South Worcestershire Joint Core Strategy

Water Cycle Study

September 2010

FINAL REPORT

JBA Consulting
Magna House
South Street
ATHERSTONE
Warwickshire
CV9 1DF
UK
t: +44 (0)1827 722 710
f: +0845 8627772

www.jbaconsulting.co.uk

REVISION HISTORY

Revision Ref./ Date Issued	Amendments	Issued to
Draft Report June 2009		Fred Davies (SWJCS) 1 copy Rachel Whiteman (EA) 1 copy Paul Hurcombe (Severn Trent Water) 1 copy
Draft Final Report v1.0 November 2009	Updated as requested by the Environment Agency and Severn Trent Water Nov 2009	Fred Davies (SWJCS) 1 copy Sian Griffiths (SWJCS) 1 copy Rachel Whiteman (EA) 1 copy Paul Hurcombe (Severn Trent Water) 1 copy
Draft Final Report v1.1 January 2010	Updated as requested by the Environment Agency Jan 2010	Ruth Clare (EA) 1 copy (electronic)
Final Report v1.0 September 2010	Updated as requested by the Environment Agency and SWJCS Feb, July and August 2010	Sian Griffiths (SWJCS) 7 copies

CONTRACT

This report describes work commissioned by South Worcestershire Joint Core Strategy in October 2008

Prepared by: Georgina Niciecki BSc, MSc
Assistant Analyst

Philip Emonson BSc MSc FRGS
Analyst

Reviewed by: David Pettifer, CEng, FICE, FCIWEM, MEPS
Director

PURPOSE

This document has been prepared solely as a Water Cycle Study Report for South Worcestershire Joint Core Strategy. JBA Consulting accepts no responsibility or liability for any use that is made of this document other than by South Worcestershire Joint Core Strategy for the purposes for which it was originally commissioned and prepared.

ACKNOWLEDGMENTS

JBA would like to thank all those at Wychavon District Council, Worcester City Council, Malvern Hills District Council, Severn Trent Water, Natural England and the Environment Agency who provided information and data to support this project. Their assistance is gratefully acknowledged.

EXECUTIVE SUMMARY

1.1 Background

In October 2008 JBA Consulting was commissioned to undertake a Water Cycle Study (WCS) for South Worcestershire Joint Core Strategy, including the areas of Wychavon District Council (WDC), City of Worcester Council (COWC) and Malvern Hills District Council (MHDC). Major towns include Worcester, Droitwich Spa, Great Malvern, Evesham and Pershore, Tenbury Wells and Upton upon Severn. Significant watercourses within the study area are the River Severn, River Avon, River Salwarpe and the River Teme.

This study will assist local authorities to select and develop sustainable development allocations where there is minimal impact on the environment, water quality, water resources, infrastructure and flood risk. This study identifys areas where there may be conflict between any proposed strategic site allocations and the requirements of the environment and recommends potential solutions.

There are sixteen proposed strategic site allocations within five urban areas, Worcester, Droitwich Spa, Great Malvern, Pershore and Evesham. Current projections show that fifteen of the allocations will contain a total of 13,700 dwellings, three primary schools, two secondary schools and 25ha of employment land. One proposed strategic site allocation has been allocated solely as employment land. Employment land was unable to be assessed in detail within this study as the exact type of development proposed is currently unavailable. Tenbury Wells and Upton upon Severn have been broadly assessed where possible as they are potential locations for future development

A sequential approach was undertaken to develop this water cycle study, four stages were considered when assessing the impact of the development on the infrastructure, water resources, water quality/environment and flood risk. Firstly the current status, secondly the potential pressures, thirdly the impact of the new development and finally the how the impact can be managed.

1.2 Current Status and Impact of the Proposed Strategic Site Allocations

Severn Trent Water states that they will be able to accommodate all proposed strategic site allocations and potential windfall sites. However, it was found that improvements to the sewage treatment, sewerage and water supply infrastructure would be necessary for the majority of the proposed strategic site allocations.

Water Resources are scarce within the region. Catchment Abstraction Management Strategies produced by the Environment Agency show that the surface water and groundwater in the study area is either being over-abstracted or there is no water available for further abstractions. The Environment Agency have strict licensing policies for new and existing abstractions from groundwater and surface water resources to ensure that the environment is protected.

Severn Trent Water predict a net increase of approximately 31Megalitres/day (Ml/d) in water consumption from 2006 – 2035 in their Severn Water Resource Zone. The supply/demand balance for the zone became negative in 2006/2007. The current projected supply/demand shortfall is around 120Ml/d by 2035, taking into account the effects of climate change. This shortfall will arise if no further investment was made to leakage reduction, demand management and resource development. Severn Trent Water outlined proposals for investment to maintain the target headroom required to ensure security of supply to customers over the next 25 years. Sustainable and efficient use of available water resources will be required and in the long term there will be a need for more water resources and treatment capacity to meet the supply/demand balance.

The Water Framework Directive (WFD) states that all water bodies should achieve a ‘good’ status by 2015. Watercourses that flow through or near to the proposed strategic site allocations are currently failing to reach the WFD ‘good’ status in terms of either their chemical or ecological quality. The proposed strategic site allocations can increase the pressure on the environment and water quality due to, polluted surface runoff increased wastewater and associated nutrients and chemicals. None of the proposed strategic site allocations are within groundwater protection zones and the current groundwater chemical quality is good, therefore in terms of pollution they are unlikely to have an adverse impact on the groundwater. However, many of the proposed strategic site allocations are above minor aquifers and in Worcester and Droitwich the groundwater quantitative status is assessed as poor. Any development should be designed and managed so that it promotes groundwater recharge where possible, without increasing pollution risks and does not adversely impact upon the SSSIs that are nearby. As part of this study initial water quality modelling for BOD, Ammonium and Phosphate has been undertaken to analyse the impact that the proposed strategic site allocations may have on water quality in the receiving watercourse downstream of the Sewage

Treatment Works. The results show that currently the BOD, Ammonium and Phosphate levels at Powick STW exceed the targets set for the receiving watercourse (and will increase if the full proposed strategic site allocations are developed). It is therefore expected that improvements would be required to meet the resulting consent tightening. However, Severn Trent have stated that an alternative could be to extend the final effluent outfall from Powick STW so that it discharges directly to the River Severn. This is a distance of just over 1km across farmland and is considered feasible. The proposed strategic site allocations will also increase the Phosphate levels in the receiving watercourse at Droitwich-Ladywood STW as well as increasing the levels of BOD though not above the target level.

In terms of volumetric headroom, spare capacity exists within existing consents at Powick and Evesham. At Worcester further analysis of measured DWF is required. For instances in which spare headroom currently exists, but for which there is not capacity to accommodate the full allocations (such as Powick and Droitwich), a new consent will be required in the future. Application of this by Severn Trent Water will require review of the quality conditions.

In terms of flood risk, the main risk to the proposed strategic site allocations is from fluvial or surface water flooding. Groundwater flooding is not considered to pose a significant risk to the potential proposed strategic site allocations. New developments have the potential to increase flood risk through increase runoff volumes and rates, this should be managed through the use of appropriate attenuation schemes. The South Worcestershire SFRA should be consulted for more detailed information on the Flood Risk within the area, including the 100 year plus climate change flood outline.

1.3 Management

The proposed strategic site allocations are able to be accommodated but all of them will need some infrastructure improvement whether it is for sewerage, sewage treatment or water supply. Severn Trent Water has supplied notional solutions and costs for the improvements required. The costs for sewerage do not include potential improvements required for the Fernhill Heath and Great Malvern developments; Great Malvern was also unable to be assessed in terms of investment for water supply infrastructure. A notional total cost for improvements is in the region of £7.3m for the water supply infrastructure and £4.3m-£4.4m for the sewerage infrastructure. It is probable that there will be additional costs due to sewage treatment work hydraulic capacity or treatment upgrades, however at present exact costs are unavailable.

As water resources are scarce in the South Worcestershire area, demand management options are a vital consideration when planning and building any developments within the proposed strategic site allocations to provide sustainability both in terms of the aquatic environment and water supply. Severn Trent Water propose household retrofitting (the installation of water efficient products in existing developments) as well as other water efficiency options and works to reduce leakage. With increased water efficiency and water metering Severn Trent Water predict that by 2035, for a normal year, the average household per capita consumption will be 133litres/head/day. This shows progress towards achieving the Government's long term vision of 130litres/head/day. The current recommendation outlined by the Homes and Communities Agency is that developers should build new homes to at least a Level 3 standard under the Code for Sustainable Homes. In the long term Severn Trent Water proposes to increase the capacity of the Derwent Valley Aqueduct and continue to reduce leakages and improve water efficiency in the region.

Surface water from the proposed strategic site allocations should be disposed of where possible via infiltration techniques. If it is found that infiltration techniques are not suitable, surface water should be discharged into a watercourse via appropriate attenuation schemes rather than into the existing sewer network. The design of surface water drainage should include an allowance for climate change.

Management options such as SuDS should be utilised in terms of flood management attenuating the peak runoff rates and volumes from developments. They should also be utilised for their water quality treatment and habitat potential. All of the proposed strategic site allocations should be looking to install SuDs that help maintain the water quality.

Indicative costs for the construction of attenuation ponds have been calculated for each of the proposed strategic site allocations. It would cost in total in the region of £22.6m to provide attenuation ponds for the attenuation of peak runoff rates and volumes at all the proposed strategic site allocations. Any additional volume required for water quality treatment and long term storage of increased volume and runoff should be included in the calculation of the final storage volumes as well as the cost of land. Maintenance costs will also need to be considered when choosing a SuDS technique, it is estimated to cost annually between £0.50 - £1.50/m^2 of attenuation pond surface area to maintain a attenuation pond. This cost is for regular maintenance and does not include major maintenance activities such as sediment removal or insurance costs.

1.4 Recommendations and Policy

It is recommended this study is reviewed when final versions of the Severn Trent Water Resource Management Plan, Severn River Basin Management Plan and Severn Corridor and Teme CAMS are published.

Additional modelling of the sewer networks, treatment works and water supply systems should be carried out to increase the accuracy of the results in Severn Trent Water's Growth Point Studies once the proposed strategic site allocations and dwelling numbers are finalised. This will allow more accurate costings and solutions to be developed and to confirm the potential constraints to development.

New hydraulic models should be created for watercourses where models are currently not available from the Environment Agency. Surface Water Management Plans should be undertaken for Worcester, Droitwich Spa and Great Malvern to produce a more accurate assessment of the flood risk to the proposed strategic site allocations.

As part of this study initial water quality modelling has been undertaken to analyse the impact that the proposed strategic site allocations may have on water quality in the receiving watercourse downstream of the Sewage Treatment Works. It was found that changes to current discharge consents may be necessary at Powick STW for BOD, Ammonium and Phosphorus as well as possible modifications to Ammonium consents at Droitwich STW and Evesham STW. None of the consents identified are below those achievable using Best Available Techniques (BAT) and as such there are no potential 'show stoppers' to development in terms of water quality.

A Water Efficiency Policy has been developed in conjunction with the South Worcestershire Joint Core Strategy to limit the impact of the proposed strategic site allocations on the water resources.

The Water Cycle Study should be treated as a "dynamic document" that is periodically reviewed as further information becomes available. This will provide a better understanding of the impact of the developments on the water supply, wastewater infrastructure and water quality.

This page is intentionally left blank.

CONTENTS

CONTENTS

LIST OF FIGURES

LIST OF MAPS

LIST OF TABLES

ABBREVIATIONS

BOD	Biochemical Oxygen Demand
BRE	Building Research Establishment
CAMS	Catchment Abstraction Management Strategy
CC	Climate Change
CIRIA	Construction Industry Research and Information Association
COWC	City of Worcester Council
Defra	Department for the Environment, Food and Rural Affairs
DMA	District Meter Areas
DWF	Dry Weather Flow
DO	Deployable Output
EA	Environment Agency
EIA	Environmental Impact Assessment
FFT	Flow to Full Treatment (The maximum flow that can be treated by a plant.)
FRA	Flood Risk Assessment
GWMU	Groundwater Management Unit
Ha	Hectare
HOF	'Hands Off Flow'
JBA	Jeremy Benn Associates Ltd
LDD	Local Development Document
LDF	Local Development Framework
LPA	Local Planning Authority
MHDC	Malvern Hills District Council
m AOD	Metres Above Ordnance Datum
Mhh	Metered Household
Ml/d	Megalitres/day
pcc	Per Capita Consumption
PPS25	Planning Policy Statement 25
RBMP	River Basin Management Plan
RSS	Regional Spatial Strategy
SEA	Strategic Environmental Assessment
SFRA	Strategic Flood Risk Assessment
SHLAA	Strategic Housing Land Availability Assessment
SPZ	Source Protection Zone
SR	Storage Reservoir
SSSI	Site of Specific Scientific Interest
STW	Sewage Treatment Works
SuDS	Sustainable Drainage Systems
SWJCS	South Worcestershire Joint Core Strategy
WD	Water Delivered
WDC	Wychavon District Council
WFD	Water Framework Directive
WRMP	Water Resources Management Plan
WRMU	Water Resources Management Unit
WRZ	Water Resources Zone
Unhh	Unmetered Household
USPL	Underground Supply Pipe Leakage

This page is intentionally left blank.

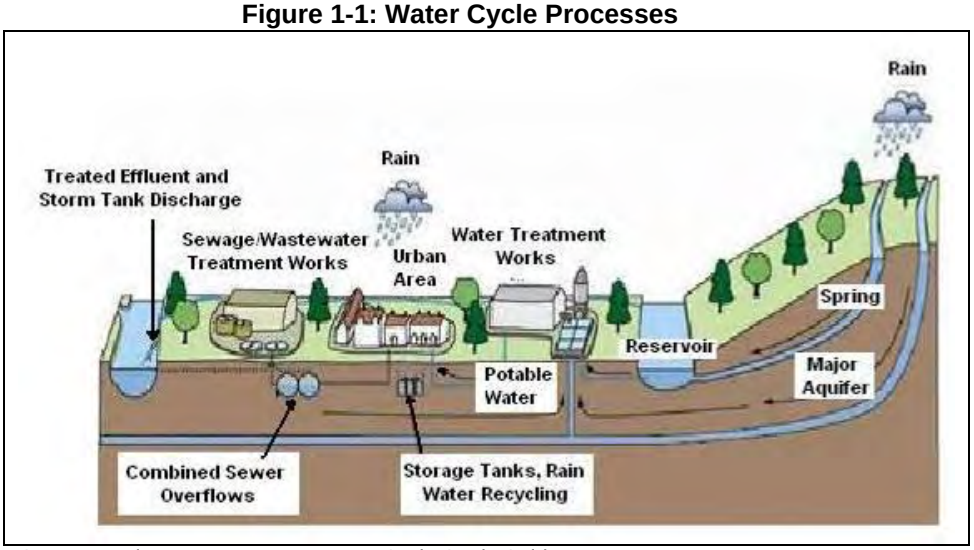
1 INTRODUCTION

1.1 Background

In October 2008 JBA Consulting was commissioned to undertake a Water Cycle Study (WCS) for South Worcestershire Joint Core Strategy, including the areas of Wychavon District Council (WDC), City of Worcester Council (COWC) and Malvern Hills District Council (MHDC). Major towns within the area include Worcester, Droitwich Spa, Great Malvern, Evesham and Pershore, Tenbury Wells and Upton upon Severn. Significant watercourses within the study area are the River Severn, River Avon, River Salwarpe and the River Teme.

New homes require the provision of clean water, safe disposal of wastewater and protection from flooding. A large number of homes may cause existing infrastructure to be overwhelmed and can adversely affect the environment. Climate change brings with it new challenges such as increased rainfall that can put greater pressure on the existing infrastructure, planning for water has to take this into account. The water cycle can be seen in Figure 1-1 below, and shows how the natural and man-made processes and systems interact to collect, store or transport water in the environment.

Figure 1-1: Water Cycle Processes



*Source: Environment Agency – Water Cycle Study Guidance

This study will assist local authorities to select and develop sustainable development allocations where there is minimal impact on the environment, water quality, water resources, infrastructure and flood risk. This has been achieved by identifying areas where there may be conflict between any proposed development and the requirements of the environment and by recommending potential solutions.

The Water Cycle Study should be treated as a "dynamic document" that is periodically reviewed as further information becomes available. This will provide a better understanding of the impact of the developments on the water supply and wastewater infrastructure and water quality.

1.2 Scope and Objectives of the Water Cycle Study

The Councils have put forward their proposed strategic site allocations for the South Worcestershire Joint Core Strategy Preferred Options document. The West Midlands Regional Spatial Strategy (RSS) Phase 2 Revision (draft) gives "option 2" housing targets for South Worcestershire, indicating that 24,500 new dwellings should be built between 2006-2026.

The Water Cycle Study is required in order to assess the constraints and requirements that will arise from the proposed growth on the water infrastructure.

The overall objective of the Water Cycle Study is to understand the environmental and physical constraints of the development and identify opportunities for more sustainable planning and improvements that may be required to achieve the required level of development. This is assessed by considering the following issues:

- Water Supply;
- Wastewater and Treatment;
- Water Quality and the Environment;
- Demand Management; and
- Flood Risk

This report focuses upon the proposed strategic site allocations provided by the Councils within five urban areas: Worcester, Droitwich Spa, Great Malvern, Pershore and Evesham (See Map 2). The report outlines the current status of the environment and infrastructure, identifies the possible constraints to the development and the impacts from the development, and gives recommendations as to any improvements or mitigation required including approximate costings.

1.3 Stakeholders and consultation

It is important that a Water Cycle Study brings together all partners and stakeholders knowledge, understanding and skills to help to understand the environmental and physical constraints to development. The following stakeholders were consulted during this Water Cycle Study and have provided data for use within the study:

- Severn Trent Water
- Environment Agency
- Natural England
- Worcester City Council
- Wychavon City Council
- Malvern Hills District Council

1.4 Study Area

The study area is South Worcestershire, including Wychavon, City of Worcester and Malvern District Councils. The main towns within the study area are Worcester, Evesham, Droitwich Spa, Great Malvern, and Pershore, Tenbury Wells and Upton upon Severn (See Map 1).

Significant watercourses within the study area are the River Severn, River Avon, River Salwarpe, Barbourne Brook and River Teme.

The key transport route passing through the study area is the M5 motorway.

2 DATA COLLECTION AND METHODOLOGY

2.1 Overview

A sequential approach was undertaken to develop this water cycle study, four stages were considered when assessing each area outlined in the objectives for this report. The four stages were:

- **Current State** – For each objective, e.g. Water Supply or Water Quality, the current status was assessed to provide a baseline and to identify areas that may be affected by new development and additional demand.
- **Pressures** – The potential pressures to the environment and infrastructure were established by identifying the development targets and external pressures, for example climate change.
- **Impact** – For each objective the potential impacts of new development were assessed.
- **Management** – Sustainable management strategies were identified to help reduce or prevent the potential impacts of new development on the surrounding environment.

The following sections outline the data that has been provided by the stakeholders, how it was used to assess each objective and the limitations of the data provided and used within its study.

2.2 Housing growth and trajectories

2.2.1 Data

The West Midlands Regional Spatial Strategy (RSS) Phase 2 Revision (draft) gives "option 2" housing targets for South Worcestershire, indicating that 24,500 new dwellings should be built between 2006-2026. Proposed strategic site allocations have been identified within the South Worcestershire Joint Core Strategy (SWJCS) Strategic Housing Land Availability Assessment (SHLAA) undertaken in June 2008 and the three Councils have provided datasets for 16 proposed strategic site allocations, including the potential number of dwellings and allocated employment land in their Pre-Submission document. Of the final 16 proposed strategic site allocations, five are located in Worcester, three in Droitwich Spa, four in Great Malvern, one in Pershore and three in Evesham.

2.2.2 Data Limitations

The potential dwelling numbers, employment land and site locations are the most up to date at the time this study was produced. However, these have the potential to change in the future and therefore this study may be required to be updated should changes occur. These current projections are also more up to date than the housing numbers used within Severn Trent Water's Growth Point Studies (see sections 2.2 and 2.3). This study only considers the new proposed developments until 2026, and therefore this document will only be relevant for those developments, further studies would be required if new developments were proposed for after this time.

2.3 Wastewater

2.3.1 Data

Severn Trent Water provided JBA with their Growth Point Studies (December 2008) that includes the assessment of the impacts of the proposed strategic site allocations on their wastewater assets between 2006 and 2026.

2.3.2 Data Limitations

The Growth Point Study only assesses the impact of the potential residential properties and does not assess the impact of the employment land. Severn Trent Water have provided JBA with some guidance as to the impact of different employment types but advises that for an accurate assessment of the impacts of the employment the exact type of the employment proposed would be required, e.g. office buildings or heavy industry. This information is not currently available.

There have been an additional four proposed strategic site allocations added since the Growth Point Study has been undertaken, these are Worcester North, Hill End, Blackmore Park and Cheltenham

Road. Information has been provided by Severn Trent Water regarding these additional allocations, however, the summaries for these allocations may not be as detailed as for the other 12 allocations that were included within the Growth Point Study.

The total number of potential dwellings for the allocations assessed within the Severn Trent Water Growth Point varies from those currently projected. Some allocations assessed also differ slightly in location and size.

The current projected housing numbers and site locations have been compared to those within Severn Trent Water's Growth Point Studies to assess whether the conclusions within the Growth Point Studies are robust in light of the changes in housing numbers/location for some sites.

Further detailed modelling will be required when the proposed strategic site allocations, dwelling numbers and employment are finalised.

Summary

- **Dwelling numbers and site locations outlined in the South Worcestershire Joint Core Strategy Pre-Submission document may change in the future and only accounts for potential development to 2026.**
- **An additional four strategic allocations have been added since Severn Trent Water's Growth Point Studies were undertaken and some sites are slightly different in size and location.**
- **The Growth Point Studies do not assess the impact of the employment land. This has been broadly assessed where possible. Further assessments are required once employment type is finalised.**

2.4 Water Resources and supply

2.4.1 Data

Severn Trent Water provided JBA with their Growth Point Studies (December 2008) that include the assessment of the impacts of the proposed strategic site allocations on their water supply assets between 2006 and 2026.

The Warwickshire Avon, Severn Corridor, Worcestershire Middle Severn, Severn Vale and Teme Catchment Abstraction Management Strategies have been used to assess the status of water resources within South Worcestershire.

Severn Trent Water Resources Management Plan 2009 (Draft) and Statement of Response were also used as a source of information for supply and demand issues between 2006 and 2026 as well as water efficiency issues.

2.4.2 Data Limitations

The same limitations due to the different dwelling numbers, site locations and employment land apply for the Severn Trent Water - Water Supply Growth Point Study as explained in section 2.3.2. It must be noted that the Growth Point Study has been used in this report for analysis of the existing infrastructure. However, Severn Trent Water have provided more up to date Dry Weather Flow data which has been used in the water quality assessment.

The current projected dwelling numbers and site locations have been compared to those within Severn Trent Water's Growth Point Studies to assess whether the conclusions within the Growth Point Studies are robust in light of the changes in dwelling numbers/location for some allocations. Further detailed modelling will be required when the proposed strategic site allocations, dwelling numbers and employment are finalised.

The Severn Trent Water Resources Management Plan (WRMP) is still at draft stage. A Statement of Response to comments following a public consultation on the draft plan is available on the Severn Trent

Water website. A comment on the Severn Trent Water website states that unless they are required to make further changes, the final plan will reflect the latest position.

2.5 Water Quality and the Environment

2.5.1 Data

The Environment Agency's Severn River Basin Management Plan (Final) has been used to assess the Water Quality within South Worcestershire. The Environment Agency has produced Catchment Abstraction Management Strategies (CAMS) for the region;

- The Warwickshire Avon Catchment Abstraction Management Strategy (June 2006) includes information on Pershore and Evesham;
- The Severn Corridor Catchment Abstraction Management Strategy (2003 and updated in 2007) includes information on Worcester;
- The Teme Catchment Abstraction Management Strategy (2005) include information on Worcester and Tenbury Wells;
- The Worcestershire Middle Severn Catchment Abstraction Management Strategy (December 2006) includes information on Droitwich Spa; and
- The Severn Vale Catchment Abstraction Management Strategy (January 2008) includes information of Great Malvern and Upton upon Severn.

The Environment Agency CAMS listed above give an indication of the environmental stress to the watercourses and to groundwater with regards to low flow. The Environment Agency has also provided JBA with their Groundwater Source Protection Zones for the study area.

Natural England has provided information regarding SSSIs and other areas of protection within the study area that may be affected by the proposed strategic site allocations. They have also provided information regarding the benefits of green infrastructure.

In order that assessment of the water quality from the Sewage Treatment Works post-development could be undertaken, the Environment Agency supplied river flow and water quality data for upstream of the STWs, as well as current target data. Severn Trent Water provided discharge data for each STW, which supersedes that of the December 2008 Growth Point Studies, and was incorporated into this analysis.

2.5.2 Data Limitations

Several of the CAMS are due to be updated in the next few years and should be reviewed when complete.

The assessment of the water quality and environment is broad scale and there may be a need for site specific investigations to determine a more accurate assessment of the potential impacts of the proposed strategic site allocations on the environment and water quality.

2.6 Flood Risk Management

2.6.1 Data

This Water Cycle Study has been prepared in parallel with the South Worcestershire Strategic Flood Risk Assessment (Final). Therefore the findings in relation to flood risk are based on those within the SFRA.

2.6.2 Data Limitations

The information in this document is a summary of risks to the strateigic allocations based on the information in the SFRA. The SFRA should be consulted for more detailed information about Flood Risk in the area.

Summary

- **The Severn Trent Water Resources Management Plan is only a draft version.**
- **The second cycle Catchment Abstraction Management Strategies are due to be published in 2010.**
- **Subsequently this study may require updating when final versions of reports are available.**
- **The Final Severn River Basin Management Plan has been used in this study.**
- **The assessment of the water quality and environment is broad scale and there may be a need for site specific investigations.**

3 DEVELOPMENT SCENARIOS AND KEY DEVELOPMENTS

3.1 Introduction

The West Midlands Regional Spatial Strategy (RSS) Phase 2 Revision (draft) gives "Preferred Option (Dec 2007)" housing targets for South Worcestershire, indicating that 24,500 new dwellings should be built between 2006-2026. The new dwellings are to be distributed within the three districts in South Worcestershire, Worcester City, Malvern Hills and Wychavon (see Map 1). The following table shows the amount of new dwellings per planning area and the average annual requirements.

Table 3-1 Proposed Dwellings per Planning Area (2006- 2026)[1]

Planning Area	Proposed Dwellings	Annual Average Requirement (2006- 2026)
Malvern Hills	4,900*	245
Worcester City	10,500*	525
Wychavon	9,100*	455
South Worcestershire Total	24,500	1,225

* Of the 10,500 for Worcester City, 3,200 will be within Worcester City and 7,300 will be adjacent to the city within the surrounding districts of Malvern Hills and Wychavon.

The target from April 2007 was 18,749 dwellings, accounting for all completed housing constructions in 2006 and those allocated land, with planning permission or under construction.

In order to assess the impact of these new developments on the water cycle infrastructure it is important to know the spatial pattern of the new dwellings. Sixteen proposed strategic site allocations have been identified as key development areas and are located within five urban areas in the South Worcestershire study area, Worcester, Droitwich Spa, Great Malvern, Pershore and Evesham (see Map 2). Fifteen of the allocations are proposed for residential developments, some of which also contain employment land and one allocation has been proposed for employment land (see figures 3-1 to 3-5). For the purpose of this study the allocations have been separated into the five urban areas rather than into the three districts as the allocations can overlap between districts. A further two urban areas, Tenbury Wells and Upton upon Severn, have been assessed where possible as these are probable locations for future development.

Windfall housing sites are those that have not been identified in advance through development plans. The adopted Local Plans for the three South Worcestershire Local Authorities contain a windfall allowance of dwellings likely to come forward in each area in addition to those on proposed strategic site allocations. The South Worcestershire Joint Core Strategy (SWJCS) Strategic Housing Land Availability Assessment (SHLAA) report shows an annual average of 641 total windfall completions for South Worcestershire, or 412 in urban brownfield locations, based on windfall completion rates between 2005 and 2007. A longer term average (past 6 years) shows an annual average of 418 dwellings on brownfield windfall sites.

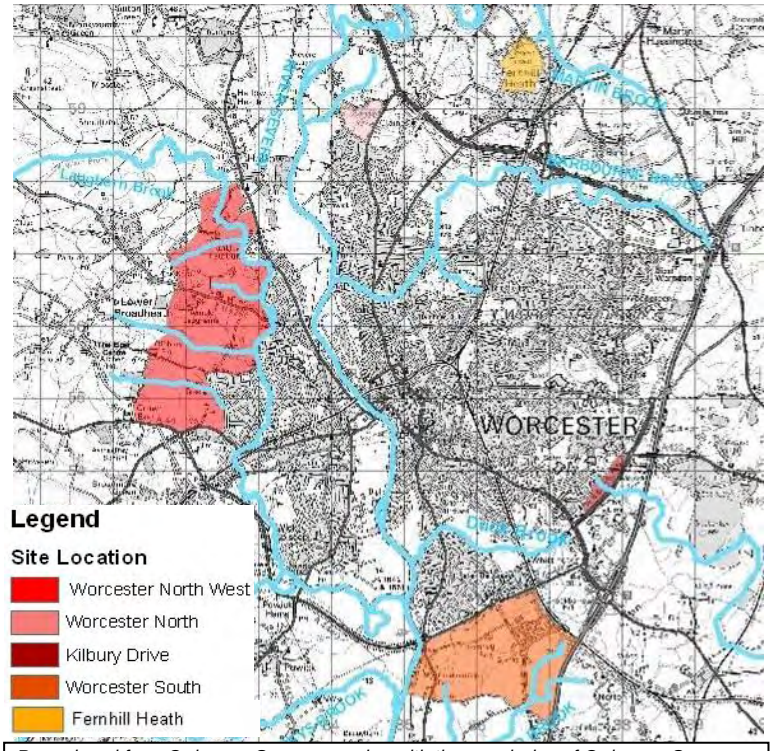
The total amount of new dwellings currently proposed is a total of 13,700 dwellings on the 15 proposed strategic site allocations. This indicates that if all the land is developed with the potential amount of dwellings the 2026 target of 18,749 new dwellings will be not be met. However, there is the potential for a number of windfall properties and a possible 2,000 additional houses within the Worcester North West proposed strategic site allocation. The following sections indicate the current spatial distribution and numbers of potential dwellings provided by Worcester City Council.

[1] Original Source – West Midlands RSS, Phase 2 Revision – Draft Preferred Option Dec 2007 (extracted from South Worcestershire Joint Core Strategy SHLAA report June 2008.

3.2 Worcester

Figure 3-1: Worcester – Proposed Strategic Site Allocations

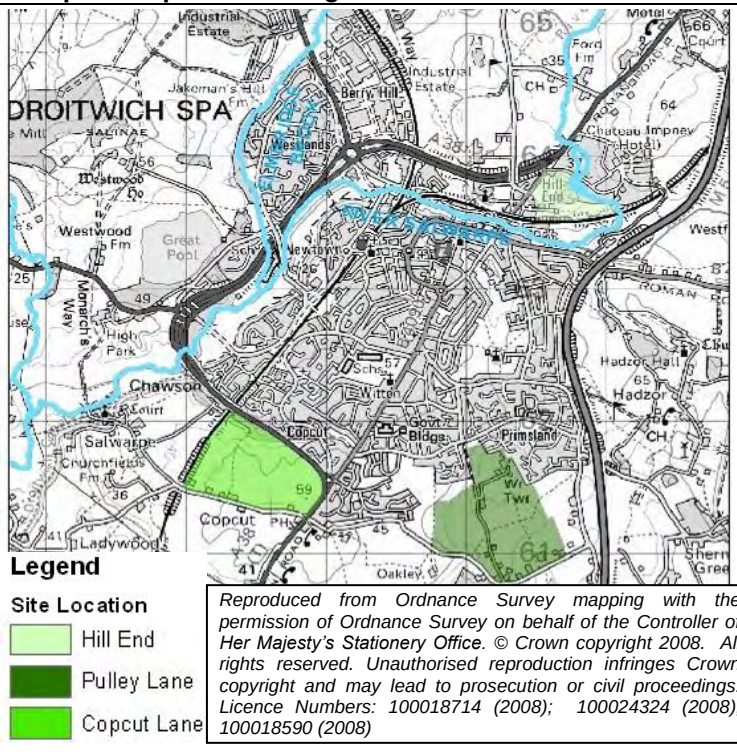
Five of the sixteen proposed strategic site allocations are in or surrounding Worcester.
Worcester North West Area: 364 hectares 3,500 potential dwellings
Worcester North Area: 21 hectares 350 potential dwellings
Kilbury Drive Area: 15 hectares 300 potential dwellings
Worcester South Area: 243 hectares 3,000 potential dwellings 20ha of employment land 1 secondary school 1 primary school
Fernhill Heath Area: 33 hectares 500 potential dwellings
Total Number of Dwellings 7,650



3.3 Droitwich Spa

Figure 3-2: Droitwich Spa - Proposed Strategic Site Allocations

Three of the sixteen proposed strategic site allocations are in or surrounding Droitwich Spa.
Hill End Area: 14 hectares 250 potential dwellings
Pulley Lane Area: 59 hectares 1,000 potential dwellings
Copcut Lane Area: 46 hectares 800 potential dwellings 4ha of employment land 1 primary school
Total Number of Dwellings 2,050



3.4 Great Malvern

Figure 3-3: Great Malvern - Proposed Strategic Site Allocations

Four of the sixteen proposed strategic site allocations are in or surrounding Great Malvern.

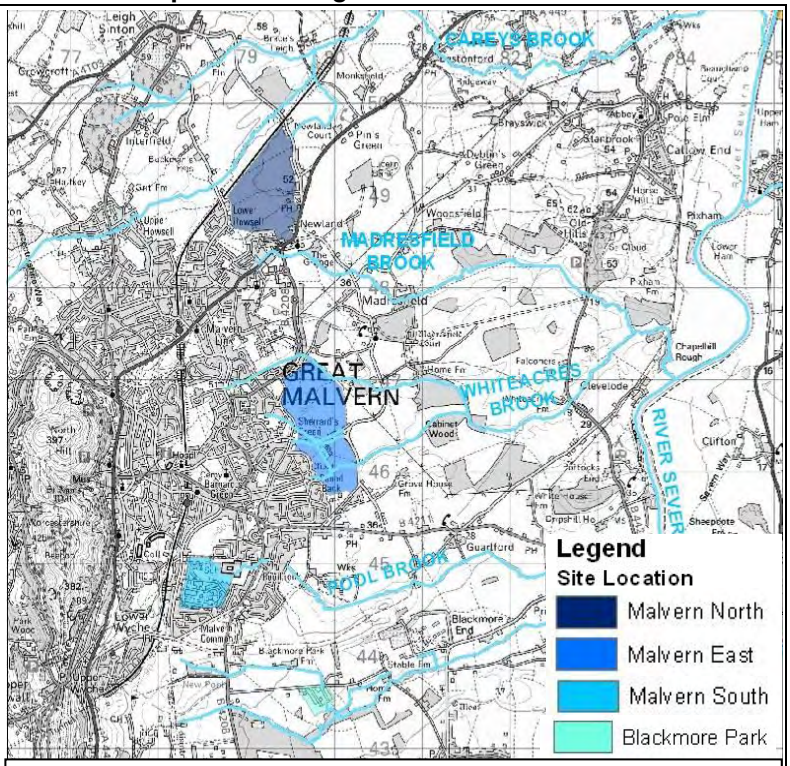
Malvern North
Area: 61 hectares
800 potential dwellings
10ha of employment land
1 primary school

Malvern East
Area:75 hectares
400 potential dwellings

Malvern South
Area:25 hectares
300 potential dwellings

Blackmore Park
Area: 9 hectares
All Employment Land

Total Number of Dwellings
1,500



Reproduced from Ordnance Survey mapping with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office. © Crown copyright 2008. All rights reserved. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. Licence Numbers: 100018714 (2008); 100024324 (2008); 100018590 (2008)

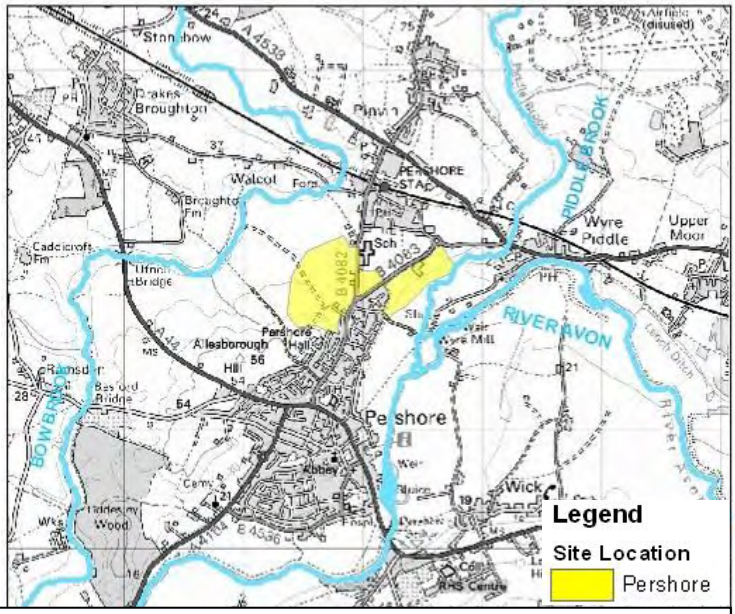
3.5 Pershore

Figure 3-4: Pershore- Proposed Strategic Site Allocations

One of the sixteen proposed strategic site allocations is in Pershore.

Pershore
Area: 53 hectares
900 potential dwellings

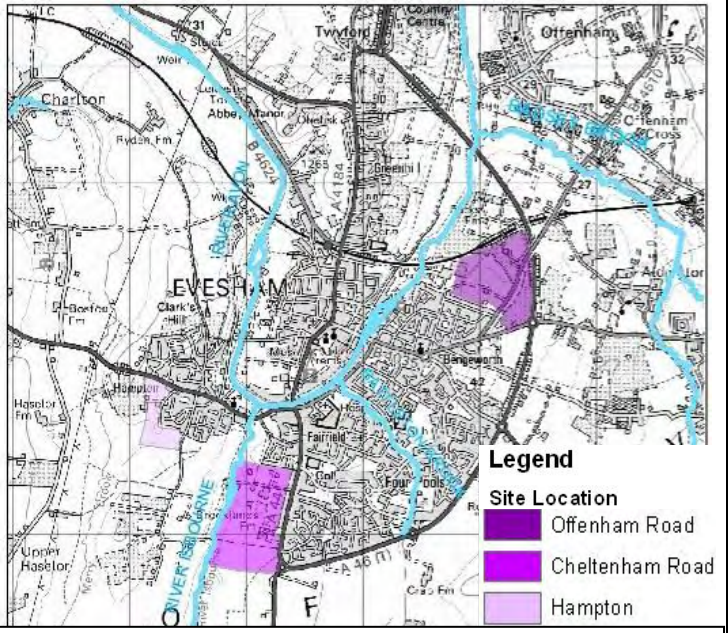
Total Number of Dwellings
900



Reproduced from Ordnance Survey mapping with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office. © Crown copyright 2008. All rights reserved. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. Licence Numbers: 100018714 (2008); 100024324 (2008); 100018590 (2008)

3.6 Evesham

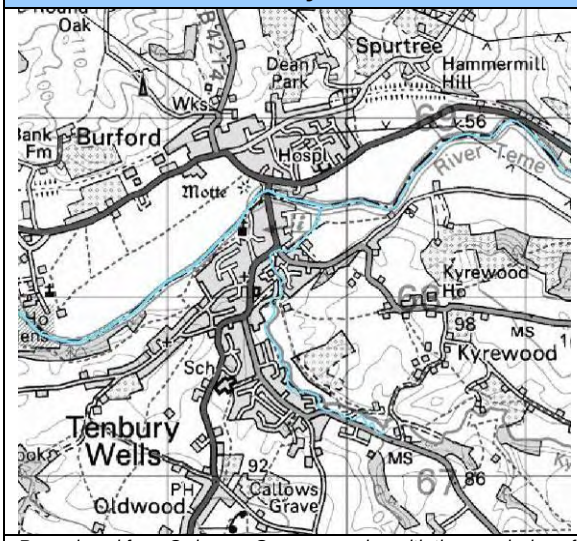
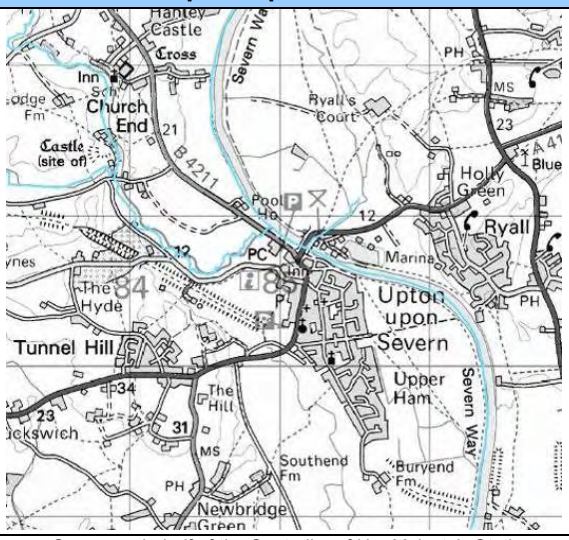
Figure 3-5: Evesham - Proposed Strategic Site Allocations

Three of the sixteen proposed strategic site allocations are in or surrounding Evesham.	
Offenham Road Area: 39 hectares 800 potential dwellings	
Cheltenham Road Area: 46 hectares 800 potential dwellings	
Hampton Area: 11 hectares 500 potential dwellings	
Total Number of Dwellings 2,100	

3.7 Tenbury Wells and Upton upon Severn

These urban areas are included within this study as they are possible locations for future development sites. No proposed strategic site allocations were submitted within the pre-submission document.

Figure 3-6: Tenbury Wells and Upton upon Severn Urban Areas

Tenbury Wells	Upton upon Severn
	

3.8 Employment Land

The majority of the land within the proposed strategic site allocations will be allocated for residential properties, however some of the land has been allocated as employment land. The current proposal, provided by Worcester City Council, indicates that four of the fifteen proposed strategic site allocations include employment land and Blackmore Park in the east of Great Malvern is exclusively for employment land. The following proposed strategic site allocations have land allocated to employment:

- **Worcester South** – 20ha of employment land; a secondary school and a primary school;
- **Pulley Lane** – a secondary school;
- **Copcut Lane** – 4ha of employment land and a primary school;
- **Malvern North** – 10ha of employment land and a primary school;
- **Blackmore Park** – 9ha of employment land.

Employment land can range from heavy industry to office buildings. The type of employment constructed on the proposed strategic site allocation can affect the scale of the impact that the development could have on the water and wastewater infrastructure, water resources and water quality. Therefore Severn Trent Water was unable to assess in detail the impact of the employment land on the water supply, sewerage and sewer infrastructure as the exact type of employment was unknown. The detailed assessment of the water supply and wastewater infrastructure undertaken by Severn Trent Water and outlined in Chapters 4 and 5 is therefore only based on the number of proposed residential properties. To allow a general assessment of potential impacts of non-residential developments, Severn Trent Water has provided a summary of indicative values of water supply and wastewater for potential employment types.

Summary

- **There are 16 proposed strategic site allocations, 15 of which are either solely residential or a mix of residential and employment land. One site is allocated for employment land only.**
- **The proposed strategic site allocations are distributed between Worcester, Droitwich Spa, Great Malvern, Evesham and Pershore.**
- **The total amount of new dwellings currently proposed, provided by Worcester City Council, for the proposed 15 residential sites is 13,700.**
- **There is the potential for a number of windfall sites and a possible 2000 additional houses within the Worcester North West proposed strategic site allocation.**
- **Tenbury Wells and Upton Upon Severn have been broadly assessed where possible as they are likely locations for windfall sites.**

This page is intentionally left blank.

4 WASTEWATER COLLECTION AND TREATMENT

Severn Trent Water is responsible for the operation and maintenance of the wastewater collection and treatment infrastructure for South Worcestershire. This includes the collection and treatment of surface water originating from surfaces within private properties that are connected directly to the wastewater network through combined systems. This does not include, unless adopted by Severn Trent Water, systems that do not connect directly to the wastewater network, e.g. SuDS or highway drainage.

In December 2008 the Severn Trent Water ADO8 Growth Point Study for Worcester undertaken by Jacobs Engineering UK Ltd. was issued. The study assessed the adequacy of the current sewerage assets to meet the growth in demand expected in South Worcestershire and was based on information provided by the SWJCS. The aim of the study was to assess for each area the capability of existing sewerage strategic assets to cope with the increases in demand in the future. The assessment considered the capabilities of available licensed water abstraction, available water treatment capacity, available trunk sewer capacity, available sewage capacity and impacts on treatment consents.

The detailed assessment was undertaken for the proposed residential strategic site allocations only and does not include employment land. The potential impact of employment land and windfall sites on the infrastructure has been addressed separately in section 4.6. The proposed strategic site allocations have been updated since the Severn Trent Water Growth Point Study was undertaken and consequently there are four additional proposed strategic site allocations that have not been included within the study which are to be included within this study. These are Worcester North, Cheltenham Road in Evesham, Hill End in Droitwich Spa and Blackmore Park in Great Malvern. Severn Trent Water has provided a summary for the additional allocations for the purpose of this study except for Blackmore Park that could not be assessed as it is exclusively for employment land, the exact type of land use would be required for Severn Trent Water to be able to comment on the impact of this proposed strategic site allocation.

Kilbury Drive was also not included within the allocations assessed in the Growth Point Study. However, the Whittington site in the study is in a similar location, is similar in size and has the same number of potential dwellings as the proposed strategic site allocation at Kilbury Drive. It is also adjacent to the Whittington site. Therefore most of the projections for the Whittington site can be used to give an estimate for the Kilbury Drive allocation.

It is important to recognise that the assessment, notional solutions and costs within the Growth Point Study are only indicative of the possible improvements necessary and further modelling will be required in the future once the proposed strategic site allocations, number of dwellings and type of employment are finalised.

Summary

- **Severn Trent Water has provided a summary for the additional allocations, Cheltenham Road, Worcester North and Hill End, not included in the Growth Point Study. No information could be provided for Blackmore Park as it is allocated entirely as employment land.**
- **The Whittington site in Growth Point Study has been used to give an estimate of the impact of Kilbury Drive as it is in a similar location, is a similar size and has the same number of potential dwellings as the proposed site at Kilbury Drive.**
- **The assessment, notional solutions and costs within the Growth Point Study are only indicative of the possible improvements necessary and further modelling will be required in the future once the proposed strategic site allocations, number of dwellings and type of employment are finalised.**

4.1 Assumptions and methodology

The methodology and assumptions described below are those used by Jacobs Engineering UK Ltd to assess the sewerage and sewage treatment in South Worcestershire unless stated otherwise.

4.1.1 Sewage Treatment

The peak dry weather flow (DWF) and peak storm flows are taken from the models obtained to give a simplistic idea of the increase in flows to the works from the 'Formula A Flow' calculated for the proposed strategic site allocations. These DWFs have been used to assess the impact of individual proposed strategic site allocations on the sewage treatment works.

The relevant sewage treatment works (STW) identified to accept the additional discharges from the proposed strategic site allocations are shown in Figure 4-1. These were identified based on the direction that adjacent ground falls and the size and available capacity of the sewer to the adjacent developments.

The following sections include a summary of the information currently available on sewage treatment capacity. This was provided by Severn Trent Water in addition to the Jacobs Engineering UK Ltd Report.

4.1.2 Sewerage

The capacity of sewerage systems was assessed through discussion between Jacobs Engineering UK Ltd with Severn Trent Water Operations. Models for each proposed strategic site allocation were issued by Severn Trent Water and simulations were run to show the affects that the proposed developments would have on the sewerage systems.

Baseline

A range of storm durations with a 10 year return period were simulated and the storm duration that gave the worst condition on the system was then used at the critical duration for the models. A range of return periods were then simulated to show the sewerage systems ability to cope during different conditions. This gave the baseline conditions.

Impact of Proposed Developments

Information relating to the proposed strategic site allocations and populations was issued by Severn Trent Water and added to the hydraulic models as storm and foul sub-catchments. To be able to develop notional schemes to accommodate the additional foul flows and the magnitude of foul storage several assumptions were made by Jacobs Engineering UK Ltd. These are as follows:

(i) Foul Water

- Populations were assigned for the proposed strategic site allocations based on 2.5 people per property.
- Wastewater generated for the proposed strategic site allocations was based on 180litres/head/day with a design flow of 3DWF; 10% infiltration has been applied as a base flow.
- The 'Sewers for Adoption' recommendation includes the 10% allowance for creep in the foul systems, allowing for misconnections into the foul system.

(ii) Storm Water

- The impermeable contribution has been assumed based on 35% of the total proposed strategic site allocation area with all storm discharge limited to a greenfield runoff rate of 5l/a per hectare, the remaining storm flow will be accommodated by on-site attenuation.
- Severn Trent Water advised Jacobs Engineering UK Ltd that the solution did not utilise combined sewers for storm water discharge, where possible it should be discharged into existing watercourses thus limiting the amount of flow entering the works and reducing operating costs.
- There may be natural attenuation on the proposed strategic site allocations that has not been accounted for.

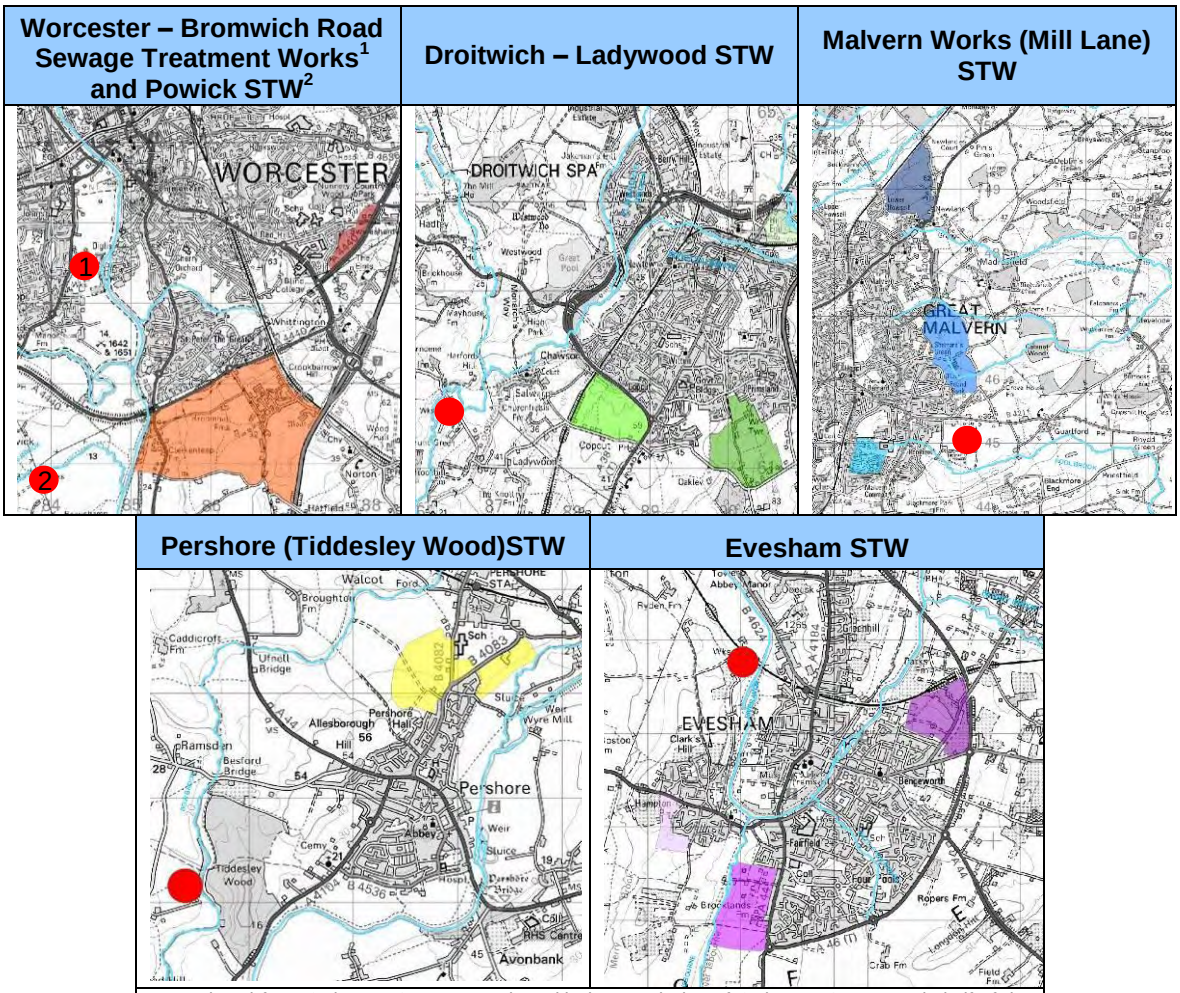
- No allowance has been made for industrial discharge
- All cost estimates made for rising mains are based on GPS SDR11 PE100 pipes and their nominal sizes.

4.2 Proposed Strategic Site Allocations impact on Peak DWF and Peak Storm Flow

The following section outlines the additional Formula A flows (foul flows) for the proposed strategic site allocations and the impact that these flows have on the peak storm flows to the relevant treatment works after modelling.

A summary of the additional discharges flowing to the relevant works can be found in Table 4-1 and the locations of the works can be found in Figure 4-1.

Figure 4-1: Sewage Treatment Works identified to accept the additional discharges



Reproduced from Ordnance Survey mapping with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office. © Crown copyright 2008. All rights reserved. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. Licence Numbers: 100018714 (2008); 100024324 (2008); 100018590 (2008)

Table 4-1: Summary of additional foul flows

Proposed Strategic Site Allocations	Additional Properties	Increase in 'Formula A' Foul Flows (l/s)	Sewage Treatment Works (STW)
Worcester	3,800*	203	Worcester – Bromwich Road STW
	3,000	160	Powick STW
	500	27	Droitwich – Ladywood STW
Droitwich Spa	1,750	94	Droitwich – Ladywood STW
Great Malvern	1,740	93	Malvern Works (Mill Lane) STW
Pershore	1,000	53	Pershore STW
Evesham	2,300	123	Evesham STW

*excluding additional dwellings in Worcester North

4.2.1 Worcester Sewage Treatment Works

The Worcester Central model indicates the addition of Worcester North West and Kilbury Drive will have very little effect on the treatment works on Bromwich Road. The increase in peak Dry Weather Flow (DWF) is 9% for each development due to the difference in critical storms (Table 4-2). The model does not include the additional flows from Worcester North (see section 4-4). Worcester North West pumps 50l/s and has no effect on the peak storm flow feeding to the works, though Kilbury Drive has an estimated 5% increase in peak storm flow at the works, assuming that this is equal to the Whittington development modelled. The Worcester – St Peters model indicates that there is a 60% increase in peak DWF and a 26% increase in peak storm flows to the Powick STW from the Worcester South Development.

Table 4-2: Affects of Proposed Strategic Site Allocations in Worcester on Flows to Sewage Treatment Works

		Current Conditions		Post Development Conditions	
Proposed Strategic Site Allocations	**Works**	**Peak DWF (l/s)**	**Peak Storm (l/s)**	**Peak DWF (l/s)**	**Peak Storm (l/s)**
Worcester North West	Worcester - Bromwich Road	525	1,887	578	1,886
Worcester North	Worcester - Bromwich Road	Not Available	Not Available	Not Available	Not Available
Kilbury Drive*	Worcester - Bromwich Road	525	1,784	578	1,882
Worcester South	Powick	20	62	50	78
Fernhill Heath**	Droitwich - Ladywood	Not Available	Not Available	Not Available	Not Available

*Only an estimate as model results are for a site at Whittington, next to Kilbury Drive, which is of similar size and has the same number of proposed dwellings.
**Was not considered in the Growth Point Study due to lack of model and data information.

Table 4-3 indicates potential pressures on the treatment works capacity from the proposed strategic site allocations and subsequent improvements that may be required. Severn Trent Water have a statutory

obligation to provide additional treatment capacity to accept future domestic development flows, however potential investment requirements are to be reviewed when the dwelling numbers and site locations have been finalised by the Councils.

Table 4-3: Sewage Treatment Works Capacity in Worcester

Sewage Treatment Works	Total Connected Population Equivalent (PE) at 31 March 2009	Proposed new dwellings	New Development population @ 2.3hd/dwelling	%PE Increase	Comments from Severn Trent Water*
Worcester–Bromwich Road	106,515	3,800**	8,740	8%	May need to upgrade elements of treatment process but as the works discharges directly to the River Severn. Severn Trent Water do not anticipate any issues with accepting early phases of development.
Powick	11,118	3,000	6,900	62%	This will require significant capacity improvements to inlet pumping and provision of additional primary, secondary and new tertiary treatment.

*Further information about the current treatment processes can be found in Table 6-1
**Excluding additional properties in Worcester North

4.2.2 Droitwich Spa Sewage Treatment Works

The following assessment of Droitwich Ladywood STW is based on the addition of 1,750 dwellings and does not include Hill End, increasing the number of dwellings proposed to 2,050 (see section 4-4). Droitwich Ladywood Works will receive an increase in peak DWF of 46% and a 4% increase in peak storm flow. It is suggested by Jacobs Engineering that the lower increase in peak storm flow may be due to the hydraulic restrictions within the sewerage system.

Table 4-4: Affects of Proposed Strategic Site Allocations in Droitwich Spa on Flows to Sewage Treatment Works

		Current Conditions		Post Development Conditions	
Proposed Strategic Site Allocations	Works	Peak DWF (l/s)	Peak Storm (l/s)	Peak DWF (l/s)	Peak Storm (l/s)
All proposed allocations in Droitwich	Droitwich - Ladywood	71	511	104	531

Table 4-5 indicates potential pressures on the treatment works capacity from the proposed strategic site allocations and subsequent improvements that may be required. This assessment includes the Fernhill Heath allocation in Worcester but not the Hill End allocation in Droitwich. Severn Trent Water have a statutory obligation to provide additional treatment capacity to accept future domestic development flows, however potential investment requirements are to be reviewed when the dwelling numbers and site locations have been finalised by the Councils.

Table 4-5: Sewage Treatment Works Capacity in Droitwich

Sewage Treatment Works	Total Connected Population Equivalent (PE) at 31 March 2009	Proposed new dwellings	New Development population @ 2.3hd/dwelling	%PE Increase	Comments from Severn Trent Water*
Droitwich - Ladywood	41,138	2,250	5,175	13%	Marginal. Will have some capacity for initial phasing but detailed assessments will be required to confirm whether additional capacity is required

*Further information about the current treatment processes can be found in Table 6-1.

4.2.3 Great Malvern Sewage Treatment Works

A model is currently not available for Great Malvern, therefore the potential increase in peak storm flow could not be assessed. The increase in 'Formula A' (foul flow) for the proposed dwellings is 93l/s (Table 4-1) This is likely to be pumped to the Malvern Works (Mill Lane) and concerns were raised within the Growth Point Studies report as to the capacity of the storm tank which stores the flows in excess of 3 DWF during critical conditions to cope with the additional flows. However, there should be no increase in storm flows to the sewage treatment works as all storm runoff from the proposed strategic site allocations will be directed into SUDs and not into the foul sewer systems. Therefore storm tank capacities will not be affected by the proposed strategic site allocations.

Table 4-6 indicates potential pressures on the treatment works capacity from the proposed strategic site allocations and subsequent improvements that may be required. Severn Trent Water have a statutory obligation to provide additional treatment capacity to accept future domestic development flows, however potential investment requirements are to be reviewed when the dwelling numbers and site locations have been finalised by the Councils.

Table 4-6: Sewage Treatment Works Capacity in Great Malvern

Sewage Treatment Works	Total Connected Population Equivalent (PE) at 31 March 2009	Proposed new dwellings	New Development population @ 2.3hd/dwelling	%PE Increase	Comments from Severn Trent Water*
Great Malvern	33,342	1740	4,002	12%	There are mothballed filters at the works which may be able to provide additional capacity.

*Further information about the current treatment processes can be found in Table 6-1.

4.2.4 Pershore Sewage Treatment Works

This assessment is based on 1,000 dwellings in Pershore, which is a similar number to the 900 dwellings currently proposed. Therefore the assessment is as an acceptable indication of the possible pressures on the system.

The Pershore model indicates that there will be no increase in peak storm flow to the Pershore works as all flows are pumped, it is assumed that these pumps will be sufficient to manage the increase in future flows. However there is an increase in the overall volume of flow to the treatment works. It is noted that there is a small risk to the storm tanks that may not be large enough to accommodate the additional

flows. It is recommended in the Growth Point Studies that further checks be carried out on treatment capacity during the final design process.

Table 4-7: Affects of Proposed Strategic Site Allocations in Pershore on Flows to Sewage Treatment Works

		Current Conditions		Post Development Conditions	
Proposed Strategic Site Allocations	**Works**	**Peak DWF (l/s)**	**Peak Storm (l/s)**	**Peak DWF (l/s)**	**Peak Storm (l/s)**
All proposed allocations in Pershore	Pershore	50	135	51	135

Table 4-8 indicates potential pressures on the Pershore treatment works capacity from the proposed strategic site allocations and subsequent improvements that may be required. Severn Trent Water have a statutory obligation to provide additional treatment capacity to accept future domestic development flows, however potential investment requirements are to be reviewed when the dwelling numbers and site locations have been finalised by the Councils.

Table 4-8: Sewage Treatment Works Capacity in Pershore

Sewage Treatment Works	Total Connected Population Equivalent (PE) at 31 March 2009	Proposed new dwellings	New Development population @ 2.3hd/dwelling	%PE Increase	Comments from Severn Trent Water*
Pershore	10,638	1000	2,300	22%	Possibly has some hydraulic capacity but Severn Trent Water expect that additional treatment will be required to meet quality standards.

*Further information about the current treatment processes can be found in Table 6-1.

4.2.5 Evesham Sewage Treatment Works

This assessment does not include the allocation at Cheltenham Road (see Section 4-4) and is based on 2,300 dwellings in Evesham. The current number of dwellings proposed in Evesham is 2,100, a similar number to that used in the assessment and therefore the results provide an acceptable indication of the pressures from the new allocations.

The Evesham model indicates that the Evesham treatment works will receive a 21% increase in peak DWF from the proposed strategic site allocations. The model indicates that there is no increase in peak storm flow as this is supplied by pumping mains and the spill volume at the pump stations does not increase due to the additional flows. It may also be due to the hydraulic restrictions within the sewerage systems.

Table 4-9: Affects of Proposed Strategic Site Allocations in Evesham on Flows to SewageTreatment Works

		Current Conditions		Post Development Conditions	
Proposed Strategic Site Allocations	**Works**	**Peak DWF (l/s)**	**Peak Storm (l/s)**	**Peak DWF (l/s)**	**Peak Storm (l/s)**
All proposed allocations in Evesham	Evesham	78	310	94	310

Table 4-10 indicates potential pressures on the Pershore treatment works capacity from the proposed strategic site allocations and subsequent improvements that may be required. Severn Trent Water have a statutory obligation to provide additional treatment capacity to accept future domestic development flows, however potential investment requirements are to be reviewed when the dwelling numbers and site locations have been finalised by the Councils.

Table 4-10: Sewage Treatment Works Capacity in Evesham

Sewage Treatment Works	Total Connected Population Equivalent (PE) at 31 March 2009	Proposed new dwellings	New Development population @ 2.3hd/dwelling	%PE Increase	Comments from Severn Trent Water*
Evesham	23,737	2,300	5,290	22%	Additional capacity will be needed but further assessment will be required to determine how much of initial phasing can be accepted prior to triggering investment.

*Further information about the current treatment processes can be found in Table 6-1.

Summary

- **No model is available to assess the impact of Great Malvern on the sewage treatment infrastructure.**
- **Severn Trent Water has a statutory obligation to provide additional treatment capacity to accept future domestic development flows.**
- **In detailed assessment should be undertaken when proposed strategic site allocations locations and dwelling numbers/employment type is finalised.**

4.3 Sewage Treatment Works - Hydraulic Capacity

Table 4-11 provides an estimate of the spare hydraulic capacity at the sewage treatment works and identifies those that will exceed the capacity due to the proposed strategic site allocations. It includes details of current consent and an indication of current likely headroom based on a comparison of consented DWF vs measured DWF (based on average 2005-2009 flow figures). It must be noted that these represent the most up-to-date data available from Severn Trent Water, and in this respect differ from those presented above and used in the Growth Point Study (December 2008) undertaken by Jacobs Engineering UK Ltd. Using a160l/hd/day and an average occupancy rate of 2.4hd/dwelling Severn Trent Water have calculated an estimated spare headroom (in dwellings) within the current consent.

On March 31st 2010 the Environment Agency issued a variation to the discharge consent, and hence DWF, for Worcester Bromwich Road STW. The new DWF is 33,000m^3/d. This was updated, following an exercise to rationalise consented discharge volumes, where flow measurement installed in AMP3 has shown that the actual flows discharged are higher than those permitted.

Table 4-11 indicates that Droitwich – Ladywood, Worcester Bromwich Road and Powick sewage treatment works do not have sufficient spare hydraulic capacity at present to accommodate the proposed strategic site allocations.

Severn Trent Water have noted that whilst sewage treatment works may not have sufficient spare capacity to accept the levels of development being proposed in its catchment area this does not necessarily mean that development cannot take place. Under Section 94 of the Water Industry Act 1991 sewerage undertakers have an obligation to provide additional treatment capacity as and when required. There are no physical constraints to the expansion of sewage treatments works if this is required.

Table 4-11: Potential Impact of Proposed Developments On Sewage Treatment Works Hydraulic Capacity

Sewage Treatment Works Name	OS Grid Ref		Current PE	Current / observed dry weather flow (m3/d)	Estimated spare hydraulic capacity		Proposed Strategic Site Allocations	Potential Impact of the proposed strategic site allocations	Physical constraints regarding provision of additional treatment capacity (RAG)	Any other comments
	Eastings	Northings			PE	Dwellings (@ 2.4hd/ dwelling)	Number of Dwellings			
Malvern (Mill Lane)	379800	244800	33,342	8,160	28,827	12,010	1,500	Can accommodate the proposed strategic site allocations without upgrades	No land or other constraints preventing expansion	Comparison of current measured dry weather flow against the consented dry weather flow consent indicates that there is reasonable hydraulic capacity at this site. Notwithstanding this we do not envisage any issues in dealing with additional growth at Malvern STW.
Evesham	402900	244700	23,737	4,684	6,959	2,900	2,100	Can accommodate the proposed strategic site allocations without upgrades but will bring the works close to its current capacity limit	No land or other constraints preventing expansion	Comparison of current measured dry weather flow against the consented dry weather flow consent indicates that there is reasonable hydraulic capacity at this site. Notwithstanding this we do not envisage any issues in dealing with additional growth at Evesham STW.
Droitwich (Ladywood)	386400	261600	41,138	7,104	494	210	2,550	Cannot accommodate all proposed strategic site allocations. Further modelling will be required and subsequent upgrades may be needed.	No land or other constraints preventing expansion	There is negligible hydraulic headroom at this sewage works but we do not envisage any issues in dealing with future growth needs in the catchment. As part of the EA's National Environment Programme we are expecting to meet a new 2mg/l P consent by Sept 2014.
Pershore (Tiddesley Wood)	392400	245000	10,638	2,418	8,876	3,700	900	Can accommodate the proposed strategic site allocations without upgrades	No land or other constraints preventing expansion	Comparison of current measured dry weather flow against the consented dry weather flow consent indicates that there is reasonable hydraulic capacity at this site. Notwithstanding this we do not envisage any issues in dealing with additional growth at Pershore STW.
Powick	383800	250800	11,118	2,346	3,075 (See comments)	1,280 (See comments)	3,000	Cannot accommodate all proposed strategic site allocations. Further modelling will be required and subsequent upgrades may be needed.	No land or other constraints preventing expansion	Comparison of current measured dry weather flow against the consented dry weather flow consent indicates that there is reasonable hydraulic capacity at this site, however the current sizing data for the biological filters indicate there could be stress from a load perspective. Notwithstanding this we do not envisage any issues in dealing with future growth demand at Powick STW catchment.
Worcester (Bromwich Road)	384361	253530	106,515	33,000 (See Comments)	See comments	See comments	4,150	Cannot accommodate all proposed strategic site allocations. Further modelling will be required and subsequent upgrades may be needed.	No land or other constraints preventing expansion	Comparison of current measured dry weather flow against the consented dry weather flow consent indicates that there is zero hydraulic capacity at this site, however the current sizing of the ASP Diffused Air Plant indicates that there is hydraulic capacity available and so indicates there could be a problem with measured dry weather flow data. Actual spare capacity needs further detailed process analysis but notwithstanding this we do not envisage any issues in dealing with future growth demand in the Worcester STW catchment.

This page is intentionally left blank.

4.4 Sewerage

The following sections show the results of the modelling undertaken by Jacobs Engineering Ltd for the Severn Trent Water AD08 Growth Point Study. The results show how the increase in storm water should be treated for each proposed strategic site allocation and how the sewerage infrastructure will need to be improved to accommodate the additional peak foul flow. For further information regarding storm water in terms of the greenfield runoff, surface water flooding and mitigation see Chapter 7.

Storm Water

Severn Trent Water states that for all of the proposed strategic site allocations storm water cannot be discharged via existing sewers and that it should be where possible discharged to a local watercourse via a new storm system. This will limit the amount of flow entering the treatment works. The flow into the watercourse should be limited to the greenfield runoff rate to avoid a negative impact on the environment and all remaining flow will be attenuated on site. For further information about storm water discharges and storage reference should be made to Chapter 7.

Foul Water

4.4.1 Worcester

Table 4-12 shows the additional foul flows from the proposed strategic site allocations within Worcester. Some improvements are required to the infrastructure to accommodate the additional foul flows (Table 4-13).

Table 4-12: Additional Foul Flows for Worcester

Proposed Strategic Site Allocations	Properties	Foul (l/s)
Worcester North West	3,500	187
Worcester North	300	Not available
Kilbury Drive*	300	16
Worcester South	300	160
Fernhill Heath	500	27

* The Whittington site in the Growth Point Study has been used to produce data for Kilbury Drive as it is a similar size and has the same number of potential dwellings and is adjacent to Kilbury Drive.

Table 4-13: Worcester Proposed Strategic Site Allocations - Foul Water Engineering Solutions

Proposed Strategic Site Allocations	Description
Worcester North West	Produces a peak foul flow of 187l/s for a 40yr critical storm duration. Existing sewerage system is already heavily overloaded. A pumping station is required to limit flows entering the system. Flow will need to be pumped to cross Laughern Brook to reach Worcester sewerage system. The proposed pumping station parameters can be found in Table 4-16. An onsite storage facility is required to accommodate 339m^3 for the critical storm design event. In addition to storm water attenuation storage.
Worcester North	See Section 4.5
Kilbury Drive	See Section 4.5
Worcester South	Produces a peak foul flow of 160l/s. Based on assumption that the inverted siphon was modelled correctly (29m deep) a pumping facility with storage is required to accommodate additional flow. Pump station would be located to the north west boundary of the proposed strategic site allocation where ground elevation is low to enable gravity flow from the development to the station. The proposed pump station parameters can be found in Table 4-16. An onsite storage facility is required to accommodate approximately 1107m^3 for the critical design event. In addition to storm water attenuation storage.
Fernhill Heath	Will drain to the terminal sewage pumping station at Fernhill Heath which pumps flows to Droitwich STW. This pumping station has been identified by Severn Trent Water as being under capacity for the existing flows. An outline solution is that additional storage will be provided upstream of the pumping station to include the flows from the proposed 500 dwellings and improve the existing problem.

4.4.2 Droitwich Spa

Two of the proposed strategic site allocations, Pulley Lane and Copcut Lane, are situated along the same flow route to the south side of the town. Table 4-14 shows the additional foul flows calculated for the proposed strategic site allocations. The model indicated no flooding along this route for the current conditions or when the developments are added. The model (using HydroWorks software) highlighted a slight increase in some surcharge states but no major changes in depth, therefore no additional work is recommended to accommodate the proposed strategic site allocations as the existing sewer system appears to have sufficient spare capacity. This does not include Hill End to the north of the town. Information regarding this proposed strategic site allocation can be found in section 4.5. The modelling is based on 1,750 properties whereas the current number of proposed dwellings is 2,050, this is only a slight increase and therefore the assessment is still acceptable as an indication of the impact on the infrastructure.

Table 4-14: Additional Foul Flows for Droitwich Spa

Proposed Strategic Site Allocations	Properties	Foul (l/s)
Hill End	250	Not available
Pulley Lane	250	13
Copcut Lane	1,200	64

4.4.3 Great Malvern

The additional foul flows produced by the proposed strategic site allocations can be found in Table 4-15. To date there is no up to date model available for Great Malvern to assess the infrastructure capacity. The Growth Point Study states that a return period analysis undertaken in Severn Trent Water's 1997 Drainage Area Plans Report indicates that there should not be any capacity issues with the gravity sewers for the proposed developments. Malvern North would need to be pumped to the top of the 375mm diameter pipe running to the east of Great Malvern. Flows gravitate to Hall Green SPS which is the terminal pumping stations with a nominal duty/assist/assist pump configuration. Data received as part of the Growth Point Study highlights that the Hall Green pumping station is severely overloaded. A new model is required to check capacities before detailed work is carried out in the future.

Table 4-15: Additional Foul Flows for Great Malvern

Proposed Strategic Site Allocations	Properties	Foul (l/s)
Malvern North	1,100	59
Malvern East	500	27
Malvern South	140	8
Blackmore Park	n/a	n/a

4.4.4 Pershore

This assessment is based on 1,000 dwellings in Pershore, which is a similar number to the 900 dwellings currently proposed. Therefore the assessment is as an acceptable indication of the possible pressures on the system. The additional foul flows to the system generated by the proposed strategic site allocations can be found in Table 4-16.

It is assumed that the proposed strategic site allocations will drain to a junction in the sewer just off Wyre Road (S095471209) where the sewage is pumped to Pershore STW to the south of the town. At this junction there is an overflow where the sewage can discharge into the River Avon. The increase in flows from the proposed strategic site allocations indicates no increase in modelled spill to the watercourse from this overflow for a 40 year event. However, it should be noted that the pump rate at this location is an assumed value. It is recommended by Jacobs Engineering that the true pump rates be determined in order to confirm that the new development does not adversely affect the performance of the overflow and does not require any improvements.

Table 4-16: Additional Foul Flows for Pershore

Proposed Strategic Site Allocations	Properties	Foul (l/s)
Pershore (Western area of site)	400	21
Pershore (Central area of site)	50	3
Pershore (Eastern area of site)	400	21

4.4.5 Evesham

This assessment does not include the allocation at Cheltenham Road (see Section 4-5) and is based on 2,300 dwellings in Evesham. The current number of dwellings proposed in Evesham is 2,100, a similar number to that used in the assessment and therefore the results provide an acceptable indication of the pressures from the proposed allocations.

The additional foul flows to the system generated by the proposed strategic site allocations can be found in Table 4-17.

Table 4-17: Additional Foul Flows for Evesham

Proposed Strategic Site Allocations	Properties	Foul (l/s)
Offenham Road	1,500	80
Cheltenham Road	850	Not available
Hampton	800	43

It was found that improvements were required to accommodate the proposed strategic site allocations assessed in the Growth Point Study.

Table 4-18 Evesham Proposed Strategic Site Allocations - Foul Water Engineering Solutions

Proposed Strategic Site Allocations	Description
Offenham Road	Modelling shows the sewer system downstream of the proposed strategic site allocation is currently heavily overloaded for 1, 2 and 5 year design storms. The option proposed within the study is to pump direct to the sewage works but this would require two major river crossings. It may be possible to utilise the railway bridges, whether as conduits or masks for pipe bridges. It is envisaged that the majority of the route will be laid within public highway. However, Severn Trent Water note that any agreement with Railtrack will entail extensive negotiations and may still be impossible. Unless agreement is reached with Railtrack the cost of the two river crossings may prove prohibitive. The proposed pump station parameters can be found in Table 4-17.
Cheltenham Road	See Section 4.5
Hampton	The model indicates that the proposed strategic site allocation increases local flooding by 330m^3 for a 40 year critical duration. The increases in surcharge upstream of the modelled connection point may increase the risk of flooding to any low lying properties. Due to overloaded downstream sewers, localised upsizing was considered not to be an option and so it was recommended that the foul discharge be pumped to control the flows entering the sewers. The modelled storage volume required for a storm with a return period of 40 years is 336m^3. The design for offsite sewerage will take into account the heavily overloaded sewers downstream of the first connection point by allowing for the capacity and will be controlled via telemetry linked to monitors in the downstream system. It was assumed that all flows are pumped and the pumping station will be sited to the west of the development adjacent to the water course. The proposed pump station parameters can be found in Table 4-17. An onsite storage facility is required to accommodate 336m^3 for the critical storm design event. In addition to storm water attenuation storage.

4.5 Summaries for the Additional Proposed Strategic Site Allocations

The following are summaries provided by Severn Trent Water for the sewerage at the three allocations not included within the Growth Point Studies.

Worcester North - Worcester

Severn Trent Water would not expect a development of 300 dwellings to have a significant impact on the sewerage requirements of the area. Severn Trent Water's hydraulic drainage area sewer model indicates some localised hydraulic deficiencies downstream but there are no reports of actual flooding. Severn Trent Water expects that the allocation would not require any significant reinforcement investment. More detailed information regarding storm water in terms of surface water flooding and mitigation for this proposed strategic site allocation can be found in Chapter 7.

Kilbury Drive – Worcester

Kilbury Drive is not included within the allocations assessed in the Growth Point Study. However, the Whittington site in the study is a similar size and has the same number of potential dwellings as the proposed strategic site allocation at Kilbury Drive. It is also adjacent to the Whittington site. Therefore most of the projections for the Whittington site can be used to give an estimate for Kilbury Drive. Severn Trent Water has advised that it is likely a pumping station would be required as the topography of the site appears to fall away to the north east. The nearest suitable connection point to the public sewerage system is to the south west.

Hill End - Droitwich Spa

Severn Trent Water only issued modelling work for the south of the system in Droitwich as the allocations were previously all located in that area. The Hill End allocation is located on the opposite side of the catchment to the treatment works which are located in the south west of Droitwich. Severn Trent Water envisages that the allocation will need to drain via approximately 4.5km of sewer which runs parallel to the River Salwarpe/Droitwich Canal. Severn Trent Water expects that there would not be any significant capacity improvements required providing surface water is not connected to the foul sewer, however, without modelling the area Severn Trent Water are unable to comment in detail on the potential impacts of the allocation.

Cheltenham Road - Evesham

This allocation is upstream of known hydraulic problems and Severn Trent Water would therefore expect reinforcement work to be necessary. Severn Trent Water states that some sewerage reinforcement is likely to be necessary for the allocation. It is estimated that this would cost between £250,000 - £350,000 due to downstream restrictions associated with the siphon under the river/combined sewer overflow and terminal pumping station to Evesham STW. It should be noted that this is estimated without the benefit of any modelling. More detailed information regarding storm water in terms of surface water flooding and mitigation for this proposed strategic site allocation can be found in Chapter 7.

Summary

- **Severn Trent Water state that storm water should not be discharged to existing foul sewers but into the nearest watercourse via appropriate attenuation. Therefore no investment will be required for improvements to storm tanks, but investment in SuDS will be required for attenuation.**
- **Improvements are required to the foul water infrastructure in Worcester (Worcester North West, Worcester South, Fernhill Heath and Kilbury Drive) and Evesham (Hampton, Cheltenham Road and Offenham Road).**
- **No model was available for Great Malvern and true pumps rates are not available for Pershore.**
- **Further modelling is required for all allocations when the locations and dwelling numbers/employment type is finalised.**

4.6 Notional Solutions and Costs

4.6.1 Sewage Treatment

It is projected that there will be an additional 770l/s of foul flow for treatment across the sewage treatment works (Table 4-1). No specific engineering solutions were identified in the Growth Point Studies, however, the increase in flows will cause Droitwich Ladywood, Powick and Worcester Bromwich Road treatment works to reach capacity and require expansion (Table 4-11).

When the current estimation of future development that can be accommodated at the Sewage Treatment Works at Worcester, Powick and Droitwich, is allocated by Planning Permissions, developers will be requested to undertake an assessment of the sewage treatment works to prove whether hydraulic capacity has been reached or not. Severn Trent Water should be contacted to agree the requirements and costs, if necessary, for up-rating the works.

Planning for the proposed strategic site allocation should account for the 3-4 year period required for capacity and/or treatment upgrades to the sewage treatment works identified in the Water Cycle Study. If capital maintenance was required on a treatment works or there were other investment drivers (e.g. quality) and Severn Trent Water were aware of potential development in the catchment then provision of additional capacity would be considered as part of the project. However, at present there are no specific plans for maintenance to any of the treatment works.

4.6.2 Sewerage

Additional capacity will be required to manage the increase in foul discharges. Storm flows will be limited to the Greenfield runoff rate and directed to the nearest watercourse via attenuation, therefore no investment in storm sewers is required. A summary of the notional schemes identified to increase the capacity of foul sewers can be found in Table 4-19. A breakdown of the schemes for Worcester and Evesham can be found in Tables 4-20 and Table 4-21 respectively. Any site specific upgrades to sewerage infrastructure will be expected to be funded by developer contribution. The tables below provide an indication as to which proposed strategic site allocations may require more investment by developers. The infrastructure upgrades would normally require 12 months to install/upgrade from the time the developer agrees to the funding.

Table 4-19: Summary of Notional Schemes for Foul Sewer Improvements

Proposed Strategic Site Allocations	Notional Scheme Summary	Cost
Worcester	New pumping stations with storage for three developments.	£2,236,000
Droitwich Spa	No scheme required	£0
Great Malvern	No options considered at this stage.	-
Pershore	No scheme required	£0
Evesham	One RTC pumping station with storage. Duty/assist pump configuration with rising main (storage not included). Sewerage reinforcement	£2,077,000-£2,177,000
Total Cost		£4,313,000 - £4,413,000

Table 4-20: Breakdown of Schemes of Worcester

Proposed Strategic Site Allocations	Notional Scheme	Storage Volume (m^3)	Cost
Worcester North West	New pumping station passing flows of 50l/s, 34KW pump, 480m of rising main (315mm diameter), with storage.	339	£714,000

Proposed Strategic Site Allocations	Notional Scheme	Storage Volume (m^3)	Cost
Worcester North	Not Assessed	-	-
Kilbury Drive	Expected to require a pumping station. Specific details unknown.	Unknown	£710,000*
Worcester South	New pumping station passing flows of 30l/s, 16KW pump, 70m of rising main (250mm diameter), with storage.	1107	£812,000
Fernhill Heath	Not Assessed	-	-
Total Cost			£2,236,000

*Severn Trent Water advised a pumping station is likely to be required at Kilbury Drive, as topography of the site appears to fall away to the north east whereas the nearest suitable connection point to the public sewerage system is to the south west, costs would be similar to the Whittington site.

Table 4-21: Breakdown of Schemes for Evesham

Proposed Strategic Site Allocations	Notional Scheme	Storage Volume (m^3)	Cost
Offenham Road	New pumping station with duty/assist pumps passing 80l/s (Formula A), Two 48KW pumps, 1660m of rising main (315 diameter), storage not allowed for	-	£1,030,000*
Cheltenham Road	Some sewerage reinforcement is likely	-	£250,000-350,000**
Hampton	New pumping station with passing flows of 37l/s, 3KW pumps, 700m of rising main (280 diameter), with storage.	336	£797,000
Total Cost		£2,077,000 - 2,177,000	

*Cost does not include storage or additional price required for river crossings.

** Cost estimated by Severn Trent Water without the use of detailed models.

Summary

- **Total cost of improvements to sewage treatment works is unavailable at present.**
- **Information provided by Severn Trent Water indicates that Powick, Worcester (Bromwich Road) and Droitwich (Ladywood) sewage treatments works will require hydraulic capacity upgrades. There are no physical constraints to upgrades.**
- **Planning for the proposed strategic site allocations should account for the 3-4 year process required for major upgrades to capacity/treatment at the sewage treatment works, minor improvements may be completed earlier.**
- **Total cost of improvements to the sewerage infrastructure is in the region of £4,300,000-£4,400,000 excluding the potential costs for the Great Malvern and Fernhill Heath proposed strategic site allocations.**
- **Any site specific upgrades to sewerage infrastructure will be expected to be funded by developer contribution and would normally take 12 months to complete.**
- **The solutions and costs are notional and will need to be reassessed once the final development locations and dwelling numbers are confirmed.**

4.7 Employment Land and Windfall Sites

The exact type of employment to be developed on the land allocated for employment is currently unknown. However, Severn Trent Water has provided guidelines used for estimating Non-Domestic Dry Weather Flows in sewerage modelling (Table 4-22). This gives an indication as to which employment types will potentially have more of an impact on the sewerage and sewage treatment infrastructure. This information may be used to advise on the type of employment that may be appropriate in the South Worcestershire area and as an indication of the potential flows from the secondary and primary schools that have been potentially allocated sites in Worcester, Droitwich Spa and Great Malvern.

Figure 4-22: Severn Trent Water guidelines for Estimating Non-Domestic Dry Weather Flows in Sewerage Modelling.

Business Category	Daily Flow Rate (l/day/Ha)	Trade Profile/s Used	Hours/day
Office/Commercial (O)	25,000	3 (1.0 x 8am to 6pm WD)	10
Arts (public access) (ART)	6,000	3 (1.0x 8am to 6pm WD)	10
Accommodation (non-domestic) (AC)	91,575	1(1.0 x 24h Constant Profile WD&WE)	24
Retail (R).	15,000	4 (1.0 x 9am to 6pm WD&WE)	9
Educational (ED)	32,550	5 (1.0 x 9am-5pm WD)	8
Industrial (e.g. manufacturing etc) (I)	22,500	2 (1.0x 6am to 6pm WD)	12
Dry Industry (e.g. warehousing etc) (DI)	10,000	3 (1.0 x 8am to 6pm WD)	10
Licensed Premises (LP)	72,000	6 (0.5 x 12pm to 6pm; 1.0 x 6pm to 12am WE&WD)	9
Sports (SP)	6,500	6 (0.5 x 12pm to 6pm; 1.0 x 6pm to 12am WE&WD)	9
Healthcare (H)	90,750	1 (1.0 x 24h Constant Profile, WD & WE)	24

Severn Trent Water have advised that windfall sites of approximately 200 properties may need some localised reinforcement work to the sewerage distribution networks, which would only usually take 12 months to complete. However, detailed hydraulic modelling would be required to confirm the extent of any upgrading once specific locations/developers are known, though Severn Trent Water do not envisage that there would be any major problems.

In the short term Severn Trent Water should usually be able to accommodate a windfall site within the sewage treatment works headroom (subject to the size of the treatment works). If additional long term capacity was required, the time scale for completion would depend on what assets required upgrading. It would take between 3-4 years for major capacity improvements whereas minor improvements could be completed earlier.

4.8 Tenbury Wells and Upton Upon Severn

These were previously identified as possible proposed strategic site allocations and as such there is some information regarding the areas in the Growth Point Study.

Tenbury Wells

The Growth Point Study states that the Severn Trent Water's 2004 Drainage Area Plans Report indicated that there were no hydraulic problems in the catchment. The Growth Point Study looked at an additional 125 properties, these were not expected to affect the sewer performance. If properties are proposed in Tenbury Wells in the future the area would have to be reassessed when more detailed drainage proposals are available.

Severn Trent Water do not envisage any capacity or treatment issues at the Tenbury Sewage Treatment Works should there be an addition of 100 properties (Table 4-23).

Table 4-23: Sewage Treatment Works Capacity in Tenbury Wells

Sewage Treatment Works	Total Connected Population Equivalent (PE) at 31 March 2009	Proposed new dwellings	New Development population @ 2.3hd/dwelling	%PE Increase	Comments from Severn Trent Water*
Tenbury	14,014	100	230	2%	Not expected to be a problem

*Further information about the current treatment processes can be found in Table 6-1.

Upton upon Severn

There is no hydraulic model available for Upton upon Severn. It is recommended in the Growth Point Study that the pumping stations at Ryall and Tunnell Hill are assessed to confirm their capacity and whether they would be able to cope with new developments. If properties are proposed in Upton upon Severn, Tunnel Hill or Ryall in the future the area would have to be assessed in more detail.

4.9 Conclusion

Sewage Treatment

Severn Trent Water have a statutory obligation to provide additional treatment capacity to accept future domestic development flows and do not usually operate their sewage treatment works with spare capacity. Three sewage treatment works, Worcester Bromwich Road, Powick and Droitwich have been identified as having hydraulic capacity restraints, however there is no physical constraints to upgrades that are required to accommodate the proposed strategic site allocations at these locations. (Table 4-11). No specific engineering solutions were identified in the Growth Point Studies nor were any costs identified. Planning for the proposed strategic site allocations should account for the 3-4 year process of upgrading these sewage treatment works. To minimise financial risks associated with building additional treatment capacity for tentative development proposals, Severn Trent Water would not usually invest in additional treatment capacity until a development has outline planning permission. Normally Severn Trent Water is able to provide any major additional capacity improvements within 3-4 years, minor improvements may be completed earlier.

Sewerage

There are several proposed strategic site allocations where the existing foul sewer system has enough spare capacity to be able to accommodate the additional foul flows (Table 4-24). However, for the majority of the proposed strategic site allocations the sewerage infrastructure requires investment. Notional solutions have been proposed by Severn Trent Water and it is estimated that these will cost in total in the region of £4.3m to £4.4m. It is important to remember that these solutions are notional and the cost does not include the potential improvements required due to the Fernhill Heath and Great Malvern developments. The solutions and costs will need to be reassessed once the final allocations and dwelling numbers are confirmed.

Sewerage infrastructure capacity improvements are usually initiated once a developer agrees to fund the required improvements and would normally take up to 12 months to complete.

Table 4-24: Summary of investment required to sewerage infrastructure to accommodate the Proposed Strategic Site Allocations

Proposed Strategic Site Allocations	Sewerage	
	Investment	Phasing
Worcester		
Worcester North West		
Worcester North		
Kilbury Drive		
Worcester South		
Fernhill Heath		
Droitwich Spa		
Hill End		
Pulley Lane		
Copcut Lane		
Great Malvern		
Malvern North		
Malvern East		
Malvern South		
Blackmore Park		
Pershore		
Pershore		
Evesham		
Offenham Road		
Cheltenham Road		
Hampton		

Legend: (Investment **/** Phasing**)**

- Proposed Strategic Site Allocation cannot be accommodated
- Investment is required to accommodate the proposed strategic site allocations **/** 12 months required for upgrade
- No Investment required **/** current system can accommodate the proposed strategic site allocations
- Has not been assessed but investment **/** 12 months is likely to be required to accommodate the proposed strategic site allocations

Table 4-25: Summary of conclusions for Sewage Treatment Works

Sewage Treatment Works*	Investment	Phasing
Worcester (Bromwich Road)		
Powick		
Droitwich (Ladywood)		
Malvern (Mill Lane)		
Pershore (Tiddsley Wood)		
Evesham		

Investment Legend	Phasing Legend
Investment is likely to be required to be able to accommodate all proposed strategic allocations	A maximum of 3-4 years will be required to upgrade the treatment works*
Investment may be required if more allocations are proposed than currently stated	A maximum of 3-4 years will be required to upgrade treatment works if upgrades are found to be necessary.
No investment is required	The current system can accommodate the proposed strategic site allocations

NOTE: Worcester North West, Worcester North and Kibury Drive all feed to Worcester Bromwich Road, Worcester South feeds to Powick and Fernhill Heath feeds to Droitwich Ladywood. The other proposed strategic site allocations feed to their corresponding treatment works, e.g. all sites in Great Malvern feed to Malvern (Mill Lane).

*Severn Trent Water have advised that this is the worse case scenario for major capacity upgrades, minor upgrades may take less time to complete. Severn Trent Water has also advised that there may be some capacity available to accept early phases of development without the need for upgrades at all but Powick Sewage Treatment Works (Worcester South).

This page is intentionally left blank.

5 WATER RESOURCES AND SUPPLY

5.1 Introduction

The Environment Agency use Catchment Abstraction Management Strategies (CAMS) to help manage the water resources of a catchment. These will contribute to the implementation of the Water Framework Directive. Within these CAMs the areas are divided into Water Resource Management Units (WRMUs) and Groundwater Management Units (GWMUs). There are five CAMS that are relevant to South Worcestershire and the urban areas covered within this report. These are as follows:

- The Warwickshire Avon Catchment Abstraction Management Strategy (June 2006) includes information on Pershore and Evesham;
- The Severn Corridor Catchment Abstraction Management Strategy (2003 and update in 2007) includes information on Worcester;
- The Teme Catchment Abstraction Management Strategy (2005) includes information on Worcester and Tenbury Wells;
- The Worcestershire Middle Severn Catchment Abstraction Management Strategy (December 2006) includes information on Droitwich Spa;
- The Severn Vale Catchment Abstraction Management Strategy (January 2008) includes information of Great Malvern and Upton upon Severn.

For the protection of the water resources and the environment an abstraction licence from the Environment Agency is required to abstract more than 20m^3/day from a 'source of supply' (e.g. river, stream, well, lake). The Environment Agency can issue licences with restrictions for the protection of the environment, an example is 'Hands–off flow' (HOF). In the Severn Basin this requires abstractions to cease if the flow in the river drops below that which is required to protect the environment. Before a new licence is granted or a time limited licence is renewed the Environment Agency requires that their renewal criteria is satisfied and local considerations are accounted for.

The Government is currently consulting on proposals for imposing mandatory time limits on all water abstraction licences in England and Wales. Currently, time limits are imposed on all new abstraction licences and there has been an attempt to encourage the voluntary conversion of existing licences to time-limited status. Despite these attempts, only 20% of all abstraction licences are subject to time limits at this time. As things stand, the remaining licence holders can continue to extract water for an unlimited period unless their licence is revoked. Under the new proposals the Environment Agency would be given powers to alter the volumes and conditions on new and existing licences. These powers are seen as a crucial step in ensuring the sound management and appropriate allocation of water resources in order to cope with the anticipated impacts of climate change. They will also help the Government achieve the objectives set out in the 2008 water strategy document, Future Water.

The Government are also currently consulting on implementing the remaining abstraction provisions of the Water Act 2003. This includes new regulations that will bring some currently exempt activities, such as trickle irrigation of crops (spray irrigation is currently licensable), under the licensing arrangements. It will also maintain some exemptions, such as most abstractions within water meadows that are a low risk to the environment and other water users. The new regulations will come into force on 1 October 2010 and cover England and Wales and help to fulfil the UK's obligations to the EU's Water Framework Directive. Further information can be found on the Defra website. The following sections relating to the CAMS will require updating when the Second Cycle CAMS are completed in 2010.

Four categories are used within the CAMS to identify the status of surface water, groundwater resources and licence availability within a catchment (Table 5-1).

Table 5-1: Resource availability status categories

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 higher 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.

*Source = The Warwickshire Avon Catchment Abstraction Management Strategy (June 2006)

5.2 Water Resources - Existing Situation

5.2.1 Surface Water Resources

Table 5-2 shows the existing situation of surface water resources for Worcester, Droitwich Spa, Great Malvern, Pershore and Evesham. Figure 5-1 shows the location of the relevant watercourse reaches and their status. The Integrated WRMU status has been used over the Individual WRMU status. The Integrated WRMU are the individual unit and the units downstream, this allows a better resource availability estimate as it protects the river downstream.

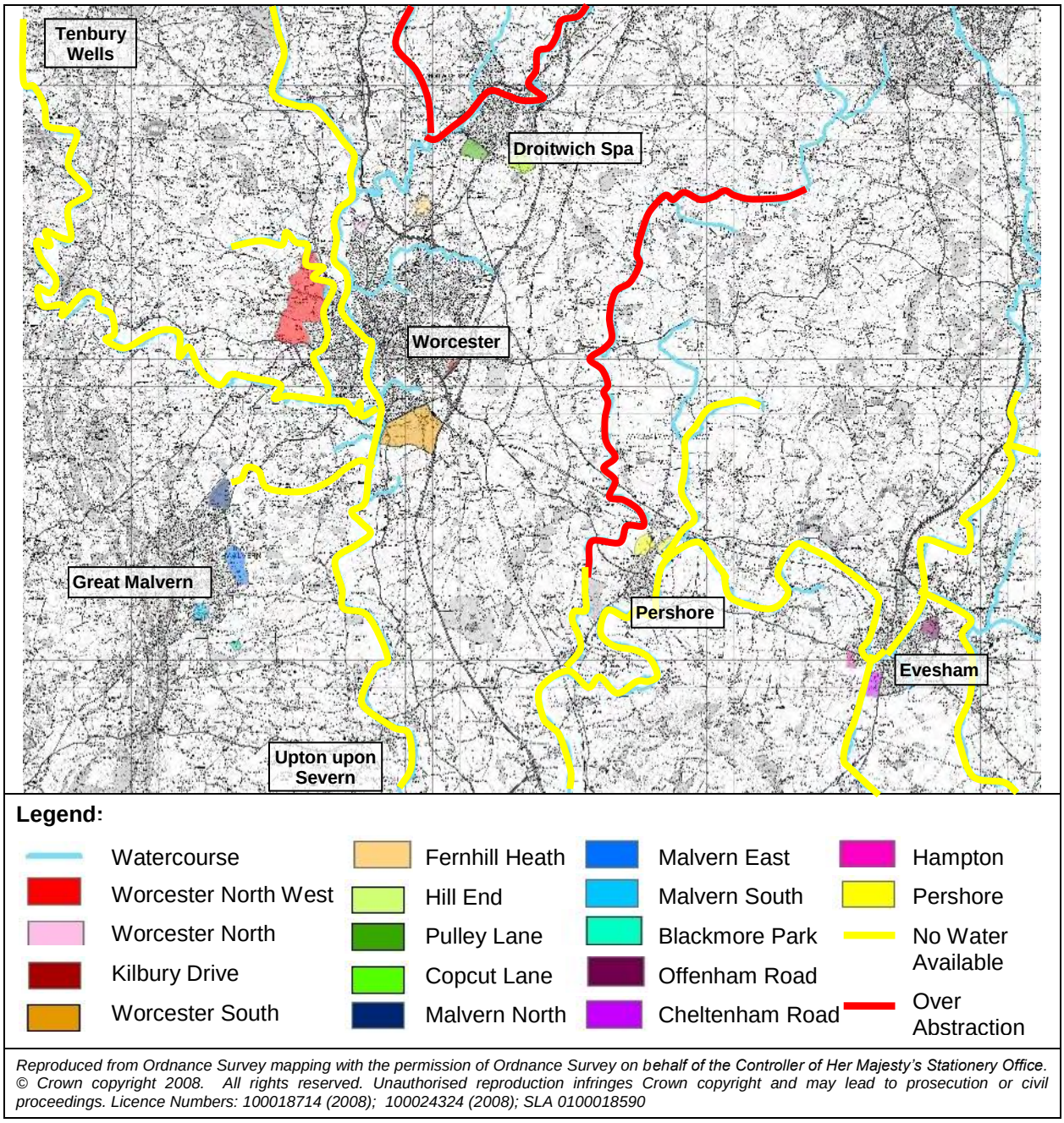
Table 5-2: Water Resources Availability

Proposed Strategic Site Allocations	Current Resource Availability Status*	Target Resource Availability 2018/19	Rivers	CAMS Water Resource Management Unit (WRMU)
Worcester	No Water Available	No Water Available	River Severn	Unit 6 – River Stour confluence to River Teme confluence
	No Water Available	No Water Available	River Teme and Laughern Brook	Teme WRMU
Droitwich Spa	Over Abstracted	Over Abstracted	River Salwarpe and Hadley Brook	Unit 2 – Rivers Worfe, Stour and Salwarpe
Great Malvern	No Water Available	No Water Available	Careys Brook	Unit 1 – Severn Vale North West Tributaries
	No Water Available	No Water Available	River Severn	Unit 7- River Teme – Confluence to Saxons Lode
Pershore	Over Abstracted	No Water Available	Bow Brook to the north of Tiddesley Wood	Besford Bridge

Proposed Strategic Site Allocations	Current Resource Availability Status*	Target Resource Availability 2018/19	Rivers	CAMS Water Resource Management Unit (WRMU)
	No Water Available	No Water Available	Bow Brook from the north edge of Tiddesley Wood and the River Avon	Upper Pound
	No Water Available	No Water Available	Piddle Brook	Wyre Piddle
Evesham	No Water Available	No Water Available	River Avon	Evesham
	No Water Available	No Water Available	River Avon and River Isbourne	Upper Pound
Tenbury Wells	No Water Available	No Water Available	River Teme	Teme WRMU
Upton upon Severn	No Water Available	No Water Available	River Severn	Unit 7- River Teme – Confluence to Saxons Lode

All the proposed strategic site allocations have a status of either 'No Water Available' or 'Over Abstracted' in terms of surface water (Figure 5-1). This will have implications for anyone wanting a new licence or wanting to renew a time restricted licence. The licensing strategies for each proposed strategic site allocation are discussed in Section 5.4. Map 5 shows the surface water resources status for the area.

Figure 5-1: Current Status of Water Resource Management Units in South Worcestershire



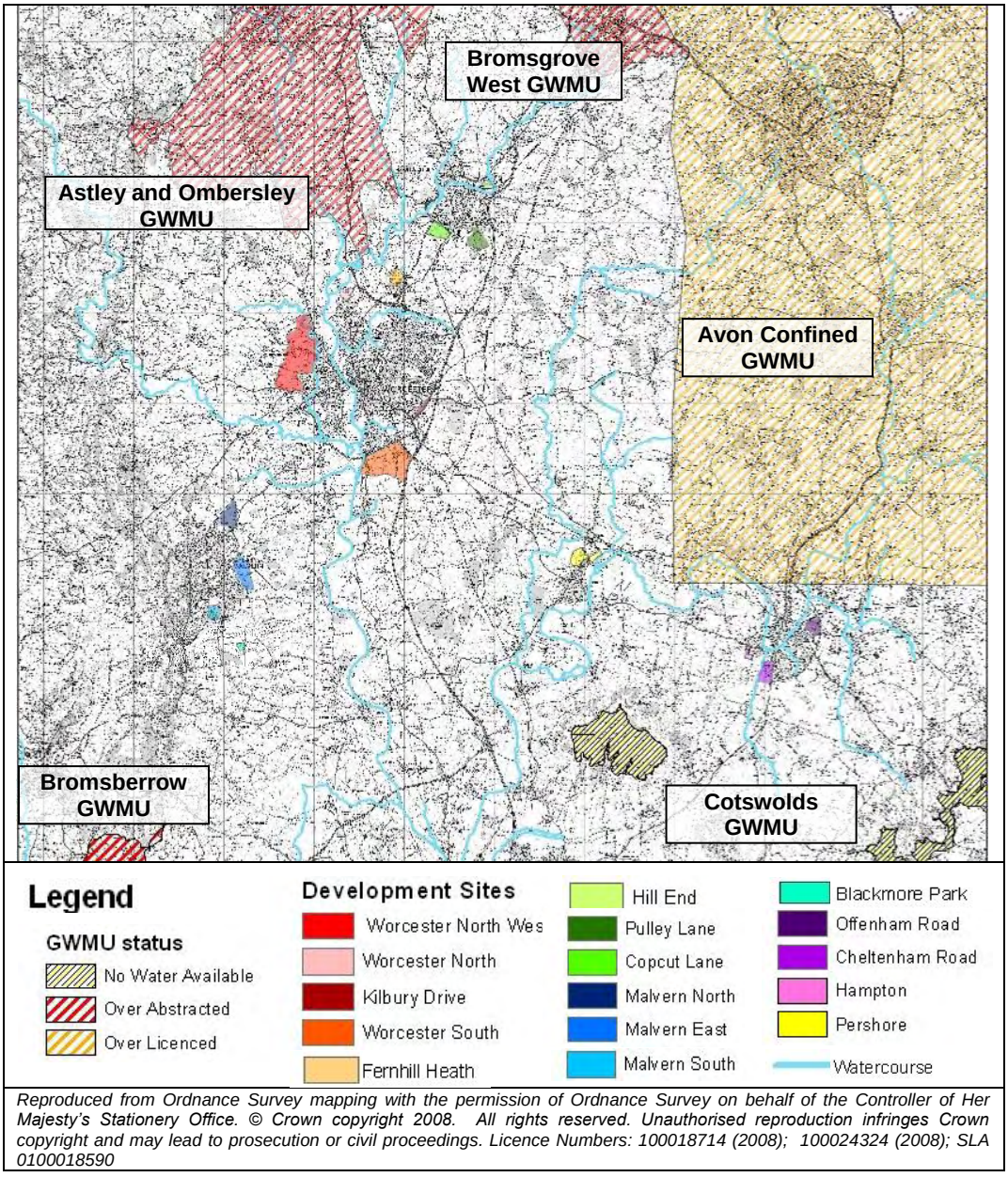
Summary

- **The EA requires any persons abstracting more than 20m^3/day from a 'source of supply' to have an abstraction licence.**
- **Surface Water and Groundwater Resources are scarce in the South Worcestershire study area.**
- **The majority of the rivers near the proposed strategic site allocations have 'no water available at low flows, though some may be available at high flows with appropriate restrictions.**
- **River Salwarpe and Hadley Brook in Droitwich as well as Bow Brook to the west of Pershore are over abstracted and existing abstraction is causing unacceptable damage to the environment at low flows. Water may still be available at high flows, with appropriate restrictions.**

5.2.2 Groundwater Resources

Figure 5-2 shows the existing situation of groundwater resources for Worcester, Droitwich Spa, Great Malvern, Pershore and Evesham. The licensing strategies for the areas are outlined in section 5.4.

Figure 5-2: Current Status of Groundwater Management Units in South Worcestershire



5.3 Influence of the Proposed Strategic Site Allocations

The proposed strategic site allocations need a water supply and this will increase the pressures on the already scarce water resources in South Worcestershire.

The following sections outline how the proposed strategic site allocations may affect the Water Resources and Supply in South Worcestershire and the surrounding area. Possible strategies are identified that will manage or prevent future damage to the environment and still ensure that the proposed strategic site allocations will have sufficient water supply.

5.4 CAMs Future Resource Status and Licensing Strategies

The Environment Agency undertook a sustainability appraisal and the outcome was a target resource status for the WRMUs. The target resource status for the WRMUs within the study can be found in Table 5-2.

5.4.1 Licensing Strategies for the WRMUs

To achieve the target resource status for the WRMUs the Environment Agency have outlined licensing strategies specific to the WRMU within the CAMS. The Environment Agency state that within all WRMUs the use of other strategies such as the promotion of water efficiency from abstractors should be encouraged. More information on water efficiency techniques can be found in Chapter 8.

Licensing strategies account for all abstraction uses, not just water supply but also agriculture and industry. The main abstractions within the South Worcestershire region are for water supply and agriculture, with a much smaller proportion being accounted for by commercial and industrial uses.

Table 5-3: WRMU Licensing Strategies for Worcester

Proposed Strategic Site Allocation	Licensing Strategy	WRMU and Rivers
Worcester	**New Licences:** all new licences have a time limit of 31 March 2010 (in line with delivery of the next Severn Corridor CAMS; all new or varied abstractions on the River Severn for consumptive abstraction greater than 0.02Ml/day will be issued subject to a condition restricting them when regulation at Bewdley is ≥500Ml/day from any source; all applications will be reviewed in terms of the potential impact on freshwater flows to the Severn Estuary; licences will be granted generally with the lowest HOF possible on a first come first served basis, as more licenses are granted this HOF will need to be increased to preserve the variability of flows. **Existing Licences:** Renewal of time limited licenses subject to the renewal criteria and local considerations. The renewal criteria are as follows: the licence holder should demonstrate that they need the water; that they will make efficient use of the water; and the licence is deemed to be environmentally sustainable by the Environment Agency.	Unit 6: River Stour confluence to River Teme confluence (River Severn)
	New Licences: River Teme catchment from source to u/s River Onny confluence, subject to a HOF of 240 Ml/day on River Teme at Tenbury; River Teme catchment from u/s River Onny to Tenbury gauging station, including the River Corve, subject to a HOF of 190 Ml/day on River Teme at Tenbury; River Teme catchment d/s of Tenbury, subject to a HOF of 230 Ml/day on River Teme at Knightsford; Where abstractions are requested on minor tributaries, a HOF tied to a local measuring structure is usually necessary; because the Teme catchment directly contributes to the Severn Corridor new and varied consumptive licences will be restricted when regulation at Bewdley is greater than or equal to 500 Ml/d from any source; all new licences have a time limit of 31 March 2013. **Existing Licences:** all time limited licences are likely to be renewed if the proposal meets the renewal criteria (see above).	Teme WRMU (River Teme and Laughern Brook)

Table 5-4: WRMU Licensing Strategies for Droitwich Spa

Proposed Strategic Site Allocation	Licensing Strategy	WRMU and Rivers
Droitwich Spa	**New Licences:** No new licences will be granted for abstraction at times of low flow; all new licences on the River Salwarpe will be considered up to 4Ml/d and will be subject to a HOF of 40Ml/day; after this water has been licensed licences will be considered up to 5Ml/day with a HOF of 50Ml/d; any licences will be subject to restrictive daily pumping capacity in order to protect flow variability. **Existing Licences:** all time limited licences should meet the renewal criteria (see Worcester); no increase in quantity will be granted during times of low flow; all increases will be subject to the HOFs outlined above; any licences granted or varied in this unit will be subjected to a restrictive daily pumping capacity of 0.5Ml/day in order to protect flow variability.	Unit 2 – Rivers Worfe, Stour and Salwarpe (River Salwarpe and Hadley Brook)

Table 5-5: WRMU Licensing Strategies for Great Malvern

Proposed Strategic Site Allocation	Licensing Strategy	WRMU and Rivers
Great Malvern	**New Licences:** No new consumptive surface water licences will be granted at low flows ; licences will be considered up to a total of 0.8Ml/day for Careys Brook with a HOF of 55Ml/day at Wedderburn Bridge, after this water has been licensed abstractions will be considered up to a total of 1.7Ml/day with a HOF of 85Ml/day, once this has been licenced abstractions will be considered up to a total of 3.3Ml/day with a HOF of 130Ml/day; all new licences will be time limited; new groundwater licences from minor aquifers will be assessed on case by case status;if within a groundwater exemption zone (5% of the WRMU) they will not require a licence until the Environment Agency has successfully applied to remove the exemption under the Water Act 2003; all new licences will be examined on a case by case basis to ensure impacts are not directly affecting the development of either the Longdon and Eldersfield Marsh or the Teme and Severn confluence Wetland Restoration Zones. **Existing Licences:** Renewal of time limited licenses subject to the renewal criteria (see Worcester) and local considerations. All abstraction licence applications will be subject to an assessment to take account of any local issues and be granted on a first come first served basis.	Unit 1 – Severn Vale North West Tributaries (Careys Brook)
	New Licences: New licences have a time limit of 31 March 2010 (in line with delivery of the next Severn Corridor CAMS); new or varied abstractions on the River Severn for consumptive abstraction greater than 0.02Ml/day will be issued subject to a condition restricting them when regulation at Bewdley is $\geq$500Ml/day from any source; all applications will be reviewed in terms of the potential impact on freshwater flows to the Severn Estuary; licences will be granted with the lowest HOF possible on a first come first served basis, as more licenses are granted the HOF will be increased. **Existing Licences:** Renewal of time limited licenses subject to the renewal criteria and local considerations (see Worcester).	Unit 7- River Teme – Confluence to Saxons Lode (River Severn)

Table 5-6: WRMU Licensing Strategies for Pershore

Proposed Strategic Site proposed strategic site allocations Allocation	Licensing Strategy	WRMU and Rivers
Pershore	**New Licences**: None will be granted. **Existing Licences**: Renewal of time limited licenses subject to the renewal criteria and local considerations (see Worcester).	Besford Bridge (Bow Brook to the north of Tiddesley Wood)
	Prevention of abstraction at flows lower than Q95, this is the flow exceeded in the river for 95% of the time. **New Licences**: No new consumptives licences at low flows; surface water licences granted subject to a HOF condition of 1,800 Ml/day at Deerhurst; licences will be granted up to a limit of 16.2 Ml/day net impact from this section of the River Avon; abstractions from minor tributaries may be subject to different restrictions; all new licences have a time limit of 31 March 2013; new groundwater licences from minor aquifers will be assessed on case by case status. **Existing Licences**: Renewal of time limited licenses subject to the renewal criteria (see Worcester) and local considerations and the above HOF condition.	Upper Pound (Bow Brook from the north edge of Tiddesley Wood and the River Avon between Evesham and Upper Pound)
	Prevention of abstraction at flows lower than Q74, this is the flow that is exceeded in the river for 74% of the time. **New Licences**: No new consumptives licences at low flows; surface water licences granted subject to a HOF condition of 11Ml/d at Wyre Piddle and 1,800 Ml/day at Deerhurst; licences will be granted up to a limit of 1.7Ml/day net impact, once used up, new or varied licences will be granted with a higher HOF at Wyre Piddle and same HOF at Deerhurst; abstractions from minor tributaries may be subject to different restrictions; all new licences have a time limit of 31 March 2013; new groundwater licences from minor aquifers will be assessed on case by case status. **Existing Licences:** Renewal of time limited licenses subject to the renewal criteria (see Worcester) and local considerations and the above HOF condition.	Wyre Piddle (Piddle Brook)

Table 5-7: WRMU Licensing Strategies for Evesham

Proposed Strategic Site Allocation	Licensing Strategy	WRMU and Rivers
Evesham	Prevention of abstraction at flows lower than Q92, this is the flow that is exceeded in the river for 92% of the time. **New Licences**: No new consumptives licences at low flows; surface water licences granted subject to a HOF condition of 409Ml/day at Evesham and a HOF of 1,800Ml/day at Deerhurst; licences will be granted up to a limit of 12.5Ml/d for the whole catchment upstream of Evesham, once used up, new or varied licences will be granted with a higher HOF of 450Ml/day at Evesham and still a HOF of 1,800Ml/day, the remaining resource at this level of restriction is approximately 33Ml/d for the whole catchment upstream of Evesham; abstractions from minor tributaries may be subject to different restrictions; all new licences have a time limit of 31 March 2013; new groundwater licences from minor aquifers will be assessed on case by case status. **Existing Licences:** Renewal of time limited licenses subject to the renewal criteria (see Worcester) and local considerations and the above HOF condition.	Evesham (River Avon from downstream confluence with the River Stour to Evesham)
	Prevention of abstraction at flows lower than Q95, this is the flow exceeded in the river for 95% of the time. **New Licences**: No new consumptives licences at low flows; surface water licences granted subject to a HOF condition of 1,800 Ml/day at Deerhurst; licences will be granted up to a limit of 16.2 Ml/day net impact from this section of the River Avon; abstractions from minor tributaries may be subject to different restrictions; all new licences have a time limit of 31 March 2013; new groundwater licences from minor aquifers will be assessed on case by case status. **Existing Licences**: Renewal of time limited licenses subject to the renewal criteria and local considerations and the above HOF condition.	Upper Pound (River Avon between Evesham and Upper Pound and River Isbourne)

5.4.2 Licensing Strategies for GWMUs

The target status for the GWMUs for 2018 are as follows;

- The Astley and Ombersley GWMU and Bromsgrove West GWMU will remain as 'over – abstracted';
- The Avon Confined GWMU and Bromsberrow GWMU are expected to be reduced to 'no water available'; and
- The Cotswolds GWMU will remain as 'no water available'.

To achieve the target resource status for the GWMUs the Environment Agency have outlined licensing strategies specific to the GWMU within the CAMS.

Table 5-8: Licensing Strategies for GWMUs

GWMU	Licensing Strategy
Bromsgrove West **Astley and Ombersley**	Prevention of current situation worsening further and regain as much licensed water as possible. **New Licences:** No further water available for abstraction, no new consumptive licences. **Existing Licences:** No additional water will be granted, Licences due for renewal should pass the renewal criteria (see Worcester WRMU Unit 6); existing licences may be reduced to the maximum abstracted quantities in recent years for all licences due for renewal in the next CAMS cycle, if the need for quantities can not be justified.
Avon Confined	**New Licences:** No further water available for abstraction, no new consumptive licences. **Existing Licences:** The EA will encourage reduction in licensed quantities that are not used and will investigate revoking licences that have not been used in the last 7 years (or last 4 years if not used since April 2004); time limited licences may be renewed on more restrictive terms to recover resources.
Bromsberrow	**New Licences:** No new licences due to the 'Over-abstracted' status and no new groundwater licences from minor aquifers; abstraction from within the groundwater exemption zone will not require a licence until the Environment Agency has successfully applied to remove the exemption under the Water Act 2003. **Existing Licences:** renewal of time limited licences, subject to the renewal criteria (see Worcester WRMU Unit 6), local conditions and HOF conditions; encouraging voluntary reductions in actual used volume with equivalent reduction in licensed volume.
Cotswolds GWMU	Area of GWMU located within the River Stour and Badsey Brook Catchment; **New Licences:** Water available for abstraction, new licences granted provided yields are sustainable and there are no local derogation issues. **Existing Licences:** Continued encouragement of water efficient practices.
	Area of GWMU located within the River Isbourne catchment: **New Licences:** No water available for abstraction, no new consumptive licences. **Existing Licences:** time limited licence may be renewed under more restrictive terms to recover resources.

Summary

- **To improve the status of surface water resources in the South Worcestershire area the EA CAMS state that for most areas no new licences will be granted for low flows, licences at higher flows will have strict restrictions and in some cases no licences will be granted at any flow level.**
- **To improve the status of groundwater resources no new abstraction licences will be granted.**
- **Renewal of existing surface water and groundwater licences may be subject to more stringent conditions than previously.**

5.5 Water Resources Management Plan Review

Severn Trent Water have developed a Draft Water Resources Management Plan 2009 (WRMP) that sets out their proposed 25 year strategy for maintaining the balance between the supply and demand for water in their region and to maintain their level of service of no more than three hosepipe bans per 100 years. Severn Trent Water also produced a Draft WRMP Statement of Response which includes their latest thinking on areas of the Draft WRMP raised by respondents of a public consultation, and also released their latest assessment of the supply demand balance. The following review of the Draft WRMP includes the updates from the statement of response. The following sections outline the future issues and strategies regarding water usage (household and non-household) and supply and demand. The Draft WRMP takes into account the housing growth targets set out in the West Midlands RSS and therefore accounts for the housing growth within the Water Cycle study area. Information on demand management in terms of leakage and water efficiency can be found in Chapter 8.

5.5.1 Introduction

South Worcestershire falls within the Severn Water Resource Zone 3 (WRZ3). The zones are defined as the largest possible zone in which all water resources, excluding external transfers, can be shared. Within any given zone there is the same risk to all customers of supply failure from a resource shortfall. Where values are quoted from the Statement of Response an updated baseline scenario from 2007/2008 has been used instead of the 2006/2007 baseline used in the Draft WRMP. The values quoted from both documents are based on a 'dry year' scenario and therefore represent worst case conditions when water consumption is higher than average and water resources available are lower than average.

Baseline scenarios within the Draft Water Resources Management Plan have been forecast under the policy assumptions specified in the EA's Water Resources Planning Guideline[2], with the continuation of existing demand management (leakage, metering and water efficiency) policies and measures without any further enhancement, but with climate change impacts included. Final planning scenario demand forecasts have been generated to reflect Severn Trent Water's proposed water efficiency metering and leakage strategy (see section 5.6.2).

5.5.2 Water Demand

Household

The Government's 'Future Water: The Governments Strategy for Water in England' (February 2008) envisages that by 2030 the average household per capita consumption (pcc) could be reduced to 130litres/head/day. Severn Trent Water's latest projections of normal year useage indicate that under the "baseline" scenario, if they continued with the current policies, by 2035 the average pcc for household customers for the entire Severn Trent Water Region would be around 138litres/head/day. With increased water efficiency and water metering predicted in the future the projection for 2035 for a normal year is 133litres/head/day, which shows progress towards achieving the Government's long term vision. The following table is an assessment of water consumption for the WRZ3 zone in terms of measured households (M hh), charged based on meter reading, unmeasured households (Un hh), charged based on the rateable value of the property, total household underground supply pipe leakage (USPL) and the total water delivered (WD).

Table 5-9: Household Consumption and Water delivered in the Severn (WRZ3) Zone 2006/07 to 2034/35 under the baseline scenario

		2006/2007	2014/2015	2034/2035
Severn Zone (WRZ 3)	**Un hh consumption Ml/d**	244.25	210.07	135.01
	M hh consumption Ml/d	87.68	129.61	229.28
	Total USPL Ml/d	44.97	44.57	43.57
	Total WD Ml/d	376.91	384.25	407.86

[2] Environment Agency. 2007. Water Resouces Planning Guideline. [online] http://publications.environment-agency.gov.uk/pdf/GEHO1208BPDC-E-E.pdf

The Draft WRMP shows that under the baseline scenario Severn Trent Water predict that for the period up to 2035 there will be a 109Ml/day reduction in consumption by Un hh and a 142Ml/day increase in M hh. There will be a decrease of approximately 1.5Ml/day in total USPL. Overall, taking into account Un hh, M hh and USPL, there is an net increase of approximately 31Ml/day in water consumption from 2006 – 2035. These values may need to be updated when the final WRMP becomes available.

Severn Trent Water predict that the expected increase in overall household consumption resulting from increasing population would be partially offset by changes in behaviour, technology and other factors influencing demand. Further information on demand management and water efficiency can be found in Chapter 8.

Non-Household

Since the Draft WRMP Severn Trent Water have updated their analysis of the relationship between economic activity and water consumption for the different industry sectors across the Severn Trent Water region. The long term projections of non-household consumption have been revised to reflect the improved datasets and modelling. The new projections in the Statement of Response show a large reduction in water consumption in the period up to 2035 from approximately 400 Ml/day in 2006/07 to approximately 270 Ml/day in 2035.

5.5.3 Available Water

Water as a resource is scare in the Severn River Basin. Severn Trent Water assessed the baseline amount of water available within WRZ3 at 2010, and where possible predicted the situation in 2035. The following areas were assessed, deployable output (DO), outages, process loss and available potable water imports and exports.

Deployable Output

This assessment takes into consideration the network constraints, available output from sources, in relation to licence limitations, pump capacity, borehole yield, distribution limitations and climate change. Current predictions taken from the updated table in the Severn Trent Water's Statement of Response indicate that the DO at 2010 is 648.74Ml/day for WRZ3. The Statement of Response also includes an updated assessment of climate change impact on DO. It is thought that there will now be a loss of 63.82 Ml rather than a loss of 19.45 Ml as used in the draft WRMP. There is also a loss of 1 Ml due to a reduction in abstraction from Brockhill (Severn) Resource Zone under the Environment Agency's Restoring Sustainable Abstraction Programme. Therefore by 2035 will have decreased to approximately 583.9Ml/d, taking into consideration the more severe impact of climate change predicted within Severn Trent Water's Statement of Response. However, the 2035 predictions do not include reductions in DO due to increase nitrate concentrations at groundwater sources.

Outage

Outage is defined as a temporary loss of deployable output that lasts typically for less than 3 months. The average annual outage allowance to 2035 is approximately 3% of the total Deployable Output (the 80th percentile was used accepting a 20% risk that the outage allowance may be smaller than is actually needed). The maximum expected value within the water industry is normally around 10% of DO. The following table indicates the relative contribution of the components of the overall outage risk in WRZ3, These results should be regarded as indicative rather than definitive. The largest components of the outage allowance are related to planned and unplanned maintenance of treatment plant and pollution at river intakes.

Table 5-10: Components of Outage Allowances for WRZ3

Cause of Outage	Percentage
Borehole pump failures	3 %
Power loss at groundwater sources	12 %
Power loss at WTWs	7 %
Auto shut down of unmanned WTWs	9 %
Pollution at river intakes	18 %
Planned maintenance of WTWs	29 %
Unplanned events at WTWs	12 %
Planned maintenance of boreholes	9 %
Mains failures and other issues	2 %

Process Loss

This is the measure of water lost across the treatment streams at the works and is typically only around 1% of the abstracted volume. The following table shows the process loss at the Water Treatment Works (WTW) within WRZ3.

Table 5-11: Process Losses for WRZ3

	WTW	Process Loss
Severn Zone (WRZ3)	Campion Hills	8%
	Draycote	1%
	Mythe	3%
	Strensham	3%
	Trimpley	8%
	Whitacre	8%
	Shelton	7%

Water Available For Use (WAFU) – Baseline 2010

The water available for use is calculated as follows:

WAFU = DO – Outage – Process Loss

The DO has been updated since the Draft WRMP to 648.74 Ml/day. The outage has been re-calculated using this new value resulting in an outage of 19.20 Ml/day, it has been assumed that the process loss remains the same as the Draft WRMP at 17.21 Ml/day.

The resulting WAFU for WRZ3 is approximately 612.3 Ml/day.

Available Potable Water Imports and Exports

Potable water imports and exports also constitute as gains to and losses from the WAFU. There are no exports out of the WRZ3. There is 35Ml/d of potable imports available into the WRZ3. This consists of 20Ml/d from the Birmingham Zone (WRZ4) and 15Ml/d from the East Midlands Zone (WRZ6).

This gives a total WAFU of approximately 647.3 Ml/day for WRZ3.

These values may need to be updated when the final WRMP becomes available.

5.6 Supply/Demand Balance

5.6.1 Target Headroom

Target Headroom represents the minimum buffer that companies should plan to maintain between water available for use and demand in order to cater for uncertainties in the estimation of supply and demand values. The Environment Agency's Water Resources Planning Guideline (April 2007) instructs water companies not to include any allowances in headroom for loss or non-renewal of abstraction licences. The guidelines state that where abstraction licences may not be renewed in the future, notice will be given to companies in sufficient time to take action to restore the supply/demand balance. Table 5-12 outlines the overall target headroom requirement over the next 25 years taken from the Draft WRMP and may require updating when the final WRMP becomes available.

Table 5-12: Target Headroom Requirements (Ml/d) for WRZ3 - Severn

	2009-2010	2014-2015	2019-2020	2024-2025	2029-2030	2034-2035
Severn Zone (WRZ3)	41.18	48.84	49.69	52.19	51.60	54.56

The supply/demand balance became negative in 2006/2007 and looks to remain in deficit in the future. The Draft WRMP indicates that the baseline deficit in 2035 will be 96.6 Ml/d. Severn Trent Water have since re-assessed the supply/demand balance and in their Statement of Response indicated that the latest assessment of climate change on DO gives a more severe impact than in the draft WRMP, however, they note that at the same time the assessment for demand for water is lower than predicted in the draft WRMP. The net effect is that the current projected supply/demand shortfall, taken from Severn Trent Water's latest assessment, is around 120Ml/d by 2035. It should be noted that the projected shortfall would arise if no further investment was made to leakage reduction, demand management and resource development. The following section outlines Severn Trent Water's proposals for investment to maintain the target headroom required to ensure security of supply to customers over the next 25 years.

5.6.2 Severn - WRZ 3 Final Strategy

To produce a supply/demand balance investment strategy, the WRMP process requires Severn Trent Water to consider a wide range of strategic options within four categories to derive an 'unconstrained' list of potential investment option for the future. The four categories are listed below:

- Customer Side Options;
- Production Side Options;
- Distribution Side Options and;
- Supply Side Options.

The process then requires a review of the potential options to screen out those that are most infeasible and/or have unacceptably adverse effects in order to derive a 'constrained' list of options. These options can then be taken forward for a more detailed review of engineering, social and environmental costs and benefits. The screening process uses a scoring system and applying the expert judgement of internal (Severn Trent Water) and external specialists on engineering, planning, operational and environmental issues. This process has been extended and developed so that for the 2009 WRMP it constitutes a Strategic Environmental Assessment (SEA) of the 'optioneering process' and of the plan to balance supply and demand in the most advantageous way, from combined financial, social and environmental perspectives. The outputs of the options screening process are then subjected to an investment appraisal process to derive the overall least cost practicable strategy for balancing supply and demand. This final strategy for the Severn WRZ3 zone is summarised in Table 5-13.

The Severn Trent Water 'Water Resources Plan' (2004) proposed a supply/demand balance investment strategy to remove the shortfall by 2010 by increasing their supply capability through a combination of water resources, treatment and distribution schemes as well as through more metering, demand management and leakage reduction. Severn Trent Water state that good progress was made on delivering leakage reduction, metering and water efficiency elements of the strategy but there were

problems with a key component, the new river intake and water treatment works at Ombersley, near Worcester.

The scheme identified in the 2004 plan that was most likely to majorly affect the water supply in South Worcestershire was the Ombersley water treatment works. The objective of this scheme was to abstract from the River Severn and treat 30Ml/d into supply. The choice of the location was such that water would be pumped in the Southern Strategic Main at a point where the water could be transferred into the Company's Strategic Grid via an existing main or via the Southern Strategic Main into Worcester and potentially onto Gloucestershire. However, the deployable output benefit of this works would rely on flow augmentation into the River Severn during the critical dry season.

There were problems encountered around gaining the appropriate planning permissions and justifying the additional abstraction licence that would be required. The River Severn is classified as having 'no water available', no new abstraction licences are to be allowed at times of low flow, and if they are allowed at higher flows restrictions would be in place to control them (Figure 5-1 and Table 5-3). Therefore the original 2010 target for the project was not met. During the 2009 draft WRMP the Ombersley scheme was re-tested as an option to the supply-demand balance solution in light of the problems encountered. The scheme remains un-viable and has therefore been removed as an option with the final strategy. More options are now available in the 2009 plan to make more effective use of the existing water resource base through enhancing their strategic grid capability.

The draft WRMP also assessed schemes that required further abstractions from the River Wye, which currently supplies 10% of the South Worcestershire study area, mainly in Ledbury and West Malvern, areas where there is potential for windfall allocations. It was found that further abstractions from the River Wye would be detrimental to the environment and therefore Severn Trent Water have acknowledged that no further abstractions from the river would be available.

In the short term the strategy proposed in the draft WRMP (2009) as a solution to the supply/demand balance deficit maximises the use of the existing resources. In the long term Severn Trent Water have identified the need for more water resources to maintain the supply/demand balance. The strategy proposed assumes that with the existing network and resource base, 20Ml/d of supply is available from the East Midlands zone via the existing east/west strategic link.

The final strategy proposes a scheme to increase the capacity of the Derwent Valley Aqueduct in order to give the capability to deploy more water from treatment works along the River Derwent to the south of the East Midlands zone, and to provide further support to the east/west link. This would not only provide an increase in deployable output to both the East Midlands and Severn zones, but would also provide supply resilience benefits too.

The Derwent Valley Aqueduct Scheme will release unused production capacity at Ogston, Homesford, Little Eaton, Church Wilne and Melbourne WTWs. In water resources modelling terms this capacity is currently unused when the deployable output of the East Midlands Zone is met. The scheme will allow between 50 and 60 Ml/d of water to be moved southwards into Leicestershire and on into the Severn Zone via the Company's East-West Link. The impact of this transfer will be to supplement the production at the WTWs in the Severn and Birmingham Zones by offsetting the existing production at these works. The production at Strensham and Trimpley will be particularly supported by this transfer, meaning that the exports off the River Severn Aqueduct into South Worcester and off the Shropshire Rural Main (into South Shropshire) will be supported. The Derwent Valley Aqueduct project is scheduled to be completed within AMP period 5 (2010 – 2015).

The Derwent Valley Aqueduct will not be relied upon for maintaining the supply demand balance. Severn Trent Water's preferred option in the Draft WRMP also includes leakage and demand management strategies that will play a major role in coping with the increase in demand (Table 5-13). Section 8.22 outlines Severn Trent Water's leakage and efficiency/demand management programme.

Table 5-13 shows the proposed supply/demand balance strategy for WRZ3 – Severn. For more information regarding water efficiency and leakage see Chapter 8.

Table 5-13: The proposed supply/demand balance strategy for WRZ3 – Severn

AMP Period	Proposed Intervention
AMP 5 2010-2015	• Additional household metering • Household and non-household water efficiency programme • Leakage control through combination of active leakage control, mains replacement and pressure control. • Derwent Valley Aqueduct duplication – Kings Corner to Hallgates.
AMP 6 2015-2020	• New Birmingham groundwater source • Minworth aquifer storage and recovery • Highters Heath aquifer storage and recovery • Household and non-household water efficiency programme • Leakage control through combination of active leakage control, mains replacement and pressure control.
AMP 7 2020-2025	• Household and non-household water efficiency programme • Leakage control through combination of active leakage control, mains replacement and pressure control.
AMP 8 2025-2030	• Norton aquifer storage and recovery • River Leam flow compensation change • Household and non-household water efficiency programme • Leakage control through combination of active leakage control, mains replacement and pressure control.
AMP 9 2030-2035	• Whitacre aquifer storage and recovery • Household and non-household water efficiency programme • Leakage control through combination of active leakage control, mains replacement and pressure control.

This table has been updated from the latest assessment from Severn Trent Water's 'Latest assessment of the supply/demand balance' available on their website. The details behind the latest planning assumptions and the investment plan that Severn Trent Water are proposing will be presented in full in the final WRMP and therefore this section will require updating once the final WRMP is available.

Summary

- **The supply/demand deficit for the Severn WRZ became negative in 2004 and is predicted to be in 120Ml/d in deficit in 2035, without investment leakage reduction, demand management and resource development.**
- **Severn Trent Water will maximise the use of existing water resources efficiently but note in the long term there will be a need for more water resources and treatment capacity to maintain the supply/demand balance.**
- **The proposed Derwent Valley Aqueduct scheme will allow between 50 and 60 Ml/d of water to be moved southwards into Leicestershire and on into the Severn Zone via the Company's East-West Link and support production at Strensham and Trimpley Treatment Works.**
- **The Government envisage household pcc to be 130l/h/d by 2030, Severn Trent Water predict with their improved water efficiency and water metering the pcc in 2035 will be 133l/h/d.**

5.7 Water Supply – Infrastructure

5.7.1 Introduction

It should be recognised that the following detailed analysis does not include the impact of employment land on the supply infrastructure. To provide a more accurate assessment of the pressures on the water supply and infrastructure, the exact type of employment proposed would be required. It is important that Severn Trent Water is informed of any employment proposed with a high water demand so that this can be included within their forecasts and modelling. A broad assessment of the impact of employment land and windfall sites has been included in section 5.8.

Severn Trent Water is responsible for the operation and maintenance of water supply and distribution infrastructure for South Worcestershire. In December 2008 the Severn Trent Water AD08 Growth Point Study for Worcester undertaken by Jacobs Engineering UK Ltd. was issued. The study carried out a high level assessment of the adequacy of the current sewerage assets to meet the growth in demand expected between 2006 and 2016 in Worcestershire and was based on information provided by the SWJCS. The aim of the study was to assess the capability of the existing water strategic assets to cope with the increases in demand envisaged. The assessment considered the capabilities of available licensed water abstraction, available water, available trunk mains and service reservoir capacities and impacts. The study also looked at the any strategic capacity constraints and possible investment options.

The proposed strategic site allocations have been updated since the Severn Trent Water Growth Point Study was undertaken and consequently there are four additional allocations that have not been included within the study which are to be included within this study. These are Worcester North, Cheltenham Road in Evesham, Hill End in Droitwich Spa and Blackmore Park in Great Malvern. Severn Trent Water has provided a summary for the additional allocations for the purpose of this study except for Blackmore Park that could not be assessed due to it being solely for employment land.

The following sections discuss the methodology and assumptions used in the Growth Point Study to assess water supply issues and the specific issues for each allocation. It is important to recognise that the assessments, notional solutions and costs within the Growth Point Study are only indicative of the possible improvements necessary and further modelling will be required in the future once the proposed strategic site allocations, number of dwellings and type of employment are finalised.

5.7.2 Assumptions and methodology

The following methodologies and assumptions are those used by Jacobs Engineering Ltd. for the Severn Trent Water Growth Point Study (2008).

Modelling

- Domestic demands in models were factored by 25% to represent peak conditions and simulations were run for 24 hours to provide a ‘benchmark’ analysis. For the proposed strategic site allocations a per capita consumption of 150l/day/head was used along with an occupancy rate of 2.5 people per household following guidance from Severn Trent Water. The models were assessed in terms of pressures, velocities and head losses and comparisons made for before and after development to identify areas negatively affected by the allocations.
- The following parameters were followed as requested by Severn Trent Water; pressure should not fall below 20m at the property boundary, velocities should not exceed 1m/s (unless directed otherwise) and head loss should not be greater than 2m/1000m.

Reservoir Storage

- Assessment was based on current demand on the reservoir, the current storage time and affects of additional demand from the proposed strategic site allocations. The change in storage hours was then established and shortfalls addressed. The optimum residence time was taken to be between 18-24 hours.

Resource Headroom

- A worst case scenario was assumed. The total demand from all the proposed strategic site allocations is 5.6Ml/d which was applied to the three major reservoirs in the area to determine if the reservoirs could accommodate additional demands.

Summary

- **In the Growth Point Study, Severn Trent Water assessed the capacity of the water supply infrastructure to meet the demands of the residential properties proposed in the proposed strategic site allocations.**
- **Non-residential water supply and windfall sites have been broadly assessed separately to the Growth Point Study.**
- **Severn Trent Water has provided a summary for the additional allocations not included in the Growth Point Study, Cheltenham Road, Worcester North and Hill End. No information could be provided for Blackmore Park as it is allocated solely for employment land.**
- **The Whittington site in the Growth Point Study has been used to give an estimate of the impact of Kilbury Drive as it is in a similar location, is a similar size and has the same number of potential dwellings as the allocation at Kilbury Drive.**

5.7.3 Worcester

The exact figures determined in the models should only be used as an estimate and further modelling is required when the proposed strategic site allocations and dwelling numbers are finalised. The following analysis does not include the additional properties within Worcester North. However, consultation with Severn Trent Water has led to the proposal of a new notional solution for Worcester that includes Worcester North.

Demand Growth

The following table shows the proposed strategic site allocations and the additional demand on the system. The proposed 6,800 properties in Worcester (excluding the Worcester North and Fernhill Heath*) represents a 12.5% increase.

Table 5-14: Water Supply Demand Growth in Worcester

Proposed Strategic Site Allocations	Number of Properties	Additional Demand l/s	Additional Demand Ml/d
Worcester North West	3,500	15.19	1.31
Worcester North	350	Not assessed	Not assessed
Kilbury Drive	300	1.30	0.11
Worcester South	3,000	13.02	1.13
Fernhill Heath	500	See Table 5-17	See Table 5-17
Total	6,800*	31.67	2.74

*Excluding Worcester North as not assessed in the Growth Point Study and Fernhill Heath as it is included in the Droitwich system and has been assessed with the Droitwich proposed sites (Table 5.17).

Reservoir Storage Capacities/Residence Times

Worcester is fed primarily by Elbury Hill Storage Reservoir (SR) which receives its supply from a 600mm main from Stensham WTW and an 800mm main from Trimpley WTW. Elbury SR supplies Rainbow Hill SR and Newtown SR, both within the city of Worcester. Elbury Hill has a relatively low residence time and supplies at high number of properties, the addition of 6800 properties reduces the residence time further (Table 5-15). Rainbow Hill has a relatively high retention time which reduces nearer to the recommended

retention time with the addition of 3500 properties (Table 5-15). There is little affect on the Newtown SR as only 150 additional properties are to be supplied (Table 5-15).

Table 5-15: Reservoir Storage Capacity and Residence Times - Worcester

Service Reservoir	Storage Capacity	Current Residence Time (hrs)	Current Properties Supplied	Additional Properties to be Supplied	New Residence Time (hrs)
Elbury Hill	17.51	13	55,200	6,800	11.57
Rainbow Hill	4.55	46	12,400	3,500	35.87
Newtown	1.14	28	2,100	150	26.13

Operational Deficiencies

It was determined that the system can support the proposed growth of 7,150 properties, although there will be a reduction in headroom available. A notional solution for Worcester North West consists of linking District Meter Areas (DMAs) DMA6382 (static head) and DMA6380 (fed by Rainbow Hill SR, boosted supply). This involves laying 3,750m of 300mm diameter water main from the junction of Oldbury Road and Newbury Road to Peachley Lane. As the Worcester North West allocation is large it is proposed that approximately 50% of the new houses will be in areas of higher elevation and will be supplied from the boosted supply and the other 50% will be in lower elevations, to be supplied under static pressure to reduce the impact on the pumps.

A further 2,800m of 400mm main and a new distribution booster is proposed in the north of Worcester. In addition, since the Growth Point Study was undertaken Worcester South has been reviewed. Originally no additional infrastructure was needed; however, it is now thought that a dedicated main will be required for this development consisting of 1,850m of main at a cost of £800,000, though this remains a notional solution.

The proposed notional solution includes the additional properties in the Worcester North proposed strategic site allocation. The estimated cost of the notional solution is £3.0m.

Network Analysis

The following network analysis does not include the additional properties within the Worcester North allocation and also uses the original notional solution proposed within the Growth Point Study that does not include the 2,800m of 400mm and new distribution booster. This should therefore be used as an indication of the possible impact of the proposed strategic site allocations but would need to be re-modelled when the proposed strategic site allocations and property numbers have been finalised.

The models were assessed for head loss and maximum velocities to give an analysis of the current situation. The head losses and maximum velocities are within the current Severn Trent Water standards. The proposed strategic site allocations and notional scheme were then added to the model. The head losses and maximum velocities in Worcester remain generally within the current Severn Trent Water standards. Table 5-16 shows the results of the network analysis undertaken.

Table 5-16: Summary of Network Analysis of Worcester

Number	Existing Situation	Post Development	Comment
1	<10m/1,000m	<10m/1,000m	In some sections of main in the city centre head loss is high. With the addition of notional solutions, no change is observed.
2	3m/1,000m	3m/1,000m	A main from the city centre to the south west of Worcester does not meet Severn Trent Water standards.
3	<20m	<20m	Large areas within DMA6747 in the north of Worcester suffer from low pressure. When the notional solutions were assessed some pressures increased to 30m. Some sections of main in the east have pressures below 20m before and after the notional solution and developments were applied to the model.
4	0.78m/s	1.1m/s	In the north of Worcester a section of main has an increased velocity after the notional solution was applied. This is above the Severn Trent Water standard but is acceptable.

5.7.4 Droitwich Spa

Demand Growth

The following table shows the proposed strategic site allocations and the additional demand on the system. At the time it was proposed that 2,250 properties were to be developed in Droitwich Spa (excluding Hill End). This includes Fernhill Heath from the Worcester allocations as it is included in the Droitwich system. The Growth Point Study included an additional allocation to the left of Copcut Lane. The current projected number of houses in Copcut Lane and Pulley Lane, the two allocations in the south of Droitwich, are similar the total number for the three allocations in the south of Droitwich assessed in the Growth Point Study. Therefore, the pressures on the system will be similar to those identified in the study, though the figures determined in the models should only be used as an estimate and further modelling is required when the proposed strategic site allocations and dwelling numbers are finalised. Severn Trent Water informed JBA that the additional 250 properties in Hill End are unlikely to require additional improvements to those outlined in the following assessment.

Table 5-17: Water Supply Demand Growth in Droitwich Spa

Proposed Strategic Site Allocations	Number of Properties	Additional Demand l/s	Additional Demand Ml/d
Hill End	250	Not Assessed	Not Assessed
Pulley Lane	250	1.08	0.09
Copcut Lane	1,200	5.21	0.45
Fernhill Heath	500	2.17	0.19
Total*	2,250	9.76	0.84

Reservoir Storage Capacities/Residence Times

The following table indicates that the additional demands should not adversely affect the storage times in Yew Tree Hill Tower and Storage Reservoir, however the residence are times are still in excess of 35 hours.

Table 5-18: Reservoir Storage Capacity and Residence Times – Droitwich Spa

Service Reservoir	Storage Capacity	Current Residence Time (hrs)	Current Properties Supplied	Additional Properties to be Supplied	New Residence Time (hrs)
Yew Tree Hill	0.9	46	1,020	250	36.94
Yew Tree Hill SR	0.68	46	10,927	2,000	38.88

Operational Deficiencies

The models indicated that the addition of the proposed strategic site allocations reduced the pressures in the southern region (Fernhill Heath) of Droitwich Spa, where the majority of the allocations are proposed. However, even though the system can accommodate the additional demand, the allocations have significantly reduced the headroom capacity within the system. Three notional solutions have been proposed to solve this issue where a worst case scenario has been assumed.

Table 5-19: Notional Solutions and Costs for Droitwich Spa

Scheme	Specifications	Cost
1	5km of 300mm dia main. Lay the main from Westwood Borehole (BH) southwest of the existing 6 inch main in Porters Mill Lane. From there, the 300mm main will reinforce the 6 inch main eastwards towards the A38 near Copcut. When constructed the valve at the entrance to DMA 6924 should be closed to provide a single feed from Westwood BH, with the option to re-open the valve to provide security of supply.	£1,420,000
2	250m of 225mm dia main. When additional demand is applied in DMA6923, the pressure in the DMA is below that of the acceptable level. To resolve this the development should be fed via an new 225mm main fed directly from Yew Tree SR.	£61,000
3	4,300m of 25mm dia main. Required to reinforce the supply into Worcester DMA6747 as current system can not accommodated the 3000+ properties of DMA6747. Therefore DMA6747 should be fed from Westwood BH to the north, previously supplied from Rainbow Hill SR to the south of the DMA. It is proposed that the new main should connect into DMA6747 at the junction of A449 and Whinfield Road). The previous supply into DMA6747 is to be isolated via a series of closed valves.	£1,057,000

Network Analysis

The models were assessed for head loss and maximum velocities to give an analysis of the current situation. The head losses and maximum velocities are generally within the current Severn Trent Water standards. The proposed strategic site allocations and notional schemes were then added to the model. The head losses and maximum velocities in Worcester remain generally within the current standards. The following table shows the results of the network analysis undertaken.

Table 5-20: Summary of Network Analysis of Droitwich Spa

Number	Existing Situation	Post Development	Comment
1	1-3.7m/1,000m	0.03-1.7m/1000m	A reduction of 2m/100m west of Westwood Pumping Station, therefore reducing the head loss in line with the Severn Trent Water standards.
2	1.1m/s	0.8m/s	Reduction of flow in northwest of Droitwich, remains within the Severn Trent Water standards.
3	<20m	<20m	In the west and centres of Droitwich pressures remain below 20m. In the centre of Droitwich some pressures have increased above 20m.
4	Average 25-35m	Average 45m	In the west and southwest rural Droitwich pressure increases.

5.7.5 Great Malvern

Demand Growth

Table 5-21 shows the proposed strategic site allocations and the additional demand on the system. It was proposed at the time of the study that 1,740 properties were to be allocated to Great Malvern. The current projected number of houses is 1,500 and therefore the pressures on the system will be similar to those identified in the study. However, the distribution of the houses between the three proposed strategic site allocations may be different thus the exact figures determined in the models should only be used as an estimate. Further modelling will be required when the proposed strategic site allocations and dwelling numbers are finalised. The assessment does not include Blackmore Park as the exact type of employment would be required for an accurate assessment of the additional demands.

Table 5-21: Water Supply Demand Growth in Great Malvern

Proposed Strategic Site Allocations	Number of Properties	Additional Demand l/s	Additional Demand Ml/d
Malvern North	1,100	4.77	0.41
Malvern East	500	2.17	0.19
Malvern South	140	0.61	0.05
Blackmore Park	n/a	n/a	n/a
Total	1,740	7.55	0.65

Reservoir Storage Capacities/Residence Times

The full extent of DMA re-zoning is unknown (see following paragraph) so an accurate assessment of the impact of the proposed strategic site allocations on reservoir storage and resident times could not be undertaken in the Growth Point Study.

Operational Deficiencies

The Growth Point Study indicates that Severn Trent Water is planning significant network alterations in the near future, but the full extent of the changes is currently unknown. The proposed works include a

number of DMA re-zonings and existing mains being abandoned. A new 315mm main has been laid along Worcester Road, from the junction with Trinity Road to the junction at Albert Park, but is not in commission at present. North Malvern Service Reservoir is currently not in commission and is intended to be permanently abandoned. Cowleigh Service Reservoir provides the alternative supply direct to the DMAs.

The model used in the Growth Point Study does not reflect the above alterations and these will impact greatly on the outcome of the analysis of the impact of the demand growth. It was found that there were a number of issues with the current model which prevented an assessment of the proposed strategic site allocations. No notional schemes could be confidently developed.

Network Analysis

The models were only assessed for the current situation in terms of head loss and maximum velocities. The head losses and maximum velocities are generally within the current Severn Trent Water standards.

Some pipelines in the south west area of Great Malvern have a headloss between 1m/1,000m and 5m/1,000m. There a many discrete sections of piping within Great Malvern with high headloss of up to 5m/1,000m and a high velocity of2m/s.

The minimum pressures in Great Malvern range from below 20m to above 50m, sections throughout Great Malvern and most of the northern area of Great Malvern have pressures below the standards set out by Severn Trent Water.

5.7.6 Pershore

Demand Growth

Table 5-22 shows the proposed strategic site allocations and the additional demand on the system. It is proposed that 1,000 properties are developed in Pershore, this includes 150 properties in an allocation now not included in the development projections. Table 5-22 shows the demand growth for the current allocation, excluding the additional 150 properties. The current projected number of houses is 900 and therefore the pressures on the system will be similar to those identified in the study, however the exact figures determined in the models should only be used as an estimate and further modelling is required when the proposed strategic site allocations and dwelling numbers are finalised.

Table 5-22: Water Supply Demand Growth in Pershore

Proposed Strategic Site Allocation	Number of Properties	Additional Demand l/s	Additional Demand Ml/d
Pershore	850	3.7	0.32

Reservoir Storage Capacities/Residence Times

Table 5-23 indicates that the additional demands have reduced the residence times in Fladbury Service Reservoir by approximately 50% to 18.64 hours. As the current residence time is relatively high at 38 hours the reduction in the time after development is not an issue.

Table 5-23: Reservoir Storage Capacity and Residence Times – Pershore

Service Reservoir	Storage Capacity	Current Residence Time (hrs)	Current Properties Supplied	Additional Properties to be Supplied	New Residence Time (hrs)
Fladbury	-	38	818	850	18.64

Operational Deficiencies

The models indicated that the addition of the allocations caused a widespread reduction in pressures to below 15m head in DMA6307, where all the allocations are proposed. Two notional solutions have been identified to resolve these problems.

Table 5-24: Notional Solutions and Costs for Pershore

Scheme	Specifications	Cost
1	**1,500m of 225mm dia main**. The current High Level System feeding DMA6307 fails under the additional demands as sufficient water can not be supplied to feed the proposed developments. The solution is to reinforce the single feed into DMA6037 and supply the new development via a new 225mm dia main, from Worcester Road/Church Road to Wyre Road. The additional supply will be via Fladbury Service Reservoir, in turn fed by the River Severn Aqueduct.	£394,000
2	**250m of 225mm dia main.** Source into Fladbury Service Reservoir is at present only a single main supply from the River Severn Aqueduct. With the additional demand there is a need to provide security of supply to the area if required. The notional solution is a 225mm dia main alongside the existing main. This will provide contingency to the system should there be an issue with one of the mains feeding into Fladbury.	£61,000

Network Analysis

The models were assessed for head loss and maximum velocities to give an analysis of the current situation. The head losses and maximum velocities are generally within the current Severn Trent Water standards. The proposed strategic site allocations and notional schemes were then added to the model. The head losses and maximum velocities in Worcester remain generally within the current standards. The following table shows the results of the network analysis undertaken.

Table 5-25: Summary of Network Analysis of Pershore

Number	Existing Situation	Post Development	Comment
1	1.3m/s	1.3m/s	No change in velocity, remains outside of Severn Trent Water standards.
2	1.1m/s & 8m/1000m	0.5m/s & 0.8m/1000m	Reduced values due to the new twin main north of Fladbury Service Reservoir. Now within the Severn Trent Water Standards.
3	2-5m/1000m	2-5m/1000m	No change in head loss, remains outside of Severn Trent Water standards.
4	0.17m/1000m	1.1m/1000m	Increase in head loss but remains within Severn Trent Water standards.
5	<20m	<20m	Three areas of main in Pershore have low pressure and there is no change after the development and notional schemes are included in the model.
6	38m	40m	Increase in pressure of 2m
7	28m	32m	Increase in pressure of 4m

5.7.7 Evesham

Demand Growth

Table 5-26 shows the proposed strategic site allocations and the additional demand on the system. It is proposed that 2,300 properties are developed in Evesham. There is an additional allocation at Cheltenham Road, added to the proposed strategic site allocations sites in Evesham, but not included in the Growth Point Study. However the total number of dwellings currently proposed for the three allocations is 2,100, which is less than that assessed in the Growth Point Study. Therefore the pressures on the system will be similar to those identified in the study. The exact figures determined in the models should only be used as an estimate and further modelling is required when the proposed strategic site allocations and dwelling numbers are finalised. Severn Trent Water was asked to comment on any additional pressures from the additional allocation. They noted that mains reinforcement would need to be provided (see Table 5-28).

Table 5-26 shows the demand growth for the current proposed strategic site allocations, excluding Cheltenham Road.

Table 5-26: Water Supply Demand Growth in Evesham

Proposed Strategic Site Allocations	Number of Properties	Additional Demand l/s	Additional Demand Ml/d
Offenham Road	1,500	6.51	0.56
Cheltenham Road	800	n/a	n/a
Hampton	800	3.47	0.30
Total	2,300	9.98	0.86

Reservoir Storage Capacities/Residence Times

Table 5-27 indicates that the additional demands have reduced the residence times in Sheriffs Lench Service Reservoir and Sugarbrook Service Reservoir, which feeds Sheriffs Lench. The small amount of additional demand from the proposed strategic site allocations compared to the current demand on the system means that there is little affect to the residence times.

Table 5-27: Reservoir Storage Capacity and Residence Times – Evesham

Service Reservoir	Storage Capacity	Current Residence Time (hrs)	Current Properties Supplied	Additional Properties to be Supplied	New Residence Time (hrs)
Sheriffs Lench (Fed from Sugarbrook)	10.55	36	18,364	2,300	31.99
Sugarbrook	45.55	81	47,986	2,300	77.30

Operational Deficiencies

The models indicated that two sections of the system within DMA6979, where all the proposed strategic site allocations are located, had pressures of between 10 and 20m head. Table 5-28 presents the notional solutions to deal with the issues.

Table 5-28: Notional Solutions and Costs for Evesham

Scheme	Specifications	Cost
1	To increase the pressures in the high elevation, north section of DMA6976 a variable speed booster pump (15kW) should be installed at the junction of Pershore Road and Workman Road. To ensure the lower elevation area is not affected by the new booster 3 valves should be closed (00WTYY35, 00WTYSFP, 00WTYSFQ).	£224,000
2	The pressures in DMA6569, to the south of Evesham is also affected by the proposed strategic site allocations. The solution is to install a variable speed booster pump (30kW) at Hinton Cross to resolve the issues.	£241,000
3	Severn Trent Water informed JBA that the additional allocation at Cheltenham Road is likely to require mains reinforcement, the notional solution is a 450mm main 2.4 Km long.	£800,000

Network Analysis

The models were assessed for head loss and maximum velocities to give an analysis of the current situation. The head losses and maximum velocities are generally within the current Severn Trent Water standards. The proposed strategic site allocations and notional schemes were then added to the model. The head losses and maximum velocities in Worcester remain generally within the current standards. Table 5-29 shows the results of the network analysis undertaken.

Table 5-29: Summary of Network Analysis of Evesham

Number	Existing Situation	Post Development	Comment
1	1.9m/1000m	3m/1000m	Increase in head loss in water main feeding into the south of Evesham, this is above Severn Trent Water standards.
2	0.7m/100m	1.5m/1000m	In the main from Sheriffs Lench Service Reservoir to Evesham the head loss increased but is within Severn Trent Water standards.
3	0.7m/s	1.1m/s	In the main from Sheriffs Lench Service Reservoir to Evesham there is an increase in velocity above the Severn Trent Water Standards.
4	<20m	<20m	Areas on the outskirts of Evesham have sections of main that are below Severn Trent Water standards for pressure.

5.8 Windfall Sites and Non – Residential Water Use

5.8.1 Non-Residential Water Use

Some non-residential development will have a higher demand for water supply than typical housing or employment developments, for example the food processing or brewing industries. From the previous section it can be seen that the Severn Water Resources Zone has a supply/demand balance that is already in deficit, which could be a major concern if water hungry industry is proposed. At present no such industry has been proposed therefore this is not an issue that needs to be considered in detail. This should be reviewed further should such an industry be proposed on one of the proposed strategic site allocations in the future as the introduction of this type of industry could create significant problems for the water supply within the area, especially in the short term before the improvements suggested by

Severn Trent Water are in operation. If an industry should want to locate in a rural area and apply for a private water abstraction licence this will be subject to approval from the Environment Agency. Tables 5-3 to 5-8 should be consulted for the current status of water resources in the region and restrictions to new licences.

The Severn area, with its negative supply-demand balance, would benefit from typical office based employment development that has a much lower water supply requirement per land area than residential use (Table 5-14)

Table 5-30: Severn Trent Water's Guidelines for Estimating Non-Domestic Water Supply*

Business Category	Daily Flow Rate (l/day/Ha)	Trade Profile/s Used	Hours/day
Office/Commercial (O)	25,000	3 (1.0 x 8am to 6pm WD)	10
Arts (public access) (ART)	6,000	3 (1.0x 8am to 6pm WD)	10
Accommodation (non-domestic) (AC)	91,575	1(1.0 x 24h Constant Profile WD&WE)	24
Retail (R).	15,000	4 (1.0 x 9am to 6pm WD&WE)	9
Educational (ED)	32,550	5 (1.0 x 9am-5pm WD)	8
Industrial (e.g. manufacturing etc) (I)	22,500	2 (1.0x 6am to 6pm WD)	12
Dry Industry (e.g. warehousing etc) (DI)	10,000	3 (1.0 x 8am to 6pm WD)	10
Licensed Premises (LP)	72,000	6 (0.5 x 12pm to 6pm; 1.0 x 6pm to 12am WE&WD)	9
Sports (SP)	6,500	6 (0.5 x 12pm to 6pm; 1.0 x 6pm to 12am WE&WD)	9
Healthcare (H)	90,750	1 (1.0 x 24h Constant Profile, WD & WE)	24

* Severn Trent Water note that these are only guidelines as water consumption is very specific to individual sites depending on the process involved.

5.8.2 Windfall Sites

Severn Trent Water have advised that windfall sites of approximately 200 properties may need some localised reinforcement work to the water distribution networks, which would only usually take 12 months to complete. However, detailed hydraulic modelling would be required to confirm the extent of any upgrading once specific locations/developers are known, though Severn Trent Water do not envisage that there would be any major problems.

5.9 Tenbury Wells and Upton Upon Severn

These were previously identified as possible site allocations and as such there is some information regarding the areas in the Growth Point Study.

5.9.1 Tenbury Wells

Tenbury Wells is fed by Burford Storage Reservoir with a capacity of 1.20Ml and is supplied from the Trmipley Rural Main via Hollywaste Reservoir.

The head losses and maximum velocities in the Tenbury District are generally within the current Severn Trent Water standards.

The minimum pressures vary considerably, between below 20m and above 50m bead. Sections to the south of Burford Storage reservoir and the area south of Tenbury town have pressures below the recommended Severn Trent Water standards.

Severn Trent Water did not find any operational deficiencies when 100 properties were added to the model to the east of the Tenbury Wells. This should be reassessed if windfall sites are proposed to confirm that there are no deficiencies.

5.9.2 Upton upon Severn

Upton upon Severn is fed by Severn Stoke Storage Reservoir with a capacity of 0.62 Ml and is supplied via an iron main which branches off the Strensham Water Treatment Works main.

The head losses, maximum velocities and pressures in the Upton District are generally within the current Severn Trent Water standards.

Severn Trent Water did not find any operational deficiencies when 100 properties were added to the mode, 50 in Tunnel Hill and 50 in Ryall. This should be reassessed if windfall sites are proposed to confirm that there are no deficiencies.

Summary:

- **The total cost of improvements within Worcester, Droitwich Spa, Evesham and Pershore is in the region of £7,300,000. This excludes potential costs of improvements in Great Malvern as notional solutions were not able to be developed given uncertainties in the current model.**
- **The assessment, notional solutions and costs within the Growth Point Study are only indicative of the possible improvements necessary and further modelling will be required in the future once the proposed strategic site allocations, number of dwellings and type of employment are finalised.**
- **Severn Trent Water have advised that windfall sites of approximately 200 properties may need some localised reinforcement work to the water distribution networks but do not envisage that there would be any major problems.**

5.10 Conclusions

5.10.1 Water Resources

Water as a resource is scare in the Severn River Basin. Table 5-30 indicates that the proposed strategic site allocations are all located near areas that have been designated as having no water available or are over licensed or over abstracted.

Severn Trent Water predict a net increase of approximately 31Ml/day in water consumption from 2006 – 2035 in the Severn Water Resource Zone. The supply/demand balance for the Zone became negative in 2006/2007 and looks to remain in deficit in the future. The current projected supply/demand shortfall is around 120Ml/d by 2035.

Severn Trent Water has proposed improving the water supply to the area by the Derwent Valley Aqueduct duplication – Kings Corner to Hallgates to support the east/west link. There are limitations to how much water can be supplied to the new properties due to abstraction license restrictions.

It is important to focus on water efficiency solutions to promote good use of the water that is available as well as trying to improve the infrastructure or increase the supply. Severn Trent Water proposes to promote household retrofit (installation of water efficient products in existing development s) as well as other water efficiency options and further reduce leakage. ‘Future Water: The Governments strategy for water in England (February 2008) envisages that by 2030 average household per capita consumption (pcc) could be reduced to 130litres/head/day. With increased water efficiency and water metering Severn Trent Water predict that by 2035 for a normal year the average household pcc is 133litres/head/day, which shows progress towards achieving the Government’s long term vision.

5.10.2 Water Supply Infrastructure

Severn Trent Water is responsible for the operation and maintenance of water supply and distribution infrastructure for South Worcestershire. This study concludes that investment will be required to the water supply infrastructure at all of the proposed strategic site allocations for it to be able to accommodate them (Table 5-31). Severn Trent Water has proposed notional solutions and the estimated total cost of improvements is estimated to be in the region of £7.3m. This estimate does not include the Great Malvern developments and should be reassessed when to include Great Malvern when the proposed strategic site allocation locations and dwelling numbers are confirmed.

Any site specific upgrades to the water supply infrastructure will be expected to be funded by developer contribution. As identified in the Growth Point Study, all of the proposed strategic site allocations require some upgrades to the water supply infrastructure to accommodate them, the study also provides an indication as to which of the proposed strategic site allocations may require more investment by developers. The infrastructure upgrades would normally require 12 months to install/upgrade from the time the developer agrees to the funding.

Employment land has not been assessed in detail within this study as the exact type of employment to be developed is currently unknown. The impact on the water supply infrastructure can vary depending on the type of employment and it is recommended that this is assessed in the future.

Table 5-31: Summary of the Current Status of the Water Resources relevant to the Proposed Strategic Site Allocations

Proposed Strategic Site Allocations	Groundwater Resources	Surface Water Resources
Worcester		
Worcester North West		
Worcester North		
Kilbury Drive		
Worcester South		
Fernhill Heath		
Droitwich Spa		
Hill End		
Pulley Lane		
Copcut Lane		
Great Malvern		
Malvern North		
Malvern East		
Malvern South		
Blackmore Park		
Pershore		
Pershore		
Evesham		
Offenham Road		
Cheltenham Road		
Hampton		

Legend:
Over Abstracted
Over Licensed/No Water Available
Water Available

Table 5-32: Summary of Investment required to the Water Supply Infrastructure

Proposed Strategic Site Allocations	Water Supply	
	Investment	Phasing
Worcester		
Worcester North West		
Worcester North		
Kilbury Drive		
Worcester South		
Fernhill Heath		
Droitwich Spa		
Hill End		
Pulley Lane		
Copcut Lane		
Great Malvern		
Malvern North		
Malvern East		
Malvern South		
Blackmore Park		
Pershore		
Pershore		
Evesham		
Offenham Road		
Cheltenham Road		
Hampton		

Legend: (Investment**/**Phasing**)**

- Proposed strategic site allocations cannot be accommodated **/** maximum 3-4 years required for upgrade
- Investment is required to accommodate proposed strategic site allocations **/** 12 months required for upgrade
- No Investment required/current system can accommodate the proposed strategic site allocations
- Has not been assessed but investment likely to be required **/** 12 months is likely to be required to accommodate proposed strategic site allocations

6 WATER QUALITY AND ENVIRONMENTAL ISSUES

6.1 Policy

6.1.1 Regional Spatial Strategy

The Regional Spatial Strategy (RSS) for the West Midlands was published in 2008. Chapter 8 of the RSS entitled Quality of the Environment contains policies and guidance on the water environment. Policy QE9 states that:

A. Development plan policies and plans of the Environment Agency and other agencies should be co-ordinated, 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 conservation of the natural, built and historical environment.

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

6.1.2 Urban Wastewater Treatment Directive (UWWTD)[3]

The UWWTD is an EU Directive that concerns the collection, treatment and discharge of urban wastewater and the treatment and discharge of waste water from certain industrial sectors. The objective of the Directive is to protect the environment from the adverse effects of the abovementioned wastewater discharges. More specifically Annex II.A(a) sets out the requirements for discharges from urban wastewater treatment plants to sensitive areas which are subject to eutrophication. One or both parameters may be applied depending on the local situation. The values for concentration or for the percentage reduction shall apply. For specific information regarding concentration limits please refer to the UWWTD.

6.1.3 Habitats Directive

The EU Habitats Directive aims to protect the wild plants, animals and habitats that make up our diverse natural environment. The directive created a network of protected areas around the European Union of national and international importance called Natura 2000 sites.
These sites include:

- **Special Areas of Conservation (SACs)** - these support rare, endangered or vulnerable natural habitats, plants and animals (other than birds).
- **Special Protection Areas (SPAs)** - support significant numbers of wild birds and their habitats.

Special Protection Areas and Special Areas of Conservation are established under the EC Birds Directive and Habitats Directive respectively. All in all the directive protects over 1000 animals and plant species

[3] UWWTD - http://ec.europa.eu/environment/water/water-urbanwaste/legislation/directive_en.htm?lang=_e

and over 200 so called "habitat types" (e.g. special types of forests, meadows, wetlands, etc.), which are of European importance.

6.1.4 Freshwater Fish Directive

The EC Freshwater Fish Directive aims to protect and improve the quality of rivers and lakes to encourage healthy fish populations. It sets water quality standards and monitoring requirements for areas of water which are chosen, or 'designated' by Defra and the Welsh Assembly Government. These 'designated' areas of water are selected because they are significant bodies of water which are capable of supporting fish populations. In the UK, the directive is implemented through the Surface Waters Regulations 1997. A total of 34,500km of rivers and canals and more than 200 still waters are designated under the directive. The list of designated waters is held on the Defra website in a series of Schedules. In 2013, this directive will be repealed. Waters currently designated as Fish Directive waters will become protected areas under the Water Framework Directive.

6.1.5 The Water Framework Directive

The WFD was first published in December 2000 and transposed into English and Welsh law in December 2003. It introduced a more rigorous concept of what ‘good status’ should mean than the previous environmental quality measures. The WFD estimated that 95% of water bodies were at risk of failing to meet “good status”.

River Basin Management Plans are required under the WFD and are strategies that should influence development plans and be influenced by them. The final Severn River Basin Management Plans was published in December 2009. One WFD objective is to have ‘no deterioration,’ therefore all water bodies must meet the class limits for its status class declared in the Final Severn River Basin Management Plan. A second objective requires all water bodies to achieve good ecological status. Future development needs to be planned carefully so that it helps towards achieving the WFD and does not result in further pressure on the water environment and compromise WFD objectives. The WFD objectives are summarised below.

The Environmental Objectives for surface waters are:

- Prevent deterioration in status for water bodies
- Aim to achieve good ecological and good surface water chemical status in water bodies by 2015
- For water bodies that are designated as artificial or heavily modified, aim to achieve good ecological potential by 2015
- Comply with objectives and standards for protected areas where relevant
- Reduce pollution from priority substances and cease discharges, emissions and losses of priority hazardous substances.

The Environmental Objectives for groundwater are:

- Prevent deterioration in the status of groundwater bodies
- Aim to achieve good quantitative and good groundwater chemical status by 2015 in all those bodies currently at poor status
- Implement actions to reverse any significant and sustained upward trends in pollutant concentrations in groundwater
- Comply with the objectives and standards for protected areas where relevant
- Prevent or limit the input of pollutants into groundwater.

Protected Area Objectives

The WFD specifies that areas requiring special protection under other EC Directives and waters used for the abstraction of drinking water are identified as protected areas. These areas have their own objectives and standards.

Article 4 of the WFD requires Member States to achieve compliance with the standards and objectives set for each protected area by 22 December 2015, unless otherwise specified in the Community legislation under which the protected area was established. Some areas may require special protection

under more than one EC Directive or may have additional (surface water and/or groundwater) objectives. In these cases, all the objectives and standards must be met.

The type of protected areas are:

- areas designated for the abstraction of water for human consumption (Drinking Water Protected Areas);
- areas designated for the protection of economically significant aquatic species (Freshwater Fish and Shellfish)
- bodies of water designated as recreational waters, including areas designated as Bathing Waters;
- nutrient-sensitive areas, including areas identified as Nitrate Vulnerable Zones under the Nitrates Directive or areas designated as sensitive under Urban Waste Water Treatment Directive (UWWTD);
- areas designated for the protection of habitats or species where the maintenance or improvement of the status of water is an important factor in their protection including relevant Natura 2000 sites.

Many WFD protected areas coincide with water bodies, these areas will need to achieve the water body status objectives in addition to the protected area objectives. Where water body boundaries overlap with protected areas the most stringent objective applies, that is the requirements of one EC Directive should not undermine the requirements of another.

The objectives for Protected Areas relevant to this study are as follows:

Drinking Water Protected Areas

- Ensure that, under the water treatment regime applied, the drinking water produced meets the requirements of the Drinking Water Directive; and
- Ensure necessary protection in the Drinking Water Protected Areas with the aim of avoiding deterioration in water quality in order to reduce the level of purification treatment required in producing drinking water.

Economically Significant Species (Freshwater Fish Waters)

- To protect or improve the quality of running or standing freshwater to enable them to support fish belonging to:
  - Indegenous species offering a natural diversity; or
  - Species the presence of which is judged desirable for water management purposes by the competent authorities of the Member States

Nutrient Sensitive Areas (Nitrate Vulnerable Zones)

- Reduce water pollution caused or induced by nitrates from agricultural sources and
- prevent further such pollution

Nutrient Sensitive Areas (Urban Waste Water Treatment Directive)

- To protect the environment from the adverse effects of urban waste water discharges and waste water discharges from certain industrial sectors.

Natura 2000 Protected Areas (water dependent SACs and SPAs

The objective for Natura 2000 Protected Areas identified in relation to relevant areas designated under the Habitats Directive or Birds Directive is to:

- Protect and, where necessary, improve the status of the water environment to the extent necessary to achieve the conservation objectives that have been established for the protection or improvement of the site's natural habitat types and species of Community importance in order to

ensure the site contributes to the maintenance of, or restoration to, favourable conservation status

6.2 Ecological and Chemical Water Quality Status in the South Worcestershire Region

The Water Quality status of the rivers has been assessed using the Environment Agency Final Severn River Basin Management Plan. Maps 3 and 4 at the end of this report show the ecological quality and chemical quality of the watercourses relevant to the proposed strategic site allocations

Ecological Quality

The ecological quality of a watercourse is classified by monitoring the following:

- the condition of biological elements, e.g. fish
- concentrations of the supporting physio-chemical elements, e.g oxygen or ammonia
- concentrations of specific pollutants (synthetic and non synthetic), e.g. copper
- for the 'high' status the hydromorphology should be undisturbed.

The river stretch is classified on a scale of 'high', 'good', 'moderate', 'poor' or 'bad'. To achieve a 'high' status the river should be largely undisturbed and thus this is also the reference condition, which is required to be able to make a comparison between water body conditions. To achieve a good status the river must have biological, structural and chemical characteristics similar to those expected under nearly undisturbed conditions.

Good ecological status is defined as a slight variation from undisturbed natural conditions in natural water bodies. However, artificial and heavily modified water bodies are unable to achieve natural conditions. The River Severn, River Avon and Merry Brook are classed under the WFD as being heavily modified water bodies. They have a target of achieving good ecological potential, which recognises their important uses, whilst making sure ecology is protected as far as possible. Ecological potential is also measured on the scale 'high', 'good', 'moderate', 'poor' and 'bad'. UKTAG outline how heavily modified or artificial watercourses should be classified in their Guidance on the Classification of Ecological Potential for Heavily Modified Water Bodies and Artificial Water Bodies (2008) report.

Chemical Quality

The chemical status is assessed by compliance with environmental standards for chemicals that are priority substances and priority hazardous substances. The chemical status of a water body is either good or it fails. The chemical status classification for the water body, and the confidence in this, is determined by the worst scoring chemical. The chemical status of heavily modified water bodies is measured in the same way as for natural water bodies. Good chemical status means that concentrations of pollutants (priority substances and priority hazardous substances) in the water body do not exceed the environmental limit values specified in the Water Framework Directive Article 16 daughter Directive.

A priority substance is a pollutant, or group of pollutants, presenting a significant risk to or via the aquatic environment that has been identified at Community level under Article 16 of the Water Framework Directive. They include 'priority hazardous substances'. An assessment of chemical status is only required in water bodies where priority substances and other specific pollutants are know to be discharged in significant quantities. If a water body is labelled as 'does not require assessment' it is because these pollutants are not discharged into this water body in significant quantities.

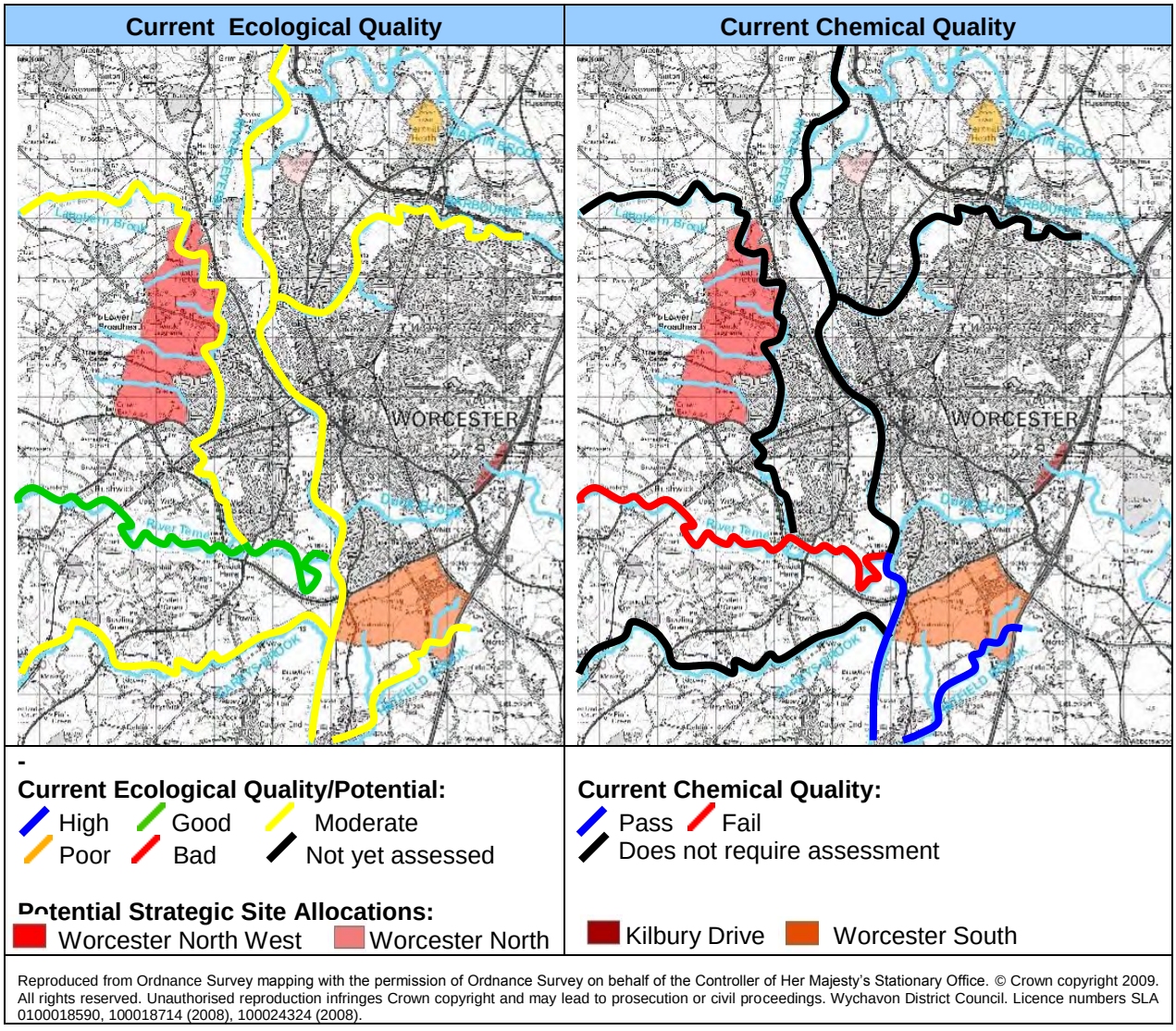
Overall Good Status is the status achieved by a surface water body when both the ecological status and its chemical status are at least good.

The following sections show the existing situation for the watercourse within each urban area and highlight the existing pressures on the rivers. The impact of the proposed strategic site allocations is then assessed and possible management solutions and policies outlined. Tenbury Wells and Upton upon Severn have been included in the assessment as potential locations for future development.

6.2.1 Worcester

The main river flowing through Worcester is the River Severn. Its tributaries include Barbourne Brook, Duck Brook (north of Worcester South), the River Teme and it's tributary Laughern Brook (south and east of Worcester North West respectively).

Figure 6-1: Current Ecological and Chemical Status of Watercourses in Worcester



The current ecological quality for the majority of rivers within Worcester is moderate, indicating that they have been moderately disturbed by anthropological activity and are at present below the recommended 'good' status or 'good potential' under the WFD. The only river in Worcester to achieve good ecological status is the River Teme. The River Severn, Laughern Brook and Careys Brook have poor quality due to unacceptable levels of phosphorus.

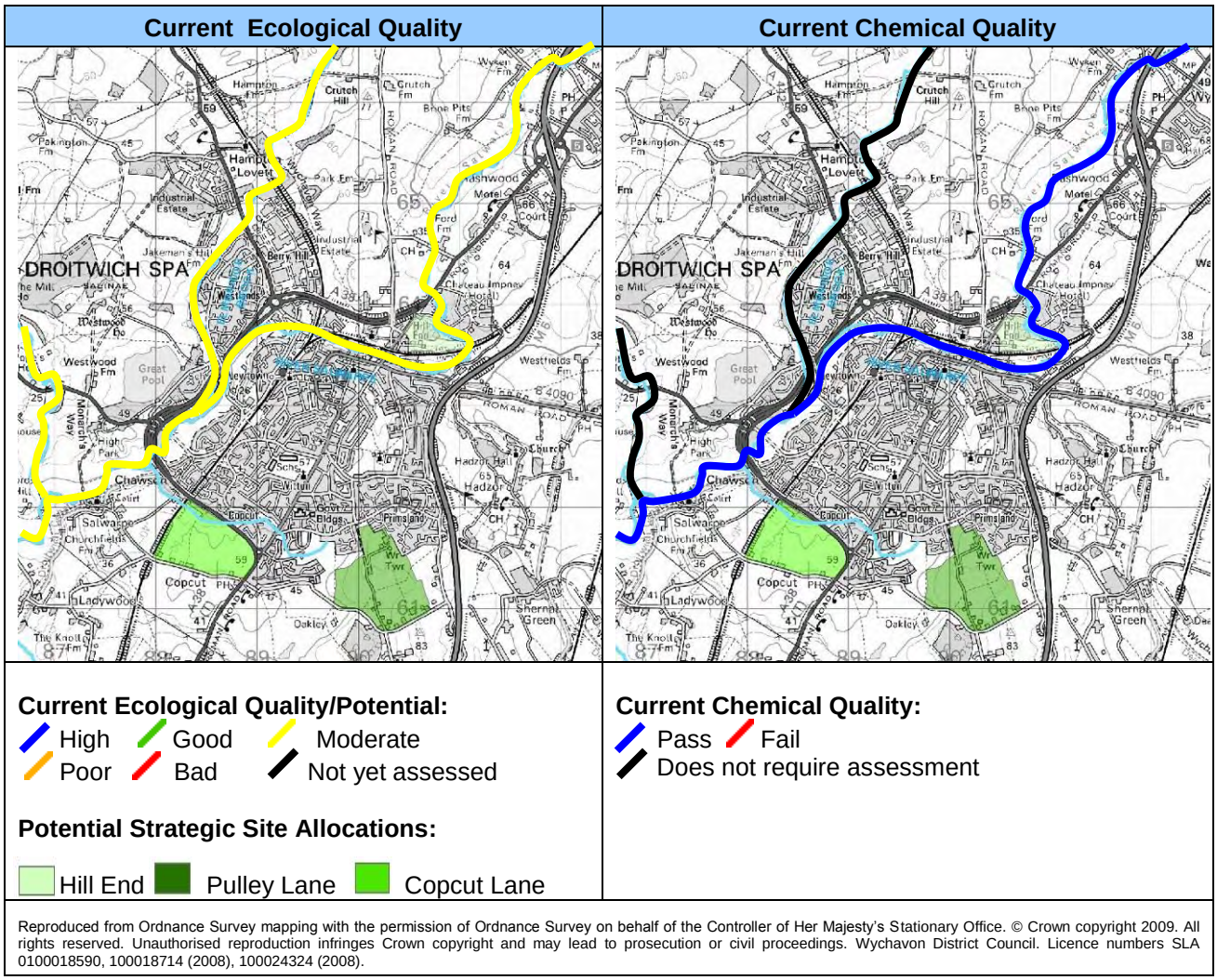
The River Severn, downstream of the River Teme and Hatfield Brook pass in terms of Chemical Quality whereas the River Teme fails due to Tributyltin Compounds. Release of Tributyltin Compounds is primarily from their use in wood preservatives and in marine antifouling paints on for example ships,

quays, buoys, and potentially from their manufacture, transport and use. There are no natural sources. Other rivers within the Worcester area do not require assessment under the WFD for Chemical Quality.

6.2.2 Droitwich Spa

The main river flowing through Droitwich Spa is the River Salwarpe. Elmbridge Brook flows through the north of Droitwich Spa and joins the River Salwarpe to the west of the town.

Figure 6-2: Current Ecological and Chemical Status of Watercourses in Droitwich Spa



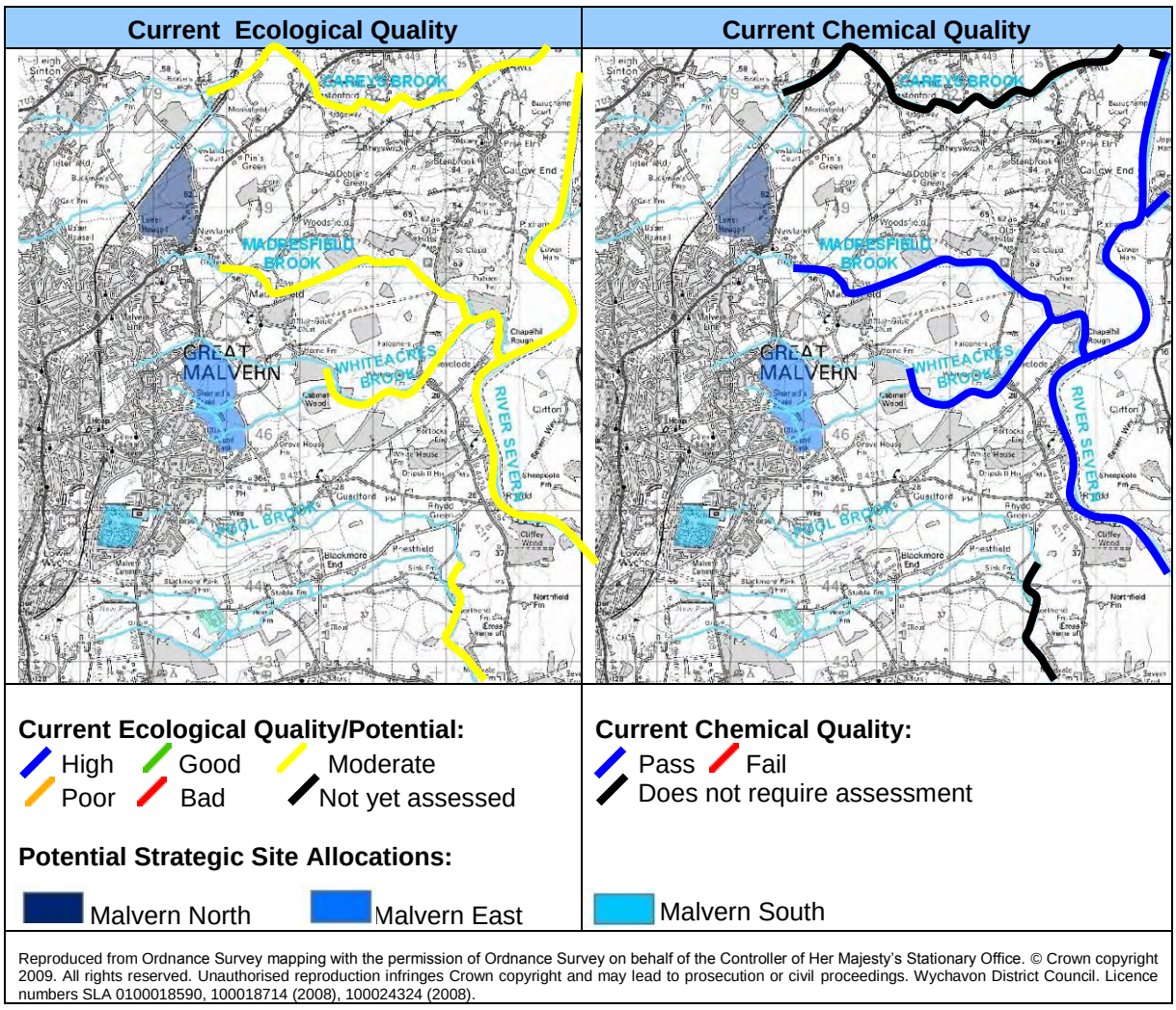
The River Salwarpe, Hadley Brook and Elmbridge Brook all have a moderate ecological quality status as they flow through or near to Droitwich Spa. The River Salwarpe, Elmbridge Brook and Hadley Brook do not achieve the good status required under the WFD due to unacceptable levels of phosphorus. Phosphorus levels are particularly bad in the River Salwarpe which is why it is now a designated sensitive area to eutrophication.

The River Salwarpe has passed the chemical quality assessment and Elmbridge Brook and Hadley Brook do not require assessment.

6.2.3 Great Malvern

The main river flowing from north to south parallel to Great Malvern is the River Severn. Several tributaries flow into the river that originate from the town, these include; Careys Brook (north of Malvern North); Madresfield Brook (south of Malvern North); Whiteacre Brook (north of Malvern East) and Pool Brook (Malvern South).

Figure 6-3: Current Ecological and Chemical Status of Watercourses in Great Malvern



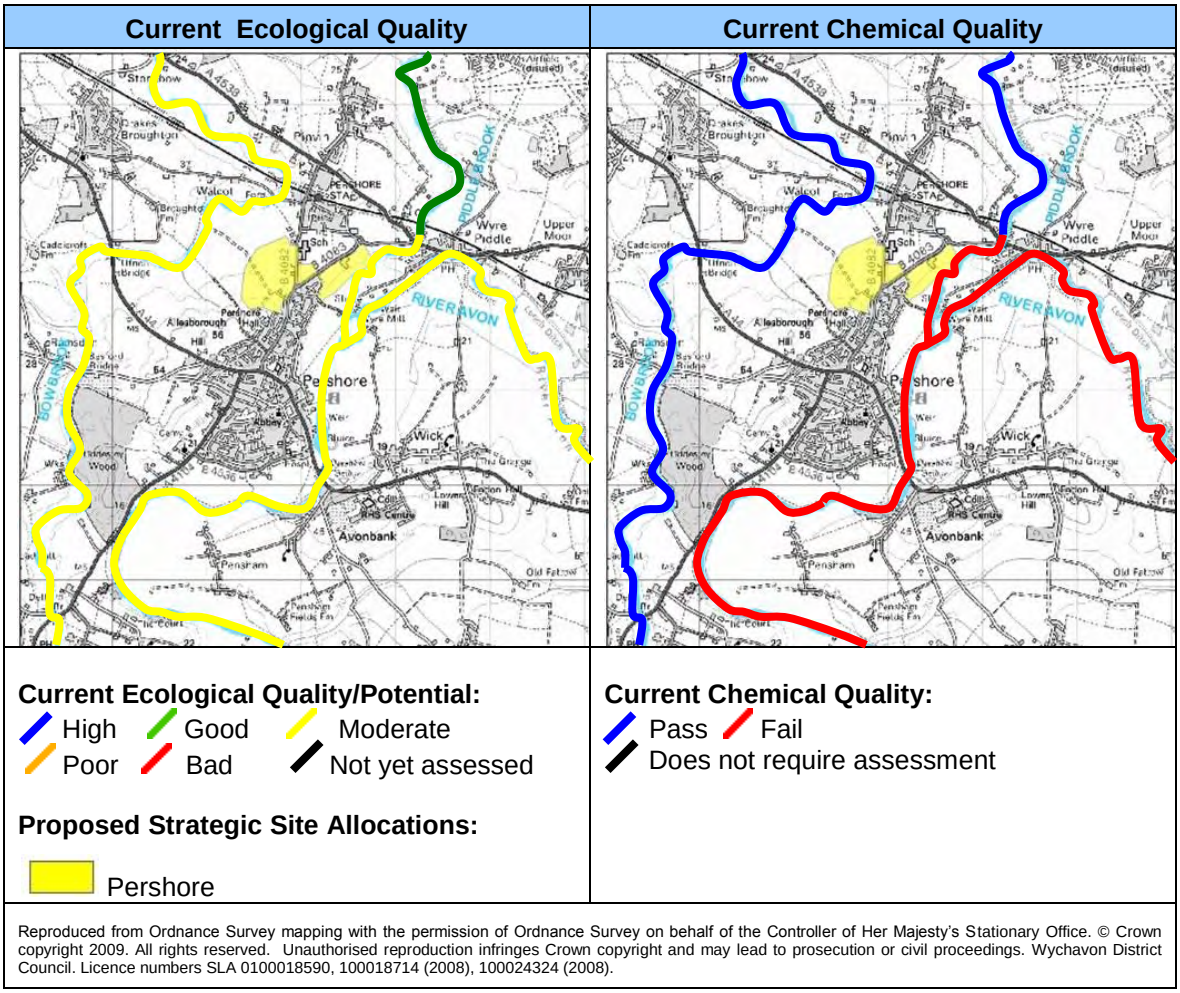
Pool Brook, Whiteacres Brook, Madresfield Brook, the River Severn and Careys Brook all have a moderate ecological status/potential, all the watercourses have unacceptable levels of phosphorus to achieve a good ecological status under the WFD.

River Severn, Pool Brook, Whiteacres Brook and Madresfield Brook have passed the chemical assessment and Careys Brook does not require assessment.

6.2.4 Pershore

The main rivers to the east of Pershore are the River Avon and its tributary Piddle Brook. Bow Brook flows to the west of Pershore. The proposed strategic site allocation is between Piddle Brook and Bow Brook.

Figure 6-4: Current Ecological and Chemical Status of Watercourses in Pershore



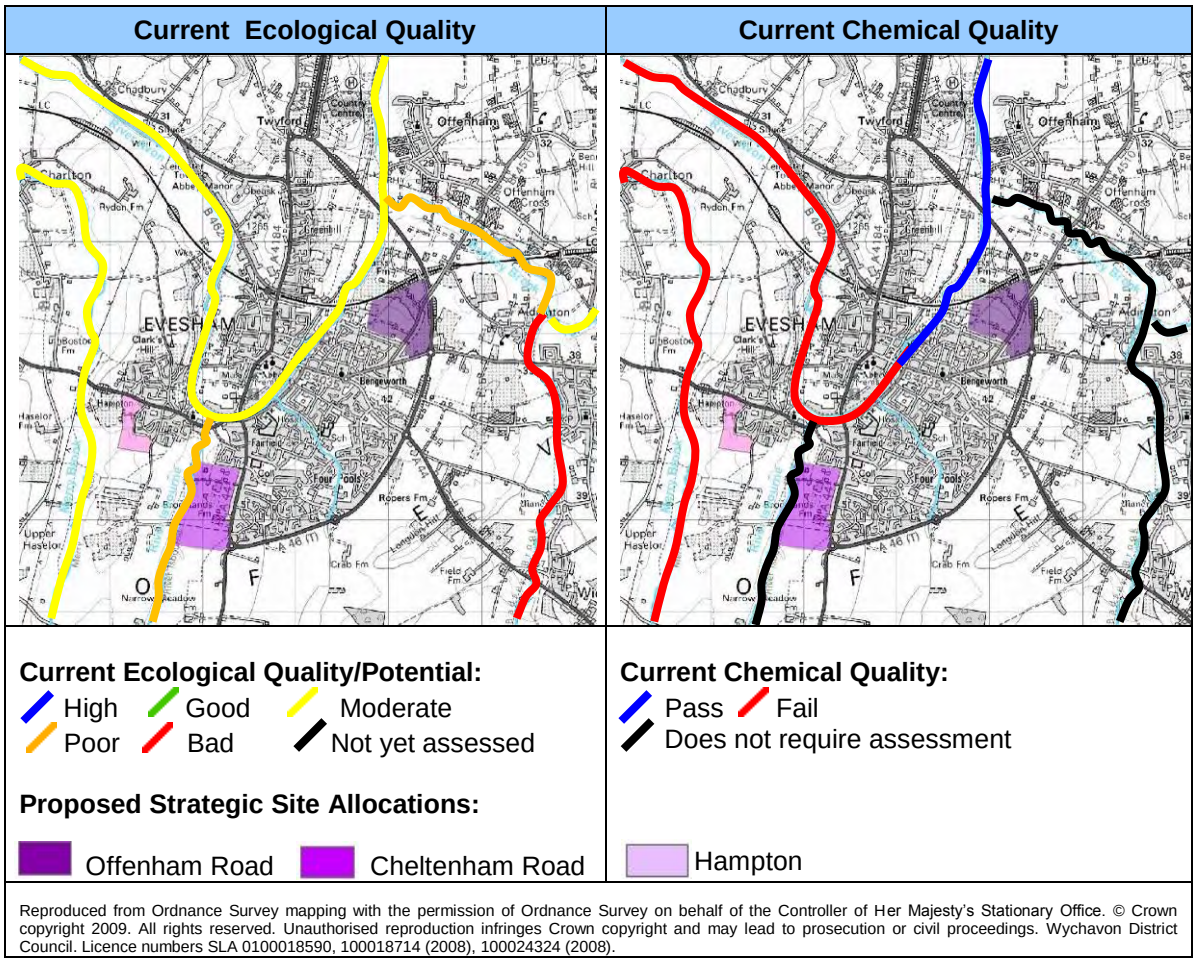
Bow Brook and the River Avon both are currently classed as having a moderate ecological potential. Piddle Brook upstream of the A4538 has a good ecological status, downstream of the A4538 to the confluence with the River Avon the quality declines to a moderate status. Both Bow Brook and the River Avon do not achieve good status under the WFD as they contain unacceptable levels of phosphorus.

The River Avon and the lower reach of Piddle Brook have failed the chemical assessment, this is due to unacceptable levels of Benzo(ghi) perelyne and indeno (123-cd) pyrene. Benzo(ghi) perelyne and indeno (123-cd) pyrene are Polycyclic aromatic hydrocarbons (PAHs) that are formed when certain fuels and wastes are incompletely burnt. They are often absorbed onto particles of soot emitted from combustion sources. The majority of PAHs are released in vehicle exhaust gas, industrial and domestic boilers. PAHs are also present in mineral oils, tars, creosote, carbon black and pitch. Releases of PAHs to the environment can also occur through some natural combustion processes such as forest fires.

6.2.5 Evesham

The main river that flows through Evesham is the River Avon. The River Isbourne flows to the west of the Cheltenham Road proposed development site. Badsey Brook flows to the east of Evesham and joins the River Avon to the north of the Offenham Road proposed strategic site allocation. Battelton Brook is a small tributary to the River Avon that flows through the southeast of Evesham.

Figure 6-5: Current Ecological and Chemical Status of Watercourses in Evesham



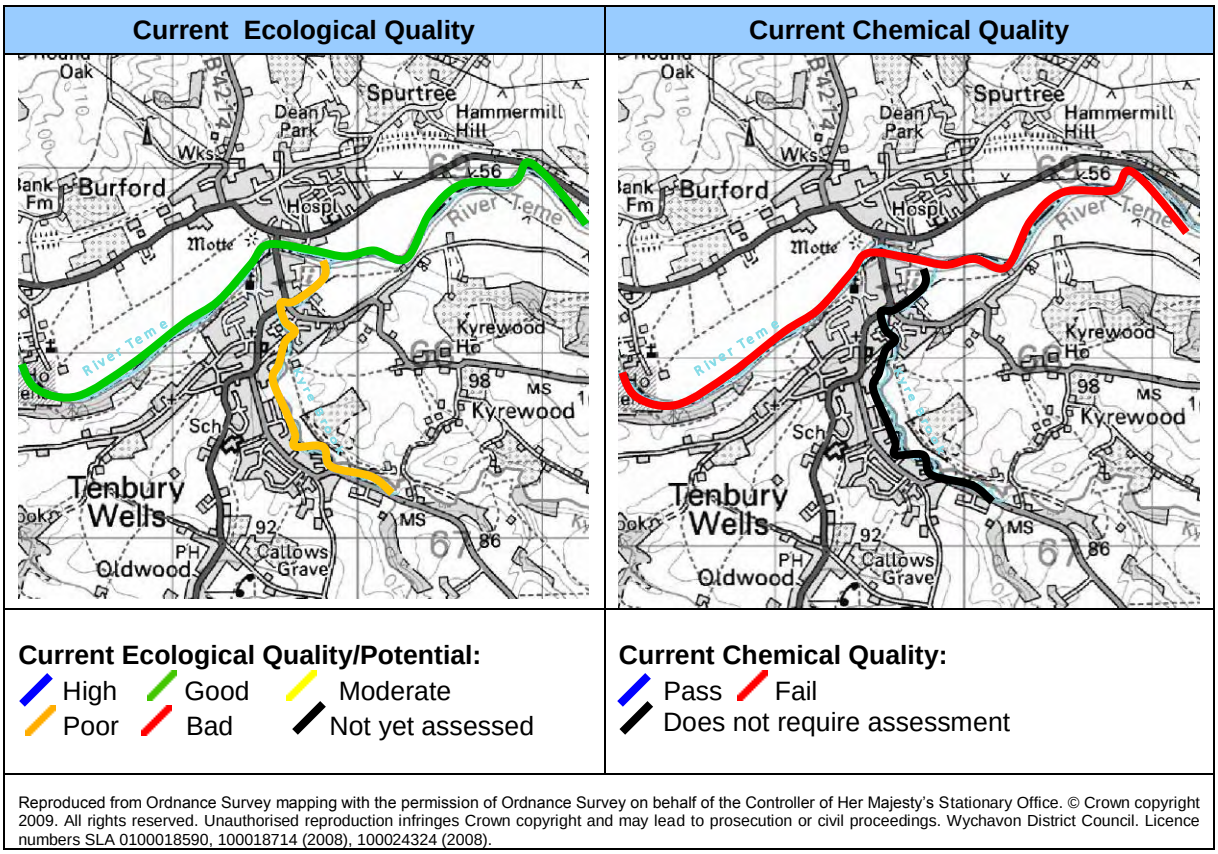
The River Avon and Merry Brook have a moderate ecological potential. The River Isbourne and the lower reach of Badsey Brook have a poor ecological status and the upper reaches of Badsey Brook has been classified as bad. All of the watercourses mentioned contain unacceptable levels of phosphorus to be able to achieve a good status. Additionally the River Isbourne is classified as having poor levels of fish and Badsey Brook has poor (lower reach) and bad (upper reach) levels of Diatoms, contributing to their poor and bad classifications respectively.

The River Avon in the east of Evesham passes the Chemical Assessment under the WFD. The River Avon that flows through the west of Evesham and Merry Brook have failed due to unacceptable levels of Benzo(ghi) perelyne and indeno (123-cd) pyrene (see section 6.2.4).

6.2.6 Tenbury Wells

The River Teme flows to the north of Tenbury Wells and Kyre Brook flows south to north along the east of Tenbury Wells.

Figure 6-6: Current Ecological and Chemical Status of Watercourses in Tenbury Wells



The River Teme has good ecological status, whereas Kyre Brook has a poor ecological status, this is due to poor levels of fish within the watercourse.

The River Teme is currently failing to meet the requirements to pass the chemical quality assessment as designated under the WFD. The River Teme fails dues to unacceptable levels of Tribultyltin Compounds. As previously mentioned, in section 6.2.1, Tribultyltin Compounds are found in wood preservatives and in marine antifouling paints. Kyre Brook does not require assessment.

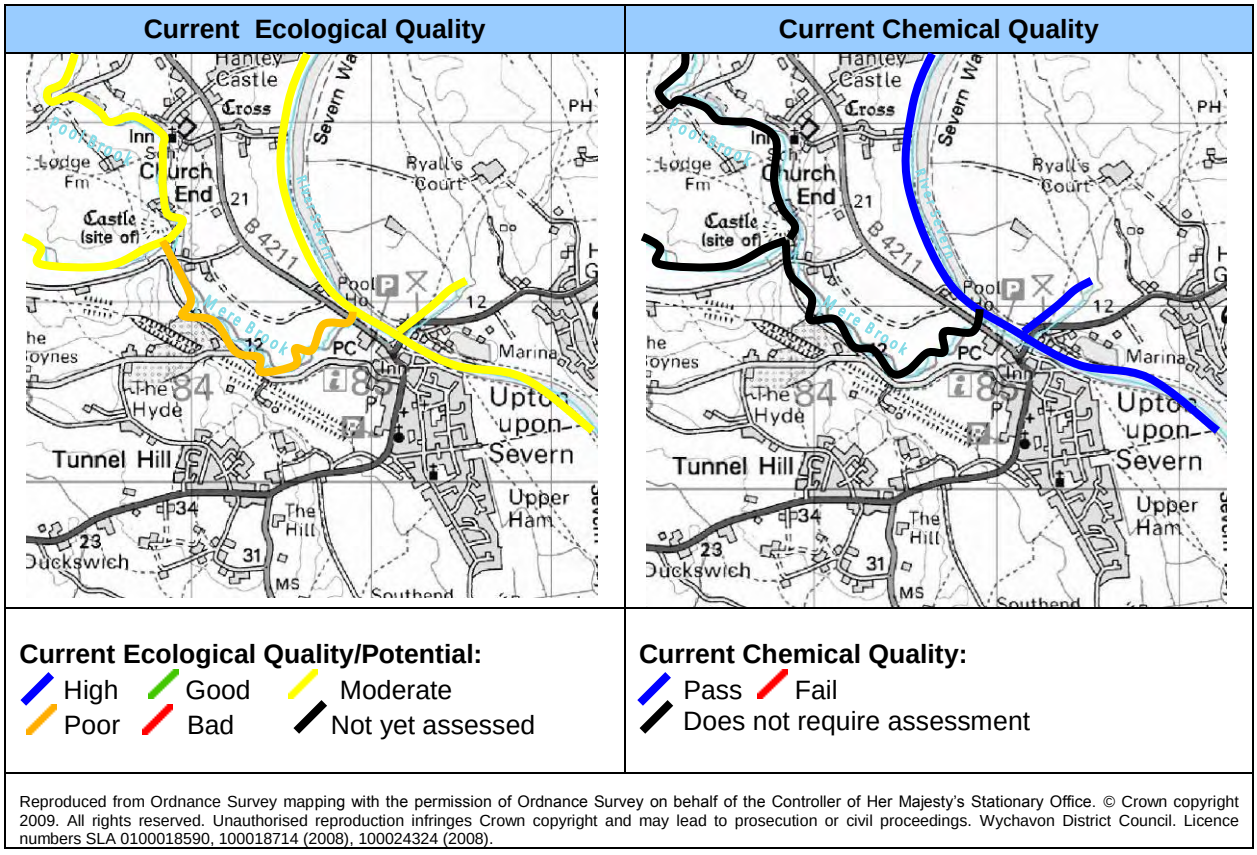
6.2.7 Upton upon Severn

The main river that flows through Upton upon Severn is the River Severn. Mere Brook flows into the River Severn to the north of Upton upon Severn.

The River Severn has moderate ecological potential. Pool Brook and Mere Brook upstream of the confluence with Pool Brook have a moderate ecological status, Mere Brook downstream of the confluence with Pool Brook has a poor ecological status. Pool Brook, Mere Brook and the River Severn contain unacceptable levels of phosphorus.

The River Severn passes the chemical quality assessment as designated under the WFD. Mere Brook and Pool Brook do not require assessment.

Figure 6-7: Current Ecological and Chemical Status of Watercourses in Upton Upon Severn

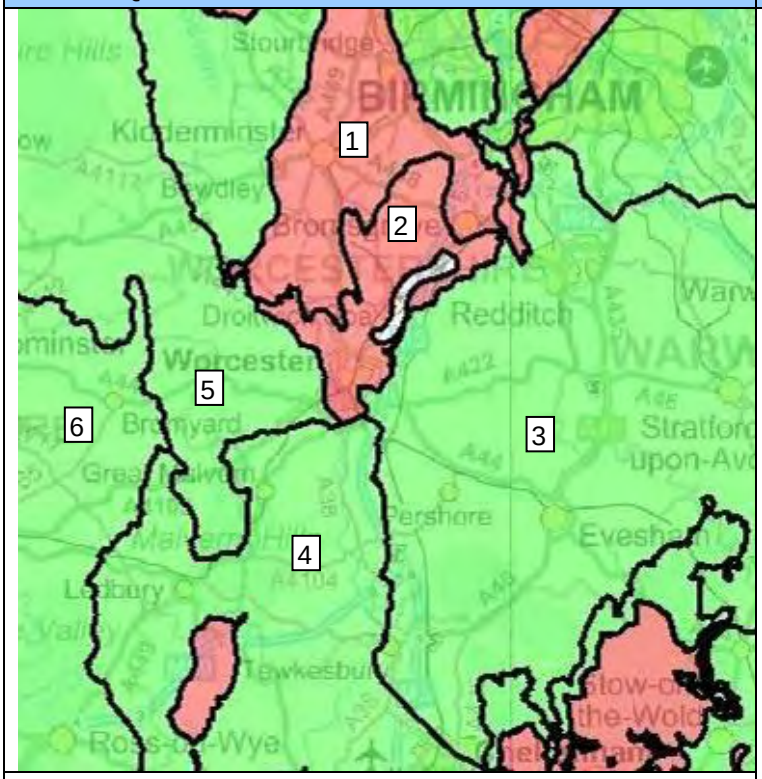


6.2.8 Current Groundwater Status

The status of the groundwater quality under the WFD has been determined by looking at the Quantitative status and the Chemical status. The Quantitative status is an expression of the degree to which a body of groundwater is affected by direct and indirect abstractions. If this complies with the Water Framework Directive requirements the status is good. The Chemical status is an expression of the overall quality of the groundwater body and its impact on those receptors identified in the Water Framework Directive and the Groundwater Daughter Directive (Dec 2006).

The following maps have been extracted from the Environment Agency's website and can be found under the 'What's in your Back Yard' section, information can also be found in the Final Severn River Basin Management Plan.

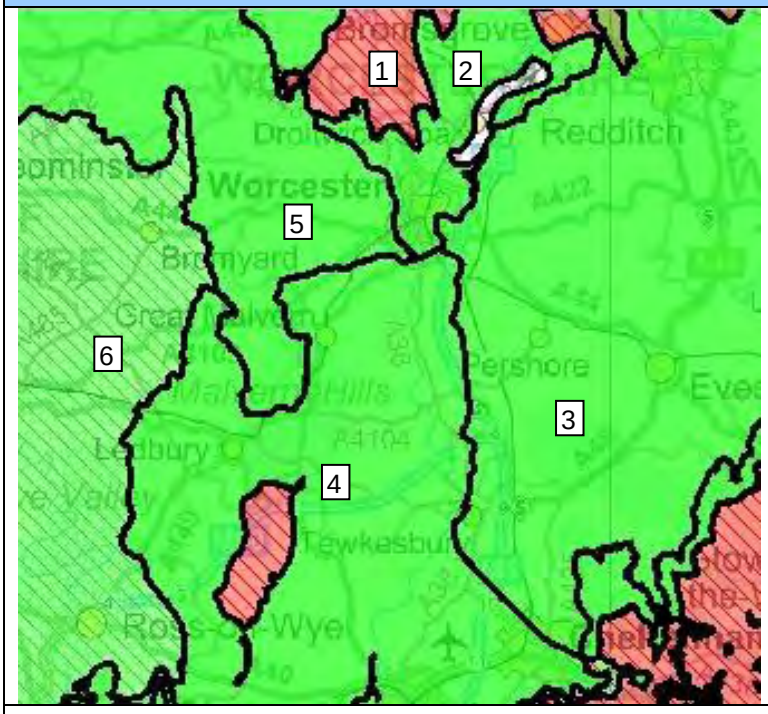
Figure 6-8: Current Groundwater Quantitative Status

Current Quantitative Status	WFD Groundwater Areas Assessed
	1. Worcestershire Middle Severn – PT Sandstone 2. Worcester Middle Severn – Mercia Mudstone 3. Warwickshire Avon – Secondary Mudrocks 4. Severn Vale – Secondary combined 5. Teme – Secondary Mudrocks 6. Wye Minor
Current Quantitative Status: **Good** **Poor** **Not Yet Assessed**	

*source: Environment Agency – What's in your backyard - River Basin Management Plan Maps

The current quantitative status is generally good within the area. However, the map indicates that there is pressure on groundwater resources at Worcester and Droitwich Spa (1 and 2 on Figure 6-8). More information regarding the abstraction licences and status of groundwater resources can be found in Chapter 5.

Figure 6-9: Current Chemical Groundwater Quality

Current Chemical Status	WFD Groundwater Areas Assessed
	1. Worcestershire Middle Severn – PT Sandstone 2. Worcester Middle Severn – Mercia Mudstone 3. Warwickshire Avon – Secondary Mudrocks 4. Severn Vale – Secondary combined 5. Teme – Secondary Mudrocks 6. Wye Minor
Current Chemical Status: **Good** **Good (Deteriorating)** **Poor** **Poor (Deteriorating)** **Not Yet Assessed**	

*source: Environment Agency – What's in your backyard - River Basin Management Plan Maps

All of the groundwater sources in Figure 6-9 are designated as Drinking Water Protected Areas under the WFD. The Groundwater Directive (2006/118/EC) requires that for good chemical status to be achieved for groundwater bodies the Drinking Water Protected Area objectives must be met.

The current chemical status of groundwater in the South Worcestershire area is generally good. The area around Droitwich Spa has a poor chemical status that is still deteriorating.

6.2.9 Groundwater Source Protection Zones

The Environment Agency has a Groundwater Protection Policy to help prevent groundwater pollution. In conjunction with this the Environment Agency have defined groundwater Source Protection Zones (SPZs) to help identify high risk areas and implement pollution prevention measures. The SPZs show the risk of contamination from activities that may cause pollution in the area, the closer the activity, the greater the risk. There are three main zones (inner, outer and total catchment) and a fourth zone of special interest which is occasionally applied.

- **Zone 1 (Inner protection zone)**
  This zone is designed to protect against the transmission of toxic chemicals and water-borne disease. It indicates the area in which pollution can travel to the borehole within 50 days from any point within the zone and applies at and below the water table. There is also a minimum 50 metre protection radius around the borehole.

- **Zone 2 (Outer protection zone)**
  This zone indicates the area in which pollution takes up to 400 days to travel to the borehole, or 25% of the total catchment area, whichever area is the biggest. This is the minimum length of time the Environment Agency think pollutants need to become diluted or reduce in strength by the time they reach the borehole.

- **Zone 3 (Total catchment)**
  This is the total area needed to support removal of water from the borehole, and to support any discharge from the borehole.

- **Zone of special interest**
  This is defined on occasion, usually where local conditions mean that industrial sites and other polluters could affect the groundwater source even though they are outside the normal catchment area.

Figure 6-10: Groundwater Source Protection Zones

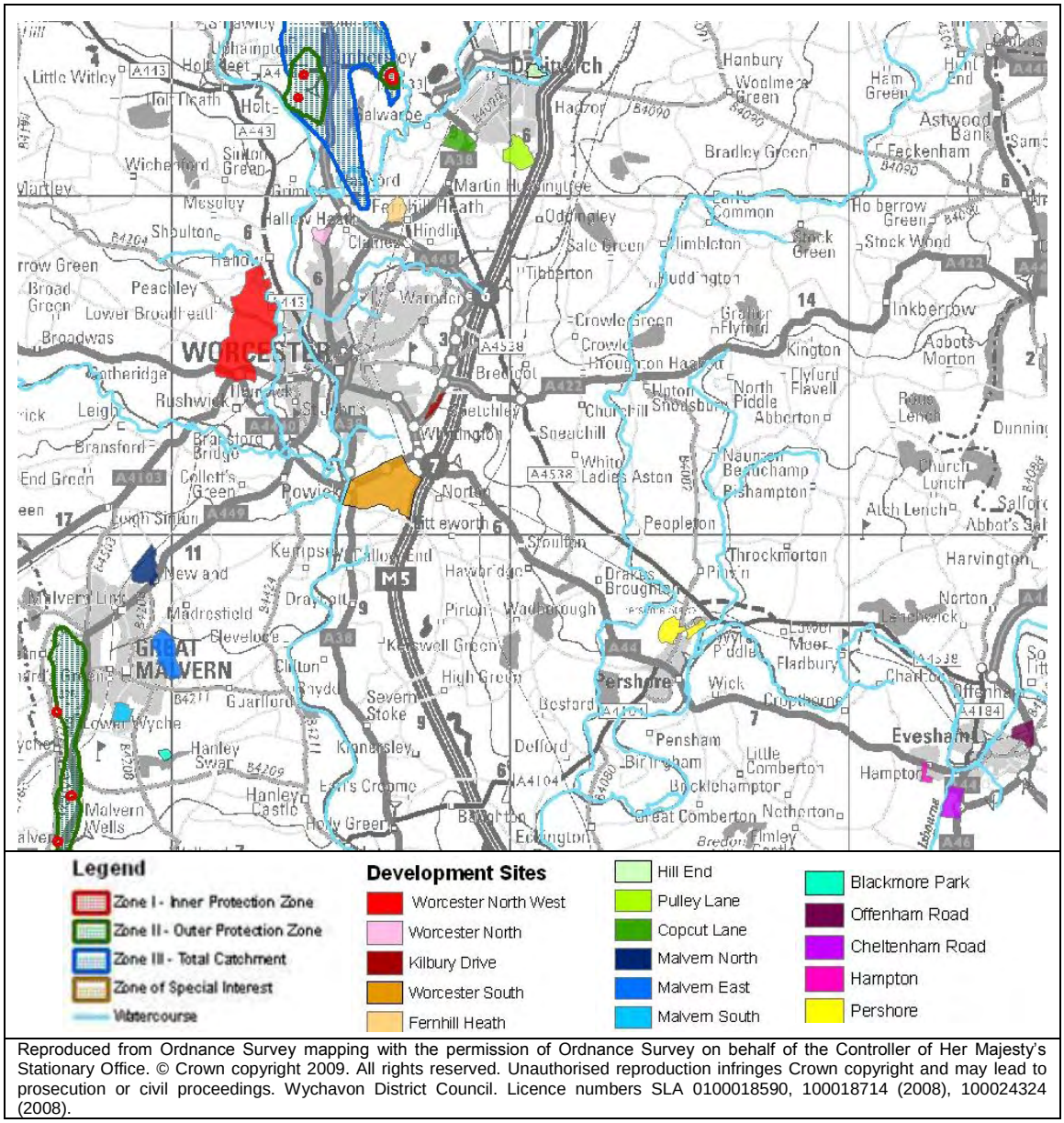
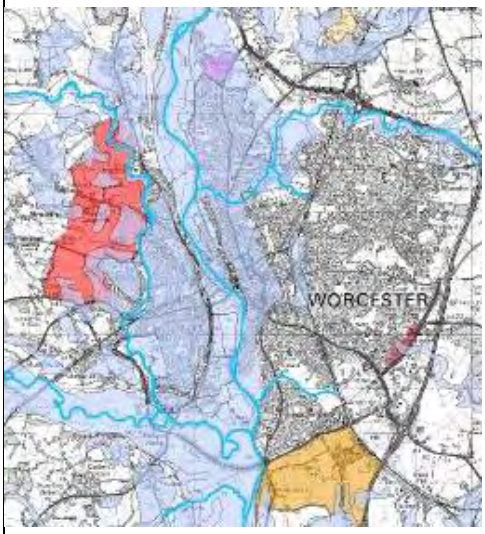


Figure 6-10 shows that the proposed strategic site allocations are all outside the designated groundwater protection zones. However, Figure 6-11 shows that several of the allocations are above minor aquifers that may potentially be 'sensitive' or used for private water supplies. Therefore minor aquifers will need to be protected from pollution (see section 6-5).

Figure 6-11: Minor Aquifers

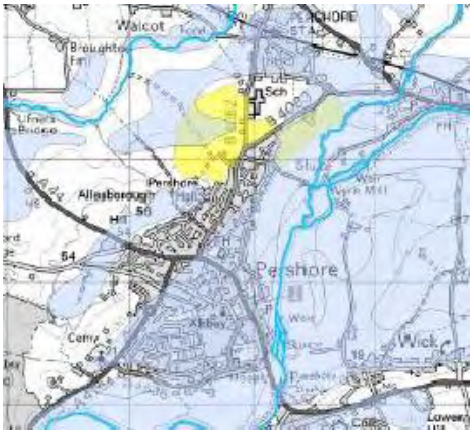


Worcester

Droitwich Spa

Great Malvern

Evesham



Pershore

Tenbury Wells

Upton upon Severn

Summary:

- **The groundwater chemical quality in the study area is achieving a 'good' status under the WFD standards.**
- **The groundwater quantitative status is poor for the area covering Worcester and Droitwich Spa. None of the proposed strategic site allocations fall within the Environment Agency groundwater source protection zones.**
- **Several of the proposed strategic site allocations are above minor aquifers that are potentially 'sensitive' to pollution from any new development.**

6.3 Existing Pressures

6.3.1 Over Abstraction

The Final Severn River Basin Management Plan outlines several pressures that are specifically significant water management issues within the Severn River Basin District. The worst of these is over abstraction. The largest use of water is for public water supply, the water industry accounts for half of the total water abstracted.

The Environment Agency regulates the amount of water that can be abstracted from a watercourse to ensure sufficient flow to maintain the ecology. Anyone wanting to take more that 20m^3/day from a 'source off supply' (river/stream etc) must have an abstraction licence. To protect the Environment the Environment Agency can issue a licence with conditions, e.g. 'hands-off flow' (HOF), if the flow or level in the river drops below that which is required to protect the environment the abstraction must stop. Water efficiency is one of the tests that will need to be satisfied before the EA will grant a new licence or renew a time-limited licence (more information on water efficiency can be found in Chapter 8).

The Catchment Abstraction Management Strategies (CAMS) show how much water is available for abstraction and whether the watercourse is being over abstracted and therefore impacting on the aquatic and riparian habitat. Five CAMS cover the study area, these are:

- The Warwickshire Avon CAMS;
- The Severn Corridor CAMS;
- The Worcestershire Middle Severn CAMS
- The Severn Vale CAMS; and
- The Teme CAMS

A summary of the current and future water resource availability can be found in Chapter 5.

6.3.2 Point Source Pollution

Point sources such as sewage treatment works can contribute a steady input of nutrients to watercourses. Excess nutrients can cause eutrophication leading to reduced oxygen and light within the watercourse which can have a negative impact on the river ecology.

- *Nitrate*

The Severn River Basin Management Plan (Final) specifies that 32% of nitrate pollution to fresh waters in the Severn River Basin District occur from sewage treatment works. High nitrates can not only have an adverse affect on the aquatic environment but can also affect the water supply, impacting on the deployable output and target headroom (Chapter 5), as there is a limit to the amount of nitrate allowed within drinking water.

- *Phosphorus*

High phosphorus concentrations are the main cause of eutrophication in fresh waters. The key sources are agriculture, sewage treatment works, dosing for drinking water and other domestic effluents (e.g. washing detergents). It is estimated that 75% of the phosphorus load in the Severn River Basin District is derived from point sources. The assessment of the ecological status of the watercourses within the Final Severn River Basin Management Plan indicates that there are unacceptable levels of phosphorus within most of the watercourses of interest to this study, as indicated in the previous section. The Environment

Agency has identified five sewage treatment works that can affect watercourses that have been classed as 'sensitive', which relates to the UWWTD protected area classification within the Final Severn River Basin Management Plan. These watercourses have been designated as 'sensitive' due to the high nutrient levels in the water. Most wastewater must have at least secondary treatment (biological treatment) but for these 'sensitive' receiving waters an extra treatment is required before discharging into them (Figure 6-13). The Environment Agency's over-arching policies are not to allow any breach of a statutory standard (e.g. discharge water quality consents) due to urban growth and to reduce deterioration to water quality due to urban growth. Under the WFD there should be no deterioration to the current ecological status of the receiving watercourses. Pershore and Evesham Sewage Treatment Works have been classified since 2005 and as such already have measures in place for nutrient removal (see Table 6-2). The Environment Agency have noted that phosphate assessments will be required at Worcester Bromwich Road, Droitwich Ladywood and Powick treatment works to determine if the discharge consent from the sewage treatment works will require a limit to meet the WFD no deterioration objective. Therefore Water Quality Modelling has been undertaken for these sewage treatment works as well as for Evesham. The discharge consent for Droitwich Spa – Ladywood sewage treatment works also has limits for cyanide, nickel, lead, copper, chromium, zinc and cadmium, all of which could be tightened by the increase in DWF.

6.3.3 Water Quality Modelling

Water Quality Modelling has been undertaken for Worcester Bromwich Road, Droitwich Ladywood, Powick and Evesham Sewage Treatment Works to form an assessment of the impact of the proposed strategic site allocations on the downstream water quality in the receiving watercourse. In addition, assessments have been made based on incremental increases of 250 homes to each STW, so that the impact from additional wind-fall sites can be considered. The three contaminants examined as part of this investigation into water quality are BOD (Biochemical Oxygen Demand), Ammonium and Phosphates. It must be noted that the assessment at Worcester Bromwich Road STW has taken account of the updated DWFs issued by the Environment Agency in March 2010. Modelling has also been undertaken to determine indicative limits of new consents where they will be required to meet the Environment Agency 'no deterioration' and 'good status' targets under the WFD.

Methodology

The Environment Agency's software RQP (River Quality Planning, v2.5, September 2001) has been used in conjunction with their recommended guidance document 'Calculation of River Needs Consents'. The following data were required for inclusion into the RQP software:

- Upstream river data
  - Mean flow
  - 95% exceedance flow
  - Mean water quality
  - Standard deviation of river quality
- Discharge data
  - Mean flow
  - Standard deviation of flow
  - Mean quality
  - Standard deviation of quality

The Environment Agency supplied the input data required for the water quality modelling, which also incorporated up to date current DWFs provided by Severn Trent Water Ltd for this study (2005-2009), and the updated DWF for Worcester Bromwich Road STW (March 2010). The methodology used to predict the future DWF at the treatment works has been based on the same methodology used by Severn Trent Water to provide an indication of hydraulic capacity at the treatment works. The following assumptions made by Severn Trent Water have been used to predict the future DWF:

- 160l/h/d.
- An average occupancy rate of 2.4.

This equates to an additional 384l/d/dwelling. The additional DWF for the number of potential strategic site allocations has been calculated and added to the current DWF for each treatment works to provide an estimate of the future DWF. The future DWF has also been calculated for increments of 250 dwellings. The full calculations and methodology are presented in Appendix A.

Consents

The current consents for each contaminant at each of the STWs were provided by Severn Trent Water Ltd and are shown below. These represent the concentration of discharge permitted prior to mixing with the receiving watercourse.

Table 6-1 Current Consents

Contaminant (mg/l)	STW			
	Droitwich	Worcester	Powick	Evesham
BOD	25	25	25	25
Ammonium	10	15	20	None set
Phosphate	None set*	None set	None set	2

* As part of the EA's National Environment Programme Severn Trent Water Ltd are expecting to meet a new 2mg/l P consent by Sept 2014.

The table below demonstrates whether the current consents are being achieved, based on data provide by the Environment Agency.

Table 6-2 Current Consents Achievement

Contaminant (mg/l)		STW			
		Droitwich	Worcester	Powick	Evesham
BOD	Consent	25	25	25	25
	95th Percentile Current Discharge	12.7	7.8	22.0	10.8
Ammonium	Consent	10	15	20	None set
	95th Percentile Discharge	1.2	3.5	10.9	6.1
Phosphate	Consent	None set*	None set	None set	2
	Mean Current Discharge	7.0	1.9	6.2	1.7

* As part of the EA's National Environment Programme Severn Trent Water Ltd are expecting to meet a new 2mg/l P consent by Sept 2014.

The above data demonstrates that at Droitwich the discharge quality is currently below the BOD and Ammonium consents. This is also the case at Worcester, Powick and Evesham (although currently an Ammonium consent is currently not set at Evesham).

In terms of Phosphates, consents are commonly not currently set. There is however a 2mg/l consent at Evesham, which as the current data shows is being achieved. Also, if it is the intention to achieve a 2mg/l consent of Phosphate by 2014 at Droitwich, further work is required to reduce the current discharge quality (7.0mg/l).

Results

The full suite of results for the Water Quality Modelling is presented in Appendix A. This demonstrates the impact on water quality from increments of 250 properties to each Sewage Treatment Works. The Water Quality Modelling undertaken has demonstrated that at Evesham and Worcester Bromwich Road Sewage Treatment Works, there is likely to be no change in the levels of BOD, Ammonium and Phosphate downstream as a result of the proposed strategic site allocations. This contrasts to Powick and Droitwich Sewage Treatment Works, where an increase in all contaminant levels is expected. It is

believed that the reason for limited increase in contaminant levels at Evesham and Worcester Sewage Treatment Works is due to the dilution effect in a receiving watercourse which has higher flows (River Avon and Severn respectively). Hence, the dilution downstream is such that no change in water quality is observed, despite the increase in discharge through the STWs.

The table below summarises the water quality modelling based on the full proposed strategic site allocations. The results of the Water Quality Modelling based on incremental increases of 250 properties are shown in Appendix A.

Table 6-3 Impacts of Proposed Strategic Site Allocations on Water Quality

Contaminant (mg/l)		Sewage Treatment Works			
		Droitwich	Worcester	Powick	Evesham
Number of Properties		+ 2,250	+ 4,150	+3,000	+2,100
BOD	Current mean Upstream Quality	1.90	1.58	1.34	2.12
	Current 90 percentile Downstream Quality	3.8	2.3	9.6	3.9
	Target 'no deterioration' and 'good status' (90 Percentile)	5.0	4.0	4.0	4.0
	Future 90 percentile Downstream Quality	3.9	2.3	11.1	3.9
	% Increase	3.0	0.0	16.0	0.0
	Target Achieved	Yes	Yes	No	Yes
Ammonium	Current Mean Upstream Quality	0.10	0.07	0.06	0.11
	Current 90 percentile Downstream Quality	0.3	0.1	3.9	0.2
	Target 'no deterioration' and 'good status' (90 percentile)	0.3	0.3	0.3	0.3
	Future 90 percentile Downstream Quality	0.3	0.1	4.6	0.2
	% Increase	3.6	0.0	18.0	0.0
	Target Achieved	Yes	Yes	No	Yes
Phosphate	Current Mean Upstream Quality	0.8	0.3	0.2	0.4
	Current Mean Downstream Quality	1.4	0.3	2.2	0.4
	Target 'no deterioration' (annual average)	1.0	1.0	0.25	1.0
	Target 'Good Status' (annual average)	0.12	0.12	0.12	0.12
	Future Mean Downstream Quality	1.4	0.3	2.7	0.4

Contaminant (mg/l)		Sewage Treatment Works			
		Droitwich	Worcester	Powick	Evesham
Number of Properties		+ 2,250	+ 4,150	+3,000	+2,100
	% Increase	4.4	0.0	22.0	0.0
	'No Deterioration Target Achieved	No	Yes	No	Yes
	'Good Status' Target Achieved	No	No	No	No

Table 6-3 demonstrates that if the full proposed strategic site allocations are granted permission there is likely to be a 3% increase in BOD levels downstream of the Droitwich STW, and a 22% increase downstream of the Powick STW. Whilst this increase at Droitwich is not sufficient to exceed the current target of 5mg/l, the target at Powick is not currently being met. There is no increase in BOD downstream of Worcester and Evesham STWs, this is also found to be the case for levels of Ammonium. However, the water quality modelling has predicted that a 3.6% increase in Ammonium levels at Droitwich and 18% increase at Powick is likely. As with levels of BOD, this increase is not sufficient to exceed the target for Droitwich, whereas the target at Powick for Ammonium levels is not currently met. In terms of levels of phosphate from the proposed strategic site allocations, it is predicted that there will be a 4.4% increase at Droitwich and a 22% increase at Powick. At both of these locations the 'no deterioration' target is currently being exceeded.

Discharge Consents

Modelling was also undertaken to determine whether new consents are required to meet the water quality targets due to the increase in DWF to the sewage treatment works. The full methodology and reasoning behind the recommendations of consents can be found in Appendix A.

In the majority of cases the current consents are sufficient to accommodate the full number of proposed strategic site allocations. Powick Sewage Treatment Works is the most affected by increased DWF as it feeds to a smaller watercourse than the others. Currently the 'No deterioration' and 'Good Status' targets are not being achieved, as such any new consents should be put in place before any further DWF is directed to this treatment works. The consents below are only an indication of the consent that is likely to be required. The final consent should be calculated through detailed modelling and agreed upon when final allocation numbers are confirmed and future DWF values are updated.

There are also uncertainties due to the quantity of water quality data available at some of the treatment works, this has been recognised as an issue in the Final Severn River Basin Management Plan as a reason for extending the deadline to meet the Phosphorus 'Good Status' target on these watercourses. Once this monitoring data is available there will be more evidence to suggest whether a tighter consent on the sewage treatment works to achieve the 'good status' is advisable in terms of cost-benefit. It should also be noted that the Water Framework Directive aspiration to achieve 'Good Status' also needs to consider other diffuse pollution and not just point discharge from sewage treatment works. This should be considered as part of any future detailed modelling.

The indicative future consents for Powick are:

- BOD – 10mg/l
- Ammonium – 1mg/l
- Phosphate – 2mg/l
- Upgrades to treatment facilities

In the case of Powick the level of developments proposed to the south of Worcester would represent an increase in DWF, and it is expected that improvements would be required to meet the resulting consent tightening. However, Severn Trent have stated that an alternative could be to extend the final effluent outfall

from Powick STW to that it discharges directly to the River Severn. This is a distance of just over 1km across farmland and is considered feasible.

Severn Trent Water will be required to demonstrate that they can maintain the current level of treatment for Ammonium (95%tile) at Droitwich and Evesham. If this is can be maintained with the future DWF then there will be no need to impose a new consent on the treatment works. Consents would have to be revisited should it not be possible to maintain current levels of treatment at the future DWFs for the proposed strategic site allocations. The following are indicative consents should they be deemed necessary.

- Droitwich
  - Indicative new consent of 2mg/l
  - Current level of treatment (1.2mg/l) should be maintained for future DWF to meet 'no deterioration' and 'good status' targets.
  - May require upgrades to treatment facilities if current level of treatment will not be maintained with increased DWF.

- Evesham
  - Discharge quality required to accommodate the full proposed strategic site allocations and achieve the targets is 18.7mg/l of Ammonium.
  - Indicative new consent of 20mg/l
  - May require upgrades to treatment if discharge quality of 18.7mg/l is not achievable with current facilities at future maximum DWF.

None of the indicative future consents required are below the BATs for sewage treatment. Therefore this modelling indicates that there are no potential 'show-stoppers' in terms of sewage treatment capacity. The following table summarises the outcomes of the modelling. The limitations of this modelling and the need to confirm dwelling numbers should be considered before final consents are agreed.

Figure 6-12: Summary of Treatment Consent Conclusions for Sewage Treatment Works

Sewage Treatment Works	Determinant		
	BOD	Ammonium	Phosphorus
Evesham			
Worcester			
Powick			
Droitwich			

Will require a new consent to accommodate the potential strategic site allocations, upgrades will be required to treatment at the works.

Will require a new consent. May require upgrades to treatment facilities should those in place be insufficient to maintain current levels of treatment at future maximum DWFs.

No change in consent required, no upgrades necessary.

The above discussion focuses on quality conditions in relation to consent. In terms of volumetric headroom, Severn Trent Water has confirmed that spare headroom currently exists within existing consents at Powick, Evesham and Worcester. However, in the case of Worcester there is no DWF headroom under the current discharge consent. In Table 4-11 it is stated that:

"Comparison of current measured dry weather flow against the consented dry weather flow consent indicates that there is zero hydraulic capacity at this site, however the current sizing of the ASP Diffused Air Plant indicates that there is hydraulic capacity available and so indicates there could be a problem with

measured dry weather flow data. Actual spare capacity needs further detailed process analysis but notwithstanding this we do not envisage any issues in dealing with future growth demand in the Worcester STW catchment."

Therefore, there may be some DWF volumetric headroom available, and Severn Trent Water will undertake detailed modelling when development pressure arises. Should it be deemed necessary from this analysis that an increase in volumetric headroom will be required, Severn Trent Water will need to apply to increase the DWF volumetric consent. For instances in which spare headroom currently exists, but for which there is not capacity to accommodate the full allocations (such as Powick and Droitwich, see Table 4-11), a new consent will be required in the future. Application of this by Severn Trent Water will require review of the quality conditions above.

Severn Trent Water do not envisage any impact on water quality from storm tanks as any additional storm runoff will be directed into SuDS rather than into the foul sewer network. Severn Trent Water noted that other potential problems to water quality could be from Combined Sewer Overflows (CSOs). These are also controlled by discharge consents from the Environment Agency. There will be no increase in storm flows to this sewer network as all storm runoff from the proposed developments will be attenuated in Sustainable Drainage Systems before discharging directly to a nearby watercourse (further information can be found in Chapter 7). The impact of new developments would need to be assessed through detailed hydraulic modelling. This would be guided by advice from the Environment Agency. In terms of increases in foul sewerage to the network, this has been accounted for in the infrastructure improvements outlined in Chapter 4 and as such there will be no increase in overflows from this network above that of the current discharge consents.

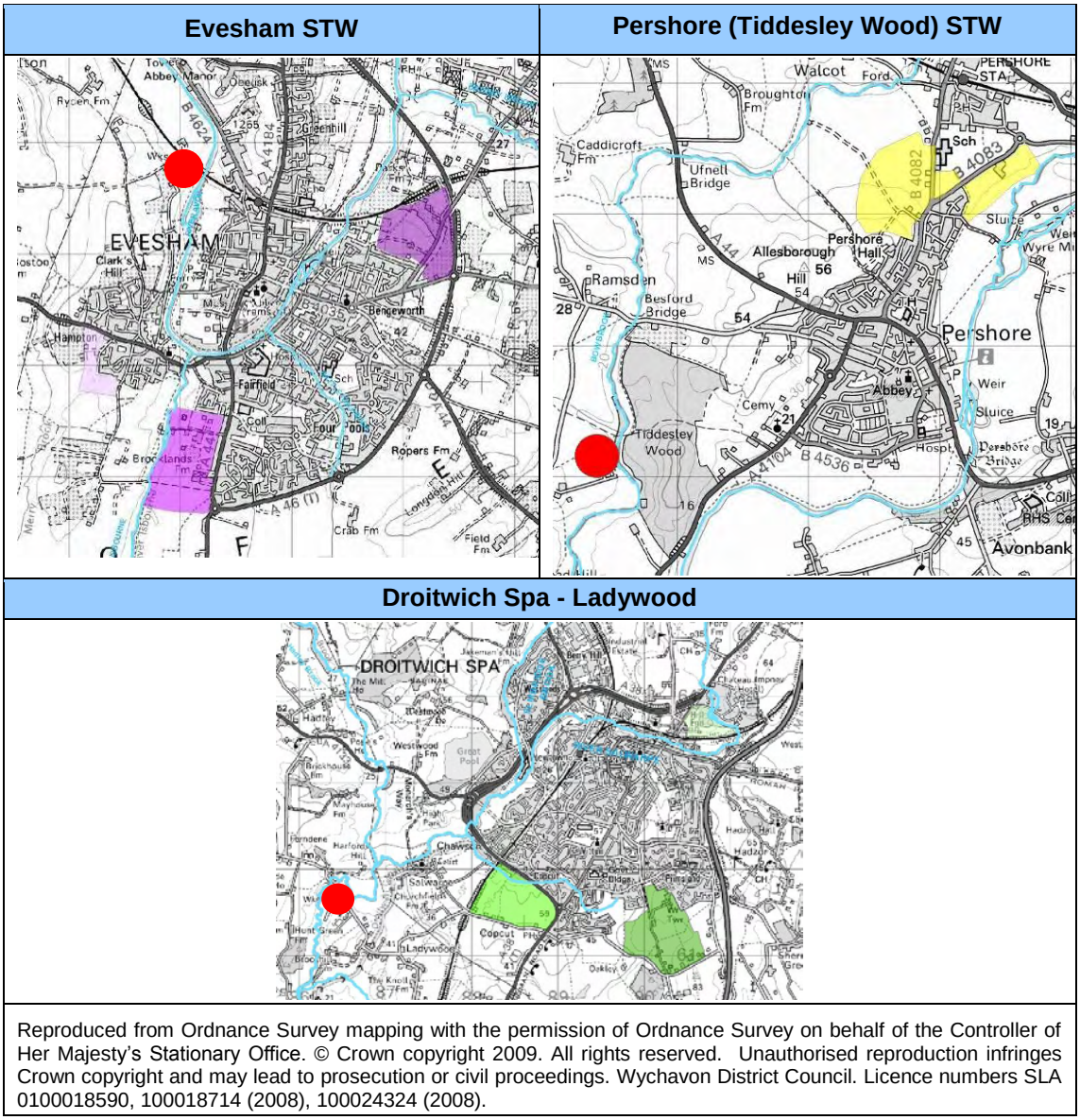
Severn Trent Water has confirmed that investment into upgrades at STWs would be undertaken as the need arises once development has been confirmed. This would also have the benefit of keeping customer bills low, as additional capacity would not be required until it is needed. The investment would be provided through the supply demand funding mechanism with Ofwat.

Table 6-4: Current treatment processes at the Sewage Treatment Works

Sewage Treatment Works Name	OS Grid Ref		Current treatment process	Current quality performance (RAG)	Future quality issues (RAG)	Physical constraints regarding provision of additional treatment capacity (RAG)	Any other comments	Receiving Watercourse	River Catchment	Current Consent Information							
	Eastings	Northings								Consent Ref	FFT	DWF (m3/d)	Amm (summer)	Amm (Winter)	BOD (mg/l)	SS (mg/l)	P
Malvern (Mill Lane)	379800	244800	Re-Circulating Filtration	Marginal	None expected to be an issue	No land or other constraints preventing expansion	Comparison of current measured dry weather flow against the consented dry weather flow consent indicates that there is reasonable hydraulic capacity at this site. Notwithstanding this we do not envisage any issues in dealing with additional growth at Malvern STW.	River Severn	Middle Severn	S/08/26522/R	20,460	13400	15		25	45	
Evesham	402900	244700	Re-Circulating Filtration, Modular Sand Filtration and Chemical Dosing	Good	None expected to be an issue	No land or other constraints preventing expansion	Comparison of current measured dry weather flow against the consented dry weather flow consent indicates that there is reasonable hydraulic capacity at this site. Notwithstanding this we do not envisage any issues in dealing with additional growth at Evesham STW.	River Avon	Middle Severn	S/17/26427/R	16,330	5797			25	45	2
Droitwich (Ladywood)	386400	261600	Act Sludge - Diff Air / Recirc Filt	Marginal	None expected to be an issue	No land or other constraints preventing expansion	There is negligible hydraulic headroom at this sewage works but we do not envisage any issues in dealing with future growth needs in the catchment. As part of the EA's National Environment Programme we are expecting to meet a new 2mg/l P consent by Sept 2014.	River Salwarpe	Middle Severn	S/07/55591/R	16,848	7183	10		25	45	n/a see comments
Pershore (Tiddesley Wood)	392400	245000	Act Sludge - Diffused Air, Chemical Dosing	Marginal	None expected to be an issue	No land or other constraints preventing expansion	Comparison of current measured dry weather flow against the consented dry weather flow consent indicates that there is reasonable hydraulic capacity at this site. Notwithstanding this we do not envisage any issues in dealing with additional growth at Pershore STW.	Bow Brook	Middle Severn	S/19/26007/R	7,638	3838	5		15	25	2
Powick	383800	250800	Re-Circulating Filtration	Marginal	None expected to be an issue	No land or other constraints preventing expansion	Comparison of current measured dry weather flow against the consented dry weather flow consent indicates that there is reasonable hydraulic capacity at this site, however the current sizing data for the biological filters indicate there could be stress from a load perspective. Notwithstanding this we do not envisage any issues in dealing with future growth demand at Powick STW catchment.	Carey's Brook	Middle Severn	S/08/25693/R	6,653	2838	20	0	25	45	
Worcester (Bromwich Road)	384361	253530	Act Sludge - Diffused Air	Good	None expected to be an issue	No land or other constraints preventing expansion	Comparison of current measured dry weather flow against the consented dry weather flow consent indicates that there is zero hydraulic capacity at this site, however the current sizing of the ASP Diffused Air Plant indicates that there is hydraulic capacity available and so indicates there could be a problem with measured dry weather flow data. Actual spare capacity needs further detailed process analysis but notwithstanding this we do not envisage any issues in dealing with future growth demand in the Worcester STW catchment.	River Severn	Middle Severn	S/07/56066/R		33,000	15		25	45	

This page is intentionally left blank.

Figure 6-13: Sewage Treatment Works Monitored to Protect Sensitive Receiving Waters under UWWTD



6.3.4 Diffuse Pollution

Unlike point sources, diffuse sources of nutrients are influenced more by hydrological events. Diffuse pollution can reach water bodies by overland flow or infiltrate and reach them through groundwater. The main sources of diffuse pollution within the Severn River Basin District are nitrates, sediment, pesticides and urban and transport pollution. Sediments and nitrates are primarily as a result of soil erosion and runoff from agricultural areas, however construction can also add to the sediment problem. Pershore, Evesham, Droitwich Spa and areas to the north and south of Great Malvern currently fall within Nitrate Vulnerable Zones, areas to the east and west of Great Malvern and Worcester became new Nitrate Vulnerable Zones in January 2009. Nitrate Vulnerable Zones now cover approximately 70% of the England. For further information regarding Nitrate Vulnerable Zones please consult the DEFRA website[4].

Runoff from urban areas can include many different chemicals (e.g. petrol/oil).

[4] Nitrate Vulnerable Zones - http://www.defra.gov.uk/environment/quality/water/waterquality/diffuse/nitrate/index.htm

Sewerage effluent from houses in un-sewered areas can be a source of pollution through poor maintenance, design or installation of septic tanks

There is potential for windfall sites to be located within un-sewered areas and require either:

- a septic tank and discharged to a soakaway or drainage field,
- or a package treatment plant, which may discharge to a soakaway or direct to surface waters.

The Environment Agency[5] do not require consent for discharges of sewage from a small sewage treatment plant or septic tank into a soakaway or drainage field, if:

- it is not in a Groundwater Source Protection Zone 1 (the Inner Zone);
- it has a volume of less than $2m^3$ per day;
- the installation was designed and built to the standards applicable when it was installed; and
- it is properly maintained.

The Environment Agency does require consent for discharges of sewage from small sewage treatment plants to:

- inland surface watercourses; and
- tidal waters

If the above guidelines are followed sewerage effluent from houses in unsewered areas should not have a detrimental impact to the surrounding watercourses.

6.3.5 Sediments

Sediments carried in overland flow from agricultural land and from land under development can impact on the water quality of the receiving watercourse. High sediment loads can damage fish spawning grounds, increase turbidity and can carry pollutants such as phosphorus.

6.3.6 Physical Modification

Physical changes to a watercourse can result in habitat damage or loss. Dredging and straightening are two examples of physical changes that occur to rivers in urban areas.

6.3.7 Endocrine disrupters

Endocrine disrupters are hormones that disrupt the normal working of the endocrine (hormonal) system in animals and plants. They can mimic the action of natural hormones, block their action, interfere with their action or can produce other effects. There is considerable evidence that endocrine disrupters have had an impact on fish development, growth and reproduction. Male fish have been seen to become ‘feminised’, though there is a lack of understanding of how this impacts the fish populations. Endocrine disrupters, particularly oestrogen found in birth control pills, have been found in treated sewerage effluent.

6.3.8 Organic pollution

In this case organic pollution is in the form of ammonia and biochemical oxygen demand (BOD). The toxicity of ammonia to fish and other aquatic life is dependent on the pH and temperature of the water. Increasing pH increases the proportion of toxic 'free' ammonia. Biochemical Oxygen Demand is not an individual pollutant, but a measure of the amount of biodegradable organic matter present. A high concentration of Biochemical Oxygen Demand exerts a high oxygen demand on water, leading to oxygen depletion with potentially severe impacts on the whole ecosystem. Much of the pressure from organic pollution is the result of discharges of treated sewage effluent. Tightening of discharge standards and cessation of discharges of raw sewage to coastal waters over the past 15 years has resulted in marked improvements in water quality.

6.3.9 Climate Change

Changing weather patterns resulting from climate change will bring challenges with drier summers and wetter winters. The effects of future climate change, such as increased rainfall, could exacerbate the impacts of the new developments on the water quality and environment. For example, increased runoff

[5]Discharge consents - who needs one? http://www.environment-agency.gov.uk/business/regulation/32038.aspx

from urban areas could carry more pollutants to the watercourses and the decrease in summer rainfall could put more pressure on the already limited water resources in the region.

6.4 The Potential Impact of the Proposed Strategic Site Allocations

The proposed strategic site allocations have the potential to have a negative impact on the environment and water quality of the watercourses nearby. The following section outlines the potential impacts both on land and in the watercourses.

6.4.1 Environmental Impact

The Strategic Environmental Assessment (SEA) Vol2 undertaken by Faber Maunsell for Severn Trent Water as part of the Draft Water Resources Management Plan indicates that some of the proposed schemes for improvement to the infrastructure will have negative effects on the environment, the majority of which will be associated with the laying of new pipelines, creation of new boreholes and construction of infrastructure. Many of these impacts can also be related to the construction of new residential properties and associated infrastructure. The SEA also states that in the long term the improvement of infrastructure will have a positive effect on the environment and water quality. The potential negative impacts on the environment from the developments and water supply/sewerage infrastructure improvements include:

- Habitat loss and species disturbance along pipeline routes and areas associated with new infrastructure and residential developments;
- Pressure to sustain low flows within the watercourses due to over-abstraction;
- Temporary landscape and visual impacts associated with ground disturbance, construction activities and machinery/plant associated with laying of pipelines and construction of infrastructure;
- Permanent landscape and visual impacts due to presence of new water treatment works;
- Loss or disturbance of archaeological features along pipeline routes and in areas associated with new infrastructure developments;
- Energy consumption and CO2 emissions associated with piping water and treating increased volumes of water;
- Land sterilisation along pipeline easement;
- Community disturbance during construction e.g. traffic and footpath diversions;
- Temporary air quality impacts associated with dust generated during construction; and
- Noise and vibration generated from construction activities (pipeline laying and borehole drilling).

6.4.2 Water Quality Impact

The potential negative impacts of proposed strategic site allocations on water quality are as follows:

- Sediment runoff from the potential strategic site allocations, leading to increased turbidity in the watercourses;
- Changes to stream morphology, increased erosion or deposition rates;
- Aquatic habitat disturbance through increased temperatures and flood frequencies;
- Pollutants in runoff from the new urban areas, such as petrochemicals;
- Pollutants in sewage effluent such as phosphorus from detergents, endocrine disrupters and organic pollutants; and
- Possible groundwater contamination during borehole drilling and via soakaways

The Environment Agency have produced maps showing the predicted ecological and chemical status of the surface water bodies and groundwater in 2015, taking into account the impact of changes implemented due to the Water Framework Directive. The predictions for the South Worcestershire study area can be found within the Final Severn River Basin Management Plan or on the Environment Agency's website in the 'What's in your backyard?' pages.

Summary:

- **Other potential pressures on the watercourses due to the proposed strategic site allocations include sediment, nutrients (from sewage treatment works), pollutants from urban areas e.g. petrols or oils, endocrine disrupters, physical modifications and organic pollution and over abstraction**
- **Climate change could potentially exacerbate the pressures on the watercourses, for example, increased runoff from urban areas could carry more pollutants to the watercourses and a decrease in summer rainfall could put pressure on the already limited water resources in the region.**
- **Water Quality modelling undertaken has demonstrated that at Evesham and Worcester Sewage Treatment Works, there is likely to be no change in the levels of BOD, Ammonium and Phosphate downstream as a result of the proposed proposed strategic site allocations. At Powick and Droitwich Sewage Treatment Works an increase in contaminant levels is expected and may result in a tighter consent to meet the WFD of 'no deterioration' to current ecological status.**

6.4.3 Sites of Special Scientific Interest (SSSIs)

Natural England has a duty to designate SSSIs when it is of the opinion that an area of land is of special interest due to its flora, fauna or geological or physiographical features. This opinion is based on specialist judgment which is informed by scientific guidelines. Natural England notify all owners and occupiers , the local planning authority, Secretary of State for Environment, Food and Rural Affairs, the Environment Agency, water and sewerage companies and internal drainage boards.

There are several water related SSSIs within South Worcestershire, and some are located near to the proposed strategic site allocations. The proposed strategic site allocations may potentially adversely impact upon the SSSIs through increased risk of pollution or reduction in the water resources available to the environment. For example, the River Teme (Figure 6-14) is classified by Natural England as being in an 'unfavourable condition with no change' i.e. no improvement. One reason for this status is water pollution due to urban discharges, e.g. sewage discharges. Oakley Pool, a lowland fen/marshland south of Droitwich Spa is classified as unfavourable and declining due to inappropriate water levels based on breeding birds interest analysis (Figure 6-15).

The following maps (figures 6-14 to 6-20) show the water related SSSIs within the vicinity of the proposed development areas as classified by Natural England. The Environment Agency's CAMS have been used to help identify which of the SSSIs are water related. Within the CAMS it is stated that Upton Ham is dependent on typical winter flood conditions but is not affected by the river channel directly. The whole of the River Teme has been designated a SSSI as a representative of near natural and biologically rich river type associated with mudstones and sandstones. Grimley Brick Pits along with Northwick Marsh are thought to be in hydraulic continuity with the River Severn during elevated flows.

The CAMS also state that the Teme and Severn Confluence Wetland Restoration Zone is present in the catchment of Carey's Brook and plans are in place to convert the fields to the east of Powick STW to wet grassland (Figure 6-14).

In addition to the SSSIs in the Figures 6-14 to 6-20, Upham Meadow and Summer Leasow, Long Meadow, Portway Farm Meadows, Banall Meadow, Yellow House Meadow, Castlemorton Common, Stockwood Meadows, Foster's Green Meadows, Rye Street Meadows, Burley Dene Meadows and New Inn Meadow are located within the study area and have all been identified within the Environment Agency's CAMS as SSSIs that could be affected by abstractions from watercourses nearby and could influence the amount of water available.

Lyppard Grange Ponds SAC is classified as a Protected Area under the Habitats Directive (Figure 6-14). The objective is to achieve favourable conservation status (to protect and where necessary improve the water or water-dependent environment to the extent necessary to maintain at or improve to favourable conservation status the water dependent habitats and species for which the Protected Area is designated, in this case the Great Crested Newt. Lyppard Grange Ponds SAC is currently meeting its environmental objectives as required by Article 4(1c).

Figure 6-14: Water Related SSSIs in Worcester

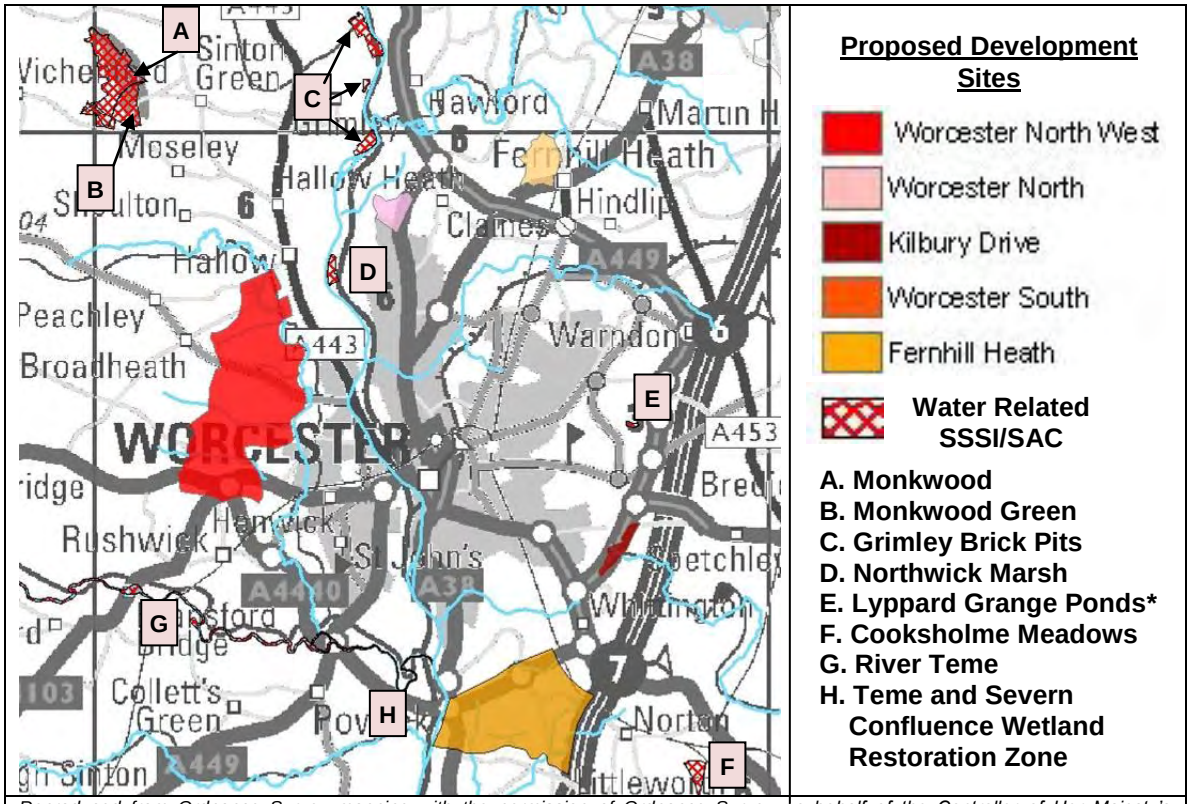


Figure 6-15: Water Related SSSIs in Droitwich Spa

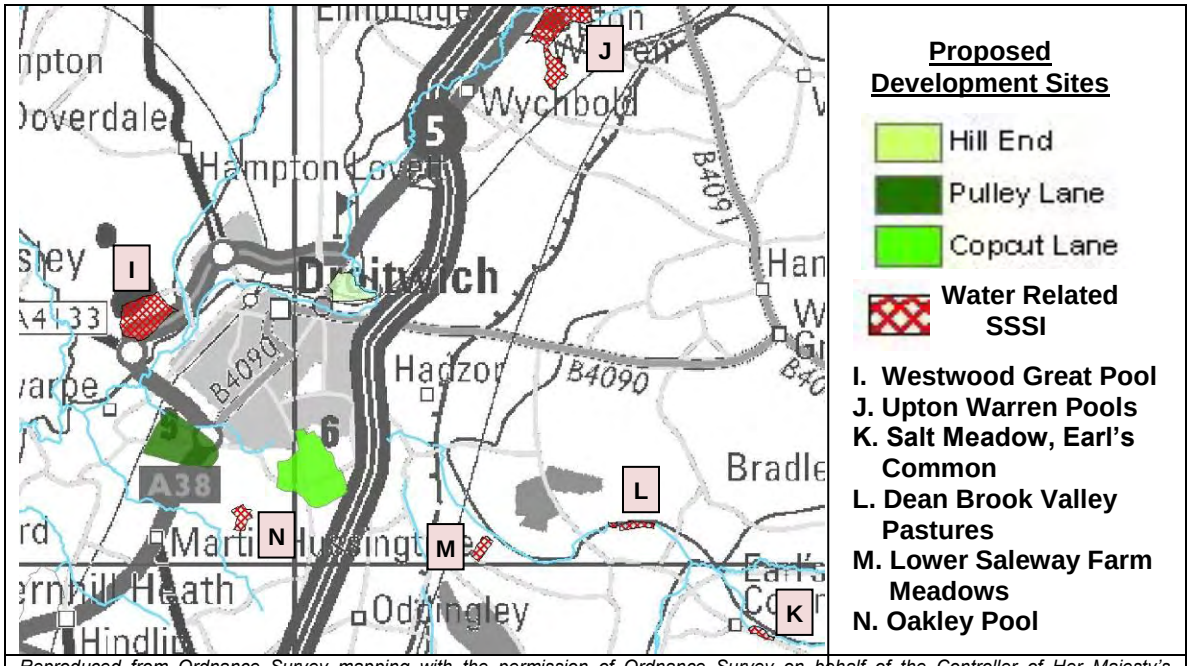


Figure 6-16: Water Related SSSIs in Great Malvern

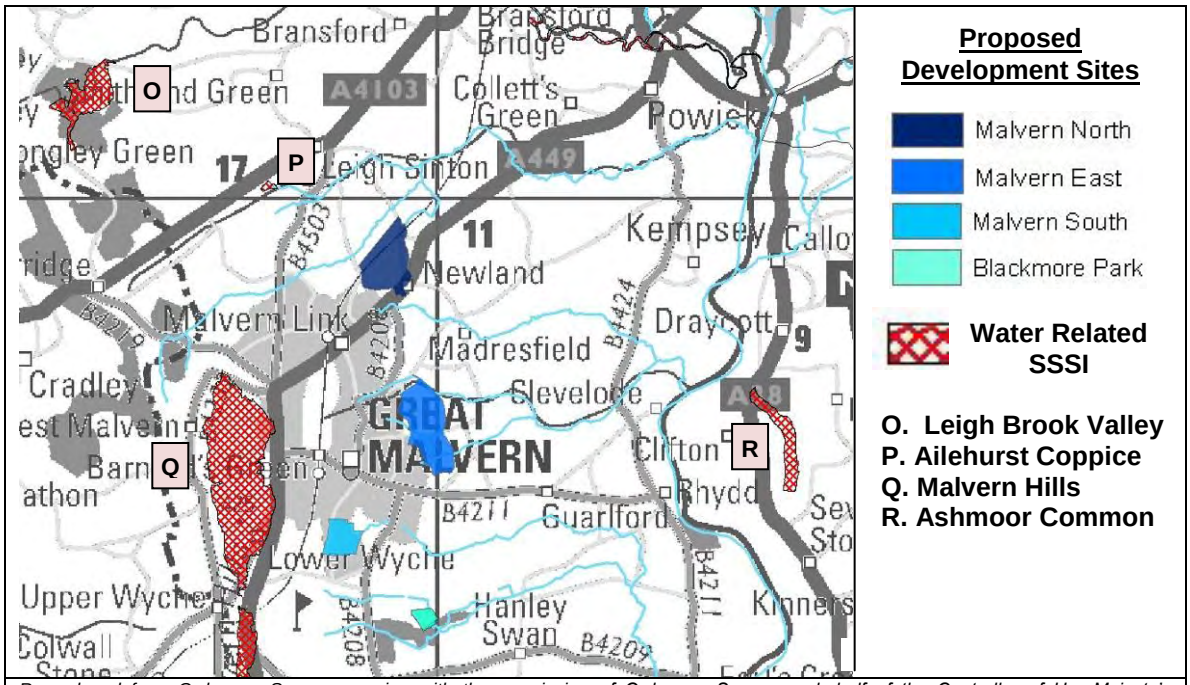


Figure 6-17: Water Related SSSIs in Pershore

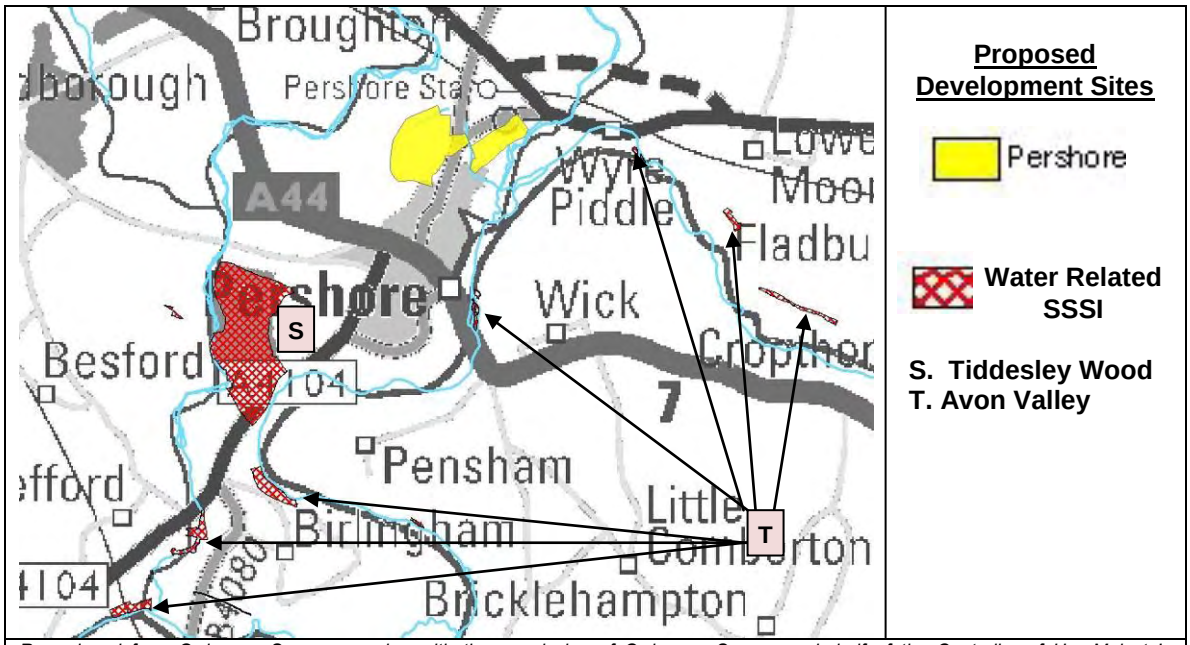


Figure 6-18: Water Related SSSIs in Evesham

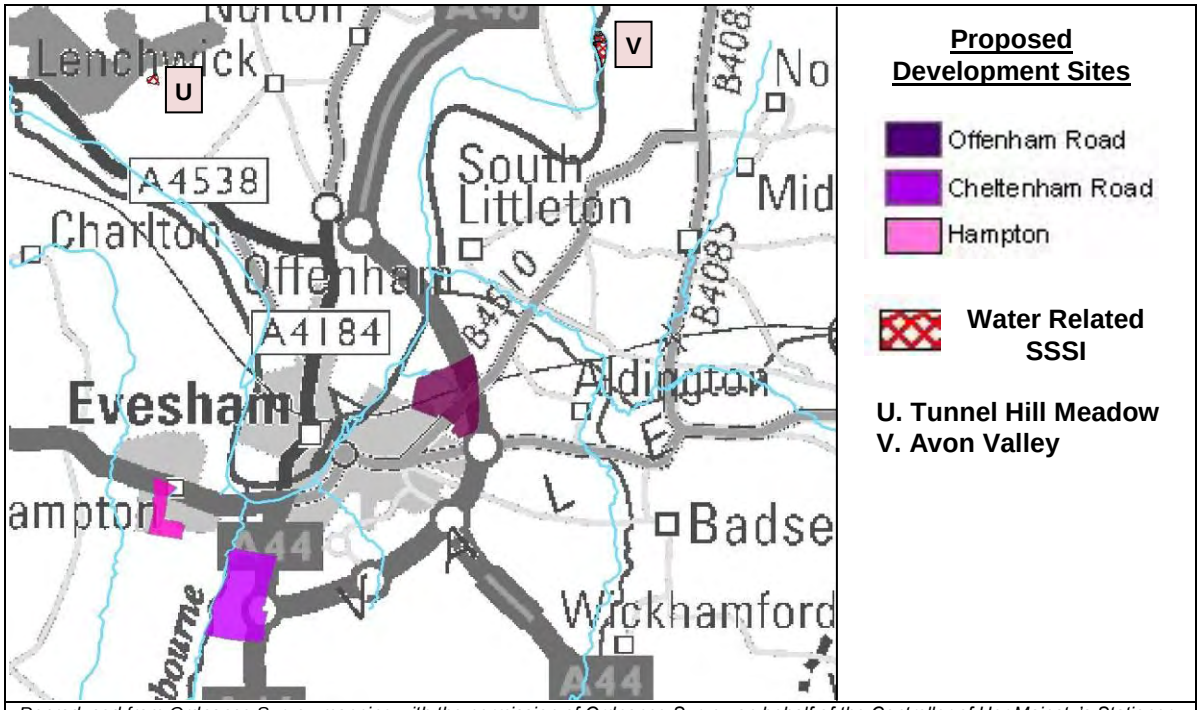


Figure 6-19: Water Related SSSIs in Tenbury Wells

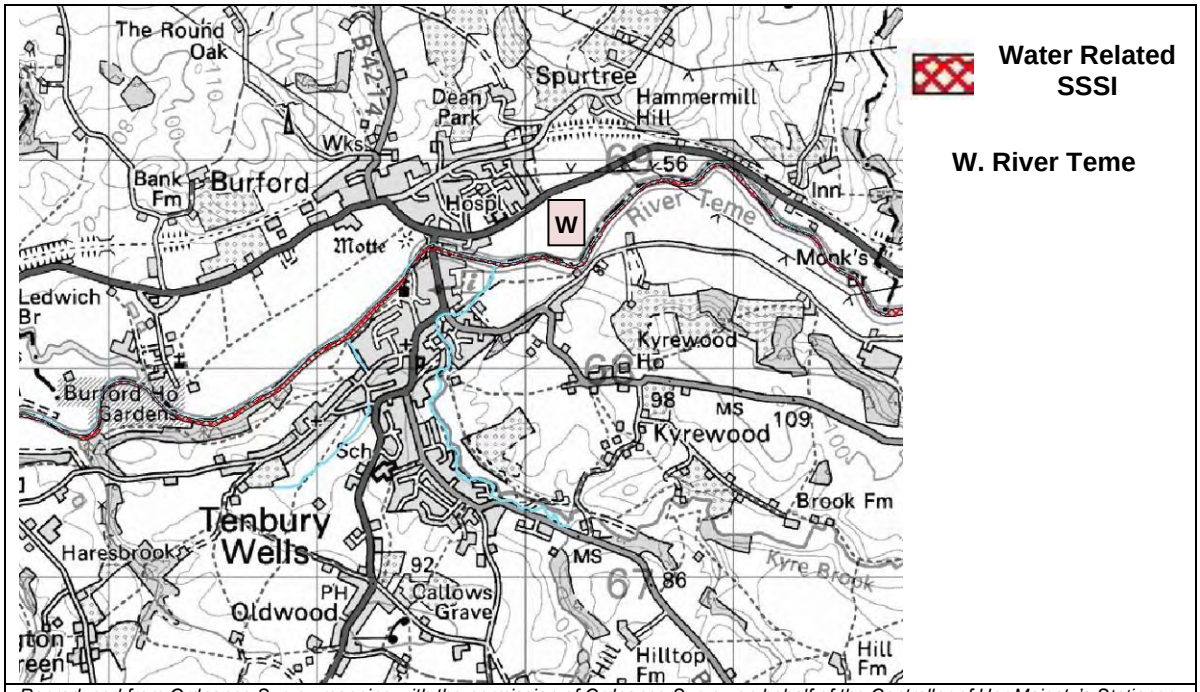
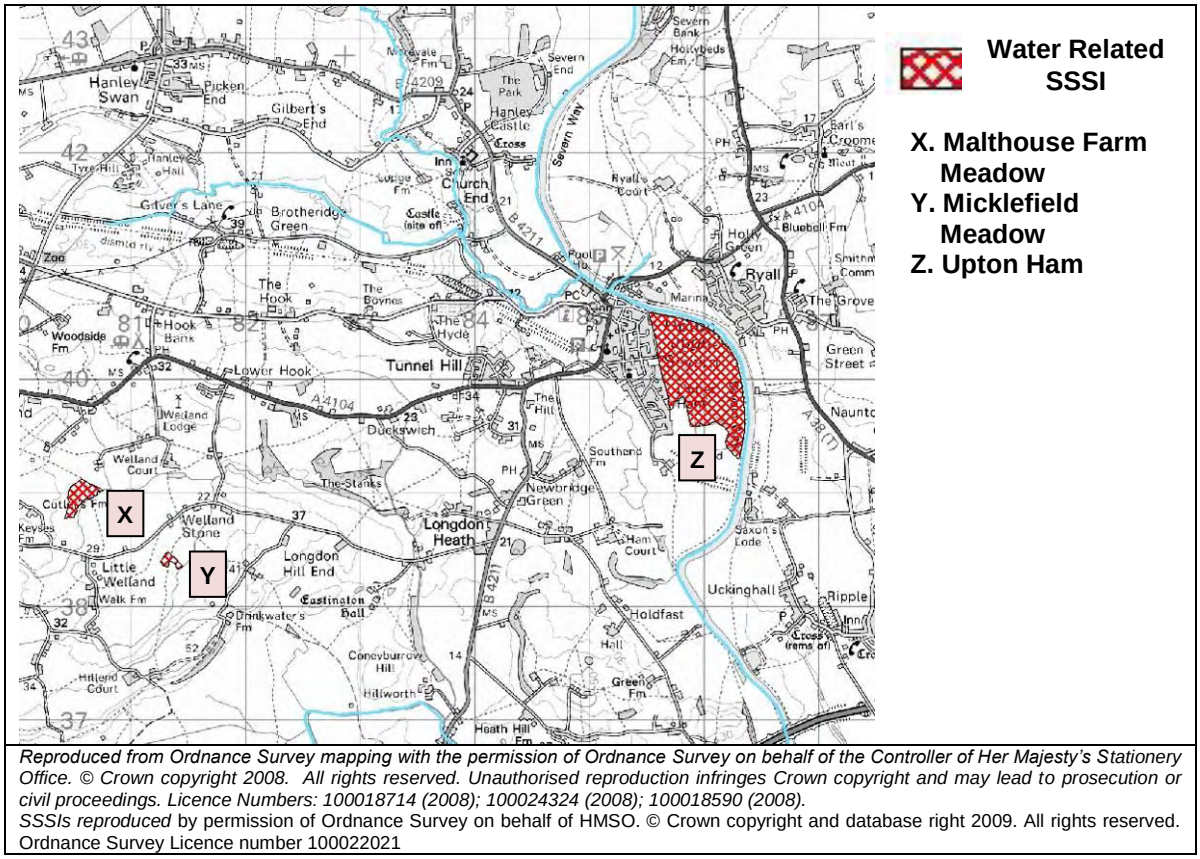


Figure 6-20: Water Related SSSIs in Upton upon Severn



Reproduced from Ordnance Survey mapping with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office. © Crown copyright 2008. All rights reserved. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. Licence Numbers: 100018714 (2008); 100024324 (2008); 100018590 (2008).
SSSIs reproduced by permission of Ordnance Survey on behalf of HMSO. © Crown copyright and database right 2009. All rights reserved. Ordnance Survey Licence number 100022021

6.5 Management Options and Policies

The following management options outline how the proposed strategic site allocations can minimise their impact on the neighbouring watercourses by reducing both diffuse and point sources of pollution. (e.g. SuDS), the policies that are relevant to the Severn River Basin that have been or will be implemented under the Water Framework Directive are also discussed in this section (refer also to Section 6-1 for information on policies).

New developments are required to attenuate surface water runoff and SuDs are the recommended approach as stated in PPS25 and Building Regulations H (see Chapter 7). Developers should also take the opportunity to maximise the water quality and amenity/ecological benefits. HR Wallingford's study, 'Maximising the Ecological Benefits of Sustainable Drainage Schemes' (2003), states that the maximum ecological benefits derived from SuDs may come from improvements to the still water aquatic environment and that the best that can often be achieved for the receiving waters is to prevent further deterioration. It may be possible to create near pristine chemical quality within the standing water component of SuDs. It is also noted that the success of SuDs in terms of improving aquatic environments will only be reached if the SuDs schemes include some clean waterbodies and the implementation of treatment trains and that planting of non-native species is banned, which is potentially the biggest adverse impact of SuDs schemes.

Table 6-3 indicates the water quality treatment and ecology potential for a selection of the SuDS techniques available, further details about how SuDs can improve or maintain water and ecological quality can be found in the CIRIA SuDS Manual (2007).

Table 6-5: SuDS - Ecology and Water Quality Treatment Potential

SuDS Component	Water Quality Treatment	Ecology potential	Comment
Filter Strips	Medium	Medium	Vegetated strips of land designed to accept runoff as overland sheet flow from upstream development.
Ponds	Good	Good	Provide attenuation and treatment, support emergent and submerged vegetation. Runoff detained and treated in the pool.
Swales	Good	Medium	Swales are linear vegetated drainage features and water can be stored or conveyed. They can allow for infiltration where appropriate and can replace conventional gullies and drainage pipes at the roadside.
Bio-retention	Good	Good	Shallow, landscaped depressions, typically underdrained, aimed at treating and managing runoff from frequent rainfall events.
Pervious Pavements	Good	Poor	Suitable for pedestrian and vehicular use and can allow rainwater to infiltrate through them, can provide good water quality treatment.
Infiltration Basins	Good	Good	Vegetated depressions designed to store runoff and infiltrate it gradually into the ground.
Stormwater Wetlands	Good	Good	Provide attenuation and treatment, comprise of shallow ponds and marshy areas, covered almost entirely with aquatic vegetation. Can provide significant ecological benefits.

*Source – CIRIA SuDS Manual 2007

The indicative storage volumes calculated for the proposed strategic site allocations (Chapter 7) do not include the Water Quality Treatment Volume. This is the water that remains in the pond during the dry weather periods. The CIRIA SuDS manual indicates that the volume should be sized to accommodate at least 10mm of runoff from the impermeable surfaces. It is especially important to consider the use of SuDS for employment land. Depending on whether this land is used for offices or industrial buildings, the impacts on the water quality and environment can be severe.

The impermeable surfaces in urban areas reduce rates of infiltration and therefore reduce rates of recharge to the underlying aquifers. The quantitative groundwater status for Worcester and Droitwich Spa has been assessed as poor, and therefore any additional impermeable surfaces in these areas will potentially reduce groundwater recharge further. SuDS can help return water to groundwater by slowing down rainfall runoff in soakaways, permeable surfaces, ponds and wetlands. It is therefore advised that where possible these SuDS are used in preference to others in Worcester and Droitwich Spa. These SuDS can potentially make the groundwater more vulnerable to pollution, however, if the scheme is properly designed and maintained this should not be a problem.

Table 6-4 shows which of the proposed strategic site allocations would most benefit from the consideration of water quality and ecological improvements when implementing SuDS. A ‘traffic light’ system has been determined taking into consideration the proximity of the site to water related SSSIs and the ecological and chemical water quality status of the watercourses nearby and whether the site is within a groundwater SPZ (Table 6-4). For example, if the site is situated near a wetland it would benefit from having a source of native species nearby to colonise any new aquatic environments within the site. The site would therefore benefit from the implementation of SuDs with good ecological potential. Such a site is Worcester South that is adjacent to the Teme and Severn Confluence Wetland Restoration Zone. A further example is if the watercourse nearby was suffering from high nutrient levels it would benefit from SuDS that help reduce the levels of nutrients within the watercourse.

Table 6-6: Potential to benefit from SuDs in terms of Water Quality, Ecology and Groundwater Recharge

Proposed Strategic Site Allocations	Potential to benefit from SuDs in terms of Water Quality, Ecology and Groundwater Recharge
Worcester	
Worcester North West	
Worcester North	
Kilbury Drive	
Worcester South	
Fernhill Heath	
Droitwich Spa	
Hill End	
Pulley Lane	
Copcut Lane	
Great Malvern	
Malvern North	
Malvern East	
Malvern South	
Blackmore Park	
Pershore	
Pershore	
Evesham	
Offenham Road	
Cheltenham Road	
Hampton	

Legend:

SuDS with a good potential for water treatment ,ecology and groundwater recharge should be a utilised (Table 6-2 'Good').

SuDS with a good potential to enhance water treatment ,ecology and groundwater recharge should be utilised where possible, other options may potentially be considered (Table 6-2 'Medium').

SuDS with a good potential to enhance water treatment ,ecology and groundwater recharge should be utilised where possible but are less critical, other options may potentially be considered (Table 6-2 'poor').

6.5.1 Green Infrastructure

Green infrastructure comprises of networks of multi-functional open space, at all scales to connect resources into functional networks and produce the maximum public benefit. A revised Green Infrastructure Study for South Worcestershire, building on the Green Infrastructure Strategy for Worcester developed in 2007[6], is being prepared led by Worcestershire County Council and Natural England.

Green infrastructure encompasses all open space elements within rural and urban landscapes. Examples include:

- Woodland
- Watercourses
- Playing fields
- Nature reserves
- Cemeteries
- Footpaths
- Hedgerows
- Amenity landscaping

SuDS can provide ecological gain and in doing so have the potential to contribute towards the green infrastructure network in South Worcestershire. In addition, provision of flood storage areas and increasing flood storage capacity through, for example, floodplain naturalisation, can also add to the green infrastructure. Green infrastructure is not only beneficial to the environment but also to the developer by improving the "liveability" of areas and their attractiveness to residents.

The Green Infrastructure Strategy for Worcester (2007) outlines how improvements can be achieved within the city, a selection of suggestions from the Strategy are shown below, for further information please consult the original document:

- Consideration of local landscape character at the initial design stages of development schemes;
- New landscaping should reflect local species and habitats unless there are over-riding reasons for a different approach, and should contribute to local and national Biodiversity Action Plan targets;
- All new developments should incorporate Sustainable Drainage systems, with maintenance and adoption processes agreed at the outset;
- New areas of informal open space created as a result of Worcester's strategic growth, as well as existing areas, should deliver multiple benefits, for example informal public recreation, biodiversity enhancement and storm water attenuation.

The South Worcestershire Joint Core Strategy - Evidence Base Green Infrastructure Study for the Growth Areas – a desktop site analysis undertaken in 2008 by Worcester Wildlife Trust[7] provides additional site specific information for the proposed strategic site allocations regarding green infrastructure and ecological constraints.

In line with the South Worcestershire Joint Core Strategy Strategic Flood Risk Assessment (SFRA) it is proposed to have a 20% green infrastructure area (disregarding gardens) on each of the proposed strategic site allocations.

6.5.2 Environmental Assessment

Severn Trent Water's Strategic Environmental Assessment states that through the implementation of appropriate environmental mitigation measures such as route selection studies and environmental surveys required under UK legislation, (for example the Conservation (Natural Habitats & c.) Regulations 1994 and Wildlife and Countryside Act 1981 (amended by the Countryside and Rights of Way Act 2000), potential detrimental effects on the environment could be avoided or minimised. The SEA also states that

[6] Faber Maunsell, (2007) ://www.swjcs.org/evidence_base/green_infrast_web/green_infrastructure_strategy.pdf

[7] http://www.swjcs.org/evidence_base/SWJCSEvidenceReportFinal/Main_Report.pdf

screening exercises would also be required to determine whether pipeline or housing developments would be subject to an Environmental Impacts Assessment (EIA), further reducing the potential for any significant adverse effects on the environment.

6.5.3 Abstraction Licences

The Catchment Abstraction Management Strategies, a result of the WFD, outline how abstraction licences are put in place to protect the environment and ensure that there is enough water to support the habitats (Chapter 5).

6.5.4 River Basin Management

The Final Severn River Basin Management Plan outlines several mechanisms that help to protect water bodies that have abstractions for drinking water. A 'mechanism' means the policy, legal and financial tools that are used to bring about particular actions. These mechanisms include statutory protected areas, such as the 'sensitive' receiving waters (Figure 6-13) and advisory source protection zones around groundwater abstractions, established under the Environment Agency's Groundwater Protection policy (section 6.2.9). The Water Industry Act 1991 Part III outlines the general duties for protecting and managing the quality and sufficiency of supplies.

The Urban Waster Water Treatment Directive (91/271/EEC) outlined in section 6-1 of this report sets limits to the amount of Phosphorus and Nitrogen that is acceptable within water bodies. In sensitive receiving waters, such as those identified in Figure 6-14, which have been identified as 'sensitive' due to high phosphorus levels, the larger sewage discharges into these areas must be treated to reduce their load of nutrients (tertiary treatment). This is implemented under the Urban Waste Water Treatment Regulations 1994, sewerage undertakers have to develop a programme for improving discharges every five years.

The Final Severn River Basin Management Plan also outlines mechanisms that can help to limit the pollution of water bodies by controlling point and diffuse sources and priority substances, these mechanisms include the use of discharge consents and the prosecution of people causing or knowingly permitting entry or discharge of pollution into controlled waters, both of which are outlined in the Water Resources Act 1991; building regulations, such as the use of SuDS; detergent regulations and pesticide regulations, tributyltin antifouling products were disapproved in 2003, leading to antifouling products being removed from the UK market.

Summary:

- **The proposed strategic site allocations could potentially impact upon water related SSSIs in the vicinity by increasing the pressure on water resources or increasing the risk of water pollution.**
- **New developers should maximise the water quality and amenity/ecological benefits when installing SuDS for surface water flood management especially as the water quality in the area requires improvement.**
- **Wetlands and ponds should be high priority SuDS choices for development sites near, but not restricted to, already established wetlands/ponds, especially SSSIs, as they can provide a local source of flora and fauna that may naturally colonise the new habitats.**
- **Infiltration techniques should be implemented where possible in Worcester and Droitwich Spa to assist with groundwater recharge, pollution should be prevented by good design and management.**
- **In line with the South Worcestershire Joint Core Strategy Strategic Flood Risk Assessment (SFRA) it is proposed to have a 20% green infrastructure area (disregarding gardens) on each of the proposed strategic site allocations. SuDS can provide ecological gain and in doing so have the potential to contribute towards the green infrastructure network in South Worcestershire.**
- **Severn Trent Water's Strategic Environmental Assessment states that screening exercises would also be required to determine whether pipeline or housing developments would be subject to an Environmental Impacts Assessment (EIA).**

6.6 Conclusion

6.6.1 Water Quality

The watercourses that flow through or near to the proposed strategic site allocations are currently failing to reach the WFD standards in terms of either their chemical or ecological quality (Table 6-5). The proposed developments can increase the pressure on the environment and water quality due to, for example, increased wastewater and associated nutrients and chemicals, as well as increasing the pressure on the aquatic habitat as water resources are already scarce. None of the proposed strategic site allocations are within groundwater protection zones and the current groundwater chemical quality is good, therefore in terms of pollution they are unlikely to have an adverse impact on the groundwater. However, several of the proposed strategic site allocations are above minor aquifers that are potentially 'sensitive' to pollution from any new development. The groundwater quantitative status is generally good apart from the area covering Worcester and Droitwich Spa.

Table 6-7: Summary of the Water Quality in the area relevant to the Proposed Strategic Site Allocations

Proposed Strategic Site Allocations	Chemical Water Quality of nearest watercourse	Ecological Water Quality of nearest watercourse	Groundwater Chemical Quality	Sewage Treatment
Worcester				
Worcester North West				
Worcester North				
Kilbury Drive				
Worcester South				
Fernhill Heath				
Droitwich Spa				
Hill End				
Pulley Lane				
Copcut Lane				
Great Malvern				
Malvern North				
Malvern East				
Malvern South				
Blackmore Park				
Pershore				
Pershore				
Evesham				
Offenham Road				
Cheltenham Road				
Hampton				

Legend:

- Failed the WFD standards/Poor Ecological Status/will require tighter treatment consent and upgrades to treatment processes to meet WFD 'no deterioration'.
- Moderate Ecological Status under the WFD standards/will require tighter consent and possibly require upgrades to treatment processes to meet WFD 'no deterioration'.
- Passed the WFD standards/Good Ecological Status/No new consents or upgrades required to meet 'no deterioration'.

6.6.2 Management

Management options such as SuDS should be utilised not only in terms of flood management but also for their water quality treatment and habitat potential. All of the allocations should be looking to install SuDs that help maintain or improve the water and ecological quality and groundwater recharge to the area. SSSIs that are nearby should not be adversely affected by new developments in terms of both water quality and water resources.

The Water Quality modelling undertaken has demonstrated that at Evesham and Worcester Sewage Treatment Works, there is likely to be no change in the levels of BOD, Ammonium and Phosphate downstream as a result of the proposed strategic site allocations. This contrasts to Powick and Droitwich Sewage Treatment Works, where an increase in contaminant levels is expected. Indicative future consents have been calculated. The limitations of this modelling and the need to confirm dwelling numbers should be considered before final consents are agreed.

The indicative future consents for Powick are:

- BOD – 10mg/l
- Ammonium – 1mg/l
- Phosphate – 2mg/l
- Upgrades to treatment facilities

In the case of Powick the level of developments proposed to the south of Worcester would represent an increase in DWF, and it is expected that improvements would be required to meet the resulting consent tightening. However, Severn Trent have stated that an alternative could be to extend the final effluent outfall from Powick STW to that it discharges directly to the River Severn. This is a distance of just over 1km across farmland and is considered feasible.

Severn Trent Water will be required to demonstrate that they can maintain the current level of treatment for Ammonium (95%tile) at Droitwich and Evesham. If this is can be maintained with the future DWF then there will be no need to impose a new consent on the treatment works. Consents would have to be revisited should it not be possible to maintain current levels of treatment at the future DWFs for the proposed strategic site allocations. The following are indicative consents should they be deemed necessary.

- Droitwich
    - Indicative new consent of 2mg/l, taking into consideration potential upstream water quality improvements due to being in a nitrate vulnerable zone.
    - Current level of treatment (1.2mg/l) should be maintained for future DWF to meet ‘no deterioration’ and ‘good status’ targets.
    - May require upgrades to treatment facilities if current level of treatment will not be maintained with increased DWF.

- Evesham
    - Discharge quality required to accommodate the full proposed strategic site allocations and achieve the targets is 18.7mg/l of Ammonium.
    - Indicative new consent of 20mg/l, taking into consideration potential upstream water quality improvements due to being in a nitrate vulnerable zone.
    - May require upgrades to treatment if discharge quality of 18.7mg/l is not achievable with current facilities at future maximum DWF.

In addition the focus on quality conditions in relation to consent, volumetric headroom has been analysed. Severn Trent Water has confirmed that spare headroom exists within existing consents at Powick, Evesham and Worcester. In the case of Worcester there is no DWF headroom under the current discharge consent. However, due to discrepancies in the measured DWF against the sizing of the plant indicates that there could be a problem with the measured DWF. Therefore, there may be some DWF volumetric headroom available, and Severn Trent Water will undertake detailed modelling when development pressure arises. Should it be deemed necessary from this analysis that an increase in

volumetric headroom will be required, Severn Trent Water will need to apply to increase the DWF volumetric consent. For instances in which spare headroom currently exists, but for which there is not capacity to accommodate the full allocations (such as Powick and Droitwich, see Table 4-11), a new consent will be required in the future. Application of this by Severn Trent Water will require review of the quality conditions above.

None of the indicative future consents required are below the BATs for sewage treatment. Therefore this modelling indicates that there are no potential 'show-stoppers' in terms of sewage treatment capacity. With regards to CSOs, no additional storm flow will be connected to the network, all will be attenuated using SUDS and then discharged to the nearest watercourse. Severn Trent Water will increase the capacity of the local sewer network should it be required to provide sufficient capacity for future DWF and ensure no additional discharges from CSOs above that of the current consent.

Local planning authorities and regional planning bodies can help to deliver WFD objectives by including policies on sustainable water management in their development plans, including policies in Regional Spatial Strategies (RSS), strategic policies in Core Strategies and other Development Plan Documents.

This page is intentionally left blank.

7 FLOOD RISK MANAGEMENT

7.1 Introduction

There are four main sources of flooding groundwater, surface water, fluvial and tidal. The South Worcestershire SFRA is the main source of information regarding the flood risk to the proposed strategic site allocations. The SFRA indicates that the main causes of flooding to the allocations are considered to be fluvial and surface water (either overland or from sewers). Flood risk from canal and reservoir breaches and groundwater were also considered. No tidal risk has been included as even though there can be a tidal influence on the River Severn as far as Worcester, the effect of fluvial flows is dominant.

Main rivers/watercourses are usually larger streams and rivers, however, they do include smaller rivers of local significance. Defra decides which rivers are classified as a main river. A main river can include any structure or appliance that controls or regulates the flow of water in, into, or out of, the main river. The Environment Agency carry out flood defense works on main rivers only.

An ordinary watercourse is every river, stream, ditch, drain, cut, dyke, sluice, sewer (other than a public sewer) and passage through which water flows and which does not form part of a main river. The local authority, or Internal Drainage Board where relevant, maintain and carry our flood defense works on ordinary watercourses.

Under the Land Drainage Act 1991, consent from the Environment Agency is required if you want to construct a culvert or flow control structure (such as a weir) on any watercourse.

The South Worcestershire SFRA has been prepared in line with current planning policy, specifically PPS25, for more information regarding the relevant planning policies please refer to the SFRA.

The Sequential Test is a key part of PPS25, which steers new development to areas at the lowest risk of flooding. It is the Environment Agency's view, in line with PPS25, that allocations should be made outside of the flood risk areas (i.e. in Flood Zone 1) wherever possible. If there are no reasonably appropriate Flood Zone 1 sites, allocations should be made in Flood Zone 2 first, considering flood risk vulnerability of land uses. Only where there are no reasonably available sites in Flood Zones 1 or 2 should Flood Zone 3 allocations be made. The information in this study has been sourced from the South Worcestershire SFRA, it is the SFRA that should be referred to by the Local Planning Authorities when carrying out a Sequential Test.

In addition, PPS25 also introduces the Exception Test which allows limited scope for departures from the sequential approach where development is essential to meet the wider aims of sustainable development. When the Exception Test is required, decision makers should apply it at the earliest stage in the preparation of all Local Development Documents (LDDs). All three elements of the Exception Test need to be passed before development is permitted. For more information on Sequential and Exception Tests please consult PPS25 and the South Worcestershire SFRA.

Any information regarding foul water sewer flooding has been sourced from Severn Trent Water's Growth Point Study.

7.1.1 Historical Flooding

Fluvial flooding has occurred in the South Worcestershire Joint Core Strategy area on several occasions in the past. The most recent noticeable events occurred in 1998, 2000, and 2007, when several hundred properties flooded on each occasion. The floods in 1998 were attributed to a large storm event whilst the November and December 2000 events were the largest flood events since 1947. In 2007, there were over 1,600 recorded incidents of flooding in Wychavon alone and nearly 200 properties flooded in Worcester. This particular event was a combination of fluvial and surface water flooding.

For further information about historical surface water flood events please refer to the surface water flood maps included in the following sections.

There have been no reports of groundwater flooding in the study area.

The following sections outline the flood risks to the proposed strategic site allocations in South Worcestershire.

7.2 Worcester - Kilbury Drive

7.2.1 Watercourses

The primary flood risk is from an ordinary watercourse flowing west to east across the centre of the proposed strategic site allocation that takes water from upstream of the site boundary. This watercourse is a tributary to Bow Brook, which is a main watercourse.

7.2.2 Fluvial Flood Risk

The proposed strategic site allocation is entirely situated within Flood Zone 1. The Environment Agency generally opposes the use of culverts due to their environmental impacts and prefer it if watercourses remain as open channels, especially when the catchment extends upstream of the proposed strategic site allocation. The watercourse flowing through the Kilbury Drive allocation would therefore need to be preserved as an open channel and remain in its current position. A flood risk assessment would be required to evaluate the flood risk from the watercourse and establish the actual flood risk to the site. In line with the SFRA a minimum 8m maintenance access corridor either side of the watercourse is required. This may be reduced in particular circumstances with agreement from the Environment Agency or Local Authority.

7.2.3 Groundwater Flood Risk

The South Worcestershire SFRA indicates there is no record of any groundwater flooding within the proposed strategic site allocation. Groundwater flooding is not considered to pose a significant risk to the site.

7.2.4 Surface Water Flood Risk to the Proposed Strategic Site Allocation

There are records of historical surface water flooding on the western boundary of the proposed strategic site allocation (Figure 7-1). With further development and creation of impermeable ground surfaces, surface water flooding may become a problem to the rest of the site. Figure 7-1 provides an indication of the vulnerability of the proposed strategic site allocation to surface water flooding, these maps were determined by modelling the topography and rainfall intensity for the area. For more information please refer to the South Worcestershire SFRA. The site layout should take into account the risk of overland flow from impermeable surfaces and residual flooding by directing it away from vulnerable properties.

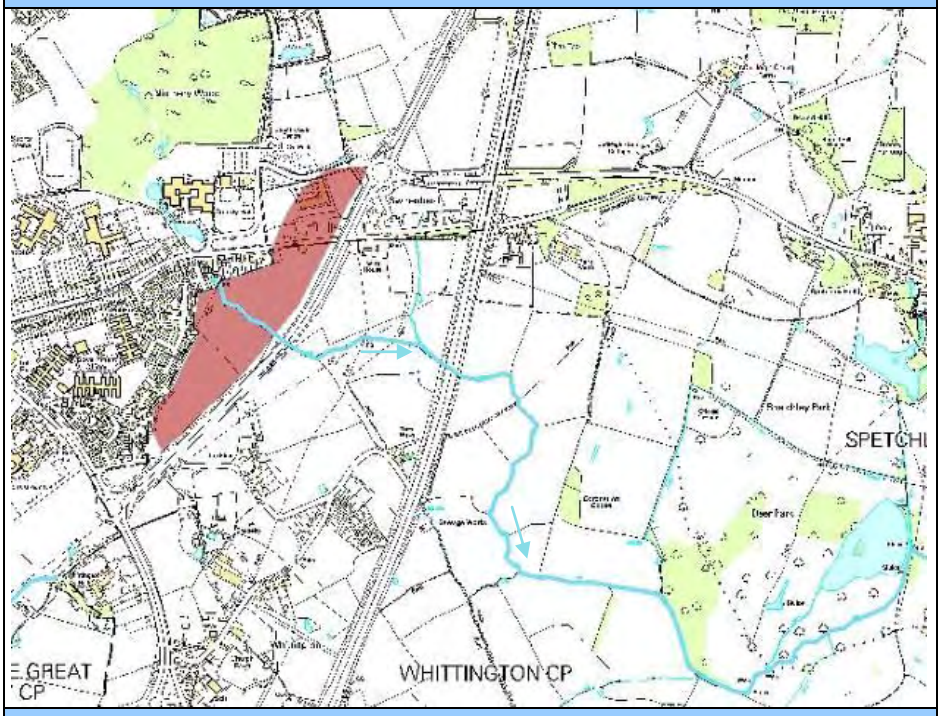
7.2.5 Surface Water Flood Risk from the Proposed Strategic Site Allocation

To prevent any future development within the proposed strategic site allocation from increasing the flood risk downstream, surface water flow rates from the proposed strategic site allocation should be restricted to existing Greenfield runoff rates. Consultation with the local authority and the Environment Agency should be undertaken at an early stage. Surface Water should be disposed of where possible via infiltration techniques. The proposed strategic site allocation is situated on poorly draining clay, which indicates that it is unlikely infiltration techniques would be appropriate, however, a site specific investigation would be required to confirm the soil type and whether the ground conditions are suitable. If it is found that infiltration techniques are not suitable, surface water should be discharged into the ordinary watercourse via appropriate attenuation schemes, rather than into the existing sewer network, this is supported by Severn Trent Water in their Growth Point Study.

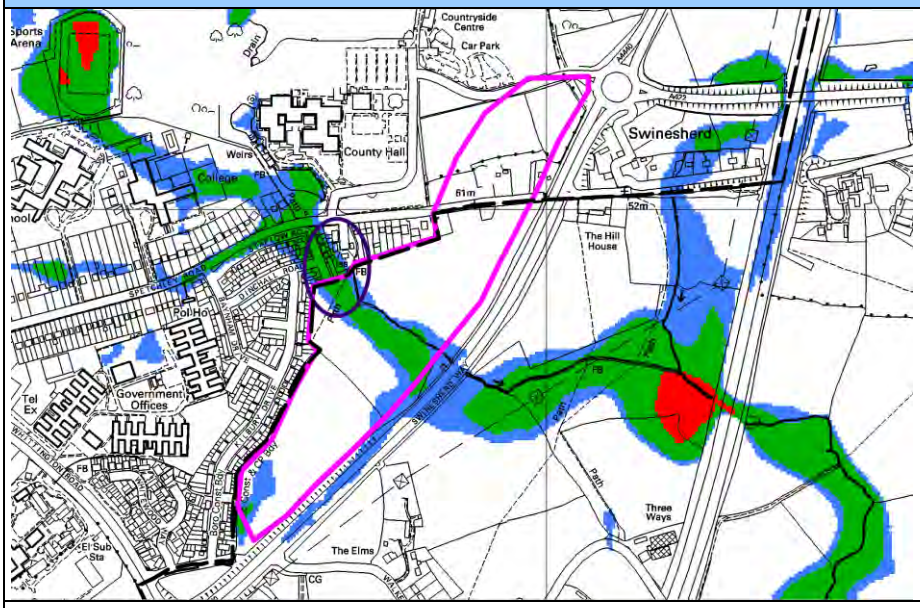
SuDS should be used to attenuate the surface water runoff. Details of SuDS Techniques available can be found in Section 7.20.

Figure 7-1: Kilbury Drive – Watercourses and Surface Water Flooding

Watercourses



Surface Water Flood Risk and Historical Flooding



7.3 Worcester South

7.3.1 Watercourses

The River Severn, a main watercourse, flows north to south along the eastern border of the proposed strategic site allocation (Figure 7-2). Hatfield Brook, an ordinary watercourse, flows from east to west through the southeast corner of the proposed strategic site allocation. A tributary to Hatfield Brook flows north to south through the western area of the proposed strategic site allocation, the confluence with Hatfield Brook is within the site boundary. There are several minor watercourses within the site boundary.

7.3.2 Fluvial Flood Risk

The proposed strategic site allocation is predominantly situated within Flood Zone 1, however a small area adjacent to the River Severn is within Flood Zones 2 and 3. There is a risk of fluvial flooding from the River Severn and possibly from Hatfield Brook. There will be restrictions to development in the floodplain adjacent to the River Severn and Hatfield Brook, which should be retained as an open channel. A detailed assessment of the River Severn and Hatfield Brook is required to establish the actual flood risk and will indicate whether there will be restrictions to development. The Environment Agency requires an 8m maintenance corridor adjacent to the left bank of the River Severn. In line with the SFRA a minimum 8m maintenance access corridor either side of the watercourse is required. This may be reduced in particular circumstances with agreement from the Environment Agency or Local Authority.

Hatfield Brook's tributary within the proposed strategic site allocation may possibly be incorporated into the on-site infrastructure if it was confirmed that there is no upstream catchment outside of the site boundary.

7.3.3 Groundwater Flood Risk

The South Worcestershire SFRA indicates there is no record of any groundwater flooding within the proposed strategic site allocation. Groundwater flooding is not considered to pose a significant risk to the site.

7.3.4 Surface Water Flood Risk to the Proposed Strategic Site Allocation

There is a risk from surface water flooding, particularly with the effects of future climate change. There has been historical surface water flooding within the proposed strategic site allocation boundary and to the north (Figure 7-2). With further development and creation of impermeable ground surfaces, surface water flooding may become a problem. The site layout should take into account the risk of overland flow from impermeable surfaces and residual flooding by directing it away from vulnerable properties.

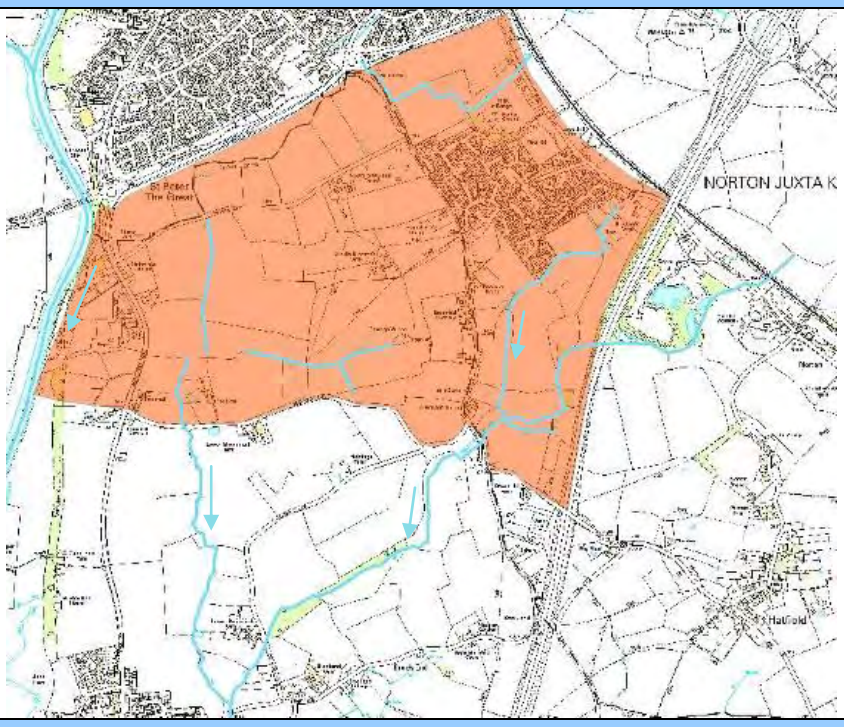
The Environment Agency has identified that there is a problem of fluvial flooding from Hatfield Brook downstream of Worcester South in Kempsey. The Environment Agency is considering a flood alleviation scheme for the village, however they still require surface water flows from new developments to be attenuated to greenfield runoff rates. Any surface water drainage solution should take fully into account the flooding issues downstream at Kempsey.

7.3.5 Surface Water Flood Risk from the Proposed Strategic Site Allocation

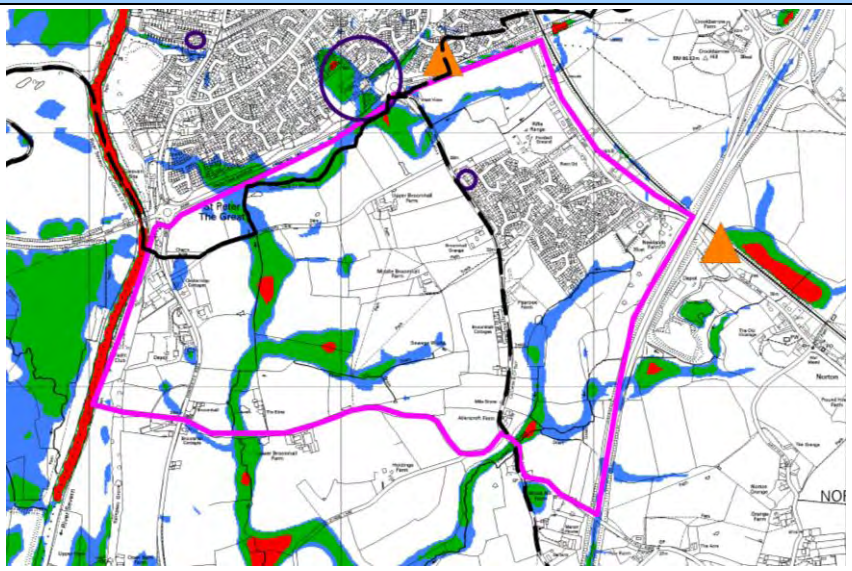
Surface water should be disposed of where possible via infiltration techniques. The proposed strategic site allocation is situated on poorly drained clay soil and as such infiltration techniques are unlikely to be suitable, however a site specific investigation would be required to confirm the soil type and whether the ground conditions are suitable. If it is found that infiltration techniques are not suitable, surface water should be discharged where possible directly into the River Severn watercourse via appropriate attenuation schemes, rather than into Hatfield Brook due to the existing flood problems downstream. Discharge into the watercourse rather than into the existing sewer network is supported by Severn Trent Water as outlined in their Growth Point Study. SuDS should be used to attenuate the surface water runoff (see Section 7.20).

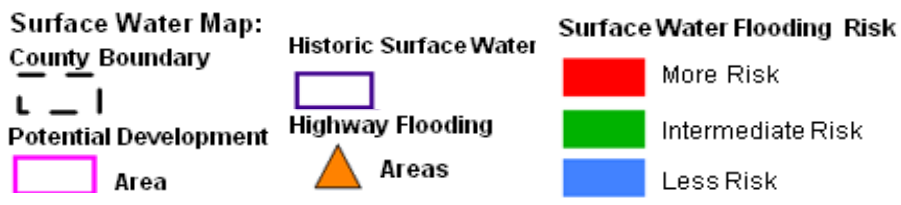
Figure 7-2: Worcester South – Watercourses and Surface Water Flooding

Watercourses



Surface Water Flood Risk and Historical Flooding





7.4 Worcester North West

7.4.1 Watercourses

Laughern Brook, a main watercourse, flows from the north to south through an area in the north of the proposed strategic site allocation and along the eastern border for most of the allocation. There are also several smaller tributaries traversing the site from west to east towards Laughern Brook (Figure 7-3).

7.4.2 Fluvial Flood Risk

The proposed strategic site allocation is situated predominantly within Flood Zone 1, however a small area in the north of the proposed strategic site allocation adjacent to Laughern Brook is within Flood Zones 2 and 3. There is potentially a fluvial flood risk from Laughern Brook and the smaller tributaries that traverse the allocated area. A detailed flood risk assessment of Laughern Brook will be required to assess the extent of actual flood risk to the site. Restrictions to development on the floodplain will need to be taken into account. In line with the SFRA a minimum 8m maintenance access corridor either side of the watercourse is required. This may be reduced in particular circumstances with agreement from the Environment Agency or Local Authority.

The two small tributaries in the north of the site may possibly be incorporated into the on-site infrastructure if there is no upstream catchment associated with the watercourses outside of the proposed strategic site allocation's boundary.

The two small tributaries in the southern area of the proposed strategic site allocation would need to remain as open channels in line with the Environment Agency's policy to maintain open watercourses and prevent culverting. These tributaries will need to be assessed within a flood risk assessment to determine whether they pose a flood risk to the site. There are several pond features in the south of the site. These should be retained where possible as they would have both amenity and ecological benefits to the proposed strategic site allocation and could possibly be incorporated in line with the required open space provision. The smaller tributaries that are maintained should have a minimum 8m maintenance access corridor either side of the watercourse. This may be reduced in particular circumstances with agreement from the Environment Agency or Local Authority.

7.4.3 Groundwater Flood Risk

The South Worcestershire SFRA indicates that there is no record of any groundwater flooding within the proposed strategic site allocation. Groundwater flooding is not considered to pose a significant risk to the site.

7.4.4 Surface Water Flood Risk to the Proposed Strategic Site Allocation

There has been historical flooding to the west and east of the proposed strategic site allocation's boundary The closest occurrence of surface water flooding was on the eastern boundary (Figure 7-3) Surface water flooding may be a problem in some parts of the proposed strategic site allocation (Figure 7-3). The site layout should take into account the risk of overland flow from impermeable surfaces and residual flooding by directing it away from vulnerable properties.

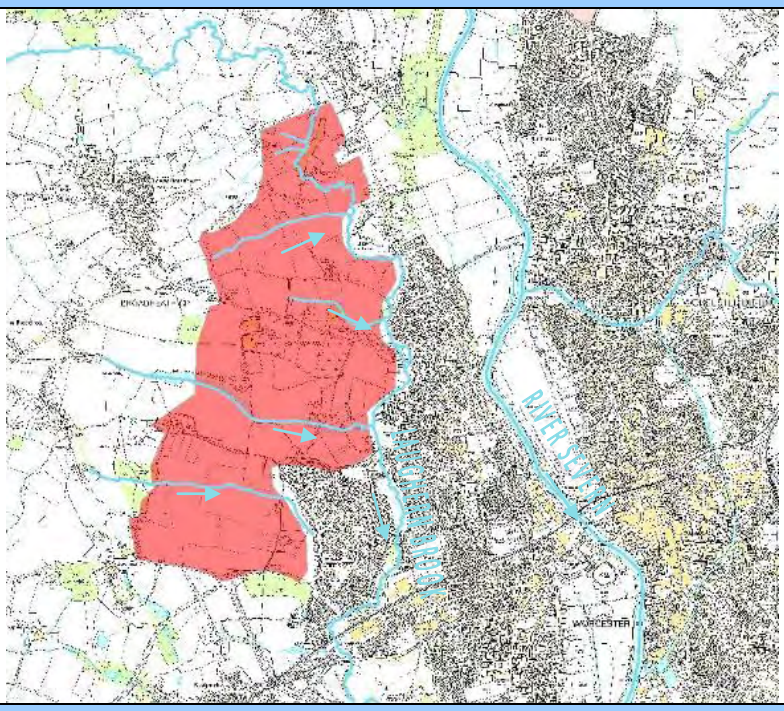
7.4.5 Surface Water Flood Risk from the Proposed Strategic Site Allocation

Surface water flow rates should be restricted to existing Greenfield runoff rates. Consultation with the local authority and the Environment Agency should be undertaken at an early stage. Surface water should be disposed of where possible via infiltration techniques. The soil type within the proposed strategic site allocation's boundary is mainly poorly drained clay with some sandy soils, therefore infiltration techniques may be appropriate in some areas. A site specific investigation would be required to confirm the soil type and whether the ground conditions are suitable. If it is found that infiltration techniques are not suitable, surface water should be discharged into the Laughern Brook either directly through appropriate attenuation schemes or via the existing tributaries and appropriate attenuation schemes, rather than into the existing sewer network, this is supported by Severn Trent Water in their Growth Point Study.

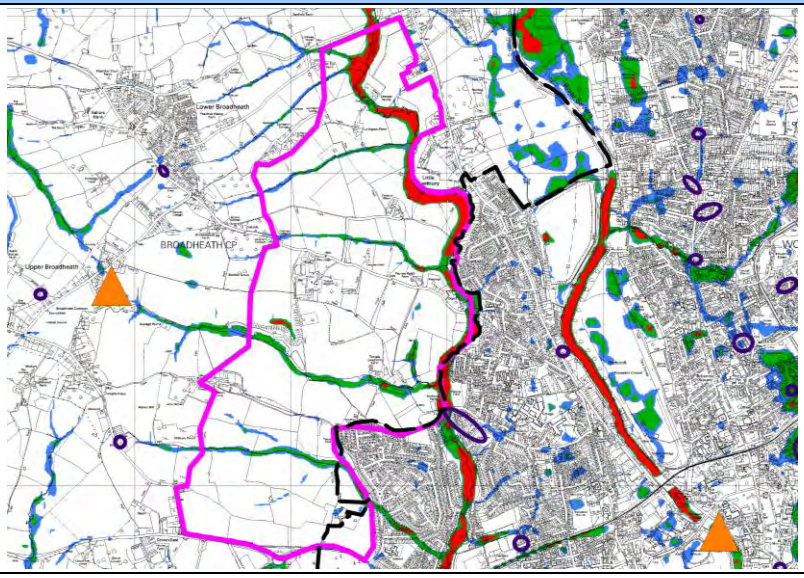
SuDS should be used to attenuate the surface water runoff (see Section 7.20).

Figure 7-3 Worcester North West – Watercourses and Surface Water Flooding

Watercourses



Surface Water Flood Risk and Historical Flooding



Surface Water Map:
County Boundary
Potential Development Area
Historic Surface Water
Highway Flooding Areas
Surface Water Flooding Risk
More Risk
Intermediate Risk
Less Risk

7.5 Worcester North

7.5.1 Watercourses

There is no watercourse traversing the proposed strategic site allocation. There is an ordinary watercourse that flows to the north west of the proposed strategic site allocation and into the River Severn (Figure 7-4). The Environment Agency has advised that it is possible that a culverted watercourse runs through the proposed strategic site allocation. In light of this developers must look at the opportunity of opening the culvert up.

7.5.2 Fluvial Flood Risk

The proposed strategic site allocation is situated entirely within Flood Zone 1. Depending on whether a culverted watercourse is present, and it is converted to an open watercourse, a detailed flood risk assessment may be required to determine the 100+CC flood zone of the watercourse. A site investigation would be required to determine if the watercourse is present. There is also a possible fluvial flood risk from the ordinary watercourse to the north west of the proposed strategic site allocation. This would also require a detailed flood risk assessment.

7.5.3 Groundwater Flood Risk

The South Worcestershire SFRA indicates that there is no record of any groundwater flooding within the proposed strategic site allocation location. Groundwater flooding is not considered to pose a significant risk to the site.

7.5.4 Surface Water Flood Risk to the Proposed Strategic Site Allocation

The primary risk to the proposed strategic site allocation is from overland surface water. With further development and creation of impermeable ground surfaces, surface water flooding may become a problem. There are no historical records of surface water flooding within the vicinity of the proposed strategic site allocation (Figure 7-4). The site layout should take into account the risk of overland flow from impermeable surfaces and residual flooding by directing it away from vulnerable properties.

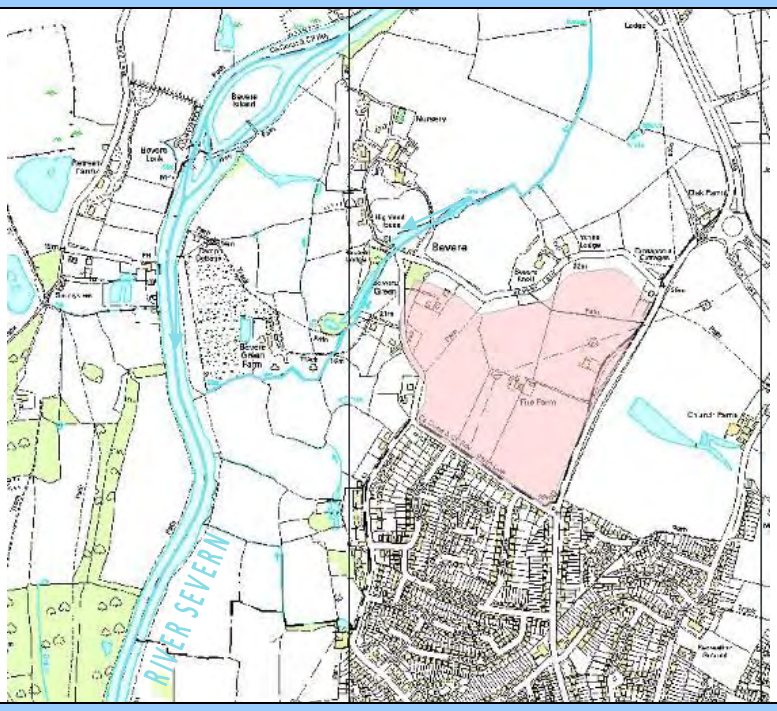
7.5.5 Surface Water Flood Risk from the Proposed Strategic Site Allocation

Surface water flow rates should be restricted to existing Greenfield runoff rates. Consultation with the local authority and the Environment Agency should be undertaken at an early stage. Surface water should be disposed of where possible via infiltration techniques. The proposed strategic site allocation is situated mainly on silty soils and some poorly drained clay soils, indicating that infiltration techniques may be suitable in some areas. A site specific investigation would be required to confirm the soil type and whether the ground conditions are suitable. If it is found that infiltration techniques are not suitable, surface water should be discharged into directly into a watercourse via appropriate attenuation schemes, rather than into the existing sewer network, this is supported by Severn Trent Water in their Growth Point Study. If it is found that there is an culverted watercourse through the proposed strategic site allocation and it is converted to an open watercourse then surface water should be discharged to this via appropriate attenuation schemes, if the watercourse outfalls to the River Severn. If no suitable watercourse is found on site, surface water will need to be discharged to the ordinary watercourse approximately 180m to the north west of the proposed strategic site allocation. This would require additional off-site infrastructure.

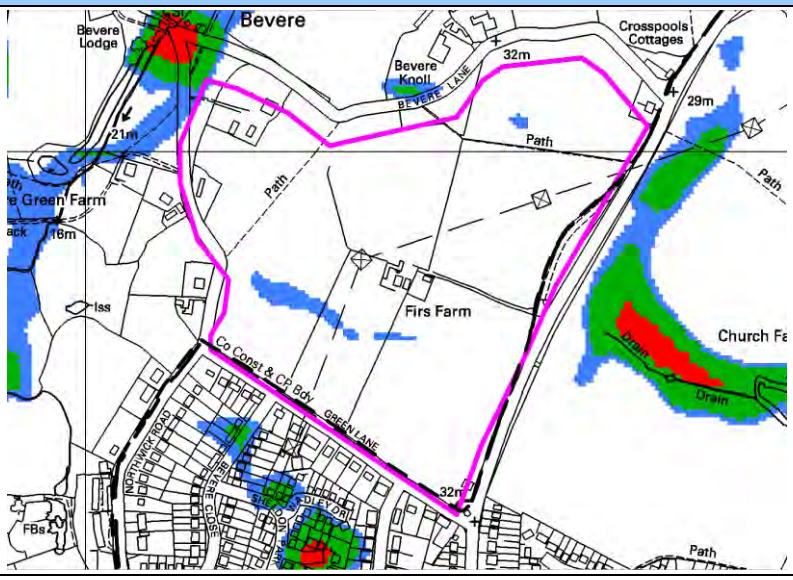
SuDS should be used to attenuate the surface water runoff. Details of SuDS Techniques available can be found in Section 7.20.

Figure 7-4: Worcester North – Watercourses and Surface Water Flooding

Watercourses



Surface Water Flood Risk and Historical Flooding



Surface Water Map:

County Boundary

Potential Development Area

Historic Surface Water

Highway Flooding Areas

Surface Water Flooding Risk

More Risk

Intermediate Risk

Less Risk

7.6 Worcester - Fernhill Heath

7.6.1 Watercourses

There are no obvious watercourses traversing the proposed strategic site allocation. There is a minor watercourse, a tributary to Martin Brook, which flows south to north from the northern boundary (Figure 7-5). Martin Brook flows to the east of the proposed strategic site allocation and is a tributary to the River Salwarpe.

7.6.2 Fluvial Flood Risk

The proposed strategic site allocation is situated entirely within Flood Zone 1. There may be a fluvial flood risk from the tributary to the north of the proposed strategic site allocation, this would need to be hydraulically assessed in a flood risk assessment to determine actual flood risk to the site.

7.6.3 Groundwater Flood Risk

The South Worcestershire SFRA indicates that there is no record of any groundwater flooding within the proposed strategic site allocation location. Groundwater flooding is not considered to pose a significant risk to the site.

7.6.4 Surface Water Flood Risk to the Proposed Strategic Site Allocation

The primary flood risk to Fernhill Heath is from overland surface water. The proposed strategic site allocation is situated on poorly drained clay which has the potential to produce a high amount of runoff. Further development and the creation of impermeable ground surfaces may mean surface water flooding becomes a problem. There have been instances of historical surface water flooding to the south east of the proposed strategic site allocation as shown in Figure 7-5. The site layout should take into account the risk of overland flow from impermeable surfaces and residual flooding by directing it away from vulnerable properties.

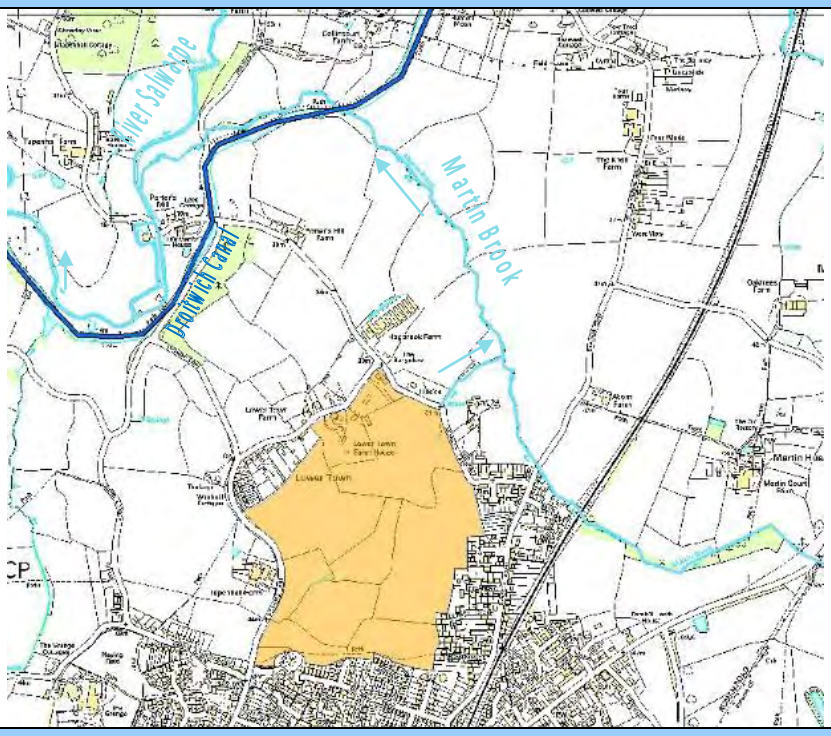
7.6.5 Surface Water Flooding from the Propsoed Strategic Site Allocation

Surface water flow rates should be restricted to existing Greenfield runoff rates. Consultation with the local authority and the Environment Agency should be undertaken at an early stage. Surface water should be disposed of where possible via infiltration techniques. The proposed strategic site allocation is situated on poorly drained clay and it is therefore unlikely that infiltration will be an acceptable method, however, a site specific investigation would be required to confirm the soil type and whether the ground conditions are suitable. If it is found that infiltration techniques are not suitable, surface water should be discharged into directly into the small tributary on the northern border that flows into Martin Brook via appropriate attenuation schemes, rather than into the existing sewer network, this is supported by Severn Trent Water in their Growth Point Study. If this is not possible then surface water will need to be discharged to the ordinary watercourse to the north east of the proposed strategic site allocation. This would require additional off-site infrastructure.

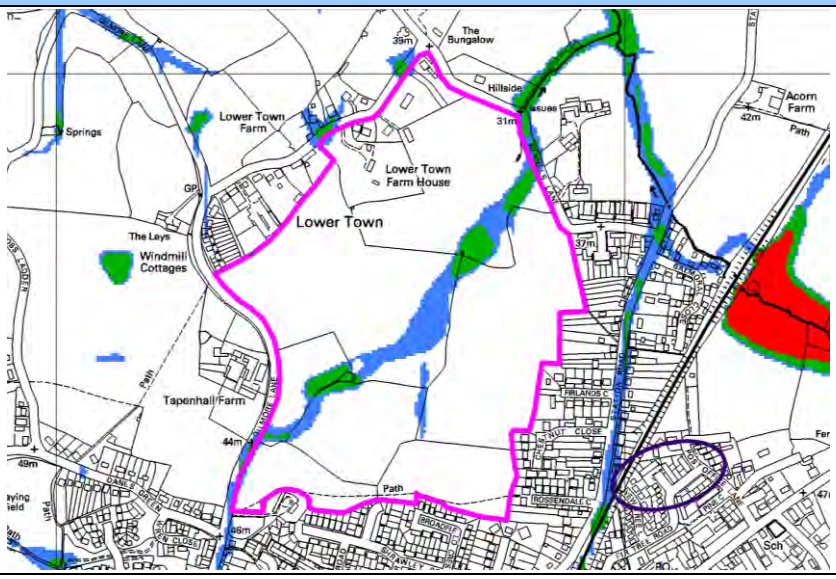
SuDS should be used to attenuate the surface water runoff. Details of SuDS Techniques available can be found in Section 7.20.

Figure 7-5: Fernhill Heath - Watercourses and Surface Water Flooding

Watercourses



Surface Water Flood Risk and Historical Flooding



Surface Water Map:

County Boundary

Potential Development Area

Historic Surface Water Highway Flooding Areas

Surface Water Flooding Risk

More Risk

Intermediate Risk

Less Risk

7.7 Droitwich Spa – Hill End

7.7.1 Watercourses

A main watercourse, the River Salwarpe, flows north to south. The River Salwarpe enters the proposed strategic site allocation at the north east corner and continues along the eastern boarder (Figure 7-6).

7.7.2 Fluvial Flood Risk

The proposed strategic site allocation is predominantly within Flood Zone 1, though a small area in the east of the proposed strategic site allocation adjacent to the River Salwarpe is within Flood Zones 2 and 3. The main fluvial flood risk is from the River Salwarpe. A detailed flood risk assessment of the River Salwarpe will be required to assess the actual flood risk to the site. Restrictions to development on the floodplain will need to be taken into account. In line with the SFRA a minimum 8m maintenance access corridor either side of the watercourse is required. This may be reduced in particular circumstances with agreement from the Environment Agency or Local Authority.

7.7.3 Groundwater Flood Risk

The South Worcestershire SFRA indicates that there is no record of any groundwater flooding within the proposed strategic site allocation location. Groundwater flooding is not considered to pose a significant risk to the site.

7.7.4 Surface Water Flood Risk to the Proposed Strategic Site Allocation

There are no historical records of surface water flooding within or in the vicinity of the proposed strategic site allocation. There is a risk of surface water flooding becoming a problem with further development and the creation of impermeable ground surfaces. Figure 7-6 indicates the areas that are most vulnerable to surface water flooding. The site layout should take into account the risk of overland flow from impermeable surfaces and residual flooding by directing it away from vulnerable properties.

7.7.5 Surface Water Flood Risk from the Proposed Strategic Site Allocation

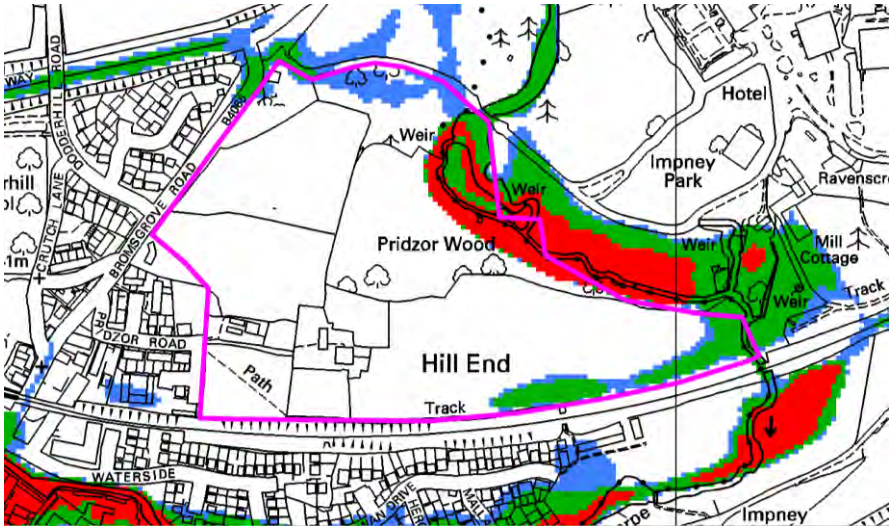
Surface water flow rates should be restricted to existing Greenfield runoff rates. Consultation with the local authority and the Environment Agency should be undertaken at an early stage. Surface water should be disposed of where possible via infiltration techniques. The soil type within the proposed strategic site allocation's boundary is poorly drained clay, therefore infiltration techniques are likely to be inappropriate for this area, however, a site specific investigation would be required to confirm the soil type and whether the ground conditions are suitable or not. If it is found that infiltration techniques are not suitable, surface water should be discharged into the River Salwarpe directly via appropriate attenuation schemes, rather than into the existing sewer network.

SuDS should be used to attenuate the surface water runoff. Details of SuDS Techniques available can be found in Section 7.20.

Figure 7-6 Hill End - Watercourses and Surface Water Flooding

Watercourses

Surface Water Flood Risk and Historical Flooding



Surface Water Map:

County Boundary

Potential Development Area

Historic Surface Water Highway Flooding Areas

Surface Water Flooding Risk

More Risk

Intermediate Risk

Less Risk

7.8 Droitwich Spa – Pulley Lane

7.8.1 Watercourses

There are no obvious watercourses within the proposed strategic site allocation's boundary. There are three ordinary watercourses nearby, one to the east on the other side of the M5 motorway, one to the west, flowing east to west through the urban outskirts of Droitwich Spa and one to the south, flowing south to north (Figure 7-7).

7.8.2 Fluvial Flood Risk

The proposed strategic site allocation is situated entirely within Flood Zone 1, there are no watercourses within the boundary and the nearest watercourse is approximately 260m to the north west of the proposed strategic site allocation. Therefore, there is little risk of fluvial flooding to the proposed strategic site allocation. The flood risk to the proposed strategic site allocation from fluvial and other sources of flooding would need to be assessed for development proposals comprising one hectare or above.

7.8.3 Groundwater Flood Risk

The South Worcestershire SFRA indicates that there is no record of any groundwater flooding within the proposed strategic site allocation. Groundwater flooding is not considered to pose a significant risk to the site.

7.8.4 Surface Water Flood Risk to the Proposed Strategic Site Allocation

There are no historical records of surface water flooding within or in the vicinity of the proposed strategic site allocation. There is a risk of surface water flooding becoming a problem with further development and the creation of impermeable ground surfaces. Figure 7-7 indicates the areas that are most vulnerable to surface water flooding. The site layout should take into account the risk of overland flow from impermeable surfaces and residual flooding by directing it away from vulnerable properties.

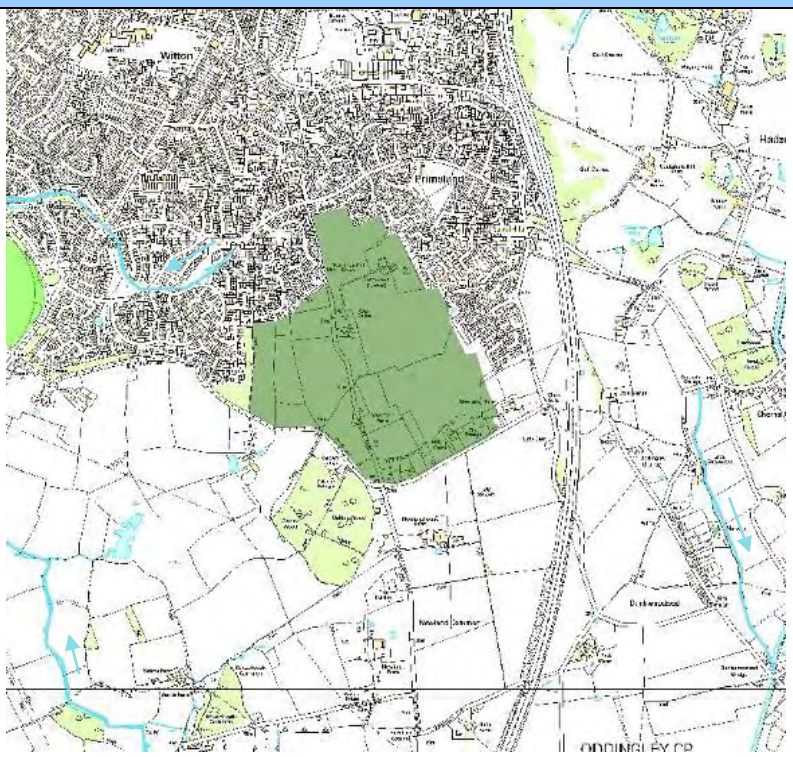
7.8.5 Surface Water Flood Risk from the Proposed Strategic Site Allocation

Surface water flow rates should be restricted to existing Greenfield runoff rates. Consultation with the local authority and the Environment Agency should be undertaken at an early stage. Surface water should be disposed of where possible via infiltration techniques. The soil type within the proposed strategic site allocation's boundary is poorly drained clay, therefore infiltration techniques are likely to be inappropriate for this area, however, a site specific investigation would be required to confirm the soil type and whether the ground conditions are suitable or not. If it is found that infiltration techniques are not suitable, surface water should be discharged into the watercourse via appropriate attenuation schemes, rather than into the existing sewer network. There is no suitable watercourse within the boundary to receive surface water and the nearest watercourse, 250m to the northwest is within the urban extent and would not be recommended as an option. The two other watercourses are approximately 720m to the east and 950m to the southwest, both would require significant off-site infrastructure. Direct discharge to surface water sewers will not be permitted.

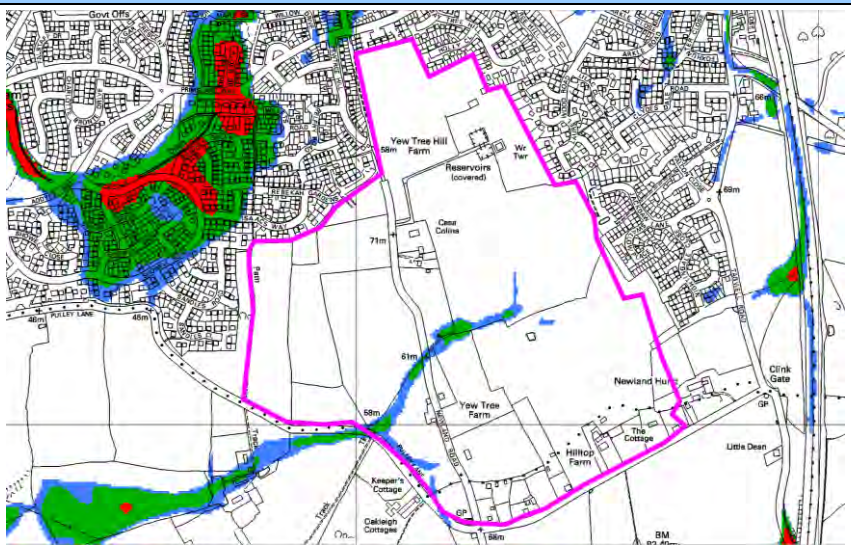
SuDS should be used to attenuate the surface water runoff. Details of SuDS Techniques available can be found in Section 7.20.

Figure 7-7: Pulley Lane - Watercourses and Surface Water Flooding

Watercourses



Surface Water Flood Risk and Historical Flooding



Surface Water Map:

County Boundary

Potential Development Area

Historic Surface Water Highway Flooding Areas

Surface Water Flooding Risk

More Risk

Intermediate Risk

Less Risk

7.9 Droitwich Spa – Copcut Lane

7.9.1 Watercourses

There is an ordinary watercourse that flows through the northern area of the proposed strategic site allocation from east to west and joins the River Salwarpe after crossing the Droitwich Canal (Figure 7-8). There is a further ordinary watercourse that flows to the south in an east – west direction.

7.9.2 Fluvial Flood Risk

The proposed strategic site allocation is within Flood Zone 1. There is a risk of fluvial flooding from the ordinary watercourse that flows through the north of the proposed strategic site allocation. This watercourse would need to be hydrologically modelled to assess the actual flood risk to the site from the watercourse. In line with the SFRA a minimum 8m maintenance access corridor either side of the watercourse is required. This may be reduced in particular circumstances with agreement from the Environment Agency or Local Authority.

The watercourse within the boundary should be maintained as an open channel. There is a possibility that it could be diverted to the northern boundary, nevertheless the watercourse would need to be designed to maintain a natural appearance and be environmentally sustainable.

7.9.3 Groundwater Flood Risk

The South Worcestershire SFRA indicates that there is no record of any groundwater flooding within the proposed strategic site allocation. Groundwater flooding is not considered to pose a significant risk to the site.

7.9.4 Surface Water Flood Risk to the Proposed Strategic Site Allocation

There are no historical records of surface water flooding within or in the vicinity of the proposed strategic site allocation. There is a risk of surface water flooding becoming a problem with further development and the creation of impermeable ground surfaces. Figure 7-8 indicates the areas that are most vulnerable to surface water flooding. The site layout should take into account the risk of overland flow from impermeable surfaces and residual flooding by directing it away from vulnerable properties.

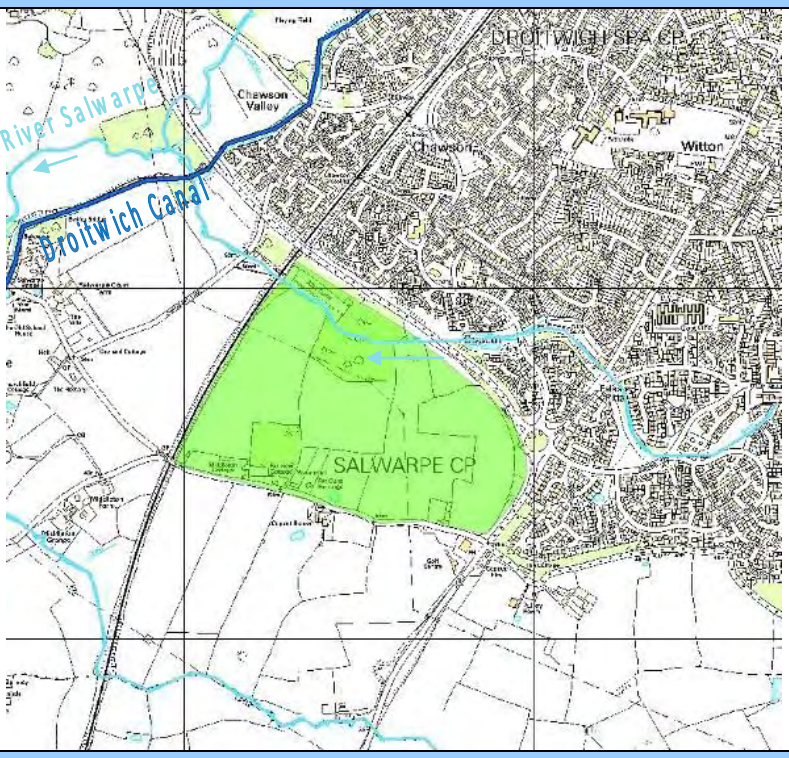
7.9.5 Surface Water Flood Risk from the Proposed Strategic Site Allocation

Surface water flow rates should be restricted to existing Greenfield runoff rates. Consultation with the local authority and the Environment Agency should be undertaken at an early stage. Surface water should be disposed of where possible via infiltration techniques. The soil type within the proposed strategic site allocation's boundary is poorly drained clay, therefore infiltration techniques are likely to be inappropriate for this area. A site specific investigation would be required to confirm the soil type and whether the ground conditions are suitable or not. If it is found that infiltration techniques are not suitable, surface water should be discharged into the ordinary watercourse on site via appropriate attenuation schemes, rather than into the existing sewer network.

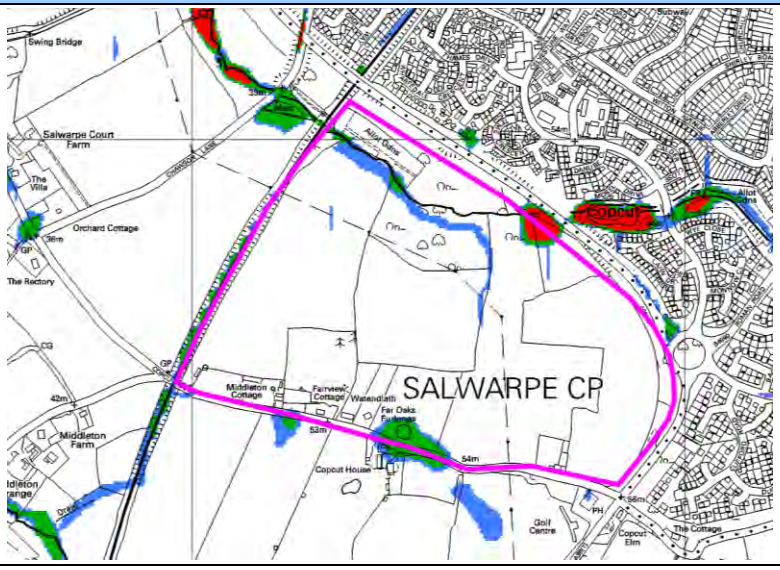
SuDS should be used to attenuate the surface water runoff. Details of SuDS Techniques available can be found in Section 7.20.

Figure 7-8: Copcut Lane - Watercourses and Surface Water Flooding

Watercourses



Surface Water Flood Risk and Historical Flooding



Surface Water Map:

County Boundary

Potential Development Area

Historic Surface Water Highway Flooding Areas

Surface Water Flooding Risk

More Risk

Intermediate Risk

Less Risk

7.10 Great Malvern – Malvern North

7.10.1 Watercourses

Whippets Brook, an ordinary watercourse, flows on the opposite side of the railway line that forms the eastern border of the proposed strategic site allocation. There is an ordinary watercourse, a tributary to Whippets Brook, which begins near the northern boundary on the opposite side of Stocks Lane. There is a further ordinary watercourse to the south that flows west to east through the urban fringes of Great Malvern (Figure 7-9).

7.10.2 Fluvial Flood Risk

The proposed strategic site allocation is within Flood Zone 1 and there are no obvious watercourses within the boundary. However, there is a potential risk of fluvial flooding from the ordinary watercourses to the north and south of the proposed strategic site allocation. These would need to be assessed further to determine their actual flood risk.

7.10.3 Groundwater Flood Risk

The South Worcestershire SFRA indicates that there is no record of any groundwater flooding within the proposed strategic site allocation. Groundwater flooding is not considered to pose a significant risk to the site.

7.10.4 Surface Water Flood Risk to the Proposed Strategic Site Allocation

With the exception of an area of road to the west of the proposed strategic site allocation that is susceptible to flooding, there are no historical records of surface water flooding within or in the vicinity of the proposed strategic site allocation. There is a risk of surface water flooding becoming a problem with further development and the creation of impermeable ground surfaces. Figure 7-9 indicates the areas that are most vulnerable to surface water flooding. The site layout should take into account the risk of overland flow from impermeable surfaces and residual flooding by directing it away from vulnerable properties.

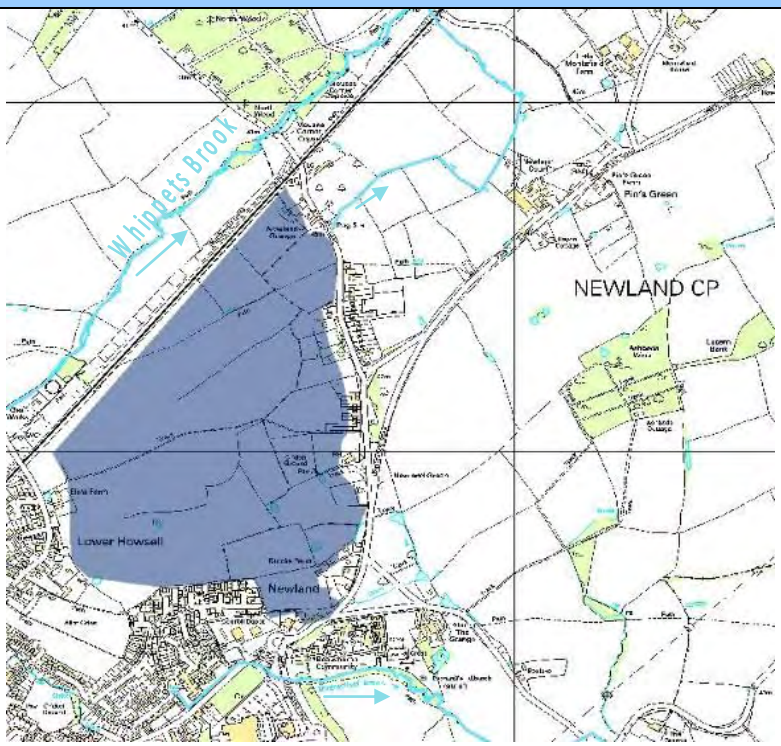
7.10.5 Surface Water Flood Risk from the Proposed Strategic Site Allocation

Surface water flow rates should be restricted to existing Greenfield runoff rates. Consultation with the local authority and the Environment Agency should be undertaken at an early stage. Surface water should be disposed of where possible via infiltration techniques. The soil type within the proposed strategic site allocation's boundary is poorly drained clay, therefore infiltration techniques are likely to be inappropriate for this area. A site specific investigation would be required to confirm the soil type and whether the ground conditions are suitable or not. If it is found that infiltration techniques are not suitable, surface water should be discharged into Whippet Brook by the existing tributary to the north of site, which may require some off-site infrastructure, or via a new off-site sewer, rather than into the existing sewer network. Either solution would require routing through appropriate attenuation schemes.

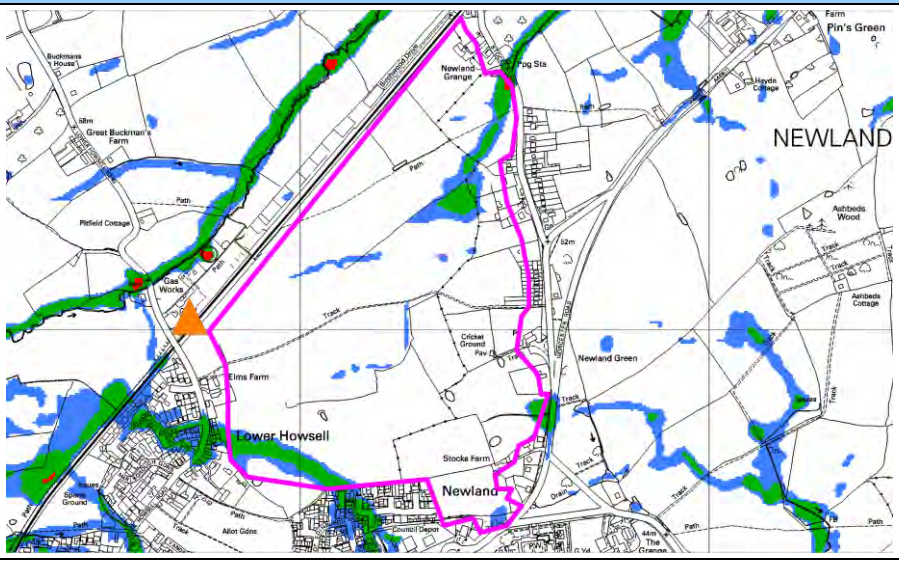
SuDS should be used to attenuate the surface water runoff. Details of SuDS Techniques available can be found in Section 7.20.

Figure 7-9: Malvern North - Watercourses and Surface Water Flooding

Watercourses



Surface Water Flood Risk and Historical Flooding



Surface Water Map:

County Boundary

Potential Development Area

Historic Surface Water Highway Flooding Areas

Surface Water Flooding Risk

More Risk

Intermediate Risk

Less Risk

7.11 Great Malvern – Malvern East

7.11.1 Watercourses

Whiteacres Brook flows through the north of the proposed strategic site allocation from west to east, and a tributary to Whiteacres Brook flows through the south of the area from west to east, both are classified as ordinary watercourses. There is also a network of minor watercourses and water features, (e.g. moat pond), in the southern area of the proposed strategic site allocation (Figure 7-10).

7.11.2 Fluvial Flood Risk

The proposed strategic site allocation is almost entirely within Flood Zone 1. The primary fluvial flood risk to the area is from Whiteacres Brook with a further risk from the tributary and network of watercourses in the south of the site. All watercourses traversing the proposed strategic site allocation area would need to be assessed in detail through hydrological modelling to determine the actual flood risk and any restrictions to development.

The watercourses should be retained as open channels. Where possible the minor watercourse flowing north to south within the boundary and the associated water features should be retained as they may provide ecological and amenity benefits and could possibly be used in line with open space provision. In line with the SFRA a minimum 8m maintenance access corridor either side of the watercourse is required. This may be reduced in particular circumstances with agreement from the Environment Agency or Local Authority.

7.11.3 Groundwater Flood Risk

The South Worcestershire SFRA indicates that there is no record of any groundwater flooding within the proposed strategic site allocation. Groundwater flooding is not considered to pose a significant risk to the site.

7.11.4 Surface Water Flood Risk to the Proposed Strategic Site Allocation

There are several historical records of surface water flooding in the urban area to the west of the proposed strategic site allocation, two of which occur on the border. There is a risk that surface water flooding will become a problem in with further development and the creation of impermeable ground surfaces. Figure 7-10 indicates the areas that are most vulnerable to surface water flooding. The site layout should take into account the risk of overland flow from impermeable surfaces and residual flooding by directing it away from vulnerable properties.

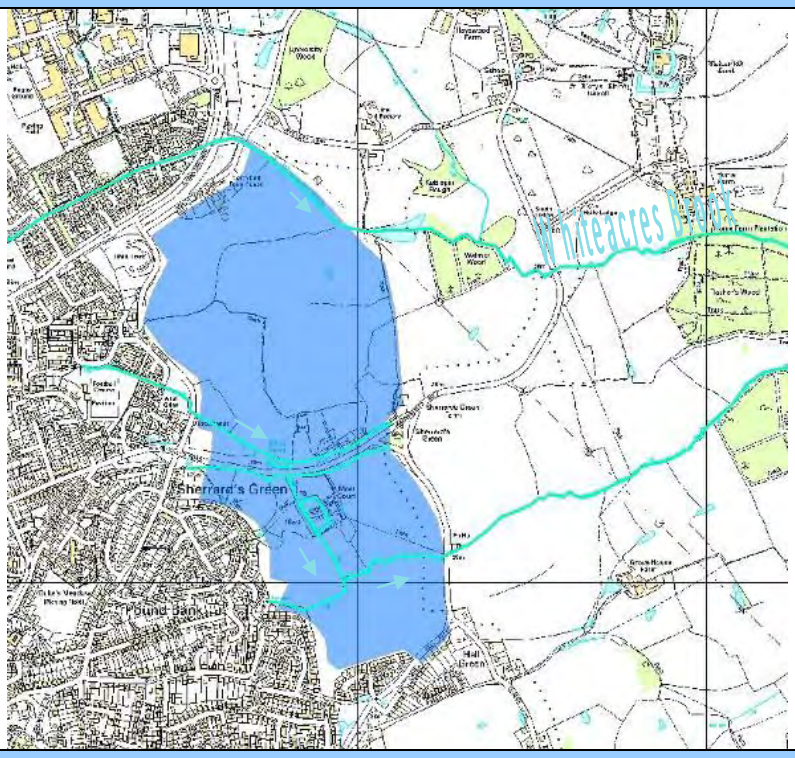
7.11.5 Surface Water Flood Risk from the Proposed Strategic Site Allocation

Surface water flow rates should be restricted to existing Greenfield runoff rates. Consultation with the local authority and the Environment Agency should be undertaken at an early stage. Surface water should be disposed of where possible via infiltration techniques. The soil type within the proposed strategic site allocation's boundary is poorly drained clay, therefore infiltration techniques are likely to be inappropriate for this area. A site specific investigation would be required to confirm the soil type and whether the ground conditions are suitable or not. If it is found that infiltration techniques are not suitable, surface water should be discharged into the ordinary watercourse in the south of the proposed strategic site allocation or Whiteacres Brook in the north via appropriate attenuation schemes, rather than into the existing sewer network.

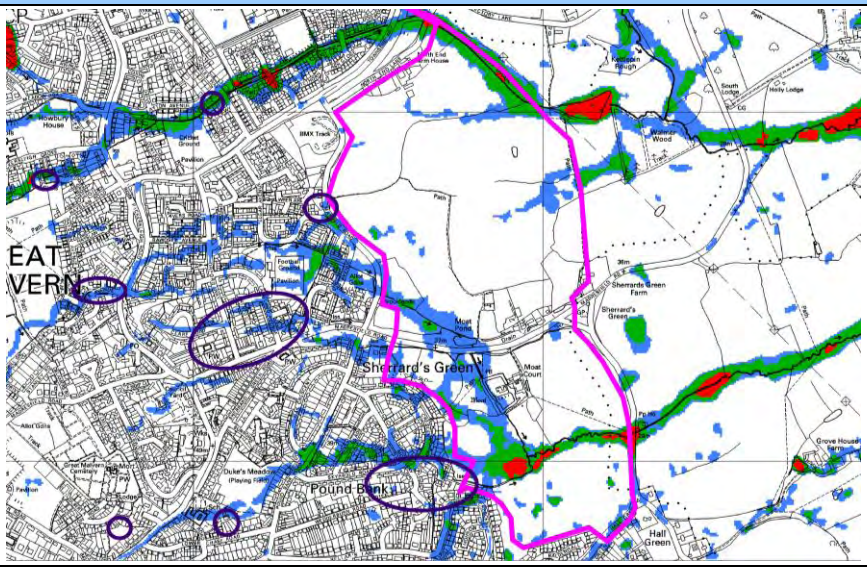
SuDS should be used to attenuate the surface water runoff. Details of SuDS Techniques available can be found in Section 7.20.

Figure 7-10: Malvern East - Watercourses and Surface Water Flooding

Watercourses



Surface Water Flood Risk and Historical Flooding



Surface Water Map:

County Boundary

Potential Development Area

Historic Surface Water

Highway Flooding Areas

Surface Water Flooding Risk

More Risk

Intermediate Risk

Less Risk

7.12 Great Malvern – Malvern South

7.12.1 Watercourses

Pool Brook, an ordinary watercourse, begins at the eastern border of the proposed strategic site allocation and flows away from the area in an easterly direction (Figure 7-11). There are no obvious watercourses within the site boundary, it should be confirmed that Pool Brook does not flow within the boundary.

7.12.2 Fluvial Flood Risk

There are no watercourses within the boundary and the proposed strategic site allocation is classified as being within Flood Zone 1. There may be a fluvial flood risk from Pool Brook that should be assessed in detail to determine the actual flood risk to the proposed strategic site allocation from the watercourse.

7.12.3 Groundwater Flood Risk

The South Worcestershire SFRA indicates that there is no record of any groundwater flooding within the proposed strategic site allocation. Groundwater flooding is not considered to pose a significant risk to the site.

7.12.4 Surface Water Flood Risk to the Proposed Strategic Site Allocation

There is a historical record of surface water flooding in the urban area to the south of the proposed strategic site allocation. There is a risk of surface water flooding becoming a problem with further development and the creation of impermeable ground surfaces. Figure 7-11 indicates the areas that are most vulnerable to surface water flooding. The site layout should take into account the risk of overland flow from impermeable surfaces and residual flooding by directing it away from vulnerable properties.

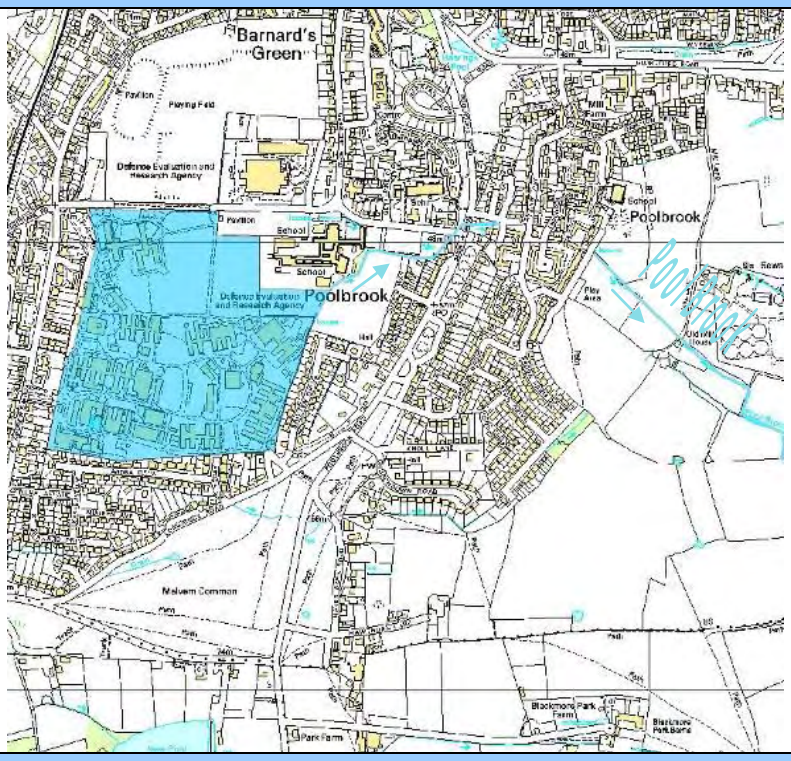
7.12.5 Surface Water Flood Risk from the Proposed Strategic Site Allocation

The site is situated on predominantly brownfield land. Surface water runoff should be restricted to existing runoff rates. Surface Water should be disposed of via the appropriate attenuation systems to Pool Brook or to the existing sewer system, however, this would be subject to at least a 20% decrease in existing flow rates. Surface water should be disposed of where possible via infiltration techniques. The soil type within the proposed strategic site allocation's boundary is poorly drained clay, therefore infiltration techniques are likely to be inappropriate for this area, however, a site specific investigation would be required to confirm the soil type and whether the ground conditions are suitable or not.

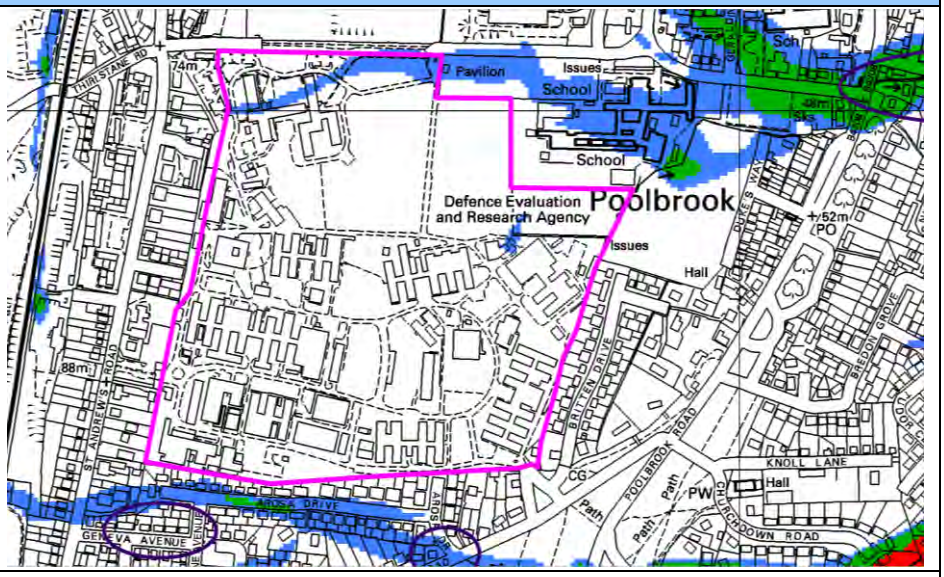
SuDS should be used to attenuate the surface water runoff. Details of SuDS Techniques available can be found in Section 7.20.

Figure 7-11: Malvern South - Watercourses and Surface Water Flooding

Watercourses



Surface Water Flood Risk and Historical Flooding



Surface Water Map:

County Boundary

Potential Development Area

Historic Surface Water Highway Flooding Areas

Surface Water Flooding Risk

More Risk

Intermediate Risk

Less Risk

7.13 Great Malvern – Blackmore Park

7.13.1 Watercourses

There is an ordinary watercourse that flows into the north of the proposed strategic site allocation and appears to be culverted under existing buildings and emerges within the southern boundary (Figure 7-12). There is a further minor watercourse, a tributary to Pool Brook, which flows west to east in the southern area of the proposed strategic site allocation.

7.13.2 Fluvial Flood Risk

The proposed strategic site allocation is classified as being within Flood Zone 1. There may be a fluvial flood risk from the minor watercourse that flows through the proposed strategic site allocation and the minor watercourses to the south. They should both be assessed in detail to determine the actual flood risk to the proposed strategic site allocation.

7.13.3 Groundwater Flood Risk

The South Worcestershire SFRA indicates that there is no record of any groundwater flooding within the proposed strategic site allocation. Groundwater flooding is not considered to pose a significant risk to the site.

7.13.4 Surface Water Flood Risk to the Proposed Strategic Site Allocation

There are no records of historical surface water flooding on the proposed strategic site allocation or in the surrounding area. There is a risk of surface water flooding becoming a problem with further development and the creation of impermeable ground surfaces. Figure 7-12 indicates the areas that are most vulnerable to surface water flooding. The site layout should take into account the risk of overland flow from impermeable surfaces and residual flooding by directing it away from vulnerable properties.

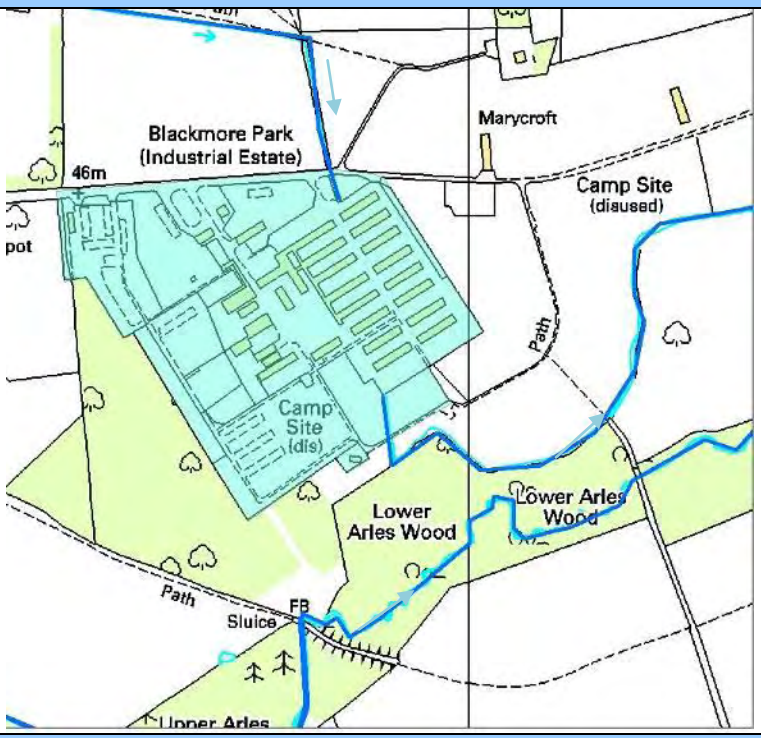
7.13.5 Surface Water Flood Risk from the Proposed Strategic Site Allocation

The site is situated on predominantly brownfield land. Surface water runoff should be restricted to existing runoff rates. Surface Water should be disposed of via the appropriate attenuation systems possibly to the existing minor watercourse or to the existing sewer system, however, this would be subject to at least a 20% decrease in existing flow rates.

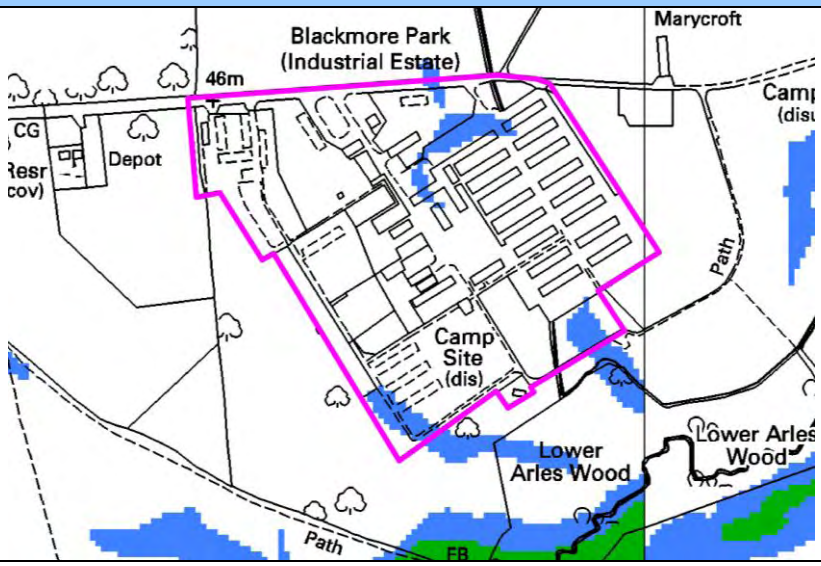
SuDS should be used to attenuate the surface water runoff. Details of SuDS Techniques available can be found in Section 7.20.

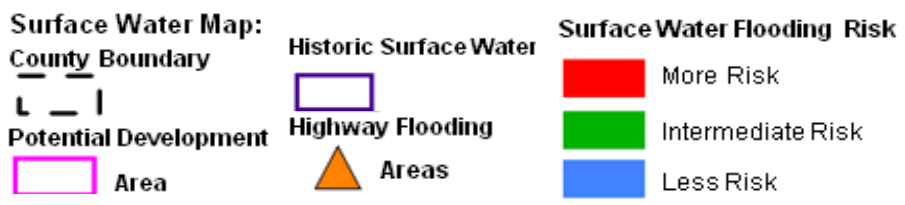
Figure 7-12: Blackmore Park - Watercourses and Surface Water Flooding

Watercourses



Surface Water Flood Risk and Historical Flooding





7.14 Pershore

7.14.1 Watercourses

There are several ordinary watercourses that traverse the proposed strategic site allocation and one that flows between the two proposed strategic site allocation areas (Figure 7-13). These watercourses are tributaries to Piddle Brook, a main watercourse, which flows to the west of the proposed strategic site allocation that is in turn a tributary to the River Avon, a main watercourse, which flows parallel to the ordinary watercourse.

7.14.2 Fluvial Flood Risk

The majority of the proposed strategic site allocation is within Flood Zone 1, however an area adjacent to the River Avon is in Flood Zones 2 and 3. This will have implications for development due to restrictions outlined in PPS25.

It is probable that the minor watercourses within the centre of the western part of the proposed strategic site allocation could be integrated into the on-site infrastructure if it was confirmed that it does not have a catchment area that extends upstream of the proposed strategic site allocation (Figure -7-13). It is likely that the watercourse within the eastern part of the proposed strategic site allocation would need to be maintained as an open channel. It may be possible to realign the watercourse to the site boundary but the watercourse would need to be designed to maintain a natural appearance and be environmentally sustainable. The watercourse that flows close to the eastern boundary thorough the eastern area of the proposed strategic site allocation should be retained and again it may be possible to divert the watercourse to the boundary.

All the watercourses that are to be retained within the boundary and those near the proposed strategic site allocation would need to be assessed in detail in a flood risk assessment to determine the actual flood risk these watercourses pose to the proposed strategic site allocation. This may require the development of new hydrological models. In line with the SFRA a minimum 8m maintenance access corridor either side of the watercourse is required. This may be reduced in particular circumstances with agreement from the Environment Agency or Local Authority.

7.14.3 Groundwater Flood Risk

The South Worcestershire SFRA indicates that there is no record of any groundwater flooding within the proposed strategic site allocation. Groundwater flooding is not considered to pose a significant risk to the site.

7.14.4 Surface Water Flood Risk to the Proposed Strategic Site Allocation

There are no records of historical surface water flooding within the proposed strategic site allocation's boundary or in its vicinity. There is a risk of surface water flooding becoming a problem with further development and the creation of impermeable ground surfaces. Figure 7-13 indicates the areas that are most vulnerable to surface water flooding. The site layout should take into account the risk of overland flow from impermeable surfaces and residual flooding by directing it away from vulnerable properties.

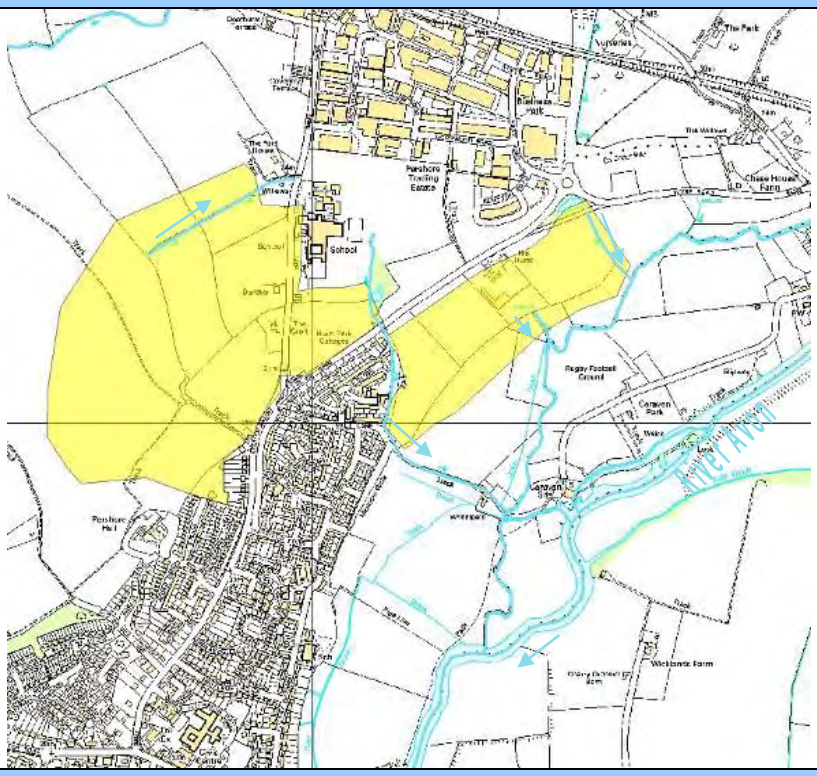
7.14.5 Surface Water Flood Risk from the Proposed Strategic Site Allocation

Surface water flow rates should be restricted to existing Greenfield runoff rates. Consultation with the local authority and the Environment Agency should be undertaken at an early stage. Surface water should be disposed of where possible via infiltration techniques. The soil type within the proposed strategic site allocation's boundary is intermediate silty soils and poorly drained clay, therefore infiltration techniques may be appropriate for some areas. A site specific investigation would be required to confirm the soil type and whether the ground conditions are suitable or not. If it is found that infiltration techniques are not suitable, surface water should be directed into the River Avon via the existing tributaries and appropriate attenuation schemes, rather than into the existing sewer network.

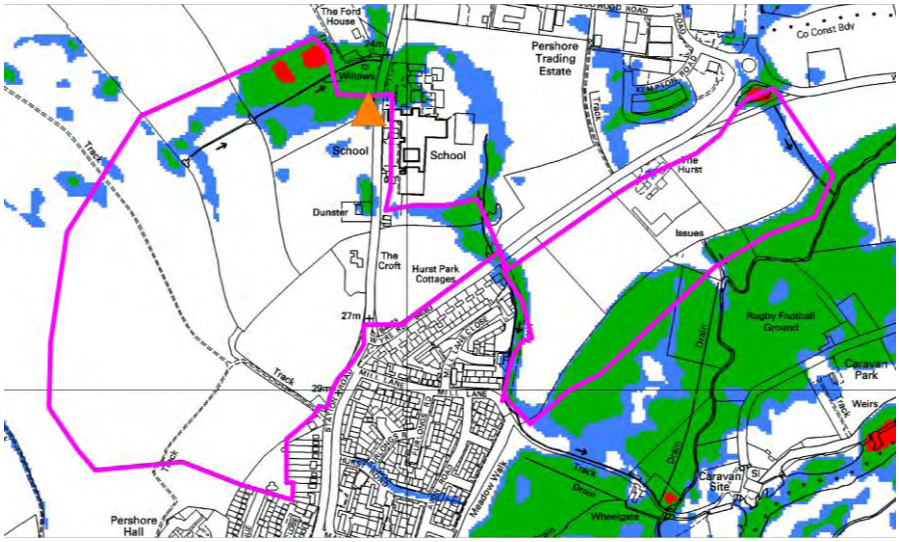
SuDS should be used to attenuate the surface water runoff. Details of SuDS Techniques available can be found in Section 7.20.

Figure 7-13: Pershore - Watercourses and Surface Water Flooding

Watercourses



Surface Water Flood Risk and Historical Flooding



Surface Water Map:

County Boundary

Potential Development Area

Historic Surface Water Highway Flooding Areas

Surface Water Flooding Risk

More Risk

Intermediate Risk

Less Risk

7.15 Evesham – Offenham Road

7.15.1 Watercourses

The River Avon, a main watercourse, flows in a north to south direction to the west of the development proposed strategic site allocation. There is also an ordinary watercourse that flows through the area (Figure 7-14).

7.15.2 Fluvial Flood Risk

The proposed strategic site allocation is entirely within Flood Zone 1. The ordinary watercourse within the boundary may possibly be incorporated into the on site infrastructure if it is confirmed that the catchment area does not extend upstream beyond the boundary. If the watercourse is to remain an in detail flood risk assessment would be required to determine the actual flood risk. In line with the SFRA a minimum 8m maintenance access corridor either side of the watercourse is required. This may be reduced in particular circumstances with agreement from the Environment Agency or Local Authority.

7.15.3 Groundwater Flood Risk

The South Worcestershire SFRA indicates that there is no record of any groundwater flooding within the proposed strategic site allocation. Groundwater flooding is not considered to pose a significant risk to the site.

7.15.4 Surface Water Flood Risk to the Proposed Strategic Site Allocation

There is one record of historical surface water flooding to the southwest of the proposed strategic site allocation's boundary. There is a risk of surface water flooding becoming a problem with further development and the creation of impermeable ground surfaces. Figure 7-14 indicates the areas that are most vulnerable to surface water flooding. The site layout should take into account the risk of overland flow from impermeable surfaces and residual flooding by directing it away from vulnerable properties.

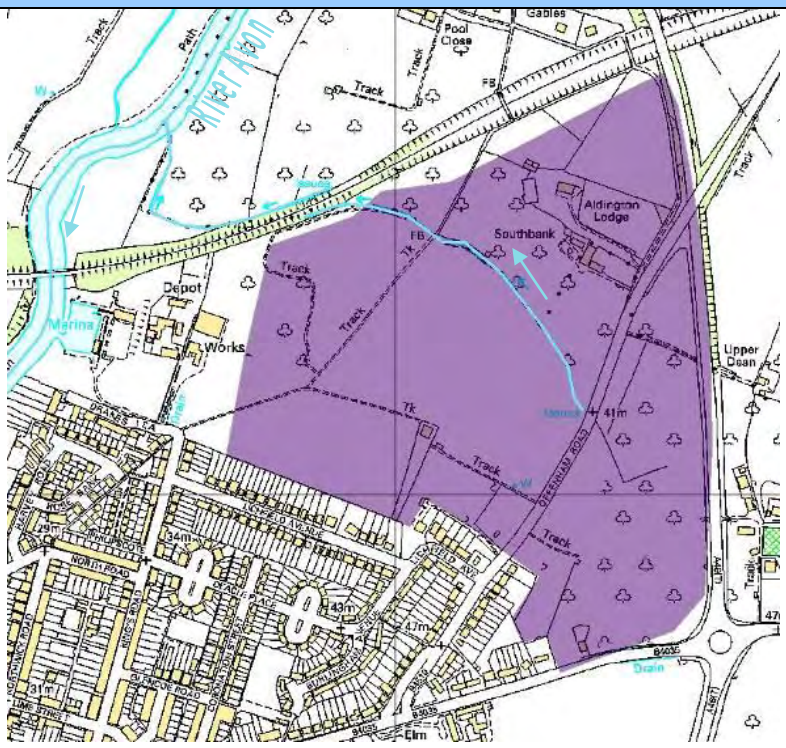
7.15.5 Surface Water Flood Risk from the Proposed Strategic Site Allocation

Surface water flow rates should be restricted to existing Greenfield runoff rates. Consultation with the local authority and the Environment Agency should be undertaken at an early stage. Surface water should be disposed of where possible via infiltration techniques. The soil type within the proposed strategic site allocation's boundary is intermediate silty soils, therefore infiltration techniques may be appropriate for some areas. A site specific investigation would be required to confirm the soil type and whether the ground conditions are suitable. If it is found that infiltration techniques are not suitable, surface water should be directed into the River Avon via the appropriate attenuation schemes. The water may be directed to the River Avon via the existing tributaries or possibly via new off-site infrastructure and a new outfall to the River Avon. It will not be permitted to discharge surface water runoff into the existing sewer network.

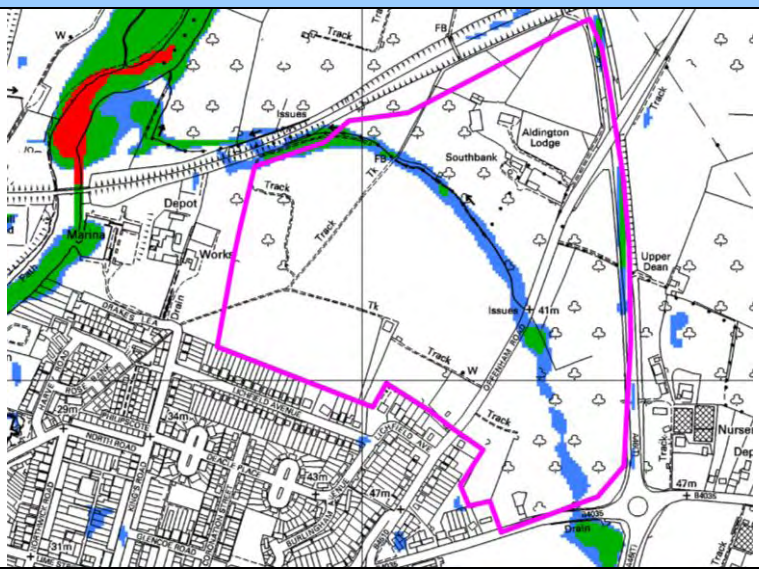
SuDS should be used to attenuate the surface water runoff. Details of SuDS Techniques available can be found in Section 7.20.

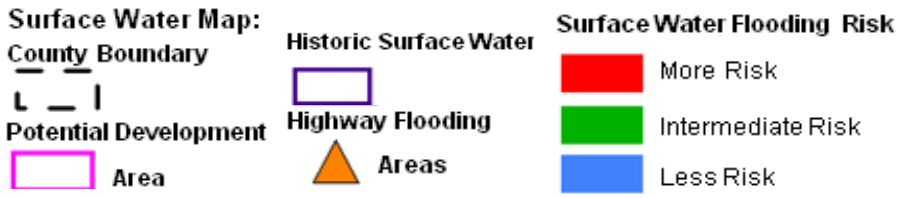
Figure 7-14: Offenham Road - Watercourses and Surface Water Flooding

Watercourses



Surface Water Flood Risk and Historical Flooding





Reproduced from Ordnance Survey mapping with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office. © Crown copyright 2008. All rights reserved. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. Licence Numbers: 100018714 (2008); 100024324 (2008); 100018590 (2008).

7.16 Evesham – Cheltenham Road

7.16.1 Watercourses

The River Isbourne, a main watercourse, flows in a northerly direction along the western border of the proposed strategic site allocation. The River Avon flows in a westerly direction to the north of the proposed strategic site allocation and there is an ordinary watercourse that flows in a northerly direction to the east (Figure 7-15).

7.16.2 Fluvial Flood Risk

The majority of the proposed strategic site allocation is within Flood Zone 1 and there are no obvious watercourses within the boundary. A small area of the proposed strategic site allocation adjacent to the River Isbourne, the main fluvial flood risk, is within Flood Zones 2 and 3. A detailed assessment of the River Isbourne will be required to identify the actual flood risk.

In line with the SFRA a minimum 8m maintenance access corridor either side of the watercourse is required. This may be reduced in particular circumstances with agreement from the Environment Agency or Local Authority.

7.16.3 Groundwater Flood Risk

The South Worcestershire SFRA indicates that there is no record of any groundwater flooding within the proposed strategic site allocation. Groundwater flooding is not considered to pose a significant risk to the site.

7.16.4 Surface Water Flood Risk to the Proposed Strategic Site Allocation

There are no records of historical surface water flooding to within the proposed strategic site allocation's boundary or in the vicinity. There is a risk of surface water flooding becoming a problem with further development and the creation of impermeable ground surfaces. Figure 7-15 indicates the areas that are most vulnerable to surface water flooding. The site layout should take into account the risk of overland flow from impermeable surfaces and residual flooding by directing it away from vulnerable properties.

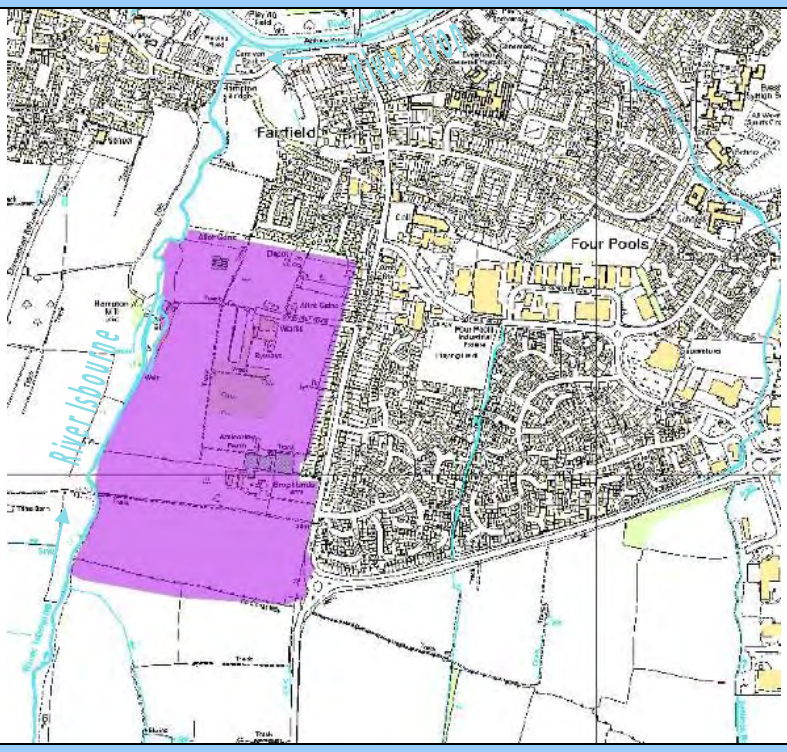
7.16.5 Surface Water Flood Risk from the Proposed Strategic Site Allocation

Surface water flow rates should be restricted to existing Greenfield runoff rates. Consultation with the local authority and the Environment Agency should be undertaken at an early stage. Surface water should be disposed of where possible via infiltration techniques. The soil type within the proposed strategic site allocation's boundary is intermediate silty soils, therefore infiltration techniques may be appropriate for some areas. A site specific investigation would be required to confirm the soil type and whether the ground conditions are suitable. If it is found that infiltration techniques are not suitable, surface water should be directed into the River Isbourne via appropriate attenuation schemes, rather than into the existing sewer network.

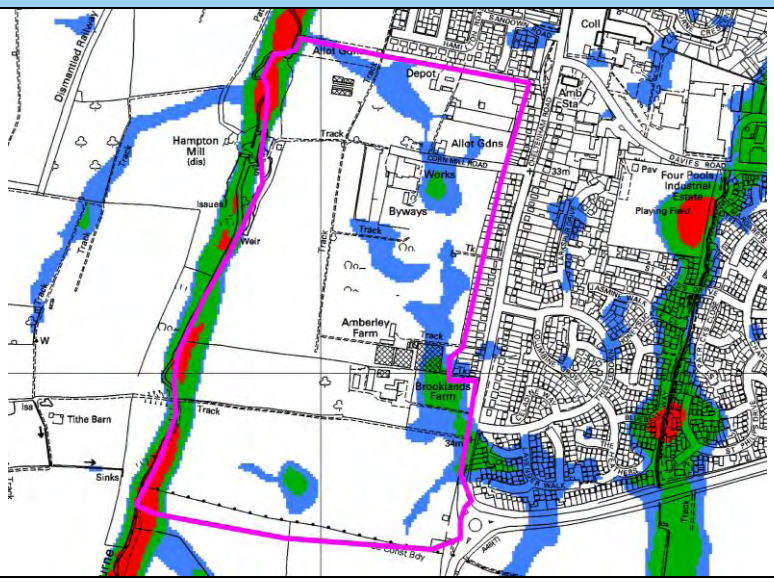
SuDS should be used to attenuate the surface water runoff. Details of SuDS Techniques available can be found in Section 7.20.

Figure 7-15: Cheltenham Road - Watercourses and Surface Water Flooding

Watercourses



Surface Water Flood Risk and Historical Flooding



Surface Water Map:

County Boundary

Potential Development Area

Historic Surface Water Highway Flooding Areas

Surface Water Flooding Risk

More Risk

Intermediate Risk

Less Risk

7.17 Evesham – Hampton

7.17.1 Watercourses

Merry Brook, an ordinary watercourse, flows in a northerly direction to the west of the proposed strategic site allocation and the River Avon and River Isbourne, both main watercourses, are found to the east. There is an ordinary watercourse that flows across the northern area of the proposed strategic site allocation (Figure 7-16).

7.17.2 Fluvial Flood Risk

The proposed strategic site allocation is situated entirely within Flood Zone 1. The ordinary watercourse that flows through the proposed strategic site allocation should be maintained as an open channel and a detailed assessment of the actual flood risk to the site will be required. In line with the SFRA a minimum 8m maintenance access corridor either side of the watercourse is required. This may be reduced in particular circumstances with agreement from the Environment Agency or Local Authority.

7.17.3 Groundwater Flood Risk

The South Worcestershire SFRA indicates that there is no record of any groundwater flooding within the proposed strategic site allocation. Groundwater flooding is not considered to pose a significant risk to the site.

7.17.4 Foul Water Flood Risk

Severn Trent Water's Growth Point Study indicates that the foul sewerage system is overloaded for a 40 year design storm on a critical design event. Flooding was modelled on Pershore Road though this is not confirmed by the Floods Register, which only identifies an incident on Hillside Close, though this location will not be affected by the proposed strategic site allocation as the additional flows will be controlled and stored for a 40 year storm event (Chapter 4).

7.17.5 Surface Water Flood Risk to the Proposed Strategic Site Allocation

There is one record of historical surface water flooding to the north of the proposed strategic site allocation. There is a risk of surface water flooding becoming a problem with further development and the creation of impermeable ground surfaces. Figure 7-16 indicates the areas that are most vulnerable to surface water flooding. The site layout should take into account the risk of overland flow from impermeable surfaces and residual flooding by directing it away from vulnerable properties.

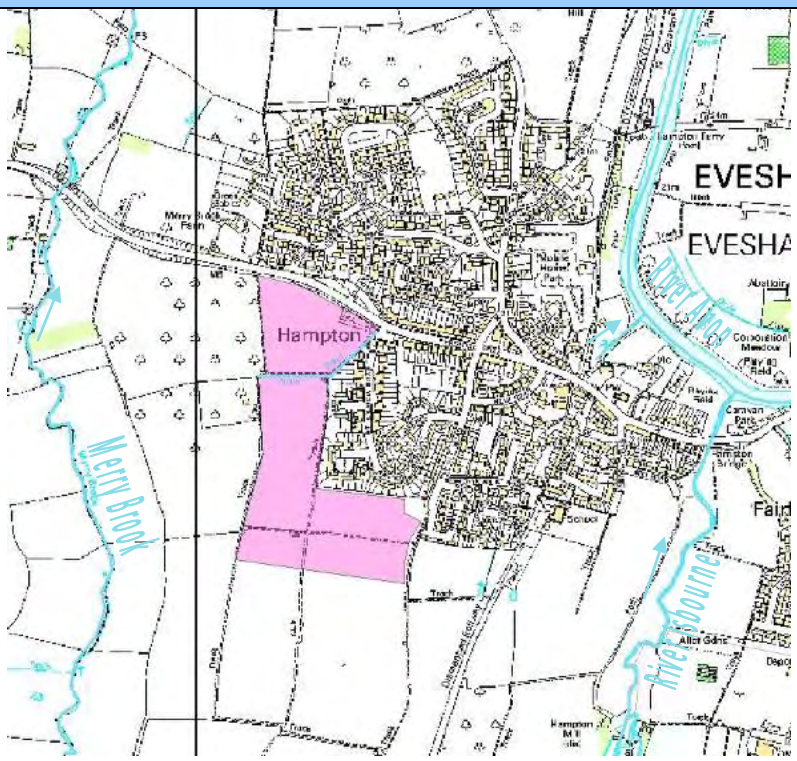
7.17.6 Surface Water Flood Risk from the Proposed Strategic Site Allocation

Surface water flow rates should be restricted to existing Greenfield runoff rates. Consultation with the local authority and the Environment Agency should be undertaken at an early stage. Surface water should be disposed of where possible via infiltration techniques. The soil type within the proposed strategic site allocation's boundary is intermediate silty soils, therefore infiltration techniques may be appropriate for some areas. A site specific investigation would be required to confirm the soil type and whether the ground conditions are suitable. If it is found that infiltration techniques are not suitable, surface water should be directed possibly into Merry Brook, approximately 250m to the west of the proposed strategic site allocation, the River Isbourne, or possibly into the ordinary watercourse, all would need to be via appropriate attenuation schemes. It will not be permitted to discharge surface water into the existing sewer network. It is likely that there will be a need for new off-site infrastructure.

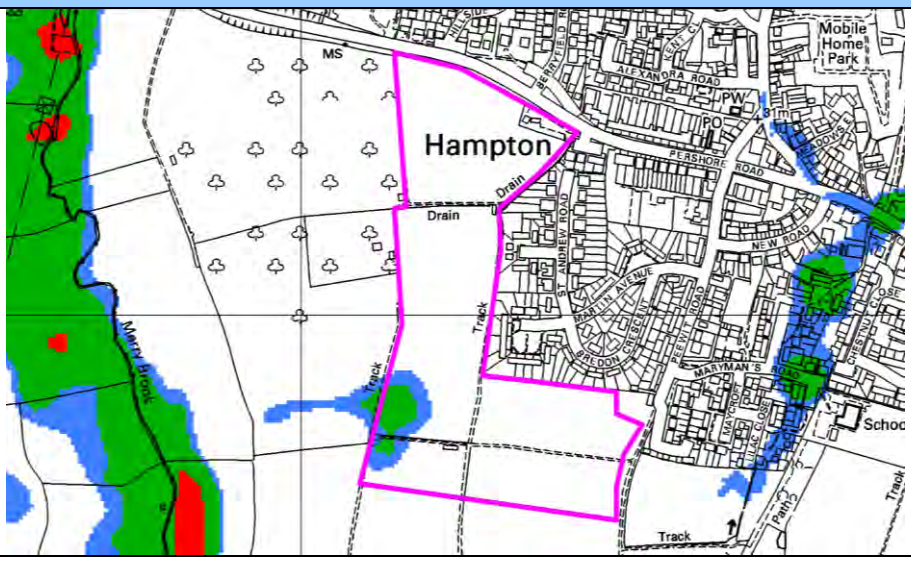
SuDS should be used to attenuate the surface water runoff. Details of SuDS Techniques available can be found in Section 7.20.

Figure 7-16: Hampton - Watercourses and Surface Water Flooding

Watercourses



Surface Water Flood Risk and Historical Flooding



Surface Water Map:

County Boundary

Potential Development Area

Historic Surface Water Highway Flooding Areas

Surface Water Flooding Risk

More Risk

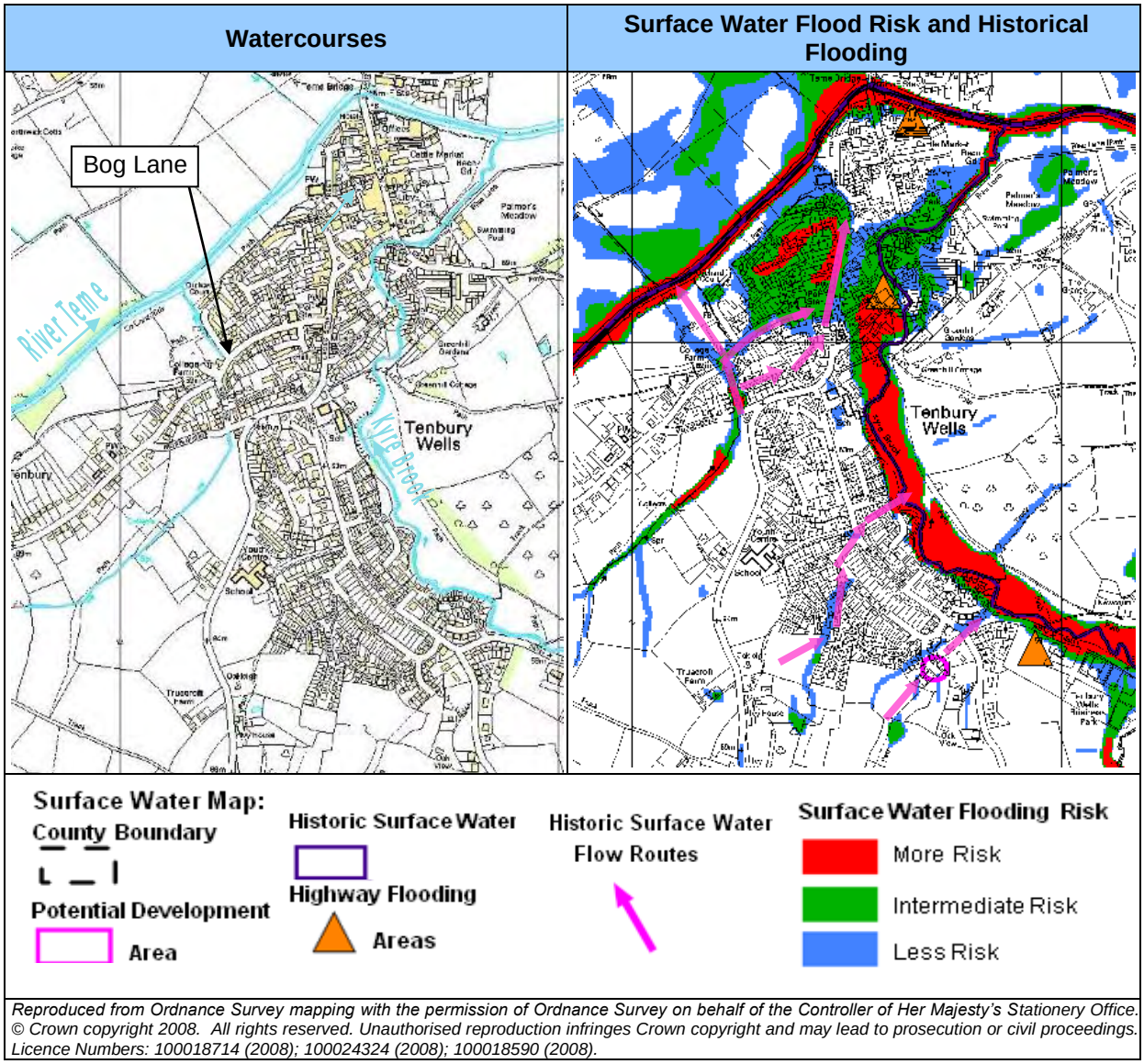
Intermediate Risk

Less Risk

7.18 Tenbury Wells

The main causes of flooding within Tenbury Wells are from the River Teme, a main watercourse, and surface water flooding from sewers and overland flow. In addition, a culverted section of an un-named watercourse causes flooding at Bog Lane. There is also a potential flood risk from Kyre Brook, a main watercourse, to future development. As with all of the risks identified this would need to be assessed in detail within a site specific Flood Risk Assessment. Figure 7-17 indicates the areas that are most vulnerable to surface water flooding. SuDS should be used to attenuate the surface water runoff. Details of SuDS Techniques available can be found in Section 7.20.

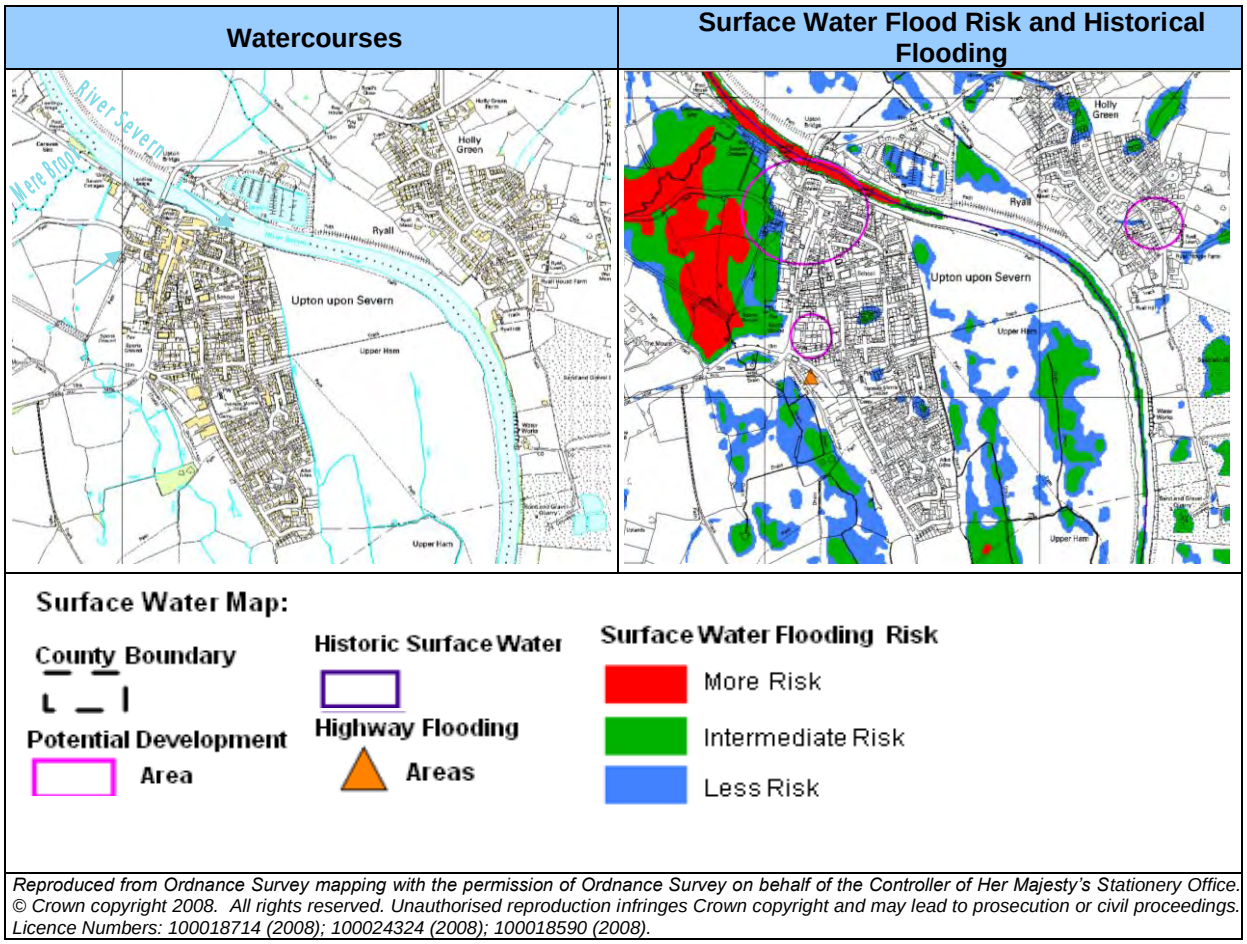
Figure 7-17: Tenbury Wells Watercourses and Surface Water Flooding



7.19 Upton upon Severn

The main causes of flooding within Upton upon Severn are from the River Severn and surface water flooding from sewers and overland flow. There is an important flood flow route to west of the town during extreme flood events on the River Severn, which essentially isolates the town. There are several minor watercourses that traverse the land surrounding Upton upon Severn that would need to be assessed should a development be proposed in these areas. For surface water flood maps of the area please refer to the South Worcestershire SFRA. SuDS should be used to attenuate the surface water runoff. Details of SuDS Techniques available can be found in Section 7.20.

Figure 7-18: Upton upon Severn Watercourses



Summary:

- **The main sources of flooding to the proposed strategic site allocations are from the River Severn, the River Teme, Laughern Brook, Hatfield Brook, Whiteacres Brook, Pool Brook, the River Salwarpe, the River Avon, Merry Brook, the River Isbourne and several other ordinary watercourses that flow adjacent to or through the proposed strategic site allocations as well as flooding from sewers and overland flow.**
- **There are no records of historical groundwater flooding in the area and groundwater flooding is not considered to be a significant risk.**
- **Surface water flow rates should be restricted to existing Greenfield rates and should be directed to the nearest watercourse via appropriate attenuation rather than to an existing sewer. Discharges to Hatfield Brook should be avoided as there are identified flood problems downstream.**

7.20 Flood Risk Management Options

7.20.1 Fluvial Flood Mitigation

Mitigation measures should be seen as a last resort to address flood risk issues. Consideration should first be given to avoiding and minimising risk by planning sequentially across a defined area and within a site. Once risk has been minimised, only then should mitigation measures be considered. Where allocations remain in high risk Flood Zone areas, it needs to be demonstrated in a detailed FRA that technically feasible flood mitigation options are available. These measures must be designed to provide an appropriate level of flood mitigation to a site for the lifetime of the development. The measures required may result in some practical constraints on development and/or require significant financial cost where flood risk is high. The minimum acceptable standard of protection against flooding for new property within flood risk areas is the 1% annual probability for fluvial flooding and a breach during a 0.5% annual probability tidal event, with allowance for climate change over the lifetime of the development.

Normally, suitable mitigation measures for a future development will be determined through assessment of flood depths via hydrological and hydraulic modelling (or use of existing models) carried out as part of a Flood Risk Assessment. Often the determining factor in deciding whether a particular development can or cannot proceed is the financial feasibility of flood risk mitigation rather than technical limitations. Detailed technical assessments are required in the FRA to assess this feasibility, together with a commercial review by the developer of the cost of the mitigation works.

It is assumed that floor level raising will continue to be the traditional mitigation measure. It should be noted that the Environment Agency see actual land raising as a last option. Thought will also be required to ensure safe access and egress is available during flood events including climate change scenarios.

The layout design can play a significant part in the management of any residual risk of flooding to the development, for example due to blockage or failure of drainage systems. More vulnerable development should be positioned in areas of the site at least risk of flooding. Gaps between buildings can be strategically positioned for flood water to flow though, causing minimum damage. Boundary treatments can be designed to allow flow through rather than “trap” flood water in low areas of the site, hence railings might be more appropriate than solid walls. The layout should be designed with some thought towards the proposed site levels. Ideally, buildings should not be placed in low spots or with doorways facing a slope.

Whilst flooding mitigation measures can usually be implemented in most sites, it is worth noting that in some instances the findings of individual FRAs may determine that the risk of flooding to a proposed development is too great and mitigation measures are not feasible. In these instances, the development will be subject to an objection by the Environment Agency.

For more detailed information on mitigation options please refer to the South Worcestershire SFRA.

7.21 Surface Water Flood Management – The SuDS Hierarchy

Sustainable Drainage Systems (SuDS) are management practices which enable surface water to be drained in a way which mimics, as closely as possible, the run-off prior to site development. The choice of flow management facilities within a single site is heavily influenced by constraints including (but not limited to) topography, geology (soil permeability), available area, former site use, proposed site use, groundwater conditions, future adoption and maintenance possibilities. The design, construction and ongoing maintenance regime of such a scheme must be carefully defined, and a clear and comprehensive understanding of the existing catchment hydrological processes and existing drainage arrangements is essential.

The Building Regulations Part H (Drainage and Waster Disposal) states that there is a preferred hierarchy for the disposal of surface water arising from development. Consideration should be given in the first instance to the on-site disposal of surface water via infiltration techniques. For infiltration SuDS techniques it is imperative that the water table is low enough and a site-specific infiltration test is undertaken in accordance with BRE365 or CIRIA 156. Where proposed strategic site allocations lie

within or close to groundwater protection zones or minor aquifers further restrictions may be applicable, and guidance should be sought from the Environment Agency.

The Environment Agency's Groundwater Source Protection Zones (Figure 6-10) indicate where there may be restrictions on the use of infiltration techniques if there may be a risk of pollution entering the groundwater. All of the proposed proposed strategic site allocations are outside of the designated zones, however, many of the proposed strategic site allocations are above minor aquifers and therefore there should be some consideration to mitigation against groundwater pollution when using infiltration techniques in these areas. Site specific ground investigations will be required to determine whether the soil type is suitable. Offsite disposal of surface water should be considered only if site conditions are unsuitable for infiltration. In this case consideration should be given first to disposal to a local watercourse. Disposal to the sewer system should only be considered if neither infiltration nor disposal to a watercourse is viable. The site layout of developments should account for design capacity exceedence of above ground attenuation areas and include safe flow routes through the development should exceedence should occur.

There are many different SuDS techniques which can be implemented. Further information can also be found in the Environment Agency's Standing Advice[8]. The suitability of the techniques in Table 7-1 will be dictated in part by the development proposal and site conditions. Advice on best practice is available from the Environment Agency and the Construction Industry Research and Information Association (CIRIA).

The inclusion of SuDS within developments should be seen as an opportunity to enhance ecological and amenity value, incorporating above ground facilities into the development landscape strategy. For more information on how SuDS can be used to improve ecological and water quality see Chapter 6. The Environment Agency has advised that some incorporation of watercourses into the SuDS system can be positive from a biodiversity perspective, by having a top up flow in the watercourse, however they would not advise online attenuation ponds as these can pose maintenance and pollution problems for the watercourse. SuDS must be considered at the outset, during preparation of the initial site conceptual layout to ensure that enough land is given to design spaces that will be an asset to the development rather than an after-thought. An indicative pond volume required for each proposed strategic site allocation can be found in Table 7-2.

Table 7-1 outlines the SuDs techniques that are available, more details about the individual techniques can be found in the South Worcestershire SFRA.

PPS 25 stresses that Regional Planning Bodies and Local Planning Authorities (LPAs) should:

- promote the use of SuDS for the management of run-off.
- ensure their policies and decisions on applications support and complement the Building Regulations on sustainable rainwater drainage, giving priority to infiltration over first watercourses then sewers.
- incorporate favourable policies within Regional Spatial Strategies.
- adopt policies for incorporating SuDS requirements in Local Development Documents
- encourage developers to utilise SuDS wherever practicable, if necessary through the use of appropriate planning conditions
- develop joint strategies with sewerage undertakers and the Environment Agency to further encourage the use of SuDS.

[8]National Standing Advice to Local Planning Authorities for Planning Applications – Development and Flood Risk in England (March 2007).

Table 7-1: SuDS Techniques

SuDS Technique	Flood Reduction	Pollution Reduction	Landscape and Wildlife Benefit
Living roofs	✓	✓	✓
Basins and ponds	✓	✓	✓
Constructed wetlands	✓	✓	✓
Balancing ponds	✓	✓	✓
Detention basins	✓	✓	✓
Attenuation ponds	✓	✓	✓
Filter strips and swales	✓	✓	✓
Infiltration devices	✓	✓	✓
Soakaways	✓	✓	✓
Infiltration trenches and basins	✓	✓	✓
Permeable surfaces and filter drains	✓	✓	
Gravelled areas	✓	✓	
Solid paving blocks	✓	✓	
Porous pavements	✓	✓	
Tanked systems	✓		
Over-sized pipes/tanks	✓		
Storm cells	✓		

Summary:

- **In terms of fluvial flooding, consideration should first be given to minimising risk by planning sequentially across a site. Once risk has been minimised, only then should mitigation measures be considered. It is assumed that floor level raising will continue to be the traditional mitigation measure.**
- **SuDS should be used to mitigate against surface water flooding, also taking into consideration their water quality, ecological and amenity values.**

7.22 The cost of SuDs

7.22.1 Construction Costs

The SuDs Manual 2007 - CIRIA Report C697 states that the construction costs of SuDs should include:

- the cost of erosion and sediment control during construction
- material costs
- construction (labour and equipment costs)
- planting and landscaping costs

There are many factors that could influence the cost of the scheme, for example, soil type, groundwater protection zones, design features such as heavily planted ponds and the site location as sediment removal from site may become more expensive.

To produce indicative costs for SuDs on the proposed strategic site allocations the maximum storage volume for surface water runoff was calculated for each site. The storage volumes displayed are calculated with an assumption that 80% of the site will be developed impermeable ground. The design of surface water drainage should include climate change. PPS25 states that as a guide residential properties require a 30% increase in peak rainfall intensity and for commercial properties a 20% increase is required. The exact percentage should be negotiated on a site by site basis. A 30% factor for climate

change has been included in the calculations to give a conservative storage volume for residential development.

The storage volumes calculated have been used to give indicative costs for a selection of SuDs components using the costings in Table 25.1 in the SuDs Manual (2007). The storage volumes do not include the additional volume required for long term storage or water quality treatment, this would need to be included in the storage volume calculation for the proposed strategic site allocations when the site dwelling numbers and area are finalised. The selection of SuDs in Table 7-2 has been chosen as they are also good for water quality treatment and several have good ecological benefits.

These costs are only indicative, actual costs will be site specific, any of the influencing factors listed above could mean costs are more or less than stated.

Table 7-2: Indicative SuDs Components Capital Costs Ranges in 2004

			SuDs Component			
			Attenuation Pond	Permeable pavement	Wetland	Soakaways
Proposed Strategic Site Allocations	Storage Volume (m^3)	Greenfield Runoff for 2yr Event (l/s)	Indicative Cost (£)*	Indicative Cost (£)*	Indicative Cost (£)*	Indicative Cost (£)*
WORCESTER						
Worcester North West	234,634	1077	7,625,605	12,200,968	9,150,726	30,502,420
Worcester North	12,215	89.08	396,988	635,180	476,385	1,587,950
Kilbury Drive	8875	51.62	288,438	461,500	346,125	1,153,750
Worcester South	144,117	1029.46	4,683,803	7,494,084	5,620,563	18,735,210
Fernhill Heath	20,661	118.38	671,483	1,074,372	805,779	2,685,930
DROITWICH SPA						
Hill End	8,803	56.38	286,098	457,756	343,317	1,144,390
Pulley Lane	35,736	219.58	1,161,420	1,858,272	1,393,704	4,645,680
Copcut Lane	28,113	175.89	913,673	1,461,876	1,096,407	3,654,690
GREAT MALVERN						
Malvern North	39,154	233.3	1,272,505	2,036,008	1,527,006	5,090,020
Malvern East	47,855	284.23	1,555,288	2,488,460	1,866,345	6,221,150
Malvern South	16,670	88.58	541,775	866,840	650,130	2,167,100
Blackmore Park	5,636	36.2	140,900	225,440	169,080	563,600
PERSHORE						
Pershore	34,213	162.28	1,111,923	1,779,076	1,334,307	4,447,690
EVESHAM						
Offenham Road	25,061	108.93	814,483	1,303,172	977,379	3,257,930
Cheltenham Road	29,947	147.88	973,278	1,557,244	1,167,933	3,893,110
Hampton	8,000	32.16	260,000	416,000	312,000	1,040,000

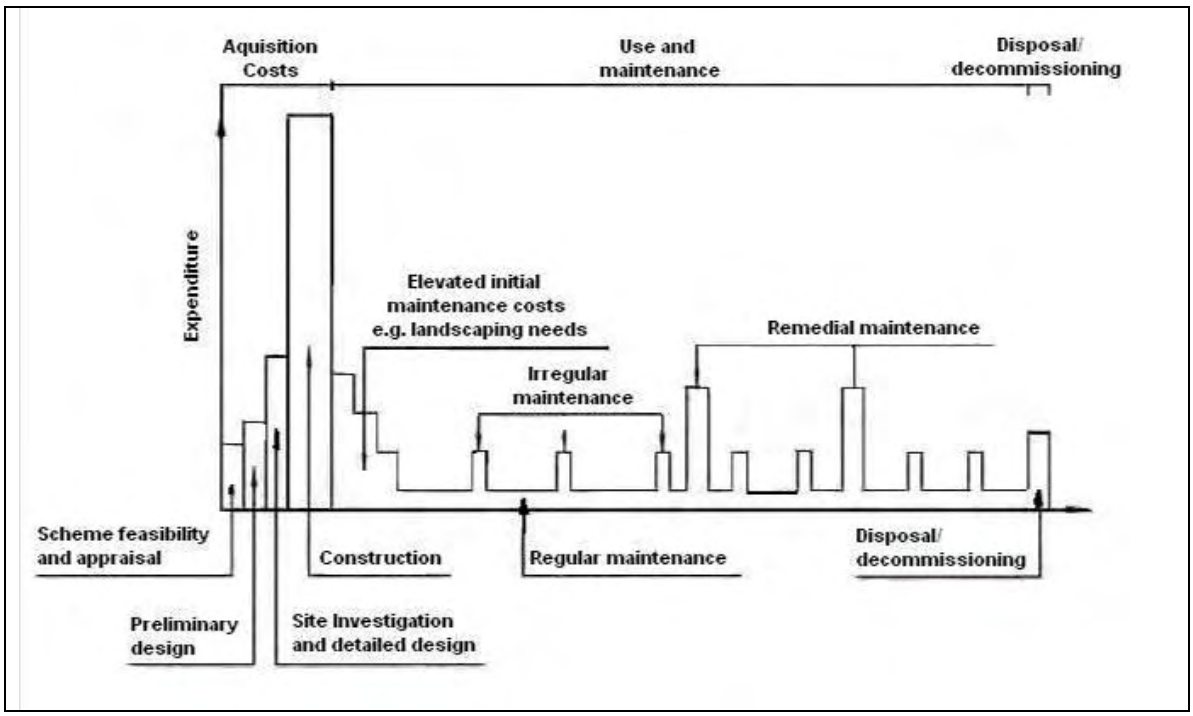
*Cost includes an additional 30% for design, contingency and planning costs.

The SuDs manual (2007) indicates that generally the total volume or area of a component is likely to be a good indicator of the cost. The design, contingency and planning costs can be expressed typically as 30% of the total construction costs, unless initial site investigation costs are likely to be significant. The costs do not take into consideration land costs.

7.22.2 Maintenance and Operation Costs

When costing SuDs it is important to take into consideration the whole life span of the scheme and not just the construction costs. Figure 7-19 illustrates how maintenance costs need to be accounted for when implementing a SuDs scheme. To keep the costs of maintenance to a minimum it is important to design the SuDs scheme with maintenance issues and costs in mind.

Figure 7-19: Conceptual Model of SuDS Expenditure Profile



* Source – CIRIA SuDS Manual 2007 - Report C697

Operation and maintenance areas can include the following as outlined in the SuDs Manual (2007):

- inspection and monitoring
- regular maintenance (clearing inlets/outlets, collecting trash/debris, grass cutting)
- irregular maintenance (responding to problems e.g. blocked culverts, pollution incidents, vegetation death)
- remedial maintenance (major mid life refurbishment e,g. Soakaway replacement, sediment removal)

The costs to maintain the SuDs are mainly due to labour, equipment and material costs, replacement of or additional plants and the disposal of vegetation or sediment. As with construction costs, the cost of maintenance can vary depending on factors such as location, ease of access and design e.g. sediment management system design. Table 7-3 from the SuDs Manual (2007) outlines indicative annual maintenance costs for a selection of the SuDs components and further details of maintenance costs can be found in table 25.2 in the SuDs Manual (2007).

Table 7-3: Indicative SuDs Maintenance and Operation Cost Ranges in 2004

Component	Cost (£) (Annual Cost for regular maintenance only)	Unit
Filter Drain/Infiltration trench	0.2 - 1	/m^2 of filter surface area
Swale	0.10	/m^2 of swale surface area
Soakaway	0.10	/m^2 treated area
Permeable pavement	0.5-1	/m^3 of storage volume
Wetland	0.10	/m^2 of wetland surface area
Attenuation Pond	0.5-1.5	/m^2 of attenuation pond surface area

Adoption and future maintenance of above ground SuDS facilities by local authorities as public open space will require early discussion between the developer, the local authority and Severn Trent Water. Above ground attenuation can be adopted by the local authority as public open space, with the provision of a payment to the local authority via a Section 106 Agreement under the Town and Country Planning Act. This must be agreed at an early stage and ideally discussed in advance of the planning application to allow the contribution to be ring fenced specifically for the facility.

If future maintenance arrangements are to be assigned to a management company, this should be discussed at an early stage with Severn Trent Water. This can have implications on the adoption of the remaining site drainage and consequently adoption of any highways on the development.

Allowance should be made by whomever is to take future responsibility for the SuDS facilities, for checking the SuDS designs and for inspection during construction, if necessary employing competent individuals to perform this task.

Information should be provided to make the end-users of the development aware of SuDS and in particular their responsibilities to maintain and not to remove any privately owned SuDS facilities. If deemed necessary the removal of permitted development rights or the inclusion of covenants in the deeds of properties could be considered.

Summary:

- **SuDS costs include planning, construction and maintenance costs.**
- **An estimate of the cost of construction and design, contingency and planning of a attenuation pond for all of the development sites is in the region of £22,600,000. This does not include the cost of including additional storage volume for water treatment and long term storage which should be added in the detailed design stage, or the cost of land.**
- **An estimate of the cost of annual regular maintenance is £0.50 – £1.50/m^2 of the attenuation pond surface area. This cost is for regular maintenance and does not include major maintenance activities such as sediment removal or insurance costs.**
- **These costs are only indicative, actual costs will be site specific. Costs vary depending on the SuDS technique utilised.**
- **Adoption and future maintenance of above ground SuDS facilities by the local authorities as public open space requires early discussion between the developer, the local authority and Severn Trent Water.**

7.23 Conclusions

The main causes of flooding are considered to be fluvial and surface water (either overland or from sewers). The following conclusions should be used as a guide to the potential flood risk and detailed Flood Risk Assessments will be required for any new development to define the actual flood risk. There are existing detailed hydraulic models owned by the Environment Agency covering these areas and they will provide a more detailed assessment of the flood risk, as such developers are advised to request information from these models from the Environment Agency at the site specific Flood Risk Assessment stage. If models are not available for a watercourse a new hydraulic model should be developed as part of the Flood Risk Assessment.

7.23.1 Fluvial Flood Risk

The following table indicates which proposed strategic site allocations are perceived to be most at risk from fluvial flooding. The proposed strategic site allocations most at risk are those that have part of or the entire site within Flood Zone 3 and/or 2 and a watercourse flows through the area. Those proposed strategic site allocations at the lowest risk are entirely within Flood Zone 1 with no watercourse within the boundary. The remaining proposed strategic site allocations have a moderate flood risk, where they are partially or fully within Flood Zones 2 and/or 3 but no watercourse flows through the area; or the proposed strategic site allocation is within Flood Zone 1 and there is a watercourse that flows through it that could potentially provide a flood risk.

Table 7-4: Summary of Fluvial Flood Risk to the Proposed Strategic Site Allocations

Proposed Strategic Site Allocation	Fluvial Flood Risk
Worcester	
Worcester North West	
Worcester North	
Kilbury Drive	
Worcester South	
Fernhill Heath	
Droitwich Spa	
Hill End	
Pulley Lane	
Copcut Lane	
Great Malvern	
Malvern North	
Malvern East	
Malvern South	
Blackmore Park	
Pershore	
Pershore	
Evesham	
Offenham Road	
Cheltenham Road	
Hampton	

Legend:

- Part or all of site within Flood Zone 3 and/or 2 and a watercourse flows through the proposed strategic site allocation.
- Part or all of site within Flood Zone 3 and/or 2 and no watercourse within the site boundary OR Site is entirely in Flood Zone 1 but there is a watercourse that flows through the proposed strategic site allocation.
- Development site entirely within Flood Zone 1 and no watercourse flows through the proposed strategic site allocation.

Mitigation measures should be seen as a last resort to address flood risk issues. Consideration should first be given to avoiding and minimising risk by planning sequentially across a defined area and within a site. Once the risk has been minimised, only then should mitigation measures be considered. Where allocations remain in high risk Flood Zone areas, it needs to be demonstrated in a detailed Flood Risk Assessment that technically feasible flood mitigation options are available. These measures must be designed to provide an appropriate level of flood mitigation to a site for the lifetime of the development. It is assumed that floor level raising will continue to be the traditional mitigation measure.

7.23.2 Surface Water Flood Risk

The following table indicates which proposed strategic site allocations are perceived to be most at risk from surface water flooding. Those perceived to have the greatest risk have historical surface flood events within their boundary. The proposed strategic site allocations classed as at moderate risk are those where there have been historical surface water flood events adjacent to the boundary. The proposed strategic site allocation with the lowest risk from surface water flooding are those with no record of historical surface water flood events within the vicinity.

Table 7-5: Summary of Surface Water Flood Risk to the Proposed Strategic Site Allocations

Proposed Strategic Site Allocation	Surface Water Flood Risk
Worcester	
Worcester North West	
Worcester North	
Kilbury Drive	
Worcester South	
Fernhill Heath	
Droitwich Spa	
Hill End	
Pulley Lane	
Copcut Lane	
Great Malvern	
Malvern North	
Malvern East	
Malvern South	
Blackmore Park	
Pershore	
Pershore	
Evesham	
Offenham Road	
Cheltenham Road	
Hampton	

Legend:

- Historical surface water flooding within the site boundary.
- Historical surface water flooding adjacent to the site boundary.
- No historical surface water flooding near the site.

It should be noted that even though some proposed strategic site allocations have been classified as being at low risk from surface water flooding on the basis that there has been no flood event within the vicinity in the past, there is the potential to increase the surface water flood risk with new development due to the increase in impermeable areas.

Surface water should be disposed of where possible via infiltration techniques. The Environment Agency advises the use of above ground attenuation schemes over other techniques, this is also in line with recommendations in Chapter 6, the use of SuDS to promote good ecological and water quality. If it is found that infiltration techniques are not suitable, surface water should be discharged into a watercourse via appropriate attenuation schemes rather than into the existing sewer network. SuDS should be promoted to mitigate against surface water runoff from the proposed strategic site allocations.

7.23.3 Groundwater

The South Worcestershire SFRA indicates that there are no records of any groundwater flooding within any of the proposed strategic site allocations. Therefore groundwater flooding is not considered to pose a significant risk to the proposed strategic site allocations.

7.24 Recommendations

It is recommended that Surface Water Management Plans are undertaken for Worcester, Droitwich Spa and Great Malvern.

The South Worcestershire SFRA should be consulted for more detailed information regarding flood risk and policy that may affect the proposed strategic site allocations.

8 DEMAND MANAGEMENT

8.1 Policy

The understanding of environmental issues has developed significantly since the Water Resources Act 1963 created the current framework for abstraction licensing. The European Water Framework Directive came into force in December 2000 and became part of UK law in December 2003 and has led to the need to use water efficiently in a way that can sustain future supplies.

In March 1999, Taking Water Responsibly set out administrative and legislative changes to the water abstraction licensing system in England and Wales. Many of the changes in Taking Water Responsibly were implemented within current legislation (Water Resources Act 1991 & Environment Act 1995), but other changes needed new legislation, these are contained in the Water Act 2003.

The removal of various exemptions from licence control is one of the final changes proposed by the Water Act 2003. The main exemptions being removed affect abstractions of more than 20 cubic metres a day in England and Wales:

- for dewatering, navigation and irrigation other than spray irrigation purposes (which is already subject to licence control) and transfers into Internal Drainage Board (IDB) areas;
- from certain exempt areas and rivers in England that border Scotland;
- by Crown bodies;
- by visiting forces.

Separate regulations will also bring together some existing exemptions and introduce a small number of new exemptions.

The Government has finished the consultation period on these proposals and on how transitional regulations would bring existing abstractors under licence control. This will complete changes to the licensing system made by the Water Act 2003 and help to fulfil the duty under the EU's Water Framework Directive. Further information can be found on the Defra website.

The Government is also currently consulting on proposals for imposing mandatory time limits on all water abstraction licences in England and Wales. Currently, time limits are imposed on all new abstraction licences and there has been an attempt to encourage the voluntary conversion of existing licences to time-limited status. Despite these attempts, only 20% of all abstraction licences are subject to time limits at this time. As things stand, the remaining licence holders can continue to extract water for an unlimited period unless their licence is revoked. Under the new proposals the Environment Agency would be given powers to alter the volumes and conditions on new and existing licences. These powers are seen as a crucial step in ensuring the sound management and appropriate allocation of water resources in order to cope with the anticipated impacts of climate change. However, the Environment Agency have raised concerns during the Government Consultation period of the difficulty they face in revoking licences as there is no funding available for compensation liability that arises.

There are several policies that focus on water use. The Water Supply (Water Fittings) Regulations 1999 have replaced local water byelaws in England and Wales and were made under section 74 of the Water Industry Act 1991 to prevent the waste, misuse, undue consumption, contamination or erroneous measurement of drinking water. They set minimum standards for the water consumption of toilets, which can account for 30% of household water consumption, washing machines, dishwaters and other appliances with a high water demand. The maximum flush volume for new toilets is now 6 litres and there are more efficient dual flush systems. The regulations also outline requirements for the reduction in leakage and an increase in durability of pipes. The Water Industry Act 1991 also promoted the efficient use of water as did the Pollution Prevention and Control Regulations 2000, through the promotion of water-efficient appliances.

The Environment Agency Water Resources Strategy – Regional Action Plan for the Midlands identifies their six key priorities for the Midlands Region. These are as follows:

- High-flow reservoirs: The EA wants to increase the number of agricultural high-flow storage reservoirs in over abstracted catchments. This will help to reduce abstraction pressure and increase agricultural resilience to climate change
- Abstractor groups and licence trading: The EA want to see more abstractor groups in the Midlands Region and want to use these groups to facilitate licence trading. The EA will work with abstractor groups to improve communication and investigate the potential for sharing water.
- Water Efficiency: The EA want everyone to make informed decisions about how to use water efficiently, 89% of greenhouse gas emissions associated with water abstraction, treatment, transport, use and disposal are from water use in the home. It is necessary to increase water efficiency to reduce demand and greenhouse gas emissions.
- Household Metering: The EA want the number of metered households to increase in line with levels identified in the final Water Company Business Plans. They will promote metering to households who would benefit financially from a metered tariff.
- Conjunctive Use: The EA want to increase the number of conjunctive use schemes in Midlands Region (conjunctive use is the combined use of groundwater and surface water sources, e.g. use of groundwater when river flows are low and river water when river flows are not low). These schemes provide environmental and economic benefits by improving resilience to climate change, reducing long-term constant rate groundwater abstraction, and reducing the impact of abstraction on surface water low-flows.
- Restoring Sustainable Abstraction (RSA): The EA want all abstractions in Midlands Region to be sustainable. Over the next five years they will investigate over 100 schemes and develop cost beneficial solutions for any abstractions having an adverse impact on the environment under the RSA programme. In particular they will continue to monitor and model the sandstone aquifer to develop sustainable solutions and increase resilience of our public water supplies.

8.2 Water efficiency

8.2.1 Severn Trent Water – Metering

The option of having a water meter installed for free and paying on a metered basis has been available since 1995 and people who take this up are referred to as ‘optants’. All newly constructed household properties have had water meters fitted since 1989 and pay for water and wastewater services on a metered basis. By 2007, 28% of households in the Severn Trent Water area were metered and it is predicted that a minimum of 72% of households will be metered by 2035. Severn Trent Water do not have any policies for compulsory metering within existing households. Severn Trent Water found that it was only cost effective to reduce the supply/demand deficit in the Staffs and East Shropshire WRZ and East Midlands WRZ, not in the Severn WRZ. However, they have developed other means of increasing water efficiency other than increased metering.

8.2.2 Severn Trent Water - Efficiency Strategies

Within the Catchment Abstraction Management Strategies (CAMs) the Environment Agency promote the use of water efficient practices to help reduce the pressures on the groundwater and surface water resources. Severn Trent Water outline how they will promote and implement water efficient practices within their Draft Water Resources Management Plan (WRMP). The following shows the current projects Severn Trent Water are promoting: (as recommended in Ofwat’s Efficiency Initiatives – Good Practice Register for Water and Sewerage Companies 2007)

- They distribute a Save-a-flush cistern displacement device to customers, organisations and businesses on request. Since 2005 they have distributed over 350,000 devices and estimate that around 250,000 of those have been installed creating an estimated saving of around 2.5Ml/day.
- They offer discounted water butts and the opportunity to purchase a discounted rain saver kit which includes a water butt, lid and down pipe connection. Between 2005 and 2007 they have sold a total of 14,819 kits.
- They have set up a partnership with Envirowise to assess the potential benefits of targeting major commercial and industrial customers, their top 250 water users. They aim to raise awareness of the importance of water efficiency within these businesses and

advise them on how the can implement changes to become more efficient. They have hosted a series of efficiency focus workshops and each company was provided with free consultancy support to advise them on potential efficiency improvements. The lessons from these workshops will be assessed to see if similar advice and support could be given to smaller non domestic users for whom Envirowise support is not available.

- Two trials were undertaken to investigate the use off retrofit water efficient devices in domestic properties and schools. These trials involved the audit of customers' properties and the installation of appropriate water efficient devices such as toilet dual flush systems and efficient shower heads and similar "domestic type" water use for school buildings.
- They have been carrying out education programmes for over 15 years with 5 education centres offering a full day of activities free of charge for schools, resource packs for schools including CDs, a "Be Smart" scheme for schools to meet four water-based goals that incorporate National Curriculum requirements and annual sponsorship of a variety of competitions.

Severn Trent Water aim to continue with these activities in the future and expand the range. In November 2008 Ofwat set Severn Trent Water a new efficiency target for 2010 to 2015 which requires them to reduce customer consumption by on average 1 litre/property/day, equating to 3.27Ml/day annually or 16.35Ml/day by 2015.

The following is a programme was taken from Severn Trent Water's Statement of Response. Work completed since the Draft WRMP has significantly improved Severn Trent Water's understanding of the relative effectiveness of the available water efficiency options. This work has included the completion of two large scale pilot programmes investigating efficiency opportunities in both domestic and institutional properties. Severn Trent Water have also used the Ofwat water efficiency initiatives – Good Practice Register and the Waterwise Evidence Base for Large Scale Water Efficiency when developing our options. The programme covers the period 2010 to 2015 and is projected to save around 16.35Ml/day by 2015, compared to the 2Ml/day predicted in the Draft WRMP.

The appropriate mix of options will vary due to differences between WRZs in demographics, housing stock age and type, proportions of domestic, commercial and institutional properties. It should also be noted that Severn Trent Water are undertaking trials and contributing to the Waterwise projects and they hope to have more robust evidence to inform the final WRMP09. They expect as the evidence base and technology improves and further best practice is identified the options will be updated and the programme revised.

- **Provision of Cistern Displacement Devices (CDD)**: The continuing distribution of "Save-a-Flush" device, improvement on distribution rate through active promotion to enable the continuation of a 1Ml/day useage reduction up to 2015.

- **Partner Activity:** Partnering a range of product manufacturers and suppliers to provide access to water efficiency products and services to our customers. Optimising existing contacts to promote water efficient practices and products and to change customer behaviour.

- **Self Audit:** Encourage all customers to undertake self audits of their water use and make information available to all consumers on how they can reduce wasteage.

- **Severn Trent Water sites:** Construction or refurbishment of offices will include 'best in class' water useage equipment and behaviours, including water efficient fixtures, fittings and an educated workforce as well as rainwater harvesting and greywater reuse. Additionally they will reduce the potable water use on existing wastewater sites and Severn Trent Water office facilities.

- **Institutional and Commercial Audit and Retrofit:** Delivery of water efficient devices to 600 schools by the end of 2009/10. Extension of this programme to deliver water efficient

devices to institutional and commercial premises through the provision of advice, audits and where practicable water efficient devices.

- **Household Audit and Retrofit:** Targeted domestic retrofits and the subsequent retrofit installation of water efficient products have the potential to deliver significant water savings within existing housing stock. The aim is to target installation of efficient devices in the Social Housing sector.

- **Product Subsidies:** Continuation of the provision of water efficient products to help reduce waste, provision has been allowed for product promotion, subsidy and education required to raise consumer awareness and encourage uptake.

Severn Trent Water will update and revise this programme where appropriate as the evidence base improves and further best practice is identified.

8.2.3 Severn Trent Water - Leakage Reduction

Within their statement of response to the Draft WRMP, Severn Trent Water envisages that they will reduce leakage to 453Ml/day by 2015. They have assessed the cost impact of never allowing leakage to rise over the forecast period and their strategy in the Final WRMP will be based around this principle. They also envisage that a new policy will be adopted where household meters are installed at the point where customers' supply pipes join Severn Trent Water's pipes, this will enable a quicker identification of the location of leaks on customers' supply pipes.

Within Severn Trent Water's options for reduction of the supply/demand deficit in the Severn WRZ3 in the Draft WRMP is the reduction in leakage. Table 8-1 outlines how the optimised leakage control interventions required to meet the economic leakage targets.

Leaking water mains have been identified as one of the major sources of nitrate to groundwater[9]. Therefore by reducing leakage from water mains there is a positive effect not only on water resources but also on groundwater quality.

Table 8-1: The optimised leakage control interventions required to meet the economic leakage targets.*

	2010-2015	2015-2020	2020-2025	2025-2030	2030-2035
Base Leakage (2009/2010)	162.0	-	-	-	-
Active Leakage Control (£m per annum)	6.4	7.5	7.0	6.4	7.0
Mains Replacement Cost (£m per annum)	12.6	12.7	9.1	11.0	12.2
Mains Replaced (km)	393	429	313	326	376
Pressure Costs (£m per annum)	0.0	0.0	0.04	0.0	0.0
Leakage Target (Ml/day)	161.1	151.8	155.0	161.5	158.1

*This table was extracted from the Draft WRMP and will need updating when the final version is available.

[9] Environment Agency – Groundwater Protection: Policy and Practice (GP3).

Summary:

- **It is important to focus on demand management and water efficiency as the water resources and abstraction licences are limited in the region.**
- **Severn Trent Water predicts that a minimum of 72% of households in their region will be metered by 2035.**
- **Severn Trent Water are promoting several water efficient practices (as recommended in Ofwat's Efficiency Initiatives – Good Practice Register for Water and Sewerage Companies 2007), including the provision of Cistern Displacement Devices (CDD) and water efficient product subsidies.**
- **Severn Trent Water's 'Water Efficiency' programme is projected to save around 16.35Ml/day by 2015.**
- **Severn Trent Water envisages that they will reduce leakage to 453Ml/day by 2015.**

8.3 Sustainable Housing

There has been significant progress in recent years by the Government in promoting and driving water efficiency in new homes and buildings in England and Wales. The Building Regulations in England and Wales for the first time include water efficiency regulations, a whole-building standard of 125 litres per person per day.

The Code for Sustainable Housing has been prepared by the Government in consultation with the BRE and CIRIA. It is intended that this code should be the only national standard for design and construction of sustainable homes and that it should guide the industry to improve and achieve sustainable home building. The Code for Sustainable Homes became operational in England in April 2007 and a Code rating for new build homes became mandatory from 1st May 2008. The new requirement to have **a rating** against the Code **does not** make it mandatory to build a Code home or to have each new home assessed against the Code. It does however mean that all buyers of new homes be given clear information about the sustainability of the new home. However, the Government is considering making it mandatory to build a Code home in the future.

There are different levels of sustainability that can be achieved within the code ranging from a one star rating (★) up to a six star rating (★★★★★★). There are a number of minimum standards that must be achieved to gain a one star (★) sustainability rating and energy efficiency and water efficiency categories also have minimum standards that must be achieved at every level of the code, recognising their importance to the sustainability of any home.

The Green Infrastructure Strategy for Worcester (2007) recommends that developers should build new homes to at least a 'one star' standard under the Code for Sustainable Homes, especially as the Government is considering making it mandatory for all development in the future.

The Homes and Communities Agency was formed on 1st December 2008 bringing English Partnerships and the Housing Corporation together referred to by the HCA as 'the single conversation'. In 2007, the Housing Corporation prescribed a minimum standard of Code for Sustainable Homes Level 3 in their Design and Quality Standards. English Partnerships also set Code for Sustainable Homes level 3 as the minimum standard for new build housing and a BREEAM Very Good rating for non domestic buildings in their quality standards (Section 8.4).

In line with the current view from the HCA it is recommended that new residential developments within the proposed strategic site allocations strive to achieve a Level 3 under the Code for Sustainable Homes, a level of 105 litres/person/day (l/p/d), 20 l/p/d less than the Building Regulations 17.K value of 125l/p/d.

The 'Water Efficiency Calculator for New Dwellings[10]' is a Government document that sets out the Water Calculation Methodology for assessing the whole house water efficiency of new dwellings. The latest document is the September 2009 version and replaces the previous May 2009 version.

[10] http://www.communities.gov.uk/publications/planningandbuilding/watercalculator

The calculation method is to be used to assess compliance against the water performance targets in Building Regulations 17.K and the Code for Sustainable Homes now uses this calculator as the Assessment Methodology for WAT1.

The Code for Sustainable homes may become one of the driving forces behind systems such as rainwater harvesting and greywater reuse becoming more common in the UK. The following sections are an overview of the two systems. Further information can be found in the Environment Agency's publications; Greywater: an information guide (2008) and Harvesting rainwater for domestic uses: an information guide (2008).

It should be noted that there are several relatively cheap and simple water conservation devices, such as low flow taps, aerated showers, low flush toilets and simple rainwater butts that should be considered by developers, as well as the installation of rainwater harvesting or greywater recycling systems.

Table 8-2: Summary of minimum standards for Water under the Code for Sustainable Housing

Category - Water	Code Level	Minimum Standard
Internal potable water consumption measured in litres per person per day (l/p/d)	1(★)	120 l/p/d
	2(★★)	120 l/p/d
	3(★★★)	105 l/p/d
	4(★★★★)	105 l/p/d
	5(★★★★★)	80 l/p/d
	6(★★★★★★)	80 l/p/d

*l/p/d = litres/person/day

8.3.1 Greywater Reuse

The Environment Agency information guide defines greywater as wastewater only from showers, baths and hand basins, excluding water from washing machines and kitchen sinks that is more contaminated. The Environment Agency defines 'Greywater Reuse' as the use of untreated greywater and 'greywater recycling' as the use of treated greywater. The Code for Sustainable Homes defines greywater recycling as the appropriate collection, treatment and storage of used shower, bath and tap water for use, instead of potable water, in WCs and/or washing machines. Greywater recycling systems normally collect used shower, bath and tap water and recycle this for toilet flushing.

Recycling greywater can reduce the consumption of mains water and also the volume of water discharged into the sewerage system. Greywater recycling systems vary significantly in their complexity and size from small systems with very simple treatment to large systems with complex treatment processes.

The cost of greywater systems is variable, the Environment Agency guide indicates that the cost in total is approximately £3,000, this includes £2,500 for purchase and £500 for installation. These figures are conservative but would be suitable for a ballpark calculation based on an individual domestic system whereas the cost of communal systems would be more variable. It should also be noted that installation costs could be lower if greywater systems are installed during construction, rather than through sometimes complex retrofit installations that could cost considerably more. The costs outlined in the Environment Agency guide do not include maintenance and running costs, as these depend on the type of system and are not well documented.

8.3.2 Rainwater Harvesting

Rainwater can be harvested from roofs and areas of hard standing, such as driveways but suppliers can advise on the best product for a particular situation. The Environment Agency guide states that around 2000 rainwater harvesting systems were installed in the UK in 2006/2007, compared to approximately 500 systems in 2003/2004. This is still a relatively small number compared to some other countries, for

example it has been estimated that in Germany between 50,000 and 100,000 rainwater harvesting systems are installed each year.

Rainwater is most commonly collected entirely from roofs as water from other hard standing areas may have poorer water quality, for example water from driveways may add oil or faecal matter to the water system. If properly collected and stored the resulting water can be used for several purposes such as toilet flushing and garden watering, however it may only be used for drinking water if treatment to a potable quality is provided. The BSI 'Rainwater Harvesting Systems – Code of Practice' (2009) establishes standards for water quality standards for rainwater use. This states that water quality should be measured in relation to the guideline values below for parameters relating to health risk, and for parameters relating to system operation. These provide an indication of the water quality that a well-designed and maintained system is expected to achieve for the majority of operating conditions.

Table 8-3 Guideline values for bacteriological monitoring

Parameter	Guideline values by use		System Type
	Pressure washers and garden sprinklers	Garden watering and WC flushing	
Escherichia coli Number / 100 mL	**1**	**25**	Single site and communal domestic systems
Intestinal enterococci Number / 100 mL	**1**	**100**	Single site and communal domestic systems
Legionella Number / 100 mL	**100**	**-**	Where analysis is necessary as indicated by risk assessment
Total coliforms Number / 100 mL	**10**	**1,000**	Single site and communal domestic systems

Table 8-4 Guideline values for general system monitoring

Parameter	Guideline values	System Type
Dissolved oxygen in stored rainwater	>10% saturation or >1 mg/L O_2 (whichever is least) for all uses	All systems
Suspended solids	Visually clear and free from floating debris from all uses	All systems
Colour	Not objectionable for all uses	All systems
Turbidity	<10 NTU for all uses (<1 NTU if UV disinfection is used)	
pH	5-9 for all uses	Single site and communal domestic systems
Residual chlorine	<0.5 mg/L for garden watering <2 mg/L for all other uses	All systems, where used
Residual bromine	<2 mg/L for all uses	All systems, where used

It must be noted that quality will fluctuate particularly following rainfall events, when there could be a short-term change.

As with greywater systems, rainwater harvesting systems can be installed in new and existing buildings, though it is more cost effective to install them during construction rather than during retrofitting. The potential savings due to rainwater harvesting depends on the demand for non-potable water and amount of rainwater that can be supplied, which depends on the roof area available for collection and the amount

of local rainfall. Savings will be greater in larger buildings, such as schools, due to their larger roof areas and potentially greater demand for non-potable water.

8.4 Non – Residential Development

In 1990 the BREEAM assessment process was created with the first two versions covering offices and homes. Versions are updated regularly in line with UK Building Regulations and different building versions have been created since its launch to assess various building types.

These versions essentially look at the same broad range of environmental impacts:

- Management
- Health and Wellbeing
- Energy
- Transport
- Water
- Material and Waste
- Landuse and Ecology
- Pollution

Credits are awarded in each of the above areas according to performance. A set of environmental weightings then enables the credits to be added together to produce a single overall score. The building is then rated on a scale of; pass, good, very good, excellent or outstanding; and a certificate awarded to the development.

The categories relevant to this study are Water, Landuse and Ecology and Pollution. BREEAM credits are awarded where the following measures are in place:

Water:
- Water efficient appliances (e.g. low flush toilets)
- Water metering
- Leak detection systems
- Water butts

Landuse and Ecology:
- Is it brownfield or are you rededicating a contaminated site?
- Can you make any ecological enhancements?
- Are you protecting or endangering existing ecological features?
- Are you making the best use of your building footprint?

Pollution
- Building in a low flood risk area and attenuation of surface water run off
- Good practice in terms of oil interceptors/filtration in car parks and other risk areas

The DCSF (Department for Children, Schools and Families) has made it a condition of capital funding that new build and refurbishment projects achieve a ‘VERY GOOD’ rating under BREEAM Schools. The requirement covers:

- All major new-build projects valued at over £500,000 (primary schools) and £2million (secondary schools)
- All refurbishment projects valued at over £500,000 (primary schools) and £2million (secondary schools) and affecting more than 10% of the floor area of the school
- Smaller schemes may be suitable for formal BREEAM assessment. Designers should, as far as practicable, apply the same standards to all projects.

The Office of Government Commerce (OGC) requires a BREEAM rating of 'EXCELLENT' for all new buildings from March 2003.

As of 1st of July 2008, all health authorities in the UK (Department of Health, Welsh Health Estates, Health Facilities Scotland and the Department of Health Social Services and Public Safety) require that new healthcare buildings seeking Outline of Business Case (OBC) approval commit to achieving an EXCELLENT rating and all refurbishments commit to achieving a VERY GOOD.

For further information regarding the BREEAM standards please refer to their website[11]

Summary:

- **The Building Regulations in England and Wales include water efficiency regulations, a whole-building standard of 125 l/p/d. Non-domestic buildings should adhere to the BREEAM standards where applicable.**
- **Current guidance from the Homes and Communities Agency recommends that developers should build new homes to at least Level 3 standard under the Code for Sustainable Homes, a standard of 105 l/p/d**
- **There are several relatively cheap and simple water conservation devices, such as low flow taps, aerated showers, low flush toilets and simple rainwater butts that should be also be considered by developers.**

8.5 Conclusion and Policy

This Water Cycle Study (WCS) has shown that water resources and abstraction licences are limited within the region are scarce and that it is important to focus on demand management and water efficiency. Non-domestic buildings should adhere to the BREEAM standards where applicable.

Therefore the following policy has been developed to reduce the impact of new developments within the South Worcestershire WCS area on the scarce water resources. This policy is based on the Code for Sustainable Homes definition of greywater recycling.

WATER RESOURCES POLICY

- All new development units will be restricted to a maximum water usage of 105 litres/person/day for indoor potable water and 5% of units within a development will be required to achieve a maximum water usage of 90 litres/person/day for indoor potable water. Rainwater Harvesting and/or Greywater Recycling systems will be a requirement for all new development units.

Reasoned Justification:

As water resources are scarce in the South Worcestershire area, demand management options are a vital consideration when planning and building new developments in order to provide sustainability both in terms of the aquatic environment and water supply. In line with the current view from the Homes and Communities Agency (HCA) it is recommended that new residential developments within the proposed strategic site allocations strive to achieve a Level 3 under the Code for Sustainable Homes, a level of no more than 105 litres/person/day (l/p/d). The definition of Greywater Recycling for this policy is 'the appropriate collection, treatment and storage of used shower, bath and tap water for use, instead of potable water, in WCs and/or washing machines. Greywater recycling systems normally collect used shower, bath and tap water and recycle this for toilet flushing. The definition of Rainwater Harvesting Systems for this policy recommendation includes the use of water butts for outdoor water use as well as for use instead of potable water in WCs and/or washing machines. The incorporation of rainwater harvesting systems as standard in all new developments will not only increase efficiency in the home but can also contribute to a reduction in surface water runoff. It is important to strive to achieve additional

[11] http://www.breeam.org

water savings, leading to 5% of all development units being required to achieve the upper tier of the Code for Sustainable Homes Level 4 of no more than 90 l/p/d by 2011. It should be noted that there are several relatively cheap and simple water conservation devices, such as low flow taps, aerated showers, low flush toilets and simple rainwater butts that may be sufficient to achieve 105l/p/d and should be considered before the more expensive systems. However, to achieve 90 l/p/d the installation of more complex rainwater harvesting or greywater recycling systems may also be required where options for improving the efficiency of terminal fittings (taps, toilets etc) have been maximised. Shared systems can be utilised to reduce the per unit cost of greywater or rainwater harvesting systems, for example communal systems can be installed in apartment blocks. The information below is a selection of options available to developers to achieve the required target levels, this is by no means an exhaustive list.

- Water Efficient Shower Heads
- Dual flush toilets
- Reduced flow rate taps
- Water Efficient appliances, e.g dishwasher and washing machines

All new developments are required to incorporate a rainwater harvesting or greywater recycling system which could consist of but is not limited to one of the following options:

- Rainwater harvesting systems:
    - Internal systems (e.g. feeding washing machines and/or toilets)
    - External systems (e.g. Water Butts, for watering the garden, car washing etc)
    - Combination systems (internal and external use)
- Greywater recycling systems:
    - Direct reuse systems (no treatment) – e.g. bath water used directly for watering gardens
    - Short retention systems (take wastewater from the bath or shower and apply a basic treatment technique such as skimming debris off the surface and allowing particles to settle to the bottom of the tank and stores for a short period of time)
    - Biological systems (bacteria are used to remove organic material from wastewater)
    - Bio-mechanical systems (The most advanced domestic greywater treatment systems that use a combination of biological and physical treatment)

9 CONCLUSIONS

9.1 Water Supply and Wastewater

The proposed strategic site allocations are able to be accommodated but all of them will need some infrastructure improvement whether it is for sewerage, sewage treatment or water supply. Severn Trent Water have supplied notional solutions and costs for the improvements required (Table 9-1). The costs for sewerage do not include potential improvements required for the Fernhill Heath and Great Malvern proposed strategic site allocations; Great Malvern was also unable to be assessed in terms of investment for water supply infrastructure. Any site specific upgrades to sewerage/water supply infrastructure will be expected to be funded by developer contribution. The infrastructure upgrades would normally require 12 months to install/upgrade from the time the developer agrees to the funding. Severn Trent Water has a statutory obligation to provide additional treatment capacity to accept future domestic development flows.

Severn Trent Water has provided an estimate of current spare hydraulic capacity at the sewage treatment works. This assessment identifies three works that will require additional hydraulic capacity to be able to accommodate flows from the proposed strategic site allocations associated with them. These sewage treatment works are Powick, Worcester (Bromwich Road) and Droitwich (Ladywood). When the current estimation of future development that can be accommodated at the Sewage Treatment Works at Worcester, Powick and Droitwich, is allocated by Planning Permissions, further detailed assessments will be required to determine whether the sewage treatment works can accommodate the development. Following the results of this assessment, Severn Trent Water should be contacted to agree the requirements and costs, if necessary, for up-rating the works. Planning for the proposed strategic site allocations should account for a maximum 3-4 year period required for capacity and/or treatment upgrades to the sewage treatment works identified in the Water Cycle Study.

The solutions and costs will need to be reassessed once the final allocations and dwelling numbers are confirmed.

Table 9-1: Notional Cost of Wastewater and Water supply Infrastructure Improvements required to accommodate the Proposed Strategic Site Allocations

	Water Supply	Sewerage	Sewage Treatment
Notional Cost for proposed development sites	£7,300,000	£4,300,000-£4,400,000	Unknown at present
Notional Total Cost for infrastructure improvement	**£11,600,000 - £11,700,000**		

9.2 Water Resources

With investment it is possible to improve the infrastructure so that all of the potential dwellings proposed in the proposed strategic site allocations are supplied with water and wastewater services. However, there is already pressure on the water resources within the area and Severn Trent Water predict a net increase of approximately 31Ml/day in water consumption from 2006 – 2035 in the Severn Water Resource Zone. The supply/demand balance for the Zone became negative in 2006/2007 and looks to remain in deficit in the future. The current projected supply/demand shortfall is around 120Ml/d by 2035 taking into consideration climate change. It should be noted that the projected shortfall would arise if no further investment was made to leakage reduction, demand management and resource development.

Pressure on the water resources can lead to increased pressure on the aquatic environment. The Environment Agency have strict licensing policies for new and existing abstractions from groundwater and surface water resources to ensure that the environment is protected. The Government is currently consulting on new proposals, including mandatory time limits on all water abstraction licences in England and Wales and new regulations that will bring some currently exempt activities, such as the irrigation of

crops, under the licensing arrangements and maintain some exemptions, such as most abstractions within water meadows that are a low risk to the environment and other water users. These powers are seen as a crucial step in ensuring the sound management and appropriate allocation of water resources in order to cope with the anticipated impacts of climate change.

As water resources are scarce in the South Worcestershire area, demand management options are a vital consideration when planning and building the new developments to provide sustainability both in terms of the aquatic environment and water supply. Severn Trent Water propose to promote household retrofitting (installation of water efficient products in existing developments) as well as other water efficiency options and further reduce leakage. 'Future Water: The Governments strategy for water in England (February 2008) envisages that by 2030 the average household per capita consumption (pcc) could be reduced to 130litres/head/day. With increased water efficiency and water metering Severn Trent Water predict that by 2035 for a normal year the average household per capita consumption is 133litres/head/day, which shows progress towards achieving the Government's long term vision. The current recommendation outlined by the Homes and Communities Agency is that developers should build new homes to at least a Level 3 standard under the Code for Sustainable Homes.

As a result of this Water Cycle Study the following policy has been developed to reduce the impact of the proposed strategic site allocations on the scarce water resources and is based on the Code for Sustainable Homes definition of greywater recycling.

WATER RESOURCES POLICY

- All new development units will be restricted to a maximum water usage of 105 litres/person/day for indoor potable water and 5% of units within a development will be required to achieve a maximum water usage of 90 litres/person/day for indoor potable water. Rainwater Harvesting and/or Greywater Recycling systems will be a requirement for all new development units.

Reasoned Justification:

As water resources are scarce in the South Worcestershire area, demand management options are a vital consideration when planning and building new developments in order to provide sustainability both in terms of the aquatic environment and water supply. In line with the current view from the Homes and Communities Agency (HCA) it is recommended that new residential developments within the proposed strategic site allocations strive to achieve a Level 3 under the Code for Sustainable Homes, a level of no more than 105 litres/person/day (l/p/d). The definition of Greywater Recycling for this policy is 'the appropriate collection, treatment and storage of used shower, bath and tap water for use, instead of potable water, in WCs and/or washing machines. Greywater recycling systems normally collect used shower, bath and tap water and recycle this for toilet flushing. The definition of Rainwater Harvesting Systems for this policy recommendation includes the use of water butts for outdoor water use as well as for use instead of potable water in WCs and/or washing machines. The incorporation of rainwater harvesting systems as standard in all new developments will not only increase efficiency in the home but can also contribute to a reduction in surface water runoff. It is important to strive to achieve additional water savings, leading to 5% of all development units being required to achieve the upper tier of the Code for Sustainable Homes Level 4 of no more than 90 l/p/d by 2011. It should be noted that there are several relatively cheap and simple water conservation devices, such as low flow taps, aerated showers, low flush toilets and simple rainwater butts that may be sufficient to achieve 105l/p/d and should be considered before the more expensive systems. However, to achieve 90 l/p/d the installation of more complex rainwater harvesting or greywater recycling systems may also be required where options for improving the efficiency of terminal fittings (taps, toilets etc) have been maximised. Shared systems can be utilised to reduce the per unit cost of greywater or rainwater harvesting systems, for example communal systems can be installed in apartment blocks. The information below is a selection of options available to developers to achieve the required target levels, this is by no means an exhaustive list.

- Water Efficient Shower Heads

- Dual flush toilets
- Reduced flow rate taps
- Water Efficient appliances, e.g dishwasher and washing machines

All new developments are required to incorporate a rainwater harvesting or greywater recycling system which could consist of but is not limited to one of the following options:

- Rainwater harvesting systems:
    - Internal systems (e.g. feeding washing machines and/or toilets)
    - External systems (e.g. Water Butts, for watering the garden, car washing etc)
    - Combination systems (internal and external use)
- Greywater recycling systems:
    - Direct reuse systems (no treatment) – e.g. bath water used directly for watering gardens
    - Short retention systems (take wastewater from the bath or shower and apply a basic treatment technique such as skimming debris off the surface and allowing particles to settle to the bottom of the tank and stores for a short period of time)
    - Biological systems (bacteria are used to remove organic material from wastewater)
    - Bio-mechanical systems (The most advanced domestic greywater treatment systems that use a combination of biological and physical treatment)

9.3 Water Quality and the Environment

The watercourses that flow through or near to the proposed strategic site allocations are currently failing to reach the WFD standards in terms of either their chemical or ecological quality. The proposed strategic site allocations can increase the pressure on the environment and water quality due to, for example, increased wastewater and associated nutrients and chemicals, as well as increasing the pressure on the aquatic habitat as water resources are already scarce. None of the proposed strategic site allocations are within groundwater protection zones and the current groundwater chemical quality is good. However, several of the proposed strategic site allocations are above minor aquifers that may potentially be 'sensitive' or used for private water supplies. Therefore minor aquifers will need to be protected from pollution.

As part of this study initial water quality modelling for BOD, Ammonium and Phosphate has been undertaken to analyse the impact that the proposed proposed strategic site allocations may have on water quality in the receiving watercourse downstream of the Sewage Treatment Works. The results show that currently the BOD, Ammonium and Phosphate levels at Powick exceed the target levels for the receiving watercourse, and these will increase with the full proposed proposed strategic site allocations. This is also the case for the levels of Phosphate at Droitwich-Ladywood STW.

Indicative future consents have been calculated. The limitations of this modelling and the need to confirm dwelling numbers should be considered before final consents are agreed.

The indicative future consents for Powick are:

- BOD – 10mg/l
- Ammonium – 1mg/l
- Phosphate – 2mg/l

- Upgrades to treatment facilities

Severn Trent Water will be required to demonstrate that they can maintain the current level of treatment for Ammonium (95%tile) at Droitwich and Evesham. If this is can be maintained with the future DWF then there will be no need to impose a new consent on the treatment works. Consents would have to be revisited should it not be possible to maintain current levels of treatment at the future DWFs for the proposed strategic site allocations. The following are indicative consents should they be deemed necessary.

- Droitwich
    - Indicative new consent of 2mg/l, taking into consideration potential upstream water quality improvements due to being in a nitrate vulnerable zone.
    - Current level of treatment (1.2mg/l) should be maintained for future DWF to meet 'no deterioration' and 'good status' targets.
    - May require upgrades to treatment facilities if current level of treatment will not be maintained with increased DWF.

- Evesham
    - Discharge quality required to accommodate the full proposed strategic site allocations and achieve the targets is 18.7mg/l of Ammonium.
    - Indicative new consent of 20mg/l, taking into consideration potential upstream water quality improvements due to being in a nitrate vulnerable zone.
    - May require upgrades to treatment if discharge quality of 18.7mg/l is not achievable with current facilities at future maximum DWF.

None of the indicative future consents required are below the BATs for sewage treatment. Therefore this modelling indicates that there are no potential 'show-stoppers' in terms of sewage treatment capacity. With regards to CSOs, no additional storm flow will be connected to the network, all will be attenuated using SUDS and then discharged to the nearest watercourse. Severn Trent Water will increase the capacity of the local sewer network should it be required to provide sufficient capacity for future DWF and ensure no additional discharges from CSOs above that of the current consent.

Severn Trent Water have confirmed that investment into upgrades at STWs would be undertaken as the need arises once development has been confirmed. This would also have the benefit of keeping customer bills low, as additional capacity would not be required until it is needed. The investment would be provided through the supply demand funding mechanism with Ofwat.

Management options such as SuDS should be utilised not only in terms of flood management but also for their water quality treatment, habitat potential and where possible groundwater recharge. All of the proposed strategic site allocations should be looking to install SuDS that help maintain the water quality. Some proposed strategic site allocations are classed as high priority where the water quality nearby is poor and needs to be improved rather than just maintained. At these locations SuDS with the greatest potential of enhancing ecology and water quality should be considered and utilised first. SSSIs that are nearby should not be adversely affected by new development in terms of both water quality and water resources. Nearby SSSIs should be considered during the SuDS selection process. For example, the Worcester South proposed strategic site allocation is adjacent to the Teme and Severn Confluence Wetland Restoration Zone, and would therefore benefit from having a source of native species nearby to colonise any new aquatic environments within the proposed strategic site allocation, such as new ponds or wetlands.

9.4 Flood Risk

The main risk to the proposed strategic site allocations is from fluvial of surface water flooding. Groundwater flooding is not considered to pose a significant risk to the proposed strategic site allocations. The South Worcestershire SFRA should be consulted for more detailed information on the Flood Risk to the area.

Surface Water should be disposed of where possible via infiltration techniques. If it is found that infiltration techniques are not suitable, surface water should be discharged into a watercourse via

appropriate attenuation schemes rather than into the existing sewer network. The Environment Agency advises the use of above ground attenuation schemes over other techniques, this is also in line with recommendations that SuDS should be used to enhance ecological and water quality.

Indicative costs for the construction of an attenuation pond within each of the proposed strategic site allocations have been calculated. It would cost in total approximately £22,600,000 to provide attenuation ponds for the attenuation of peak runoff rates and volumes for all the proposed strategic site allocations. Any additional volume required for water quality treatment and long term storage of increased volume and runoff should be included in the calculation of the final storage volumes as well as the cost of land. Maintenance costs will also need to be considered when choosing a SuDS technique, it is estimated to cost annually between £0.50 - £1.50/m^2 of attenuation pond surface area to maintain a attenuation pond. This cost is for regular maintenance and does not include major maintenance activities such as sediment removal or insurance costs.

9.5 Climate Change

It is important to include climate change in the planning of all aspects of new developments:

- The design of surface water drainage should include an allowance for climate change. PPS25 states that as a guide residential properties require a 30% increase in peak rainfall intensity and for commercial properties a 20% increase is required. The exact percentage should be negotiated on a site by site basis. An allowance for climate change has been included in the calculations of attenuation storage in Chapter 7.
- It is predicted that there will be an increase in storm intensity in the summer as well as wetter winters. SuDS can be used to help reduce the runoff from urban areas and improve the quality of the water that does reach the watercourse.
- The 100 year flood outline modelled should include a 20% increase in peak river flow to account for climate change as stated in PPS25. This has been included in the South Worcestershire SFRA.
- When predicting the amount of water available for use climate change should be taken into consideration. Severn Trent Water allow for climate change when analysing their supply/demand balance.

This page is intentionally left blank.

Table 9-2: Summary of Constraints on Development

Proposed Strategic Site Allocation	Sewage Treatment		Sewerage		Water Supply		Fluvial Flood Risk	Groundwater Resources	Surface Water Resources	Chemical Water Quality of nearest watercourse	Ecological Water Quality of nearest watercourse	Groundwater Chemical Quality
	I*	P**	I	P	I	P						
Worcester												
Worcester North West												
Worcester North												
Kilbury Drive												
Worcester South												
Fernhill Heath												
Droitwich Spa												
Hill End												
Pulley Lane												
Copcut Lane												
Great Malvern												
Malvern North												
Malvern East												
Malvern South												
Blackmore Park												
Pershore												
Pershore												
Evesham												
Offenham Road												
Cheltenham Road												
Hampton												

The 'traffic light' criteria for each category is slightly different, please refer to individual chapter conclusions for explanations.

* I = Rating in terms of investment. ** P = Rating in terms of phasing/timing restraints

This page is intentionally left blank.

10 RECOMMENDATIONS AND POLICY

It is recommended that this study is reviewed once the final Severn Trent Water Resource Management Plan and the second cycle CAMS are published.

The Water Cycle Study should be treated as a "dynamic document" that is periodically reviewed as further information becomes available or governmental policies are updated/changed. This will provide a better understanding of the impact of the developments on the water supply, wastewater infrastructure and water quality.

10.1 Further Work

Additional modelling of the sewer networks and water supply systems should be carried out to increase the accuracy of the results once the proposed strategic site allocations and dwelling numbers are finalised and type of employment is known. This will allow more accurate costings and solutions to be developed and to confirm the potential constraints to development.

It is also recommended that new hydraulic models are created for watercourses where models are currently not available from the Environment Agency. Surface Water Management Plans should be undertaken for Worcester, Droitwich Spa and Great Malvern to produce a more accurate assessment of the flood risk to the proposed strategic site allocations.

In the case of Worcester STW there are known discrepancies in the measured DWF. Therefore, there may be some DWF volumetric headroom available. Further analysis of measured DWF here is therefore required.

When the current estimation of future development that can be accommodated at the Sewage Treatment Works at Worcester, Powick and Droitwich, is allocated by Planning Permissions, developers will be requested to undertake an assessment of the sewage treatment works to prove whether hydraulic capacity has been reached or not. Following the results of this assessment, Severn Trent Water should be contacted to agree the requirements and costs, if necessary, for up-rating the works. In addition developers will be requested to ensure that there is consent (volumetric) capacity. If a development will lead to the volumetric condition being exceeded, a new consent will be required triggering a review of the quality conditions.

10.2 Policy

An important constraint to development in the South Worcestershire that has been identified in this study is the scarcity of water resources and the limited abstraction licences available. An outcome of this study is a Greywater Recycling Policy that has been developed in conjunction with the South Worcestershire Joint Core Strategy to limit the impact of the proposed strategic site allocations on the water resources. The policy is outlined below and is based on the Code for Sustainable Homes definition of greywater recycling:

WATER RESOURCES POLICY

- All new development units will be restricted to a maximum water usage of 105 litres/person/day for indoor potable water and 5% of units within a development will be required to achieve a maximum water usage of 90 litres/person/day for indoor potable water. Rainwater Harvesting and/or Greywater Recycling systems will be a requirement for all new development units.

Reasoned Justification:

As water resources are scarce in the South Worcestershire area, demand management options are a vital consideration when planning and building new developments in order to provide sustainability both in terms of the aquatic environment and water supply. In line with the current view from the Homes and Communities Agency (HCA) it is recommended that new residential developments within the proposed strategic site allocations strive to achieve a Level 3 under the Code for Sustainable Homes, a level of no more than 105 litres/person/day (l/p/d). The definition of Greywater Recycling for this policy is 'the

appropriate collection, treatment and storage of used shower, bath and tap water for use, instead of potable water, in WCs and/or washing machines. Greywater recycling systems normally collect used shower, bath and tap water and recycle this for toilet flushing. The definition of Rainwater Harvesting Systems for this policy recommendation includes the use of water butts for outdoor water use as well as for use instead of potable water in WCs and/or washing machines. The incorporation of rainwater harvesting systems as standard in all new developments will not only increase efficiency in the home but can also contribute to a reduction in surface water runoff. It is important to strive to achieve additional water savings, leading to 5% of all development units being required to achieve the upper tier of the Code for Sustainable Homes Level 4 of no more than 90 l/p/d by 2011. It should be noted that there are several relatively cheap and simple water conservation devices, such as low flow taps, aerated showers, low flush toilets and simple rainwater butts that may be sufficient to achieve 105l/p/d and should be considered before the more expensive systems. However, to achieve 90 l/p/d the installation of more complex rainwater harvesting or greywater recycling systems may also be required where options for improving the efficiency of terminal fittings (taps, toilets etc) have been maximised. Shared systems can be utilised to reduce the per unit cost of greywater or rainwater harvesting systems, for example communal systems can be installed in apartment blocks. The information below is a selection of options available to developers to achieve the required target levels, this is by no means an exhaustive list.

- Water Efficient Shower Heads
- Dual flush toilets
- Reduced flow rate taps
- Water Efficient appliances, e.g dishwasher and washing machines

All new developments are required to incorporate a rainwater harvesting or greywater recycling system which could consist of but is not limited to one of the following options:

- Rainwater harvesting systems:
    - Internal systems (e.g. feeding washing machines and/or toilets)
    - External systems (e.g. Water Butts, for watering the garden, car washing etc)
    - Combination systems (internal and external use)
- Greywater recycling systems:
    - Direct reuse systems (no treatment) – e.g. bath water used directly for watering gardens
    - Short retention systems (take wastewater from the bath or shower and apply a basic treatment technique such as skimming debris off the surface and allowing particles to settle to the bottom of the tank and stores for a short period of time)
    - Biological systems (bacteria are used to remove organic material from wastewater)
    - Bio-mechanical systems (The most advanced domestic greywater treatment systems that use a combination of biological and physical treatment)

APPENDIX A: WATER QUALITY MODELLING

This page is intentionally left blank.

Introduction

For each of the three STWs identified by Severn Trent Water Ltd as being of limited capacity (Droitwich – Ladywood, Worcester Bromwich Road and Powick) an assessment has been made of the impact of the proposed strategic site allocations on the downstream water quality in the receiving watercourse. In addition, Evesham STW has been identified as able to accommodate the proposed strategic site allocations without upgrades, but bringing the works close to its current capacity limit. For this reason Evesham STW was also included in the assessments. In addition, assessments have been made based on incremental increases of 250 homes to each STW, so that the impact from additional wind-fall sites can be considered.

Further to these assessments indicative future permit conditions have also been determined to identify if there are any potential show stoppers in terms of future permits being tighter than Best Available Technique (BAT) and therefore potentially unachievable to the water company.

The three contaminants examined as part of this investigation into water quality are BOD (Biochemical Oxygen Demand), Ammonium and Phosphates.

Policies Influencing Water Quality

The Environment Agency has two over-arching principles that underpin all Environment Agency water quality planning:

- No breach of statutory standards due to housing and development growth in England and Wales.
- No deterioration to water quality due to housing and development growth in England and Wales.

Water companies have obligations under existing legislation:

- The Water Industry Act 1991 requires sewerage undertakers to effectually drain the catchment and effectually deal with the contents of the sewer.
- The Urban Waste Water Treatment Directive (UWWTD) requires sewerage systems to be designed, maintained, and constructed in accordance with Best Technical Knowledge Not Entailing Excessive Cost (BTKNEEC) notably regarding limitation of pollution by storm overflows, the volume and characteristics of urban waste water and prevention of leaks.

Methodology

The Environment Agency's software RQP (River Quality Planning, v2.5, September 2001) has been used in conjunction with their recommended guidance document 'Calculation of River Needs Consents'.
The software relies on a Mass Balance Equation, which determine how discharges affect the mean or percentiles of river water quality. The model incorporates Monte Carlo sampling techniques, a process by which the mean and standard deviations of the four log-normal distributions of river and effluent flow and quality are mixed together according to the Mass Balance Equation.

Input Variables

The following data were required for inclusion into the RQP software:

Upstream River Data

- Mean flow
- Standard deviation of flow
- Mean water quality
- Standard deviation of river quality

Discharge Data

- Mean flow
- Standard deviation of flow
- Mean quality
- Standard deviation of quality

River Quality Target Data

- No deterioration target
- 'Good Status' target

Upstream River Data

The upstream river data was supplied by the Environment Agency. In the case of Powick STW, the receiving watercourse, Carey's Brook, is ungauged and hence no continuous flow data series were available. An estimate of the mean and Q95 flows on Carey's Brook was provided by the Environment Agency from 2000, representing the most suitable data available.
Upstream river quality data was supplied at the nearest sampling location upstream of the STW. The distances of these are as follows:

- Droitwich: 262m upstream of STW
- Worcester: 1,486m upstream of STW
- Powick: 183m upstream of STW
- Evesham: 1,967m upstream of STW

The Environment Agency guidance document 'Calculation of River Needs Consents' states that:

"Where the nearest upstream monitoring point is some distance upstream of the discharge, it can be important to allow for the effects of Natural Purification from the monitoring point to the point in the river just upstream of the discharge".

It is believed that the water quality sampling locations upstream of Droitwich and Powick STWs are acceptable. Whilst the distance of the sampling points upstream of both Worcester and Evesham STWs is greater, no consideration of Natural Purification has been made, thereby providing estimates of downstream water quality which represent some degree of conservatism.

The following table summarises the input model data.

Table A1-1: Model Input Data (Upstream)

Upstream Input Data		STW			
		Droitwich	Worcester	Powick	Evesham
Receiving Watercourse		River Salwarpe	River Severn	Carey's Brook	River Avon
Mean Flow (l/s)		1,360	78,300	133.1	15,710
95% Exceedance Flow (l/s)		350	15,000	12.73	3,000
Mean Water Quality (mg/l)	BOD	1.90	1.58	1.34	2.12
	Ammonium	0.10	0.07	0.06	0.11
	Phosphate	0.77	0.32	0.16	0.35
Standard Deviation of River Quality	BOD	1.21	0.55	0.62	1.54
	Ammonium	0.07	0.04	0.10	0.07
	Phosphate	0.40	0.21	0.06	0.13

Discharge Data

The Environment Agency supplied discharge quality data for each STW for each of the three contaminants. These are provided below.

Table A1-2: Model Input Data (STW quality)

Upstream Input Data		STW			
		Droitwich	Worcester	Powick	Evesham
Mean Water Quality (mg/l)	BOD	6.37	3.74	14.03	5.44
	Ammonium	1.00	0.87	5.57	2.49
	Phosphate	6.90	1.89	6.15	1.62
Standard Deviation of River Quality	BOD	3.30	2.08	4.26	2.57
	Ammonium	0.97	3.40	2.74	1.88
	Phosphate	2.10	1.11	1.67	1.67

The discharge flow data can be assumed to increase as more flows are directed through the STWs. The 'Calculation of River Needs Consents' document states that mean daily flow can be calculated as 1.25 times the Dry Weather Flow (DWF) and the standard deviation can be taken as one-third of the mean. Current DWFs have been supplied by Severn Trent Water Ltd for each of the STWs, based on average 2005-2009 flows. These were used to calculate the current discharge flows, allowing the baseline water quality downstream of the STWs to be established. These are provided below.

Table A1-3: Model Input Data (STW current flow)

Upstream Input Data	STW			
	Droitwich	Worcester	Powick	Evesham
Current DWFs (l/s)	82.22	381.94	27.15	54.21
Mean Flow (l/s)	102.78	477.43	33.94	67.77
Standard Deviation of Flow	34.26	159.14	11.31	22.59

It must be noted that for the Worcester Bromwich Road STW the updated DWFs, issued March 2010, have been incorporated.

In order to establish how flow (discharge from the STW) will change in the future as the number of developments increases, an assessment of future DWFs was required. The Growth Point Study by Jacobs in 2008 for Severn Trent Water Ltd established an increase in flows to the works based on modelling and using the "Formula A Flow" calculated for the proposed developments. These were based on DWFs at the time of calculation. This baseline differs from those more up to date current DWFs provided by Severn Trent Water Ltd for this study (2005-2009), and also the updated Worcester DWF of March 2010. In addition, the number of proposed strategic site allocations has been refined with time.

The methodology used to predict the future DWF at the treatment works has been based on the same methodology used by Severn Trent Water to provide an indication of hydraulic capacity at the treatment works. The following assumptions made by Severn Trent Water have been used to predict the future DWF:

- 160l/h/d.
- An average occupancy rate of 2.4.
- The most up to date current DWFs have been used as a baseline.

This equates to an additional 384l/d/dwelling. The additional DWF for the number of potential strategic site allocations has been calculated and added to the current DWF for each treatment works to provide an estimate of the future DWF. This also allowed an incremental assessment of 250 homes to be undertaken, rather than just the impact of all the proposed strategic site allocations. The mean and standard deviation flows were calculated as previously described for the range of different numbers of additional properties as shown in the following table.

Table A1-4: Model Input Data (future STW DWFs and flows)

Upstream Input Data	STW			
	Droitwich	Worcester	Powick	Evesham
+ 250 properties				
Future DWFs (l/s)	83.33	383.06	28.26	55.32
Mean Flow (l/s)	104.17	478.82	35.33	69.16
Standard Deviation of Flow	34.72	159.61	11.78	23.05
+ 500 properties				
Future DWFs (l/s)	84.44	384.17	29.38	56.44
Mean Flow (l/s)	105.56	480.21	36.72	70.54
Standard Deviation of Flow	35.19	160.07	12.24	23.51
+ 750 properties				
Future DWFs (l/s)	85.56	385.28	30.49	57.55
Mean Flow (l/s)	106.94	481.60	38.11	71.93
Standard Deviation of Flow	35.65	160.53	12.70	23.98
+ 1,000 properties				
Future DWFs (l/s)	86.67	386.39	31.60	58.66
Mean Flow (l/s)	108.33	482.99	39.50	73.32
Standard Deviation of Flow	36.11	161.00	13.17	24.44
+ 1,250 properties				
Future DWFs (l/s)	87.78	387.50	32.71	59.77
Mean Flow (l/s)	109.72	484.38	40.89	74.71
Standard Deviation of Flow	36.57	161.46	13.63	24.90
+ 1,500 properties				
Future DWFs (l/s)	88.89	388.61	33.82	60.88
Mean Flow (l/s)	111.11	485.76	42.27	76.10
Standard Deviation of Flow	37.04	161.92	14.09	25.37
+ 1,750 properties				
Future DWFs (l/s)	90.00	389.72	34.93	61.99
Mean Flow (l/s)	112.50	487.15	43.66	77.49
Standard Deviation of Flow	37.50	162.38	14.55	25.83
+ 2,000 properties				
Future DWFs (l/s)	91.11	390.83	36.04	63.10
Mean Flow (l/s)	113.89	488.54	45.05	78.88
Standard Deviation of Flow	37.96	162.85	15.02	26.29
Full Proposed Strategic Site Allocations				
Number of properties	+2,250 properties*	+4,150 properties**	+3,000 properties	+2,100 properties
Future DWFs (l/s)	92.22	398.83	40.49	64.44
Mean Flow (l/s)	115.28	498.54	50.61	80.54
Standard Deviation of Flow	38.43	166.18	16.87	26.85

* Note: this includes 500 properties for the Fernhill Heath development

** Note: this is a total of the strategic site allocations proposed for Worcester NW, Worcester N and Kilbury Drive)

River Quality Target Data

The current consents for each contaminant at each of the STWs were provided by Severn Trent Water Ltd and are shown below. These represent the concentration of discharge permitted prior to mixing with the receiving watercourse.

Table A1-5: Current Consents

Contaminant (mg/l)	STW			
	Droitwich	Worcester	Powick	Evesham
BOD	25	25	25	25
Ammonium	10	15	20	None set
Phosphate	None set*	None set	None set	2

* As part of the EA's National Environment Programme Severn Trent Water Ltd are expecting to meet a new 2mg/l P consent by Sept 2014.expecting to meet a new 2mg/l P consent by Sept 2014.

The use of current discharge quality to calculate the future impact on downstream quality at varying DWFs is based on the assumption that the quality of the discharge does not worsen in the future. with the additional flows through the STWs

The table below demonstrates whether the current consents are being achieved, based on data provide by the Environment Agency. Permit limits for BOD and Ammonia are the 95 percentiles, whereas for Phosphate it is the annual average (mean).

Table A1-6 Current Consents Achievement

Contaminant (mg/l)		STW			
		Droitwich	Worcester	Powick	Evesham
BOD	Consent	25	25	25	25
	95 percentile Current Discharge	12.8	7.8	22.0	10.8
Ammonium	Consent	10	15	20	None set
	95 percentile Current Discharge	1.2	3.5	10.9	6.1
Phosphate	Consent	None set*	None set	None set	2
	Mean Current Discharge	7.0	1.9	6.2	1.7

* As part of the EA's National Environment Programme Severn Trent Water Ltd are expecting to meet a new 2mg/l P consent by Sept 2014.

The above data demonstrates that at Droitwich the discharge quality is currently below the BOD and Ammonium consents. This is also the case at Worcester, Powick and Evesham (although currently an Ammonium consent is currently not set at Evesham).

In terms of Phosphates, consents are commonly not currently set. There is however a 2mg/l consent at Evesham, which as the current data shows is being achieved. Also, if it is the intention to achieve a 2mg/l consent of Phosphate by 2014 at Droitwich, further work is required to reduce the current discharge quality (7.0mg/l).

The RQO target data for each receiving watercourse has been supplied by the Environment Agency, for each watercourse for each contaminant. These are provided below.

Table A1-7: RQO No Deterioration and Good Status Target Data

	Ammonia (mg/l) (90%ile)		BOD (mg/l) (90%ile)		P (mg/l) (annual average)	
Sewage Treatment Works	Target for ND	To meet status class (usually good status unless already achieving high status)	Target for ND	To meet status class (usually good status unless already achieving high status)	Target for ND	To meet status class (usually good status unless already achieving high status)
Worcester STW	0.3	0.3	4.0	4.0	1.0	0.12
Powick STW	0.3	0.3	4.0	4.0	0.25	0.12
Droitwich	0.3	0.3	5.0	5.0	1.0	0.12
Evesham	0.3	0.3	4.0	4.0	1.0	0.12

Model Results

The RQP software model was simulated for increments of 250 properties to demonstrate the change of mean river quality downstream of the STWs following dilution in the receiving watercourse. In addition, simulations were undertaken for the full strategic developments proposed. The results of these model runs can be found in tables A1-10 to A1-12.The following information is a discussion of the reasoning behind the indicative consent levels and sensitivity tests undertaken due to limitations of the modelling and data.

Phosphate apportionment

The water quality modelling undertaken as part of this study indicates that to achieve the 'good status' level of phosphates at all locations assessed would require improvements to the upstream river quality. However, the measured upstream river quality data currently includes inputs from diffuse pollution sources. The issue of phosphate apportionment is to determine the most important sources of phosphate, so that appropriate management can be undertaken. This is especially significant given the requirement of the WFD to achieve 'good status' by 2015 WFD.

Modelling has been undertaken to demonstrate the impact of phosphate purely from STWs, against the 'good status' target. This is to determine whether improvements are required both upstream as well as at each STW. The analysis was undertaken through assuming that the upstream diffuse sources of pollution had been addressed (i.e. 'good status' achieved upstream). This was performed through setting the upstream quality at the level of 'good status' in the model. Current and future (full allocation) conditions were then simulated to demonstrate the impact that this would have on mean phosphate levels against the 'good status' target. The following table highlights the results from this.

Table A1-8: Results of Discharge Quality Sensitivity Test

Mean Phosphate (mg/l)	Worcester	Powick	Droitwich	Evesham
Target	0.12	0.12	0.12	0.12
Current scenario	0.14	2.15	0.77	0.13
Future scenario	0.14	2.64	0.83	0.13

The results demonstrate that at all four STWs the 'good status' is currently not achieved. In the cases of Worcester and Evesham, the levels of phosphate will remain constant in the future following the full allocation. The levels at these sites only marginally exceed the 'good status' target. The reason for the constant level of phosphate is due to the dilution effect in the receiving watercourse; Worcester discharges into the River Severn and Evesham discharges into the River Avon both of which have high flow volumes, thereby reducing the impact of any additional DWF in the future.

However, the opposite is the case at both Powick and Droitwich. At both these sites current levels of phosphate significantly exceed the 'good status' target. Improvement would therefore be required in order that the target is achieved in respect of current DWFs. In addition, given the lower flow volumes of the received watercourse there is a noticeable increase in the levels in the future given the full allocations.

POWICK STW

This sewage treatment works is located on Careys Brook, a tributary to the River Severn. Unlike the treatment works at Evesham and Worcester there is less natural dilution of discharge water as flows are much lower in Carey's Brook than in the River Avon and River Severn. The current discharge water quality is within the current consents in place for BOD (25mg/l) and Ammonium (20mg/l), there is no consent for Phosphorus. However, this modelling has shown that these consent limits are not sufficient to meet the WFD 'no deterioration' and 'good status' targets. Severn Trent water have recognised previously that to accommodate the potential strategic site allocations it would be necessary to provide additional primary and secondary treatment as well as new tertiary treatment.

Limitations to consent modelling for Powick

Quality of Discharge Data

Water quality data and river flow data has been provided by the Environment Agency for the purpose of this study. There is less discharge water quality data available for this treatment works compared to the other three assessed. This may be because this works is not classed as feeding a 'sensitive receiving watercourse' as designated under the UWWTD. Therefore there has not been as regular sampling at this location, especially with regards to Phosphorus, as at other treatment works. According to the Environment Agency guidance document 'Calculation of River Needs Consents,' where the calculated consent turns out to be a lot tighter than the current quality using the mean and standard deviation for the current discharge quality then you should repeat the calculation. You should use the mean and standard deviation for a discharge quality which is typical of the type of works which will be needed to achieve the calculated consent. This is advisable as the extent to which the discharge quality varies about the mean does depend on the type of treatment. Therefore as the calculated consents for Powick were tighter than the current quality for Phosphorus, Ammonium and BOD, it was deemed necessary for these to be re-run using the discharge quality data at a different works.

- Evesham STW has tertiary treatment in place for nutrient removal and a current consent of 2mg/l therefore this works was used to provide the discharge quality data for phosphates.
- There is no consent for Ammonium at Evesham, therefore Worcester STW discharge quality data has been used for this model run.
- Worcester STW discharge water quality data has also been used to test the BOD consent at Powick.

Results of Discharge Quality Sensitivity Test

The results below show that the ratio between the mean and standard deviation affects the phosphorus consent more than the other two, most likely as nutrient removal is a significant difference in treatment techniques between Evesham and Powick STWs. Due to the little available discharge quality data at this location the recommendations for the indicative future consents for Phosphates (2mg/l) and Ammonium (1mg/l) are based on the mean and SD ratio of discharge quality from sewage treatment works with existing treatment in place to meet the required level of quality. The consent recommendation for Ammonium is also the limit of Best Available Technique (BAT), normally quoted as being 1mg/l for Ammonium.

Table A1-9: Results of Discharge Quality Sensitivity Test

	BOD (mg/l)	Ammonium (mg/l)	Phosphates (mg/l)
Using Powick Discharge Quality Mean and Standard Deviation	7.1	0.6	0.4
Using Alternative Discharge Quality Mean and Standard Deviation	8.3 (+1.2)	1 (+0.4)	2.2 (+1.6)

Quality of Upstream Flow Data

In the absence of physical flow measurements on Careys Brook an estimate of flow was undertaken by the Environment Agency based on three theoretical methods (Micro Low Flows, Low Flows 2000 and Normalised Base Curves). Current meter gaugings were available but produced poor results when regression analysis was performed by the Environment Agency with records from Haw Bridge gauging station. In light of this a degree of uncertainty of ±40% was attached to the values provided. Therefore a sensitivity test has been undertaken on the upstream river flows to understand there impact on the predicted downstream river quality and future discharge consents. This sensitivity test was undertaken on the impact of the future DWF from the full potential strategic site allocation on downstream water quality only.

Results of River Flow Sensitivity Test

The results of this test show that the changes in upstream flow have the greatest impact on the BOD downstream quality and discharge consent at Powick STW. Due to the uncertainties in the upstream river flow combined with the outcome of the sensitivity test on the discharge quality data, an indicative future consent of 10mg/l has been recommended.

Table A1-10: Results of River Flow Sensitivity Test

	BOD (mg/l)		Ammonium (mg/l)		Phosphates (mg/l)	
	River Quality D/S	Discharge Consent	River Quality D/S	Discharge Consent	River Quality D/S	Discharge Consent
Using Estimated Flow provided by the Environment Agency	11.1	7.1	4.6	0.6	2.7	0.4
Plus 40% Error	9.9 (-1.2)	7.8 (+0.7)	4.1 (-0.5)	0.7 (+0.1)	2.3 (-0.4)	0.4 (+0.04)
Minus 40% Error	13.0 (+1.9)	6.3 (-0.8)	5.6 (+0.5)	0.5 (-0.1)	3.3 (+0.6)	0.3 (-0.1)

Achievement 'Good Status' Target

The water quality modelling undertaken as part of this study indicates that to achieve the 'good status' level of phosphates at all locations assessed would require improvements to the upstream river quality, as well as at the STW. The Final Severn River Basin Management Plan shows that to achieve the 0.12mg/l level of phosphates within the watercourse would not be attainable by 2015. The deadline has been extended to 2027 due to it being disproportionately expensive to achieve this target by 2015. This also links back to the lack of monitoring data available at Powick STW, there is not sufficient biological data or other evidence at this location to justify taking additional measure to control the risk of eutrophication. Careys Brook has not been designated as a 'sensitive receiving watercourse' under the UWWTD and as such has not been classed as being eutrophic or significantly at risk of becoming eutrophic. Therefore, unlike Droitwich STW, no measures have been identified to reduce the phosphorus levels at Powick STW. Additional monitoring is recommended, if not already being undertaken, downstream of Powick STW to gather additional evidence that treatment to remove phosphorus, beyond that required to meet the 'no deterioration' status, would be justified. A new consent of 2mg/l will contribute towards achieving 'good status' while also achieving the 'no deterioration' target as stated under the WFD. For Ammonium and BOD the 'good status' target is the same as the 'no deterioration' target, therefore the indicative consents recommended will also help to achieve the 'good status' targets.

EVESHAM STW

Evesham STW is located on the River Avon with a mean flow of 15,710l/s, much greater than the flow in Careys Brook. As such there is a greater potential for natural dilution of pollutants from the STW when they enter the river. Therefore the current consents for Phosphates and BOD are able to accommodate the increased DWF from the full potential strategic site allocations feeding to the STW. There is currently no consent for Ammonium at this treatment works. The modelling shows that if the current level of treatment is maintained with the additional DWF then the 'no deterioration' and 'good status' targets will be achieved. It is recommended that Severn Trent Water ensure that for the future DWF for all potential strategic allocations they will be able to maintain the levels of discharge quality currently being achieved at this works. If the current level of treatment is unattainable at the future DWFs then a consent may be required. The modelling shows that to achieve the Ammonium targets at the full number of potential strategic allocations an indicative consent of 20mg/l is recommended, taking into consideration the possibility of improvements to the upstream water quality due to ongoing agricultural changes as this area is in a nitrate vulnerable zone. Therefore it is possibly not necessary to set a stricter consent of 15mg/l at this works at this time.

Achievement of 'Good Status' Target

For Ammonium and BOD the 'good status' target is the same as the 'no deterioration' target, therefore the consents recommended cover these targets. The Final Severn River Basin Management Plan shows that to achieve the 0.12mg/l level of phosphates within the watercourse would not be attainable by 2015. The deadline has been extended to 2027 due to it being disproportionately expensive to achieve this target by 2015. To achieve the 'good status' target on the River Avon at this location of 0.12mg/l further improvements to the upstream river quality would be required, this STW is only one source of phosphorus to the River Avon and as such, placing a tighter consent on this treatment works may not be advisable in terms of cost/benefit. This works already has a 2mg/l consent as part of the UWWTD as it discharges into a 'designated sensitive receiving watercourse.' The River Basin Management Plan indicates additional monitoring should be undertaken, if not already being undertaken, downstream of Evesham STW to gather additional evidence that further treatment to remove phosphorus, beyond that required to meet the 'no deterioration' status, would be justified in terms of costs and benefits.

DROITWICH STW

Droitwich STW is located on the River Salwarpe, with less potential for dilution than the River Avon and River Severn but has a higher mean flow than Careys Brook. The current consent level for BOD at Droitwich STW is sufficient to accommodate the full potential strategic site allocations DWF and not cause deterioration in the downstream river quality to below the 'no deterioration' or 'good status' targets. The modelling shows that to achieve these targets at the full number of potential strategic allocations a new consent would be required at a level of 1.2mg/l, however this is not taking into consideration the possibility of improvements to the upstream water quality due to ongoing agricultural changes as this area is in a nitrate vulnerable zone. The current level of treatment is at the required level to meet the targets, this would need to be maintained with the additional DWF. It is recommended that Severn Trent Water demonstrate that for the future DWF for all potential strategic allocations they will be able to maintain the levels of discharge quality currently being achieved at this works. An indicative future consent for Ammonium is 2mg/l, taking into account the potential for improvements in upstream water quality it is possibly not necessary to set a strict consent of 1mg/l at this works at this time.

Achievement of 'Good Status' Target

For Ammonium and BOD the 'good status' target is the same as the 'no deterioration' target, therefore the consents recommended cover these targets. The Final Severn River Basin Management Plan shows that to achieve the 0.12mg/l level of phosphates within the watercourse would not be attainable by 2015. The deadline has been extended to 2027 due to it being disproportionately expensive to achieve this target by 2015. To achieve the 'good status' target on the River Salwarpe at this location of 0.12mg/l further improvements to the upstream river quality would be required, this STW is only one source of phosphorus to the River Salwarpe and as such, placing a tighter consent on this treatment works would probably not be advisable in terms of cost/benefit. This works has been identified as requiring a new consent of 2mg/l as part of the UWWTD as it discharges into a 'designated sensitive receiving watercourse.' Severn Trent Water is aiming to achieve this consent by 2014 as part of the Environment Agency's National Environment Programme. The River Basin Management Plan indicates additional monitoring should be undertaken, if not already being undertaken, downstream of Droitwich STW to gather additional evidence that further treatment to remove phosphorus, beyond that required to meet the 'no deterioration' status, would be justified in terms of costs and benefits.

WORCESTER STW

Worcester STW is located on the River Severn which has the highest flows of all the rivers within this assessment and therefore provides the largest potential for natural dilution of the discharge. The modelling undertaken found the current BOD and Ammonium consents to be sufficient to accommodate the potential strategic site allocations. There is currently no consent for Phosphorus at this treatment works and the modelling shows that no consent is required to accommodate the full predicted future DWF and achieve the 'no deterioration' target.

Achievement of 'Good Status' Target

For Ammonium and BOD the 'good status' target is the same as the 'no deterioration' target, therefore the consents recommended cover these targets. The Final Severn River Basin Management Plan shows that to achieve the 0.12mg/l level of phosphates within the watercourse would not be attainable by 2015. The deadline has been extended to 2027 due to it being disproportionately expensive to achieve this target by 2015. This works has not been identified for designation under the UWWTD as discharging into a 'sensitive receiving watercourse.' To achieve the 'good status' target on the River Severn at this location of 0.12mg/l further improvements to the upstream river quality would be required, this STW is only one source of phosphorus to the River Severn and as such, placing consent on this treatment works would probably not be advisable in terms of cost/benefit. The River Basin Management Plan indicates additional monitoring should be undertaken, if not already being undertaken, downstream of Worcester STW to gather additional evidence that treatment to remove phosphorus to meet the 'good status' target would be justified in terms of costs and benefits. It is not recommended to impose a consent at this treatment works until this further monitoring is undertaken and upstream sources of Phosphorus are taken into consideration.

Combined Sewer Overflows (CSOs)

The Environment Agency has a legal obligation under the Environment Act 1995 to use their powers to prevent, minimise, remedy or mitigate the effects of pollution. The Environment Agency's 'No Deterioration' policy reflects this hierarchy and puts 'No increased load' as our optimum objective therefore their position is to avoid new or increased CSO discharges.

Severn Trent Water will not allow any storm runoff from the proposed strategic site allocations to connect to the sewer network. All storm flow will be attenuated in Sustainable Drainage Systems (SUDS) and discharged to the nearest watercourse. As such Severn Trent Water do not envisage impact on water quality from sewer overflows as any additional storm runoff will be directed into SUDS rather than into the combined sewer network.

If the proposed strategic site allocations are to be connected to the existing combined sewer network and infrastructure upgrades are required then these will be undertaken to ensure that there is sufficient capacity in the network to avoid increased discharges from existing combined sewers. The sewer infrastructure capacity has been assessed in Section 4.4 along with necessary upgrades and costs required to accommodate the potential strategic site allocations.

Conclusions

In the majority of cases the current consents are sufficient to accommodate the full number of proposed strategic site allocations. Powick Sewage Treatment Works is the most affected by increased DWF as it feeds to a smaller watercourse than the others. Currently the 'No deterioration' and 'Good Status' targets are not being achieved, as such any new consents should be put in place before any further DWF is directed to this treatment works. The consents below are only an indication of the consent that is likely to be required. The final consent should be calculated through detailed modelling and agreed upon when final allocation numbers are confirmed and future DWF values are updated. The indicative future consents for Powick are:

- BOD – 10mg/l
- Ammonium – 1mg/l
- Phosphate – 2mg/l
- Upgrades to treatment facilities will be required to meet discharge quality levels required.

Severn Trent Water will be required to demonstrate that they can maintain the current level of treatment for Ammonium (95%tile) at Droitwich and Evesham. If this is can be maintained with the future DWF then there will be no need to impose a new consent on the treatment works. Consents would have to be revisited should it not be possible to maintain current levels of treatment at the future DWFs for the proposed strategic site allocations. The following are indicative consents should they be deemed necessary.

- Droitwich
  - Indicative new consent of 2mg/l
  - Current level of treatment (1.2mg/l) should be maintained for future DWF to meet 'no deterioration' and 'good status' targets.
  - May require upgrades to treatment facilities if current level of treatment will not be maintained with increased DWF.

- Evesham
  - Discharge quality required to accommodate the full proposed strategic site allocations and achieve the targets is 18.7mg/l of Ammonium.
  - Indicative new consent of 20mg/l
  - May require upgrades to treatment if discharge quality of 18.7mg/l is not achievable with current facilities at future maximum DWF.

None of the indicative future consents required are below the BATs for sewage treatment. Therefore this modelling indicates that there are no potential 'show-stoppers' in terms of sewage treatment capacity. The following table summarises the outcomes of the modelling. The limitations of this modelling and the need to confirm dwelling numbers should be considered before final consents are agreed. With regards to CSOs, no additional storm flow will be connected to the network, all will be attenuated using SUDS and then discharged to the nearest watercourse. Severn Trent Water will increase the capacity of the local sewer network should it be required to provide sufficient capacity for future DWF and ensure no additional discharges from CSOs above that of the current consent.

The above discussion focuses on quality conditions in relation to consent. In terms of volumetric headroom, Severn Trent Water has confirmed that spare headroom exists within existing consents at Powick, Evesham and Worcester. However, in the case of Worcester there is no DWF headroom under the current discharge consent. In Table 4-11 it is stated that:

"Comparison of current measured dry weather flow against the consented dry weather flow consent indicates that there is zero hydraulic capacity at this site, however the current sizing of the ASP Diffused Air Plant indicates that there is hydraulic capacity available and so indicates there could be a problem with measured dry weather flow data. Actual spare capacity needs further detailed process analysis but notwithstanding this we do not envisage any issues in dealing with future growth demand in the Worcester STW catchment."

Therefore, there may be some DWF volumetric headroom available, and Severn Trent Water will undertake detailed modelling when development pressure arises. Should it be deemed necessary from this analysis that an increase in volumetric headroom will be required, Severn Trent Water will need to apply to increase the DWF volumetric consent. For instances in which spare headroom currently exists, but for which there is not capacity to accommodate the full allocations (such as Powick and Droitwich, see Table 4-11), a new consent will be required in the future. Application of this by Severn Trent Water will require review of the quality conditions above.

This page is intentionally left blank.

Table A1-11: Summary Table of Model Results For BOD

	BOD (mg/l) 90th percentile			
	Droitwich	**Worcester**	**Powick**	**Evesham**
Current d/s level	3.8	2.3	9.6	3.9
+ 250 homes	3.8	2.3	9.8	3.9
+ 500 homes	3.8	2.3	10.0	3.9
+ 750 homes	3.8	2.3	10.2	3.9
+ 1000 homes	3.8	2.3	10.3	3.9
+ 1250 homes	3.8	2.3	10.4	3.9
+ 1500 homes	3.8	2.3	10.6	3.9
+ 1750 homes	3.8	2.3	10.7	3.9
+ 2000 homes	3.9	2.3	10.7	3.9
Full Strategic Allocation	3.9	2.3	11.1	3.9
TARGET No deterioration	5.0	4.0	4.0	4.0
TARGET Good Status	5.0	4.0	4.0	4.0
Current Consent (95%tile for BOD and Ammonia, Mean for P)	25	25	25	25
Current Discharge Quality (95%tile for BOD and Ammonia, Mean for P)	12.7	7.8	22.0	10.4
Future Consent Required to Accommodate Full Proposed Strategic Allocations at No Deterioration Target (95%tile for BOD and Ammonia, Mean for P)	Current Consent Sufficient	Current Consent Sufficient	7.1	Current Consent Sufficient
Future Consent Required to Accommodate Full Proposed Strategic Allocations at Good Status target (95%tile for BOD and Ammonia, Mean for P)	Current Consent Sufficient	Current Consent Sufficient	7.1	Current Consent Sufficient
Achievable discharge level using Best Available Technique.	5mg/l			
Recommended new consents given uncertainties in data and modelling and with regards to BATs and cost/benefit.	20	25	10	25

Table A1-12: Summary Table of Model Results For Ammonium

	Ammonium (mg/l)			
	90th percentile			
	Droitwich	Worcester	Powick	Evesham
Current d/s level	0.3	0.1	3.9	0.2
+ 250 homes	0.3	0.1	4.0	0.2
+ 500 homes	0.3	0.1	4.1	0.2
+ 750 homes	0.3	0.1	4.1	0.2
+ 1000 homes	0.3	0.1	4.2	0.2
+ 1250 homes	0.3	0.1	4.3	0.2
+ 1500 homes	0.3	0.1	4.3	0.2
+ 1750 homes	0.3	0.1	4.4	0.2
+ 2000 homes	0.3	0.1	4.4	0.2
Full Strategic Allocation	0.3	0.1	4.6	0.2
TARGET No deterioration	0.3	0.3	0.3	0.3
TARGET Good Status	0.3	0.3	0.3	0.3
Current Consent (95%tile for BOD and Ammonia, Mean for P)	10	15	20	None Set
Current Discharge Quality (95%tile for BOD and Ammonia, Mean for P)	1.2	3.5	10.9	6.1
Future Consent Required to Accommodate Full Proposed Strategic Allocations at No Deterioration Target (95%tile for BOD and Ammonia, Mean for P)	1.2	Current Consent Sufficient	1	18.7
Future Consent Required to Accommodate Full Proposed Strategic Allocations at Good Status target (95%tile for BOD and Ammonia, Mean for P)	1.2	Current Consent Sufficient	1	18.7
Achievable discharge level using Best Available Technique.	1mg/l			
Recommended new consents given uncertainties in data and modelling and with regards to BATs and cost/benefit.	2*	15	1	20*

*Current levels of treatment if maintained with increased DWFs are sufficient to meet targets. New consents may be required to ensure levels do not go above those required and account for possible improvements in upstream water quality as both treatment works are in nitrate vulnerable zones.

Table A1-13: Summary Table of Model Results For Phosphates

	Phosphates (mg/l) Annual Average (mean)			
	Droitwich	**Worcester**	**Powick**	**Evesham**
Current d/s level	1.4	0.3	2.2	0.4
+ 250 homes	1.4	0.3	2.2	0.4
+ 500 homes	1.4	0.3	2.3	0.4
+ 750 homes	1.4	0.3	2.3	0.4
+ 1000 homes	1.4	0.3	2.4	0.4
+ 1250 homes	1.4	0.3	2.4	0.4
+ 1500 homes	1.4	0.3	2.4	0.4
+ 1750 homes	1.4	0.3	2.5	0.4
+ 2000 homes	1.4	0.3	2.5	0.4
Full Strategic Allocation	1.4	0.3	2.7	0.4
TARGET No deterioration	1.0	1.0	0.25	1.0
TARGET Good Status	0.12	0.12	0.12	0.12
Current Consent (95%tile for BOD and Ammonia, Mean for P)	None Set*	None Set	None Set	2
Current Discharge Quality (95%tile for BOD and Ammonia, Mean for P)	7.0	1.9	6.2	1.7
Future Consent Required to Accommodate Full Proposed Strategic Allocations at No Deterioration Target (95%tile for BOD and Ammonia, Mean for P)	2.3	Not Required	2.2	Current Consent Sufficient
Future Consent Required to Accommodate Full Proposed Strategic Allocations at Good Status target (95%tile for BOD and Ammonia, Mean for P)	Would require improvement in u/s water quality	Would require improvement in u/s water quality	Would require improvement in u/s water quality	Would require improvement in u/s water quality
Achievable discharge level using Best Available Technique.	1mg/l			
Recommended new consents given uncertainties in data and modelling and with regards to BATs and cost/benefit.	2	Not Required	2	2

This page is intentionally left blank.

MAPS

This page is intentionally left blank.

MAP 1 - STUDY AREA AND MAIN URBAN AREAS

This page is intentionally left blank.

MAP 2 – PROPOSED STRATEGIC SITE ALLOCATIONS

This page is intentionally left blank.

MAP 3 - CURRENT ECOLOGICAL STATUS OF SURFACE WATER BODIES

This page is intentionally left blank.

MAP 4 - CURRENT CHEMICAL STATUS OF SURFACE WATER BODIES

This page is intentionally left blank.

MAP 5 - CURRENT STATUS OF SURFACE WATER RESOURCES

This page is intentionally left blank.

REFERENCES

This page is intentionally left blank.

References

BRE, (1991). Soakaways - Digest 365

Department for Communities and Local Government, (2006). Code for Sustainable Homes
A step-change in sustainable home building practice

Environment Agency, (2003). The Severn Corridor Catchment Abstraction Management Strategy

Environment Agency, (2005). The Teme Catchment Abstraction Management Strategy

Environment Agency, (2006). The Warwickshire Avon Catchment Abstraction Management Strategy

Environment Agency, (2006). The Worcestershire Middle Severn Catchment Abstraction Management Strategy

Environment Agency, (2007). National Standing Advice to Local Planning Authorities for Planning Applications – Development and Flood Risk in England 2007.

Environment Agency, (2008). The Severn Vale Catchment Abstraction Management Strategy

Environment Agency, (2008). Greywater: an information guide

Environment Agency, (2008). Harvesting rainwater for domestic uses: an information guide

Environment Agency, (2009). Severn River Basin Management Plan (Draft)

European Parliament, (2000). Water Framework Directive. (http://www.defra.gov.uk/environment/water/wfd/)

HR Wallingford, (2003). Maximising the Ecological Benefits of Sustainable Drainage Schemes

CIRIA, (2007). SuDS Manual – CIRIA Report C697

Severn Trent Water Ltd., (2008). ADO8 Growth Point Studies Worcestershire (Report numbers: Worcestershire B06019X5-02 and B06019X5/Wor-03

Severn Trent Water Ltd., (2009). Draft Water Resources Management Plan

South Worcestershire Core Strategy, (2007). Worcester Green Infrastructure Strategy

South Worcestershire Core Strategy, (2008). Evidence Base Green Infrastructure Study for the Growth Areas

South Worcestershire Core Strategy, (2008). Strategic Housing Land Availability Assessment.

South Worcestershire Core Strategy, (2009). South Worcestershire Strategic Flood Risk Assessment (Draft)

UKTAG, (2008). Guidance on the Classification of Ecological Potential for Heavily Modified Water Bodies

Government Office for the West Midlands (2008). Regional Spatial Strategy for the West Midlands