# Warwick District Council
# Local Plan Examination

# Response to Inspector's Matters and Issues

# Matter 13 – Other Policies

# Flooding and Water

Policy FW1 – Development in Areas at Risk of Flooding
Policy FW2 – Sustainable Urban Drainage
Policy FW3 – Water Conservation
Policy FW4 – Water Supply

# Issue

Whether other policies are justified, effective and consistent with national policy.

# October 2016

**Flooding and Water - Policy FW1 – Development in Areas at Risk of Flooding**

In responding to the following questions the Council should deal with each policy in turn, address key points raised in representations and refer to suggested modifications to overcome issues of soundness.

1. **What is the basis for the policy? What is it seeking to achieve?**

a) The policy sets out the criteria to be addressed in areas at risk of flooding, before consideration of a site for potential development, highlighting the need to refer to the latest Environment Agency mapping which is a regularly updated resource. The policy makes it clear that built development in the functional floodplain will not be allowed. There is also a requirement for improvement where culverting and modification of watercourses has happened in the past. This has the potential to reduce the risk of flooding and improve water management systems.

b) The purpose of the policy is to direct development away from areas that are identified as being at risk of flooding. If for wider sustainability reasons the site is considered viable for development, then the policy measures included within the plan will ensure that the development will be appropriately flood resilient and contribute to effectively managing flood risk not only for the proposed site, but will contribute to reducing flood risk within the wider catchment.

c) Further detailed information can be found in Appendix 1 to this statement.

**2. How does the policy relate to the evidence base?**

a) The policy relates to the SFRA produced on behalf of the Council in 2013 (FW02) and a level 2 SFRA specifically for the Stratford Road site in February 2016 (FW08PM), and the Water Cycle Study, 2010 (currently under review) (FE01).

b) Environment Agency mapping which is regularly updated has also been utilised in informing the policy and approach. Additional advice on sustainable urban drainage has been gathered from the Lead Local Flood Authority (Warwickshire County Council) and by reference to the Warwickshire Surface Water Management Plan, 2015 (appended to this statement at Appendix 2) and River Basin Management Plan (Severn river basin district RBMP), 2015

c) The policy is fully supported by the findings and recommendations included within the Flood Risk Management Plan, Flood Risk Management Plan and River Basin Management Plan. It has been developed in conjunction with the Environment Agency, who fully support our approach.

3. **Is the policy sufficiently clear? Will it provide sufficient guidance for decision making?**

a) The policy explains the steps toward satisfying the national and local safeguards and requirements in general terms and gives applicants and decision makers a clear steer on the need to meet high standards in order to ensure that developments address flood risk and reduce the effects of contamination to Development Management Officers, Statutory Consultees and Developers. It also addresses the need to protect priority habitat and designated nature conservation sites through the application of the policy

**4. How will the policy be implemented? Is this clear?**

a) The policy advises applicants to address the criteria in the earliest stage of site identification and will be used by decision makers to assess whether this has been done and satisfactorily addressed, as part of the planning application decision process. This should be implemented through the development of a master plan, development briefs and planning applications.

**5. How does the policy relate to national policy? How is it consistent? Are there any inconsistencies?**

a) The policy outlines what is expected when a development is proposed in an area at risk of flooding. The NPPF sets strict tests to protect people and property from flooding which local planning authorities are expected to follow. Where these tests are not met, national policy is clear that new development should not be allowed.

b) The first step in this process is to undertake a Strategic Flood Risk Assessment (SFRA) with a requirement for developers to undertake a site specific flood risk assessment to accompany planning applications in such areas. The required sequential approach to site selection has been adopted in the choice of suitable sites for the Local Plan, avoiding development in flood zone 3 and the functional flood plain as outlined by the policy.

c) The policy also ensures that where development is in locations where there is a risk of flooding, it is appropriately flood resilient and resistant, safe for users for its lifetime, and will not increase flood risk overall and implementing flood risk management.. This is compliant with the NPPF (paras 100 – 104).

d) The approach is consistent with the following sections of the National Planning Policy Framework:

i. Paragraph 17 - Within the overarching roles that the planning system ought to play, a set of core land-use planning principles should underpin both plan-making and decision-taking. These principles are that planning should include:

- support the transition to a low carbon future in a changing climate, taking full account of flood risk and coastal change, and encourage the reuse of existing resources, including conversion of existing buildings, and encourage the use of renewable resources (for example, by the

development of renewable energy);

- promote mixed use developments, and encourage multiple benefits from the use of land in urban and rural areas, recognising that some open land can perform many functions (such as for wildlife, recreation, flood risk mitigation, carbon storage, or food production);

ii. Paragraph 99 - Local Plans should take account of climate change over the longer term, including factors such as flood risk, coastal change, water supply and changes to biodiversity and landscape. New development should be planned to avoid increased vulnerability to the range of impacts arising from climate change. When new development is brought forward in areas which are vulnerable, care should be taken to ensure that risks can be managed through suitable adaptation measures, including through the planning of green infrastructure.

iii. Paragraph 100 - Local Plans should apply a sequential, risk-based approach to the location of development to avoid where possible flood risk to people and property and manage any residual risk, taking account of the impacts of climate change, by:

- safeguarding land from development that is required for current and future flood management;
- using opportunities offered by new development to reduce the causes and impacts of flooding;

iv. Paragraph 110 – In preparing plans to meet development needs, the aim should be to minimise pollution and other adverse effects on the local and natural environment.

v. Paragraph 151 – Local Plans must be prepared with the objective of contributing to the achievement of sustainable development.

vi. Paragraph 152 - Local planning authorities should seek opportunities to achieve each of the economic, social and environmental dimensions of sustainable development, and net gains across all three. Significant adverse impacts on any of these dimensions should be avoided and, wherever possible, alternative options which reduce or eliminate such impacts should be pursued. Where adverse impacts are unavoidable, measures to mitigate the impact should be considered.

6. **In overall terms is the policy justified, effective and consistent with national policy?**

a) The policy is justified in assuring the best outcome for flood prevention and the best location for development to ensure public safety and increased attenuation. This is wholly consistent with national policy; see 5 above

## Flooding and Water - Policy FW2 – Sustainable Urban Drainage

**1. What is the basis for the policy? What is it seeking to achieve?**

a) The policy addresses the problem of increased flood risk from development and land management in recent years which could be increased further by the volume of additional development proposed through the Local Plan. In order to overcome increased surface water flooding which results partly through additional hard, non-porous surfaces introduced by such development, techniques have been developed to allow the storage of bodies of water at a collection point from which it will naturally drain at a lower rate over a period of time so reducing the risk of flash flooding and encouraging green infrastructure solutions. The inclusion of Sustainable Urban Drainage systems therefore is expected within new developments to achieve this. The policy sets a limit on discharge rates based on the EA standard for new development.

**Surface Water Flooding**

b) Surface water flooding is usually the product of brief but intense storms. In rural areas this type of flooding occurs when the ground is unable to absorb the high volume of water that falls on it in a short period of time. The water remains on the surface and flows along the easiest flow path towards a low spot in the landscape. Within urban areas the non-permeability of many surfaces such as paved roads is often responsible for the ground not being able to absorb the water. Poorly maintained or inadequate drainage systems can then exacerbate the problem, leading to flow routes appearing and/or ponding of water to depths that can be a danger to life.

c) Surface water flooding has occurred across the county in the past, and often occurs in combination with other sources, such as sewers and watercourses. A review of previously published information shows that there have been a number of notable flood events in Warwickshire in recent times. Significant events include; January 1992, Easter 1998, August1999, June 2005, June/July 2007, December 2008, November 2012 and July 2014, with near misses in winter 2013/14. All of these events have been attributed in part to surface water flooding.

d) The cumulative effect and benefits of measures for the Warwickshire Avon operational catchment have been considered within the Environment Agency's River Basin Management Plan, and they include:

e) Improve management of surface water and promote implementation of sustainable drainage systems (SuDS).

f) Promote awareness and advise on the need to avoid inappropriate development in flood risk areas and the need to manage land to avoid increasing risks.

g) Identify locations where working with natural processes could reduce flood risk and improve resilience to climate change.

h) The proposed policy would meet these objectives, and support the Water Framework Directive as the River Severn River Basin Management Plan which states:

i) As the table in appendix 3 illustrates historically surface water flooding is prevalent within the district.

**Water Cycle Study**

j) The Council commissioned a Water Cycle Study in 2010 which looked in detail at measures to manage surface water and it strongly supported a whole catchment approach utilising Sustainable Drainage Infrastructure within new developments and limiting surface water run off to discharge at greenfield rates (with an allowance for climate change).

k) The recently revised Water Cycle Study supports this approach in line with the proposed modifications to the Local Plan as proposed by the Environment Agency.

l) Further detailed information can be found in Appendix 3.

**2. How does the policy relate to the evidence base?**

a) The policy relates to the SFRA (FW02) produced on behalf of the Council in 2013 and a level 2 SFRA specifically for the Stratford Road site in February 2016 (FW08PM), and the Water Cycle Study, 2010 (FW01) (currently under review).

b) Environment Agency mapping which is regularly updated has also been utilised in informing the policy and approach.

c) Additional advice on sustainable urban drainage has been gathered from the Lead Local Flood Authority (Warwickshire County Council) and by reference to the Warwickshire Surface Water Management Plan, 2015 (appended to FW1 statement) and River Basin Management Plan (FW03).

d) The Policy is strongly supported by the evidence base, and will also help to meet wider sustainability objectives including those relating to biodiversity, and it supports the delivery of green and blue infrastructure.

**3. Is the policy sufficiently clear? Will it provide sufficient guidance for decision making?**

a) The policy clearly sets out greenfield run off rates and the need for and application of SuDS. Not only does this reduce the risk of surface water flooding but aids the prevention of pollution and contamination of watercourses.

b) There is sufficient flexibility in the policy with regard to the application of SuDS to allow the decision maker to assess the suitability of the chosen scheme for the specific site and type of development. It is clear however that there are standards with regard to greenfield run off that need to be met in planning proposals.

**4. How will the policy be implemented? Is this clear?**

a) This policy will be implemented by the Lead Local Flood Authority (who are statutory consultees to the planning system). For developments within Warwick District Council the Lead Local Flood Authority is Warwickshire County Council.

b) The policy will be implemented at the time of a planning application although pre-application discussions can consider the most suitable way to comply with the policy on a site by site basis with referral, if necessary, to the Lead Local Food Authority for additional technical advice. The policy relates to all new major developments and it is therefore clear when and how this policy will be implemented.

**5. How does the policy relate to national policy? How is it consistent? Are there any inconsistencies?**

a) National policy states in the Town and Country Planning (Development Management Procedure) (England) Order 2015 that sustainable drainage systems should be provided unless demonstrated to be inappropriate.

b) The approach set out on the Policy is consistent with the following sections of the National Planning Policy Framework:

i. **Paragraph 17** - Within the overarching roles that the planning system ought to play, a set of core land-use planning principles should underpin both plan-making and decision-taking. These principles are that planning should include:

- support the transition to a low carbon future in a changing climate, taking full account of flood risk and coastal change, and encourage the reuse of existing resources, including conversion of existing buildings, and encourage the use of renewable resources (for example, by the development of renewable energy);
- promote mixed use developments, and encourage multiple benefits from the use of land in urban and rural areas, recognising that some open land can perform many functions (such as for wildlife, recreation, flood risk mitigation, carbon storage, or food production);

ii. **Paragraph 99** that in addressing climate change; *"Local Plans should take account of climate change over the longer term, including factors such as flood risk, coastal change, water supply and changes to biodiversity and landscape. New development should be planned to avoid increased vulnerability to the range of impacts arising from climate change".*

*iii.* **Paragraph 100** states that "*Local Plans should:*

- *Use the opportunities offered by new development to reduce the causes and impacts of flooding*
- *Be supported by a Strategic Flood Risk Assessment;*
- *Develop policies to manage flood risk from all sources;*
- *Take account of advice from the Environment Agency and other relevant flood risk*

*management bodies"*

*iv.* **Paragraph 109** specifically addresses the need to control water pollution in developments; "*New and existing development should be prevented from contributing to water pollution"*

v. **Paragraph 103** sets out the need for SuDS; "*Development should give "priority to the use of sustainable drainage systems" , "* and "*Developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area and beyond through ...the appropriate application of sustainable drainage systems*" (Table 1, Technical Guidance)."

vi. **Paragraph 110** – In preparing plans to meet development needs, the aim should be to minimise pollution and other adverse effects on the local and natural environment.

**6. In overall terms is the policy justified, effective and consistent with national policy?**

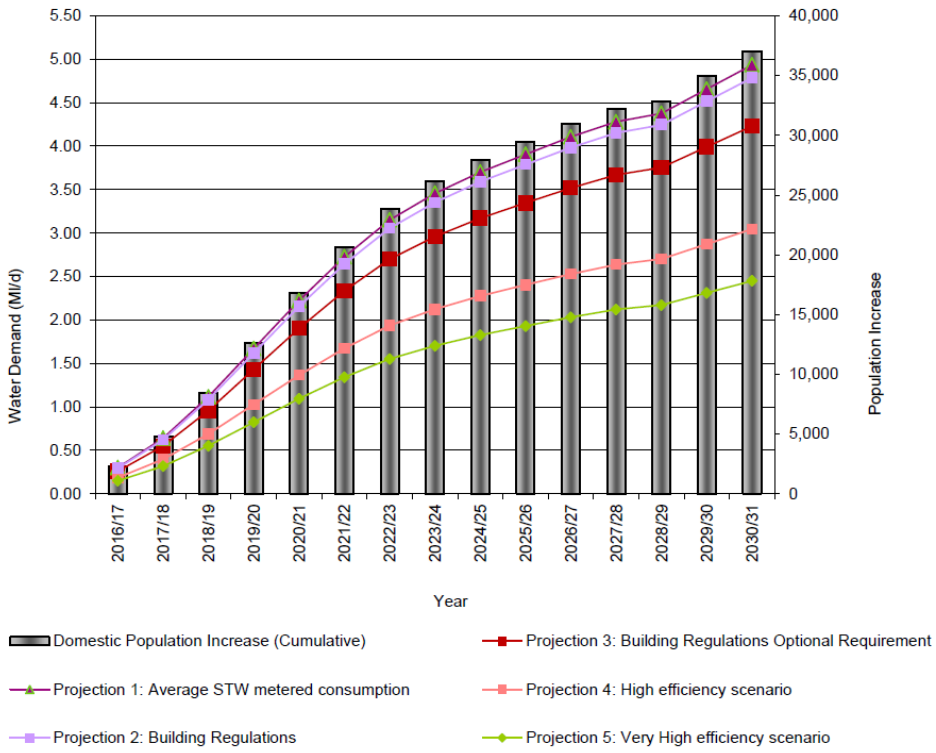
a) The policy is justified in order to comply with the NPPF in terms of providing a way of dealing with surface water flooding and reducing pollution of waterways. It is proven through the Development Management system and consistent with national policy as set out in point 5 above.

**Flooding and Water - Policy FW3 – Water Conservation**

**1. What is the basis for the policy? What is it seeking to achieve?**

a) The policy seeks to ensure new development meets good standards of efficiency of water use providing long term resilience to the future impacts of climate change in terms of water conservation. It is designed to secure water efficiency within new developments, to ensure that the proposed growth within the district does not increase water stress within the West Midlands Water Resource Area, or compromise the natural environment through over abstraction of water. The Council is committed to ensuring the creation of well-designed sustainable buildings and considers that water conservation is a key part of ensuring that developments are sustainable (see Appendix 4).

b) Within the 2016 updated sub regional water cycle study (due to be published in November 2016) five different water demand projections have been used to calculate the potential increases in water demand in Warwick. These have been based on different rates of water use that could be implemented through future policies. Using these projections, the increase in demand for water could range between 2.45 and 4.93Ml/d by 2031. The projection for Warwick is shown below.




This optional requirement delivers a substantial improvement of the two projections under the low scenario which would give a range of between 15% -16% neutrality if the local plan accepted the standard 125 litres per household per day, and helps to ensure that the proposed growth within the district is more sustainable, and measures to achieve this would be relatively cost neutral for developers..

c) Pressure on rivers and underground water stores is likely to grow due to climate change and increases in population. Actions to manage the demand for water and encourage people to use water more efficiently will be particularly important where there are acute pressures on water resources. This will involve working with water companies through Water Resource Management Plans and working with farmers and industry groups via initiatives such as on-farm reservoirs (although these may be expensive and require planning) and water audits to build resilience around water supplies. Installing water efficiency measures in the home is also an important area of activity.

d) Further detailed information relating to this question is in Appendix 5)

**2. How does the policy relate to the evidence base?**

a) The policy considers the demand for growth and balances the need for water neutrality against the cost for developers. As highlighted above there is strong evidence to support the 'optional requirement approach' as outlined within building regulations.

b) The Water Cycle Study (2010) carried out on behalf of the Council suggested that a water efficiency standard of 105 litres per person per day (exclusive of external water use)

should be applied to all new dwellings. When a standard allowance of 5 litres per person per day for external water use is applied, this figure is equivalent to the 110 litres per person per day required by the policy. This standard will be implemented through requirement G2 and Regulations 36 and 37 of the Building Regulations 2010 (as amended March 2016) – Water Efficiency which introduced a minimum water efficiency standard into the Building Regulations for the first time for new homes. It requires that the average water usage of a new home (including those created by a change of use) is no more than 125 litres per person per day or 110 litres/person/day if required as part of the planning permission; which this policy will require locally

**3. Is the policy sufficiently clear? Will it provide sufficient guidance for decision making?**

a) The proposed policy gives a specific target of water efficiency for the development of one dwelling or more. It states categorically the restrictions required in water usage per person per day on all new residential developments, thus giving clear guidance to decision makers as to what will be expected in such developments and a clear indication that non-residential applicants must show that they have incorporated water efficiency measures into their buildings. The requirement is detailed further in the explanatory text

**4. How will the policy be implemented? Is this clear?**

a) The policy will be implemented through the Building Regulations and planning condition attached to planning approvals. Approved Document G2 states that '*the potential consumption of wholesome water by persons occupying a new dwelling must not exceed …… [either] 125 litres per person per day; or … [an] optional requirement of 110 litres per person per day*'. This optional, more stringent, requirement '*applies where the planning permission under which the building work is carried out a) specifies the optional requirement* ….. ; and, makes it a condition that the requirement must be complied with'.

b) Therefore, in order for this optional requirement to apply, a planning policy to allow it is required.

**5. How does the policy relate to national policy? How is it consistent? Are there any inconsistencies?**

a) The approach is consistent with the following sections of the National Planning Policy Framework:
   i. **Paragraph 110** – In preparing plans to meet development needs, the aim should be to minimise pollution and other adverse effects on the local and natural environment.
   ii. **Paragraph 151** – Local Plans must be prepared with the objective of contributing to the achievement of sustainable development.
   iii. **Paragraph 152** - Local planning authorities should seek opportunities to achieve each of the economic, social and environmental dimensions of sustainable development, and net gains across all three. Significant adverse impacts on any of these dimensions should be avoided and, wherever possible, alternative options which

reduce or eliminate such impacts should be pursued. Where adverse impacts are unavoidable, measures to mitigate the impact should be considered.

6. **In overall terms is the policy justified, effective and consistent with national policy?**

   a) The proposed policy is justified, effective and consistent with the National Planning Policy Framework and Building Regulations.

In addition:

7. **Is Policy FW3 justified in light of the new National Technical Standards and Building Regulations?**
   a) Policy FW3 is in accordance with the technical standards, and the technical update issued in 2016 (appended on the following pages).

   b) The policy does not refer to any previous legislation such as the code for sustainable homes within its policy, and therefore we believe that is meets the tests of soundness.

**Flooding and Water - Policy FW4 – Water Supply**

In responding to the following questions the Council should deal with each policy in turn, address key points raised in representations and refer to suggested modifications to overcome issues of soundness.

1. **What is the basis for the policy? What is it seeking to achieve?**

   a) The policy seeks to ensure that there is an adequate water supply and waste water infrastructure in place to serve any new development. Additionally it signposts the Water Cycle Study, the River Severn Basin Management Plan and Strategic Business Plan as sources of guidance in achieving the most suitable locations for new development to ensure an adequate supply and infrastructure whilst enabling a good status for waterbodies to be achieved.

   b) The submitted Local Plan will deliver 16,776 homes over the next 15 years, which poses challenges in delivering the provision of water supplies and waste water infrastructure to new development.

   c) In response to the government's requirements to meet the proposed housing needs of Warwick D.C and overspill from Coventry City within the housing market area, the Council has undertaken water cycle studies to consider if there is already sufficient capacity within the Severn Trent Plc network to accommodate growth.

d) Furthermore the latest River Basin Management Plans produced by the Environment Agency to review waterbodies within Warwick D.C. Authority have been reviewed. The purpose of a river basin management plan is to provide a framework for protecting and enhancing the benefits provided by the water environment. To achieve this, and because water and land resources are closely linked, it also informs decisions on land-use planning.

e) For more detailed information, please see Appendix 6 of this statement

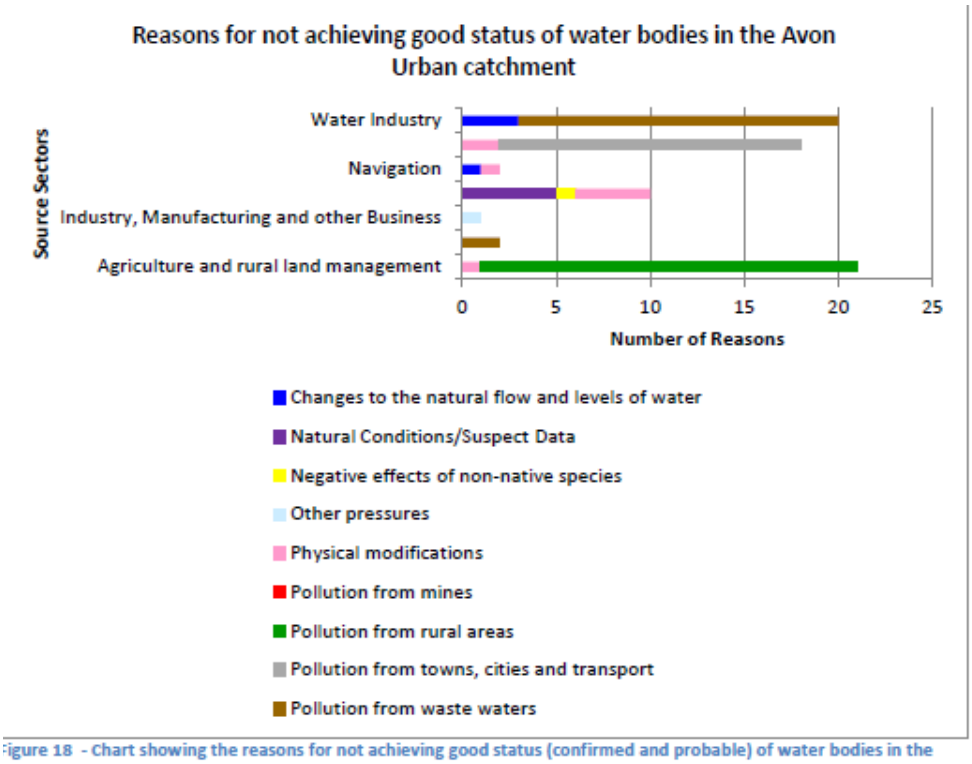



Figure 18 - Chart showing the reasons for not achieving good status (confirmed and probable) of water bodies in the Avon Urban catchment by type and source sector

f) This data highlights that there is a significant issue with regard to water resources and waste water management that requires a policy to be included within the Local Plan.

2. **How does the policy relate to the evidence base?**

a) The policy draws upon the data collected by the Environment Agency, and the Water Cycle Study (which has been developed across the Warwickshire Sub Region). The first paragraph of the policy promotes sustainable development by directing development to where there will be an adequate supply of water. Severn Trent Plc will need to provide new water supply infrastructure to support some of the proposed site allocations. The aim of the policy is to ensure that growth is delivered as efficiently as possible, and to reduce any delay in the commencement of new development because of inadequate infrastructure.

b) The second paragraph is necessary to ensure that waste water management proposals do not contribute toward further deterioration of waterbodies. Waste water is a significant reason for poor water quality, and this policy will ensure that development includes

measures to manage waste water efficiently. This could include ensuring that waste water is sent to a waste water treatment works that has the 'headroom' to effectively treat the effluent, and discouraging private package treatment plants for developments that are less able to treat waste waters.

3. **Is the policy sufficiently clear? Will it provide sufficient guidance for decision making?**

a) The policy clearly sets out what is required of new development in terms of supply, infrastructure and waterbodies status and where the guidance to achieving the policy criteria can be found. Decision makers will need to check that developers have addressed this in their proposals for a site at the earliest possible stage (pre-application advice).

b) The policy and its supporting text makes it clear for developers, and encourages them to seek pre application consultations with Severn Trent and the Environment Agency.

**4. How will the policy be implemented? Is this clear?**

a) The policy makes it clear that this applies to all new development and clearly signposts where the relevant information and guidance can be found. Decision makers are made aware of where the basis for this policy lies and how it should be used in decision making by listing the criteria which need to be addressed.

b) Both Severn Trent plc, and the Environment Agency are statutory consultees for planning applications, and they will be able to provide detailed technical guidance in relation to applications that require new water supply (and/or) waste water infrastructure to be provided. Their detailed guidance will be considered when determining planning applications.

**5. How does the policy relate to national policy? How is it consistent? Are there any inconsistencies?**

a) The Planning Practice Guidance (para 016) makes it clear that water supply and quality of waterbodies should be addressed in planning applications and that the Local Plan should set out this requirement. Early engagement with not only the local authority but also the Environment Agency and local water supply/waste disposal company is encouraged. The Local Plan Policy FW4 directs applicants to the sources of information and strengthens the national policy requirement

6. **In overall terms is the policy justified, effective and consistent with national policy?**

a) The Council considers that the proposed policy is justified, effective and consistent with the National Planning Policy Framework, specifically:

i. **Paragraph 17** – Within the overarching roles that the planning system ought to play, a set of core land use principles should underpin both plan –making and decision taking:

- Contribute to conserving and enhancing the natural environment and reducing pollution

ii. **Paragraph 109** – the planning system should contribute to and enhance the natural and local environment by:

- Preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of soil, air, water or noise pollution or land instability.

iii. **Paragraph 110** – In preparing plans to meet development needs, the aim should be to minimise pollution and other adverse effects on the local and natural environment.

iv. **Paragraph 120** – To prevent unacceptable risks from pollution and land instability, planning policies and decisions should ensure that new development for its location. The effects (including cumulative effects) of pollution on health, the natural environment or general amenity, and the potential sensitivity of the area or proposed development to adverse effects from pollution, should be taken into account.

**APPENDIX 1 (FW1)**

**Flooding and Water (Policy FW1): Further Information from the Environment Agency**

Recent years have seen a number of large scale flood events throughout the UK including April 1998, autumn 2000, February 2002, New Year 2003, February 2004, summer 2007 and November 2012. The Environment Agency has produced a number of historic flood outlines for Warwick District which illustrate the extent of the following events:

- January 1939
- February 1979
- January 1985
- September 1992
- January 1992
- April 1998
- Summer (June / July) 2007

The biggest events took place in January 1985 and April 1998. The 1985 event in particular affected the lengths of the River Avon and River Leam which flow through the District, while the 1998 event affected similar areas but did not reach as far upstream of the River Leam.

The Environment Agency has attributed both events to an exceedance of channel capacity during particularly extreme rainfall events. Records show that the 1998 flood affected several hundred properties including large areas within the District. The Environment Agency Flood Zone maps have incorporated the extent of the flooding from this event.

Widespread flooding was experienced through the District during the summer of2007 (June and July). At that time England experienced the wettest three months to the end of July since records began, with at least twice the average rainfall falling across parts of the country. The extreme conditions led to large scale urban and rural flooding across south-west England, north-east England and the Midlands.

The extreme rainfall that occurred on the 14th and 15th June 2007 resulted in significant flooding in the area of Cubbington. Flooding occurred from a number of sources including fluvial flooding, surface water and artificial drainage. The drainage systems in the area (public, private, highway or land drainage) were not designed to cope with the exceptional conditions and as a result widespread flooding occurred, with the worst locations affected being in the bowl of New Street and Knightly Close and the valley bounded by Ladycroft, Price Road, Offchurch Road in the dip and the valley through the Thwaites factory. The bowl is at the foot of a steep 85% paved catchment contributing on three sides which amounts to some 28hectares. On the fourth side green field farmland and the school playing field contribute some 26 hectares to the overland flow into the bowls. Some of the green field land is protected by the Pingle Brook Flood Alleviation Scheme constructed by Warwick District Council in 2002.

The cause of the flooding was from a combination of sources including: surface water runoff from adjacent farmland and public highways, insufficient capacity of the drainage infrastructure (surface water and foul drainage systems, public foul and surface sewers owned by Severn Trent Water), the failure of the Severn Trent Terminal Pumping Station at

Offchurch Road and, the overtopping of the Pingle Brook. It was also reported that the Pingle Brook flood alleviation scheme was overtopped. Water which fails to enter the artificial or surface water drainage system flows along the natural topography of the land and accumulates at the New Street bowl. Much of the existing drainage infrastructure is thought to be of insufficient capacity to cope with such a large volume of water.

During the July event a number of locations were affected by flooding. These included Eathorpe, Hunningham, Offchurch, Leamington, Warwick, Cubbington and Rowington.

The 2012 event impacted the District with the Rivers Leam and Avon being most at risk. The Chair of Eathorpe Parish Council, near Leamington Spa, is reported to say that he believed it was not as bad as the 1998 and 2007 floods. Castle Road in Kenilworth was also reported to be flooded between Castle Hill and Brookside Avenue.
The Environment Agency's river flow information for the River Avon in Warwick also indicates that the 2012 event produced lower river levels than the 2007 event.

The SFRA provided recommendations for what should be included in the Council's policy for flood risk management as well as providing guidance to developers on the preparation of site-specific FRAs. Council policy is considered essential to ensure that the recommended development and flood risk conditions can be imposed consistently at the planning application stage.

Flood Risk Objective 1: To Seek Flood Risk Reduction through Spatial Planning and Site Design:

- Use the Sequential Test to locate new development in least risky areas, giving highest priority to Flood Zone 1.
- Use the Sequential Approach within development sites to inform site layout by locating the most vulnerable elements of a development in the lowest risk areas. (For example, the use of low-lying ground in waterside areas for recreation, amenity and environmental purposes can provide an effective means of flood risk management as well as providing connected green spaces with consequent social and environmental benefits).
- Build resilience into a site's design (e.g. flood resistant or resilient design, raised floor levels).
- Identify long-term opportunities to remove development from the floodplain through land swapping.
- Ensure development is 'safe' for the lifetime of the development. For residential developments to be classed as 'safe', dry pedestrian egress out of the floodplain and emergency vehicular access should be possible. The Environment Agency states that dry pedestrian access/egress should be possible for the 1 in 100 year return period event plus climate change, and residual risk, i.e. the risks remaining after taking the sequential approach and taking mitigating actions, during the 1 in 1000 year event, should also be 'safe'.

Flood Risk Objective 2: To Reduce Surface Water Runoff from New Developments and Agricultural Land:

- SUDS required on all new development, infiltration systems should be the preferred means of surface water disposal, provided ground conditions are appropriate. Above

ground attenuation, such as balancing ponds, should be considered in preference to below ground attenuation, due to the water quality and biodiversity benefits they offer.

- All sites require the following:
    1. SUDS
    2. Greenfield discharge rates with a minimum reduction of 20%, as required by the Environment Agency
    3. 1 in 100 year on-site attenuation taking into account climate change
    4. Space should be specifically set aside for SUDS and used to inform the overall site layout.
    5. Promote environmental stewardship schemes to reduce water and soil runoff from agricultural land.

Flood Risk Objective 3: To Enhance and Restore the River Corridor:

- An assessment of the condition of existing assets (e.g. bridges, culverts, river walls) should be made. Refurbishment and/or renewal of the asset should ensure that the design life is commensurate with the design life of the development. Developer contributions should be sought for this purpose.
- Those proposing development should look for opportunities to undertake river restoration and enhancement as part of a development to make space for water. Enhancement opportunities should be sought when renewing assets (e.g. deculverting, the use of bioengineered river walls, raising bridge soffits to take into account climate change).
- Avoid further culverting and building over of culverts. Where practical, all new developments with culverts running through their site should seek to de-culvert rivers for flood risk management and conservation benefit.
- Set development back from rivers, seeking a minimum 8m wide undeveloped buffer strip for development by all watercourses including those where the Flood Zone does not exist. This is an Environment Agency requirement.

Flood Risk Objective 4: To Protect and Promote Areas for Future Flood Alleviation Schemes:

- Protect Greenfield functional floodplain from future development (our greatest flood risk management asset) and reinstate areas of functional floodplain which have been developed (e.g. reduce building footprints or relocate to lower flood risk zones).
- Develop appropriate flood risk management policies for the Brownfield functional floodplain, focusing on risk reduction.
- Identify sites where developer contributions could be used to fund future flood risk management schemes or can reduce risk for surrounding areas.
- Seek opportunities to make space for water to accommodate climate change.

Flood Risk Objective 5: To Improve Flood Awareness and Emergency Planning:

- Seek to improve the emergency planning process using the outputs from the SFRA.
- Encourage all those within Flood Zone 3a and 3b (residential and commercial occupiers) to sign-up to Flood Warnings Direct service operated by the Environment Agency.

- Ensure robust emergency (evacuation) plans are implemented for new developments greater than 1 hectare (ha) in size.

**Future Development within Flood Zone 2**

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

- A detailed site-specific FRA should be prepared in accordance with the NPPF and Council planning policies.
- Floor levels should be situated above the 100 year plus climate change predicted maximum level plus a minimum freeboard of 600mm.
- The development should be safe, meaning that dry pedestrian access to and from the development should be possible above the 1 in 100 year plus climate change flood level and emergency vehicular access should be possible during times of flood.
- SUDS should be implemented to ensure that runoff from the site (post development) is reduced. For all sites, the post development runoff volumes and peak flow rates should be attenuated to the Greenfield discharge rates with a minimum reduction of 20%, as required by the Environment Agency, for both Greenfield and Brownfield sites. Space should be set-aside for SUDS.

**Future development within High Probability Flood Zone 3a**

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

- A detailed site-specific FRA should be prepared in accordance with the NPPF and Council planning policies. Properties situated within close proximity to formal defences or water retaining structures (reservoirs/canals) will require a detailed breach and overtopping assessment to ensure that the potential risk to life can be safely managed throughout the lifetime of the development. The nature of any breach failure analysis should be agreed with the Environment Agency.
- The development should not increase flood risk elsewhere, and opportunities should be taken to decrease overall flood risk (such as use of SUDS and deculverting). This can be achieved by developing land sequentially via the Sequential Approach, with areas at risk of flooding favoured for green space
- Floor levels should be situated above the 1% (100 year) plus climate change predicted maximum level plus a minimum freeboard of 600mm. Within defended areas the maximum water level should be assessed from a breach analysis.
- The development should allow dry pedestrian access to and from the development above the 1 in 100 year plus climate change flood level and emergency vehicular access should be possible during times of flood. An evacuation plan should be prepared. With respect to new developments, those proposing the development should take advice from the LPAs emergency planning officer and for large-scale developments, the emergency services, when producing an evacuation plan as part

of a FRA. All access requirements should be discussed and agreed with the Environment Agency.

- Basements should not be used for habitable purposes. Where basements are permitted for commercial use, it is necessary to ensure that the basement access points are situated 600mm above the 1 in 100 year flood level plus climate change.
- SUDS should be implemented to ensure that runoff from the site (post development) is reduced. For all sites, the post development runoff volumes and peak flow rates should be attenuated to the Greenfield discharge rates with a minimum reduction of 20%, as required by the Environment Agency, for both Greenfield and Brownfield sites. Space should be set aside for SUDS.

Future development within Functional Floodplain Zone 3b

- The proposed development should be set-back from the watercourse with a minimum 8m wide undeveloped buffer zone, to allow appropriate access for routine maintenance and emergency clearance.
- Future development within Functional Floodplain Zone 3b Development should be restricted to ‘water-compatible uses’ and ‘essential infrastructure’ that has to be there. Table 2 from the NPPF (below) outlines the types of development included within this classification. It should be noted that ‘essential infrastructure’ includes essential transport infrastructure (including mass evacuation routes) which may have to cross the area at risk as well as strategic utility infrastructure such as electricity generating power station and grid and primary substations. Reference should be made to Table 2 of the NPPF when considering development within Flood Zone 3b to ensure only appropriate development is considered. ‘Essential infrastructure’ in this zone must pass the Exception Test and be designed and constructed to remain operational in times of flood and not impede water flow.

| | |
|---|---|
| Essential Infrastructure | • Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk, and strategic utility infrastructure, including electricity generating power stations and grid and primary substations. |
| Highly Vulnerable | • Police stations, Ambulance stations and Fire stations and Command Centres and telecommunications installations required to be operational during flooding.<br>• Emergency dispersal points.<br>• Basement dwellings.<br>• Caravans, mobile homes and park homes intended for permanent residential use.<br>• Installations requiring hazardous substances consent. |
| More Vulnerable | • Hospitals.<br>• Residential institutions such residential care homes, children's homes, social services homes, prisons and hostels.<br>• Buildings used for: dwelling houses; student halls of residence; drinking establishments; nightclubs; and hotels.<br>• Non-residential uses for health services, nurseries and educational establishments.<br>• Landfill and sites used for waste management facilities for hazardous waste.<br>• Sites used for holiday or short-let caravans and camping, subject to specific warning and evacuation plan. |

**River Severn River Flood Risk Management Plan**

Flood Risk Management Plans (FRMPs) are produced every 6 years and describe the sources and risks of flooding within a river basin district and catchment. They also include information on how risk management authorities (RMAs) plan to work together with communities and businesses to manage and reduce flood risk. Over the 6 year planning cycle the FRMP will help promote a greater awareness and understanding of the risks of flooding, particularly in those communities at high risk, and encourage and enable householders, businesses and communities to take action to manage the risks. FRMPs along with River Basin Management Plans (RBMPs) help all those involved in managing water to make decisions that are best for people and the environment.

FRMPs contain objectives for managing flood risk. These objectives are a common set of goals agreed by risk management authorities and they state the main ways in which work is directed to make a difference and reduce flood risk. They cover people, the economy and the environment. The objectives are split into the 3 categories to help demonstrate the balance of objectives across the plans but the categories aren't assigned a weighting in the FRMP. Objectives are used to plan and prioritise investment programmes to target investment in the most at risk communities. Objectives are prioritised at an England-wide level and Wales-wide level. This takes into account the risk, but also considers other factors such as cost benefits, the level of investment to date and other aspects such as the potential for external funding opportunities.

The Severn FRMP contains an overarching set of objectives for the river basin district as a whole.

The Severn River Basin District (RBD), shown in Figure 5.1, covers an area of just over 21,500 km2. The River Severn is the UK's longest river, stretching 350km from its source to the mouth of the Bristol Channel. The RBD has a varied landscape from the uplands of Wales, down through valleys and rolling hills of central England, to the lowlands and the Severn Estuary. As well as the River Severn and its main tributaries, the Warwickshire Avon and the Teme, the district includes the rivers of South East Wales, including the Wye, Usk and Taff, and those of the South West, including the Bristol Avon, that drain directly into the Severn Estuary.

The area is home to more than 5.75 million people, and includes major urban centres such as Bristol, Cardiff, Coventry, Worcester, Shrewsbury and Gloucester. The water bodies of the Severn RBD are made up of 7,512 km of river, 76 lakes, and 36 canals, 40 areas of groundwater and 545 km2 of estuary. The sheer size of the RBD gives rise to the huge variety of land uses, geology, topography and other descriptive factors. The catchment contains a diverse range of habitats associated with its upland areas, river valleys and floodplains, farmed landscapes and urban areas.
The river has a variety of flooding issues along its length and given the complicated nature and volume of tributaries there is a need to take a catchment-wide view to all changes within the RBD. Activities must seek to avoid passing risk on to others within the catchment without prior agreement.

There is a wide variation in the characteristics of rivers and subsequently the nature of flooding throughout the district.

The majority of the district is of a rural nature with much of this comprising agricultural land use; hence it is considered that in most areas the biggest impact on the natural flood regime comes from the management of the land for these purposes.
Longer more sustained flooding is experienced over a significant area of the district in the middle to lower lengths of the larger watercourses such as the Rivers Wye, Severn, Warwickshire Avon and Bristol Avon. Here the topography is much flatter and the geology comprises mudstones and clays that have low permeability and thus can become easily saturated. It is in these areas where many of the medium to smaller sized communities at high flood risk can be found. In addition, the groundwater table in these areas is normally high, contributing further to the level of flood risk.

There is a risk of surface water and sewer flooding in some urban locations. The rivers originating or running through such areas may also respond rapidly to rainfall due to water running off the increased area of impermeable surfaces.

There is clear scientific evidence that global climate change is happening now. Over the past century sea level rise around England and Wales has been observed and more winter rain falling in intense wet spells. Climate changes can affect flood risk in several ways and the impacts will vary depending on local conditions and vulnerability. Risk management authorities should consider climate change within the development of all plans.

Wetter winters and more intense rainfall may increase river flooding and cause more surface runoff, increasing localised flooding and erosion. In turn, this may increase pressure on drains, sewers and water quality. Storm intensity in summer could increase even in drier summers, so there is a need for better preparation for extreme events. Rising sea or river levels may also increase local flood risk inland or away from major rivers because of interactions with drains, sewers and smaller watercourses.

The 2013 / 14 winter storms and flooding had significant impacts on many communities, businesses, infrastructure and the environment within the Severn River Basin District (RBD). In the future there could be more extremes in the weather with a changing climate leading to more frequent and more severe flooding.
Investment in flood risk management infrastructure not only reduces the risks of flooding but also supports growth by helping to create new jobs, bring confidence to areas previously affected by floods and creating and restoring habitats.

Much of the RBD is rural in character, with land managed for agriculture and forestry. This includes improved grassland for extensive beef and sheep farming, large dairy farms, and some arable and specialist horticulture such as orchards and fruit. The major woodland use types are coniferous and deciduous woodland distributed throughout the catchment, for example around Ironbridge Gorge, Breiddon Forest and the Wyre Forest, much of which is ancient woodland.

The way in which land is managed can significantly impact on natural resources including the water environment. A combination of incentive, advisory and regulatory measures help farmers and other land managers protect the environment. For instance, Cross Compliance and Nitrate Vulnerable Zone rules, agri-environment schemes (Countryside Stewardship, Tir Gofal), Catchment Sensitive Farming, and incentives are available for woodland management and planting. Such schemes can be beneficial for the water environment by helping to store water, manage water levels and improve water quality.

The catchment is also characterised by urban centres that are built along the Severn and its tributaries. These population centres vary from small to medium in the upper catchments to large urban and sub-urban areas in the lowland floodplains. In urban areas a key challenge is the non-permeability of many surfaces resulting in poor infiltration rates and high surface water flows. The coastal areas around the Severn Estuary have a very particular challenge, with much of the land being reclaimed and heavily reliant on ancient systems of drainage ditches, and lying at or near sea level.

There is growing evidence that woodland measures can help to slow down or even reduce flood flows, particularly within smaller catchments. Strategic tree planting and woodland management can help reduce flood risk in a number of ways:

- Greater water use and interception by trees compared to other vegetation types helps to reduce run-off volumes;
- Woodland soils have greater capacity to absorb and store rainwater during flood events due to their more open structure and the presence of root systems; this also aids interception of overland flow from adjacent land;
- The 'hydraulic roughness' of trees and other woodland features can help to slow the flow of overland flood water;
- Soils under woodland are also generally better protected from erosion risk, thereby reducing delivery of sediment to watercourses and reducing pollutants in the water.

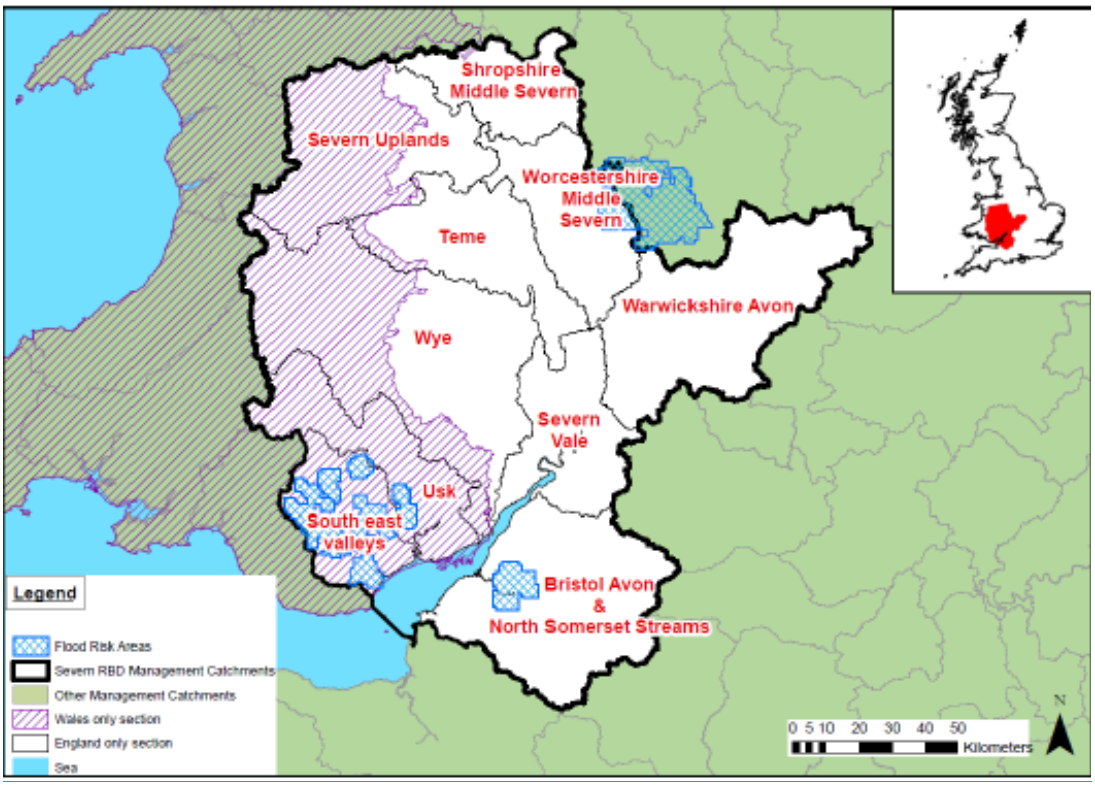
Therefore, 'woodland measures' for flood risk reduction include woodland creation – in the right place and to the right design – and the installation of woodland features such as large woody debris dams to both reconnect watercourses with already wooded riparian zones and floodplains and to slow down flood flows.

The 2011 the 'Woodland for Water' report detailed the evidence behind these conclusions. As a result 'opportunity mapping' was produced to help identify where targeted woodland measures could help to reduce flood risk. Priority locations fall into three categories:

- Floodplains – where hydraulic roughness from woodland cover slows the flow and encourages the deposition of sediment;
- Riparian zones – to intercept overland flow, protect river banks from erosion, and help slow the flow of water;
- Wider catchment planting – to protect sensitive soils from erosion, increase infiltration rates, and intercept sediment in run-off from adjacent land.

While opportunity maps can identify priority catchments where woodland creation and management can help reduce flood risk, it is important that woodland is located in the right part of the landscape and then designed and managed appropriately in order to maximise their contribution to reducing flood risk.

The River Severn River Basin Management Plan Area and Sub Catchments




**Measures across the Severn RBD as a whole:**

Many measures are specific to a catchment or smaller area. However, there are some important actions which apply across the whole Severn RBD. These are shown here and not repeated at each catchment level. Measures in FRMPs do not all have secured funding and are not guaranteed to be implemented.

Government policy that gives the highest priority to the areas at highest risk.

Preventing risk: There are  measures already in place to prevent flood risk at the River Basin District, including:

- work with others to avoid inappropriate development in the floodplain;
- ensure no increase in run-off from new developments through planning advice;
- increase awareness and encourage landowners to fulfil their riparian landowner responsibilities;
- promote flood resilience and flood proofing;
- ensure a robust, risk based, revenue maintenance programme exists that prioritises flood risk management works across each catchment.

Preparing for risk: There are  measures already in place to prepare for flood risk at the River Basin District level including:

- provide advice and information to Local Resilience Forums and local communities to enable them to reduce the impact of flooding;
- maintain and improve the flood forecasting, flood warning and flood incident management service;
- raise awareness with key partners, land owners and land managers of their roles in flood risk management and explore opportunities for joint outcomes;

- provide a flood incident response service 24 hours a day, 7 days a week;

Protecting from risk: There are measures already in place that protect from flood risk at the River Basin District level:

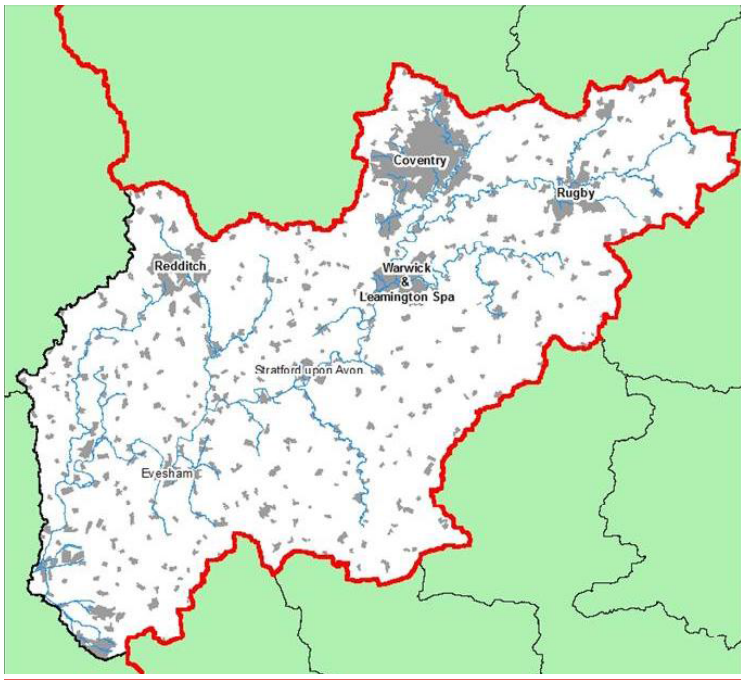
- work with landowners, local and national government to encourage best farming practices to reduce rapid surface water run-off and soil erosion;
- work with Natural England and other partners and landowners to identify opportunities for floodplain restoration;
- secure funding and deliver emergency works where needed for assets;
- incorporate climate change allowances into flood risk management works;
- identify where working with natural processes can help improve resilience to climate change.

**Warwickshire Avon Catchment**

The Warwickshire Avon catchment extends from Rugby and Lutterworth in the north east to Tewkesbury and Cheltenham in the south west covering an area of 2,870 km². The River Avon runs through the centre of the catchment in a south westerly direction with its main tributaries joining from the north and south. These include the River Sowe, River Leam, River Stour, River Arrow, River Isbourne and Bow Brook.

The landscape is mostly characterised by low lying undulating hills with the valley of the River Avon running north east to south west increasing in width until it joins the River Severn at Tewkesbury. The southern boundary of the catchment consists of the steep Cotswold escarpment off which many of the southern tributaries drain.

Warwickshire Avon Catchment




The land use within the catchment is mainly agricultural (Grade 3 – good to moderate land quality or better), with a mixture of farming, including market gardening in the Vale of

Evesham. A number of larger urban centres are located within the catchment including manufacturing industries have declined and urban regeneration is beginning to take place. Tourism and small business are also key to the financial well being of the area based in a number of urban centres including Stratford-upon-Avon, Tewkesbury, Chipping Campden, Evesham, Pershore, Henley in Arden, Warwick and Leamington Spa.
Watercourses within the catchment are used for a variety of activities. This includes recreation - the River Avon is navigable from Tewkesbury to just upstream of Stratford-upon-Avon. The area is rich in landscape and wildlife heritage, including being partially within an Area of Outstanding Natural Beauty.

Geology in the Warwickshire Avon catchment is mostly made up of clays and mudstones with sand and gravels present along much of the length of the Avon Valley. Limestone forms the higher ground of the Cotswolds escarpment and glacial tills are present within the north western corner of catchment around Rugby.

The catchment has a diverse range of designated heritage assets including scheduled monuments, listed buildings, registered parks and gardens and conservation areas, as well as a broad variety of non-designated heritage assets as identified in local authority Historic Environment Records. This resource of heritage assets includes those directly connected to the water environment such as dams, water mills and bridges as well as the potential for archaeological remains, including peat deposits and palaeo-environmental channels linked to former river channels, floodplains and other water features. Many heritage assets are also of historic landscape value such as those associated with field patterns, hedgerows, woodland and ancient trees, and contribute to the character and distinctiveness of the wider landscape. Examples of historic riverside towns in this catchment include Leamington Spa, Warwick, Stratford-on-Avon and Tewkesbury.

The Warwickshire Avon catchment is characterised by a variety of flooding scenarios ranging from rapid responses off the Cotswold escarpment and urban areas to longer flooding events within the lower reaches downstream of Pershore.
Flooding below Bredon can also be influenced by larger events on the River Severn that impact on flows from the River Avon discharging into it.

The catchment has a long and well documented history of river flooding with larger events occurring in 1901, 1947, 1968, 1998 and most recently 2007. Each event has had its own characteristics and has affected different parts of the catchment.
The April 1998 Easter floods were caused by an active frontal zone becoming stationary across the south Midlands, causing extensive flooding in a number of communities including Leamington Spa, Stratford-upon-Avon and Evesham. The River Avon at Evesham rose 4.7m causing flooding up to a mile from the river, while the River Leam at Leamington Spa rose nearly 3m causing extensive flooding in the town centre.

In 2007 approximately 2,000 properties were flooded across Warwickshire with significant flooding in Shipston-on-Stour, Wellesbourne, Henley-in-Arden, Alcester and Bidford-on Avon. In Worcestershire, properties in Evesham, Sedgeberrow and Pershore were also affected.

Other towns and cities affected by flooding include Coventry, Stratford-upon-Avon and Warwick. Flood risk in most other parts of the catchment with regards to property numbers is relatively low, owing to its rural nature.
There are a number of larger urban areas and smaller communities that are at risk of flooding within the catchment. However a number of towns and communities remain at risk such as parts of Coventry, Leamington Spa, Warwick, Stratford upon Avon, Evesham and Shipston upon Stour.

**Conclusions and objectives for the Warwickshire Avon catchment**
The Warwickshire Avon catchment has a long history of flooding, but the relatively dispersed nature of the settlements affected has meant that traditional flood defence schemes have often not been viable. Partnership working (between the Environment Agency, Regional Flood and Coastal Committee, lead local flood authorities, developers and the affected communities) to raise the necessary funds for new viable flood risk reduction schemes and to maintain existing schemes will continue to be vital.

There remains a requirement to influence the planning system to reduce flood risk by directing development away from the floodplain and to slow rates of runoff in the upstream catchment.

**Measures to manage risk in the Warwickshire Avon catchment**

Preventing risk: 47 measures including:
- Avoid inappropriate development in flood risk areas.
- Improve management of surface water and promote implementation of sustainable drainage systems (SuDS).
- Investigate potential solutions for reducing flood risk at: Bilton Road, Rugby; Butt Lane, Coventry; Kenilworth.
- Maintain current level of flood risk management in areas that benefit from flood defences, subject to availability of funding.
- Work in partnership to support implementation and review of local flood risk management strategies.

Preparing for risk: 39 measures including:
- Provide incident response service.
- Maintain flood forecasting and warning capacity, improve accuracy where possible and seek opportunities to expand service where feasible.
- Work with partners and communities to understand risk of flooding from all sources and develop plans to manage the risks.
- Promote awareness of flood risk and encourage others to prepare for flooding in high risk areas.
- Promote awareness and advise on the need to avoid inappropriate development in flood risk areas and the need to manage land to avoid increasing risks.

Protecting from risk: 33 measures including:
- Investigate, develop and implement new flood risk management schemes and measures where feasible and subject to availability of funding.

- Identify locations where working with natural processes could reduce flood risk and improve resilience to climate change.
- Review maintenance operations and work with landowners/managers to identify opportunities for reducing intensity.
- Undertake maintenance programme to replace/refurbish flood risk assets where feasible and subject to availability of funding.
- Implement actions from local flood risk management strategies.

River Severn River Basin Management Plan
The WFD covers all waters, including inland surface waters, groundwater, estuaries and coastal waters, independent of size and characteristics.

For the purpose of implementing the WFD, waters were assigned to geographical or administrative units: the river basin, river basin district and water body.
The river basin is the area of land from which all surface run-off flows through a sequence of streams, rivers and, possibly, lakes into the sea at a single river mouth or estuary.

The river basin district is the main unit for management of river basins under the WFD. River basin districts in England were identified by the Secretary of State in 2003. A river basin district includes the area of land and sea made up of one or more neighbouring river basins together with their associated groundwaters and coastal waters. The river basin districts in England and those that are cross border with Wales and Scotland are shown on the map below.

Water bodies are the units used for reporting and assessing compliance with the principal environmental objectives of the WFD. The environmental objectives of the WFD apply to water bodies and so the main purpose of identifying water bodies is to enable status to be accurately described and compared to the environmental objectives set out in the directive.

The WFD is focused on establishing an integrated approach for the protection and sustainable use of the water environment. This requires a holistic approach to managing waters, looking at the wider ecosystem and taking into account the movement of water through the hydrological cycle.

The WFD is implemented through river basin management and planning that involves setting environmental objectives for groundwater and surface waters (including estuaries and coastal waters) and devising and implementing programmes of measures to meet those objectives.

In line with government guidance), the main aspects of the Environment Agency's approach to implementing the preventing deterioration requirements of the WFD are:
- Deterioration from one status class to a lower one is not permitted.
- While deterioration within a status class does not contravene the requirements of the WFD, (except for Drinking Water Directive parameters in drinking water protected areas, and provided that the objectives and requirements of other domestic or European Community legislation are complied with) action should be taken to limit within status class deterioration as far as practicable. For groundwater quality,

measures must also be taken to reverse any environmentally significant deteriorating trend, whether or not it affects status.

- Where the water body is already in the lowest status class (bad ecological status or potential, fail to achieve good chemical status, poor groundwater chemical status, poor groundwater quantitative status or protected area not achieving relevant standards) no deterioration will be permitted.
- The preventing deterioration requirements are applied independently to each of the elements that come together to form the water body classification as required by Annex V of the WFD and Article 4 of the Groundwater Daughter Directive. This requirement may not apply to elements at high status.
- To manage the risk of the deterioration of the status of the biological elements for surface waters, the preventing deterioration requirements are applied to the environmental standards for the physico-chemical elements, including those for the moderate/poor and poor/bad status boundaries.
- action is taken to limit deterioration within the high and good status classes as far as practicable
- As an exception, where the morphology element is at high status, deterioration to good status is not permitted.

**Artificial and heavily modified water bodies**

Some water bodies contain features that provide valuable social and economic benefits or uses, for instance flood risk management schemes or reservoirs that supply drinking water. In many cases significant physical modifications have been required to support this use, for example, installing a weir or a dam. To achieve good ecological status in many of these water bodies, the existing modifications would have to be altered to such an extent that their function was compromised, such as removing a weir installed for flood defence purposes. It is important to protect the uses that benefit society and the economy. Therefore these water bodies can be designated as artificial or heavily modified (under Article 4.3 of the WFD) and their objectives determined accordingly. An exception to this is if there are other options for achieving the same benefits for society. In these cases designation would not be allowed (European Union CIS guidance document 4, 2003).

Once designated, artificial and heavily modified water bodies are required to reach the objective of good ecological potential. Good ecological potential provides a sustainable balance between the socio-economic, heritage or conservation interests that cause hydromorphological pressures and doing all that can be done to improve the ecological condition of the water body.

To assess ecological potential the pressures, impacts and mitigation measures within a water body are identified by answering a simple set of questions. This mitigation measures assessment was applied to each artificial or heavily modified water body and identified the issues relevant to the physical characteristics of that water body. The mitigation measures assessment is considered alongside the classification of the other elements to determine whether the water body has an overall status of good ecological potential.

For a water body to be able to reach good ecological potential, all of the reasonable mitigation measures to improve and protect the environment have to be in place and functioning. Some mitigation measures may already be in place, but one or more may be missing. If this is the case, the mitigation measures assessment would not support good

ecological potential and the water body can only be classified at moderate ecological potential at best.

If a specific mitigation measure would have a significant adverse impact on the designated use or the socio-economic benefits of that water body it is excluded from the classification process and thus would not prevent a water body from achieving good ecological potential. If every possible mitigation measure would create a significantly adverse impact on socio-economic, heritage or conservation interests, then a sustainable balance has already been reached and the mitigation measures assessment in the water body is considered to support good ecological potential.
Artificial and heavily modified water bodies are still required to aim to achieve good chemical status and, if also designated as a protected area, the protected area objectives.

**Extreme floods**
The Environment Agency is responsible for providing flood forecasting and warnings to the public in England. This involves monitoring rainfall, river levels and sea conditions. Combined with weather data and tidal reports the Environment Agency provides local area forecasts on the possibility of flooding and its likely severity.
Severe floods may have an impact on water body status through effects such as the loss of habitat (for example, by scouring of sediments and in-stream vegetation), the physical displacement of species or increased inputs of pollutants including sediment. These impacts may be localised and of insufficient magnitude to affect the status of an entire water body. The condition of water bodies is assessed on an annual basis and therefore any changes in status due to a severe flood may not be detected until up to a year after the event.

**Physical modification**
Plants, invertebrates and fish are affected by the flows and physical characteristics of the water environment. These hydrological and morphological features are collectively known as the water body's hydromorphology. Aquatic wildlife can be affected if the quantity and quality of water flows is altered and if habitat quality is reduced. Modifications such as straightening river channels, building weirs and reinforcing banks with concrete can constrain and stabilise the physical nature of water bodies, reducing the development and diversity of physical habitats. This can reduce the number and diversity of animals and plants present. The way land is managed can also adversely affect habitats, for example, by changing the amount of sediment that washes off both agricultural land and urban areas.

Most rivers, lakes and a large part of England's coasts have been modified to provide benefits to people such as land drainage, reduced flood risk to communities, water storage for public water supply, recreation or improved channels for navigation. In many cases these benefits and uses are still vitally important and need to be retained, while also reducing their potentially damaging impacts on flows and habitats, and subsequently on aquatic wildlife.

There is significant uncertainty about future trends for physical modifications but recent assessments indicate that some pressures will increase in response to climate and population changes. Deterioration in the ecological condition of some rivers by 2030 is forecast unless further action is taken to mitigate the impacts of, and control the development of, modifications.

**Natural flood management**
Natural flood management and 'slowing the flow' techniques such as restoration of peat moorland, woodland creation, wetlands and ponds encourage greater infiltration of water into the ground and/or hold water back. This reduces peak flows in minor watercourses and across the surface of undeveloped land. The Environment Agency will work with many other organisations and within partnerships to consider the application of these methods and to develop programmes of them alongside more traditional solutions, such as building raised flood defences

This more natural approach can reduce sediment volumes entering rivers, filter out contaminants and enhance habitats. Similar techniques may be applied in or on the fringe of urban areas where they may be referred to as green infrastructure, or sustainable drainage systems. Natural flood management to counter fluvial flood risk will involve installing measures upstream of communities at risk. Measures to satisfy Water Framework Directive objectives will be located upstream or along stretches of water with poor water quality or habitats. Locations where these coincide may require input from more stakeholders to work in collaboration, perhaps using funding from multiple sources. These are likely to provide greater benefit for a given investment and so have a high priority.

**Biodiversity 2020**
The river basin management plans will contribute to achieving habitat quality, habitat creation and restoration outcomes of Biodiversity 2020 for priority water dependent species and habitats. UK priority species and habitats are those listed under Section 41 of the Natural Environment and Rural Communities Act (2006) as being of principal importance for conserving biodiversity. Priority habitats cover a wide range of semi-natural habitat types, and can exist within or outside Natura 2000 protected areas or SSSIs.

New priority river and lake habitat maps have identified streams, rivers and lakes that are still the most natural in character, containing a dynamic mosaic of habitats and associated species. These maps can be used to help avoid deterioration and to target restoration measures to help conserve and enhance these habitats within a wider programme of action to improve ecological status.

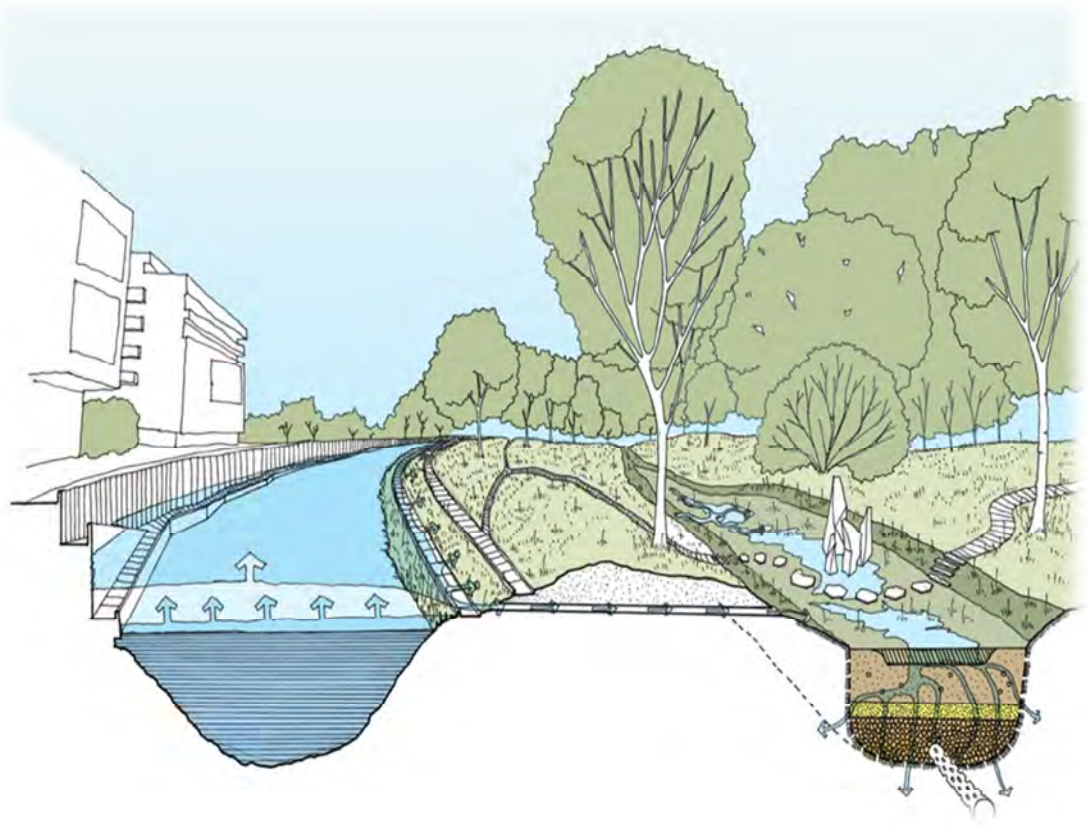
The Biodiversity 2020 strategy recommends that habitat creation and funding needs to be refocused by putting larger and more cost effective schemes in the most appropriate places. For example, wetlands should provide multiple benefits such as flood storage, mitigating diffuse pollution, restoring more natural hydrological regimes, storing carbon, and protecting groundwaters. This is in addition to the government's Biodiversity 2020 outcomes which target floodplain restoration activities on sites identified as having greatest potential for development as priority wetland habitat.

**In conclusion**
Flood risk is a combination of two components: the chance (or probability/ likelihood) that a location will flood from any source or type of flooding, and the associated impacts (or consequences) of the flooding. Flood risk management is generally concerned with reducing harm which might take the form of property damage or physical injury to people and wildlife.

However, flooding can also have beneficial effects too, in particular for wetland wildlife as well as some types of agriculture that are water dependent.

Risk captures the severity of, or related consequences produced by, a flood event. Impacts can be social, economic and environmental, for example the number of properties flooded and the level of associated economic damages. The consequences of a flood depend on the level of exposure and the vulnerability of those affected.

It is not possible to prevent all flooding, but there are a variety of actions that can be taken to manage flood risk and the impacts of flooding on communities. Flood risk managers must identify all potential options to manage flood risk and balance the needs of communities, the economy and the environment. Risk management authorities should work in partnership with each other and communities to manage flood risk, ensuring that communities understand these risks, are involved in the decision making process, and can actively prepare for the risks.

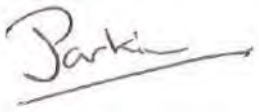


Warwickshire County Council

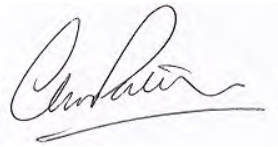
# Surface Water Management Plan Methodology Report

Warwickshire County Council

AECOM

Prepared by:  .....

John Parkin
Principal Consultant

Verified by:  .....

Chris Paterson
Director

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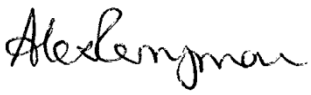
Approved by:  .....

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Warwickshire County Council Surface Water Management Plan

| Rev No | Comments | Checked by | Approved by | Date |
|---|---|---|---|---|
| 0 | First issue to Warwickshire County Council for comment | Kevin Keating | Kevin Keating | 08/12/14 |
| 1 | April 2015 Update – For Discussion with Client (not issued) | Alex Perryman | - | 30/04/15 |
| 2 | Final Draft | Alex Perryman | Chris Paterson | 19/05/15 |
| 3 | Final Issue | Alex Perryman | Chris Paterson | 27/05/15 |
| 3 | Final Issue – Updated Matrix Results (J Parkin) | Alex Perryman | Chris Paterson | 26/08/15 |
| 3 | Minor wording amendments to align with Strategy document | Michael Green | Michael Green | 08/09/15 |

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Job No 60319308 Reference SWMP-Methodology/004 Date Created August 2015

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# Abbreviations and Glossary of Terms

| | |
|---|---|
| **AECOM** | Architecture, Engineering, Consulting, Operations, and Maintenance |
| **CDAs** | Critical Drainage Areas |
| **CI** | Critical Infrastructure |
| **Climate Change** | A Large-scale, long-term shift in the planet's weather patterns or average temperatures. |
| **CSWRT** | Coventry Solihull Warwickshire Resilience Team |
| **Defra** | Department for Environment, Food and Rural Affairs |
| **ELR** | Employment Land Review |
| **FMfSW** | Flood Map for Surface Water |
| **FWMA** | Flood and Water Management Act |
| **GARA** | Growth and Regeneration Area |
| **GIS** | Geographic Information System |
| **LEP** | Local Enterprise Partnership |
| **LFRMS** | Local Flood Risk Management Strategy |
| **LLFA** | Lead Local Flood Authority |
| **MCM** | Multi Coloured Manual |
| **NPPF** | National Planning Policy Framework |
| **NRD** | National Receptors Dataset |
| **OS NGR** | Ordnance Survey National Grid Reference |
| **PDF** | Portable Document Format |
| **PFRA** | Preliminary Flood Risk Assessment |
| **Return Period** | An estimate of the likelihood of an event (or interval of time between events of a certain intensity or size) such as a flood or a river discharge. |
| **RMAs** | Risk Management Authorities |
| **SFRA** | Strategic Flood Risk Assessment |
| **SHLAA** | Strategic Housing Land Availability Assessment |
| **Stakeholder** | Person and / or organisations affected by the problem / solution, or interested in the problem / solution. |
| **SuDS** | Sustainable Drainage Systems |
| **SWMP** | Surface Water Management Plan |
| **uFMfSW** | updated Flood Map for Surface Water |
| **WCC** | Warwickshire County Council |
| **WSUD** | Water Sensitive Urban Design |

# Executive Summary

The county of Warwickshire has experienced a number of significant flood events in recent times, often with complex flooding interactions from multiple sources. Notable events include January 1992, Easter 1998, August 1999, June 2005, summer 2007, December 2008 and November 2012. Among the various responses to these events, AECOM were appointed by Warwickshire County Council (WCC) as Lead Local Flood Authority (LLFA) to undertake a Surface Water Management Plan (SWMP) and Investment Strategy. The SWMP is tasked with providing a prioritisation process for future flood risk management work. The SWMP will form the risk assessment for WCC's Local Flood Risk Management Strategy (the 'Strategy').

Surface Water Flood Risk:

In the context of this study, surface water flood risk is defined as the following.

- **Pluvial flooding**: High intensity rainfall causes surface water runoff which flows over the ground and accumulates in low-lying areas.
- **Groundwater flooding**: Water in the ground rises up above the ground surface due from within permeable rocks often as a result of prolonged or heavy rainfall.
- **Ordinary watercourse flooding**: When a watercourse (not designated as Main River) cannot accommodate the volume of water flowing in it or the channel becomes blocked, causing water to come out of the channel and flow over the surrounding land.
- **Sewer flooding**: Flooding from a sewer, usually via manholes, due to the capacity being exceeded or due to temporary problems with the system such as blockages, collapses or equipment failures (i.e. pumping stations).

The SWMP objectives are defined as the following.

1. Develop a robust understanding of surface water flood risk across the county of Warwickshire, including a prioritised list of locations at risk of flooding, taking into account the importance of both urban and rural communities, the challenges of population and demographic change and increasing pressures on urban fringes.
2. Develop recommendations for surface water management which improve emergency and land use planning, and enable better flood risk and drainage infrastructure investments.
3. Establish new and consolidate existing partnerships between key drainage stakeholders to facilitate a collaborative culture of data, skills, resource and learning sharing and exchange, and closer coordination to utilise cross boundary working opportunities.
4. Undertake engagement with stakeholders to raise awareness of surface water flooding, identify flood risks and assets, and agree mitigation measures and actions.

Warwickshire County Council

5. Develop a robust Action Plan and guidance to deliver change where partners and stakeholders take ownership of their flood risk and commit to delivery and maintenance of the recommended measures and actions.

Understanding the different sources of flooding and receptors (e.g. properties, people, environment) across Warwickshire was essential for the SWMP study, and so engagement with different Risk Management Authorities (RMAs) was developed to ensure a comprehensive understanding of flood risk is obtained, and to identify the most appropriate measures for flood risk reduction. Flood history information was obtained from the following sources.

- Districts and Boroughs, and Parish and Town Councils and community groups.
- Stakeholders and organisations:
  - Environment Agency;
  - Severn Trent Water;
  - Network Rail; and
  - Canal and River Trust.

To develop a comprehensive understanding of surface water flood risk in Warwickshire, it is important to capture where surface water flooding has occurred in the past, but to identify where surface water flooding may be more likely to occur in the future.

The Predictive flood risk information is from the Environment Agency's (EA) 'updated Flood Map for Surface Water' (uFMfSW).

The receptors and their associated flood risk vulnerability across Warwickshire have been established using the National Receptors Dataset (NRD), the National Planning Policy Framework (NPPF) and refined using project stakeholder knowledge. To understand which receptors are at greater risk, or where there are greater consequences, a series of standardised quantitative metrics have been established to enable an assessment across the entire study area. Thresholds were developed to understand where there are areas of flood risk and consequences, and analysis of these locations were undertaken in a bespoke project matrix which allowed the scoring, weighting, comparison and ranking of sites. The matrix was developed to identify surface water flooding hotspots (historic and future) that met the following threshold requirements as defined in the Strategy.

1. Flooding that poses a threat to the safety of the public or may directly result in serious injury or death.
2. Five or more residential properties internally flooded.
3. Two or more commercial properties internally flooded.
4. One or more piece of critical infrastructure affected that impact on the wider area.
5. Flooding that places vulnerable individuals or vulnerable communities at risk e.g. hospitals, care and nursing homes, schools, secure units, etc.

6. Where one or more residential property has flooded internally from the same source on five or more occasions within the last five years.

Draft outputs were tested through sensitivity analysis and have been discussed with project stakeholders. Feedback from these workshops was combined with that from the public consultation (January to March 2015), and a ranking of sites across the study area was created, in addition to supporting thematic maps for:

- Historic Surface Water Flood Risk;
- Predictive Surface Water Flood Risk; and
- Combined (Historic and Predictive) Surface Water Flood Risk.

The matrix has been developed to enable both historic and potential future flooding hotspot reporting. For this overall summary, a combined approach has been undertaken (combining both the historic and potential future flooding scores) for each OS tile or combination of OS tiles to provide a top 40 ranking. Note that large locations such as Leamington Spa will have a number of OS tiles at risk of surface water flooding from different sources - these are therefore ranked separately as different flooding locations. Large towns could therefore be named in the list more than once, but it is the specific area or community within the town which is being ranked.

The highest ranked locations will not necessarily have funded flood alleviation schemes. This stage of the SWMP is the risk assessment. The viability of flood alleviation schemes depends not only on the risk, but also on the nature of the flood risk and financial viability of a scheme relative to other areas in England and Wales (since it is necessary to compete with other locations to bid for funding from the national 'pot' of Flood Defence Grant in Aid available).

This report summarises Phases 1 and 2 of the SWMP which have been completed (see Figure 2.1). Subsequent phases of the SWMP process will further investigate the top ranking sites including discussions with project partners and other RMAs such as the EA and Severn Trent Water (STW) to identify areas of risk overlap and develop partnership schemes. Following stakeholder engagement a prioritised list will be developed with conceptual flood risk mitigation options, supporting action plans and investment strategies.

Additional deliverables from this study have included a Microsoft Excel interactive matrix and a set of SWMP Thematic Flood Maps based on the objectives in Section 1.3. The thematic flood maps are reflective of the interactive matrix outputs which can be regularly updated with new information to capture future flooding incidents, updated predictive mapping and details of flood risk management schemes and associated benefits.

An additional Strategic Flood Map has been created (both as a GIS workspace and interactive PDF) which contains all of the data that was collated and used in this commission. The interactive PDF map has been developed to allow WCC and other RMAs to visualise all of the historic flood risk, predictive flood risk and receptor data collated for this study.

# 1 Introduction

## 1.1 Purpose of the Assessment

AECOM has been appointed by Warwickshire County Council (WCC) to undertake a Surface Water Management Plan (SWMP) and Investment Strategy for the county of Warwickshire.

WCC require a SWMP and Investment Strategy to provide evidence base for their Local Flood Risk Management Strategy ('the Strategy') and to take a proactive approach to flood risk reduction through informed decision making.

This report has been produced to provide a summary of the methodology and approach of the technical work for Phases 1 and 2 of the SWMP (see Figure 2.1) and forms the risk assessment part of the Strategy.

## 1.2 Scope of the Assessment

Working in partnership with WCC and key stakeholders, AECOM were required to deliver a SWMP established upon a risk based assessment process to prioritise flooding locations across Warwickshire and develop a greater understanding of key flooding hotspot areas, risks and associated consequences. The partnership will also provide guidance and deliverables that will facilitate subsequent phases of the Defra SWMP wheel (Figure 2.1). The SWMP needs to complement the Strategy and wider WCC Lead Local Flood Authority (LLFA) responsibilities by delivering a strong evidence base and by plotting a route to access potential funding sources for flood risk reduction measures.

Chapter 6 provides a definition of flood risk, the various sources of flooding that have been considered / discounted in this study, and outlines a summary of the techniques used to assess flood risk and associated consequences.

## 1.3 Study Area Introduction

The study area of the WCC SWMP covers the entire county of Warwickshire. It is bounded to the south by Oxfordshire and Gloucestershire, the west by Worcestershire and the Birmingham conurbation (West Midlands Metropolitan County), the north by Staffordshire and Derbyshire and to the east by Leicestershire and Northamptonshire. Warwickshire is considered an average sized county, spanning 1,975km$^2$, the shape of county means that it covers an elongated geographical area (nearly 100km), resulting in a wide range of extensive rural landscapes and urban areas.

The majority of Warwickshire's population live in large towns and cities in the centre and north of the county. Market towns are prevalent in the north, such as Nuneaton, Bedworth and Rugby, whilst larger settlements of Warwick, Leamington, Stratford-upon-Avon and Kenilworth are located in the more central and western locations.

Warwickshire has a two-tier structure of local government and contains the following districts and boroughs.

- Stratford on Avon District Council.
- Warwick District Council.
- Rugby Borough Council.
- Nuneaton and Bedworth District Council.
- North Warwickshire District Council.

The City of Coventry is a separate unitary administration and so is therefore excluded from this study.

Figure 2.2 provides a map showing the context of the study area.

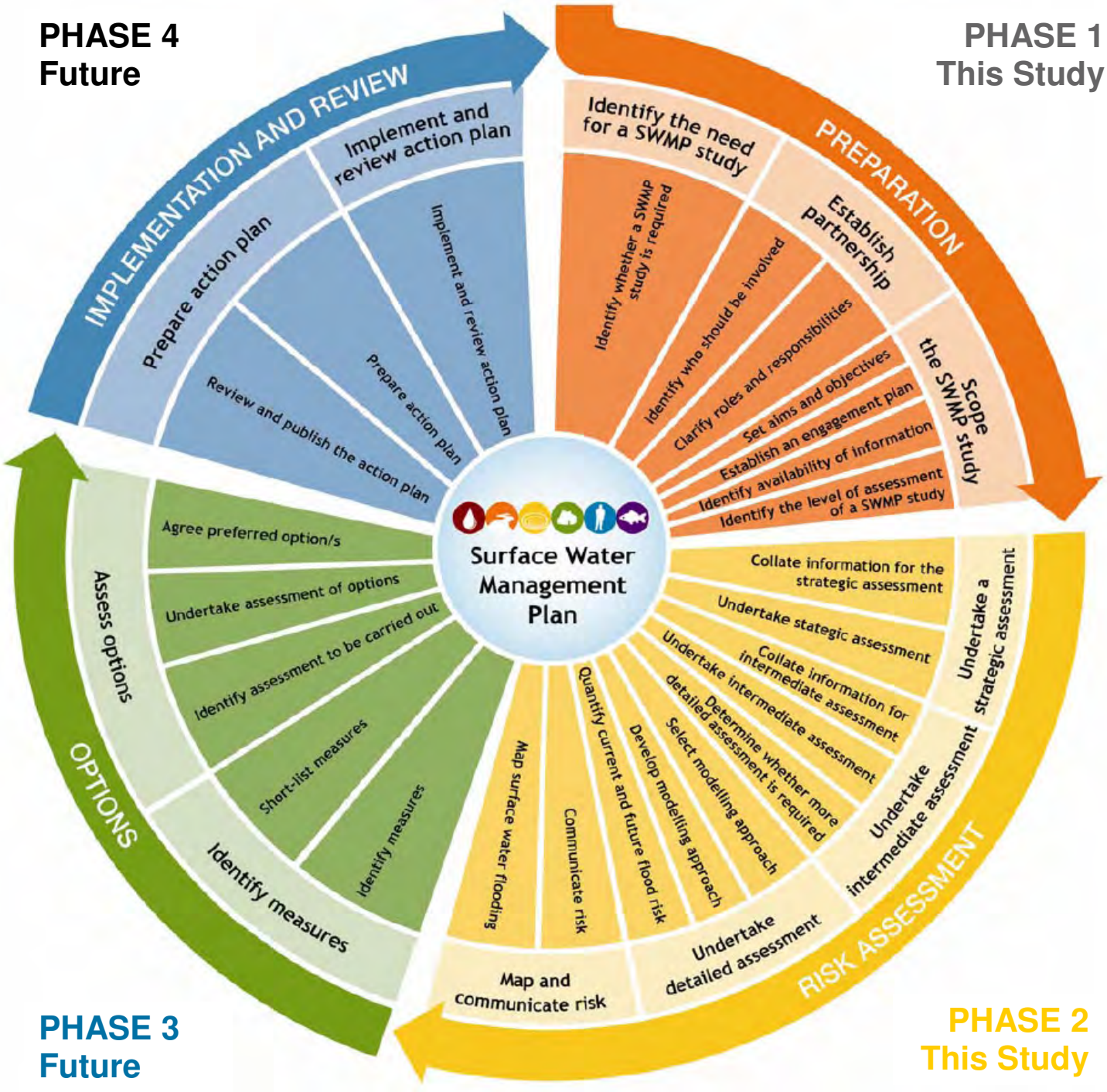



**Figure 2.1 – Defra SWMP Wheel**

Warwickshire County Council

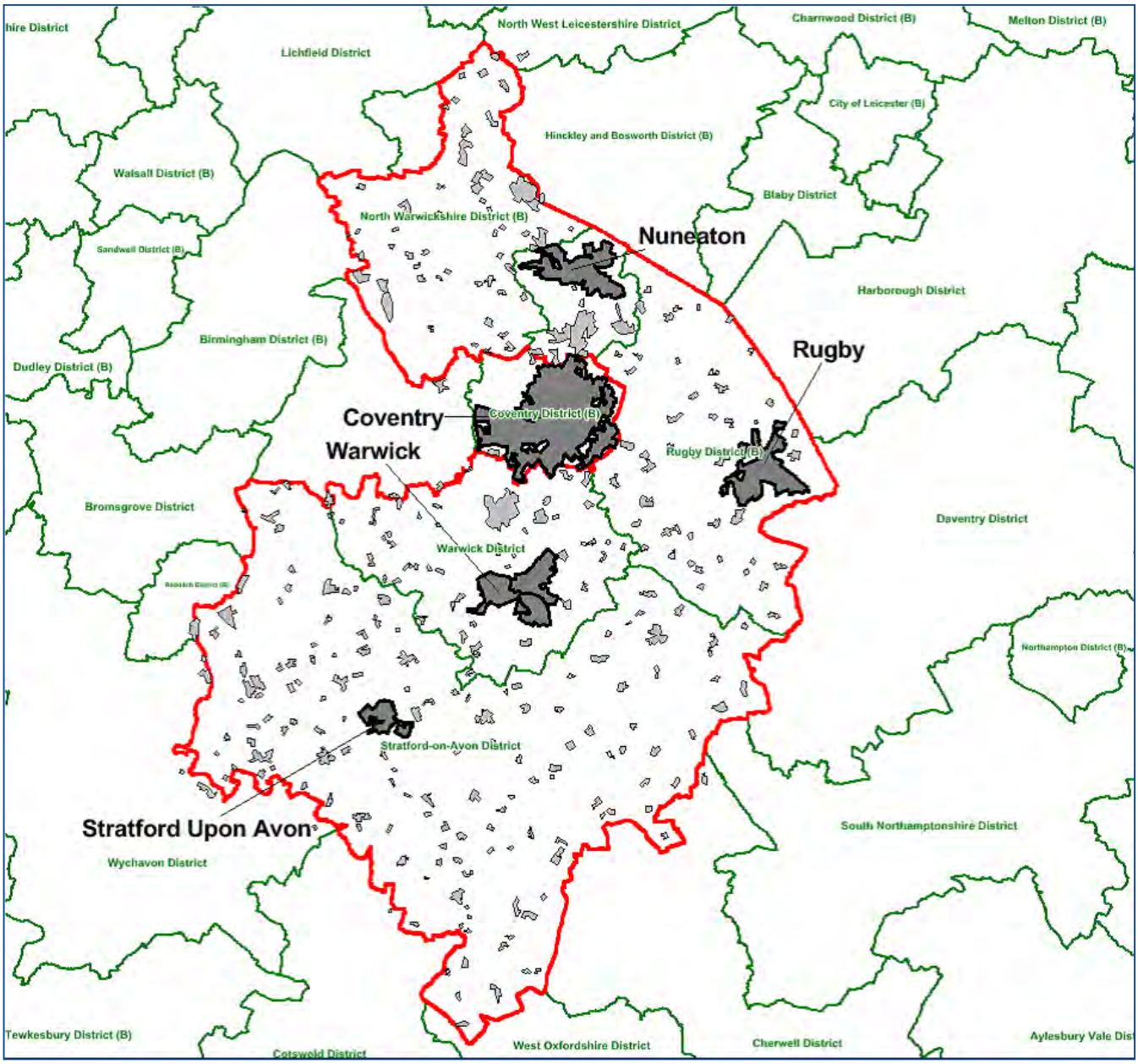



**Figure 2.2 – Warwickshire County Council SWMP Study Area Map**

## 1.4 SWMP Introduction

A SWMP outlines the preferred surface water management strategy in a given area. In this context, surface water flooding is defined as the following:

- **Pluvial flooding**: High intensity rainfall causes surface water runoff which flows over the ground and accumulates in low-lying areas.
- **Groundwater flooding**: Water in the ground rises up above the ground surface due from within permeable rocks often as a result of prolonged or heavy rainfall.
- **Ordinary watercourse flooding**: When a watercourse (not designated as Main River) cannot accommodate the volume of water flowing in it or the channel becomes blocked, causing water to come out of the channel and flow over the surrounding land.
- **Sewer flooding**: Flooding from a sewer, usually via manholes, due to the capacity being exceeded.

This SWMP study has been undertaken in consultation with key local partners and stakeholders who are responsible for flood risk management and drainage in the county, including Severn Trent Water and the Environment Agency. The partners have been consulted and engaged to develop an understanding of the locations, causes and effects of surface water flooding, and to develop potential solutions to mitigate the surface water risk for the prioritised hotspots.

This report and the finalised results will provide the evidence base for action plans to manage surface water flood risk in Warwickshire, and will influence future capital investment, asset maintenance, public engagement and understanding, land use planning, emergency planning and future developments.

## 1.5 Warwickshire Flood Risk Context

The main urban areas are Stratford upon Avon, Warwick, Leamington Spa, Rugby, Nuneaton and Bedworth - centralising the population in the centre and north of the county.

Many rural areas in Warwickshire comprise gentle rolling countryside with low lying river valleys, including the Rivers Avon, Stour, Anker and Tame. The majority of the county is located within the catchment of the River Avon, which drains into the River Severn. The Rivers Tame and Anker drain northern Warwickshire and are part of the wider River Trent catchment.

Fluvial (or "Main River") flood risk in Warwickshire can be significant in both rural and urban locations, often with complex flood flow paths and interactions with surface water flooding. Surface water flooding issues identified in this study will therefore be screened against Main River fluvial flooding to identify where potential partnership flood risk management schemes with the EA may exist. The WCC Level 1 Strategic Flood Risk Assessment (SFRA) 2008 and 2013 update study provides a comprehensive summary of the fluvial watercourses, and Figure 2.3 of this report shows the locations of the significant Main Rivers.

In addition to the gentle rolling valleys, Warwickshire has undulating pockets of high ground and steep slopes (both in the northern and southern areas). Many of these areas have a higher risk of surface water flooding due to overland flows, which can result in significant disruption to many rural communities. Much of the county is underlain by impermeable clay. In urban areas, the complex networks of surface water sewer systems and high proportion of impermeable surfaces can cause significant surface water flood risk issues.

A review of previously published information shows that there have been several notable flood events in recent times. The most recent being in November 2012 where over 300 incidents were reported to WCC (with additional information gathered as part of the data collection exercise for this commission). Examples of significant flooded areas include Aston Cantlow, Fenny Compton, Kenilworth, Gaydon, Nuneaton, Polesworth, Snitterfield, and Warwick (note that many other locations were affected by the November 2012 flood event and have been included in the data gathering exercise and subsequent analysis of this SWMP). Other notable flood events included the Easter 1998 and the summer of 2007 events. Table 2.1 provides a summary of these flood events, with a project data register include in Annex A.

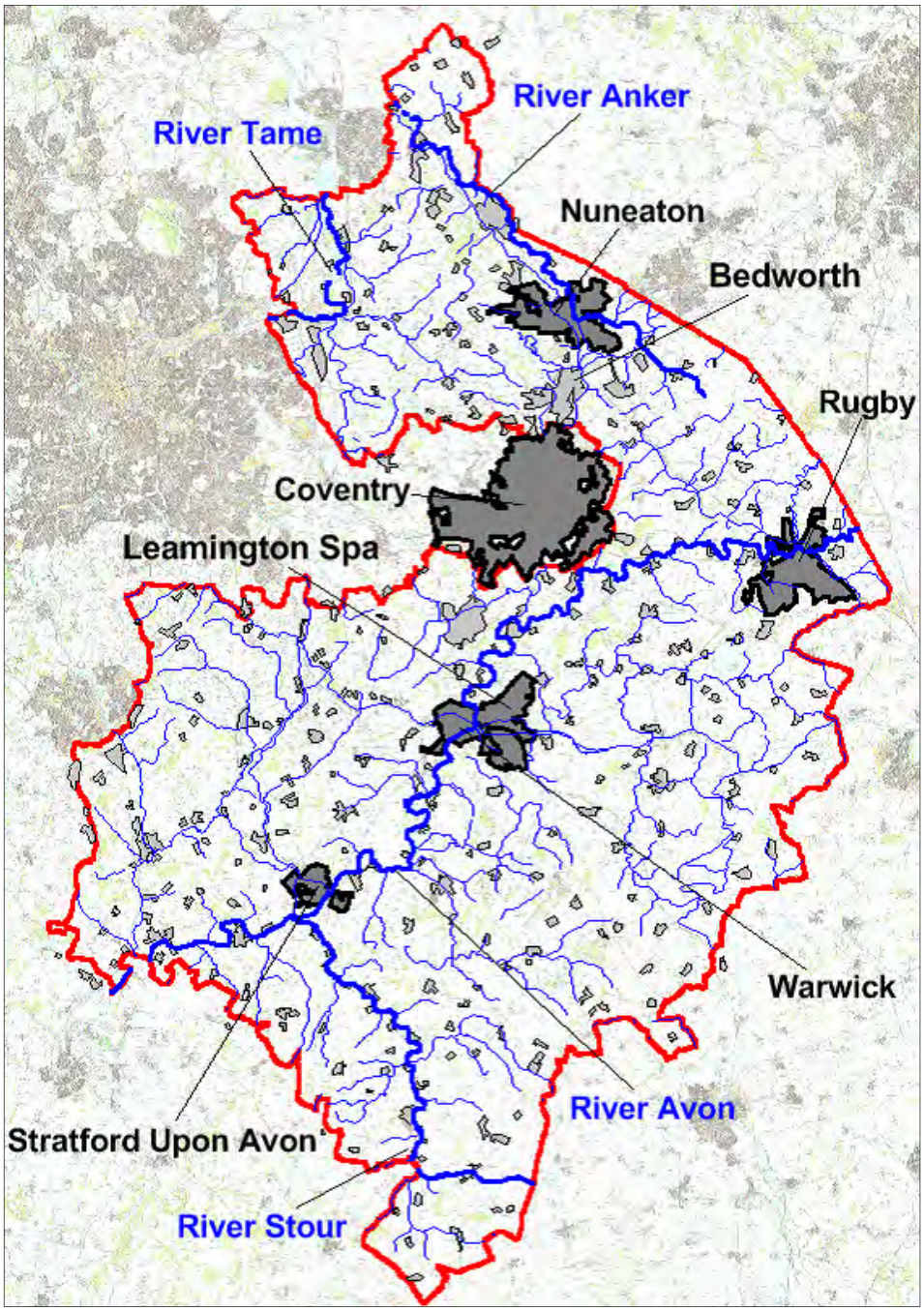



**Figure 2.3 – Warwickshire Main Urban Areas and Rivers**

**Table 2.1 – Warwickshire Flood History Summary**

| Flood Event | Recorded Duration | Source of Flooding | Number of Properties Flooded |
|---|---|---|---|
| **13th January 1992**<br><br>***WARWICK AND STRATFORD ON AVON DISTRICTS*** | < 1 day | Ordinary Watercourses<br>Sewers<br>Highways Drains<br>Main Rivers | >35 internally<br>(Snitterfield only) |
| **Easter 1998 (9th April)**<br><br>***SOUTHERN HALF OF COUNTY*** | 2 days | Ordinary Watercourses<br>Overland Flow<br>Sewers<br>*(surface water and combined)*<br>Highways Drains<br>Groundwater<br>Main River | >480 internally<br><br>>520 total |
| **9th August 1999**<br><br>***WARWICK DISTRICT ONLY*** | <24 hours | Sewers<br>*(surface water and combined)* | 31 internally<br><br>35 total |
| **June 2005 (24th - 28th)**<br><br>***WARWICK DISTRICT ONLY*** | 4 days | Sewers<br>*(surface water and combined)*<br>Main River | 32 internally<br><br>46 total |
| **Summer 2007 (June and July)**<br><br>***COUNTY -WIDE*** | 1 - 6 days | Ordinary Watercourses<br>Overland Flow<br>Sewers<br>Highways Drains<br>Main River | >1600<br><br>>1750 total |
| **December 2008**<br>***CENTRAL WARWICKSHIRE*** | 1 day | Ordinary Watercourses<br>Main River<br>Overland Flow<br>Highways Drains | 54 internally<br><br>55 total |
| **21st – 25th November 2012** | 1 – 5 days | Ordinary Watercourses<br>Overland Flow<br>Sewers<br>*(surface water and combined)*<br>Highways Drains<br>Groundwater<br>Main River | Over 300 reported incidents |

# 2 Phase 1 – Preparation

## 2.1 Introduction

This chapter provides a summary of the approach taken for Phase 1 of the SWMP, the roles and responsibilities, and the development of the aims and objectives. The headings relate to the steps of the SWMP process, as presented in Figure 2.1.

## 2.2 Identify the need for a SWMP Study

Warwickshire County Council have recognised that the development of a SWMP study would provide a strong evidence base to inform the Strategy, and would facilitate a pro-active approach to flood risk management.

### 2.2.1 Establish Partnership

The Inception Meeting for this study identified that a key requirement of the SWMP was the need to establish strong project partnerships. Whilst a formal steering group was not established for the WCC SWMP, the principles were applied, and WCC undertook a series of meetings and workshops with partners and stakeholders and provided regular communications to report on progress (see Chapter 6).

Partners and stakeholders consulted included the following:

- Parish and Town Councils and community groups;
- District and Borough Councils;
- Environment Agency;
- Severn Trent Water;
- Canal and River Trust;
- Network Rail; and
- Warwickshire Wildlife Trust.

### 2.2.2 Scope the SWMP Study

WCC took professional advice and reviewed best practice and SWMPs completed by other local authorities before scoping this SWMP.

WCC decided that a metric-based approach was required in order to provide a means for transparent decision making in the selection of sites for further investigation. This approach also allows an efficient method to update the SWMP study with new datasets in the future.

### 2.2.3 WCC SWMP Objectives

The WCC SWMP overall project objectives are as follows.

- Develop a robust understanding of surface water flood risk across the county of Warwickshire, including a prioritised list of locations at risk of flooding, taking into account the importance of both urban and rural communities, the challenges of population and demographic change and increasing pressures on urban fringes.
- Develop holistic and multifunctional recommendations for surface water management which improve emergency and land use planning, and enable better flood risk and drainage infrastructure investments.
- Establish new and consolidate existing partnerships between key drainage stakeholders to facilitate a collaborative culture of data, skills, resource and learning sharing and exchange, and closer coordination to utilise cross boundary working opportunities.
- Undertake engagement with stakeholders to raise awareness of surface water flooding, identify flood risks and assets, and agree mitigation measures and actions.
- Develop a robust Action Plan and guidance to deliver change where partners and stakeholders take ownership of their flood risk and commit to delivery and maintenance of the recommended measures and actions.

### 2.2.4 Guidance

The approach for the WCC SWMP has been guided by the Defra SWMP Technical Guidance[1]. There are normally four phases to a SWMP process, comprising:

- Phase 1 - Preparation;
- Phase 2 - Risk Assessment;
- Phase 3 - Options; and
- Phase 4 - Implementation and Review.

Whilst the current study includes Phases 1 and 2, and initial elements of Phase 3, this report summarises the approach taken for the first two phases – SWMP preparation and risk assessment.

It is important to note that the Defra guidance recommends that the process is continual, with a review and update undertaken periodically, perhaps in tandem with updates to the Strategy, following a major flood event or in response to new major development planning. The approach and tools developed will allow efficient updates to be undertaken.

[1] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69342/pb13546-swmp-guidance-100319.pdf

### 2.2.5 Deliverables

The final deliverables for the SWMP will comprise:

- the methodology report;
- SWMP results and hotspot / objective scoring analysis matrix;
- a shortlist of priority flood risk hotspots; and
- a Strategic Flood Map to present the SWMP results.

# 3 Phase 2 – Risk Assessment

## 3.1 Introduction

The chapter provides an overview of the data collation and review, the methodology and the results approach from Phase 2 of the Defra SWMP wheel - Risk Assessment (see Figure 2.1).

Phase 2 comprises two distinct halves. The first is to identify the sources, mechanisms, frequency, extent and consequences of surface water flooding in Warwickshire. The second half of the process relates to the relative assessment of the flood risk problem locations, mapping and identifying the most significant areas, known as 'hotspots'. The second stage includes capturing both predictive and historic flood risk information as well as the local knowledge and experience of partners. This provides a starting point for the identification of locations for a more detailed assessment.

## 3.2 Phase 2 Overview

The Defra guidance recommends that Phase 2 of the SWMP includes data collection, assessment, mapping and communicating risk stages. Phase 1 identified that the predictive flood risk information for Warwickshire was of sufficient quality for the SWMP study. The historic data varied in spatial content and quality, and a detailed data gathering exercise was required. Each historic dataset was assessed individually and through consultation with WCC, determined which datasets were to be carried forward to the matrix.

To undertake the assessment stage of Phase 2, a metric-based approach was developed and implemented which provides a clear audit trail of the decisions made, and produces outputs in line with the requirements of Phase 2 of the Defra SWMP wheel.

### 3.2.1 Phase 2 Key Stages

Phase 2 of the Defra SWMP wheel process is summarised below.

1. Establish the approach for data collection and agree flood risk and receptor data sets for inclusion.
2. Undertake data collection and engagement with stakeholders.
3. Develop the matrix using the accrued GIS datasets.
4. Cross reference datasets and undertake technical analysis and sensitivity testing.
5. Present findings in terms of initial hotspot identification to project stakeholders, and assess the performance of the initial objective / metric weighting selection.
6. Adjust weightings, re-run analysis and develop an agreed shortlist of sites to take forward to Phase 3.

# 4 Phase 2 - Consultation and Data Collection

## 4.1 Introduction

Credible data is needed to develop a comprehensive understanding of surface water flood risk in Warwickshire. The first stage of Phase 2 of the SWMP therefore includes the collation of such data. Information on the buildings or other assets (called “receptors”) affected by flooding is also important in order to allow the assessment of the consequences of flooding.

## 4.2 Existing Data Identified

At the start of the Surface Water Management Plan (SWMP), WCC provided its understanding of surface water flooding, as gained from the following sources.

- Ad-hoc historical records of flooding.
- The Preliminary Flood Risk Assessment (PFRA) and SFRAs.
- EA’s national surface water flood mapping published in December 2013.

Existing Historical Records

The initial historic flood risk information held by WCC that was collated at the start of the study was contained in numerous datasets (see data register in Annex A). The data tended to vary in detail, sometimes with limited geographical areas or lacking spatial references and suitable information about the nature of the flooding and receptors affected. To complement this data, information was enhanced through the work of the WCC FRMT via ongoing flood investigation studies. In addition to this, WCC as LLFA have now developed standard ways of reporting and recording flood event data in the future.

Preliminary Flood Risk Assessment and Strategic Flood Risk Assessment

A PFRA was produced for Warwickshire and this identifies areas in which the risk of surface water and groundwater flooding is significant and warrants further examination. The PFRA was prepared by WCC in order to comply with the Flood Risk Regulations 2009 and in accordance with the EA’s Final PFRA Guidance published in December 2010. The PFRA report was published in March 2011.

Environment Agency National Mapping

The EA published their updated Flood Map for Surface Water (uFMfSW) in December 2013. This dataset is the third national surface water map that has been produced by the EA. It represents an improvement over previous surface water flood maps as a result of improved modelling and flood mapping techniques.

This predictive modelling dataset is now well developed and when supported by recorded flood history, provides a good basis for analysis and prioritisation of flood risk locations.

### 4.2.1 Data Collection and Review

A key objective of the study was to collate as much flooding information as possible, assess its quality and relevance, and combine it within an analysis that would result in the identification and ranking of flood risk locations. The use of GIS software was identified as a useful tool for the analysis and visualisation of the results, flooding and at-risk areas which should assist with spatial planning. Where hard copy data was provided, detailing incidents of surface water flood risk; the information was digitised in GIS so that it could be compared with existing GIS information and integrated into the matrix.

The existing records held by WCC as outlined in Section 4.2 were supplemented with additional information obtained by the following approaches.

- A request for flood history information from:
  - the Districts and Boroughs, Parish and Town Councils and community groups; and
  - project stakeholders (including Severn Trent Water, Network Rail, Canal and River Trust and Warwickshire Wildlife Trust).
- Parish Engagement Workshops - A bespoke flood history questionnaire and map annotation exercise was undertaken as part of the Defra Pathfinder initiative[2]. Comprising of workshops across the county, Parish and Town Council, community group members and key stakeholders were encouraged to identify areas of known flood risk and provide supporting information. To capture information from Parish and Town Councils not attending the Pathfinder workshops, the flood history questionnaire was issued directly to representatives as a follow up exercise. The hard copy data was spatially and digitally uploaded into the GIS software.

Following the initial data gathering exercise and engagement workshops, a gap analysis was undertaken and WCC provided the stakeholders a further opportunity for flood history data to be provided before the technical analysis stage commenced.

Project data was assessed against the data quality scoring system referred to in the Defra SWMP Technical Guidance Document (2010). Additional weightings of data importance were then established through sensitivity testing and stakeholder engagement workshops and incorporated into the project data matrix outlined in Chapter 5.

[2] Launched by Defra in 2012, 13 pilot projects across England were selected to develop innovative projects and flood action groups that will better protect homes and businesses from flooding.

### 4.2.2 Flood Risk Datasets – Historic

The historic datasets that were used in the technical analysis are presented in Table 5.1 below, with a detailed data register provided in Annex A.

Additional flood history information has been obtained from project stakeholders the EA (fluvial / Main River flooding) and STW (sewer flooding) that will be used to assess flood risk responsibility overlaps and potential flood risk management partnership schemes.

**Table 5.1 – Key Historic Data**

| Stakeholder/Data Source | Data |
|---|---|
| Defra-funded Community Flood Resilience Pathfinder Workshops | • Historic flood incidents recorded by Parish and Town Council and community group representatives and local stakeholders |
| WCC | • Ongoing flood incident investigations<br>• Preliminary Flood Risk Assessment flood history data<br>• 2012 flood incident register<br>• Level 1 SFRA studies (2008 and 2013 update)<br>• Highways flood incidents |
| District and Borough Flood Records | • Historic flood incidents |
| Network Rail Flood History | • Historic surface water flood incidents that affected Network Rail assets and caused disruption |
| Canal and River Trust | • Historic surface water flood incidents affecting the canal network |

### 4.2.3 Flood Risk Datasets – Predictive

The predictive flood risk information used was the EA uFMfSW dataset. The 1 in 100 year flood results have been used to assess predicted surface water flooding extent, depth and hazard[3].

[3] Flood Hazard as defined by the Defra Flood Risks to People – Phase Two Document (FD2321/ TR2) (2006)

In addition, the EA second generation mapping (the Flood Map for Surface Water (FMfSW)) has been used during the sensitivity testing of the analysis as an additional check stage. See Section 5.9.1.

### 4.2.4 National Receptor Dataset

The National Receptors Dataset (NRD) has been used as the primary receptor data. The NRD was used to extract the residential, non-residential and Critical Infrastructure categories (using the Multi Coloured Manual[4] (MCM) codes in the attribute data). Entries such as ponds, reservoirs, post boxes and parks were removed from the dataset as these cannot be categorised into any of the objectives. This follows the same approach detailed in Annex 6 of the PFRA.

### 4.2.5 Critical Infrastructure

Mapping of Critical Infrastructure in Warwickshire was informed primarily by the NRD. Additional data was obtained from WCC and also Ordnance Survey (OS) Strategic Open Source data including Control of Major Accident Hazard (COMAH) sites, motorways, primary roads, A and B roads and railway lines. Network Rail was also consulted to understand the vulnerability of their local assets and known problem areas. Reference was also made to the Warwickshire PFRA 'critical services' (Annex 6 of the PFRA) to ensure consistency, given that the PFRA also informs the Strategy.

The Critical Infrastructure types were categorised based on the vulnerability to flood risk classifications in Table 2 of the National Planning Policy Framework (NPPF) Planning Practice Guidance Flood Risk and Coastal Change Table[5]. Table 5.2 details the NPPF vulnerability classification, and Critical Infrastructure type. Additional utility data was extracted out of the NRD and placed in the 'More' vulnerable category as the confidence with this dataset was low due to the large volume of data and its associated lack of detail which could skew results if placed into the 'Essential' banding.

Discussions were held with the Coventry Solihull Warwickshire Resilience Team (CSWRT) to refine the approach to Critical Infrastructure and the various categories. The SWMP output will also be discussed with CSW Resilience as there are classified sites within Warwickshire that have not been able to be included within the analysis and mapped outputs.

[4] Flood and Coastal Erosion Risk Management: A Manual for Economic Appraisal (Multi-Coloured Manual), Flood Hazard Research Centre, 2013

[5] National Planning Policy Framework, Communities and Local Government, March 2012

**Table 5.2 – Critical Infrastructure**

| Critical Infrastructure Category | Critical Infrastructure Type | |
|---|---|---|
| Essential Infrastructure | Road and rail | Water treatment works |
| Highly Vulnerable | Ambulance station<br>Fire station<br>Police services<br>Police station<br>Hospital / Emergency Responder<br>Pump house<br>Pumping | Sewage pumping<br>Sewage storage<br>Sewage treatment<br>Sludge storage<br>COMAH sites |
| More Vulnerable | Education<br>First school<br>Further education<br>Further education college<br>High school<br>Higher education<br>Infant school<br>Junior school<br>Middle school<br>Nursery<br>Pre-school education<br>Water Regulating<br>Water Distribution | Primary school<br>Private primary school<br>School<br>Secondary school<br>Technical college<br>University<br>Hospital (including A&E)<br>Medical research<br>Children's nursery<br>Medical education<br>Valve House<br>Water Settling |
| Utilities | Chimney<br>Cooling<br>Electricity generating<br>Electricity sub station<br>Gas monitoring<br>Gas regulating<br>Radar<br>Radio communications | Telecommunications<br>Telephone exchange<br>Telephone relaying<br>Television communications<br>Ventilating<br>Water distribution<br>Windmill |

### 4.2.6 Growth and Regeneration Area Datasets

Growth And Regeneration Area (GARA) datasets comprised the sources listed in Table 5.3. During the data gathering exercise it was noted that the various Districts and Boroughs were at different stages of their housing and employment allocation requirements for their Core Strategies, and that the terminology for considered and allocation areas varied. A comprehensive approach was therefore adopted for the SWMP, capturing both allocated sites and those still under consideration and combined into a single receptor dataset.

**Table 5.3 – Growth and Regeneration Area Component Datasets**

| **Growth and Regeneration Area Component Datasets** | |
|---|---|
| **Housing** | **Employment** |
| Strategic Housing Land Availability Assessment (SHLAA) sites | Local Enterprise Partnership (LEP) sites |
| Allocated Housing Sites | Employment Land Review (ELR) sites |
| Reasonable Alternative Housing Sites | Strategic Employment Sites |
| | Allocated Employment Sites |
| | Alternative Employment Sites |

# 5 Phase 2 - SWMP Flood Risk Assessment

## 5.1 Introduction

This Chapter outlines the approach to the risk assessment and describes the datasets that were used.

## 5.2 Definition of Flood Risk

Flood risk is defined in the Flood and Water Management Act (FWMA)[6] (Chapter 3, subsection 1) as "*a risk in respect of an occurrence assessed and expressed (as for insurance and scientific purposes) as a combination of the probability of the occurrence with its potential consequence*".

**Flood Risk = (the probability of a flood) x (scale of the consequences)**

The effects of flooding can range from environmental damage and pollution, disruption to people's lives (such as travel delays), damage to property (such as business premises and homes), and the risk of injury or death. There are a number of factors that can affect the scale and severity of these consequences which include the following.

- Source and type of flooding.
- Depth and velocity of flood water.
- Duration and rate of onset of flooding.
- Presence or absence of debris in the flood water.
- Degree to which people and/or assets are exposed to the flood water.
- Level and amount of warning people receive.
- Behaviour of people during a flood event.
- Extent and vulnerability of the people and properties affected.

The SWMP study had quantified and assessed relevant consequence factors to identify those areas that should be prioritised for further assessment. Important consequences are the depth of flooding (used to understand where flooding may enter a property, and to understand the risk to life), velocity of flooding (used to understand risk to life), extent of flooding (used to understand locations where communities may be cut off and isolated).

## 5.3 Historic Flooding Information

Historic flooding information collated for this commission has been used to prioritise historic flooding locations and identify historic flooding 'hotspots' (defined in Section 5.6). Historic

[6] Flood and Water Management Act 2010

data was scored by adopting a count for each property recorded as having been internally flooded by surface water flooding (as per the definition in section 1.4).

## 5.4 Predictive Flooding Information - Environment Agency Surface Water Flood Maps

The Environment Agency (EA) uFMfSW has been used to as the predictive surface water flooding dataset. Technical details of the uFMfSW and how the maps were produced can be found in the Environment Agency's "What is the updated Flood Map for Surface Water"[7] document. In the context of this SWMP, the 'Medium Risk Probability' data has been used to provide a balanced risk / consequence approach.

**Table 6.1 – Surface Water Flood Risk Probability**

| Surface Water Flood Risk Probability | Rainfall Event | Annual Expected Probability |
|---|---|---|
| Very Low | < 1 in 1000 Year | < 0.1% |
| Low | 1 in 1000 to 1 in 100 | 0.1% to 1% |
| Medium | 1 in 100 to 1 in 30 | 1% to 3.33% |
| High | >1 in 30 year | > 3.33% |

**Note** - the uFMfSW provides outputs that detail the predicted surface water flooding depth and velocity. This is important for this study to enable an assessment of flood hazard.

## 5.5 SWMP Flood Risk Assessment

This chapter describes the approach for the development and application of "metrics" used to quantify surface water flood risk in Warwickshire. Phase 2 of the Defra SWMP process requires the study to rank areas at risk of surface water flooding. The locations at most risk are termed "hotspots" and are potential locations for further detailed assessments, eventually leading to the possible introduction of measures to reduce flood risk. A summary of the process is outlined below in Figures 6.1 and 6.2.

[7] What is the updated Flood Map for Surface Water, 1.0, Environment Agency, November 2103

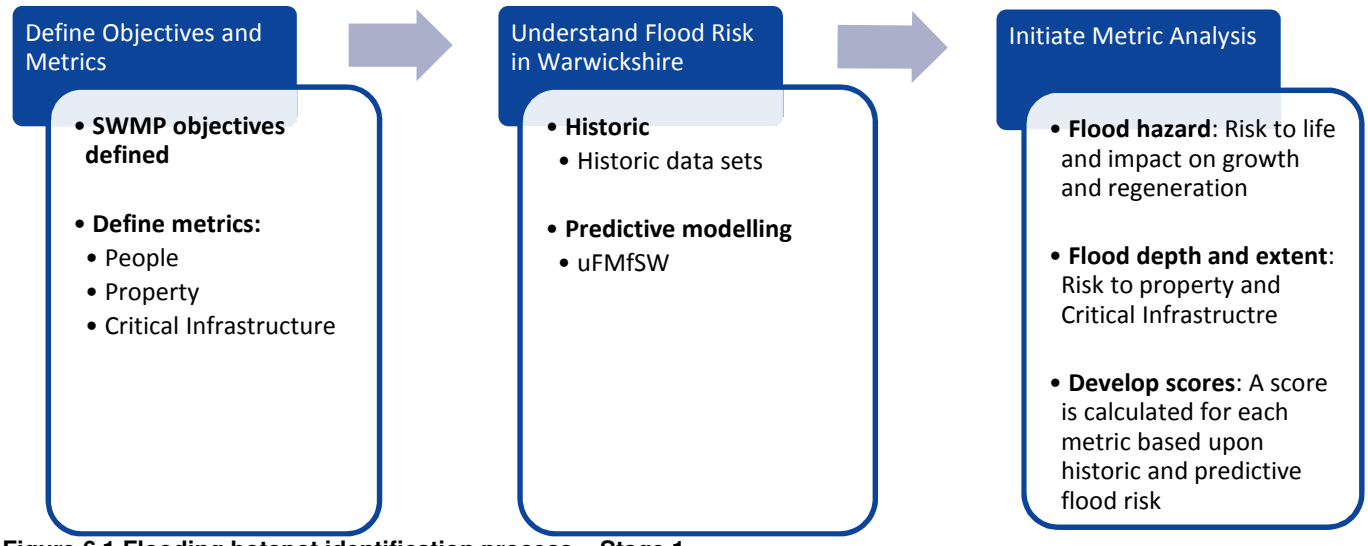



**Figure 6.1 Flooding hotspot identification process – Stage 1**

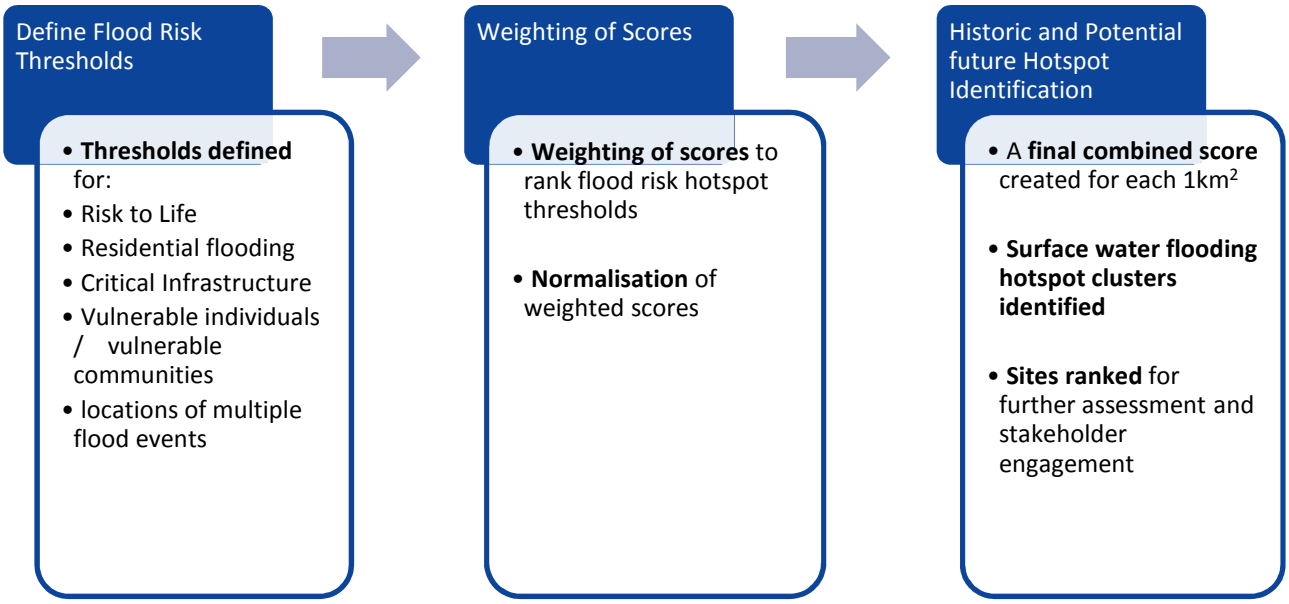



**Figure 6.2 – Flooding hotspot identification process – Stage 2**

### 5.5.1 Metrics

To quantify the surface water flood risk and report against the "technical objectives", a series of flood risk metrics have been developed relating to:

- people;
- properties (residential and non-residential);
- growth and regeneration (GARA); and
- critical infrastructure.

### 5.5.2 Grid Based Assessment

The WCC study area was divided into a grid based upon 1km$^2$ squares. This approach has been developed for the prioritisation of potential future flooding locations to allow risks to individual receptors to be aggregated and ranked. The grid has been orientated based upon the OS National Grid Reference (OS NGR) system, and allows a detailed level of analysis capable of identifying areas of risk at a community level, in a quick and consistent manner. This is comparable with the approach adopted by the EA during the development of the "Flood Risk Areas" in the PFRA.

Following a sensitivity test, a number of 1km$^2$ cells were merged together to reflect a single community and a single source or mechanism of flooding (discussed in greater detail in Section 6.33).

Historic and potential future flooding data was cross-referenced with the 1km$^2$ grid cells and exported to a "project matrix" for scoring, weighting and ranking (discussed in the following sections).

## 5.6 Surface Water Flooding Historic "Hotspot" (High Priority Site) Identification

Through careful consideration and consultation with fellow LLFAs, WCC have developed the following thresholds for prioritisation of historic flooding events. These thresholds follow closely the areas of locally significant flood risk outlined in the WCC Preliminary Flood Risk Assessment (PFRA) of 2011.

1. Flooding that poses a threat to the safety of the public or may directly result in serious injury or death.
2. Five or more residential properties internally flooded.
3. Two or more commercial properties internally flooded.
4. One or more piece of critical infrastructure affected that, impacts on the wider area*.
5. Flooding that places vulnerable individuals or vulnerable communities at risk e.g. hospitals, care and nursing homes, schools, secure units, etc.
6. Additionally, where one or more residential property has flooded internally from the same source on five or more occasions within the last five years.

**Note*: The trigger thresholds for Critical Infrastructure are based upon their vulnerability classification and comprise:

- 1 instance of Essential Critical Infrastructure; or
- 1 instance of Highly Vulnerable Critical Infrastructure; or

- 1 instance of More Vulnerable Critical Infrastructure; or
- 4 Utilities at risk of internal flooding.

### 5.6.1 Surface Water Potential Future Flooding "Hotspot" (High Priority Site) Identification Process

For the potential future flooding hotspots, a matrix has been developed in Excel which cross-references the predictive flood risk information with the receptor information. A series of rules have been developed in partnership with WCC to enable a flood risk / consequence score to be developed for each metric, which when combined and weighted, creates an overall risk-consequence score per 1km$^2$ grid cell which can be ranked to highlight the top priority sites. The rules used within the matrix spreadsheet and individual scoring and weighting approaches have been trialled with WCC during sensitivity testing (see Section 5.9.1), as well as additional testing with project partners at stakeholder workshops.

Additional analysis and scores were developed that, whilst not automatically informing the ranking of sites, provided an additional evidence base to enable informed decisions to be made when quantifying the risk and consequences of locations across Warwickshire. The approach to the scoring, weighting and data thresholds are presented in the sections below.

## 5.7 Potential Future Flooding - Metric Scoring, Weighting and Thresholds

The following sections provide an overview on the analysis that has been used to prioritise potential future flooding locations.

Flood Hazard

It was important for the Warwickshire SWMP to assess hazard and risk to life in both urban and rural locations, given the large number of rural communities and the consequences of flooding in villages and the connecting roads.

Flood hazard has been assessed at each 1km$^2$ grid cell and a score derived as follows.

**Table 6.2 – Flood Hazard Scoring**

| Hazard Score | Score |
|---|---|
| 0-0.75 | 0 |
| 0.75-1.25 | 1.25 |
| 1.25-2 | 1.5 |
| >2 | 1.75 |

| Flooded Area (sq. km) | Score |
|---|---|
| 0-0.1 | 1 |
| 0.1-0.2 | 1.1 |
| 0.2-0.3 | 1.2 |
| 0.3-0.4 | 1.3 |
| 0.4-0.5 | 1.4 |
| >0.5 | 1.5 |

Flood hazard metric scoring example:

- If a 1km2 grid cell has less than 0.1km2 affected by surface water flooding with a hazard rating of 0.75 - 1.25, then it would have a composite score of 1 x 1.25 = 1.25.
- If a 1km2 grid cell has between 0.3 and 0.4km2 affected by surface water flooding and a hazard rating of >2 it would have a composite score of 1.3 x 1.75 = 2.275.

The hazard scores have been used to develop a thematic map that provides a visual representation of risk to life from surface water flooding across Warwickshire (contained in Annex B). The hazard scores are also presented in the matrix as an additional tool to aid comparison between sites (however they do not directly inform the ranking as initial sensitivity testing showed that there was a risk of skewing results to areas with no receptors).

Risk to Residential and Non-Residential Properties

Discussions with WCC highlighted the importance of capturing the risk to non-residential properties in both urban and rural locations. The metric score to quantify the risk and consequences of flooding of properties within each 1km$^2$ grid has therefore been informed by both the number of properties affected by flooding and the flood depth. Where properties are shown to be inside the 1 in 100 year uFMfSW flood extent, flood depths have been analysed. When these depths are above 150mm (the assumed threshold elevation of all properties above the surrounding land), a score will be given to each property within the flood extent based upon the predicted depth of flooding as explained in Table 6.3.

**Table 6.3 – Flood Depth Scoring**

| Scoring for Properties | |
|---|---|
| **Depth (metres)** | **Score** |
| 0 - 0.15 | 0 |
| 0.15 - 0.3 | 1 |
| 0.3 - 0.6 | 1.1 |
| 0.6 - 0.9 | 1.2 |
| 0.9 - 1.2 | 1.3 |
| > 1.2 | 1.4 |

Property flood depth metric scoring example:

- If a property is within the 0.1 - 0.3m depth banding it will receive a score of 1, whilst a property within the greater than 1.2m depth flood zone will receive a score of 1.4. If these are the only two properties affected by flooding within the 1km$^2$ grid cell then the total property score will be 1+1.4 = 2.4.

Sensitivity testing demonstrated that the NRD property node points were often located spatially towards the centre of a property, and there was a risk of instances where a surface water flood extent may be shown to affect a building, but not reach the NRD receptor point. Therefore to reduce the likelihood of properties at risk not been correctly identified in the analysis, each residential NRD property receptor node was buffered by 5m, non-residential by 10m and Critical Infrastructure by 10m.

Critical Infrastructure

Scoring the critical infrastructure metric has a number of components. Firstly, it is informed by the flood extent and flood depth (applying the same 150mm threshold as used for property). Secondly, the vulnerability of the various types of critical infrastructure element is considered (as detailed in Table 5.2). These elements are combined to create a weighted score for each type of critical infrastructure.

Table 6.4 provides a summary of the scoring approach. It should be noted that the different types of critical infrastructure are considered to have varying levels of importance / criticality. As a result, the scoring value for flooding of critical infrastructure varies.

**Table 6.4 – Critical Infrastructure Scoring**

| Category | Unit | Score |
|---|---|---|
| Road and Rail | ** See Notes* | 0 |
| Essential Critical Infrastructure | Per occurrence | 2 |
| Highly Vulnerable Critical Infrastructure | Per occurrence | 1.5 |
| More Vulnerable Critical Infrastructure | Per occurrence | 0.6 |
| Utility ( More Vulnerable) | Per occurrence | 0.1 |

***Notes**:

I. Score has been set to zero as the results were skewed to areas with no receptors, however the functionality has remained as a sensitivity tool to assess risk to areas such as Brailes, Aston Cantlow and Lea Marston where communities can be cut-off due to flood events. The trigger level for the road and rail was set at 1m length to ensure localised flood risk locations are identified.

II. The ‘essential’, ‘high’ and ‘more’ classifications were extracted from the NRD data and based upon the NPPF classifications.

III. The 0.1 score for Utility (such as telephone masts and radio communications) has been established based upon extensive sensitivity testing and ratio weighting against those receptors in the category above (More Vulnerable) such as schools and nurseries. Scores higher than 0.1 skewed results and resulted in erroneous sites ranking in the top 40.

Critical Infrastructure metric scoring example: If a cell contains the following and they are all shown to be at risk of flooding:

- 2 Essential Critical Infrastructure; and
- 2 More Vulnerable Critical Infrastructure.

The following score would be created: 4 (2x2) + 1.2 (2x0.6) = 5.2 whereby:

- 4 (2x2) represents 2 occurrences of Essential Critical Infrastructure multiplied by the associated score of 2; and
- 1.2 (2x0.6) represents 2 occurrences of More Critical Infrastructure multiplied by the associated score of 0.6.

Growth and Regeneration Areas

The Growth and Regeneration Area (GARA) score was based upon the area of GARA within a 1km$^2$ cell shown to be at risk of surface water flooding. Sensitivity testing showed that there was a risk of skewed results, and so an appropriate scaled weighting was applied to ensure results were balanced and matched local WCC knowledge.

### 5.7.1 Normalisation of Scores and Weighting

Following the initial scoring process, all scores were normalised so that each metric has a value between zero and one, whereby zero represented the lowest overall score and one represented the highest score for that particular metric. This was undertaken to convert all the different types of metrics and units into a simple score between zero and one. This allows easier comparison between datasets, and for identification of trends and correlations. Weightings were then applied to each metric to create a total combined score, allowing direct adjustment of the perceived importance of one metric versus another through extensive sensitivity testing.

Note that the score and weighting values outlined in this report and established in the project matrix are able to be edited and refined by the user. Therefore as and when additional datasets become available to WCC, this information can be imported into the project matrix and scores and weightings adjusted based upon data relevance and quality.

The individual normalised scores for each metric were combined and weighted within the matrix to produce a composite score for each 1km$^2$ grid cell. These scores were ranked and used to inform the Matrix and thematic mapping outputs.

## 5.8 Potential Future Flooding “Hotspots” (High Priority Site)

The potential future flooding hotspots have been developed to be consistent with the historic flooding hotspots.

1. Flooding that poses a threat to the safety of the public or may directly result in serious injury or death.

2. Five or more residential properties internally flooded.
3. Two or more commercial properties internally flooded.
4. One or more piece of Critical Infrastructure affected that, impacts on the wider area*.
5. Flooding that places vulnerable individuals or vulnerable communities at risk e.g. hospitals, care and nursing homes, schools, secure units, etc.

***Note**:

I. The trigger thresholds for Critical Infrastructure are based upon their vulnerability classification and comprise:

- 1 instance of Essential Critical Infrastructure; or
- 1 instance of Highly Vulnerable Critical Infrastructure; or
- 1 instance of More Vulnerable Critical Infrastructure; or
- 4 Utilities at risk of internal flooding.

## 5.9 Matrix Outputs

The final scores from the analysis (termed 'matrix scores') were presented in a ranked top 40 list. By incorporating both the historic flood risk information and predicative future flood risk information, the following rankings have been developed to inform the prioritisation of sites for further investigation.

- Historic flooding.
- Potential future flooding.
- Combined (Historic and Potential).

The selection of 40 sites was chosen as a method to capture a wide range of sites, with varying flood risk issues and consequences and to provide a wide focus group to identify schemes for further analysis and locations where stakeholder partnership schemes may be appropriate (as discussed in Chapter 7).

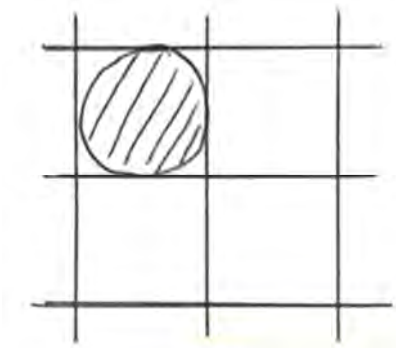
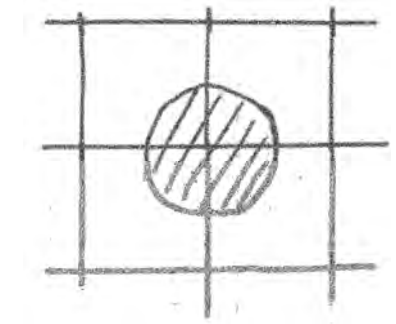
### 5.9.1 Matrix Sensitivity Analysis

A number of sensitivity tests were undertaken to fine-tune the trigger levels, scoring and weighting and also to assess the effectiveness of the choice of a 1km$^2$ grid as the basis for the analysis.

The sensitivity tests consisted of adjusting the scoring and weighting parameters and re-running the matrix analysis to assess the resultant changes to the top 40 ranked sites. Observations were made to the changes of the ranked positions of future hotspots, and the reasons for the changes. Through an iterative process and applying local WCC flood risk knowledge, the scorings and weightings were judged to be appropriate.

An additional sensitivity analysis was undertaken on the spatial positioning for the 1km$^2$ grid. The datum was shifted by 500m horizontally and vertically to provide two sensitivity scenarios, as it is recognised that a flood risk location could be located entirely within a 1km$^2$ grid cell or could be divided across a number of grid cells – depending upon the datum origin, as highlighted in Table 6.5.

**Table 6.5 – 1km$^2$ Grid Cell Datum Sensitivity Example**

| Grid Location Example | Flood Risk Location | Notes |
|---|---|---|
| 1 |  | In this scenario, a theoretical flood risk-consequence issue is shown to be within a single 1km$^2$ grid cell.<br><br>This could result in a high score for this cell. |
| 2 |  | In this scenario, a theoretical flood risk-consequence issue is shown to be divided across four 1km$^2$ grid cells.<br><br>This could result in a low score in each cell that does not reach minimum trigger levels. |

The results showed that whilst there were no significant changes to the ranking of sites, it highlighted the importance of developing 'flood risk clusters' (an approach identified at the project inception). Historic flood risk knowledge was used by WCC to develop a series flood risk clusters – by amalgamating 1km$^2$ cells where areas were at risk from common sources of flooding. This approach ensured that if flood risk and receptors were divided across 1km$^2$ grid cells, they would still be accounted for in the matrix analysis and reach the required minimum threshold levels for inclusion.

The quality of the previous FMfSW was generally regarded to be good by WCC and other RMAs in Warwickshire. To check that the updated version was suitable for use in this SWMP, an additional sensitivity test was also undertaken to compare the latest EA surface water flood modelling output (uFMfSW) against the previous generation FMfSW dataset. The result of this showed that whilst there were a number of locations where the flood extents were similar, the uFMfSW mapping provided a better match to areas of known historic surface water flood risk; this was confirmed for use in this analysis.

### 5.9.2 Post Scheme Matrix Updates

During discussions with WCC an additional requirement of the matrix was identified, which required the ability to amend the number of properties at risk following completion of WCC (or stakeholder) flood alleviation projects. Additional data columns were added to the matrix to enable an 'areas benefiting from defences / schemes' score to be calculated. This allows WCC to capture the benefits of flood alleviation schemes without overriding the original dataset (as there may be instances where risk has been lowered but not completely mitigated and so it is important to understand the residual risk if schemes were to fail).

## 5.10 Stakeholder Workshop Sensitivity Analysis

Stakeholder workshops were held on the 27th November 2014 with representatives from the Districts and Boroughs, in addition to STW and the EA. The purpose of the workshops was to present a summary of the work undertaken to date, the assumptions made, and the initial results. It was agreed with WCC that feedback on the initial top 20 hotspots (a value chosen to make the process manageable) would be important to assess the performance of the initial scoring and weighting parameters.

During the meeting, the project team discussed how well the analysis was matching areas of known surface water flood risk, and how the ranking reflected the RMAs perception of which areas were at greater risk / had greater consequences. Live trialling of scoring and weighting combinations was undertaken by the team, and the results re-ranked to assess the impact of such changes.

It was observed during the workshop that greater weight needed to be given to the historic flooding locations to avoid skewing the results too far towards national scale modelling in the updated Flood Map for Surface Water.

It was agreed that a more robust method for prioritising historic flooding locations should be utilised in the final analysis, resulting in a flooding hotspot threshold criteria being developed (as outlined in Section 5.6 of this document).

AECOM, in consultation with WCC, combined the stakeholder feedback and results of the live trials with the public consultation feedback and finalised the matrix approach to produce the improved list of the top ranking hotspots presented in Chapter 7 of this report.

# 6 Results Summary

## 6.1 Introduction

This Chapter provides a summary of the results from the SWMP analysis.

## 6.2 Matrix Outputs

Ranked Table

The matrix has been developed to enable both historic and potential future flooding hotspot reporting. For this overall summary, a combined approach has been undertaken (combining both the historic and potential future flooding scores) for each OS tile or combination of OS tiles to provide a top 40 ranking. Note that large locations such as Leamington Spa will have a number of OS tiles at risk of surface water flooding from different sources - these are therefore ranked separately as different flooding locations. Large towns could therefore be named in the list more than once, but it is the specific area or community within the town which is being ranked.

The highest ranked locations will not necessarily have funded flood alleviation schemes. This stage of the SWMP is the risk assessment. The viability of flood alleviation schemes depends not only on the risk, but also on the nature of the flood risk and financial viability of a scheme relative to other areas in England and Wales (since it is necessary to compete with other locations to bid for funding from the national 'pot' of Flood Defence Grant in Aid available).

Outputs from the matrix include the ranked results table and thematic maps displaying a spatial representation of results to allow WCC and the users to readily identify the areas with the greatest risk and consequences to:

- people;
- property (residential and commercial); and
- critical infrastructure.

Table 7.1 provides the top 40 surface water flood risk sites from the SWMP matrix analysis.

Note that the current top 40 ranking shown below in Table 7.1 is subject to further change following review of classified strategic sites of national importance and feedback from the final consultation phase.

The following examples provide a demonstration of how the table should be interpreted.

Firstly, a location may be ranked highly due to a single severe flood risk and consequence score – such as at Snitterfield which is ranked position 1. The SWMP objective normalised scores show that this location has an important historical flood risk score (the highest from the analysis). Alternatively, Kenilworth (ranked 3rd) does not feature significantly high

individual objective scores; however, it is ranked highly in the overall matrix due to the combined risk and consequence scores for a range of SWMP objectives.

**Table 7.1 – WCC SWMP Matrix Outputs: Top 40 Combined (Historic and Predictive) Flood Risk Sites**

**Dark Red shaded OS Tile names indicate where location has met the SWMP historic Hotspot Threshold for historic flood risk. Tile location can be identified using the OS Tile Finder[8]*

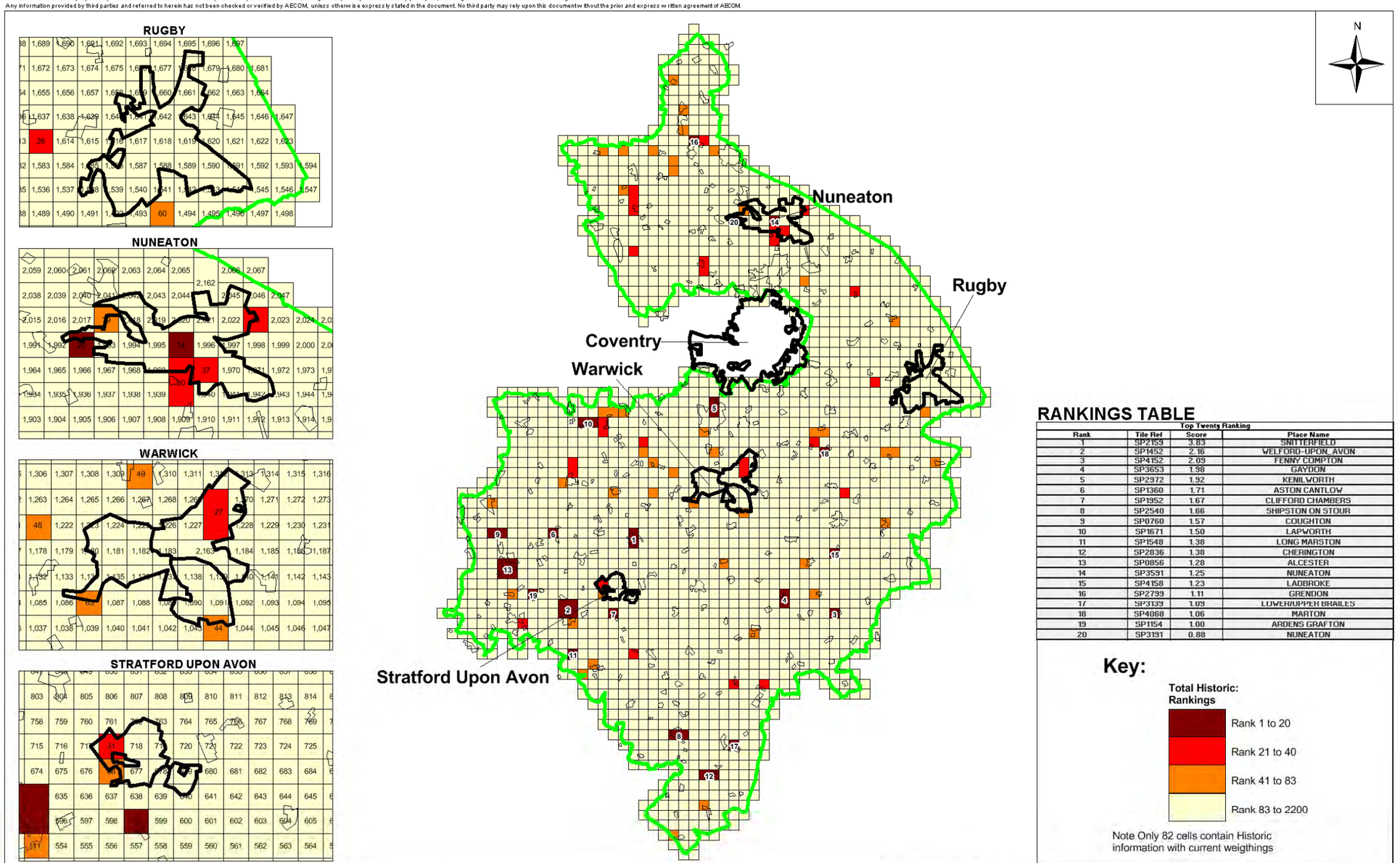
| Matrix Ranking | | | | |
|---|---|---|---|---|
| **Rank** | ***OS Tile Ref** | **Matrix Score** | **Place Name** | **Nature of Flood Risk** |
| 1 | SP2159 | 21.16 | SNITTERFIELD | Risk to Life, Main River, Ordinary Watercourse, Surface Water |
| 2 | SP2540 | 14.73 | SHIPSTON ON STOUR | Main River, Surface Water, town centre |
| 3 | SP2972 | 14.46 | KENILWORTH | Main River, Surface Water, area of Northvale Close |
| 4 | SP4152 | 12.60 | FENNY COMPTON | Ordinary Watercourse, Surface Water |
| 5 | SP1452 | 12.23 | WELFORD-UPON-AVON | Main River, Ordinary Watercourse, Surface Water, multiple locations |
| 6 | SP3653 | 11.57 | GAYDON | Ordinary Watercourse, Surface Water, village centre |
| 7 | SP3486 | 10.00 | BEDWORTH | Main River area of Delamere Road (addressed by EA scheme), Surface Water Risk |
| 8 | SP1952 | 9.63 | CLIFFORD CHAMBERS | Main River, Ordinary Watercourse, Surface Water |
| 9 | SP3266 | 9.49 | ROYAL LEAMINGTON SPA | Ordinary Watercourse, Surface Water, Foul Sewer, area of Gresham Avenue |
| 10 | SP3591 | 9.38 | NUNEATON | Ordinary Watercourse, Surface Water, Sewer Capacity, area of Queens Road |
| 11 | SP2866 | 9.25 | WARWICK | Surface Water, area of Woodloes Estate |
| 12 | SP1360 | 9.16 | ASTON CANTLOW | Main River, Ordinary Watercourse, Surface Water |
| 13 | SP0856 | 9.03 | ALCESTER | Main River, Surface Water |
| 14 | SP0760 | 8.83 | COUGHTON | Surface Water |
| 15 | SP1566 | 8.39 | HENLEY IN ARDEN | Main River, Surface Water |
| 16 | SP2799 | 7.88 | GRENDON | Ordinary Watercourse, Surface Water, Sewer Flooding, various locations |
| 17 | SP1671 | 7.83 | LAPWORTH | Ordinary Watercourse, Surface Water, multiple locations |
| 18 | SP2836 | 7.70 | CHERINGTON | Ordinary Watercourse, Surface Water, village centre |
| 19 | SP1548 | 7.55 | LONG MARSTON | Ordinary Watercourse, Surface Water, area of Welford Road |
| 20 | SP3139 | 7.07 | LOWER/UPPER BRAILES | Ordinary Watercourse, Surface Water, area of Orchard Close |
| 21 | SP3165 | 6.97 | ROYAL LEAMINGTON SPA | Main River, Ordinary Watercourse, Surface Water, town centre |
| 22 | SP4158 | 6.93 | LADBROKE | Ordinary Watercourse, Surface Water, village centre |
| 23 | SP1955 | 6.66 | STRATFORD-UPON-AVON | Ordinary Watercourse, Surface Water, area of Western Road |
| 24 | SP3691 | 5.99 | NUNEATON CENTRE | Main River, Ordinary Watercourse, Surface Water, Sewer Flooding |
| 25 | SP2765 | 5.63 | WARWICK | Main River, Ordinary Watercourse, Surface Water, area of Race Course Brook |
| 26 | SP4068 | 5.63 | MARTON | Main River, Surface Water |
| 27 | SP3191 | 5.37 | GALLEY COMMON | Ordinary Watercourse, Surface Water |

[8] http://www.ordnancesurvey.co.uk/business-and-government/help-and-support/products/tile-selector.html

| Matrix Ranking | | | | |
|---|---|---|---|---|
| **Rank** | ***OS Tile Ref** | **Matrix Score** | **Place Name** | **Nature of Flood Risk** |
| 28 | SP2886 | 5.30 | FILLONGLEY | Ordinary Watercourse, Surface Water, Foul Sewer |
| 29 | SP1154 | 5.28 | ARDENS GRAFTON | Risk to Life, Ordinary Watercourse, Surface Water, area of Little Britain |
| 30 | SP4264 | 4.91 | LONG ITCHINGTON | Risk to Life, Ordinary Watercourse, Surface Water, area of Stockton Road |
| 31 | SP3589 | 4.75 | BERMUDA | Surface Water |
| 32 | SP1855 | 4.33 | STRATFORD-UPON-AVON | Ordinary Watercourse, Surface Water, area of Drayton Avenue |
| 33 | SP2192 | 4.29 | WHITACRE HEATH | Main River, Surface Water, Sewer Flooding |
| 34 | SP1870 | 4.24 | KINGSWOOD | Surface Water, multiple locations |
| 35 | SP2899 | 4.23 | GRENDON | Surface water, proposed growth and regeneration area |
| 36 | SP3264 | 4.17 | ROYAL LEAMINGTON SPA | Ordinary Watercourse, Surface Water, centred on Whitnash |
| 37 | SP3969 | 4.15 | EATHORPE | Risk to Life, Main River, Ordinary Watercourse, Surface Water |
| 38 | SP4575 | 3.93 | LAWFORD HEATH | Risk to Life, Ordinary Watercourse, Surface Water |
| 39 | SP2269 | 3.91 | FIVE WAYS | Ordinary Watercourse, Surface Water |
| 40 | SP3445 | 3.79 | LOWER/MIDDLE/UPPER TYSOE | Ordinary Watercourse, Surface Water |

## Thematic Maps

A set of thematic maps have also been produced to complement the matrix ranked table outputs, shown in Figures 7.1 – 7.5. These are also included in Annex B of the PDF version of this report at a larger scale. The thematic maps provide a visual representation of the spatial distribution of the top 40 ranked sites. Note that a Hazard risk thematic map has also been included to provide a visual representation of the risk to life across the study area to inform wider decision making.




## RANKINGS TABLE

| Top Twenty Ranking | | | |
|---|---|---|---|
| Rank | Tile Ref | Score | Place Name |
| 1 | SP2153 | 3.83 | SNITTERFIELD |
| 2 | SP1452 | 2.16 | WELFORD-UPON_AVON |
| 3 | SP4152 | 2.09 | FENNY COMPTON |
| 4 | SP3653 | 1.98 | GAYDON |
| 5 | SP2372 | 1.92 | KENILWORTH |
| 6 | SP1360 | 1.71 | ASTON CANTLOW |
| 7 | SP1952 | 1.67 | CLIFFORD CHAMBERS |
| 8 | SP2540 | 1.66 | SHIPSTON ON STOUR |
| 9 | SP0760 | 1.57 | COUGHTON |
| 10 | SP1671 | 1.50 | LAPWORTH |
| 11 | SP1548 | 1.38 | LONG MARSTON |
| 12 | SP2836 | 1.38 | CHERINGTON |
| 13 | SP0856 | 1.28 | ALCESTER |
| 14 | SP3591 | 1.25 | NUNEATON |
| 15 | SP4158 | 1.23 | LADBROKE |
| 16 | SP2799 | 1.11 | GRENDON |
| 17 | SP3139 | 1.09 | LOWER/UPPER BRAILES |
| 18 | SP4068 | 1.06 | MARTON |
| 19 | SP1154 | 1.00 | ARDENS GRAFTON |
| 20 | SP3191 | 0.88 | NUNEATON |

**Key:**

**Total Historic: Rankings**

- Rank 1 to 20
- Rank 21 to 40
- Rank 41 to 83
- Rank 83 to 2200

Note Only 82 cells contain Historic information with current weigthings

Client: Warwickshire County Council

Project: SURFACE WATER MANAGEMENT PLAN

Title: TOTAL HISTORIC SCORE 1 IN 100 YEAR EXTENT RANKINGS

AECOM
5th Floor, 2 City Walk, LEEDS, LS11 9AR
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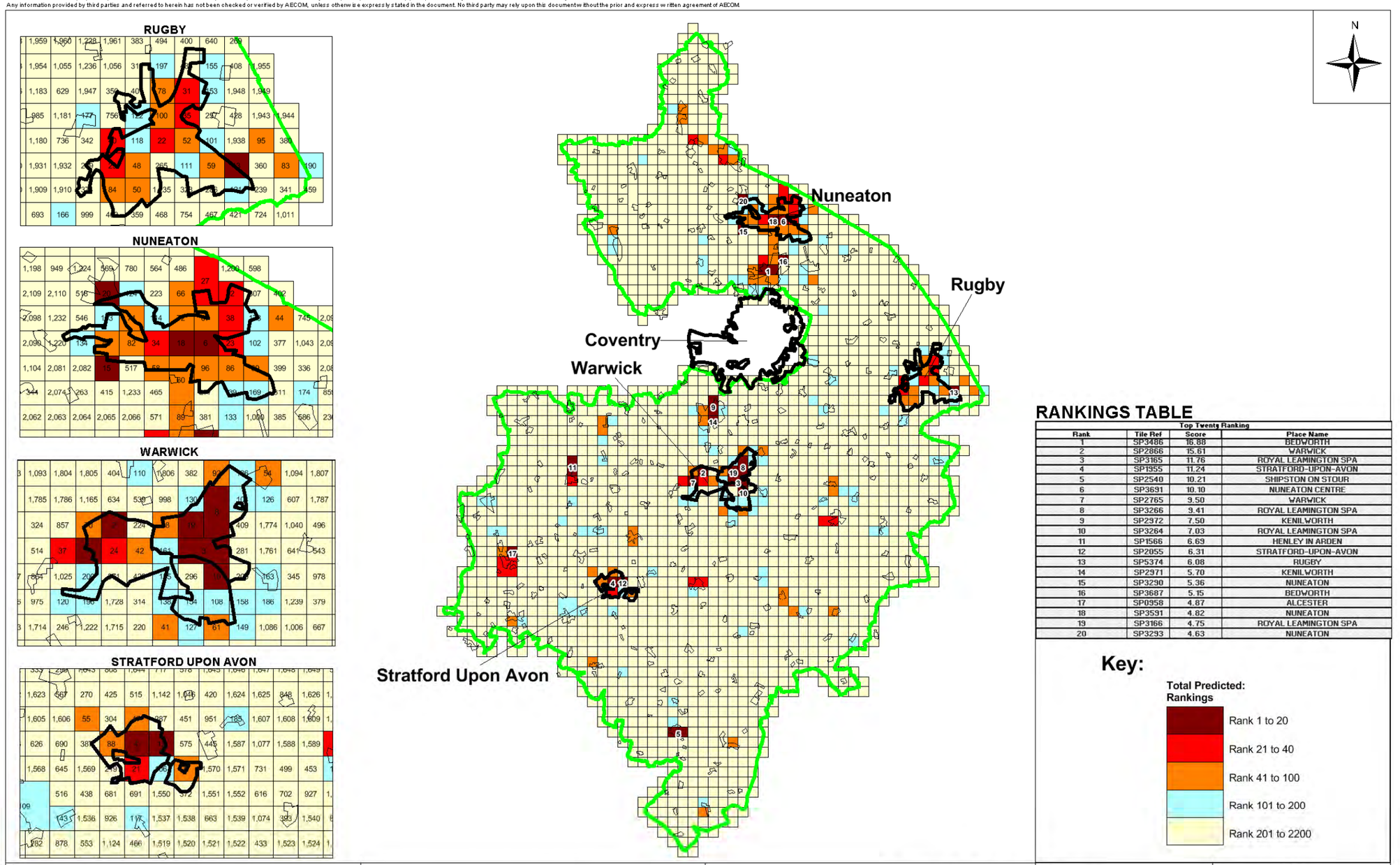
www.aecom.com

| | | | |
|---|---|---|---|
| Design: | - | Drawn: | RB |
| Chk'd: | AP | App'd: | JP |
| Date: | 25/08/2015 | Scale at A3: | 1:350,000 @ A3 |
| Drawing Number: | 60319308_9_v2 | | A3 |

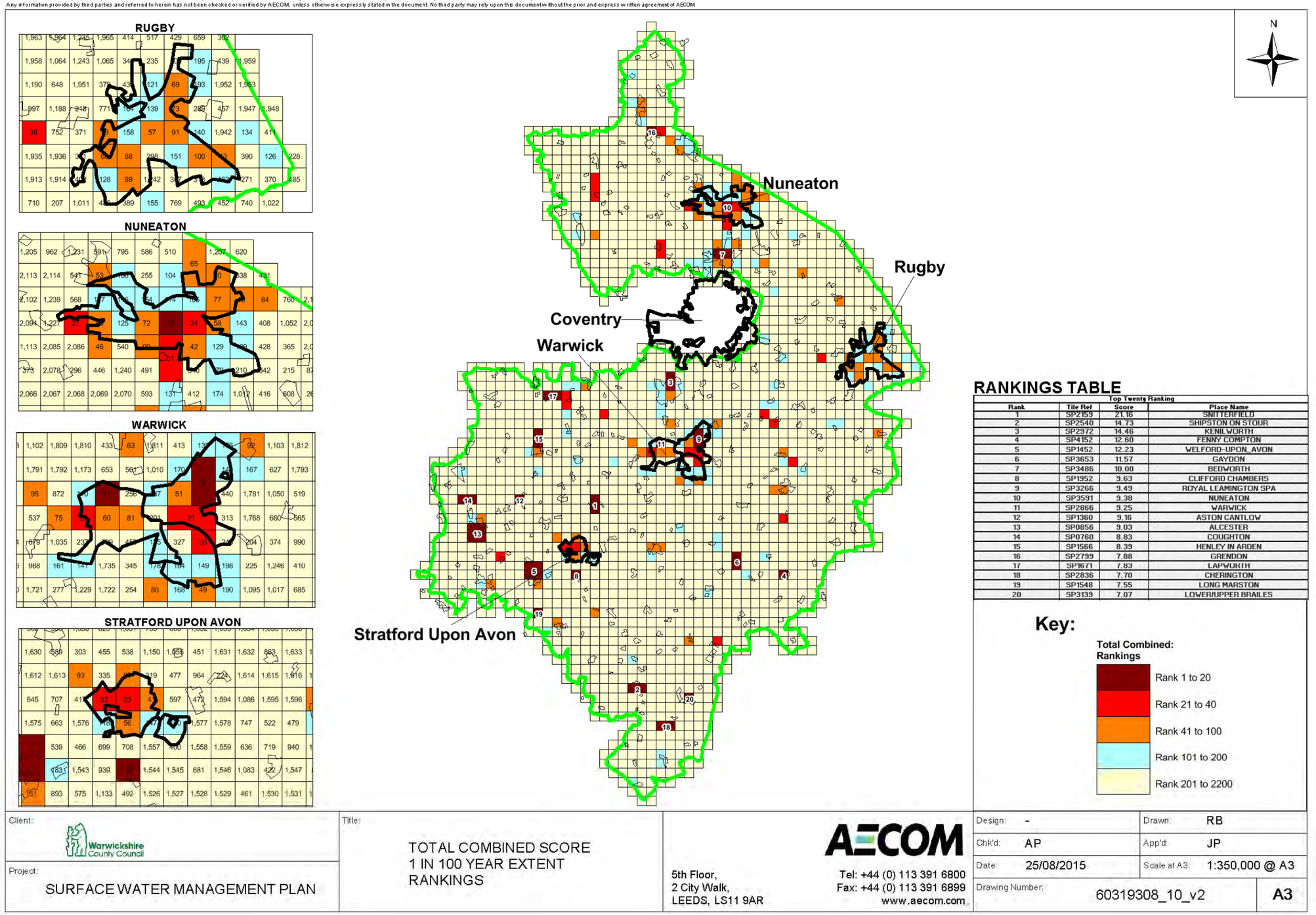
**Figure 7.1 – Total Historic Surface Water Risk Score**




## RANKINGS TABLE

| Top Twenty Ranking | | | |
|---|---|---|---|
| Rank | Tile Ref | Score | Place Name |
| 1 | SP3486 | 16.88 | BEDWORTH |
| 2 | SP2866 | 15.61 | WARWICK |
| 3 | SP3165 | 11.76 | ROYAL LEAMINGTON SPA |
| 4 | SP1955 | 11.24 | STRATFORD-UPON-AVON |
| 5 | SP2540 | 10.21 | SHIPSTON ON STOUR |
| 6 | SP3691 | 10.10 | NUNEATON CENTRE |
| 7 | SP2765 | 9.50 | WARWICK |
| 8 | SP3266 | 9.41 | ROYAL LEAMINGTON SPA |
| 9 | SP2372 | 7.50 | KENILWORTH |
| 10 | SP3264 | 7.03 | ROYAL LEAMINGTON SPA |
| 11 | SP1566 | 6.69 | HENLEY IN ARDEN |
| 12 | SP2055 | 6.31 | STRATFORD-UPON-AVON |
| 13 | SP5374 | 6.08 | RUGBY |
| 14 | SP2971 | 5.70 | KENILWORTH |
| 15 | SP3290 | 5.36 | NUNEATON |
| 16 | SP3687 | 5.15 | BEDWORTH |
| 17 | SP0958 | 4.87 | ALCESTER |
| 18 | SP3591 | 4.82 | NUNEATON |
| 19 | SP3166 | 4.75 | ROYAL LEAMINGTON SPA |
| 20 | SP3293 | 4.63 | NUNEATON |

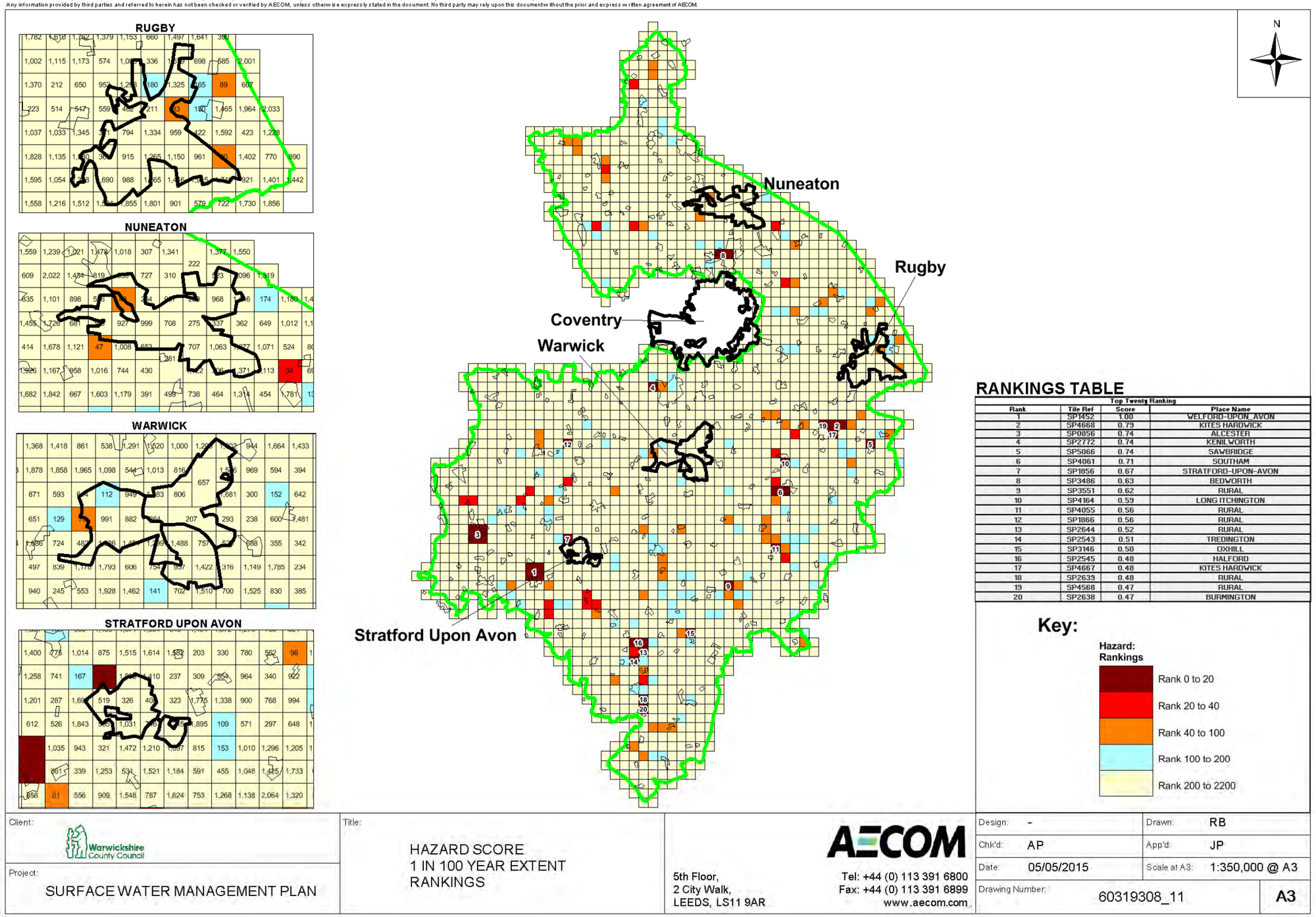
**Figure 7.2 – Total Predictive Surface Water Risk Score**




## RANKINGS TABLE

| Top Twenty Ranking | | | |
|---|---|---|---|
| Rank | Tile Ref | Score | Place Name |
| 1 | SP2153 | 21.16 | SNITTERFIELD |
| 2 | SP2540 | 14.73 | SHIPSTON ON STOUR |
| 3 | SP2972 | 14.46 | KENILWORTH |
| 4 | SP4152 | 12.60 | FENNY COMPTON |
| 5 | SP1452 | 12.23 | WELFORD-UPON_AVON |
| 6 | SP3653 | 11.57 | GAYDON |
| 7 | SP3486 | 10.00 | BEDWORTH |
| 8 | SP1952 | 9.63 | CLIFFORD CHAMBERS |
| 9 | SP3266 | 9.49 | ROYAL LEAMINGTON SPA |
| 10 | SP3591 | 9.38 | NUNEATON |
| 11 | SP2866 | 9.25 | WARWICK |
| 12 | SP1360 | 9.16 | ASTON CANTLOW |
| 13 | SP0856 | 9.03 | ALCESTER |
| 14 | SP0760 | 8.83 | COUGHTON |
| 15 | SP1566 | 8.39 | HENLEY IN ARDEN |
| 16 | SP2799 | 7.88 | GRENDON |
| 17 | SP1671 | 7.83 | LAPWORTH |
| 18 | SP2836 | 7.70 | CHERINGTON |
| 19 | SP1548 | 7.55 | LONG MARSTON |
| 20 | SP3139 | 7.07 | LOWER/UPPER BRAILES |

**Figure 7.3 – Total Combined Surface Water Risk Score**




## RANKINGS TABLE

| Top Twenty Ranking | | | |
|---|---|---|---|
| Rank | Tile Ref | Score | Place Name |
| 1 | SP1452 | 1.00 | WELFORD-UPON-AVON |
| 2 | SP4658 | 0.73 | KITES HARDWICK |
| 3 | SP0856 | 0.74 | ALCESTER |
| 4 | SP2772 | 0.74 | KENILWORTH |
| 5 | SP5066 | 0.74 | SAWBRIDGE |
| 6 | SP4061 | 0.71 | SOUTHAM |
| 7 | SP1856 | 0.67 | STRATFORD-UPON-AVON |
| 8 | SP3486 | 0.63 | BEDWORTH |
| 9 | SP3551 | 0.62 | RURAL |
| 10 | SP4164 | 0.59 | LONG ITCHINGTON |
| 11 | SP4055 | 0.56 | RURAL |
| 12 | SP1866 | 0.56 | RURAL |
| 13 | SP2644 | 0.52 | RURAL |
| 14 | SP2543 | 0.51 | TREDINGTON |
| 15 | SP3146 | 0.50 | OXHILL |
| 16 | SP2545 | 0.48 | HALFORD |
| 17 | SP4667 | 0.48 | KITES HARDWICK |
| 18 | SP2639 | 0.48 | RURAL |
| 19 | SP4568 | 0.47 | RURAL |
| 20 | SP2638 | 0.47 | BURMINGTON |

**Key:**

Hazard: Rankings

- Rank 0 to 20
- Rank 20 to 40
- Rank 40 to 100
- Rank 100 to 200
- Rank 200 to 2200

| | |
|---|---|
| Client: Warwickshire County Council | Title: HAZARD SCORE 1 IN 100 YEAR EXTENT RANKINGS |
| Project: SURFACE WATER MANAGEMENT PLAN | AECOM 5th Floor, 2 City Walk, LEEDS, LS11 9AR Tel: +44 (0) 113 391 6800 Fax: +44 (0) 113 391 6899 www.aecom.com |

| | | | |
|---|---|---|---|
| Design: - | | Drawn: RB | |
| Chk'd: AP | | App'd: JP | |
| Date: 05/05/2015 | | Scale at A3: 1:350,000 @ A3 | |
| Drawing Number: 60319308_11 | | | A3 |

**Figure 7.4 – Hazard (Risk to Life) Surface Water Risk**

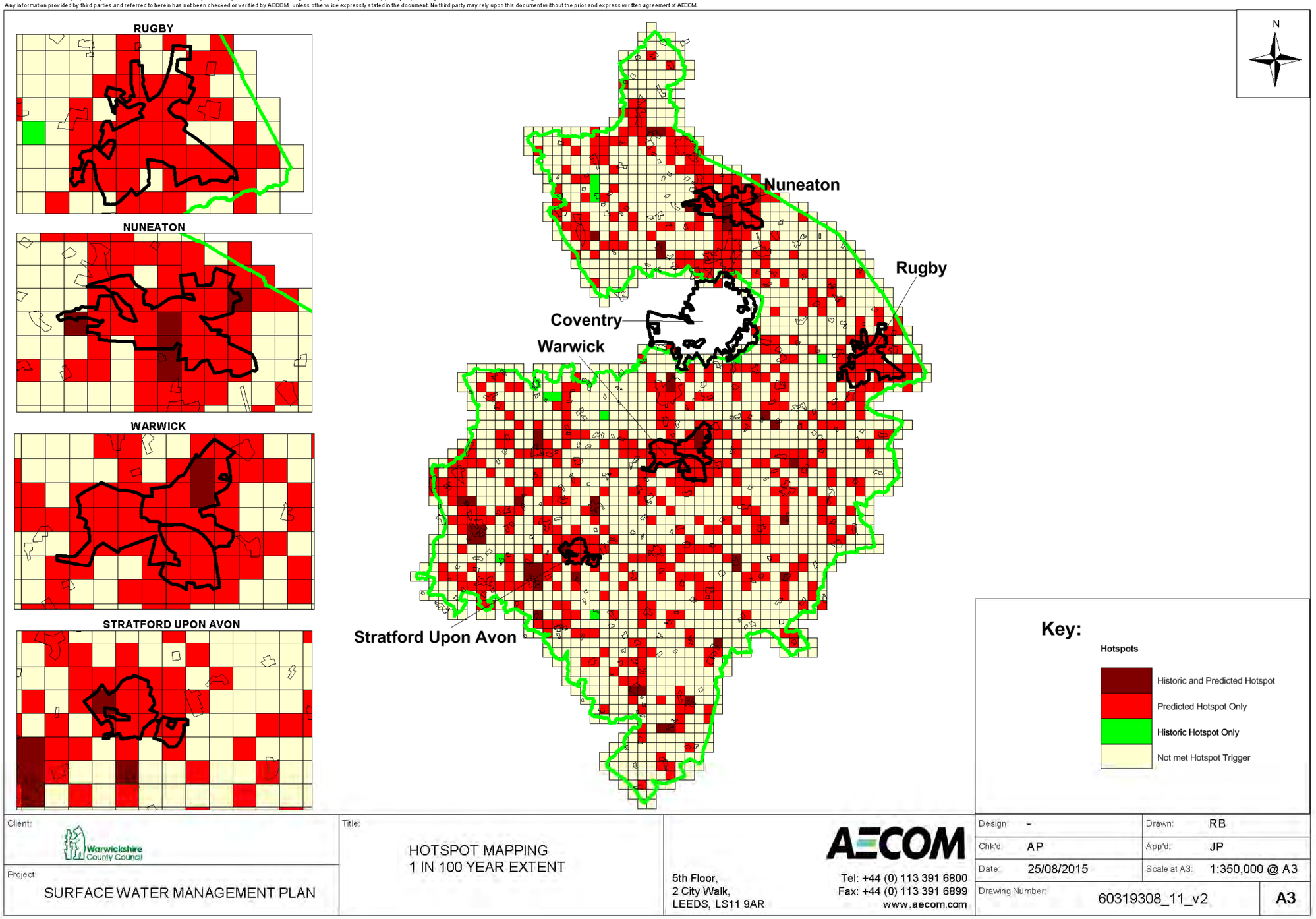



**Figure 7.5 – Historic and Predictive Flood Risk Hotspots**

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## 6.3 SWMP Strategic Flood Maps

In addition to the matrix ranked outputs and GIS Strategic Flood Maps, the digital and hard copy data that was collated and used in this commission was uploaded into a GIS workspace, and integrated PDF and project matrix. The GIS workspace and interactive PDF has been termed the SWMP Strategic Flood Maps. These allow WCC and other RMAs to visualise all of the historic flood risk information collated for this study, predictive flood risk and receptors. The GIS workspace, and project matrix is designed to be a living database and should be regularly updated with new information to capture future flooding incidents, updated predictive mapping and details of flood risk management schemes. The Strategic Flood Maps will be of particular importance when reviewing the top 40 ranked list during the subsequent stages of the SWMP process to ensure that the cells adjacent to those that rank highly are considered and the wider consequences and benefits taken into account if necessary.

Whilst the main objectives from the SWMP study are to identify the most significant surface water flooding hotspot areas, and to develop action plans and investment strategies, the SWMP Strategic Flood Maps are a useful tool for WCC and other RMAs by providing an evidence base for a wide range of planning documents and decision making processes (examples listed below):

Local Flood Risk Management Strategy

The outputs from the SWMP process will be used as the risk assessment part of the Local Flood Risk Management Strategy (LFRMS) for Warwickshire. Whilst this SWMP has developed a priority list of key surface water flood risk hotspots, there remain many locations across Warwickshire with significant risk and consequences that are outside of this list for initial further consideration at this stage. The SMWP therefore needs to remain a living Appendix of the Strategy and be updated with new datasets and flood history information.

Land Use Planning

The SWMP Strategic Flood Maps will indicate areas where a more detailed study of surface water flooding may be required. Flooding hotspots may indicate areas with drainage problems known as Critical Drainage Areas (CDAs). WCC can therefore use the SWMP information to develop surface water control policies that both steer development away from at risk areas, and reduce risk through the requirement of SuDS and other sustainable designs measures. Annex C provides a summary of potential SuDS techniques that may be appropriate.

Flood Risk Assessments

Whilst the SWMP Strategic Flood Maps are not suitable to inform site specific development related flood risk assessments, they will provide WCC and developers with a useful tool to assess if they need to seek further advice and technical support on surface water flooding when preparing a Flood Risk Assessment to support a planning application (where a proposed site is shown to be within an area subject to problematic surface water flooding).

Emergency Planning and Resilience

The SWMP Strategic Flood Maps are a useful tool to inform emergency planning and resilience. The development of the SWMP was undertaken in parallel with the Community Flood Resilience

Pathfinder project. A key message to communities in Warwickshire delivered as part of the Pathfinder workshops was that flood preparedness and resilience is a crucial first step in coping with a flood event. The SWMP Strategic Flood Maps will allow parishes and local flood action groups to further develop their understanding of local flood risk issues and provide information for community flood risk summary sheets and flood plans.

At a higher level, the SWMP Strategic Flood Maps can be used by emergency responders and resilience teams (such as CSW Resilience) to:

- raise general awareness of surface water flood risk;
- understand where suitable / unsuitable locations are for emergency control centres, evacuation centres and safe evacuation routes;
- understand the potential flood threat to critical infrastructure and to take action to identify the consequence of failure of key sites; and
- Identify the locations of vulnerable sites and groups of vulnerable people such as schools and care homes.

# 7 Next Steps for the SWMP

## 7.1 Public Consultation and Finalisation of the Priority List

This SWMP Methodology Report was issued for public consultation between January and March 2015 as an Appendix of the Local Flood Risk Management Strategy. Following the consultation, feedback and comments were reviewed and actioned where appropriate to refine the methodology and technical approach. After which, the ranking of sites has been undertaken and discussed with project partners. From this short list, a priority list has been developed of sites at risk of flooding from surface water. This is now going out for further public consultation in September 2015. Once the Strategy has been adopted by the County Council, this list will used to develop measures and actions in each of the areas at risk of flooding in the next stage of the SWMP and an investment plan will be developed.

## 7.2 Identification of Partnership Opportunities

During the development of the investment plan, further engagement with other RMAs and stakeholders will take place to identify opportunities for potential partnership schemes and joint funding applications.

Environment Agency

The top ranked surface water flooding hotspots list has been cross referenced with the Environment Agency supplied data including the Main River flood risk GIS data and information from the "Communities at Risk"[9] dataset. A visual comparison of the Communities at Risk dataset has been undertaken against the top 40 location areas. Table 8.1 provides a summary of where there are correlations between the Communities at risk dataset and the top 40 locations. Note that the Communities at Risk dataset was developed as a desktop exercise at a regional level, whereas more detail relevant to Warwickshire and using local historic knowledge has contributed to the Warwickshire SWMP.

It is planned that this table (and supporting SWMP GIS outputs) are used to inform future discussions with the Environment Agency to discuss these locations and to cross reference with current and short, medium and long term action plans and investment strategies.

**Table 8.1 – WCC SWMP Top 40 Sites and Environment Agency Communities at Risk Comparison**

| SWMP Top 40 Sites Rank | Place Name | Environment Agency Communities at Risk Data | |
|---|---|---|---|
| | | Correlation with Possible Fluvial Risk | Correlation with Possible Surface Water Risk |
| 1 | SNITTERFIELD | ✓ | ✓ |
| 2 | SHIPSTON ON STOUR | ✓ | ✓ |
| 3 | KENILWORTH | ✓ | ✓ |

[9] Midlands Communities at Risk 2013, Environment Agency Midlands, (April 2014)

| SWMP Top 40 Sites Rank | Place Name | Environment Agency Communities at Risk Data | |
|---|---|---|---|
| | | Correlation with Possible Fluvial Risk | Correlation with Possible Surface Water Risk |
| 4 | FENNY COMPTON | × | ✓ |
| 5 | WELFORD-UPON-AVON | ✓ | ✓ |
| 6 | GAYDON | × | ✓ |
| 7 | BEDWORTH | ✓ | ✓ |
| 8 | CLIFFORD CHAMBERS | ✓ | ✓ |
| 9 | ROYAL LEAMINGTON SPA | ✓ | ✓ |
| 10 | NUNEATON | ✓ | ✓ |
| 11 | WARWICK | ✓ | ✓ |
| 12 | ASTON CANTLOW | ✓ | ✓ |
| 13 | ALCESTER | ✓ | ✓ |
| 14 | COUGHTON | ✓ | ✓ |
| 15 | HENLEY IN ARDEN | ✓ | ✓ |
| 16 | GRENDON | × | ✓ |
| 17 | LAPWORTH | × | ✓ |
| 18 | CHERINGTON | ✓ | ✓ |
| 19 | LONG MARSTON | × | ✓ |
| 20 | LOWER/UPPER BRAILES | ✓ | ✓ |
| 21 | ROYAL LEAMINGTON SPA | ✓ | ✓ |
| 22 | LADBROKE | ✓ | ✓ |
| 23 | STRATFORD-UPON-AVON | ✓ | ✓ |
| 24 | NUNEATON CENTRE | ✓ | ✓ |
| 25 | WARWICK | ✓ | ✓ |
| 26 | MARTON | ✓ | ✓ |
| 27 | GALLEY COMMON | ✓ | ✓ |
| 28 | FILLONGLEY | × | ✓ |
| 29 | ARDENS GRAFTON | × | ✓ |
| 30 | STOCKTON | ✓ | ✓ |
| 31 | BERMUDA | ✓ | ✓ |
| 32 | STRATFORD-UPON-AVON | ✓ | ✓ |
| 33 | WHITACRE HEATH | ✓ | ✓ |
| 34 | KINGSWOOD | × | ✓ |
| 35 | GRENDON | × | ✓ |
| 36 | ROYAL LEAMINGTON SPA | ✓ | ✓ |
| 37 | EATHORPE | ✓ | ✓ |
| 38 | LAWFORD HEATH | × | × |
| 39 | FIVE WAYS | × | ✓ |
| 40 | LOWER/MIDDLE/UPPER TYSOE | × | ✓ |

Severn Trent Water

Discussions have also been held with Severn Trent Water to discuss potential opportunities for partnership schemes to address higher priority combined surface water flooding / sewer flooding hotspot locations.

Like with the Environment Agency, it is envisaged that further discussions with Severn Trent Water will be held to assess the top 40 (and wider) sites from this SWMP study and cross-reference against their short, medium and long term action plans and key risk areas. It is envisaged that these stakeholder workshops will be held jointly with multiple RMAs to investigate and develop multi-stakeholder opportunities.

## 7.3 Action Plans and Investment Strategies

Action plans and investment strategies will be developed in a future study for the priority locations, with a subsequent consultation period to follow. At this stage, the following broad themes for action plans and flood risk mitigation have been identified.

- Stakeholder engagement:
  - between RMAs, Districts and Boroughs and Parish and Town Councils community groups; and
  - public engagement.
- Increase understanding of surface water flood risk:
  - improving the capture and documentation of existing flood risk history data; and
  - developing hydraulic models of critical sites;
- Identify potential surface water management measures including:
  - defining Critical Drainage Areas (CDAs) and associated policies;
  - developing SuDS policies;
  - localised SuDS schemes;
  - Water Sensitive Urban Design (WSUD) / Green Infrastructure solutions;
  - development control policies;
  - soft estate (grass verges etc.) maintenance standards; and
  - partnership schemes with other RMAs (such as improvements and disconnection of surface water drainage from the combined sewer network).

# 8 Conclusions

The county of Warwickshire has experienced a number of significant flood events in recent times, often with complex flooding interactions from multiple sources. Notable events include January 1992, Easter 1998, August 1999, June 2005, summer 2007, December 2008 and November 2012. Among the various responses to these events, AECOM were appointed by Warwickshire County Council (WCC) to undertake a Surface Water Management Plan (SWMP) and Investment Strategy.

The SWMP defined the following objectives.

1. Develop a robust understanding of surface water flood risk across the county of Warwickshire, including a prioritised list of locations at risk of flooding, taking into account the importance of both urban and rural communities, the challenges of population and demographic change and increasing pressures on urban fringes.
2. Develop holistic and multifunctional recommendations for surface water management which improve emergency and land use planning, and enable better flood risk and drainage infrastructure investments.
3. Establish new and consolidate existing partnerships between key drainage stakeholders to facilitate a collaborative culture of data, skills, resource and learning sharing and exchange, and closer coordination to utilise cross boundary working opportunities.
4. Undertake engagement with stakeholders to raise awareness of surface water flooding, identify flood risks and assets, and agree mitigation measures and actions.
5. Develop a robust Action Plan and guidance to deliver change where partners and stakeholders take ownership of their flood risk and commit to delivery and maintenance of the recommended measures and actions.

An understanding of the different sources of flooding and receptors across Warwickshire was developed to ensure that a comprehensive understanding of flood risk was obtained. Flood history information was obtained from the following sources.

- Districts and Boroughs, and Parish and Town Councils and community groups.
- Stakeholders and organisations:
  - Environment Agency;
  - Severn Trent Water;
  - Network Rail; and
  - Canal and River Trust.

It was important to capture where surface water flooding has occurred in the past, but also to identify where surface water flooding may be more likely to occur in the future across

Warwickshire, and so predictive flood risk information was obtained from the Environment Agency's 'updated Flood Map for Surface Water' (uFMfSW).

The receptors and their associated flood risk vulnerability across Warwickshire were defined using the National Receptors Dataset (NRD), the National Planning Policy Framework (NPPF) and refined using project stakeholder knowledge.

A bespoke flood risk and receptor matrix was developed to understand which areas are receptors are at greater risk, or where there are greater consequences. Creating a series of metrics and thresholds, analysis was undertaken which allowed the scoring, weighting, comparison and ranking of sites, used to identify surface water flooding, historic and future 'hotspot' locations and develop a ranked output of sites for further investigation.

Draft outputs were tested through sensitivity analysis and have been discussed with project stakeholders. Feedback from these workshops was also combined with that from the public consultation (January to March 2015). Following refinements to the approach and matrix scoring, the top 40 rankings and thematic maps were developed for the following categories:

- Historic surface water flood risk;
- Predictive surface water flood risk; and
- Combined (Historic and Predictive) surface water flood risk.

The matrix has been developed to enable both historic and potential future flooding hotspot reporting. For this overall summary, a combined approach has been undertaken (combining both the historic and potential future flooding scores) for each OS tile or combination of OS tiles to provide a top 40 ranking. Note that large locations such as Leamington Spa will have a number of OS tiles at risk of surface water flooding from different sources - these are therefore ranked separately as different flooding locations. Large towns could therefore be named in the list more than once, but it is the specific area or community within the town which is being ranked.

The highest ranked locations will not necessarily have funded flood alleviation schemes. This stage of the SWMP is the risk assessment. The viability of flood alleviation schemes depends not only on the risk, but also on the nature of the flood risk and financial viability of a scheme relative to other areas in England and Wales (since it is necessary to compete with other locations to bid for funding from the national 'pot' of Flood Defence Grant in Aid available).

Subsequent stages of the SWMP process will investigate the top ranking sites further, including discussing with project partners and other Risk Management Authorities (RMAs) such as the Environment Agency and Severn Trent Water to identify areas of risk overlap and develop partnership schemes. Following stakeholder engagement a prioritised list will be developed with conceptual flood risk mitigation options, supporting action plans and investment strategies.

In addition to the project matrix and thematic maps, additional deliverables from this study have included SWMP Strategic Flood Maps which will allow WCC and other RMAs to visualise all of the historic flood risk information collated for this study, predictive flood risk and receptors. The project matrix, GIS workspace and interactive PDF is designed to be a living database and

should be regularly updated with new information to capture future flooding incidents, updated predictive mapping and details of flood risk management schemes.

# Annex A: Data Register

**Project Name: Warwickshire Surface Water Management Plan**
**Project Number:** 60319308

**Updated** 30/04/2015

| Dataset Description | Format | Source | Requested | Received (Traffic Light Status) | Notes | Date Received | Received From |
|---|---|---|---|---|---|---|---|
| **Environment Agency** | | | | | | | |
| Updated Flood Map for Surface Water (uFMfSW) | GIS | EA | ✓ | ✓ | Downloaded Extent, Depth, Velocity & Hazard from WCC Extent, Depth, Velocity & Hazard. Hard drive handed over on 10/07/14<br>Initial issue with Hazard data - WCC delivered w/c 01/09/14 - Now addressed. | 10/07/2014 | WCC and EA Geostore |
| Updated Flood Map for Surface Water (uFMfSW) - Property Counts | GIS | EA | ✓ | ✓ | Received from EA | 24/07/2014 | Michael Thomas |
| EA Communities at Risk Project data | GIS | EA | ✓ | ✓ | This project looked at EA fluvial, pluvial, historic flood data and property counts, and categorized and ranked communities at risk - resulting in an Action Plan.<br>Met EA to learn more about database and to obtain the data | 20/05/2014 | Michael Thomas |
| EA Flood Zones | GIS | EA | ✓ | ✓ | Tabfile and shapefile format | 13/05/2014 | EA Geostore |
| EA Standardised Modelling? | GIS | EA | ✓ | × | Not available for this area. | N/A | |
| Flood Alert / Warning Areas | GIS | EA | ✓ | ✓ | Tabfile and shapefile format | 13/05/2014 | EA Geostore |
| Historic Flood Outlines | GIS | EA | ✓ | ✓ | Tabfile and shapefile format | 13/05/2014 | EA Geostore |
| National Receptors Dataset | GIS | EA | ✓ | ✓ | Tabfile and shapefile format | 13/05/2014 | EA Geostore |
| Detailed River Network | GIS | EA | ✓ | ✓ | Tabfile and shapefile format | 13/05/2014 | EA Geostore |
| Areas to benefit from New & Reconditioned Flood Schemes | GIS | EA | ✓ | ✓ | Tabfile and shapefile format | 13/05/2014 | EA Geostore |
| ASTGWF | GIS | EA | ✓ | ✓ | Tabfile and shapefile format | 13/05/2014 | EA Geostore |
| 1m LiDAR data | GIS | EA | ✓ | ✓ | LiDAR format | 13/05/2014 | EA Geostore |
| Communities at Risk Data | GIS | EA | ✓ | ✓ | Have the full dataset | 28/05/2014 | Michael Thomas |
| | | | | | | | |
| **Warwickshire County Council** | | | | | | | |
| Properties in FZ2 and or at risk from Surface Water. | Email | WCC | ✓ | ✓ | Initial WCC Screening. | 28/04/2014 | Sacha Barnes |
| Schools & Landfill Sites CI Data | GIS | WCC | ✓ | ✓ | From Sophie Wynne | 27/08/2014 | Sophie Wynne |
| Critical Infrastructure Data:<br>Fire Stations (Warwickshire)<br>Police Stations (Warwickshire)<br>A&E Hospitals (Midlands) | GIS | WCC | ✓ | ✓ | From Derek Tate (WCC GIS) | 18/08/2014 | Derek Tate |
| Public Engagement / Pathfinder Workshop Date List | Email | WCC | ✓ | ✓ | - | - | - |
| OS Mapping:<br>MasterMap Data<br>OS 10k Tiles | GIS | WCC | ✓ | ✓ | MasterMap and 10k Tiles<br>MasterMap Data re-obtained on the 08/01/15 due to errors / missing data in original dataset. | 03/06/2014 | Sacha Barnes - via hard drive |
| Deprivation and Disadvantage Statistics | Web based | WCC | ✓ | Available online if needed | Will be used to select priority list from the top 40. | 17/04/2014 | Paul Rimen |
| Groundwater Flood Risk Map of England & Wales from ESI. | GIS | WCC | ✓ | ✓ | Received 01/08/14 | 01/08/2014 | Jagjit Mahal |
| Warwickshire County Highways 2007 Flood Incidents | GIS | WCC | ✓ | ✓ | Points on paper maps - digitised into MapInfo. | 24/04/2014 | Sacha Barnes |
| WCC historic records of flooding | Excel | WCC | ✓ | ✓ | Not all of it is geo-referenced. Based on data from PFRA<br>Jan 1992, Easter 1998, Aug 1999, June 2005, June/July 2007, December 2008 (not geo-referenced)<br>Only data from 2012 is geo-referenced / has an address. | 24/04/2014 | Sacha Barnes |
| WCC initial screening GIS layer (based on EA Flood Zones and FMFSW Mapping) - including property count data | MapInfo Tab Files | WCC | ✓ | ✓ | Based on properties in Flood Zone 2 and / or at risk of flooding from the 1 in 200 year Surface Water Flood Event | 24/04/2014 | Sacha Barnes |
| National Land and Property Gazetteer | GIS | WCC | ✓ | ✓ | - | 03/06/2014 | Sacha Barnes - via hard drive |
| SHLAA data, ELR, Strategic Housing Sites, Strategic Employment Sites & other growth points | GIS | WCC | ✓ | ✓ | Received all available data at time of this commission. | 03/06/2014 | Sacha Barnes - via hard drive |
| PFRA data - Reports and Spreadsheets | Mixed | WCC | ✓ | ✓ | PFRA Data - Reports on Significant Floods:<br>Jan 1992, Easter 1998, Aug 1999, June 2005, June/July 2007, December 2008 | 28/04/2014 | Sacha Barnes |
| Warwickshire Multiagency Flood Plan | Report | WCC | ✓ | ✓ | - | 28/04/2014 | From Sophie Wynne |
| Warwickshire SFRA data | Mixed | WCC | ✓ | ✓ | - | Project Inception and Various Dates - downloaded from WCC website | WCC |
| Pathfinder - Flood History Data -All collected | GIS | AECOM / WCC facilitated workshops | ✓ | ✓ | Data collected and digitised. | Various Dates. | - |
| Feedback on Hotspots - Collected as part of Key Partner Stakeholder Engagement Workshops | GIS | AECOM / WCC facilitated workshops | ✓ | ✓ | Meeting held on the 27/11/15 with WCC, EA, STW and Districts. | 27/11/2015 | - |
| North Warwickshire Proposed priority areas for Defra Flood Resilience Community Pathfinder February 2013 | Text & Web links | WCC | ✓ | ✓ | Data came via Robert Beggs from North Warwickshire Borough Council | 16/05/2014 | Robert Beggs |
| NRD Meta Data? | GIS | WCC | ✓ | ✓ | Issues opening this - re:requested.<br>Received on 10/07/14 - Checked. OK | 10/07/2014 | From Sophie Wynne |
| SFRA Data<br>PFRA Data<br>Historic Flooding Data | GIS | WCC | ✓ | ✓ | Provided at meeting on the 08-10-14 | 08/10/2014 | Michael Green |
| Supplementary Flood History Data / List of ongoing flood investigations. These have been split into the North and South | Excel | WCC | ✓ | ✓ | Sent as two Excel files. Jag notes that: "For some of the locations that are yet to be investigations (particularly in RBC), the given co-ordinates are only in the general area as detailed information has yet to be gathered." | Jag: 22-10-14<br>Paul: 14-10-14 | North provided by Paul Rimen, South provided by Jagjit Mahal |
| Flood Map for Surface Water | GIS | WCC | ✓ | ✓ | Issued on Memory Stick | 04/11/2014 | Sophie Wynne |
| LEP DATA | GIS | WCC | ✓ | ✓ | Issued on Memory Stick | 04/11/2014 | Sophie Wynne |
| Annex 6 of the attached a definition of 'critical services' used in the PFRA guidance | PDF | WCC | ✓ | ✓ | Sent by Michael Green to assist with Critical Infrastructure definition. | 10/11/2014 | Michael Green |
| Additional Pathfinder Questionnaire Flood History Info | Digitised Paper Copies | WCC | ✓ | ✓ | Sent by Sophie Wynne following WCC Flood Summit Meeting | 17/10/2014 | Sophie Wynne |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Received additional information from Paul Rimen and Jag Mahal regarding the locations flood risk management schemes and numbers of properties benefitting from defences | Excel | WCC | ✓ | ✓ | Sent by Paul and Jag on the 17th April 2015 | 17/04/2015 | Paul Rimen and Jag Mahal |
| | | | | | | | |
| **Districts & Boroughs** | | | | | | | |
| North Warwickshire BC Priority Areas | Word | NWBC | ✓ | ✓ | - | 16/05/2014 | Robert Beggs |
| Stratford District Council | Word | SDC | ✓ | ✓ | Word Doc | 14/05/2014 | Geoff Turton |
| Warwick District Flood Incident GIS Locations | GIS | WDC | ✓ | ✓ | GIS File - Info very limited though.<br>B = Highway flood locations (impassable at certain times).<br>Y = Areas of flooded properties where flooding has occurred over a number of years. | 28/04/2014 | Sacha Barnes |
| Nuneaton & Bedworth | GIS | NBBC | ✓ | ✓ | SHLAA, ELR, Strategic Housing Sites, Strategic Employment Sites. | 15/07/2014 | Simon Daly |
| Warwick District Council - SHLAA & Local Plan GIS | GIS | WDC | ✓ | ✓ | SHLAA data and:<br>a. Employment Allocations<br>b. Housing Allocations<br>c. Major Education Allocations<br>d. Major Employment Commitments<br>e. Major Housing Commitments<br>f. Sub Regional Employment Allocation | 08/08/2014 | Daniel Robinson |
| North Warwickshire Borough Council | GIS & Web Links | NWBC | ✓ | ✓ | SHLAA data, employment data, priority sites & **WEBLINKS** | 08/08/2014 | Mike Dittman |
| Stratford District Council | Web Links | STD | ✓ | ✓ | SHLAA data - Paul Harris from SDC stated that the SHLAA data was too numerous and most wasn't relevant so he sent a number of useful links instead. | 12/08/2014 | Paul Harris |
| Rugby Borough Council | GIS | RBC | ✓ | ✓ | SHLAA data | 07/08/2014 | Lizzie Betesford |
| | | | | | | | |
| **CSW Resilience** | | | | | | | |
| Critical Receptors | Telephone Discussion and Emails | CSW | ✓ | ✓ | Engaged with Jacob Forgham - need to discuss with team and MG for useful criteria.<br>Obtained Critical Infrastructure Data from Derek Tate of WCC.<br><br>CSW Resilience supplied COMAH sites and Prisons locations. | 11/08/2014 | Jacob Forgham |
| | | | | | | | |
| **Severn Trent Water** | | | | | | | |
| Numerous Datasets:<br>Return Period Analysis (RPA) data<br>Flooding Register for Warwickshire<br>Flooding Other Causes dataset. | Multi format Data | Severn Trent Water | ✓ | ✓ | Engaged with Paul Petherick and Tim Smith. Tim Smith would like to meet team and Michael. Discuss with Michael at meeting on 29th.<br>Meeting on 10/07/14 - Tim Smith to send the following data through:<br><br>DG5 GIS data<br>Return Period Analysis data<br>Flooding other causes data<br>Asset data (critical infrastructure sensitive to flood risk)<br>List of current schemes<br>Amp 5 map showing previous schemes<br>Amp 6 potential schemes | 24/11/2014 | Tim Smith at Severn Trent Water. |
| | | | | | | | |
| **Canal & River Trust** | | | | | | | |
| Overtoppings and Breaches data | GIS Shapefiles | CRT | ✓ | ✓ | Overtopping and Breach GIS data - plus anecdotal info on surface water problem areas. | 04/06/2014 | Mike Clayton |
| | | | | | | | |
| ***Additional Data That May Be Useful:*** | | | | | | | |
| Flood incidents / reports from NFU | N/A | NFU | ✓ | N/A | Engaged with Sarah Fulkner . Discussed approach for liaison with MG at WCC. Decided to consult on Hotspots when creating priority list from top 40 sites. | - | - |
| Flood incidents / reports from Network Rail | Excel table | Network Rail | ✓ | ✓ | Engaged with Steven Raj -<br>NOW RECEIVED | 22/07/2014 | Raj Steven |
| | | | | | | | |
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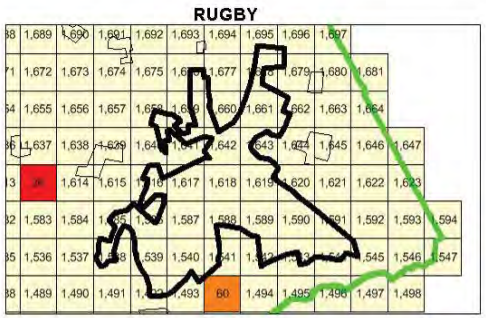
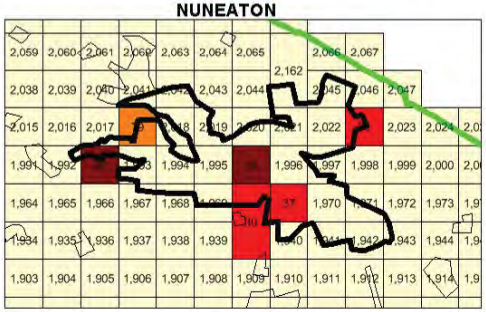
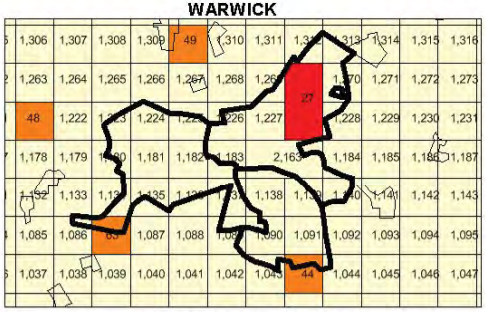
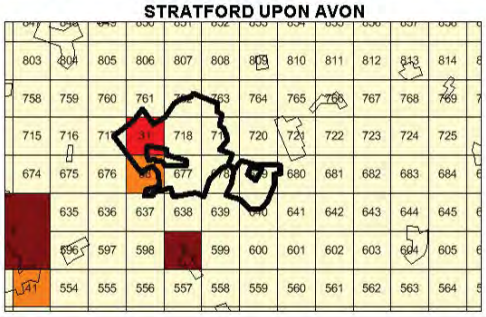
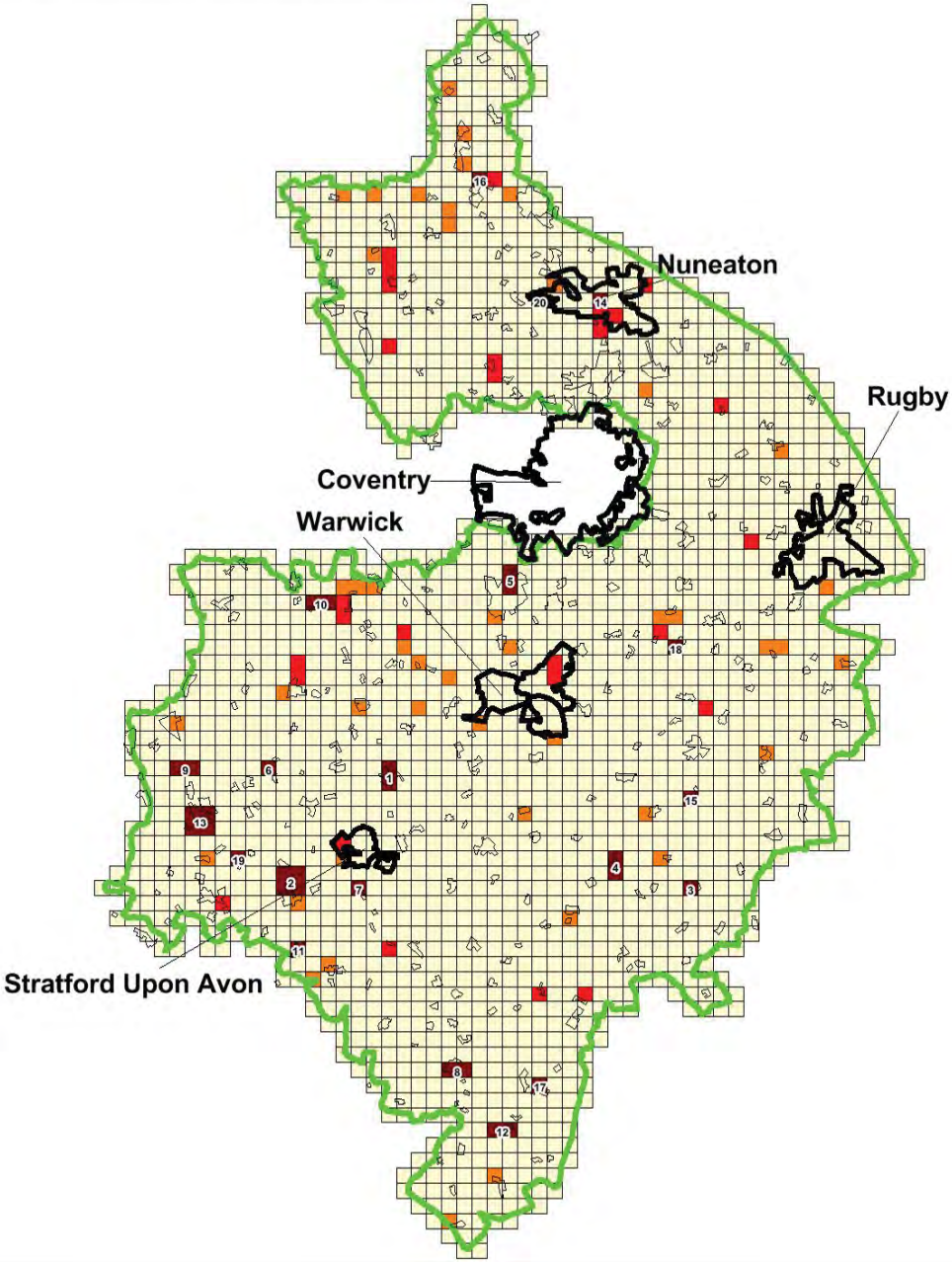
# Annex B: SWMP Thematic Maps




## RANKINGS TABLE

Top Twenty Ranking

| Rank | Tile Ref | Score | Place Name |
|---|---|---|---|
| 1 | SP2159 | 3.83 | SNITTERFIELD |
| 2 | SP1452 | 2.16 | WELFORD-UPON-AVON |
| 3 | SP4152 | 2.09 | FENNY COMPTON |
| 4 | SP3653 | 1.98 | GAYDON |
| 5 | SP2972 | 1.92 | KENILWORTH |
| 6 | SP1360 | 1.71 | ASTON CANTLOW |
| 7 | SP1952 | 1.67 | CLIFFORD CHAMBERS |
| 8 | SP2540 | 1.66 | SHIPSTON ON STOUR |
| 9 | SP0760 | 1.57 | COUGHTON |
| 10 | SP1671 | 1.50 | LAPWORTH |
| 11 | SP1548 | 1.38 | LONG MARSTON |
| 12 | SP2836 | 1.38 | CHERINGTON |
| 13 | SP0856 | 1.28 | ALCESTER |
| 14 | SP3591 | 1.25 | NUNEATON |
| 15 | SP4158 | 1.23 | LADBROKE |
| 16 | SP2799 | 1.11 | GRENDON |
| 17 | SP3139 | 1.09 | LOWER/UPPER BRAILES |
| 18 | SP4068 | 1.06 | MARTON |
| 19 | SP1154 | 1.00 | ARDENS GRAFTON |
| 20 | SP3191 | 0.88 | NUNEATON |

## Key:

**Total Historic: Rankings**

- Rank 1 to 20
- Rank 21 to 40
- Rank 41 to 83
- Rank 83 to 2200

Note Only 82 cells contain Historic information with current weigthings

Client: Warwickshire County Council

Project: SURFACE WATER MANAGEMENT PLAN

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| Chk'd: | AP | App'd: | JP |
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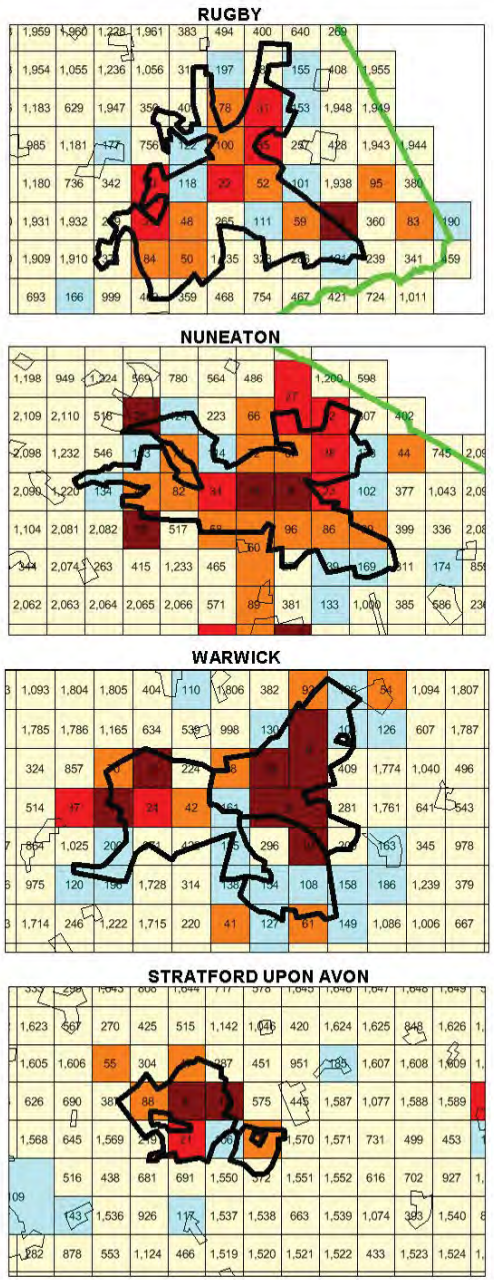


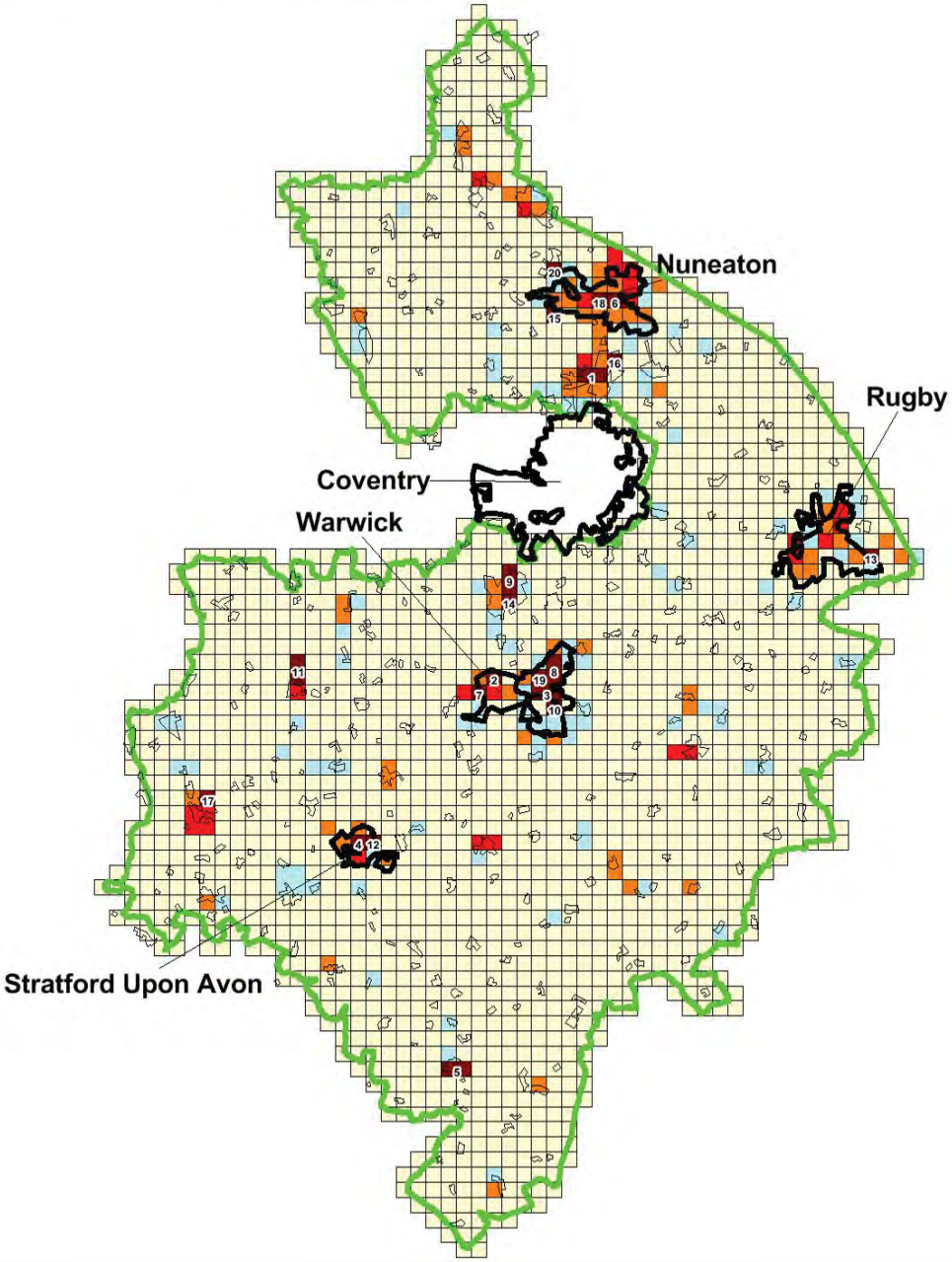



## RANKINGS TABLE

| Top Twenty Ranking | | | |
|---|---|---|---|
| Rank | Tile Ref | Score | Place Name |
| 1 | SP3486 | 16.88 | BEDWORTH |
| 2 | SP2866 | 15.61 | WARWICK |
| 3 | SP3165 | 11.76 | ROYAL LEAMINGTON SPA |
| 4 | SP1955 | 11.24 | STRATFORD-UPON-AVON |
| 5 | SP2540 | 10.21 | SHIPSTON ON STOUR |
| 6 | SP3691 | 10.10 | NUNEATON CENTRE |
| 7 | SP2765 | 9.50 | WARWICK |
| 8 | SP3266 | 9.41 | ROYAL LEAMINGTON SPA |
| 9 | SP2372 | 7.50 | KENILWORTH |
| 10 | SP3264 | 7.03 | ROYAL LEAMINGTON SPA |
| 11 | SP1566 | 6.69 | HENLEY IN ARDEN |
| 12 | SP2055 | 6.31 | STRATFORD-UPON-AVON |
| 13 | SP5374 | 6.08 | RUGBY |
| 14 | SP2971 | 5.70 | KENILWORTH |
| 15 | SP3290 | 5.36 | NUNEATON |
| 16 | SP3687 | 5.15 | BEDWORTH |
| 17 | SP0958 | 4.87 | ALCESTER |
| 18 | SP3591 | 4.82 | NUNEATON |
| 19 | SP3166 | 4.75 | ROYAL LEAMINGTON SPA |
| 20 | SP3293 | 4.63 | NUNEATON |

## Key:

Total Predicted: Rankings

- Rank 1 to 20
- Rank 21 to 40
- Rank 41 to 100
- Rank 101 to 200
- Rank 201 to 2200

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Project: SURFACE WATER MANAGEMENT PLAN

Title: TOTAL PREDICTED SCORE 1 IN 100 YEAR EXTENT RANKINGS

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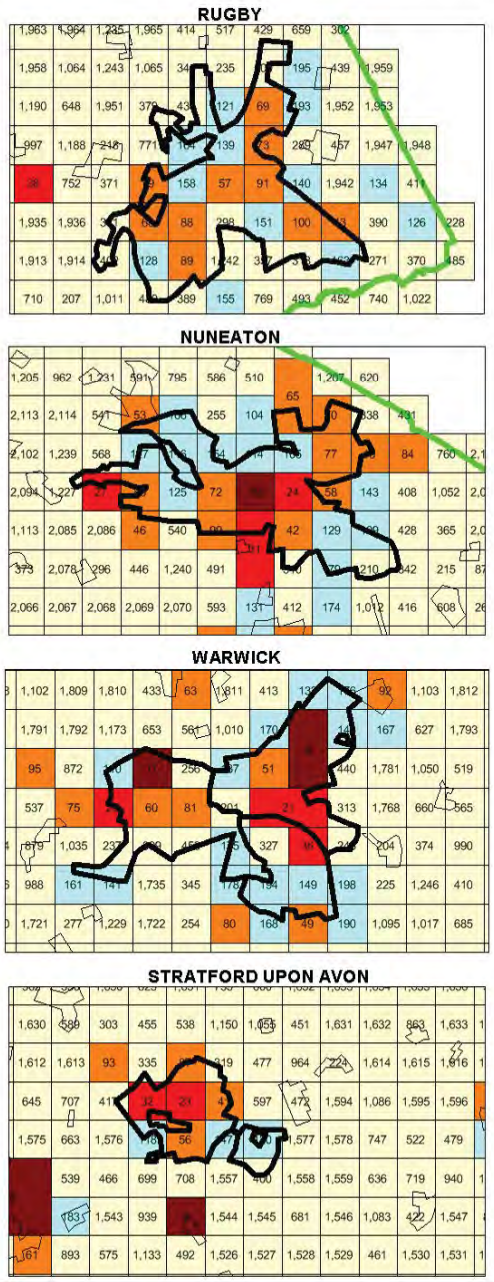


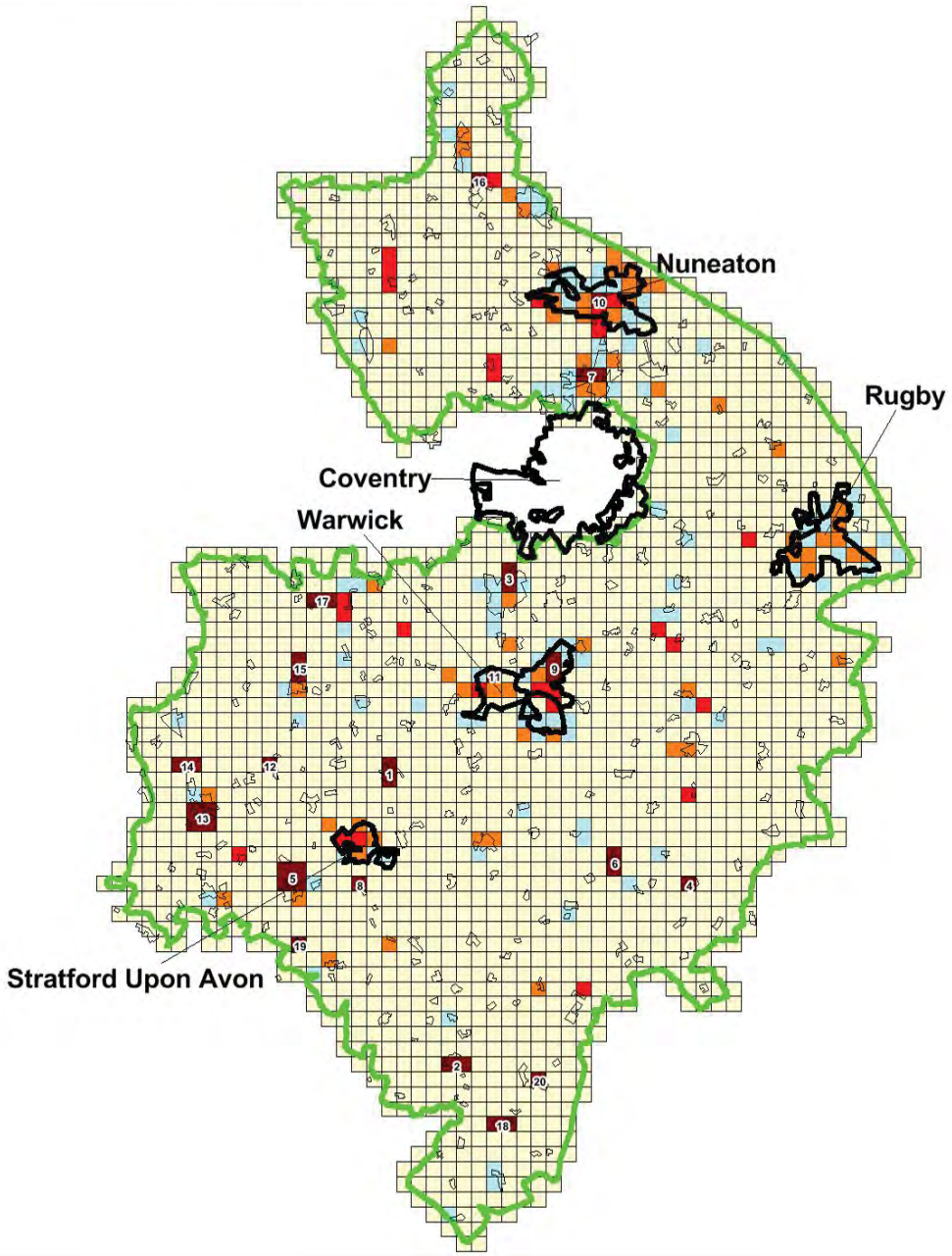


## RANKINGS TABLE

Top Twenty Ranking

| Rank | Tile Ref | Score | Place Name |
|---|---|---|---|
| 1 | SP2155 | 21.16 | SNITTERFIELD |
| 2 | SP2540 | 14.73 | SHIPSTON ON STOUR |
| 3 | SP2372 | 14.46 | KENILWORTH |
| 4 | SP4152 | 12.60 | FENNY COMPTON |
| 5 | SP1452 | 12.23 | WELFORD-UPON_AVON |
| 6 | SP3653 | 11.57 | GAYDON |
| 7 | SP3486 | 10.00 | BEDWORTH |
| 8 | SP1952 | 9.63 | CLIFFORD CHAMBERS |
| 9 | SP3266 | 9.49 | ROYAL LEAMINGTON SPA |
| 10 | SP3591 | 9.38 | NUNEATON |
| 11 | SP2866 | 9.25 | WARWICK |
| 12 | SP1360 | 9.16 | ASTON CANTLOW |
| 13 | SP0856 | 9.03 | ALCESTER |
| 14 | SP0760 | 8.83 | COUGHTON |
| 15 | SP1566 | 8.39 | HENLEY IN ARDEN |
| 16 | SP2799 | 7.88 | GRENDON |
| 17 | SP1671 | 7.83 | LAPWORTH |
| 18 | SP2836 | 7.70 | CHERINGTON |
| 19 | SP1548 | 7.55 | LONG MARSTON |
| 20 | SP3139 | 7.07 | LOWER/UPPER BRAILES |

## Key:

**Total Combined: Rankings**

- Rank 1 to 20
- Rank 21 to 40
- Rank 41 to 100
- Rank 101 to 200
- Rank 201 to 2200

Client: Warwickshire County Council

Project: SURFACE WATER MANAGEMENT PLAN

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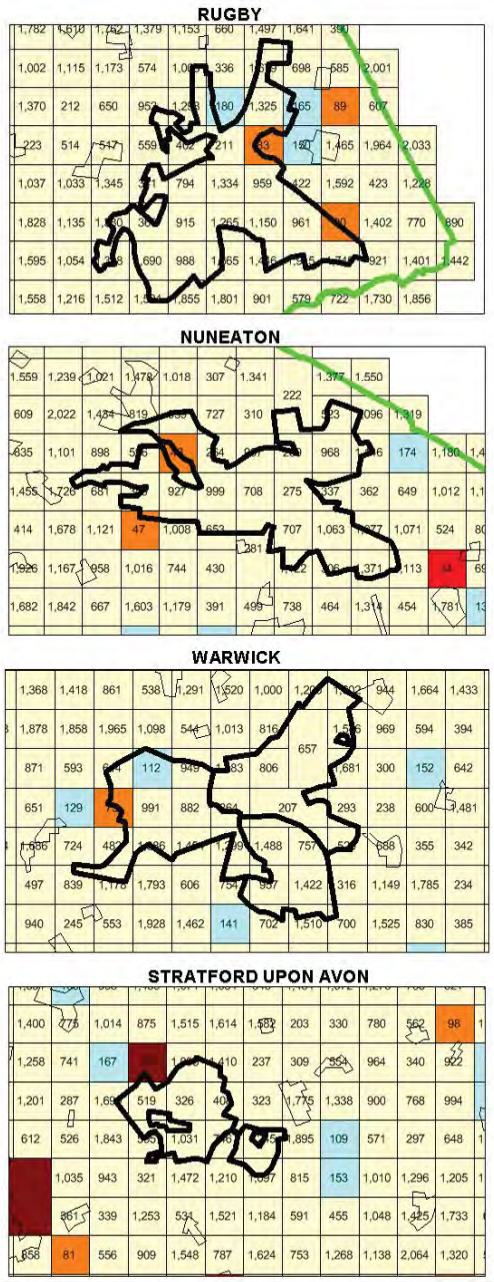


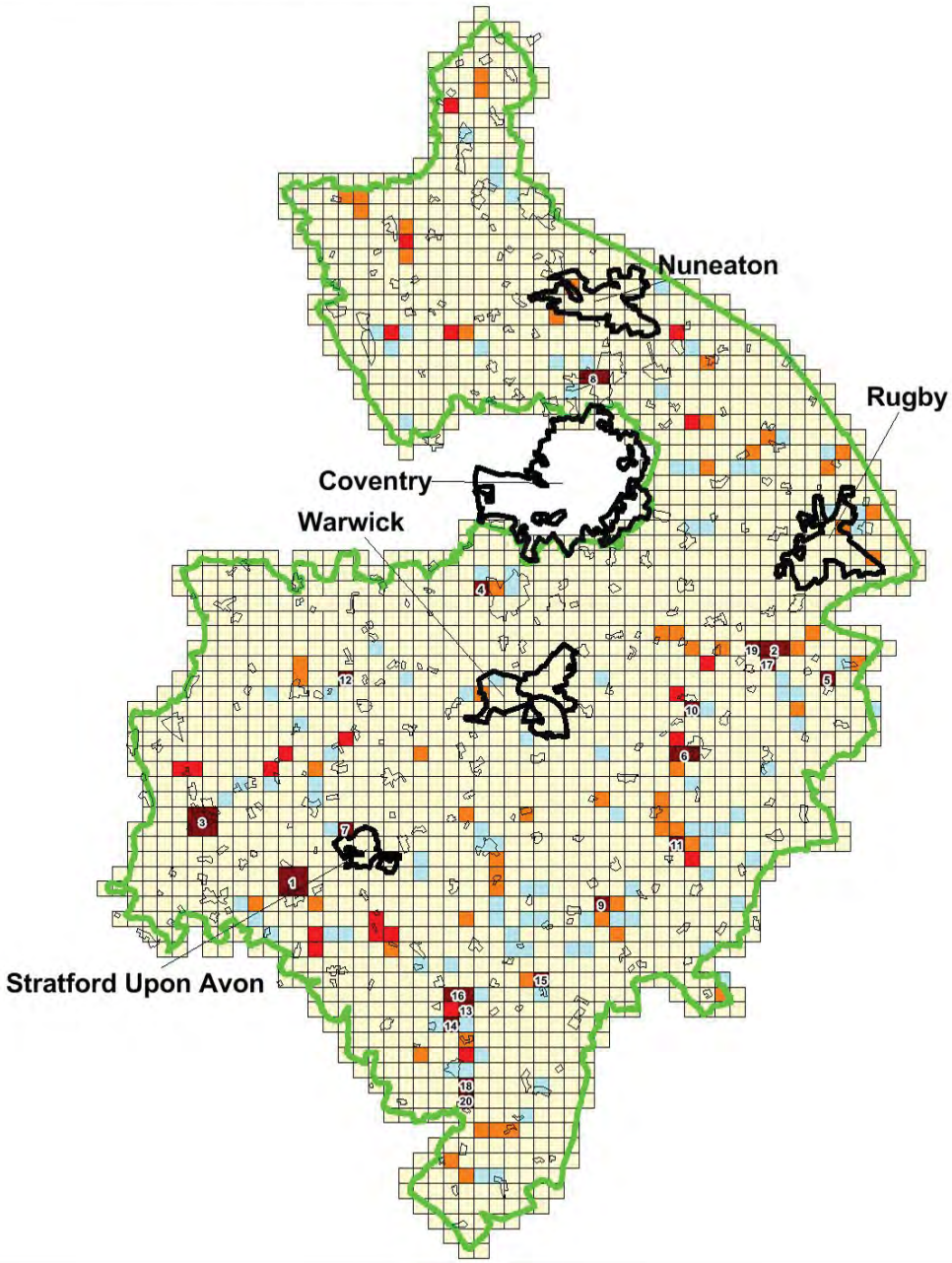



## RANKINGS TABLE

| Top Twenty Ranking | | | |
|---|---|---|---|
| Rank | Tile Ref | Score | Place Name |
| 1 | SP1452 | 1.00 | WELFORD-UPON-AVON |
| 2 | SP4668 | 0.79 | KITES HARDWICK |
| 3 | SP0856 | 0.74 | ALCESTER |
| 4 | SP2772 | 0.74 | KENILWORTH |
| 5 | SP5066 | 0.74 | SAWBRIDGE |
| 6 | SP4061 | 0.71 | SOUTHAM |
| 7 | SP1856 | 0.67 | STRATFORD-UPON-AVON |
| 8 | SP3486 | 0.63 | BEDWORTH |
| 9 | SP3551 | 0.62 | RURAL |
| 10 | SP4164 | 0.59 | LONG ITCHINGTON |
| 11 | SP4055 | 0.56 | RURAL |
| 12 | SP1866 | 0.56 | RURAL |
| 13 | SP2644 | 0.52 | RURAL |
| 14 | SP2543 | 0.51 | TREDINGTON |
| 15 | SP3146 | 0.50 | OXHILL |
| 16 | SP2545 | 0.48 | HALFORD |
| 17 | SP4667 | 0.48 | KITES HARDWICK |
| 18 | SP2639 | 0.48 | RURAL |
| 19 | SP4568 | 0.47 | RURAL |
| 20 | SP2638 | 0.47 | BURMINGTON |

## Key:

Hazard: Rankings

- Rank 0 to 20
- Rank 20 to 40
- Rank 40 to 100
- Rank 100 to 200
- Rank 200 to 2200

Client: Warwickshire County Council

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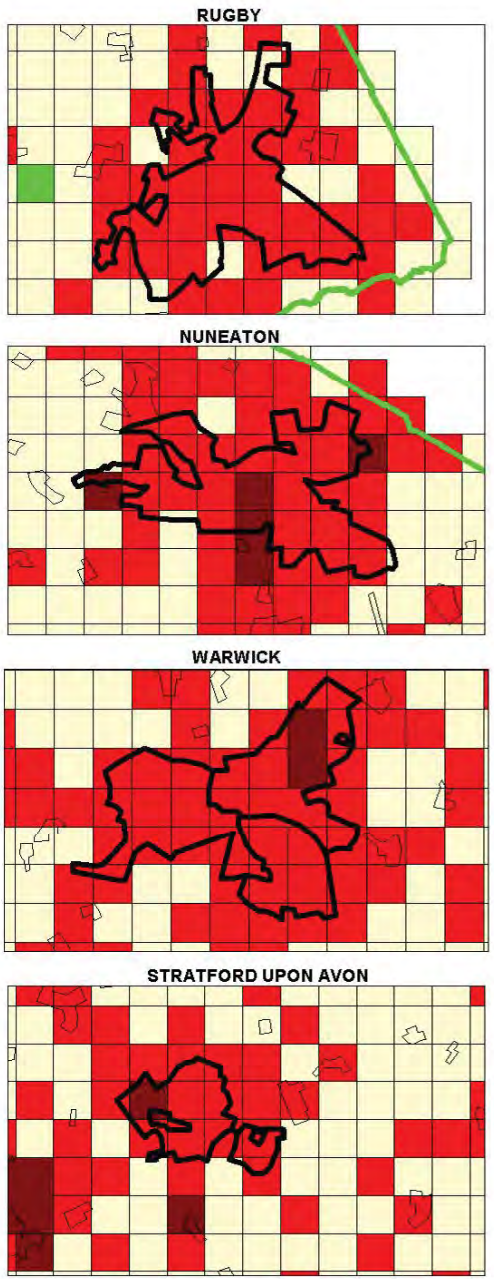


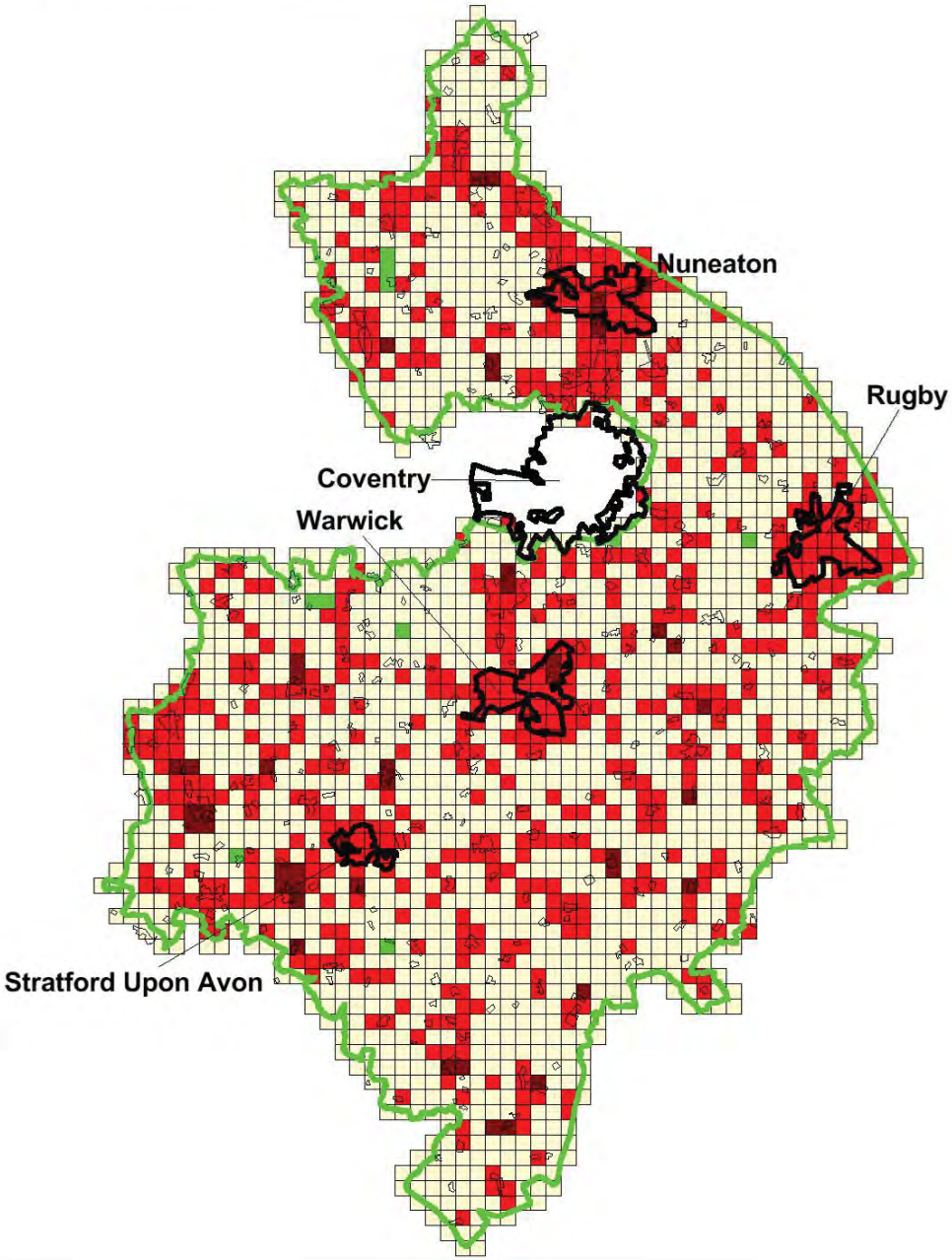



## Key:

**Hotspots**

- Historic and Predicted Hotspot
- Predicted Hotspot Only
- Historic Hotspot Only
- Not met Hotspot Trigger

Client: Warwickshire County Council

Project: SURFACE WATER MANAGEMENT PLAN

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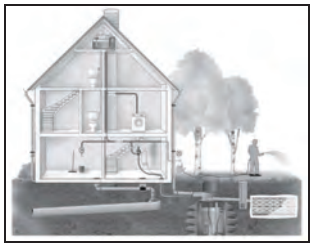
# Annex C: Sustainable Drainage Systems (SuDS)

| SuDS Type | Photo |
|---|---|
| *Source Control* | |
| **Green Roofs**<br><br>Green roofs comprise a multilayered system that covers the roof (or walls) of a building with vegetation over a drainage layer.<br><br>Green roofs are suitable for most developments. |  |
| **Rainwater Harvesting**<br><br>Rainwater harvesting is the collection and storage of rainwater from roofs and other hard surfaces.<br><br>Rainwater harvesting systems can be used for residential, commercial and industrial developments. |  |
| **Water Butts**<br><br>Water butts are a common means of harvesting rainwater for garden use via an inlet connected to roof downpipes.<br><br>Water butts are best suited to low and medium residential development where the catchment area is limited to the property and ancillary building roof area. |  |
| **Permeable Pavements**<br><br>Permeable pavements allow rainwater to infiltrate through the surface and into under-layers where it is temporarily stored before infiltrating into the ground, or released to a watercourse or drainage system.<br><br>Permeable pavements can be used for a wide variety of developments. |  |
| **Soakaways**<br><br>Soakaways store rapid runoff from a single development and allow it to infiltrate into the surrounding soil.<br><br>Soakaways are not suitable where there is a risk of contamination, where there are unstable ground conditions and where there are poor draining soils. Field investigations are required to determine infiltration rates. |  |
| *Site Control* | |
| **Filter Strips**<br><br>Filter strips are vegetated strips of land designed to accept runoff and allow it to infiltrate or be filtered by vegetation before being received by a stream or surface water collection system.<br><br>Filter strips are considered to have a large land requirement, and are not suitable for significant attenuation or if there is risk of ground contamination. |  |

| SuDS Type | Photo |
|---|---|
| **Trenches**<br><br>Trenches are shallow excavations filled with rubble, stone or other void media that create temporary subsurface storage for runoff. There are two types of trenches; filtration trenches are used where soils are impermeable or where the groundwater is vulnerable to pollution and infiltration trenches filter runoff through the stone media and infiltrate it into permeable soils. |  |
| **Swales**<br><br>Swales are linear vegetated drainage systems where surface water can be stored to allow infiltration, and/or conveyed to other SuDS components, a stream or river.<br><br>This type of SuDS design can be used in a wide variety of situations where catchments have small impermeable areas. |  |
| **Bioretention**<br><br>Bioretention areas, filters or rain gardens are shallow landscaped depressions designed to capture, filter and treat surface water.<br><br>Bioretention areas are suitable for various development types including residential plots, car parks, along highways and roads, commercial, and industrial sites and can be retrofitted into existing developments and used where the groundwater is vulnerable. |  |
| **Geocellular / Modular Systems**<br><br>Geocellular systems are high void structures which are below ground and used to infiltrate or store runoff before it is discharged to a downstream drainage system.<br><br>They can be used for a variety of development types including residential, commercial and industrial developments. This type of system can be used where there are contaminated sites. |  |
| *Regional Control* | |
| **Infiltrations Basins**<br><br>Infiltration basins are vegetated depressions that store runoff for infiltration into the subsurface soil.<br><br>The suitability of a site must be confirmed by geotechnical investigations. |  |
| **Detention Basins**<br><br>Detention basins are dry basins which temporarily store runoff by use of a controlled release which attenuates flow.<br><br>Detention basins are suitable for use on at a variety of development types including residential, commercial, industrial, contaminated sites and where there is high density infrastructure. |  |

| SuDS Type | Photo |
|---|---|
| **Ponds**<br><br>Ponds are basins which have a permanent pool of water.<br><br>Ponds can generally be used for most types of developments and redevelopments for both residential and non residential areas. |  |
| **Wetlands**<br><br>Wetlands are constructed shallow marsh systems covered almost entirely by aquatic vegetation.<br><br>Wetlands are suitable for residential, commercial and industrial developments. |  |

With a variety of SuDs techniques that can be considered for a new development, Table 8.3 outlines the capability of different SuDS techniques and their suitability in terms of providing environmental and water quality benefits. SuDS should be considered on a site-by-site basis to facilitate their effective implementation. Guidance on the planning, design, construction, operation and maintenance of SuDS is detailed in CIRIA's SuDS Manual.

Capability of different SUDS techniques (Extract from CIRIA C697, Table 1.7)

| Technique | Description | Management Train Suitability | | | | | | Water Quantity | | | | Water Quality | | | | | | | | Environmental Benefits | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Prevention | Conveyance | Pre-treatment | Source control | Site Control | Regional Control | Conveyance | Detention | Infiltration | Water Harvesting | Sedimentation | Filtration | Adsorption | Biodegradation | Volatilisation | Precipitation | Uptake by plants | Nitrification | Aesthetics | Amenity | Ecology |
| Water butts, site layout and management | Good housekeeping and design practices. | ■ | ▲ | | ■ | | | ▲ | ▲ | ■ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ |
| Pervious pavement | Allow infiltration of rainwater into underlying construction/soil. | ■ | | | ■ | ▲ | | | ■ | ■ | ▲ | ■ | ■ | ■ | ■ | ■ | | | | ▲ | ▲ | ▲ |
| Filter drain | Linear drains/ trenches filled with a permeable, often with a perforated pipe at the base of the trench. | | ■ | | ■ | ▲ | | ■ | ■ | | | | ■ | ■ | ■ | ■ | | | | | | |
| Filter strips | Vegetated strips of gently sloping ground designed to drain water from impermeable areas and filter out silt and other particulates. | | | ■ | ■ | | | ▲ | ▲ | ▲ | | ■ | ■ | ■ | ■ | | | | | ▲ | ▲ | ▲ |
| Swales | Shallow vegetated channels that conduct and/or retain water (and can permit infiltration when underlined). The vegetation filters particulates. | | ■ | | ■ | ■ | | ■ | ■ | ▲ | | ■ | ■ | ■ | ■ | | | ▲ | | ▲ | ▲ | ▲ |
| Ponds | Depressions used for storing and treating water. They have a permanent pool and bankside emergent and aquatic vegetation. | | | | | ■ | ■ | | ■ | ▲ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Wetlands | As ponds, but the runoff flows slowly but continuously through aquatic vegetation that attenuates and filters the flow. Shallower than ponds. | | ▲ | | | ■ | ■ | ▲ | ■ | ▲ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Detention Basin | Dry depressions designed to store water for a specified retention time. | | | | | ■ | ■ | | ■ | | | ■ | ▲ | ▲ | ■ | | | ■ | | ▲ | ▲ | ▲ |
| Soakaways | Sub-surface structures that store and dispose of water via infiltration. | | | | ■ | | | | | ■ | | | ■ | ■ | ■ | | | | | | | |
| Infiltration Trenches | As filter drains, but allowing infiltration through trench base and sides. | | ▲ | | ■ | ■ | | ▲ | ■ | ■ | | | ■ | ■ | ■ | ■ | | | | | | |
| Infiltration basins | Depressions that store and dispose of water via infiltration. | | | | | ■ | ■ | | ■ | ■ | | | ■ | ■ | ■ | ■ | | | | ▲ | ▲ | ▲ |
| Green roofs | Vegetated roofs that reduce runoff volume and rate. | ■ | | ■ | ■ | | | | ■ | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Bioretention areas | Vegetated areas for collecting and treating water before discharge downstream, or to the ground via infiltration. | | | | ■ | ■ | | | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Sand filters | Treatment devices using sand beds as filter media. | | | ■ | | ■ | ▲ | | ■ | ▲ | | | ■ | ■ | ■ | ■ | ■ | | | | | |
| Silt removal devices | Manhole and/or proprietary devices to remove silt. | | | ■ | | | | | | | | ■ | | | | | | | | | | |
| Pipes, subsurface storage | Conduits and their accessories as conveyance measures and/or storage. Water quality can be targeted using sedimentation and filter media. | | ■ | | | ■ | | ■ | ■ | | | ▲ | ▲ | ▲ | | | | | | | | |

| Key | |
|---|---|
| ■ | Recommended |
| ▲ | Some opportunities, subject to design |

## FW2 - APPENDIX 3 – Additional Information from the Environment Agency

1 c) The percentage of the population at a medium to high risk of flooding from surface water is similar to that of fluvial flooding at approximately 2% whilst the percentage of non-residential properties at medium to high risk in the River Severn RBD is also low at just under 3%. The impact on agricultural land within the catchment is again low with approximately 3% at medium to low risk. Surface water flooding is a risk in some urban locations within the district. Within these more localised areas the percentage of people and properties at risk may be higher.

There are a number of larger urban areas and smaller communities that are at risk of flooding within the catchment. There is risk of flooding from surface water and sewer flooding in many of the urban areas such as Rugby, Coventry, Bedworth, Leamington Spa, Warwick, Redditch and Evesham.

In this operational catchment there are approximately 31,100 people at risk from river flooding, representing 3% of the total population. Nearly 6,800 non-residential properties are at risk of flooding from river of which 1,350 are considered to be at high risk.

Surface water either directly or through the surface water sewer network is discharged into watercourses, thereby increasing the risk of flooding to communities. By reducing the discharge rate from new developments it can reduce the 'peak' flow in the river network and contribute to reducing fluvial flooding.

The Flood Risk Management Plan for the catchment includes a requirement to influence the planning system to reduce flood risk by directing development away from the floodplain and to slow rates of runoff in the upstream catchment.

While there is good understanding of the flood risk from rivers, better information on the interaction between river and surface water flooding would help identify potential solutions and inform emergency planning in urban areas.

1 e) The actions proposed in this catchment focus on reducing the impact of diffuse pollution from rural and urban sources, reducing inputs of phosphate and ammonia from water industry point sources and opening up water bodies for fish movements by removing physical barriers and improving aquatic habitats. Actions to reduce diffuse pollution would involve exploring ways to manage manures, slurry, livestock and pesticides for the benefit of the water environment, incorporating SuDS within the catchment and removing misconnections and car wash effluent from surface water drainage systems.

Delivery of these actions will require significant contributions from a variety of stakeholders including local councils, farmers, landowners, water companies, businesses, conservation bodies, anglers and community groups. All of these measures are considered to be needed to improve the water environment to as near to good status as practicable.

**Local Flood Risk Management Strategy**

Increased flood risk poses the most significant and specific climate change challenge to the UK economy. It is estimated that flood damages in England have risen by

around 60% over the past 25 years and already exceed £1 billion per year in direct costs to communities and business. A significant number of the top risks for business with respect to climate change relate to the impacts of flooding.

Under the Flood and Water Management Act (2010) ('the Act') Warwickshire County Council (WCC) became a Lead Local Flood Authority (LLFA), responsible for managing local flood risk from surface water, groundwater and ordinary watercourses in Warwickshire. One of the new duties placed upon WCC as the LLFA, to assist in the management of local flood risk, is to 'develop, maintain, apply and monitor' a Local Flood Risk Management Strategy. Due to a changing climate the risk of flooding within Warwickshire may increase as extreme rainfall events become more common and peak flood flows in rivers are expected to increase.

The key findings of this document are:

Enable planning decisions to take full account of local flood risk and seek to reduce flood risk through development.

The planning process has a significant role to play in ensuring that new developments do not increase flood risk and ensuring that they are not at risk from flooding. In order to ensure new development is safe and does not have detrimental impacts on local flood risk, particularly in areas of known flood risk, it should ideally be considered at the pre-application stage and the relevant flood risk management authorities should be involved in these discussions.

To ensure environmentally sustainable solutions are fully considered in WCC led and in all other flood risk management measures, using a catchment based approach where applicable.

Aim to ensure a no net loss of biodiversity, particularly in Local Wildlife Sites, and where possible look to provide a net gain through habitat creation and enhancement, contributing to wider environmental objectives.

To ensure no deterioration in Water Framework Directive (WFD) waterbody status as a result of flood risk management activities. And where possible look to enhance status through implementation of the recommendations of the River Basin Management Plans (RBMPs).

To work with partners to produce local policies and guidance, and set standards to promote a positive impact on flood risk from new development, and to prevent any increase in flood risk, including the possible impacts of climate change.

Work with relevant partners to promote SuDS measures for new developments through the role as a statutory consultee on major planning applications.

WCC actively seeks that new development offers betterment with regard to flood risk in order to mitigate the potential negative flood risk impacts of development.

In addition new development must ensure that it is compliant with local planning policy that is developed by each Local Planning Authority in Warwickshire.

In additional to the Local flood risk Management Strategy produced by the Lead Local flood Authority, a surface water management plan was produced.

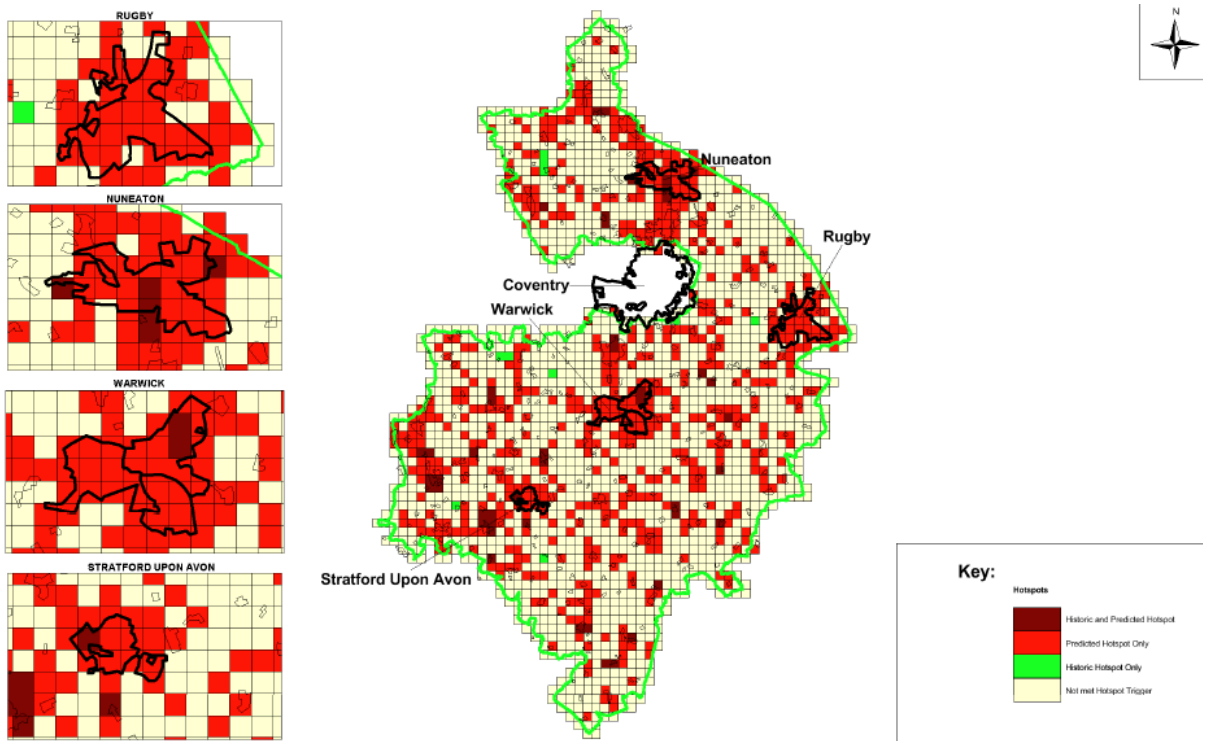
This included a matrix of the top 40 surface water flooding hotspots:

*Dark Red shaded OS Tile names indicate where location has met the SWMP historic Hotspot Threshold for historic flood risk. Tile location can be identified using the OS Tile Finder[8]

| Matrix Ranking | | | | |
|---|---|---|---|---|
| Rank | *OS Tile Ref | Matrix Score | Place Name | Nature of Flood Risk |
| 1 | SP2159 | 21.16 | SNITTERFIELD | Risk to Life, Main River, Ordinary Watercourse, Surface Water |
| 2 | SP2540 | 14.73 | SHIPSTON ON STOUR | Main River, Surface Water, town centre |
| 3 | SP2972 | 14.46 | KENILWORTH | Main River, Surface Water, area of Northvale Close |
| 4 | SP4152 | 12.60 | FENNY COMPTON | Ordinary Watercourse, Surface Water |
| 5 | SP1452 | 12.23 | WELFORD-UPON-AVON | Main River, Ordinary Watercourse, Surface Water, multiple locations |
| 6 | SP3653 | 11.57 | GAYDON | Ordinary Watercourse, Surface Water, village centre |
| 7 | SP3486 | 10.00 | BEDWORTH | Main River area of Delamere Road (addressed by EA scheme), Surface Water Risk |
| 8 | SP1952 | 9.63 | CLIFFORD CHAMBERS | Main River, Ordinary Watercourse, Surface Water |
| 9 | SP3266 | 9.49 | ROYAL LEAMINGTON SPA | Ordinary Watercourse, Surface Water, Foul Sewer, area of Gresham Avenue |
| 10 | SP3591 | 9.38 | NUNEATON | Ordinary Watercourse, Surface Water, Sewer Capacity, area of Queens Road |
| 11 | SP2866 | 9.25 | WARWICK | Surface Water, area of Woodloes Estate |
| 12 | SP1360 | 9.16 | ASTON CANTLOW | Main River, Ordinary Watercourse, Surface Water |
| 13 | SP0856 | 9.03 | ALCESTER | Main River, Surface Water |
| 14 | SP0760 | 8.83 | COUGHTON | Surface Water |
| 15 | SP1566 | 8.39 | HENLEY IN ARDEN | Main River, Surface Water |
| 16 | SP2799 | 7.88 | GRENDON | Ordinary Watercourse, Surface Water, Sewer Flooding, various locations |
| 17 | SP1671 | 7.83 | LAPWORTH | Ordinary Watercourse, Surface Water, multiple locations |
| 18 | SP2836 | 7.70 | CHERINGTON | Ordinary Watercourse, Surface Water, village centre |
| 19 | SP1548 | 7.55 | LONG MARSTON | Ordinary Watercourse, Surface Water, area of Welford Road |
| 20 | SP3139 | 7.07 | LOWER/UPPER BRAILES | Ordinary Watercourse, Surface Water, area of Orchard Close |
| 21 | SP3165 | 6.97 | ROYAL LEAMINGTON SPA | Main River, Ordinary Watercourse, Surface Water, town centre |
| 22 | SP4158 | 6.93 | LADBROKE | Ordinary Watercourse, Surface Water, village centre |
| 23 | SP1955 | 6.66 | STRATFORD-UPON-AVON | Ordinary Watercourse, Surface Water, area of Western Road |
| 24 | SP3691 | 5.99 | NUNEATON CENTRE | Main River, Ordinary Watercourse, Surface Water, Sewer Flooding |
| 25 | SP2765 | 5.63 | WARWICK | Main River, Ordinary Watercourse, Surface Water, area of Race Course Brook |
| 26 | SP4068 | 5.63 | MARTON | Main River, Surface Water |
| 27 | SP3191 | 5.37 | GALLEY COMMON | Ordinary Watercourse, Surface Water |

| Matrix Ranking | | | | |
|---|---|---|---|---|
| Rank | *OS Tile Ref | Matrix Score | Place Name | Nature of Flood Risk |
| 28 | SP2886 | 5.30 | FILLONGLEY | Ordinary Watercourse, Surface Water, Foul Sewer |
| 29 | SP1154 | 5.28 | ARDENS GRAFTON | Risk to Life, Ordinary Watercourse, Surface Water, area of Little Britain |
| 30 | SP4264 | 4.91 | LONG ITCHINGTON | Risk to Life, Ordinary Watercourse, Surface Water, area of Stockton Road |
| 31 | SP3589 | 4.75 | BERMUDA | Surface Water |
| 32 | SP1855 | 4.33 | STRATFORD-UPON-AVON | Ordinary Watercourse, Surface Water, area of Drayton Avenue |
| 33 | SP2192 | 4.29 | WHITACRE HEATH | Main River, Surface Water, Sewer Flooding |
| 34 | SP1870 | 4.24 | KINGSWOOD | Surface Water, multiple locations |
| 35 | SP2899 | 4.23 | GRENDON | Surface water, proposed growth and regeneration area |
| 36 | SP3264 | 4.17 | ROYAL LEAMINGTON SPA | Ordinary Watercourse, Surface Water, centred on Whitnash |
| 37 | SP3969 | 4.15 | EATHORPE | Risk to Life, Main River, Ordinary Watercourse, Surface Water |
| 38 | SP4575 | 3.93 | LAWFORD HEATH | Risk to Life, Ordinary Watercourse, Surface Water |
| 39 | SP2269 | 3.91 | FIVE WAYS | Ordinary Watercourse, Surface Water |
| 40 | SP3445 | 3.79 | LOWER/MIDDLE/UPPER TYSOE | Ordinary Watercourse, Surface Water |

There was also a hotspot mapping exercise undertaken for a 1 in 100 year event, and the diagram below highlights the potential issues within the District.



APPENDIX 4



# The Requirement G2 and Regulation 36

This Approved Document deals with the following Requirement from Part G of Schedule 1 and regulation 36 to the Building Regulations 2010, as amended.

| *Requirement* | *Limits on application* |
|---|---|
| **Water efficiency**<br><br>**G2.** Reasonable provision must be made by the installation of fittings and fixed appliances that use water efficiently for the prevention of undue consumption of water. | Requirement G2 applies only when a dwelling is—<br><br>(a) erected; or<br><br>(b) formed by a material change of use of a building within the meaning of regulation 5(a) or (b). |

**Water efficiency of new dwellings**

**36.**—(1) The potential consumption of wholesome water by persons occupying a new dwelling must not exceed the requirement in paragraph (2).

(2) The requirement referred to in paragraph (1) is either—
(a) 125 litres per person per day; or
(b) in a case to which paragraph (3) applies, the optional requirement of 110 litres per person per day,

as measured in either case in accordance with a methodology approved by the Secretary of State.

(3) This paragraph applies where the planning permission under which the building work is carried out—
(a) specifies the optional requirement in paragraph (2)(b); and
(b) makes it a condition that that requirement must be complied with.

(4) In this Part, "new dwelling" does not include a dwelling that is formed by a material change of use of a building within the meaning of regulation 5(g).

**Wholesome water consumption calculation**

**37.**—(1) Where regulation 36 applies, the person carrying out the work must give the local authority a notice which specifies—
(a) which of the requirements in regulation 36(2)(a) or (b) applies to the dwelling; and
(b) the potential consumption of wholesome water per person per day in relation to the completed dwelling.

**Building (Approved Inspectors) Regulations 2010**

**Application of Provisions of the Principal Regulations**

**20.**—(1) Regulation 20 (provisions applicable to self-certification schemes), 27 ($CO_2$ emission rate calculations), 29 (energy performance certificates), 37 (wholesome water consumption calculation), 41 (sound insulation testing), 42 (mechanical ventilation air flow rate testing), 43 (pressure testing) and 44 (commissioning) of the Principal Regulations apply in relation to building work which is the subject of an initial notice as if references to the local authority were references to the approved inspector.

(4) Regulation 37(2) of the Principal Regulations applies in relation to building work which is the subject of an initial notice as if after "work has been completed" there were inserted, "or, if earlier the date on which in accordance with regulation 17 of the Building (Approved Inspectors etc.) Regulations 2010 the initial notice ceases to be in force".

# 2016 AMENDMENTS TO 2015 EDITION OF APPROVED DOCUMENT G

## Section G2

**Page 16**

**Fittings approach**

*In paragraph 2.6, replace* "Similarly, where a waste disposal unit, a water softener or water re-use is specified the water efficiency calculator must be completed." *with* "Similarly, where a shower is not to be provided or where a waste disposal unit, a water softener or water re-use is to be provided the water efficiency calculator must be completed."

**Page 17**

**Optional requirement**

*In paragraph 2.11, replace* "Similarly, where a waste disposal unit, a water softener or water re-use is specified the water efficiency calculator must be completed." *with* "Similarly, where a shower is not to be provided or where a waste disposal unit, a water softener or water re-use is to be provided the water efficiency calculator must be completed."

**FW3 - Appendix 5**

1. To achieve total water neutrality, the demand post-growth must be the same as, or less than, existing demand.
2. Based on estimates of population size, existing demand in the sub-region was calculated to be 18Ml/d for Warwick.

| Neutrality Scenario | New Homes demand projections | % of existing properties to be retrofitted | Demand from Growth (Ml/d) | Total demand post growth* (Ml/d) | Total demand after metering effect (Ml/d) | Total demand after metering & retrofitting (Ml/d) | % Neutrality Achieved |
|---|---|---|---|---|---|---|---|
| Baseline | Projection 1: STW Average metered consumption | 0 | 4.93 | 22.99 | 22.27 | 22.27 | 12% |
| Low | Projection 2a: Building Regulations Mandatory | 0 | 4.79 | 22.84 | 22.12 | 22.12 | 15% |
| | Projection 2b: Low efficiency scenario | 15 | 4.79 | 22.84 | 22.12 | 22.08 | 16% |
| Medium | Projection 3a: Building Regulations optional requirement | 0 | 4.23 | 22.28 | 21.57 | 21.57 | 27% |
| | Projection 3b: Medium efficiency scenario | 20 | 4.23 | 22.28 | 19.98 | 19.74 | 65% |
| High | Projection 4: High efficiency scenario | 25 | 3.05 | 21.10 | 18.79 | 17.87 | 100% |
| Very High | Projection 5: Very High efficiency scenario | 30 | 2.45 | 20.50 | 18.20 | 17.09 | 100% |

3. The results demonstrate that total neutrality is only achieved by applying the high and very high scenario, requiring new homes to use water at a rate of 80 litres per household per day, and 62 litres per household per day.
4. The 'medium water neutrality scenario requires the implementation of the building regulations optional requirement to achieve 27% water neutrality.

**Severn River Basin Management Plan (FW06)**

5. The Severn River basin district, which covers over 21,000km$^2$, lies both in England and Wales. It extends from the Welsh uplands, through the rolling hills of the Midlands and south to the Severn Estuary.
6. The Severn River basin district has a particularly rich diversity of wildlife and habitats, supporting many species of global and national importance. For example, the Severn Estuary and its surrounding area are protected for their bird populations, habitats and migratory fish species such as Atlantic salmon, shad, lamprey and eel.
7. The river basin district is divided into ten catchments. Five of these are in England (Shropshire Middle Severn, Worcestershire Middle Severn, Warwickshire Avon, Severn Vale and Bristol Avon and North Somerset Streams); three sit across the border between England and Wales (Severn Uplands, Teme and Wye); and two are in Wales (Usk and South East Valleys). These catchments range from energetic upland streams to slower rivers in the lowlands, and include sandstone and limestone aquifers used for public water supply in the Midlands.

**Significant Water Management Issues**

8. The significant water management issues are the main issues that limit the uses and potential benefits of managing the water environment in the river basin district in a sustainable way. They have been identified based on the results of public consultation and assessments of the pressures caused by people now, in the past, and predicted in the future.
9. One of the issues highlighted includes changes to the natural flow and level of water - affecting 7% of water bodies in this river basin district
10. Reduced flow and water levels in rivers and groundwater caused by human activity (such as abstraction) or less rainfall than usual can mean that there is not enough water for people to use and wildlife might not be able to survive. Reduced flow affects the health of fish and exaggerates the impacts of barriers such as weirs. Climate change research shows that by 2050 England and Wales can expect significant seasonal variations, with higher winter and lower summer flows, and a reduction in flow overall. In the long term, there will be less water available to abstract for drinking, industry and irrigating crops.
11. The main reason water is abstracted in the Severn RBD is to supply water for the general public. The headwaters of many of the rivers have been modified by dams to form reservoirs that ultimately supply drinking water. Water released from these reservoirs helps regulate river flow and can impact on river wildlife (such as the migration of fish) if there is insufficient flow variation. The Environment Agency and Natural Resources Wales work in partnership with water companies to regulate flow on the Severn and Wye. Agriculture and horticulture also rely heavily on abstractions. While the amount of water abstracted for agriculture is relatively low compared to other uses, it usually takes place when flows are naturally at their lowest.
12. Reducing abstraction is often difficult as an alternative source of water will usually need to be found. These options may be costly and can bring new environmental issues. Other solutions to tackle unsustainable abstraction are likely to include channel modifications to increase water depths and flow velocities at low flows, Water Level Management Plans or flow augmentation arrangements linked to abstraction.

APPENDIX 6 (FW 4)

**Flooding and Water – Policy FW4: Further Information from the Environment Agency**

The River Basin Management Plan contains 4 sets of information that groups who manage land and water need to pay particular attention to, as outlined below:

Baseline classification of water bodies

One of the main purposes of this plan is to prevent water bodies deteriorating. The first step to preventing deterioration is to understand the baseline status for all the quality elements in each water body. Deterioration from the baseline is not permitted, except in very specific circumstances that are described in this plan. Preventing deterioration is one of the biggest challenges in managing the water environment.

Statutory objectives for protected areas

The River Basin Management Plan highlights the areas of land and bodies of water that have specific uses that need special protection. These include waters used for drinking water, and those that sustain the most precious wildlife species and habitats. The River Basin Management Plan ensures that these areas have the legally binding objectives in place that protect those uses from potentially harmful activities and new developments.

Statutory objectives for water bodies

The River Basin Management Plan sets out legally binding objectives for each quality element in every water body, including an objective for the water body as a whole. The default objective is good status. Less stringent objectives have been set in some cases where natural conditions, technical feasibility or disproportionate cost make improvement impractical. The default deadline for achieving objectives is 2021. However, extended deadlines of 2027 or beyond have been set in some cases where it would be more appropriate, have less impact on existing activities or where the environment will need more time to respond to the planned measures.

Summary programme of measures to achieve statutory objectives

The River Basin Management Plan provides a framework for action and future regulation. To do this it summarises the existing mechanisms, both statutory and voluntary, that are used to manage the quality of the water environment. It also summarises the types of action and who needs to do this, to achieve the statutory objectives. Although it is not a detailed action plan it provides a clear signal to those who use and affect water about what they can do to make sure there is enough good quality water for life and livelihoods in England.

Over 90% of Warwick D.C. lies within the River Severn River Basin Management Plan, where pollution from waste water affects 29% of water bodies in this river basin district.

Waste water, or sewage, can contain large amounts of nutrients (such as phosphorus and nitrates), ammonia, bacteria, harmful chemicals and other damaging substances. It can enter water bodies where sewage treatment technology to remove enough of the

phosphorus and harmful chemicals doesn't exist, from leakages from privately owned septic tanks and, in wet weather, storm overflows can discharge untreated sewage having a significant impact on bathing waters. Population growth and changes in rainfall patterns are increasing the pressure on the sewer network.

The main reason water is abstracted in the Severn RBD is to supply water for the general public. The headwaters of many of the rivers have been modified by dams to form reservoirs that ultimately supply drinking water. Water released from these reservoirs helps regulate river flow and can impact on river wildlife (such as the migration of fish) if there is insufficient flow variation. The Environment Agency and Natural Resources Wales work in partnership with water companies to regulate flow on the Severn and Wye. Agriculture and horticulture also rely heavily on abstractions. While the amount of water abstracted for agriculture is relatively low compared to other uses, it usually takes place when flows are naturally at their lowest.

Changes to the natural flow and level of water affects 7% of water bodies in the River Severn basin district. Reduced flow and water levels in rivers and groundwater caused by human activity (such as abstraction) or less rainfall than usual can mean that there is not enough water for people to use and wildlife might not be able to survive. Reduced flow affects the health of fish and exaggerates the impacts of barriers such as weirs. Climate change research shows that by 2050 England and Wales can expect significant seasonal variations, with higher winter and lower summer flows, and a reduction in flow overall. In the long term, there will be less water available to abstract for drinking, industry and irrigating crops.

Pressure on rivers and underground water stores is likely to grow due to climate change and increases in population. Actions to manage the demand for water and encourage people to use water more efficiently are particularly important where there are acute pressures on water resources. This will involve working with water companies through Water Resource Management Plans and working with farmers and industry groups via initiatives such as on-farm reservoirs (although these may be expensive and require planning) and water audits to build resilience around water supplies.

Warwick D.C.is located within two sub catchments of the River Severn Basin, The Avon Urban Catchment and the Avon Rural Catchment.

Avon Urban Operational Sub-Catchment

This catchment includes the rivers Sowe, Sherbourne, Arrow and Alne and the conurbations of Coventry, Redditch and Alcester. It is largely urban, although arable farming is the main land use activity in the south. Water abstraction for industry and public drinking water supplies is significant within the catchment, including a number of potable groundwater abstractions. The catchment provides a variety of recreational activities including angling, sailing and water sports. Designated sites in the catchment include Sites of Special Scientific Interest at Bittell Reservoir in the Upper Arrow Valley and Brandon Marsh near Coventry.

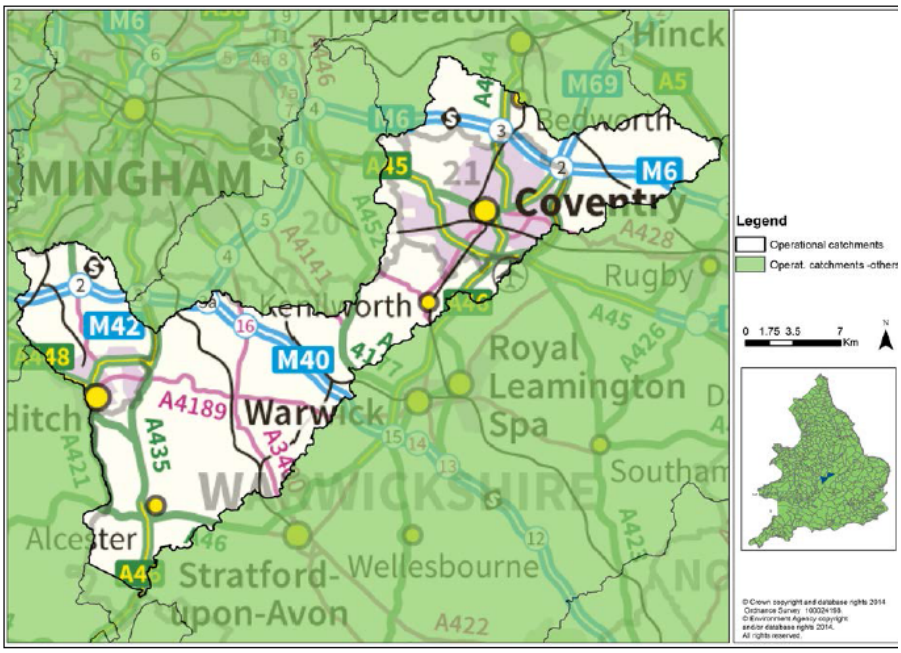



Figure 15 - Map of the Avon Urban operational catchment

There are 20 river water bodies, 3 canal water bodies, 1 lake, 0 estuarine & coastal waters and 1 groundwater water bodies in this catchment. The status (health) of the water environment in 2009 was assessed as being generally moderate. In 2014, the status of the water environment had fallen. The table below quantifies the deterioration in the quality of the waterbodies within the catchment:

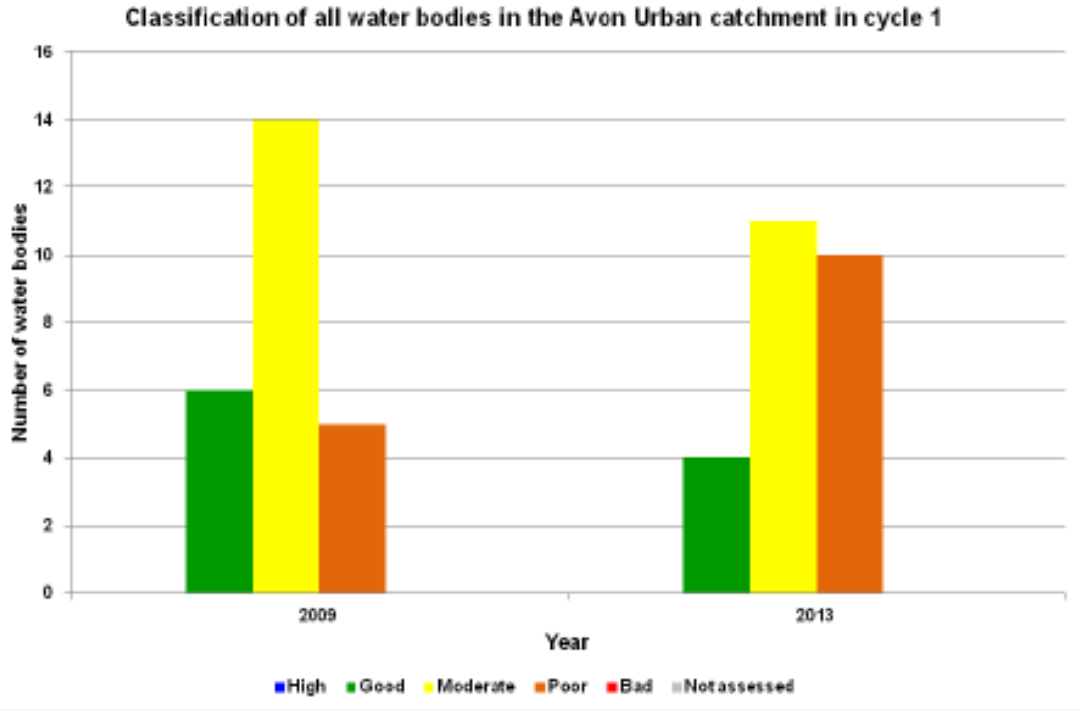
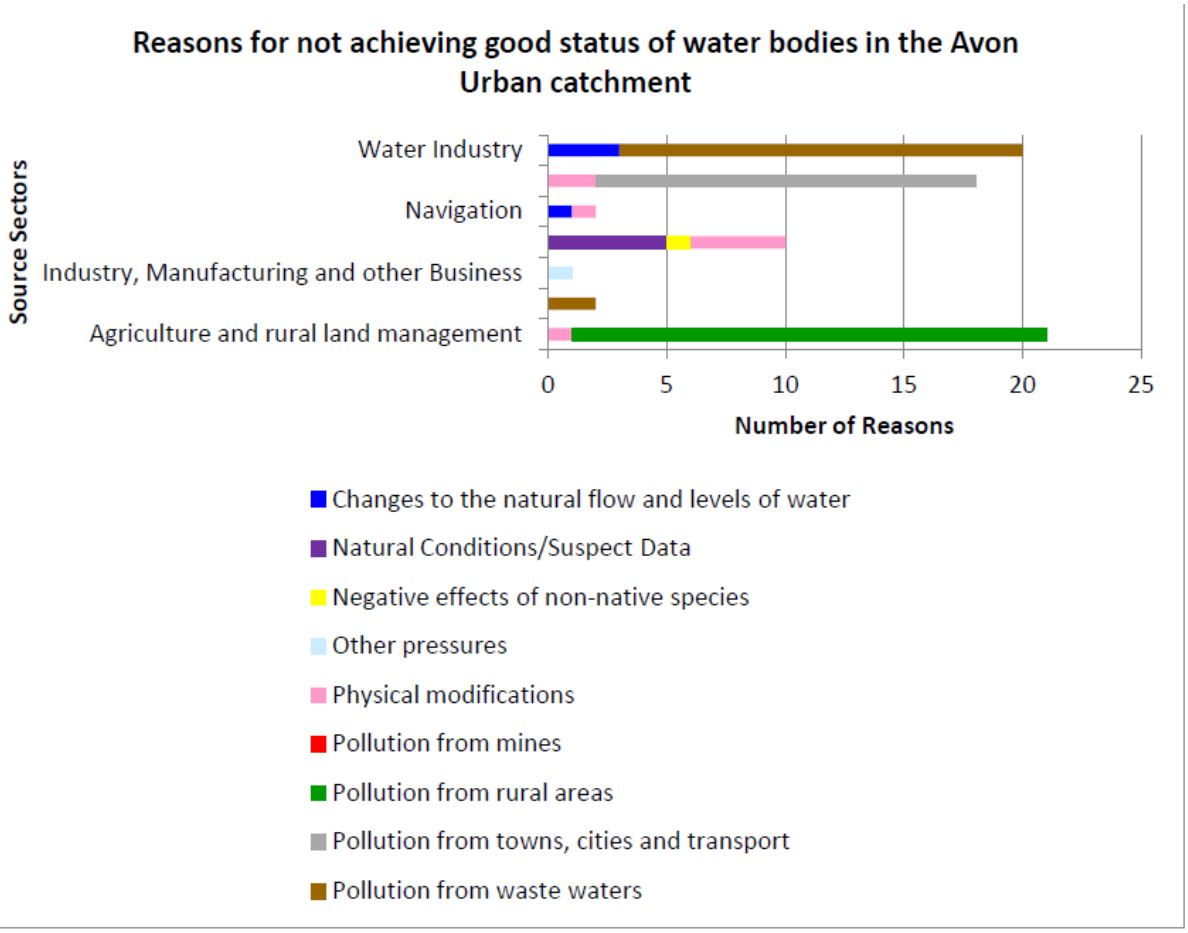



Figure 16 -The classification of all water bodies in the Avon Urban catchment in cycle 1

The table below describes the reasons for waterbodies not achieving 'good' status, which demonstrates that pollution from waste waters is a significant factor.




igure 18 - Chart showing the reasons for not achieving good status (confirmed and probable) of water bodies in the \von Urban catchment by type and source sector

Avon Rural Operational Sub-Catchment

Includes the Rivers, Avon, Swift, Leam, Itchen, Dene and Stour, and the conurbations of Rugby, Warwick and Stratford-upon-Avon. Arable farming is the dominant land use activity and the catchment sits within a Nitrate Vulnerable Zone.

Draycote Water is part of a designated drinking water protected area with the River Leam and the principal aquifers in the catchment are important for public water supply. In the south the River Stour rises in the Cotswolds, an Area of Outstanding Natural Beauty and other designated sites include the River Itchen, a Site of Special Scientific Interest in the Itchen Valley.

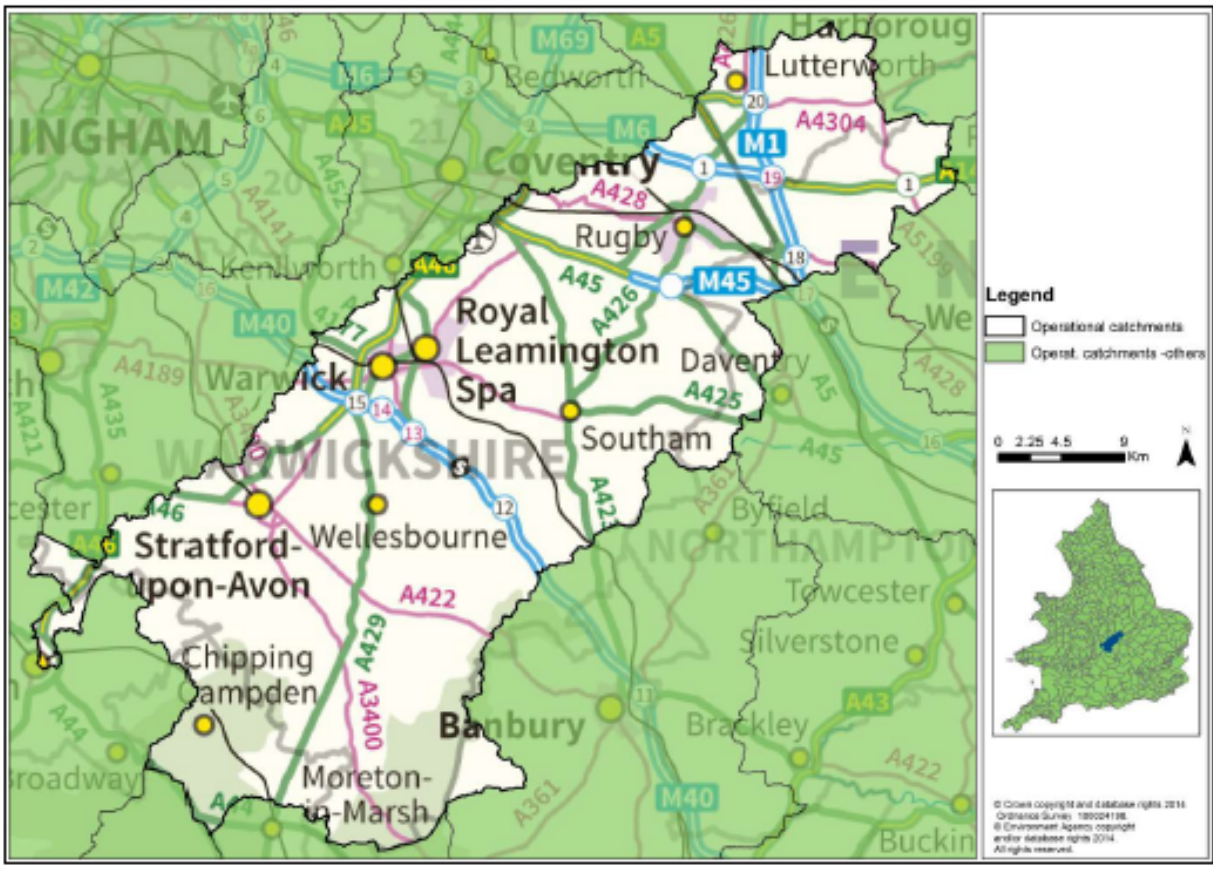



Figure 10 - Map of the Avon Rural operational catchment

There are 33 river water bodies, 6 canal water bodies, 2 lake, 0 estuarine & coastal waters and 1 groundwater water bodies in the catchment. The status (health) of the 23

water environment in 2009 was assessed as being generally moderate, however as illustrated below there has been a deterioration in the quality of the waterbodies within the catchment:

The table below describes the reasons for waterbodies not achieving ‘good’ status, which demonstrates that pollution from waste waters is a significant factor.

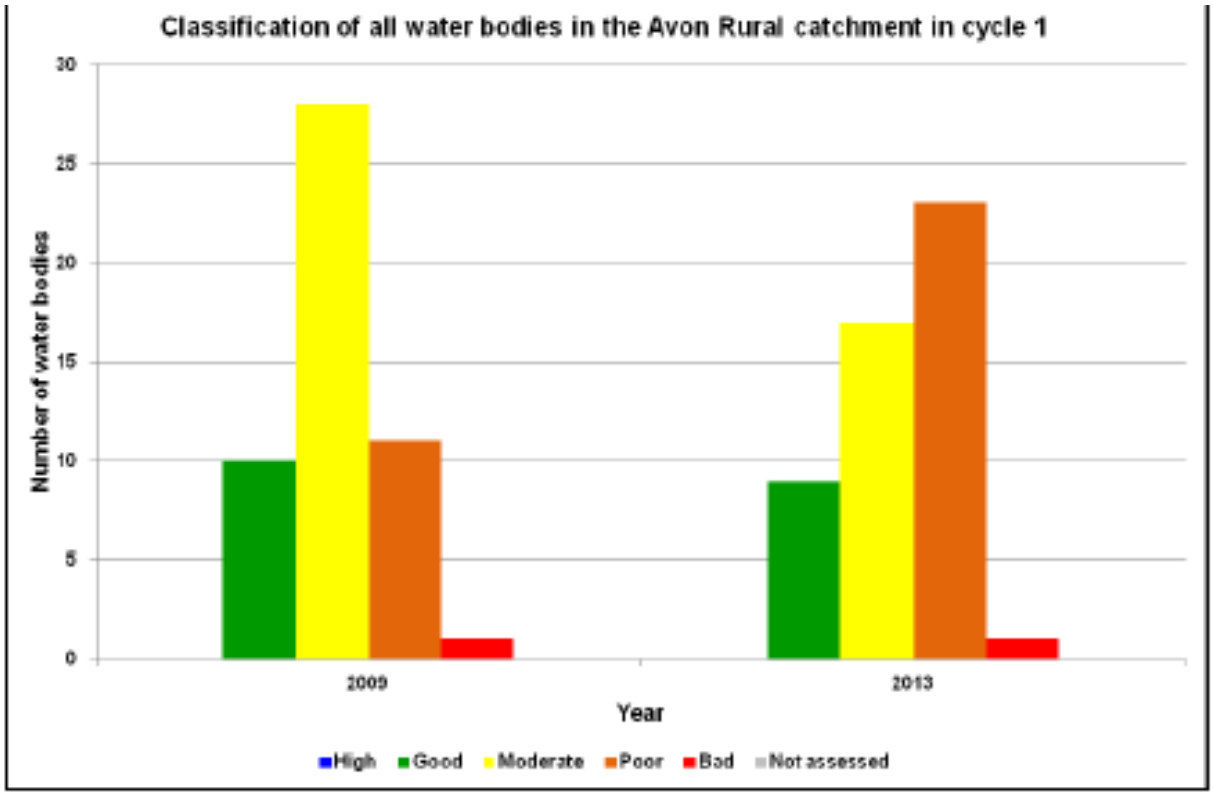



Figure 11 - Chart showing the classification of all water bodies in the Avon Rural catchment in cycle 1