus it is not possible to look at potential site specific surface water drainage requirements. However, it is possible to identify surface water drainage requirements which should be adopted when windfall developments come forward.

The following hierarchy should be adopted to manage surface water runoff from windfall development;

- where possible, infiltrate runoff using infiltration SUDS;
- where this is not possible discharge to watercourse in close consultation with the Environment Agency to ensure no increase in downstream flood risk, and;
- as a last resort connect to the public sewer system, in close consultation with Severn Trent Water.

In brownfield sites, development should seek to better existing runoff rates and volumes where possible, in agreement with the Environment Agency and the Local Planning Authority Land Drainage Officer.

8.10 Conclusions and recommendations

The county wide assessment of the suitability of different types of SUDS has identified where infiltration or attenuation SUDS approaches may be more applicable based on geology, groundwater vulnerability (i.e. aquifer) and source protection zones.

For the strategic urban extensions in Shrewsbury and Oswestry an assessment has been undertaken of the surface water drainage requirements to ensure runoff rates and volumes from the developed site are no greater than greenfield runoff rates and volumes. The analysis indicates that approximately 3-4% of the developable land will be taken up by the requirements to attenuate surface water runoff, and these requirements are not considered a constraint to development. Across the market towns, key centres and local centres, an assessment has been made of the applicability of different types of SUDS.

In general, any development (including developments in Low Probability Flood Zone 1) which does not incorporate SUDS may increase the risk of surface and/or fluvial flooding both on-site and off-site (downstream). As such effective planning policies should be implemented in accordance with the SUDS recommendations provided in this report. The following recommendations are made in light of the findings of the outline WCS:

- As a minimum runoff rates and volumes from the development site should not be greater than runoff rates and volumes prior to development up to the 100 year 6 hour rainfall event (plus an allowance for climate change). In brownfield development sites a reduction of runoff rates and volumes should be achieved compared to the existing rates and volumes. The runoff requirements for a development site should be agreed with the Environment Agency at an early stage in the planning process

- SUDS should be promoted at all scales of development. At the household level there should be a presumption away from connecting property extensions or additional hard-standing area to the sewerage network. The additional runoff should be managed at source, where possible, or connected to a watercourse (in agreement with the Environment Agency).
- Infiltration SUDS should be promoted where it is practical. Where infiltration SUDS are not applicable surface water should be discharged to a watercourse (in agreement with the Environment Agency) at a rate no greater than greenfield.
- Where infiltration SUDS are proposed, this must be supported by a groundwater risk assessment, carried out by the developer, to ensure groundwater is not polluted. Groundwater flooding should also be considered where infiltration SUDS are proposed. The presence of Nitrate Vulnerable Zones (NVZs) must also be considered as part of the development proposal.
- Surface water should not be connected to the sewerage network, unless there is no practicable alternative. Where surface water is required to be connected to the sewerage network, runoff rate from the development site should be controlled to greenfield.
- Where surface water will be connected to a watercourse, early consideration should be given to the proposed route to connect to the watercourse. As the SAB, Shropshire Council should work closely with developers at an early stage of the planning application to understand surface water routes to connect to a watercourse and the potential land ownership issues.
- Where more than one developer comes forward to develop on the strategically allocated land there will be a requirement for each developer to ensure runoff rates and volumes from their site does not exceed existing runoff rate and volume. However, within strategic development areas there are more opportunities to strategically plan the provision of surface water drainage infrastructure, to ensure runoff rates and volumes are not greater than existing across the whole of the area. For example, it may be possible to design an attenuation basin which can store runoff across the whole of the development area, and it is considered that this would be easier to operate and maintain compared to lots of smaller attenuation SUDS on separate sites. Given that Shropshire Council will need to adopt and maintain new build SUDS under the proposed Floods and Water Management Bill, a regional approach to SUDS may result in cost and efficiency savings. This would require early co-ordination and planning by Shropshire Council and it is recommended that a strategic surface water master plan[20] is developed to consider the possibilities and opportunities for the production of a strategic surface water drainage system.
- In greenfield developments there should be no flooding (from all sources) on properties up to the 100 year flood event with climate change. This can be achieved through effective master planning of the development site, and should include an allowance for managing exceedance flows[21] if surface water drainage infrastructure is exceeded. In

[20] This site may not require a full Surface Water Management Plan, as defined by Defra, but some strategic surface water master planning is recommended.
[21] Guidance of managing exceedance flows is provided in "Designing for Exceedance in urban drainage – good practice C635, CIRIA, 2006)

brownfield development it may not be possible to achieve this level of protection depending on the nature of the existing risk, but there should be a presumption against building in areas of high risk

- Runoff which is likely to be heavily contaminated must be treated by a proprietary device, which should be carefully considered to ensure the correct system is selected to remove pollutants. PPS23: Planning and Pollution Control (2004) discusses the requirements to consider the implications of contaminated land and pollution as a material planning consideration. For example; the drainage system for a car park should incorporate a filter bed wherever possible before considering an interceptor device to remove contaminants.
- If the local soil is contaminated then a lined system is generally required. This may include a drainage design which allows infiltration in the upper layer, but should incorporate an impermeable layer at its base to prevent contamination. In such cases lined underground attenuation storage is used to store a 1 in 100 year plus climate change storm event and discharges into a nearby watercourse.

9 Conclusions and recommendations

9.1 Shrewsbury

The key findings and recommendations from the outline WCS which influence growth in Shrewsbury are highlighted below.

- STW has identified that there is sufficient hydraulic capacity at Monkmoor WwTW to accommodate the proposed level of growth.
- STW has not identified any wastewater network infrastructure capacity issues, and it is unlikely that development will cause any hydraulic capacity constraints within the sewerage network. There is currently good hydraulic performance within the sewerage system.
- A new discharge consent will be required at Monkmoor WwTW to ensure no deterioration of water quality downstream of the WwTW. The analysis has shown a new discharge consent can be set within the limits of conventional treatment to ensure no deterioration of current water quality. The analysis has also shown that growth should not hinder the ability to meet the WFD downstream of the works. The findings indicate there are no water quality constraints to accommodating growth at Monkmoor WwTW.
- The proposed urban extension areas in Shrewsbury are at low fluvial flood risk and fluvial flood risk is not considered to represent a constraint to development for the urban extensions. However, some verification of flood zones will be required to confirm this. There is some predicted surface water flooding within the urban extensions, which will need to be considered during master planning of the sites. Proposed development within central Shrewsbury will be more constrained by fluvial flood risk, and each development proposal will need to be accompanied by a site-specific FRA to ensure that inappropriate development is avoided.
- The surface water mapping has identified Shrewsbury as an area of high surface water flood risk, and it is recommended that a SWMP is developed to a) test options to mitigate existing surface water flood risk, and b) to strategically plan the drainage provision within the new developments.
- The assessment for the urban extension areas has indicated that the surface water drainage requirements to ensure runoff rates and volumes do not exceed greenfield runoff rates and volumes will not be a constraint to development. Approximately 2-4% of the available land will be required to attenuate runoff. Infiltration of surface water runoff may be applicable in certain parts of Shrewsbury, and particularly in the extension area to the west.

9.2 Oswestry

The key findings from the outline WCS which influence growth in Oswestry are highlighted below.

- There is currently no hydraulic capacity at Mile Oak WwTW. STW has identified that there are no physical constraints to providing additional infrastructure, but there is an

immediate capacity issue to consider. STW has indicated there are sufficient finances in AMP5 to be able to provide additional capacity to accommodate growth and there is a capital scheme which has been promoted. Given the urban extension area will not come forward until 2014, capacity should be available at the works before these sites are developed. In the short term, Shropshire Council should continue to liaise with STW to confirm development applications will not cause further hydraulic capacity constraints. The hydraulic capacity issue is not considered to be an absolute showstopper to development. In addition, there is a possibility of draining some of the new development in Oswestry to Drenewydd-Oswestry WwTW which does have hydraulic capacity to accept proposed levels of growth up to 2026.

- There is understood to be sufficient wastewater network capacity to accommodate the urban extension area to the east of Oswestry, which lies approximately 1.5km to the north of Mile Oak WwTW. Throughout Oswestry, no major wastewater constraints have been identified, but STW has noted existing flooding problems on Victoria Road, and any development to the west of this will need to be further assessed to confirm there is sufficient capacity in the network.
- Mile Oak WwTW currently exceeds its DWF consent set by the Environment Agency, and will require a new discharge consent to accommodate growth. Modelling work suggests there is potential for a new ammonia consent to ensure no deterioration of current WFD class; however, we consider that growth at Oswestry, to the levels considered by this WCS, are not constrained by environmental capacity.
- There is a very low level of fluvial flood risk in Oswestry, which is unlikely to present a constraint to development. However, some verification of flood zones will be required to confirm this. Based on the surface water assessment, Oswestry has been classified as a high surface water flood risk area, and a SWMP should be developed to consider the complex interactions between different sources of flooding.
- With regards to surface water runoff, the proposed urban extension area lies on a highly permeable geology and surface water runoff should be infiltrated wherever possible. Based on a worst case assessment, approximately 4% of the proposed site will be needed to store surface water runoff to ensure post development rates and volumes do not exceed greenfield runoff rates and volumes. The remainder of growth in Oswestry will be suitable for both infiltration and attenuation approaches to managing surface water, depending on local characteristics of the site.

9.3 Ironbridge power station

A summary of the key evidence with regards to Ironbridge power station is provided below.

- Ironbridge power station site is at high risk of fluvial flood risk, with approximately 20% of the site in flood zones 2 & 3. Whilst this does not present an absolute constraint to development, a detailed site-specific FRA will be required when development proposals come forward to ensure that development is built away from the flood plain as a preference, and in accordance with PPS25.
- The Environment Agency ASTSWF maps indicated that parts of the Ironbridge power station are naturally susceptible to surface water flooding. When development proposals come forward surface water runoff onto the site (from outside the site boundary) will

need to be considered as part of the detailed FRA to influence the location of development. In addition, there should be no flooding up to the 100 year rainfall event, and therefore master planning of the development site will need to incorporate both fluvial and surface water flood risks.

- With regards to surface water drainage, the proposed development should ensure that surface water runoff rates and volumes are reduced compared to the current runoff rates and volumes. The percentage reduction in runoff rates and volumes should be agreed with the Environment Agency early on in the development process. Infiltration of surface water runoff may be applicable in some parts of the site, although careful consideration should be given to the risk of groundwater pollution from any contaminated land.
- No information has been provided by Severn Trent Water with regards to WwTW and wastewater network at Ironbridge power station. Shropshire Council should continue to work with Severn Trent Water to confirm the phasing of development at Ironbridge. Given that the site is unlikely to come forward prior to 2015, there is considered to be a sufficient 'lead-in' time to plan for the wastewater infrastructure needed to serve the future development.

9.4 Market towns, key centres and local centres

A summary of the key findings from the outline WCS for the market towns, key centres and local centres is provided in Table 9-1.

Settlement	WwTW summary	Wastewater network summary	Water quality summary	Flood risk summary	Surface water drainage summary	Overall summary	Preferred location for growth
Whitchurch	Sufficient hydraulic capacity to accommodate growth	Some historical capacity issues in Whitchurch which requires further investigation when development comes forward	No available information on current consented DWF	Low fluvial flood risk identified; some risk through centre of settlement. Recorded incident of SW flooding	Infiltration & attenuation SUDS applicable in Whitchurch	No major constraints to development. Some SW flooding observed and centre of settlement less suitable due to fluvial flood risk	Development in central Whitchurch likely to be less suitable to flood risk. Development to the west would be closer to the WwTW which is preferable from a network perspective
Market Drayton	Sufficient hydraulic capacity to accommodate growth	No known network constraints	New consent **not** needed to accommodate growth	Development may be constrained to the south and north by fluvial flood risk. Some surface water flooding reported	Suitable for infiltration SUDS, although part of settlement does lie in SPZ 1	Suitable site for development, likely to be environmental and infrastructure capacity to accept further growth than planned, subject to more detailed assessment. Some flood risk constraints identified.	Development less suitable to the north & south due to fluvial flood risk. Central part of settlement probably most suitable
Ludlow	No current capacity at the works for additional flows, but no physical constraints to upgrading the works	Known hydraulic restrictions to SE of Ludlow, and CSOs may be affected by development to the NW of Ludlow	New consent needed; no requirement to tighten phosphate consent to ensure no deterioration of class	Development constrained by fluvial flood risk to the north, south and west (and some to SE) Anecdotal evidence of SW flooding in level 1 SFRA and ASTSWF maps indicate medium risk	Infiltration & attenuation SUDS applicable in Ludlow. Development to the east would be approx 1km from nearest watercourse	Wastewater infrastructure constraints will require further investigation by Severn Trent as development proposals come forward, and a new discharge consent will need to be negotiated with the EA. Some flood risk constraints identified	Development most suitable in central and eastern parts of Ludlow, and less suitable to the west due to flood risk. Development to the east may be some distance to a watercourse, however.

Settlement	WwTW summary	Wastewater network summary	Water quality summary	Flood risk summary	Surface water drainage summary	Overall summary	Preferred location for growth
Bridgnorth	WwTW capacity will probably be breached in AMP7 – adequate time to plan upgrades during AMP6	Development to the east would pass through CSO, and known flooding problems which are likely to be addressed in next 2-3 years	New consent needed in AMP7 – no known constraints to setting new consents	Some fluvial flood risk posed in centre and north of settlement. Some risk of SW flooding posed within catchment (from L1 SFRA and ASTSWF maps)	Eastern half of settlement = infiltration Western half of settlement = combination of SUDS	No major constraints to development, although any development to the east may require upgrades to the wastewater network to prevent increase in operation of CSO. Development in the centre is heavily influenced by fluvial flood risk	Development most suitable in western half of settlement, although consideration needs to be given to long flow pathways to the WwTW.
Wem	No current capacity, although sufficient land available to upgrade WwTW (NB close to residential area)	Good hydraulic performance in the catchment, although some internal flooding south of R. Roden	New consent needed – no known constraints to setting new consents	Some fluvial flood risk to the north and south (R. Roden)of settlement SW mapping identifies the area at medium risk	Combination of SUDS likely to be suitable.	WwTW infrastructure needs to be provided prior to development, and new consent needs to be agreed with EA	Development less suitable to the south due to flood risk and flooding problems south of R. Roden.
Ellesmere	No information on Ellesmere WwTW – requires further analysis by Severn Trent	No known capacity issues, although impact on pumping station should be considered if development to the west of Ellesmere	No information on current DWF available to undertake analysis	Fluvial flood risk may constrain development to the south and some parts of the west. Some SW flood vulnerability identified from ASTSWF maps	Predominantly suitable for infiltration SUDS. No known watercourses to the north/north east to connect any SW runoff	Significant uncertainty about current flows to the WwTW – further assessment required by Severn Trent	

Settlement	WwTW summary	Wastewater network summary	Water quality summary	Flood risk summary	Surface water drainage summary	Overall summary	Preferred location for growth
Minsterley / Pontesbury	No current capacity, although sufficient land available to upgrade WwTW (NB close to residential area)	No known flooding problems or CSOs, but pumping station needs to be further examined prior to development	New consent needed – no known constraints to setting new consents	Fluvial flood risk to the centre of settlement and north of Pontesbury Recent development has led to overloading of drains and increase SW flooding in Minsterley Recorded SW flooding in L1 SFRA	Combination of SUDS likely to be suitable. No known watercourses in Pontesbury to connect SW discharges to	WwTW capacity may constrain development in the short term and upgrades are required to serve growth. New development must manage SW in a more sustainable way to prevent increase in SW flooding.	No specific preferred locations although local flood risk is likely to influence development locations
Bishops Castle	Sufficient hydraulic capacity to accommodate growth	Isolated hydraulic capacity issues – single flooding problem to the north and two CSOs in catchment	New consent **not** needed to accommodate growth	No fluvial flood risks identified SW mapping indicates medium risk of SW flooding	Largely suitable for attenuation, although some infiltration possible to the SE. Development to the north would be 1km from nearest watercourse	No major constraints identified; adequate infrastructure and environmental capacity for development and no fluvial flood risks identified. Some development may be at risk from SW flooding	Development to the south and SE would be in closer proximity to the works and closer to watercourse for connecting SW runoff to.

Settlement	WwTW summary	Wastewater network summary	Water quality summary	Flood risk summary	Surface water drainage summary	Overall summary	Preferred location for growth
Church Stretton	Sufficient hydraulic capacity to accommodate growth	Localised hydraulic capacity issues with outfall sewer which takes flows to WwTW. Also a CSO will be affected by development to the N and NW	New consent **not** needed to accommodate growth	Fluvial flooding constraints identified to the east from Cound Brook and south. In winter town covered by surface water flooding Combination of pluvial and fluvial flooding SW mapping indicates medium risk of SW flooding and there are recorded incidents from level 1 SFRA	Variable permeability and presence of SPZ1 to the west – types of SUDS will depend heavily on location	Significant flood risk constraints identified and much of the town is affected by pluvial and fluvial flooding. New development must be adequately protected from flooding and not increase flood risk elsewhere. Some localised capacity issues will need to be confirmed and addressed	As WwTW located 3.8km to the south of the town, development towards to south would be preferable as it would reduce the impact on the wastewater network.
Cleobury Mortimer	Capacity at the works expected to be breached in AMP6 – no known constraints to upgrading the works. Upgrades should be planned for in AMP5	Known hydraulic capacity issues in the network – limited capacity in the main outfall sewer and difficult to upgrade the network due to location of pipes	New consent needed – no known constraints to setting new consents	Minor constraints to the east of the town due to fluvial flood risk Low vulnerability to surface water flooding	Combination of SUDS likely to be suitable	Potentially significant constraints due to wastewater network capacity issues – detailed modelling needed to support any growth to the NW, W or SW of the town	Where possible development should be prioritised towards the eastern parts of the town, although minor fluvial flood risk is present to the east of existing settlement

Settlement	WwTW summary	Wastewater network summary	Water quality summary	Flood risk summary	Surface water drainage summary	Overall summary	Preferred location for growth
Clun	Capacity at the works expected to be breached in AMP6 – no known constraints to upgrading the works. Upgrades should be planned for in AMP5	No known network problems in the settlement. Development to the south would pass through syphon and would require further investigation	New consent needed in AMP6 – no known constraints to setting new consents	Some fluvial flood risks in the centre of the settlement ASTSWF and L1 SFRA indicate medium risk from SW flooding	Combination of SUDS likely to be suitable	No major constraints, but planning required during AMP5 to plan for infrastructure and environmental capacity being reached in AMP6	Development to the north of the river would present fewer risks to the wastewater network.
Craven Arms	Capacity at the works expected to be breached in AMP6 – no known constraints to upgrading the works. Upgrades should be planned for in AMP5	Localised hydraulic restrictions – development to the west of the railway may require upgrades to the network	New consent needed in AMP5/6– no known constraints to setting new consents	High % of existing settlement at fluvial flood risk and some constraints exist to the east of the town SW mapping indicates high risk of surface water flooding	Combination of SUDS likely to be suitable. Development to the west would be approximately 1km from nearest watercourse	Environment Agency maps indicates high vulnerability to SW flooding – SW flooding onto development sites must be assessed as part of development proposals No major infrastructure or environmental capacity constraints, but planning required in AMP5	From a flood risk perspective development to the west is preferable, but development in the west needs to consider upgrades to the wastewater network and distance to watercourse for SW discharges
Highley	Sufficient hydraulic capacity to accommodate growth	No known hydraulic capacity constraints	New consent **not** needed to accommodate growth	No fluvial flood risks identified Low vulnerability to surface water flooding	Combination of SUDS likely to be suitable	No constraints identified, subject to detailed modelling of the wastewater network	No specific preferred locations identified

Settlement	WwTW summary	Wastewater network summary	Water quality summary	Flood risk summary	Surface water drainage summary	Overall summary	Preferred location for growth
Much Wenlock	Capacity at the works expected to be breached in AMP7 – no known constraints to upgrading the works. Upgrades should be planned for in AMP6	Known flooding problem upstream of the main outfall sewer to the WwTW. Also a CSO on the main outfall sewer	New consent needed in AMP5/6– no known constraints to setting new consents	Significant flooding from fluvial and pluvial sources historically ASTSWF maps also indicate high vulnerability to SW flooding	Attenuations based SUDS likely to be most suitable	Significant fluvial and pluvial flood risk, which needs to be further assessed and considered when development comes forward. Minor wastewater network constraints which need further assessment	No specific preferred locations identified
Shifnal	Capacity at the works expected to be breached in AMP6 – no known constraints to upgrading the works. Upgrades should be planned for in AMP5	Reasonable hydraulic performance, but all flows pumped to works by single rising main – capacity needs to be further assessed.	New consent **not** needed to accommodate growth	Minor constraints from fluvial flood risk in the centre of settlement and unmanned watercourse to the east ASTSWF maps indicate 20% of settlement vulnerable to SW flooding	Infiltration most suitable but must consider presence of SPZ2 to east of settlement	Settlement is highly vulnerable to surface water flooding – not an absolute constraint to development but requires a surface water management strategy to ensure development is safe from flooding. Infrastructure and environmental capacity not expected to pose a major constraint to development	Development to the south would be preferable due to reduced impact on wastewater network (shorter flow path to the works)
Prees	Sufficient hydraulic capacity to accommodate growth	No known flooding problems, but one CSO which drains catchment to the east of Mill St SPS	New consent **not** needed to accommodate growth	Small percentage of settlement affected by flood zone 2 & 3 (Strine Brook) Low vulnerability to SW flooding and no recorded incidents	Combination of SUDS likely to be suitable, but to the east more suitable for attenuation based SUDS	Favourable location for development – consideration will need to be given to impacts on CSO if development drains through CSO upstream of Mill St SPS	No specific preferred locations, but impact on wastewater network is likely to be lower to the south (close proximity to the works)

Settlement	WwTW summary	Wastewater network summary	Water quality summary	Flood risk summary	Surface water drainage summary	Overall summary	Preferred location for growth
Shawbury	No current capacity at the works for additional flows, but no physical constraints to upgrading the works	One known flooding problem to SW of pumping station (although proposed scheme to resolve)	New consent **not** needed to accommodate growth	Minor constraint to the east by Roden Brook and to the west by Sundorne Brook Low vulnerability to SW flooding and no recorded incidents	Predominantly suitable for infiltration SUDS. Development to the NW and W would be >1.5km to the nearest watercourse	Relatively favourable location for development, but current capacity at WwTW will need to be further assessed prior to development going ahead.	No specific preferred locations – development to the east and west should consider fluvial flood risk as part of developer FRAs
Woore	Sufficient hydraulic capacity to accommodate growth	No known network constraints	New consent **not** needed to accommodate growth	Settlement fully located in flood zone 1 and no watercourses identified Low risk of SW identified from ASTSWF maps, and no recorded incidents	Combination of SUDS likely to be suitable. No know watercourses within 1.5km of settlement could pose a constraint to SW runoff connecting to watercourses	No major constraints to development identified, but distance to watercourses could pose a constraint to SW runoff being connected to watercourses	No specific preferred locations identified
Baschurch	No current capacity at the works for additional flows, but no physical constraints to upgrading the works	No known network constraints	New consent needed – no known constraints to setting new consents	Settlement fully located in flood zone 1 and no watercourses identified Low risk of SW identified from ASTSWF maps, and no recorded incidents	Highly variable permeability. Nearest known watercourse is 1km from the settlement which may be a constraint to connecting SW runoff to watercourse	No current infrastructure capacity at the WwTW – upgrading of the works will be needed to serve growth. New discharge consents also required, although this should not pose a constraint to development. Lack of proximity to watercourses needs to be considered	Development to the south and east would be in closer proximity to the works, and closer to watercourses (should SW need to be discharged to watercourses). On the contrary development to the north less preferable.

Settlement	WwTW summary	Wastewater network summary	Water quality summary	Flood risk summary	Surface water drainage summary	Overall summary	Preferred location for growth
Gobowen	Sufficient hydraulic capacity to accommodate growth	Flows drain to Gobowen SPS, and then pumped to the works. One known flooding problem being assessed for localised fix	New consent **not** needed to accommodate growth	Fluvial flood risk to NW and E of settlement (R. Perry) and to SW and east ASTSWF indicates low vulnerability to SW flooding, although 1 recorded incident in level 1 SFRA	Combination of SUDS likely to be suitable	No major constraint identified, although consideration of fluvial flood risk may influence development locations. Further assessment needed of capacity of pumping station	No specific preferred locations identified
St Martins	Sufficient hydraulic capacity to accommodate growth	Localised hydraulic capacity issues; further detailed modelling needed to determine if upgrades required	No information available on current DWF	No fluvial flood risk identified, and low vulnerability to SW flooding	Predominantly suitable for infiltration or attenuation SUDS.	Favourable location for development and not constraints identified for proposed development	No specific preferred locations identified
Whittington	Sufficient hydraulic capacity to accommodate growth	Flows drain to Whittington SPS, and then pumped to the works. No known flooding problems	New consent **not** needed to accommodate growth	Fluvial flood risks from 2 unnamed watercourses to the SE/E and NE Some SW capacity issues identified – resulting in flooding	Predominantly suitable for infiltration SUDS.	No major constraints to development, but fluvial flooding and needs to be further assessed through FRAs. Shropshire Council should investigate culvert capacity issues on the A5	No specific preferred locations identified

Settlement	WwTW summary	Wastewater network summary	Water quality summary	Flood risk summary	Surface water drainage summary	Overall summary	Preferred location for growth
Bayston Hill	Sufficient hydraulic capacity to accommodate growth	Isolated hydraulic performance issues (e.g. flooding in Pulley Lane). Development in the centre and to the east may affect CSO	New consent needed in AMP6/7– no known constraints to setting new consents	Some fluvial constraints to the east (Money Brook) and west (unnamed watercourse), which should be included in FRAs Low vulnerability to SW flooding	Combination of SUDS likely to be suitable. Development to the south would be approx 1.5km fro nearest watercourse which could constrain SW discharging to watercourse	Needs to be considered alongside growth in Shrewsbury. Infrastructure capacity should be achievable at Monkmoor and new discharge consents are likely to be granted by the EA.	Development preferable to the north and north east of the settlement will be closer to Monkmoor, closer to a watercourse (for discharging SW runoff) and would not affect CSO in centre
Dorrington	No current capacity at the works for additional flows, but no physical constraints to upgrading the works	No known network constraints	New consent needed in AMP6– no known constraints to setting new consents	Low vulnerability to SW flooding, but some constraints to development from the Cound Brook	Combination of SUDS likely to be suitable.	No current hydraulic capacity at the WwTW. Provided WwTW capacity can be provided in a timely manner growth should not be significantly constrained in Dorrington	

Settlement	WwTW summary	Wastewater network summary	Water quality summary	Flood risk summary	Surface water drainage summary	Overall summary	Preferred location for growth
Albrighton	No current capacity, although sufficient land available to upgrade WwTW (NB close to residential area)	Works ongoing to resolve existing flooding problems. Hydraulic modelling required to ensure development does not worsen flooding upstream of works. MOD site would drain by gravity to the works	Without MOD growth the works will not exceed DWF consent, with MOD new DWF consent would be needed. Likely to require phosphate consent beyond limit of conventional treatment to achieve both no deterioration and WFD good status	High flood risk identified from both fluvial and pluvial sources	Highly varied permeability means both infiltration and attenuation SUDS will be applicable. Presence of SPZ1 to the west should be considered	Integrated flood risk strategy required to ensure development not at risk from all sources of flooding and does not increase d/s flood risk. No existing WwTW infrastructure capacity and receiving watercourse will not be able to meet no deterioration or good WFD status without a phosphate consent significantly beyond the limit of conventional treatment	No specific locations identified, but existing fluvial and pluvial flood risk issues need to be factored in when planning new development locations
Broseley	No current capacity, although sufficient land available to upgrade WwTW (NB works located between R. Severn to east and railway line to west)	No known flooding problems, but CSOs on each catchment draining to PS. Impact of development on PS needs further assessment	New consent needed – no known constraints to setting new consents	Some fluvial constraints to development to the north (R Severn) and south (unnamed watercourse). Low vulnerability to SW flooding identified	Combination of SUDS likely to be suitable.	Provided WwTW capacity can be built in a timely manner this should not prevent development. A UPM study would be required to ensure CSOs do not operate more frequently.	Development to the east would have less impact on the wastewater network and would be in closer proximity to the WwTW

Table 9-1 Key findings from the outline WCS for the market towns, key centres and local centres

Appendix A. The Water Framework Directive

A1 Introduction

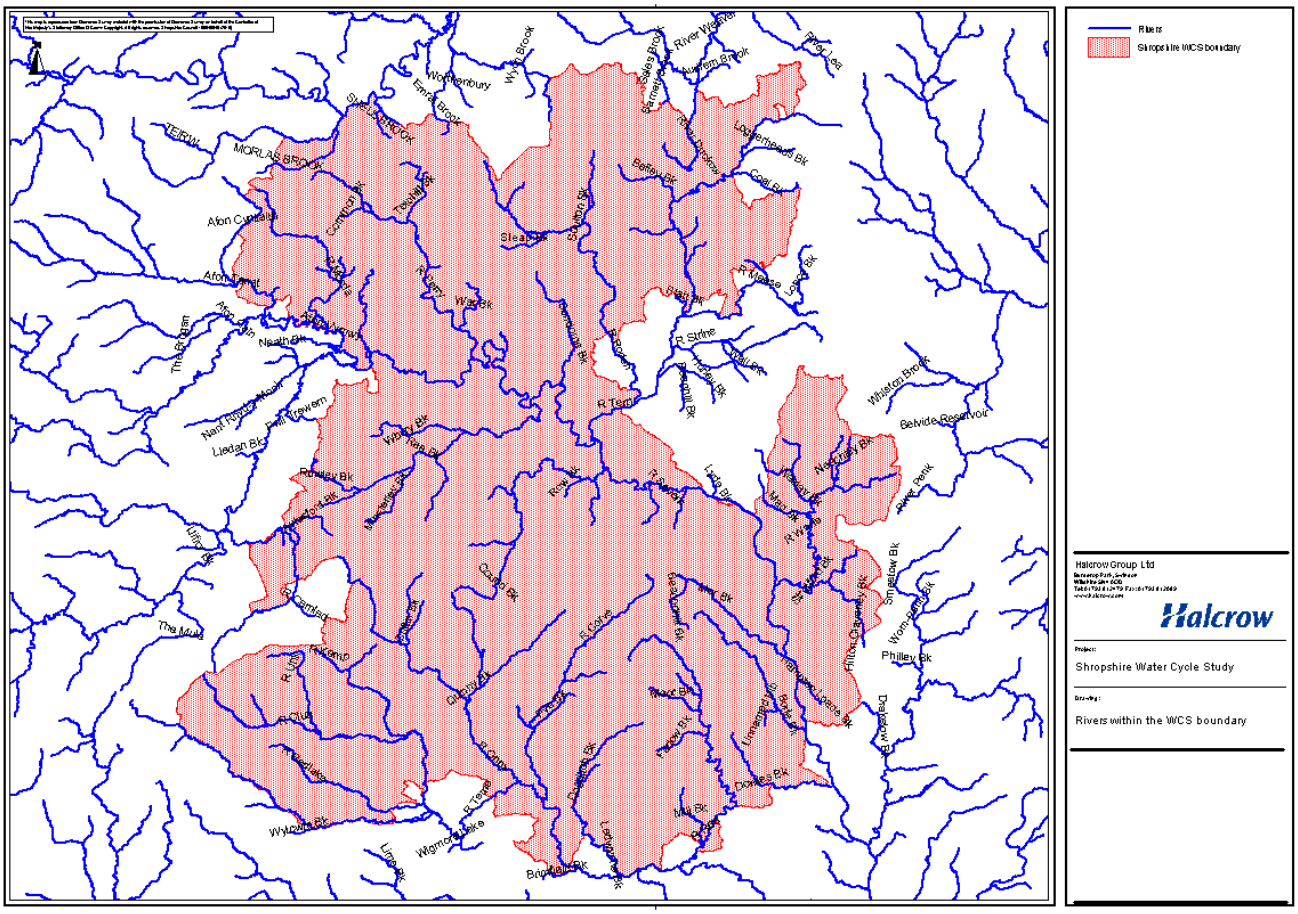


Figure A-1 Study area – Environmental assets

The Shropshire water cycle study area covers seven river basin catchment areas, Teme, Severn Uplands, Shropshire Middle Severn, Worcestershire Middle Severn, Weaver/Gowy, Middle Dee and Upper Dee. These catchments include the River Severn, Rea, Onny, Teme, Corve, Perry, Tern, Clun, and Morda. The study area covers the urban areas of Shrewsbury, Oswestry, Bridgnorth, Whitchurch, Market Drayton and Ludlow.

A2 The Water Framework Directive

The Water Framework Directive (WFD) came into force in December 2000, and was transposed into UK law in December 2003. It is the most substantial piece of European Commission water legislation to date and is designed to improve and integrate the way water bodies are managed throughout Europe. Under the WFD all Member States must:

- prevent deterioration in the classification status of aquatic ecosystems, protect them and improve the ecological condition of waters;
- aim to achieve at least good status for all waters. Where this is not possible, good status should be achieved by 2021 or 2027;

- promote sustainable use of water as a natural resource;
- conserve habitats and species that depend directly on water;
- progressively reduce or phase out releases individual pollutants or groups of pollutants that present a significant threat to the aquatic environment;
- progressively reduce the pollution of groundwater and prevent or limit the entry of pollutants, and;
- contribute to mitigating the effects of floods and droughts.

A2.1 No deterioration

The first principle of the WFD is to prevent deterioration in aquatic ecosystems. No deterioration must be met in all but very exceptional circumstances. Exceptional circumstances apply when the deterioration is caused by physical modifications to the waterbody, for example for flood risk management reasons, or the result of sustainable new human development activities. Even in such cases it is necessary to demonstrate that there was no better way to achieve the desired development, that there are no possible mitigation measures, and that it is technically infeasible or disproportionately expensive to do so. In addition, no deterioration requires that a water body does not deteriorate from its current ecological or chemical classification, and applies to individual pollutants within a water body. The Directive allows for deterioration within the limits of a status or classification. For example, if dissolved oxygen was currently classified as moderate status, then the first principle of the WFD would be to ensure no deterioration from moderate class, and the limited numerical deterioration acceptable within each classification or status would not constitute a breach of the Directive or be reported as deterioration. In exceptional circumstances only, it is acceptable to allow a deterioration of chemical status from high to good status only.

Box A.1 shows article 4.7 of the Directive which covers the exemptions from no deterioration.

Box A.1: Text of Water Framework Directive Article 4.7

Member States will not be in breach of this Directive when:

- *failure to achieve good groundwater status, good ecological status or, where relevant, good ecological potential or to prevent deterioration in the status of a body of surface water or groundwater is the result of new modifications to the physical characteristics of a surface water body or alterations to the level of bodies of groundwater, or*

- *failure to prevent deterioration from high status to good status of a body of surface water is the result of new sustainable human development activities*

and all the following conditions are met:

(a) all practicable steps are taken to mitigate the adverse impact on the status of the body of water;

(b) the reasons for those modifications or alterations are specifically set out and explained in the river basin management plan required under Article 13 and the objectives are reviewed every six years;

(c) the reasons for those modifications or alterations are of overriding public interest and/or the benefits to the environment and to society of achieving the objectives set out in paragraph 1 are outweighed by the benefits of the new modifications or alterations to human health, to the maintenance of human safety or to sustainable development, and

(d) the beneficial objectives served by those modifications or alterations of the water body cannot for reasons of technical feasibility or disproportionate cost be achieved by other means, which are a significantly better environmental option.

A2.2 Good status

Under the WFD the objective is for all water bodies to meet good ecological status by 2015. For surface waters (rivers, lakes, transitional waters), good ecological status can be defined as:

- good chemical status for the relevant substances (there are also a series of daughter directives);
- good physico-chemical status on the scale high, good, moderate, poor and bad;
- good biological class, and;
- good hydro-morphological class.

The status of a water body is measured through a series of specific standards and targets that have been developed by the UK administrations, supported by the WFD UK Technical Advisory Group (www.wfduk.org).

The manner in which overall status is assessed is by using a 'one out, all out' approach. That is, the status is determined by the lowest common denominator. The following diagram shows how this works in practice.

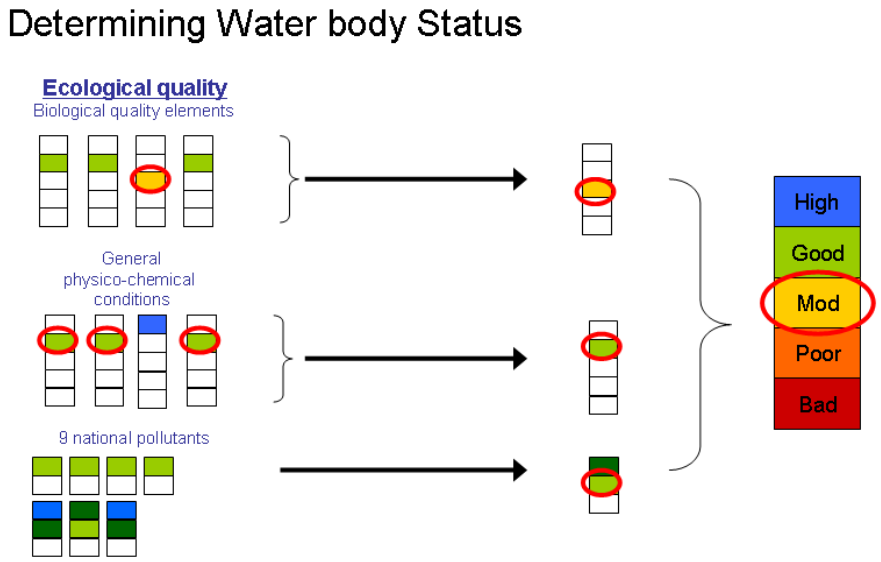


Figure A-2 Determining water body status

A2.3 Alternative objectives

Although the WFD specifies that good status should be met by 2015 there are circumstances where it is possible to delay meeting good status until 2021 or 2027, or where a lesser objective will be required. These circumstances include technical feasibility, disproportional costs, or natural conditions (recovery times). In most instances it is likely that these circumstances will lead to an extended deadline (i.e. 2021 or 2027) to meet good status, rather than setting a less stringent objective. A less stringent objective can be set for specific bodies of water when they are so affected by human activity, or their natural condition is such that the achievement of these objectives would be infeasible or disproportionately expensive, subject to certain conditions being met. These conditions include that the environmental and socioeconomic needs served by such human activity cannot be achieved by other means, which are a significantly better environmental option not entailing disproportionate costs, that the highest ecological and chemical status possible is achieved, given impacts that could not reasonably have been avoided due to the nature of the human activity or pollution, and that no further deterioration occurs.

Under Article 4 (3) of the WFD it is possible to designate water bodies as artificial or heavily modified water bodies. The WFD recognises that some water bodies have been modified to provide valuable social or economic benefits, and it is recognised these water bodies are not able to achieve natural conditions, and hence should not be required to achieve good ecological status. Artificial or heavily modified water bodies therefore have an alternative objective of meeting "good ecological potential" and these are identified in the draft River Basin Management Plans.

A2.4 River Basin Management Plans

In England and Wales, the Environment Agency is the lead authority in ensuring delivery of the WFD. The Environment Agency has prepared draft River Basin Management Plans (dRBMP), published for consultation in December 2008, which set out:

- the current status for each water body (including confidence limits);
- the objectives and targets for each water body;
- the main pressures for each water body;
- an action plan outlining what will be required, by whom, and when to meet good ecological status, and;
- justification for setting an alternative objective by 2015.

Following the consultation of the dRBMP, they will be adopted as the first RBMP in December 2009, with the aim of meeting the main environmental objectives by December 2015. RBMPs will then be periodically reviewed and updated every six years (i.e. 2021, 2027).

The Shropshire water cycle study area lies predominantly in the Severn river basin district, a small area at the north of the WCS area also lies in the Dee and North West River Basin districts. The data in this section has been taken from the Dee, Severn and North West RBMPs.

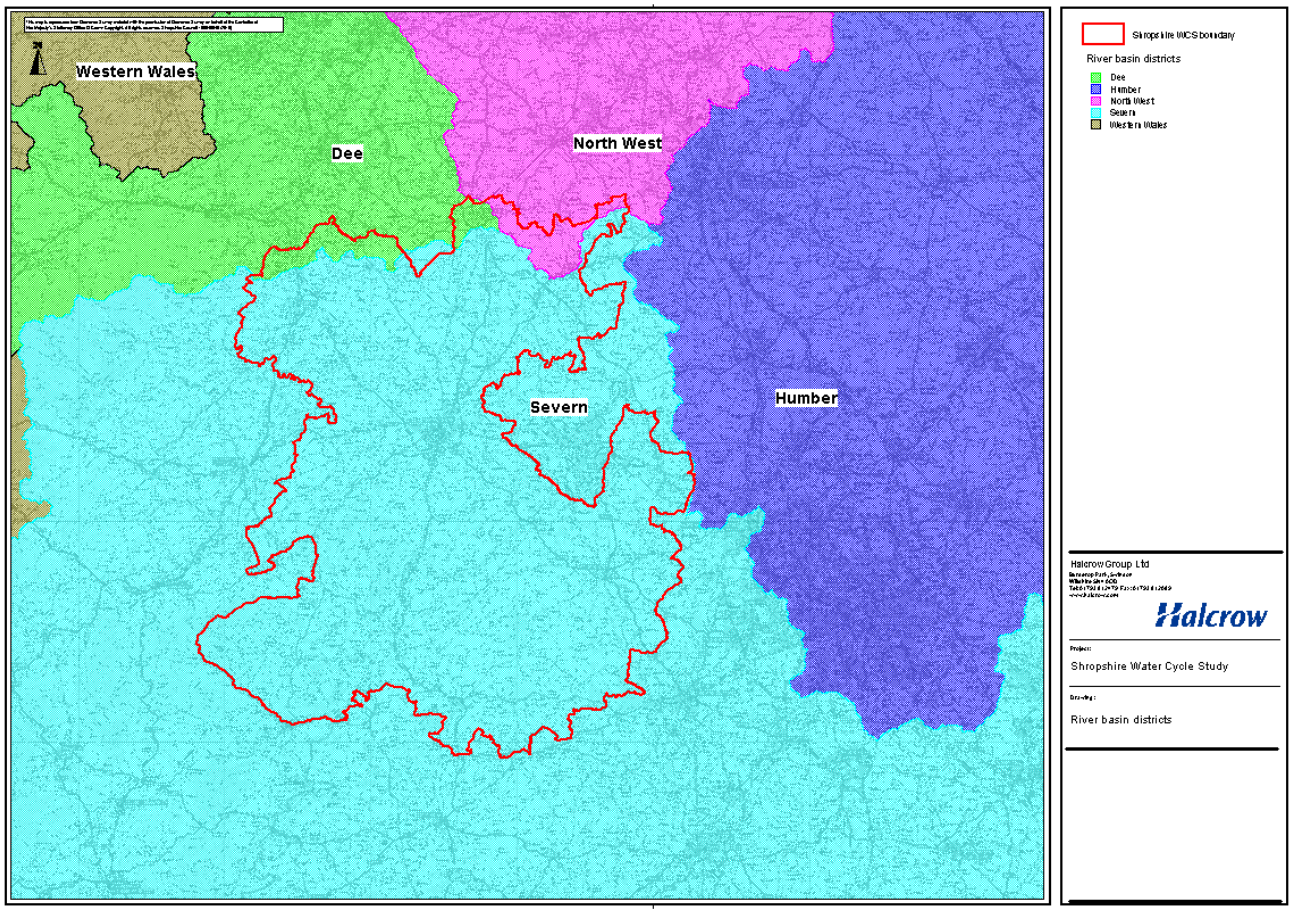


Figure A-3 River Basin districts in the Shropshire water cycle study area

A2.5 RBMPs – surface water

Dee River Basin District

Key statistics for the Upper Dee catchment at a glance

River and lake water bodies	Now	2015
Per cent at good ecological status or potential	40	53
Per cent assessed at good or high biological status *	58	58
Per cent assessed at good chemical status	80	80
Per cent at good status overall (chemical and ecological)	40	52
Per cent rivers improving for one or more element	-	44

* 52 water bodies assessed

Table A-1 Current and future water bodies status in Upper Dee catchment

The Upper Dee catchment is largely rural. It includes the main River Dee from its source above Llyn Tegid, in Snowdonia National Park, down through the Vale of Llangollen to the confluence with the Afon Ceiriog. The main areas of population are at Bala, Corwen, Llangollen and Wrexham.

Diffuse inputs such as sediments from both agriculture and forestry can affect the biological quality in parts of the catchment and some of the lakes are subject to nutrient pressure. Some

tributaries in the upper catchment are impacted by acidification or elevated metals, while others have had ecological impacts from pesticides in recent years but have largely recovered now.

Key statistics for the Middle Dee catchment at a glance

River and lake water bodies	Now	2015
Per cent at good ecological status or potential	7	10
Per cent assessed at good or high biological status *	19	19
Per cent assessed at good chemical status	67	67
Per cent at good status overall (chemical and ecological)	7	10
Per cent rivers improving for one or more element	-	14

* 16 water bodies assessed

Table A-2 Current and future water bodies status in Middle Dee catchment

The Middle Dee includes the remainder of the main River Dee from the Ceiriog down to the canalised section below Chester. Major tributaries are the river Alyn, Worthenbury Brook and Aldford brook. The main centres of population are at Chester, Mold and Whitchurch.

Here the Dee meanders though the Cheshire Plains where the landscape is dominated by dairy and arable farming. Larger manufacturing industries and the retail sector also play a key role in the economy of this area. The major drinking water abstractions are taken from this section of the Dee. The Dee meanders site is designated for its fluvial geomorphological interest which occurs in England and Wales as a Geological Conservation Review site (GCR 2955).

The biological and ecological quality here is under more pressure than the Upper Dee. These pressures include diffuse urban and diffuse rural pollution, as well as nutrient pressure from point sources such as sewage works. Physical modification also affects the rivers, with many of the brooks modified in their lower sections for flood alleviation. There are also some notable man made obstructions to fish migration, particularly on the River Alyn.

North West River Basin District

Key statistics for the Weaver Gowy catchment at a glance

River and lake water bodies	Now	2015
Percent at good ecological status and potential	13	17
Percent assessed at good or high biological status*	18	28
Percent assessed at good chemical status**	43	43
Percent at good status overall (chemical and ecological)	13	17
Percent improving for one or more element in rivers		41

* 67 water bodies assessed

** 7 water bodies assessed for chemical status

Table A-3Current and future water bodies status in Weaver Gowy catchment

The Weaver Gowy catchment is characterised by low-lying rolling countryside and beautiful plains however, parts are heavily industrialised. The River Weaver flows through dairy farmed areas of Cheshire, through Nantwich and onto Winsford where it becomes impounded and navigable, joining the Manchester Ship Canal at Runcorn. The Gowy runs to the east of Chester and meets the Mersey Estuary near the oil refinery at Stanlow.

Rural land use and agriculture is a major feature of the Weaver Gowy catchment and agricultural and septic tank pollution are common problems. Industry is concentrated around the lower catchment near Runcorn, which is an area particularly known for its chemical industry, and Ellesmere Port. The catchment is also known for its salt mines which supply salt for industrial use and for road gritting. In parts, the aquatic ecology suffers from current and past industrial discharges compounded by river modifications including weirs and locks that act as barriers to fish migration.

Severn River Basin District

Key statistics at a glance – Severn Uplands

River and lake water bodies	Now	2015
% at good ecological status or potential	**44**	**57**
% assessed at good or high biological status *	50	53
% assessed at good chemical status	50	50
% at good status overall (chemical and ecological)	44	57
% rivers improving for one or more element	-	19

* 60 water bodies assessed

Table A-4 Current and future water bodies status in Severn Uplands catchment

The Severn Uplands area is predominantly rural in character with the main towns being Oswestry, Llanidloes, Welshpool and Newtown. The catchment includes the Clywedog and Vyrnwy reservoirs in the west and the rivers Severn and Vyrnwy as well as a collection of many small tributaries.

The conservation value of the catchment is high with a large number of designated sites. The tributaries support a diverse range of ecology associated with good water quality. However, the headwaters of many streams along the western uplands are impacted by acid runoff or drainage from abandoned metal mines. Sheep dip and sediment run-off cause ecological impacts in several rivers such as the Tanat, Vyrnwy and Cain. The fish communities are dominated by brown trout and migratory Atlantic salmon and the tributaries of the Severn provide important spawning grounds for both species. The distribution of salmon is limited by the presence of obstacles such as waterfalls.

Key statistics at a glance – Shropshire Middle Severn

River and lake water bodies	Now	2015
% at good ecological status or potential	**6**	**6**
% assessed at good or high biological status *	14	17
% assessed at good chemical status	86	86
% at good status overall (chemical and ecological)	6	6
% rivers improving for one or more element	-	5

* 36 water bodies assessed

Table A-5 Current and future water bodies status in Shropshire Middle Severn catchment

The Shropshire Middle Severn catchment is largely rural with a few towns such as Shrewsbury, Newport, Market Drayton and part of Telford, although there is significant pressure for urban development. The catchment includes the River Severn and its tributaries. The area is ecologically

rich and includes a large number of designated sites, most of which come under the Midlands Meres and Mosses Ramsar Site. There are also several water related Special Areas of Conservation (SAC) in this area.

Abstraction for public supply and irrigation for agriculture can have a major impact on water resources. Several rivers are over abstracted or over licensed at low flows, for example the Coley Brook and rivers Perry and Tern. The rivers Tern and Roden suffer from excessive plant and algal growth due to excessive levels of nutrients from sewage works effluent, other industries and farming.

Key statistics at a glance – Worcestershire Middle Severn

River and lake water bodies	Now	2015
% at good ecological status or potential	**21**	**21**
% assessed at good or high biological status *	26	29
% assessed at good chemical status	90	90
% at good status overall (chemical and ecological)	21	21
% rivers improving for one or more element	-	15

* 42 water bodies assessed

Table A-6 Current and future water bodies status in Worcestershire Middle Severn catchment

The Worcestershire Middle Severn catchment is predominantly rural, but contains significant urban areas including parts of Telford, Wolverhampton, Dudley, Kidderminster and Worcester. As well as the River Severn itself, the main watercourses are the rivers Worfe, Stour and Salwarpe which are subject to unsustainable levels of abstraction at low flows. The area has many water dependent sites protected for their biodiversity and designated Sites of Special Scientific Interest. There are also two Special Areas of Conservation (SAC).

Key statistics at a glance – Teme cathment

River and lake water bodies	Now	2015
% at good ecological status or potential	60	65
% assessed at good or high biological status *	69	75
% assessed at good chemical status	50	50
% at good status overall (chemical and ecological)	58	63
% rivers improving for one or more element	-	19

* 32 water bodies assessed

Table A-7 Current and future water bodies status in Teme catchment

The River Teme is a rural river which passes through the market towns of Knighton, Ludlow and Tenbury Wells before joining the River Severn south of Worcester. Major tributaries include the rivers Clun, Onny, Corve and Rea. The whole of the River Teme is classed as a Site of Special Scientific Interest (SSSI) and parts of the River Clun are classed as a Special Area of Conservation (SAC).

Brown trout and migratory Atlantic salmon are found throughout the majority of the Teme catchment and its tributaries provide extensive spawning grounds for both species. The presence of obstacles such as weirs limits the distribution of salmon within the catchment. Water quality in

the lower reaches of the catchment is affected by diffuse pollution, mainly by nutrients and sediment. Whilst there is adequate supply of surface water in the catchment during the winter months, in the summer the Teme often experiences low flows. Abstraction mainly provides water for irrigation for agriculture, with increased use for trickle irrigation.

A2.6 RBMPs - Groundwater

Groundwater good status has a quantitative and a chemical component. Together these provide a single final classification: good or poor status. Poor quantitative status occurs if there could be adverse impacts on rivers and wetlands, where there is saline intrusion due to abstraction or where it is not certain that the amount of groundwater taken will be replaced each year by rainfall. Poor chemical status occurs if there is widespread diffuse pollution within the groundwater body, the quality of the groundwater is having an adverse impact on wetlands or surface waters, where there is saline intrusion due to over abstraction, or the quality of water used for potable supply is deteriorating significantly. There are other objectives for groundwater quality in addition to meeting good status. These are the requirements to prevent or limit the input of pollutants to groundwater and to implement measures to reverse significant and sustained rising trends in pollutants in groundwater.

Severn RBMP

There are 40 groundwater bodies in the Severn river basin district. 75 per cent of these are currently at good status overall. 78 per cent are at good chemical status and 65 per cent are currently at good quantitative status.

The main reasons for poor status are high or rising nitrate concentrations, with some failures for pesticides and other chemicals. The main reason for poor quantitative status in groundwater is that abstraction levels – mainly for drinking water – exceed the rate at which aquifers recharge. Unsustainable abstraction from groundwater is an important issue for the river basin district. The majority of the 25 per cent of groundwater bodies at poor quantitative status are the principal aquifers used for drinking water.

The RBMP states that there will not be any improvement for groundwater bodies during the first plan cycle to 2015 but also there will be no deterioration in status either. Improvement will take place over longer timescales. It takes time for clean recharge water to replenish the aquifers and because of this some groundwater bodies often take decades to recover from the effects of pollution. Concentration of pollutants can continue to rise for years after the pollution sources have been brought under control due to the time it takes for clean recharge water to reach the water table.

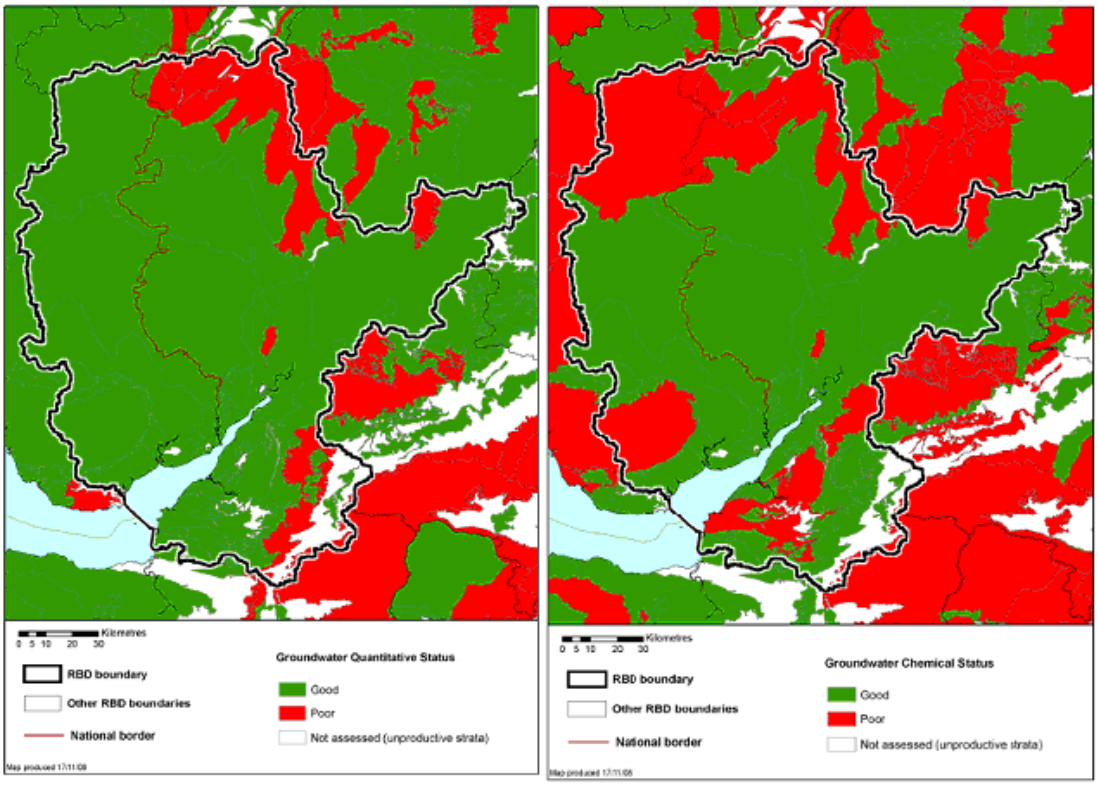


Figure A-4 shows the predicted quantitative (left) and chemical status (right) of groundwater in the Severn river basin district in 2015.

The plan identifies a range of actions to prevent deterioration and improve groundwater elements:

- Catchment Sensitive Farming or other advice led partnerships to address diffuse pollution;
- designation and enforcement of Nitrate Vulnerable Zones;
- pollution prevention activities to reduce diffuse pollution entering groundwater;
- controls on abstraction of water from groundwater bodies;
- investigations to better understand the impact of the major groundwater abstractions in the river basin district.

North West RBMP

In the North West river basin district, currently 61 percent of groundwater bodies are at good quantitative status and 44 percent are at good chemical status however only 22 percent are at overall good status.

The main reasons for poor status are high or rising nitrate concentrations, with some failures for pesticides and other chemicals. The main reason for poor quantitative status is that abstraction levels exceed the rate at which the aquifers recharge.

There will be no deterioration in groundwater status by 2015, improvement will take place over longer timescales. 61 percent of groundwater bodies are currently at good quantitative status which will be unchanged by 2015. 44 percent of groundwater bodies are currently at good chemical status and the figure will improve to 50 percent by 2015.

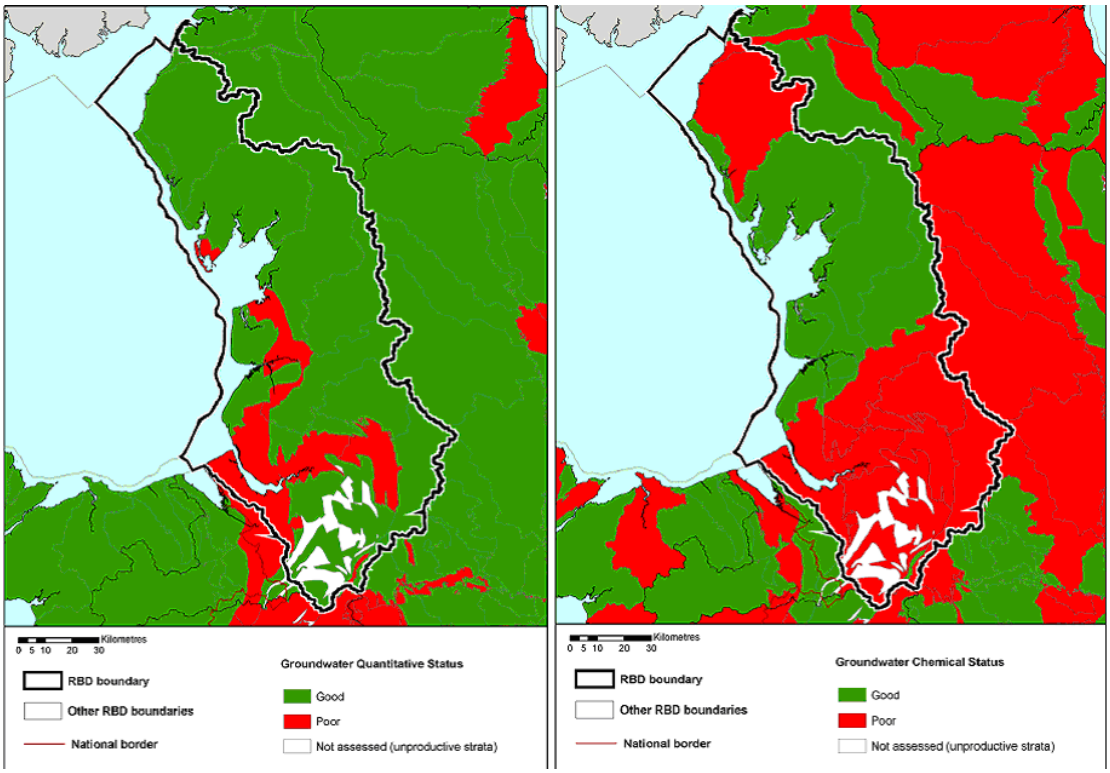


Figure A-5 shows the predicted quantitative (left) and chemical status (right) of groundwater in the North West river basin district in 2015.

In implementing the River Basin Management Plan, the Environment Agency will work with partners to improve our groundwater bodies through:

- Monitor and investigate mining related issues in aquifers.
- Investigate sources of ammonia in the Lune, Wyre and Ribble aquifers.
- Investigate Wybunbury Moss to assess if it has been significantly damaged because of groundwater pollution.
- Manage the abstraction of groundwater for industrial and commercial use through Catchment Abstraction Management System (CAMS).
- Work with the Coal Authority on various schemes to pump and treat minewater discharges.
- Use environmental permitting and pollution prevention campaigns to control discharges of hazardous substances into groundwater.
- The Environment Agency investigating, with partners, waters that are at less than good status.
- The Environment Agency continuing to monitor and investigate the increasing trends in nitrate and phosphorus in the South Cumbria Aquifers.

- Minimising and managing risks from saline intrusion of the Wirral And West Cheshire, Manchester And East Cheshire and Lower Mersey Basin And North Merseyside Aquifers, we will apply abstraction licensing controls.

Dee RBMP

In the Dee river basin district, currently 83 percent of groundwater bodies are at good quantitative status and 83 percent are at good chemical status. 67 percent are at overall good status.

The reason for poor status is due to the impact of minewaters from historic coal and metal mining activities. The main reason for poor quantitative status is due to the associated surface water impact, with the amount of groundwater baseflow (affected by local abstractions) being considered to be a contributing factor to the poor status of these surface waters.

The RBMP states that compliance will be maintained for quantitative and chemical status up to 2015. It is necessary to prevent or limit the input of pollutants into groundwater and implement measures to reverse any significant trends in pollutants. The 'prevent or limit' objective in the Water Framework Directive is the first line of defence for groundwater, and will drive action on point source pollution as well as the widespread pollutants such as nitrate that are causing deteriorating trends. As a result of these challenges, it may not be possible to achieve the objective of good status in all groundwater by 2027.

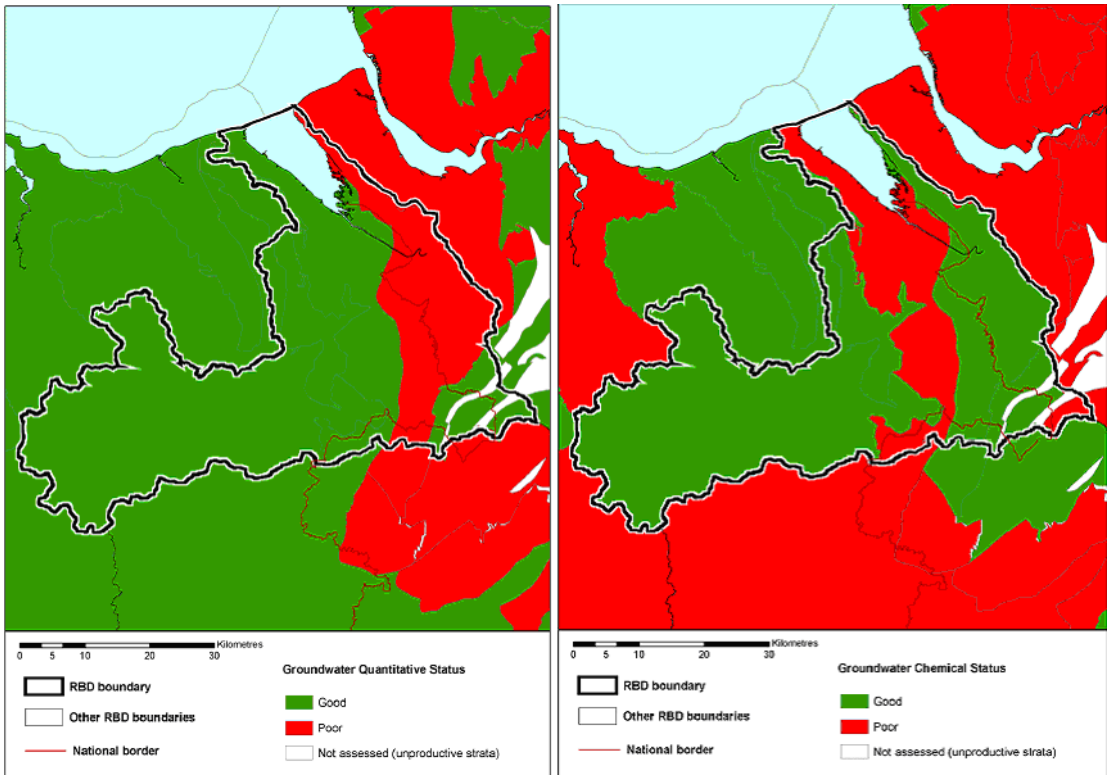


Figure A-9-1 shows the predicted quantitative (left) and chemical status (right) of groundwater in the Dee river basin district in 2015.

Some key actions for ground water:

- Proposals to address these issues include pollution prevention work to reduce the risk of groundwater pollution.

Appendix B. Overview of water company planning

B.1 Water Company Planning

STW has a responsibility to provide sufficient quantity and quality of water to meet the needs of its customers, whilst also minimising their impacts on the environment. This responsibility also applies to new customers and population growth, as well as changing demands within the existing customer base and so must be comprehensively planned for.

All water companies have a duty to produce water resource plans covering the next 25 years. These plans set out how companies intend to provide sufficient water to meet their customers' needs. Although not previously compulsory, companies have prepared 25 year water resource management plans on a voluntary basis, and shared these with the Government and regulators, since 1999. On 1 April 2007 these plans became compulsory under changes to the Water Industry Act 1991, and drafts were released for public consultation in 2008. Subsequent to comments received on the draft, STW released a Statement of Response (SoR), which summarises proposed changes to be made for the final WRMP09 due to be published in 2010.

B.1.1 Asset Management Planning

Whilst strategic plans for meeting future demand over a 25 year period are set out in the WRMP, detailed design of schemes is not undertaken until works have been granted funding by Ofwat.

Any improvements to the water services infrastructure needs to be programmed into a water company's capital programme, which runs in five year Asset Management Plan (AMP) cycles. We are currently in the AMP4 period (2005-2010) and water companies are in the process of preparing for its next submission to Ofwat, to determine its allowable capital expenditure for AMP5 (2010-2015). This funding cycle and its associated constraints can have implications for the phasing of development, and it is important that water companies are involved in the planning process to ensure that infrastructure can be provided in time.

B.2 Severn Trent Water Resource Strategy

B.1.2 Current Status

Within WRP04 STW identified a number of shortfalls in water resource capacity affecting their ability to meet target levels for the Severn Zone (WRZ3). A strategy was developed for implementing investment schemes during AMP4 which would remove this shortfall by 2010. Progress was made towards meeting the 2010 targets but a key component scheme for the Severn Zone which would have provided the required capacity was deferred until later in the 25 year planning scheme. Problems were associated with obtaining an increase in abstraction license for a 30Ml/d river intake and Water Treatment Works (WTW) at Ombersley near Worcester. The draft WRMP09 shows the WRZ currently in supply-demand deficit.

The WRP04 strategy for the Oswestry Zone (WRZ1) involved investment proposals which have been put in place to deliver a new groundwater source at Nescliffe. The draft WRMP09 baseline supply-demand forecast predicts that this new resource will raise the WRZ out of supply-demand deficit and maintain a supply-demand balance within 90% confidence levels up to 2020.

The dWRMP09 shows the Staff and East Shropshire as having a current supply-demand balance leading in from AMP4. However, this is forecast to become negative after AMP5 due to a 10 Ml/d reduction in deployable output as agreed with the Environment Agency as part of their Restoring Sustainable Abstraction (RSA) program. The supply-demand balance is predicted to continue to gradually worsen towards 2035.

Metering and Water Efficiency

Metering by 2006-07 in the STW region was 28%, which is ahead of the meter penetration projected in WRMP04. No policy is currently in place for compulsory metering of existing homes, though there are plans for the AMP5 period to trial the metering of households in the Staffs and East Shropshire WRZ on a "change of occupier" basis. A possible company wide roll-out of this policy may be realised after AMP5. The baseline assumption within the draft WRMP09 is that the current levels of free water meter uptake will continue and a penetration of 66% of households will be reached by 2035.

A number of other consumer demand management activities are currently employed by STW:

- Free installation of water meters and cistern displacement devices.
- Discounted water butts and rain saver kits.
- Targeting of top commercial and industrial users and implementation of efficiency initiatives such as the Good Practice Register and the Waterwise Evidence Base for Large-Scale Water Efficiency.
- Trials on retrofitting water efficient devices.
- Numerous education programs.

In November 2008 Ofwat set STW an efficiency target to reduce consumer consumption by an average of 1 litre/property/day between 2010 and 2015, equating to an annual reduction of 3.27 Ml/d through AMP5.

Leakage

Leakage is currently estimated at 27% of treated water. There have been various measures undertaken through the AMP4 strategies to drive down leakage such as:

- Improving leakage control processes and use of technology.
- Accountability zones to improve leakage reporting.
- Water main replacement.
- Installation of continuous pressure monitoring.
- Subsidised pipe repairs/replacement.

Draft WRMP09 baseline leakage targets for 2010 are shown in Table B-1.

Water Resource Zone	Leakage (Ml/d) [22]	% of Distribution Input
Oswestry	11	44
Staffs and East Shropshire	51	25
Severn	171	27

Table B-1 Leakage vs Distribution Input

Baseline draft WRMP09 projections for leakage are based on the maintenance of these figures for the 25 year scenario and assume neither improvement nor deterioration. Existing household underground supply pipe leakage (USPL) has been assumed to be 44l//p/d for projections, and is consistent with that reported in STW's 2007 June return. New households are predicted to have negligible USPL.

Strategic Water Grid

Around 75% of STW customers are linked by a strategic treated water transfer grid composed of a series of large diameter pipes that run from Derbyshire southwards through Leicestershire and Birmingham and into Warwickshire, Worcestershire and Gloucestershire. The nature of this grid is that water can be imported or exported around the STW region dependant upon varying demand or production. Current imports and exports can be found in Figure B-1 which shows that the WCS area is a net importer of potable water.

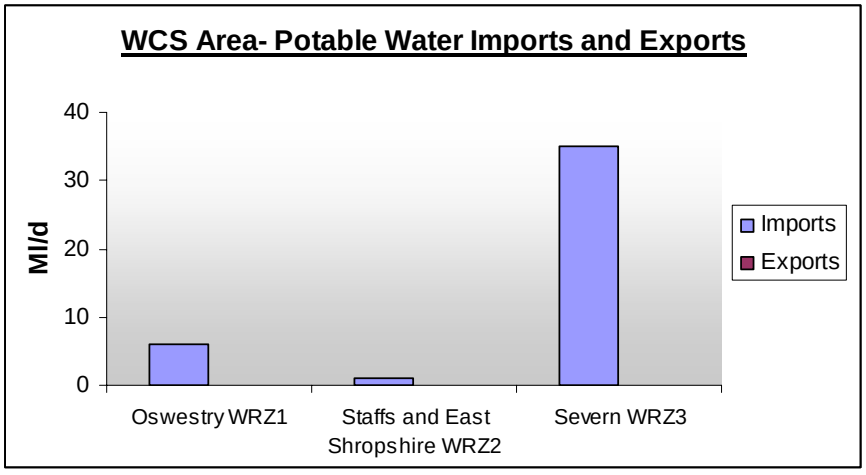


Figure B-1 Potable Imports and Exports within WRZ[23]

9.4.2 STW Baseline Forecast

In producing the draft WRMP09, STW have looked at the current supply-demand balance and predicted future supply-demand balance. The planning scenario addressed was a dry year annual

[22] Data from Table 7.8 of STW draft WRMP09, 2008.
[23] Data from Table 10.3 of STW draft WRMP09, 2008.

average supply-demand scenario as prescribed within the EA's Water Resource Planning Guidelines (WRPG). This baseline scenario demonstrates what the supply-demand outlook would be based on STW projected changes to future demand and water available for use (WAFU), assuming no change to current AMP4 demand management and leakage policies, and depicts a hypothetical situation where every year is dry year up to 2035 with unrestricted demand. Figure B-2 shows the draft WRMP09 baseline Deployable Output (DO) from the WRZs serving the study area, forecast at 2035, and their changes since WRP04.

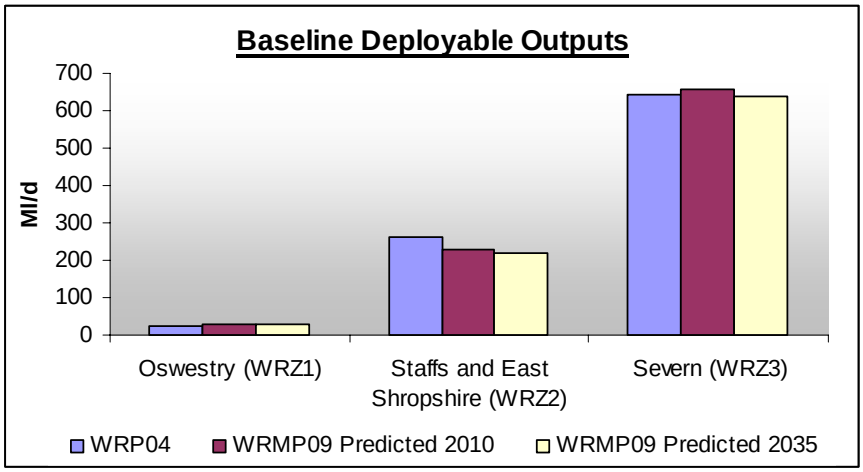


Figure B-2 Baseline and Forecast Deployable Output[24]

The majority of reductions in DO are related to groundwater contamination from predicted rising nitrate concentrations and climate change, and is most pronounced in the Staffs and East Shropshire and Severn WRZs.

A reduction of 10 Ml/d has also been applied to the DO of the Staffs and East Shropshire WRZ, to provide for sustainable reductions as part of the EA's Restoring Sustainable Abstractions program (RSA). The aim of the RSA is to mitigate possible environmental damage due to some existing licensed abstractions.

Climate Change

In forecasting future baseline DOs and demand within the draft WRMP09 STW have factored the possible impacts of climate change as per the EA's guidelines. An increase of 1.8% in consumption has been put forward by the research for this scenario which STW have spread evenly over 27 years from 2003 to 2030. STW have expressed a lack of confidence in the results of applying the prescribed climate change methodology which results in a significant deterioration in supply-demand balance during AMP5 for a number of its WRZs, including the Severn area. STW intend to carry out more detailed assessments to understand the causes of associated impacts and develop appropriate investment responses for the final version of WRMP09.

[24] Data from Tables 8.1 and 8.3 of STW draft WRMP09, 2008.

Uncertainties of the impacts have been included within the headroom assessment for the draft WRMP09.

Water Quality

A major forecast reduction in DO continues to be due to groundwater quality deterioration. STW's analysis indicates that there are uncertainties concerning increasing concentration of nitrates in many groundwater sources, mostly due to agricultural practices. Future projections are that output from several sources may be lost or severely reduced due to nitrate loadings. Nitrate problems may be managed over time and a degree of risk has been included within the AMP5 supply-demand balance. Due to the uncertainty of the long term impacts of nitrate contamination on DO, the uncertainties have only been factored into headroom requirements to 2020, with reviews to be undertaken during each successive AMP. Funding for possible investments required to mitigate nitrates will be through the STW Quality Programme, and proposed solutions presented within STW's Business Plan.

Sustainable Abstraction

The EA program Restoring Sustainable Abstraction (RSA) has a potential to impact future DO. The aim of the programme is to investigate impacts on the environment due to abstractions of water, and where such impacts arise, the possible reduction of the abstractions or other mitigating schemes. Potential reductions have been incorporated into the STW baseline planning assumptions for draft WRMP09 and amount to around 11Ml/d by 2015. The majority of investigations have yet to reach the stage where sustainability reductions can be defined, though these will be progressed for the final WRMP09.

Population and Consumption

In forecasting water demand future STW have used housing growth rates derived from Regional Spatial Strategies (RSS), population growth estimates from the Office of National Statistics and Designated Growth Points as announced by the Department for Communities and Local Government. STW express some uncertainty within these figures, where RSS projections show an increase of over 30% in new connections, compared with those seen by STW over the last 10 years. This uncertainty has been included in the supply-demand headroom assessment.

Household populations and water consumption has been predicted to change over the forecast period with increasing measured population and measured household consumption, and decreasing unmeasured population and unmeasured household consumption, respectively for all three WRZs. Changes in behaviour and other factors such as emerging technology partially offset the expected increase in household consumption. STW find that the net result on total water delivered trends in the WRZs is a small increase from the base year to end of forecast period.

Outage and Water Available for Use

For their dWRMP09, STW have adopted a risk-based approach to assessing outage and target headroom uncertainty to derive an overall probability of supply-demand balance up to the end of the 25 year forecast period. This is based on the methodology outlined by UKWIR and seeks to derive an overall probability of supply-demand balance sufficiency.

Outages were calculated using the 80th percentile values of outage probabilities, giving outages of 0.97%, 1.44% and 2.96% of total DO for WRZ1, WRZ2 and WRZ3 respectively. The resulting impact on baseline WAFU predicted at 2010 are shown in Table B-2 below. The majority of outages forecast are planned maintenance at water treatment works, though pollution at rivers is significant in Birmingham WRZ4.

Water Resource Zone	Baseline DO (Ml/d)	Outage (Ml/d)	Process Loss (Ml/d)	WAFU (Ml/d)
Oswestry (WRZ1)	26.48	0.25	0	26.23
Staffs & East Shropshire (WRZ2)	228.30	3.29	2.11	222.90
Severn (WRZ3)	658.46	19.45	17.21	609.34

Table B-2 2010 Baseline Water Available for Use[25]

Target Headroom

Target headroom is the minimum buffer planned between WAFU and demand, and caters for uncertainties within the supply-demand scenario. The adoption of target headroom has been based on an 80% level of confidence in meeting levels of service required. This level of confidence is reduced progressively to 50% by the end of the 25 year period. These levels of confidence were used by STW to reflect medium to long term uncertainties, such as the assessment of DO, magnitude of climate change and trends in nitrate levels; and that many of these uncertainties can be managed over time.

B.1.1 Supply-Demand Balance

The baseline scenario as shown by STW within draft WRMP09 describes the supply-demand outlook based on projected changes to future demand and water available for use. It assumes a hypothetical situation where every year up to 2035 is a dry year with unrestricted demand and no changes to current AMP4 demand management and leakage policies, with resources, outage and headroom determined by a probabilistic approach. The equation is given by:

Balance of supply = Deployable Output – Outage – Headroom - Demand

[25] Data from Table 10.2 of STW draft WRMP09, 2008.

Oswestry Zone

WRP04 highlighted for additional supply in this zone and produced a plan for delivery of a new groundwater supply at Nescliffe. This is predicted to maintain the supply-demand balance with reducing headroom up to 2035.

Staffs and East Shropshire Zone

The draft WRMP09 states there is confidence of a supply-demand balance between 90% and 95% confidence until the end of AMP5. At this time there is a projected stepped reduction in baseline DO. The Environment Agencies RSA programme has identified a provisional sustainability reduction in abstraction at Lizard Mill and Shifnal groundwater sources, which totals 10Ml/d to benefit the River Worfe. There is a predicted continued worsening of supply-demand balance to 2035 due to climate change and nitrate contamination trends.

Severn Zone

WRP04 demonstrated a significant risk in the Severn Zone on meeting supply level targets and outlined strategies to achieve a supply-demand balance of 80% confidence by 2010. However, problems were encountered with a new water treatment works on River Severn to supply 30Ml/d. Ombersley Water Treatment Works near Worcester was unable to be delivered before 2010 due to issues around planning permission and abstraction licensing. WRP04 also proposed the installation of Granular Activated Carbon (GAC) treatment at Frankley WTW to allow more conjunctive use of River Severn and Elan Valley supply systems and increase the deployment of treated water to the Severn zone by 20Ml/d. The scheme is due to be completed by 2009/2010 and will benefit DO.

In summary there is still a continued supply-demand risk in both Staffs and East Shropshire and Severn WRZs which worsens over the forecast period. By end of AMP5 the shortfall is 73 Ml/d and doubles by 2035. It is clear that an appropriate means of restoring and maintaining a positive supply-demand balance is required.

The final baseline supply-demand balance position as based upon the above assumptions for predicted growth, climate change, water quality, deployable output and water available for use, for each WRZ can be seen in Table B-3.

Baseline Supply-Demand Balance Position at the End of Successive AMP Periods (Ml/d)						
Zone	**Year Supply Becomes Negative**	**2014/15**	**2019/20**	**2024/25**	**2029/30**	**2034/35**
Oswestry	N/A	1.93	1.15	1.00	0.84	0.50
Staffs & East Shropshire	2014/2015	-13.91	-17.43	-25.69	-32.5	-36.95
Severn	2006/2007	-56.03	-71.67	-80.85	-86.79	-96.61

Table B-3 Baseline Supply-Demand Position to 2034/2035[26]

B.2.1 STW Preferred Plan to Balance Supply and Demand

To manage the supply-demand balance over time STW's draft WRMP09 has identified and evaluated a range of potential investment options to manage projected supply-demand deficits. These options are grouped under:

- Customer side demand management.
- Distribution side demand management.
- Production side demand management.
- Supply side demand management.

An unconstrained options list was produced which underwent a screening assessment, incorporating a Strategic Environmental Assessment, to score potential options and separate those unfeasible or with unacceptable adverse effects. Each feasible option was taken forward for a more detailed assessment including whole life cost optimisation (WiLCO) modelling and a selection of preferred options was derived by applying the principles of the UKWIR report "Economics of balancing Supply and Demand."

STW's draft WRMP09 AMP5 strategy summary is:

- Drive down leakage to 475 Ml/d by 2015.
- Increase rate of household meter uptake over and above those seen in AMP4, through promotion of free meter option and targeted policy of metering upon occupant change.
- Increase water efficiency activities beyond AMP4 levels and reduce consumption equating to around 2 Ml/d by 2015.
- Maximise use of existing water resources by improving strategic grid connectivity and resilience of the supply network. Proposals for major capital investment schemes.

B.3.1 Long Term Strategy

Oswestry WRZ

[26] Data from the Baseline data tables WRP1-BL of STW draft WRMP09, 2008.

The planned completion of the new Nescliffe borehole source in 2009/2010 is predicted to provide sufficient supply-demand headroom in AMP5. Longer term there is increasing uncertainty due to rising nitrate trends and climate change. The proposed strategy is to use water efficiency and leakage reduction measures to manage this impact.

Staffs and East Shropshire WRZ

Lizard Mill and Shifnal groundwater sources have been identified for reductions in abstraction as part of the Environment Agency RSA programme. These sources also are high nitrate sources requiring treatment to maintain DO. Due to reduction in abstraction no nitrate treatment has been proposed, though three alternative sources are under discussion with the Environment Agency. Proposals at the sources: Uckington, Beckbury and Hilton, would provide a further 17.75 Ml/d of output to the WRZ under their respective increased licence and utilisation proposals.

A further scheme at Tittesworth is proposed which would reduce the compensation release requirement from Tittesworth reservoir to the River Churnet by 5 Ml/d, directly increasing the DO of the WRZ.

Timings of proposed schemes are as follows:

- AMP5 2010-2015 – Stableford groundwater resources piped to Hilton water treatment works, and Tittesworth compensation.
- AMP6 2015-2020 – Increased Uckington groundwater export to Telford.
- AMP8 2025-2030 – Licence increase for Beckbury groundwater abstraction.

Severn WRZ

The Ombersley scheme has been reassessed since WRP04 and still forms part of the proposed supply-demand strategy but has been deferred until later in the planning period due to options of utilising existing water resources through strategic grid capability, and to also provide additional time to address promotion and approval issues.

The long term strategy assumes 20Ml/d of supply will be available from the East Midlands WRZ via the East-West Link element of the strategic grid. A scheme proposed to increase the capacity of the Derwent Valley Aqueduct (DVA) will supply more water from treatment works along the River Derwent to the south of the East Midlands Zone and hence provide further support to the East-West Link. This will increase DO to the Severn zone and provide resilience benefits.

The Frankley GAC scheme due for completion in 2009-10 will enable a further 20Ml/d of treated water to be transferred to the Severn zone from the Birmingham zone. A further 2.4Ml/d is anticipated from the Mill End GAC scheme near Kenilworth proposed for 2025-2030. The scheme will involve a new water treatment process at the Mill End groundwater source, rectifying the water quality problems associated with its current closure.

Timings of proposed schemes are as follows:

- AMP5 2010-2015 – DVA duplication providing additional support to the East-West Link of the strategic grid.
- AMP7 2020-2025 – Ombersley WTW
- AMP8 2025-2030 – Mill End GAC

In addition to all of the above schemes for each WRZ, in each AMP period there will be an ongoing drive to control leakage through a combination of active leakage control, mains replacement and pressure control; and the promotion of household retrofit of meters and other water efficiency options.

Appendix C. Overview of options for demand management

C1 *Options for Demand Management*

The estimated average use of water in England is 150 litres per head per day. Many other countries in Europe already appear to be using considerably less than this (see Figure C-1). The perception is that our water consumption could be significantly reduced without major impact upon services or quality of life.

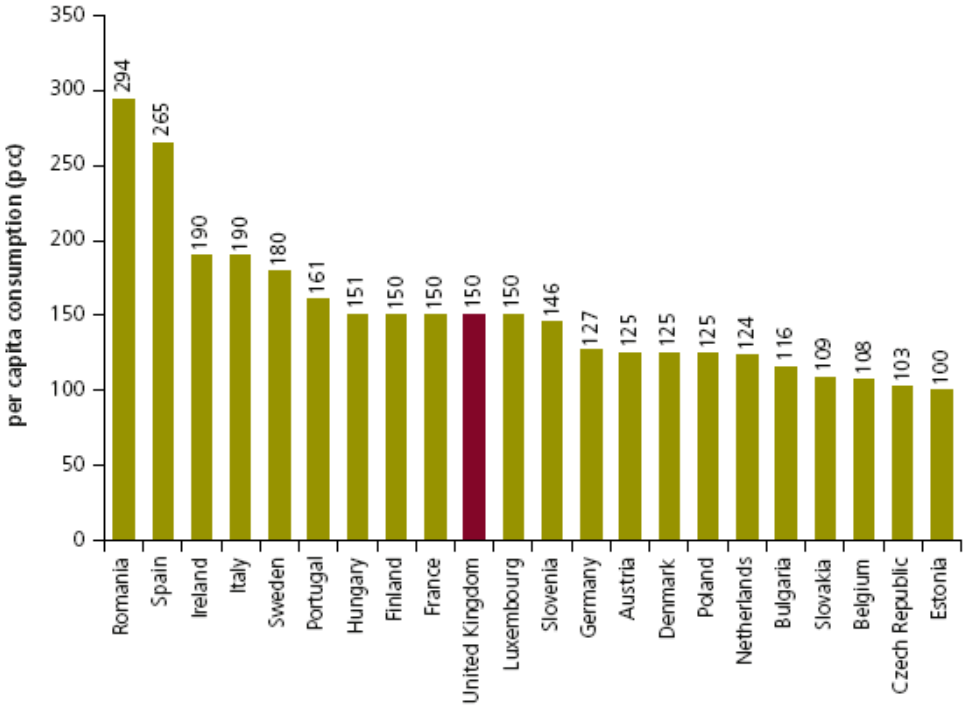


Figure C-1 EU per Capita Water Consumption (Future Water, 2008)

Key measures that in combination help achieve water neutrality, or limit the impact of development on the environment can include:

- Expanded metering;
- Enhanced regulation for water efficiency;
- Water efficient devices and retrofitting;
- Greywater recycling;
- Rain water and stormwater recycling;
- Education and community wide public awareness
- Economic measures and tariff structures.

The overall objective is that new development should have a benign effect upon the water environment. Where water neutrality cannot be achieved options for augmenting water resources can be considered, i.e. rain water harvesting.

C1.1 Metering

The measures included in the demand scenarios, in some cases, will not be practical to implement. The implementation of Environment Agency metering of 95% of existing properties by 2016 is an ambitious target and requires around 12,750 properties a year from 2010 to 2016 to be connected to a meter in the WCS area, at a cost of up to £500 each. In 2006 28% of STW customers were connected to a meter, which is about the national average. Since October 2007, water companies within seriously water stressed areas have been given extended powers to increase compulsory metering. STW have no current policy for compulsory metering in the Severn WRZ but provide free water meters and assume that current levels of water meter take up will continue through the planning period to 66% by 2035. It is suggested that measures are implemented to accelerate these levels of meter take up.

C1.2 Water Consumption in New Properties

A range of water consumption targets have been identified for new properties. The governments strategy has a requirement for a standard of 120 litres per day (l/p/d) for new properties which it anticipates will be achieved by ensuring that all new homes have fittings with a good standard of water efficiency. New requirements on water efficiency will be introduced into Building Regulations.

It is recommended that the Code for Sustainable Homes is supported as much as practicably possible depending upon each individual development. The code should be specifically targeted through local planning regime at the largest developments where the benefits from development wide collection systems would be greatest. Staggering development should also be considered so the largest developments are built later within the planning period, in the hope that by which time the code may be statutory and technology will be in place to make the more stringent levels of the code more cost-efficient and feasible.

C1.3 Water Efficient Devices and Education

The government expects the demand for water efficient products from new housing to help drive the market and improve the efficiency of everyday water using products over time. To further facilitate these improved levels of efficiency, the Water Supply (Water Fittings) Regulations 1999 will be reviewed. These cover for example the maximum water use of toilets, urinals, washing machines etc. The review will also consider enforcement issues, advances in technical standards and water conservation, and the case for setting new performance standards for key water fittings. This will also support the CSH.

An example of progressive reduction in water use is shown in Table C-1 below. It displays a comparison of water use, by component, for a standard home and the same home fitted with the best available water saving products, with progressing levels of water efficiency. Within this example the majority of water savings are made by water efficient devices either installed during new build or by retrofit replacement at the end life of existing devices, and the progressive options are detailed within the notes.

In combination with these devices water consumption is also assumed to decline through the effects of education and structured tariffs.

Component	Water Use (l/d/capita)					
	150 Standard Home	130	120 CSH Level 1/2	115	105 CSH Level 3/4	80 CSH Level 5/6
Toilet Flushing	28.8	19.2[b]	19.2[b]	16.8[d]	16.8[d]	8.4 + 8.4[f]
Taps[a]	42.3	42.3	31.8	31.8	24.9	18
Shower	30	24	24	22	18	18
Bath	28.8	25.6[c]	25.6[c]	25.6[c]	25.6[c]	22.4[e]
Washing Machine	16.7	15.3	15.3	15.3	15.3	7.65 + 7.65[f]
Dishwasher	3.9	3.6	3.6	3.6	3.6	3.9
Recycled Water[f]	-	-	-	-	-	-16.1
Total per Capita	**150.5**	**130**	**119.5**	**115.1**	**104.2**	**78**
Outdoor[g]	11.5	11.5	11.5	11.5	11.5	11.5
Total per Home	**366.68**	**319.3**	**293.52**	**284.136**	**257.412**	**195.58**

Table C-1 Targets for Water Use and Efficiency Measures[27]

Notes:
[a] combines kitchen sink and wash hand basin
[b] 6/3 litre dual-flush toilet
[c] 160 litre bath filled to 40% capacity, frequency of use 0.4/day
[d] 4.5/3 litre dual flush toilet
[e] 120 litre bath
[f] recycled water (rainwater/greywater harvesting)
[g] assumed garden use

Most water companies offer water efficient devices either free of charge or at a reduced price. This can include cistern displacement devices (such as hippos, save-a-flush), water butts, trigger hose attachments, water audits and supply pipe replacement or repairs. Water efficiency campaigns can be very successful in reducing water consumption and are continuously undertaken by water companies. As part of the government's water strategy it has published a list of top water saving tips. STW promotes a range of water efficiency measures and is involved in a number of trials and schemes to raise awareness of and promote water efficiency.

The promotion of water efficient devices and awareness of water saving measures should continue to be encouraged, such as those to be implemented by STW. Whether this can achieve a reduction in water consumption used in the scenarios above and whether this reduction per year can be maintained is uncertain. It's likely that initially with efficiency devices and education a reduction in water consumption is feasible in the initial stages of the planning period. However to continue the decrease in water consumption beyond a certain level will be difficult as campaigns saturate the customer base and existing technologies are utilised. By this point it may be that consumption can be reduced to a level whereby measures, such as additional water resources or licences to support the increase in supply will not be required.

Education and Community Wide "Soft" Measures

Water efficiency campaigns can be very successful in reducing water consumption. Public involvement is crucial if water resources are to be managed without the need for economic

[27] Table based upon Environment Agency Publication - Science Report – SC070010: Greenhouse Gas Emissions of Water Supply and Demand Management Options, 2008.

measures. Community wide soft measures are broadly designed to change water use behaviour and practices and create a water saving and efficiency culture. Provision of clear information about water use and the impact on the environment is of paramount importance if householders are to make informed decisions on water saving.

Water conservation messages can be quite difficult to market, encouraged by the perception of plentiful rainfall and the prevalence of flat rate pricing for water. Public awareness campaigns need to target long term changes in individual behaviour through:

- Creating awareness and interest;
- Educating;
- Providing necessary skills to effect change.

Components could include:

Young persons' campaigns: young people are agents of change. Engaging and making them interested in protecting water resources will help and impact the change of behaviour and habits from an early stage on. With the help of information and education materials, interactive games, cartoons, outdoor activities, etc. the young generation can learn about the importance of water in its different environments. Emphasis can also be placed on creative work incorporating water into different means of expression e.g. photographs, videos, theatre plays.

Adult campaigns: these can include lectures, small workshops, exchanges with experts, public exhibition, water audit for typical household, water saving devices, details of cost and expected savings, provide details (with model?) of raw water sources used for public water supply and potential impact of over abstraction, public visits to headworks and treatment facilities, articles in local papers, lorry with volume of water consumed by typical household

Self or water company led home water audits: water audits provide householders with a complete picture of how and where water is used in the home and hence provides necessary information to be able to assess opportunities to save water.

Water company led audits can provide more easily accessible information on areas of high consumption or waste and the payback period of water conserving equipment. There is some merit in undertaking water audits with energy audits since reducing hot water consumption also reduces energy use.

Raising the profile of aquatic environment: the objective of these measures would be to engage existing residents in the local environment and in particular the aquatic environment, and hence increase their desire to protect and conserve it. Actions could include making sure all community areas are attractive, well maintained, with low water requirement; increasing access to the environment by for example, constructing attractive activity park(s) in areas of less ecological value – aerial runway, mountain bike tracks, café etc, regular events to shout about the local natural environment, kids after school activities e.g. green gym, local competition for best wildlife or natural environment photo

Green labelling: clear labelling of the water efficiency of plant such as washing machines, dishwashers. Labelling is a simple and direct way of communicating information about a product to purchasers. There are a number of different green labelling schemes including Waterwise's Marque.

The Marque is awarded annually to products which reduce water wastage or raise the awareness of water efficiency. 27 Marques have been awarded across a broad spectrum of products including dishwashers, showerheads, water storing gels for the garden, toilets and urinals, drought resistant turf, domestic water recycling products, water butts, a waterless carwash, tap flow restrictors, a shower timer and devices to reduce the amount of water used when flushing the toilet.

Councils could be proactive in encouraging all retailers to display green labels and provide information on the different schemes where appropriate.

Green plumbers: council maintained and advertised register of plumbers having attended an accredited training programme on their role in protecting the environment.

Economic Measures – Volumetric Charging

Traditionally water use in England has been unmetered with customers paying according to the rateable value of the property. Volumetric charging increases the cost of billing but is deemed to be a fairer pricing mechanism and encourages water saving.

At present the Government does not compel water companies to install meters, although residents have a right to pay a metered charge and can request the water company install a meter free of charge, unless for particular reasons the cost is prohibitive.

As mentioned STW propose an accelerated metering programme with an aim to meter 72% customers by 2035, as updated in the SoR, and continue to promote and maintain free optant metering.

Due to historic pricing polices, economic instruments have not been widely used to promote water conservation in the UK and limited data is available on the elasticity of demand. The recent introduction of volumetric charging for some households (in particular those electing to have a meter and new build houses) has had a limited impact on domestic water consumption (reported reduction of 10% over unmetered users). This is considered to be due to the relatively low price of water in the UK rather than the inherent value of the instrument as a means of reducing water consumption.

Notwithstanding significant real price increases since privatisation of the water companies, average water and sewerage charges in England are approximately 1% to 2% of household income. This compares to the recommended maximum (WHO) of 4% to 5% of household income.

The EU Water Framework Directive reinforces use of economic concepts to control water resource management. Article 9.1 states that member states shall ensure that, by 2010, water pricing polices provide adequate incentives to ensure the efficient use of water.

Assuming the adoption of volumetric charging, options exist in terms of the:

- **Type of meter:** dumb or smart, smart meters are approximately 3 to 5 times the price of dumb meters but provide greater opportunities for the introduction of varying tariff structures, more cost effective reading (and hence more frequent reading) and facilitate improved leakage detection. Smart meters also provide the opportunity of providing customers with an easily accessible readout of water use;
- **Level of charges:** water use being related to level of charges;
- **Tariff structure:** rising block and or seasonal tariff structure can provide good incentives to reduce excessive water consumption without raising the basic rate for low volume water use. Seasonal tariffs are appropriate to encourage consumers to be extra careful with water during the summer months when water is less plentiful.

It is recognised that compulsory metering is not universally welcomed. Therefore, prior to the metering programme, consideration could be given to undertaking an intensive education and public awareness campaign together with the provision of subsidised water saving devices (cistern displacement, tap aerators, flow restrictors etc). Meters could be installed and read for a minimum of 3 months prior to the application of the new tariffs; this would allow residents to appreciate volumes of water used and undertake measures as appropriate to reduce consumption.

During this period, the water company could also consider undertaking a high profile leakage detection and reduction. In addition to reducing water abstraction, this will be designed to increase acceptance of water saving measures by existing households (surveys indicate a reticence on the part of the public to make savings whilst a significant proportion of water into supply is "lost").

In authorising the proposed tariff structure and level of charges, it is assumed that the economic regulator will make due allowance for the investment made by the water company in order to protect the environment at the cost of loss of sales.

Economic Measures - Local Environmental Tax

The objective of the local environmental tax would be to provide economic incentive to conserve water and raise revenue for local projects. In principle, if viable and legal the tax for environmental conservation could be set by local council, collected by the water service provider and ring-fenced for local community projects. Alternatively the tax could be applied nationally and managed on similar lines to the land fill tax.

C1.4 Additional Water Efficiency Options

Greywater Recycling

Greywater is wastewater from showers, baths, washbasins, washing machines and kitchen sinks, which can be reused to reduce water demands.

The physical and microbiological characteristics of greywater vary significantly depending on its origin. Water from baths, showers and wash basins is generally less heavily contaminated than that originating from the kitchen or laundry, which can contain detergents, fats, nitrogen and phosphorous. For this reason most domestic greywater reuse or recycling systems exclude the later.

Greywater can be reused directly, i.e. without treatment, if it is not stored for any length of time. Direct reuse of greywater is generally limited to:

- Subsoil garden irrigation;
- Toilet flushing.

Untreated grey water can be used for more general use in the garden. For example once cooled it may be stored in a water butt for above ground irrigation. However, care should be taken avoid long storage periods, sprinkler or spray systems and direct reuse on fruit and vegetable crops. Short retention systems containing simple valves are available to discharge greywater either to storage for outside use or to waste. Systems are also available to automatically empty tanks if water turnover is poor.

Rain Water Recycling

Rain water harvesting systems (Figure C-2 potentially offer the combined benefits of reduced water consumption from the public water supply system and reduced surface water runoff discharged to the public sewerage system. Available systems vary from installation of a simple water butt for garden watering to propriety units providing treatment, storage and delivery; depending on the level of treatment provided harvested water can be used for all purposes except drinking and food preparation

At its simplest rainwater can be collected in above ground butt for outdoor use such as garden watering and car washing. Typical systems for indoor use comprise:

- First flush diverter - To divert initial rainfall containing dust or other material from the roof;
- Filter - to removes debris from the collected rainwater and discharge it to a soakaway or the storm water sewer;
- Water storage tank – such as "green wall" systems, consisting of modular sections of polyethylene vertical tank with high storage volume-low footprint designs (www.waterwall.com.au); or rainsaver storage gutters (www.rainsaverstoragegutters.com) fed by gravity to toilet cisterns or garden watering, with overflow going direct to the storm drain or discharge system.

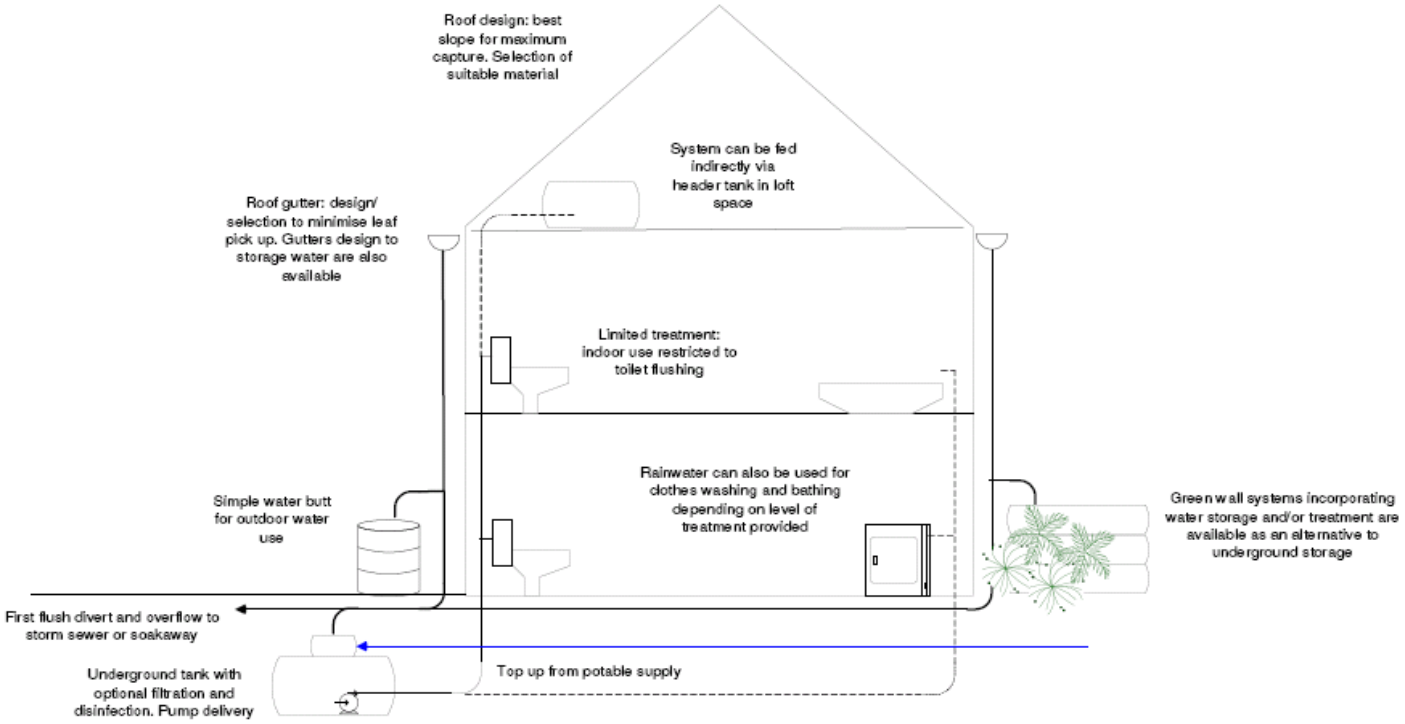


Figure C-2 Rainwater Harvesting

Stormwater Harvesting

Stormwater Harvesting can be defined as the diversion, storage and treatment of stormwater runoff from urban catchments for reuse (Figure C-3). Roof water harvesting differs from this in that it harnesses only relatively uncontaminated runoff from roof areas. Stormwater harvesting can include roof water harvesting and non-urban runoff as part of a broader scheme.

The components of a stormwater harvesting system are:

- Stormwater catchment generating stormwater runoff;
- Conveyance system (conveying stormwater to the diversion) which could be a mix of overland and piped flows;
- Stormwater quality treatment system such as a bio-retention basin as part of a Sustainable Urban Drainage System;
- Diversion to take the primary treated stormwater to stormwater storage;
- Stormwater storage system (above or below ground);
- Water treatment system (to ensure water is fit for purpose);
- Treated water distribution system (pumped and piped reticulation).

Urban stormwater runoff can be considered a primary cause of aquatic ecosystem degradation due to pollution impacts on water quality, physical stream disturbance, sedimentation and alteration of riparian flow patterns.

The environmental benefits of stormwater harvesting and its associated water savings are not only reduced overall water demand, which could delay the need to build further infrastructure, but include the potential to:

- Reduce pollutant loads entering aquatic ecosystems;
- Manage peak stormwater flows discharged from urban catchments;
- Reduce the volume and frequency of stormwater runoff;
- Provide a valuable source of water to meet urban water demands.

A recent study was commissioned by the Queensland Water Commission on Stormwater Harvesting28, involving case studies on two new mixed use developments in South East Queensland, Australia. The resulting factors for successful stormwater harvesting were found to be:

- Large scale development;
- High water demands;
- Moderate slopes which drain to singe/few points;
- Low cost storage.

In addition to the environmental benefits, the cost of stormwater was found to be around the lower end of costing for rain tanks, with cost of land for storage the main issue; though storage in an existing drainage reserve or aquifer significantly reduces costs.

[28] Stormwater Infrastructure Options to Achieve Multiple Water Cycle Outcomes, Bligh Tanner and Design Flow, August 2009.

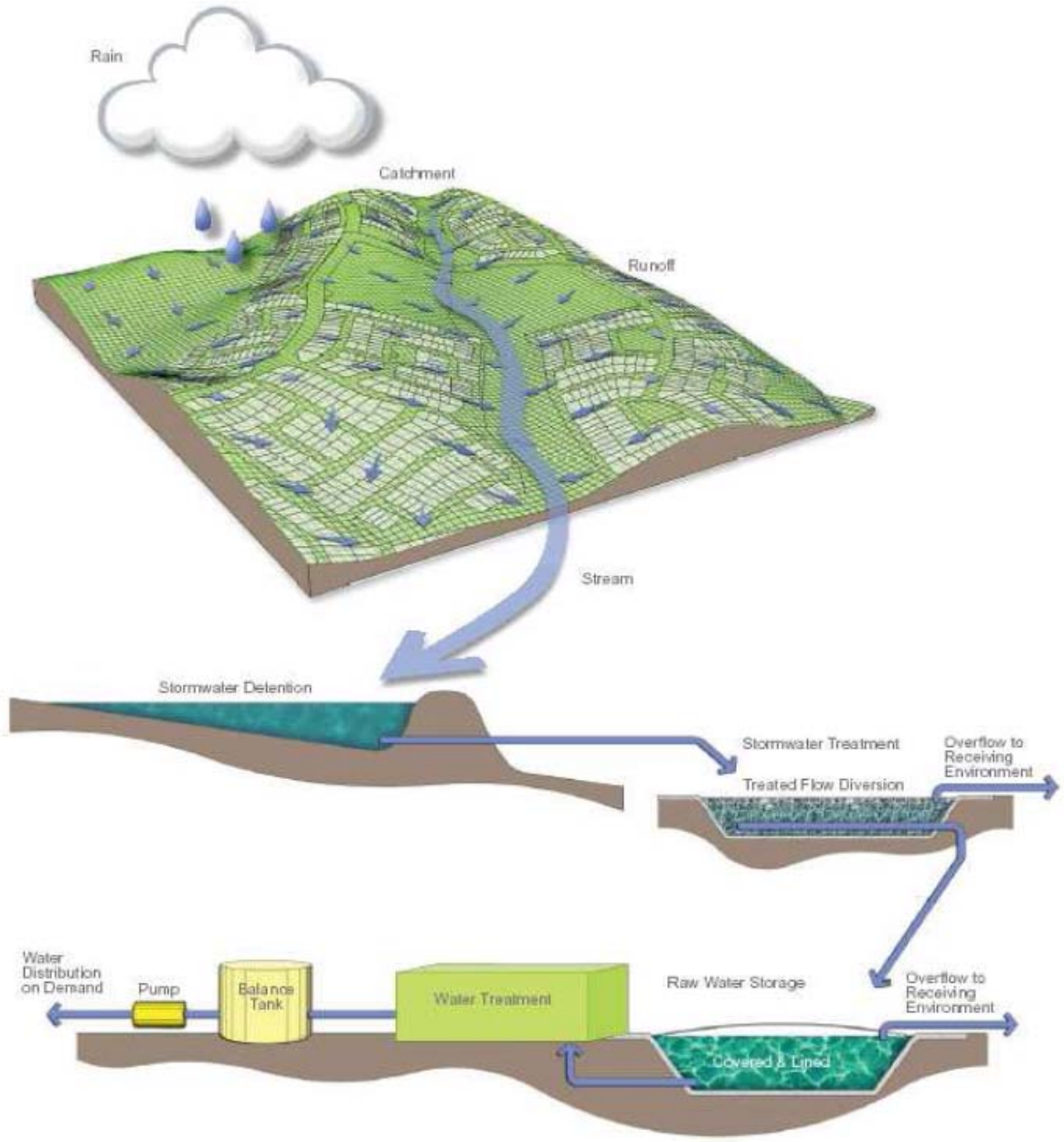


Figure C-3 Stormwater Harvesting

C1.5 Water Efficiency and Energy

Approximately 24% of domestic energy consumption in the UK goes to heating water (DTI 2002). This excludes space heating. Showering alone accounts for approximately 1% of total UK carbon emissions (MTP 2008). In addition, the treatment and distribution of water by water companies accounts for large amounts of energy consumption – e.g. Anglian Water is the largest single energy user in the East of England region, and recent estimates suggest that water companies consume more than 1% of the energy produced in the UK.

Energy prices are currently high and rising. In situations where more efficient hot water using fixtures and fittings, such as showers, baths and hot water taps are installed a major cost savings gained by the user will be through savings on the energy bill as well as the water bill.

The implementation of water efficiency measures not only reduce water demand and demand on water resources but produce associated savings in energy, financial costs and carbon emissions. Reductions in water demand can also reduce the need for additional infrastructure, resulting in further savings.

C1.6 The Cost of Water Efficiency

A specification for indoor water use of 120 litres per person per day, as per Part G of the Building Regulations and Levels 1/2 of the Code can be achieved through installing a combination of standard and efficient fittings and fixtures. CLG estimate that this will not add any cost to a new home (CLG 2008).

Code Level 3/4 can be achieved by installation of efficient water using fixtures and fittings. CLG has estimated that under current supply-demand scenarios, achieving Code Level 3 specification for water consumption of 105 litres per person per day, will add £125 to the cost of a new home (CLG 2008). Developers Countryside Properties and Taylor Wimpey have estimated £400 and £280 respectively. The variation arises from different scales of business or assumptions on scales of business, dwelling type or assumptions on dwelling type and therefore style or desirability of fittings.

To achieve a specification of 80 litres per person per day required for Code Level 5/6, it is generally accepted that some form of water recycling is required. Inclusion of a rainwater or greywater recycling system is relatively costly. CLG estimate that achieving Code Level 5/6 would add £2650 to a new standard home. However, this is likely to be less per dwelling if communal water recycling systems are installed, and CLG (2008) estimate £800 for apartments.

The cost of meeting the Code will fall as demand increases. Bathroom manufacturer Grohe have estimated that, assuming bulk supply of the fittings and fixtures, the cost of meeting Code Level 3 /4 would drop to as little as £12.50 (Grohe 2008). The Governments stated intention is to kickstart the market transformation process by requiring the public housing sector to build to medium level Code specification. However, this means that the relatively higher costs of meeting the Code during the early stages of market transformation are borne by housing associations. The National Housing Federation is lobbying for private developers to be subject to the same Code implementation timetable. At least at this stage, achieving Code Level 3/4 specification for water consumption is one of the cheapest aspects of Code implementation.

The average unit price for a metered water customer in 2008 is approximately 0.3 pence per litre including waste water charges. Average per capita consumption is about 150 litres per person per day. Assuming that actual water use in the home meets the target specification, savings on water bills can be estimated as shown in Table C-2

Average PCC	Target Specification	Savings (litres per day)	Unit cost of water (pence per litre)	Savings (pounds per person per year)	Savings per household per year (assuming 2.4 people)
150	120	30	0.3	£32.85	£98.55
150	105	45	0.3	£49.27	£147.82
150	80	70	0.3	£76.75	£229.95

Table C-2 Savings on water bills calculated from average UK metered water price and assuming specification targets are met in practice

For water bills, the payback time for specifications meeting Part G and Code Levels 1 through 4 ranges from immediately to a few years. If water recycling systems are added, the payback time is significantly longer – in the order of 10 years for systems supplying single homes. Savings on energy bills also need to be considered and in general these will at least match, and often exceed, the savings on metered water bills. Dwellings with water recycling systems will also save energy if efficient fittings are installed, but recycling systems will use energy for pumping and water treatment.

In conclusion, payback times for specifications involving efficient fittings and fixtures are reassuringly quick – a few years at most. Payback times for specifications that include recycling systems are significantly longer. Defra's water efficiency hierarchy illustrates this (Figure C-4).

Figure C-4 Indicative illustration of cost-benefit of water efficiency strategies (Defra)

Appendix D. Background information on flood risk

D1 Catchment description

Within Shropshire the main rivers include the River Severn and its tributaries (River Vyrnwy, River Perry, Rad Brook, Rea Brook, River Tern and River Teme).

D1.1 The River Severn

The River Severn rises to the west of Shropshire in the Welsh mountains. The watercourse enters the county along the western boundary by Crewgreen, and flows in an easterly direction towards Shrewsbury. From here, the Severn continues in a south-easterly direction passing to the south of Telford and through Bridgnorth, before exiting the county to the south of Highley.

In its upper reaches (within the Welsh mountains), the river catchment is high, steep and impermeable with high annual average rainfall. Despite the presence of a number of reservoirs, the catchment response is flashy. The variability in river flow near Pentre will, therefore, be relatively large. The Severn enters Shropshire by Crewgreen, to the south of Pentre. Here, the floodplain at this point is relatively flat, and therefore subject to risk of flooding. The River Vyrnwy flows south along the west Midlands regional boundary and contributes to flood risk in the region since, near its confluence with the Severn, the flood plain on the left bank of this river just north of Pentre is liable to flood. This has a positive effect, however, as a flood storage area which reduces the risk of flooding in more built-up areas downstream.

The Severn catchment upstream of Wroxeter includes most of the former Shrewsbury and Atcham, South Shropshire, and North Shropshire areas. Major tributaries include the Bromley Brook, the Oswestry Brook and the Rea Brook. The Oswestry Brook originates within Shropshire, and together with the River Morda joins the River Vyrnwy on the regional boundary which itself joins the Severn outside the western boundary of Shropshire. Flood risk within the region upstream of Wroxeter is heavily influenced by the catchment upstream of the region in Wales. The River Severn upstream of Pentre is high, steep and impermeable with high annual average rainfall and is a large 'flashy' catchment. This has a major influence on flood risk in places such as Melverley Green (SJ 3285 1812) and Pentre (by Oswestry), as well as Montfort Bridge, near Shrewsbury.

The tributaries of the Severn within the region upstream of Wroxeter are smaller and shallower than that of the Severn upstream of Pentre. Much of this area is underlain by permeable Triassic sandstones, a major aquifer. Consequently, the risk of flooding from the Bromley Brook and the Oswestry Brook is lower. The Rea Brook catchment, like that of the Severn, is relatively steep and impermeable and includes an area west of the region in Wales. The risk of flooding from the Rea Brook is therefore greater, although this does not affect any populated area until near its confluence with the River Severn in the town of Shrewsbury.

D1.2 River Tern

The River Tern catchment covers the northern and north eastern parts of the county. The major tributaries to the Tern within the catchment include the River Roden, the Lonco Brook and the River Strine. Much of the Tern catchment in Shropshire is low-lying and flat, the highest point being the Wrekin just west of Telford. Most of the catchment stands on Permian and Permo-Triassic sandstones, a major aquifer.

Flood risk in the catchment as a whole is relatively low, although the hills around Telford and the low altitude of the north of the town make the north of Telford susceptible to flooding. Furthermore, the fact that it is a built-up area means that the consequences of flooding could be considerable.

D1.3 River Teme

The River Teme catchment covers most of former South Shropshire District Council as well as parts of the former Shrewsbury & Atcham area and Bridgnorth. Major tributaries within the catchment include the River Onny, River Corve and the River Rea. The catchment is relatively high and steep, such that the upland parts of the River Teme and its tributaries are 'flashy' streams with high variability in flow rates. This 'flashiness' is exacerbated by the impermeable Ludlow rock beneath much of this upland area. This has an effect on flood risk not only in the upland areas but also in the lowland areas toward which they flow.

Most of the intermediate area of River Teme the catchment is underlain by Lower Old Red Sandstone of variable permeability (a minor aquifer). There is a broad flood plain either side of the River Teme from Ludlow to Worcester (to the south of Shropshire). The flood risk, in terms of the consequences of flooding, is clearly greatest in these built up areas, especially Ludlow (in the former South Shropshire District Council).

D2 Flood risk in context

A number of studies have been undertaken within Shropshire assessing flood risk and providing flood risk policies for the county. Studies on flood risk management in the relevant catchments are listed below. These have been reviewed as part of the work carried out for this Water Cycle Study.

The documents available for review include:

- Final Level 1 Strategic Flood Risk Assessments (SFRAs) for the Districts and Boroughs of Shropshire (September 2007)
- Shrewsbury Strategic Flood Risk Assessment (SFRA) Level 2 (August 2009)
- River Severn Final Main Stage Report Catchment Flood Management Plan (CFMP) (September 2008)
- West Midlands Regional Flood Risk Appraisal (RFRA)
- Planning Policy Sttement 25: Development and Flood Risk

D2.1 Shropshire Level 1 SFRA, 2007

Level 1 Strategic Flood Risk Assessments (SFRA) for Shropshire have been produced for the former Districts and Boroughs which now make up Shropshire Council and which are covered by this WCS. The purpose of the SFRA is to provide information on current and future flood risk (taking into account climate change) from all sources to allow decision makers to allocate development and infrastructure in accordance with PPS25.

The Level 1 SFRAs were published in September 2007 and the following key recommendations from the Level 1 SFRAs are outlined below:

To Seek Risk Reduction through Spatial Planning and Site Design:

- Use the Sequential Test to locate new development in least risky areas, giving highest priority to Flood Zone 1
- If a Sequential Test is undertaken and a site in a floodplain is identified as the only site for development, after application of Exception Test, use the sequential approach to inform the site design and seek opportunities to reduce risk
- Ensure that any redevelopment within the floodplain that is justified on wider sustainability grounds is resilient to flooding
- Identify long-term opportunities to remove development from the floodplain through land swapping
- Ensure development is 'safe'. For residential developments to be classed as 'safe', dry pedestrian egress out of the floodplain and emergency vehicular access should be possible
- Raise floor levels above the 1 in 100 year plus climate change water level

To Reduce Surface Water Runoff from New Developments and Agricultural Land:

- SUDS required on all new development
- All sites greater than 1 Ha in size require the following:
- SUDS
- Greenfield discharge rates
- 1 in 100 year on-site attenuation taking into account climate change
- Set-aside space for SUDS on all allocated sites
- Promote environmental stewardship schemes to reduce water and soil runoff from agricultural land

To Enhance and Restore the River Corridor:

- Assess condition of existing assets and renew if required to ensure their lifetime is commensurate with lifetime of the development
- Seek opportunities to undertake river restoration/enhancement as part of a development to make space for water

- Avoid further culverting and building over of culverts. All new developments with culverts running through their site should seek to de-culvert rivers for flood risk management and conservation benefit
- Set development back from rivers, seeking an 8 metre wide undeveloped buffer strip. Making space for water and additional capacity to accommodate climate change

To Protect and Promote Areas for Future Flood Alleviation Schemes

- Protect Greenfield functional floodplain from future development (our greatest flood risk management asset)
- Develop appropriate flood risk management policies for the Brownfield functional floodplain, focusing on risk reduction
- Identify sites where developer contributions could be used to fund future flood risk management schemes or can reduce risk for surrounding areas
- Seek opportunities to make space for water to accommodate climate change

To Improve Flood Awareness and Emergency Planning

- Seek to improve the emergency planning process following future updates to the SFRA
- Encourage all those within Flood Zone 3a and 3b (residential and commercial occupiers) to sign-up to Flood Warnings Direct service operated by the Environment Agency
- Ensure robust emergency (evacuation) plans are implemented for new developments greater than 1 Ha in size (the Environment Agency has noted that criteria will need to be produced to ensure validation of robustness and the consequent production of effective, enforceable operational plans)

D2.2 ***Shrewsbury Strategic Flood Risk Assessment (SFRA) Level 2 (August 2009)***

A Level 2 SFRA for Shrewsbury was completed in August 2009. The study was undertaken as the Level 1 SFRA identified the need for further assessment of the risk of flooding within Shrewsbury. In order to maintain the long term prosperity of the town, there is a need to redevelop brownfield sites. Many potential development locations are otherwise in sustainable locations, but are often at risk of flooding posed by the River Severn (as well as Rea Brook in the Abbey Foregate area). In addition, a number of the sites identified for future development are located behind flood defences within Shrewsbury.

The Level 2 SFRA therefore built on the work undertaken as part of the Level 1 SFRA, providing flood hazard information for a range of return periods and potential defence breach scenarios, in order to inform application of the Sequential and Exception Tests (by the Council), and the determination of the suitability of redevelopment of brownfield sites. Relevant policies for the management of flood risk and appropriate development of flood risk areas in Shrewsbury were put forward. In addition, the study included an assessment of some 73 potential development sites which may be taken forward for development in the future. Their suitability for development was assessed against flood risk information, to assist the Council with the Sequential Test process.

Key recommendations of the Level 2 SFRA are outlined below:

- **Application of the Sequential Test** - Use the Sequential Test to locate all new development (site allocations) in least risky areas, giving highest priority to Flood Zone 1. Where the Sequential Test alone cannot deliver acceptable sites, the Exception Test will need to be applied.
- **Protect the functional floodplain (in Greenfield and previously developed areas) –** Avoid development in the Greenfield functional floodplain in the first instance. Identify opportunities for making space for water on previously developed areas by reinstating the functional floodplain.
- **Site Layout** - apply the sequential approach within the development site by locating the most vulnerable elements of a development in the lowest flood risk areas in the first instance. The use of flood risk areas (i.e. Flood Zones 2, 3a and 3b) for recreation, amenity and environmental purposes can provide an effective means of flood risk management as well as providing connected green spaces with consequent social and environmental benefits.
- **Enhance and restore the river corridor** - identify opportunities to undertake river restoration and enhancement as part of a development to make space for water.
- **De-culvert wherever possible.** Where this is not possible, an assessment of the structural integrity of the culvert, with any required remedial work, should be carried out prior to the development. A maintenance schedule should be developed for all culverts to ensure regular clearance. Construction of new culverts should be avoided wherever possible. Investigations should be undertaken to negate the need for further culverting.
- **Set development back from watercourses -** any riverside developments should leave a minimum 8 metre wide as undeveloped buffer strip, maintaining the river and its floodplain as an enhancement feature and allowing for routine maintenance.
- **Reduce surface water runoff from new developments –** any development must ensure that post development runoff volumes and peak flow rates are attenuated to the Greenfield (pre-development) condition with a minimum reduction of 20%. SUDS should also be a requirement for all new development and space should be specifically set-aside for SUDS and used to inform the overall site layout
- **Maintenance of existing flood storage areas, including informal** – existing storage areas should be maintained and safeguarded from development.
- **Ensure a development is 'Safe' -** For residential developments to be classed as 'safe', dry pedestrian access should be provided to and from the development without crossing through the 1 in 100 year plus climate change floodplain. Major or vulnerable development should not be permitted in Flood Zones 2 and 3 unless it can be satisfied that evacuation can be carried out up to the 1 in 1000 year event.

D2.3 Catchment Flood Management Plans (CFMPs)

The River Severn CFMP covers the majority of Shropshire, Figure D-1 below details the coverage of the River Severn CFMP in Shropshire.

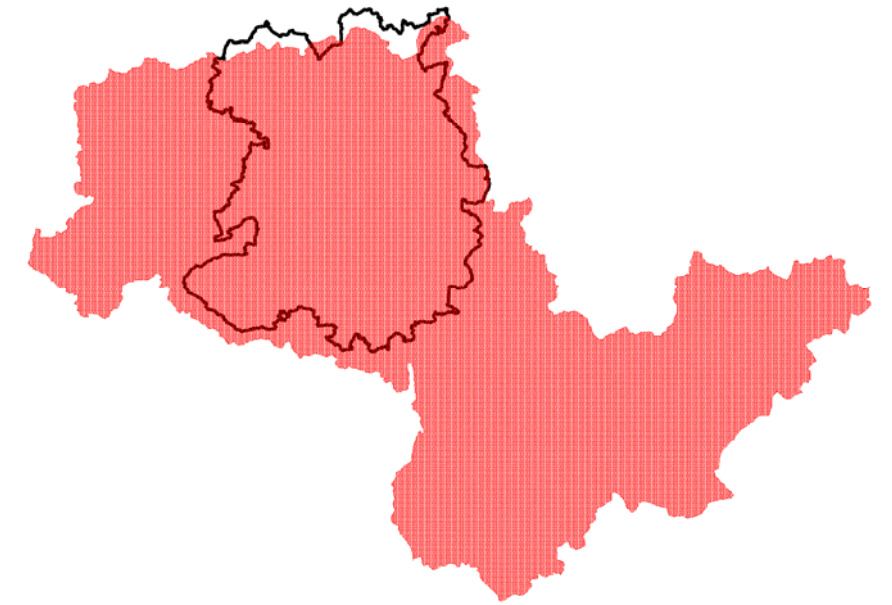


Figure D-1 CFMP coverage within the Shropshire Water Cycle Study area (red shaded area indicates the River Severn CFMP)

The River Severn CFMP is a high level document of strategic policies designed to plan for flood risk management in the catchment over the next 50-100years. A final plan of the CFMP was published in September 2008. The River Severn CFMP area has been divided into 20 Policy Units, six of which cover the area within the Shropshire Water Cycle Strategy study area. The policy units within the Severn CFMP are based on clearly defined areas within the catchment and are based on Physical characteristics (including hydrology, ecology, geomorphology, land use etc) and current and future flood risk. Determination of policy units was also influenced by the wider objectives in the catchment. One preferred appropriate policy will be applied across the policy unit.

The six policy units within the Shropshire Water Cycle Strategy are outlined in Table D-1 along with the draft flood risk management policy selected for each unit.

Policy Unit	Policy Choice
3 – Severn-Vyrnwy Confluences	Take Action with others to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits, locally or elsewhere in the catchment
4 – South Shropshire & Tributaries	Reduce existing flood risk management actions (accepting that flood risk will increase over time)
5 – North Shropshire Tributaries	Reduce existing flood risk management actions (accepting that flood risk will increase over time)

6 – Telford & Black Couuntry	Take further actions to reduce risk (now and/or in the future)
8 – Middle Severn Corridor	Take further actions to sustain the current level of risk into the future (responding to the potential increase in risk from urban development, land-use change and climate change)
19 - Teme	Continue with existing or alternative actions to manage flood risk at the current level (accepting that flood risk will increase over time from this baseline)

Table D-1 CFMP flood management units

D2.4 West Midlands Regional Flood Risk Appraisal (Halcrow, 2009)

A Regional Flood Risk Appraisal (RFRA) for the West Midlands was originally completed in September 2007. The original RFRA was commissioned during a transitional stage in flood risk planning policy and whilst the most up to date guidance at the time was used to complete the study, more guidance subsequently became available (including the PPS25 Practice Guide Companion) and therefore, the RFRA was updated in 2009 to incorporate the most up-to-date information. The updated RFRA provided a broader, more rigorous assessment of flood risk across the Region and provided a basis for further policy development, including the recommendation of sustainable flood risk management policy options for the Options Report for the Phase Three RSS options consultation and development of the Preferred Option in 2009.

Key recommendations of the RFRA relevant to the Shropshire area are outlined below:

- Floodplains should be safeguarded from future development and local authorities must apply the Sequential Test to ensure all new development is directed towards Flood Zone 1 in the first instance. Opportunities should be taken to reinstate areas of functional floodplain which have been previously developed and Flood Zones 2 and 3 should be left as open space.
- Local authorities should be aware of the progress made in surface water modelling techniques and undertake Surface Water Management Plans (SWMPs) where high surface water flood risk has been identified. All new development should make allowance for climate change by designing safe and sustainable homes.
- Surface water should be appropriately managed in all Flood Zones, with Environmental Stewardship Schemes considered in rural and upland areas to help ensure farming practices help reduce runoff to decrease flood risk in urban areas downstream.
- It is recommended that for high flood risk/high growth areas where potential flood risk constraints to development have been identified, opportunities to locate future development in lower risk areas in the wider authority or in adjoining local authorities should be sought.
- Where development is located in residual risk areas, i.e. behind defences, downstream of reservoirs or adjacent to raised sections of canals, a site-specific FRA or Level 2 SFRA should assess breach and overtopping scenarios, determining if the level or residual risk is

acceptable and the mitigation measures that should be put in place to make the developments safe. Detailed overtopping and breach analysis will provide more refined hazard information and allow LPA emergency planning teams to refine emergency plans or veto new development where the risk is too great

Appendix E. Flood Risk and Surface Water Drainage

Appendix F. Surface Water Vulnerability Mapping