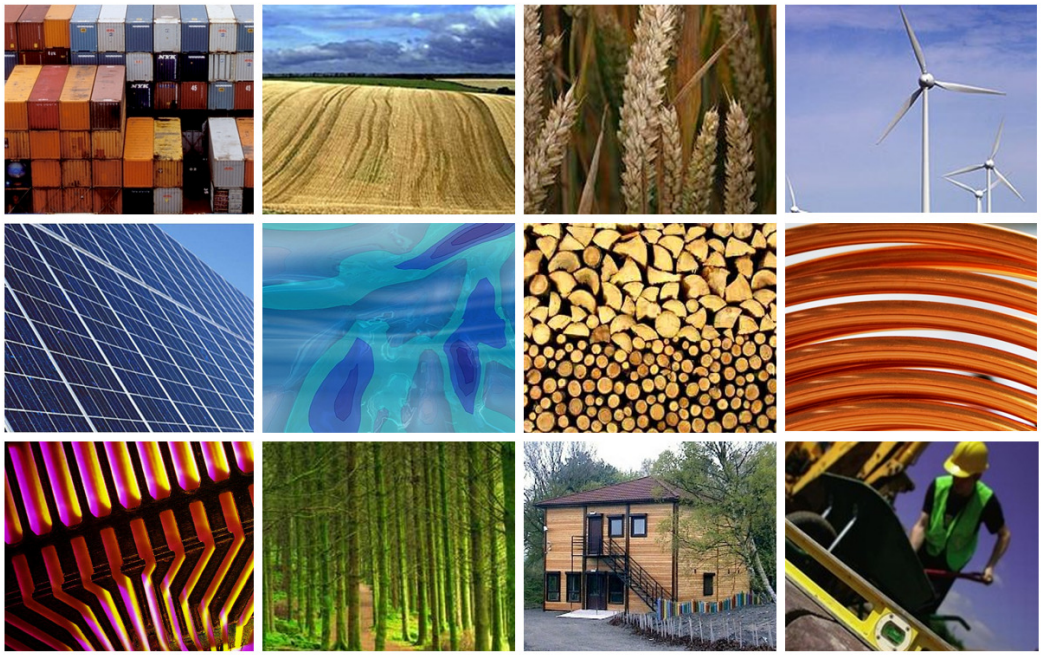
Final Report to Warwick District Council

Warwick District Council Climate Change Adaptation Study

February 2011



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Executive Summary

This report has been prepared by URSUS Consulting and Quantum on behalf of Warwick District Council (WDC) to provide assistance in planning its approach, operations and services in relation to climate change adaptation. It provides an evidence base for planning the continuation of its services, understanding the impacts on its own buildings and estate and planning for new development within the community in the face of climate change.

When the study was commissioned in August 2010, the county level Local Area Agreement (LAA) for Warwickshire included a target for achieving Level 3 in NI 188 (Progress by Local Authorities and their Partners in Addressing Climate Change Adaptation Issues) by March 2011, moving from the previously achieved Level 2. However, LAAs and national indicators were abolished by the Government in October 2010. Whilst WDC and partners in Warwickshire are therefore no longer required to report on progress against NI188, the contents of NI188 can still provide Local Authorities with a useful basis for assessing their progress on adaptation issues.

The project has the following objectives:

1. **Local climate change impacts and local vulnerabilities** – Review information already available both nationally and locally to identify local climate change impacts which WDC will need to take into account within the timescale of the UK Climate change predictions.
2. **Assess the likely impacts of climate change on Warwick District Council's service delivery** and provide recommendations to enable the development of resourced action plans for each service area, to mitigate these impacts.
3. **Adaptation of Buildings and Estate** - Assess the impacts of climate change on the buildings and estate of the Council and for future development not within WDC's ownership, but within WDC's area, and make recommendations for adaptation measures. Recommendations on how adaptation guidance can be integrated in planning guidance for new and existing development is contained in Part B of the report.

The work has been based on a combination of desk research and discussions with WDC officers, including a workshop with WDC service area heads in November 2010. The project has linked to work at the Warwickshire county level on adaptation issues led by the Warwickshire Climate Change Partnership [1]. Key findings and recommendations are summarised below.

i. Predictions for future climate change in Warwick District:

UKCP09 scenarios predict that future climate in Warwick District will lead to:

- Warmer, wetter winters with average temperatures 1.3^{o}C higher by the 2020s and 2.1^{o}C higher by the 2050s and with 5% more rain;
- Hotter, drier summers with average temperatures 1.5^{o}C higher by the 2020s and 2.6^{o}C higher by the 2050s with 7% less rain. Mean daily summer temperatures could be more than 5^{o}C higher by the 2080s; and
- More frequent extreme events including flooding, drought, high winds and sudden cold snaps.

1 Warwickshire Climate Change Partnership - www.warwickshire.gov.uk/climatechangepartnership

There is growing evidence that both gradual climate change and more frequent extreme events (eg. flooding in 1998 and 2007; gales in 2005; heatwaves in 2003 and 2006; cold snaps in 2009 and 2010) are already being experienced. The impacts across Warwickshire County have already led to significant disruption and costs in dealing with emergencies and repairing the damage.

This study has therefore identified key risks to WDC's services and assets, using a risk matrix to assess likelihood and severity of impacts and ensure that those areas of highest risk are addressed in corporate planning processes.

ii. Key Climate Change risks for WDC:

Flooding - Flooding on the scale of the 1998 or 2007 floods is the greatest risk to WDC owned and rented buildings and service delivery. Approximately 150 residential properties in Warwick, around 'Poets' Corner' and south west of Warwick hospital are at potential risk of riverine flooding; and another 42 properties on these same roads may become vulnerable in the future. Non-Council owned properties in these areas are also at risk. A number of the WDC corporate properties are also within the flood zone (Flood Zone 3a and 3b), including the Pump Rooms and leisure centres in Leamington Spa, Warwick and Kenilworth and Spencer's Yard, Leamington Spa. In addition parks and some car parks are within the flood risk zone in central Leamington Spa and parts of Warwick, while cemeteries in low lying areas may be at risk of water logging. The clean-up costs for building debris and parks are largely built into refuse and green space maintenance contracts.

There are also risks that staff will be unable to get into work, causing temporary disruption to services. All statutory and vital services (including ICT) are covered by WDC's Business Continuity Plans (BCPs). Insurance claims for flood damage to WDC buildings in 2007 totalled approximately £78,000 and while property reinstatement costs and lost rental income would be covered by insurance, costs of insurance may rise and other costs such as the cost of relocating tenants are not covered. There is also a risk that residents or businesses in these areas are not adequately insured. Opportunities for building in flood resilience/ resistance measures during planned maintenance and restoration, and building up community resilience to flooding need to be considered (for example, through use of the Community Infrastructure Levy to support investment in flood resilience).

Ice and Snow - Heavy snowfall and prolonged ice events could make it difficult for staff getting into work and cause some disruption to service delivery – mainly covered by BCPs – but could have more serious disruptive impacts on access for engineering services, refuse collection and maintenance of Council housing, causing some disruption to services and more demand for call centre and emergency services. Gritting for snow and ice can also damage multi storey car park structures, making concrete more susceptible to water ingress or cracking.

Heatwaves - Hotter drier summers and heatwaves are likely to increase tourist and visitor numbers and demand for outdoor events, recreation and leisure facilities, and could have a beneficial impact on WDC revenues. However, hotter summers are also expected to increase the incidence of anti-social behaviour and increase demand for community safety, planning and environmental services. Hot weather and water shortages will also affect staff working conditions - particularly in buildings which have not yet been adapted for heat resilience. Opportunities for low and medium cost heat resilience measures need to be considered as part of planned maintenance or restoration of buildings.

A few older properties with poor foundations in the area around Warwick Hospital are on clay soils susceptible to swelling and shrinkage and therefore subsidence. Parks, golf courses, grounds, street trees and floral planting schemes will all be adversely affected by prolonged heatwaves and drought, and it is therefore important that planting schemes increasingly take future climate into account.

High wind - Wind impacts on the ageing stock of highway and street trees could cause serious injury or fatalities from falling branches. This risk is currently managed through a regular inspection and monitoring regime and pruning of vulnerable trees. WDC is negotiating with Warwickshire County Council (WCC) to move to a three year inspection and pruning regime for Highway trees. If funds were available for a tree planting programme then the most vulnerable trees could gradually be replaced with native, fast growing and easily maintained trees (see *Part B* of the main report).

WDC Service Areas most at risk:

The WDC service area likely to be most seriously impacted by future climate change is Community Protection. Flood Alleviation and Civil Emergencies services will be impacted by flood, high wind, heatwave and snow and ice events during which they are likely to face increased demand and enquiries to WDC. During floods, WDC's flood alleviation team will need to support community recovery, provide rest centres and support the work of the emergency services. The social and economic impacts of flood will also impact on other parts of the Council such as Customer and Information Services, Cultural Services, Neighbourhood Services and Housing and Property Services.

Engineering Services are also likely to be affected by extreme events and wetter winters through damage to Council properties and structures (eg. freeze thaw damage to concrete structures, and heat damage to tarmac). Facilities Management will also be affected by staff related issues including: potential overheating of buildings and staff discomfort during heatwaves; potential wind damage to Council properties; and potential slip injuries to public and staff visiting Council premises and properties during ice/snow events.

iii. Recommended Adaptation Actions

Warwick DC already has a number of plans in place which provide a strong basis for addressing the greatest risks from climate change. These include the Emergency Plan and Business Continuity Plans for each service area. Further Council actions on climate change adaptation will help to:

- save the Council money by, for example, reducing damage to Council property from severe weather and reducing the risk of potential liabilities associated with extreme weather;
- reduce business and household costs by improving buildings so that they can withstand severe weather;
- reduce disruption of local services to households and businesses by preparing Council services for climate change and helping them become more resilient;
- create local jobs – the Local Government Association (LGA) estimate that 150,000 new jobs could be created from developing climate change measures, including building resilience; and

- access new resources – there is a range of support and funds for councils for working on climate change, including the DCLG funded Climate Change Skills fund managed in the West Midlands by Sustainability West Midlands.

A systematic approach is required to identifying adaptation actions and to strengthen the resilience of Council services and local communities to the impacts of climate change.

Overarching Corporate processes:

- Continue the on-going process of reviewing Service Area Risk Assessments and Business Continuity Plans to mitigate climate change impacts on WDC service delivery.
- Develop Business Continuity Plans in shared service areas with WCC – eg. call centres and one-stop-shop advice services.

WDC Assets:

- Identify opportunities for incorporating climate adaptation measures into refurbishment programmes for WDC owned properties (corporate, operational, commercial and housing) – eg. heat and flood resilience measures.
- Ensure that any future WDC office moves or new premises are not susceptible to climate change related risks such as flooding, overheating or water stress.
- Increase the inspection regime for trees which are vulnerable to climate change (eg. high wind events, disease from milder winters and damage during drier summers) and shift towards planting resistant native species which provide summer shade.

Planning:

- Develop a planning policy on climate change adaptation and supporting guidance which ensures that new developments in the district are designed to be resilient to and minimise the negative impacts of climate change. These policies will need to be integrated into the forthcoming new Local Plan and could be contained in a new Supplementary Planning Document (SPD) on climate change adaptation or be integrated into the existing SPD on Sustainable Buildings.
- Provide training on building adaptation issues and new adaptation planning policies / SPDs to WDC development control and building control staff, potentially making use of the regional Climate Change Skills fund managed nu Sustainability West Midlands.

Working with partners and contractors:

- Work on horizon scanning and monitoring of weather events with partners such as the Met Office, WCC and Environment Agency (EA) to identify any significant changes in climate related risks.
- Ensure that external contracts, in areas such as refuse, grounds maintenance and housing maintenance, are sufficiently flexible to take account of climate change adaptation and, where appropriate, can provide flexible emergency cover (eg. for snow/ice and tree clearance after high wind events).

Flooding - Protecting WDC assets:

- Identify WDC properties in the flood risk zone and investigate costs and benefits of retrofitting vulnerable properties with flood resistance and resilience measures – particularly for vulnerable households / tenants (such as elderly or disabled tenants).
- Ensure that flood resilience measures are phased into regular maintenance and repair schedules in premises such as the Pump Rooms and leisure centres.
- Ensure that adequate insurance is in place to cover financial impacts of flood damage to WDC properties and assets.
- Continue to ensure that valuable assets in buildings are safe from potential flood damage (eg. in the Pump Rooms and ICT systems in Riverside House). Check that the WDC's ICT remote continuity contract is in place.
- Any new WDC developments, properties and major projects should include a risk assessment of the impacts of future climate change at the project design / early stages to enable resilience measures to be integrated into projects.
- Examine the case for acquiring more land for cemeteries in less flood prone sites.

District wide flood protection:

- Develop a multi-agency flood plan with key partners (emergency services, EA, WCC, and other Districts). This should include both engineering works and helping the community and businesses increase their resilience.
- On-going monitoring of district wide flood risks, working with partners such as the Environment Agency, WCC and other Districts including reviewing the findings from the 2011 WCC/Environment Agency study on areas susceptible to flooding from poor drainage (eg. Cubbington) and identify appropriate actions to reduce this flood risk.
- Examine the benefits and costs of flood resilience or resistance measures versus flood alleviation schemes for vulnerable properties not owned by WDC.
- Examine opportunities for grants and financial support for installing flood resilience measures and products in flood risk zones and mechanisms – such as the Community Infrastructure Levy and parish precepts – to help pay for them.
- Examine the feasibility of creating a fund for retrofitting properties, potentially linked to the Community Infrastructure Levy on new development. (Government guidance indicates that the Community Infrastructure Levy could be used to fund climate change adaptation work, such as flood defences and green space improvements[2]).

Summer Heatwaves:

- Ensure that Major Emergency Plan and Service Area Crisis Plans cover heatwaves - eg. water shortages, fires, legionella or food poisoning outbreaks.
- Monitor whether WDC properties, offices and housing require enhanced cooling systems (particularly low carbon, natural cooling or blinds) or other heat resilience measures during hot spells.
- Monitor the need to revise tarmac materials and specifications if damaged during heatwaves.
- Raise public awareness about reducing risk of fires (eg. use of portable BBQs).

[2] The Community Infrastructure Levy – An Overview, DCLG March 2010.

High Wind / Storms:

- Develop Emergency and Service Area Crisis / Continuity Plans to deal with high wind / storm events - for all service areas – eg. if a Force 8 wind is forecast, put 2 clearance teams on standby.
- Work with WCC to ensure adequate tree inspection regimes to minimise risk of injury and damage from windblown trees.
- Undertake periodic checks to ensure that WDC owned premises are not susceptible to wind damage (eg. roof inspections and possible renovation of glass ceiling in the Pump Rooms).

Winter Snow/ice:

- Continue to grit in high risk areas, and ensure adequate supplies of grit and urea beads (for concrete structures).
- Monitor whether WDC properties are susceptible to ice / freeze thaw damage.
- Work with WCC to examine opportunities for including gritting of key car parks within WCC road gritting activities.

1 INTRODUCTION

1.1 AIMS

This report has been commissioned by Warwick District Council (WDC) to provide assistance in planning its approach, operations and services in relation to climate change adaptation. It provides an evidence base for planning the continuation of its services, understanding the impacts on its own buildings and estate and planning for new development within the community in the face of climate change.

When the study was commissioned in August 2010, the county level Local Area Agreement (LAA) for Warwickshire included a target for achieving Level 3 in NI 188 (progress by Local Authorities and their Partners in Addressing Climate Change Adaptation Issues) by March 2011, moving from the previously achieved Level 2. However, LAAs and national indicators were abolished by the Government in October 2010. Whilst WDC and partners in Warwickshire are therefore no longer required to report on progress against NI188, the contents of NI188 can still provide Local Authorities with a useful basis for assessing their progress on adaptation issues.

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- **Assess the likely impacts of climate change on Warwick District Council's service delivery** and provide recommendations to enable the development of resourced action plans for each service area, to mitigate these impacts.

- **Adaptation of Buildings and Estate** - Assess the impacts of climate change on the buildings and estate of the Council and for future development not within WDC's ownership, but within WDC's area, and make recommendations for adaptation measures.

The work has been based on a combination of desk based research and discussions with WDC officers, including a workshop with WDC service area heads in November 2010. The project has linked to work at the Warwickshire county level on adaptation issues led by the Warwickshire Climate Change Partnership (www.warwickshire.gov.uk/climatechangepartnership).

1.2 WHAT IS CLIMATE CHANGE ADAPTATION?

In combating climate change there is a need for action both in terms of *mitigation* and *adaptation*.

Mitigation refers to our efforts to tackle the causes of climate change by reducing emissions of greenhouse gases, through measures such as low carbon energy generation, low carbon transport and energy efficiency in buildings. The UK aims to reduce greenhouse gas emissions by 80% by 2050. However, irrespective of the success of mitigation efforts, we are still locked into some degree of climate change because of past and present greenhouse gas emissions which will result in changes to our climate for several decades to come, regardless of any present-day emission reductions.

Adaptation is about adjusting the way that we do things to minimise the negative impacts of climate change and to ensure that we are prepared for climate change. Adaptation measures focus on ensuring that services, assets, communities, businesses, infrastructure and the economy are resilient to the impacts of changing climate. Adaptation and mitigation are therefore both essential parts of our approach to climate change.

Adapting to climate change will reduce the impacts of a changing climate, both in terms of costs and the extent of damage. Examples of adaptation measures include:

- Ensuring that new buildings and infrastructure are sited in areas that minimise exposure to flood risk.
- Enhancing green space in the design of towns and cities to help manage surface water drainage and cope with rising temperatures and heatwaves.
- Ensuring that buildings can cope with rising temperatures and floods.
- Using water more efficiently in order to reduce vulnerability to droughts.
- Improving and extending ecological networks and habitat bridges, so that biodiversity can adapt and move as the climate changes.
- Making space for water along rivers and the coast.
- Creating plans that reduce impact on and ensure continuation of care for the most vulnerable groups in society (such as the elderly) during heatwaves and floods.

1.3 WHY IS CLIMATE CHANGE ADAPTATION IMPORTANT FOR LOCAL AUTHORITIES?

UK climate projections forecast that climate will change over the next decades, including increases in intense downpours and associated potential for flood events, as well as increases in storms, hotter drier summers, heatwaves and milder wetter winters. There is therefore a need to strengthen the resilience of local services and local communities to both gradual change and climate variability which gives rise to extreme weather events.

Councils have important roles to play in their local areas through their functions as:

- service providers – local services can influence how well local communities are prepared for climate change and adapt their own provision to cope with climate change, including through Council roles in planning and building control;
- estate managers – ensuring that Council property is resilient to the impacts of climate change and managing green space to alleviate climate impacts;
- community leaders – persuading and helping local people, businesses and organisations to adapt to climate change.

Council actions on climate change adaptation will help to:

- reduce household and business costs by improving buildings so that they can withstand severe weather;
- reduce disruption of households, local services, businesses and agriculture by preparing them for the impacts of climate change;
- create local jobs – the Local Government Association (LGA) estimate that 150,000 new jobs could be created from climate change measures, including building resilience to climate change;

- save the Council money by, for example, reducing damage to Council property from severe weather and reducing the risk of potential liabilities associated with extreme weather; and
- access new resources – there is a range of support and funds for Councils for work on climate change.

A systematic approach is required to identifying adaptation actions and to improve the resilience of Council services and local communities to the impacts of climate change.

1.4 REPORT STRUCTURE

The report is structured into two parts – Part A and Part B:

Part A – WDC Climate Change Adaptation Risk Assessment provides:

- **Section 2 – Policy Context, identifies policy drivers,** from the national to local level, for Local Authority actions to address climate change adaptation issues.
- **Section 3 – the Changing Climate**, including future climate change projections for Warwick District.
- **Section 4 – WDC Service Area Risk Assessment and Adaptation Actions**, including a summary of key recommendations, presented in a draft Climate Change Adaptation Action Plan for WDC.

Part B – Planning for Climate Change Adaptation provides:

- **Section 5** and **Section 6** provide recommendations for climate change adaptation of buildings and for integrating adaptation issues into the WDC Local Plan and potential Supplementary Planning Documents.

In addition, the **Annexes** contain the risk assessment matrices for WDC service areas.

Part A

WDC Climate Change Adaptation Risk Assessment

2 THE POLICY CONTEXT

The UK government has recognised the key role of local government in tackling climate change. This section outlines national and local policies which are driving consideration of climate change adaptation issues for Warwick DC.

National Policy Context:

- Climate Change Act (2008).
- NI 188.
- The Civil Contingencies Act (2004).
- The Pitt Review.
- National Heatwave Plan.
- Planning Policy Statements.
- Nottingham Declaration.

Local Policy Context:

- Strategic Flood Risk Assessment for Local Development Framework – Level 1 (2008).
- Warwickshire Sub-Regional Water Cycle Study – Warwick District Council (2010).
- Warwick District Local Plan 1996 – 2011, and the climate change policies: DP11 Drainage, DP12 Energy Efficiency and DP13 Renewable Energy Developments.
- Sustainable Buildings SPD (2008).
- Renewable and Low Carbon Energy Resource Assessment and Feasibility Study (2010).
- Warwick District Green Infrastructure Study (2010).
- WDC Emergency Plan.
- WDC Business Continuity Plan
- WDC Corporate Risk Register.

2.1 NATIONAL POLICY CONTEXT

2.1.1 Climate Change Act (2008)

The Climate Change Act became law in November 2008. The Act requires the Government to produce a UK Climate Change Risk Assessment by 2012 and to prepare a programme of adaptation measures. The Act creates new powers to direct public bodies to address climate risks and to produce an action plan. In line with this, the previous Government included the climate change adaptation indicator (NI188) within the local government performance framework, requiring local authorities to undertake a climate change risk assessment and develop an action plan to address those risks (Adaptation Reporting Power).

2.1.2 NI 188

As noted above, when Warwick DC commissioned this study in August 2010, the county level Local Area Agreement (LAA) for Warwickshire included a target for achieving Level 3 in NI 188 by March 2011, moving from the previous Level 2. However, LAAs and national indicators were abolished by the Coalition Government in October 2010. Whilst WDC and partners in Warwickshire are therefore no longer obliged to report on progress against NI188, the contents of NI188 can still be seen as providing a useful basis for Local Authorities to assess their progress on adaptation issues and ensure that all major corporate risks have been identified and planned for.

Key aspects of local authority actions on climate change adaptation (as shown in *Table 2.1* below) include:

- comprehensive risk-based assessments of vulnerabilities to current and future weather and climate;
- communication of potential vulnerabilities and opportunities to department/service heads;

- identification of effective adaptive responses, and incorporation of these into Council strategies, plans, partnerships and operations;
- implementation of appropriate adaptive responses in priority areas;
- encouraging local partners to identify major weather and climate vulnerabilities;
- embedding climate impacts and risks across Council decision making; and
- regular and continual monitoring and review of progress on adaptation actions.

Table 2.1 NI188 (now abolished) indicator level definitions

NI 188 indicator level	Technical definition
Level 0 - Getting started	• The Authority has begun the process of assessing the potential threats and opportunities across its estate and services (for example, flood and coastal resilience plans, emergency planning, community risk registers/strategies etc). • The Authority has identified and agreed the next steps to build on that assessment in a systematic and coordinated way.
Level 1 – Public commitment and impact assessment; assembling an evidence base	• The Authority has made a public commitment to identify and manage climate related risk. • It has undertaken a local risk-based assessment of significant vulnerabilities and opportunities to weather and climate, both now and in the future. It can demonstrate a sound understanding of those not yet addressed in existing strategies and actions (e.g. in land use planning documents, service delivery plans, flood and coastal resilience plans, emergency planning, community risk registers/strategies etc). • It has communicated these potential vulnerabilities and opportunities to department/service heads and other local partners and has set out the next steps in addressing them.
Level 2 – Comprehensive risk assessment (with prioritised action in some areas)	• The Authority has undertaken a comprehensive risk-based assessment of vulnerabilities to weather and climate, both now and in the future, and has identified priority risks for its services. • It has identified the most effective adaptive responses and has started incorporating these in Council strategies, plans, partnerships and operations (such as planning, flood management, economic development, social care, services for children, transport etc). • Begun implementing appropriate adaptive responses in some priority areas. • In its role as a community leader the Council has started working with its LSP encouraging identification of major weather and climate vulnerabilities and opportunities that affect the delivery of the LSP's objectives.
Level 3 – Comprehensive action plan (and prioritised action in priority areas)	• Authority embedded climate impacts and risks across Council decision making. • It has developed a comprehensive adaptation action plan to deliver the necessary steps to achieve the existing objectives set out in Council strategies, plans, investment decisions and partnership arrangements in light of projected climate change and is implementing appropriate adaptive responses in all priority areas. • This includes leadership and support for LSPs in taking a risk-based approach to managing major weather and climate vulnerabilities/opportunities across the wider local authority area.
Level 4 - Implementation, monitoring and continuous review	• The Authority and LSP are implementing the comprehensive adaptation action plan across the local authority area. • There is a robust process for regular and continual monitoring and review to ensure progress with each measure and updating of objectives. The Authority and LSP are taking appropriate adaptive responses.

2.1.3 Adaptation Sub-Committee of the statutory Climate Change Committee

A recent report by the Adaptation Sub-Committee (ASC, Sept 2010)[3] of the statutory Climate Change Committee identifies the need to take a strategic approach to land use planning to ensure that new buildings and infrastructure are sited in areas that minimise exposure to flood risk, do not increase flood risk to others, and do not create a legacy of flood defence or water supply costs; and to enhance green space, where effective, in the design of towns and cities to help manage surface water drainage and cope with rising temperatures and heatwaves. The ASC also identifies the need to design and renovate buildings – for example to ensure they can cope with rising temperatures and floods and minimise water use through appropriate use of construction materials and through better design.

2.1.4 The Civil Contingencies Act (2004)

The Civil Contingencies Act (2004) places legal responsibility on a number of 'First' and 'Second' responders to undertake emergency and contingency planning. WDC has prepared emergency plans and works with partners such as WCC, the emergency services and Environment Agency to coordinate emergency responses and risk-reduction strategies across a range of potential civil emergencies: including flu pandemics, major floods, cold periods and heatwaves. Many of the severe weather risks considered by the emergency plan will be affected by climate change.

2.1.5 The Pitt Review

Following the severe floods experienced during the summer of 2007, the Pitt Review (*Lessons learned from the 2007 Floods*, 2008) made a number of policy recommendations to reduce the risk and impacts of flooding in the future. The review identified a lack of clarity on which agencies and organisations are responsible for surface water drainage. The subsequent Flood and Water Management Bill clarifies this by giving local authorities responsibility for surface water drainage, and requires them to prepare Surface Water Management Plans in collaboration with the Environment Agency and water companies.

2.1.6 National Heatwave Plan

Heatwave conditions are defined by the Met Office as temperatures above 30°C during the day and above 15°C at night. Significant health impacts and increased deaths were recorded nationally in recent heatwaves such as during July 2006, when temperatures exceeded these levels for more than a week. In response to this, and to the potential warming impacts of climate change, the Department of Health has developed a *National Heatwave Plan for England* (2010). This includes a 'Heat-Health Watch System' for use by health and social care providers. The 'Heat-Health Watch System' uses a series of levels of heatwave alerts, in partnership with the Met Office, ranging from green through amber to red. The Heatwave Plan identifies factors which increase health risks from heatwaves, and presents a range of measures that local services can put in place to provide cooler spaces and reduce health risks during heatwaves.

[3] How well prepared is the UK for climate change?, Adaptation Sub-Committee September 2010

2.1.7 Planning policy

National planning policy places a duty on local authorities to incorporate climate change mitigation and adaptation into local development frameworks (LDFs) and highlights the importance of implementing the *Planning Policy Statement on Planning and Climate Change* (PPS1). Local authorities need to ensure that local development plans are adapted to climate change, including taking account of future flood risk, as highlighted in *PPS25 Development and Flood Risk*.

- **Planning Policy Statement 1 (PPS 1): Delivering Sustainable Development** (January 2005) sets out the Government's overarching planning policies on the delivery of sustainable development through the planning system.

- **Planning Policy Statement: Planning and Climate Change. Supplement to Planning Policy Statement 1** (December 2007): The supplement on Climate Change sets out how planning - in providing for the new homes, jobs and infrastructure needed by communities - should help shape places with lower carbon emissions and resilient to the climate change now accepted as inevitable. PPS 1 focuses on mitigation but also covers the contribution of open space and green infrastructure to urban cooling, sustainable drainage systems, and conserving and enhancing biodiversity. It also addresses known physical and environmental constraints on the development of land, such as sea level rise, flood risk and stability; and emphasises the need for taking a precautionary approach to dealing with increased risks that could arise from changes to the climate. PPS 1 specifies that local Supplementary Planning Documents (SPDs) can be developed to provide locally relevant guidance.

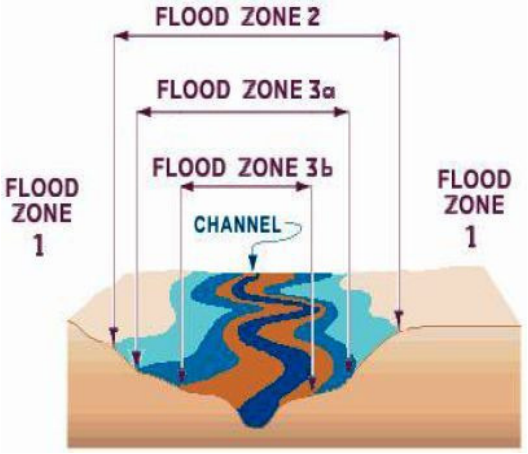
- **Planning Policy Statement 25 (PPS 25): Development and Flood Risk** (March 2010) is the key policy in relation to flooding and has introduced a sequential, risk-based approach to planning for new development in order to avoid and manage flood risk. Consideration of drainage and flooding issues is required in all locations, not just within the floodplain. PPS 25 steers new development to areas of low flood risk (Zone 1) – see *Figure 2.1* below. Where - in exceptional circumstances - new development is considered in areas of significant or moderate risk (Zones 2 and 3) applicants should apply a 'Sequential Test' to demonstrate that the development could not be built elsewhere in a lower flood risk area. Where development in flood risk zones is permitted then the development must be appropriately protected or resilient against flooding. The PPS25 sequential approach underpins the development of Local Development Frameworks / Local Plans and, as such, the sequential test will not be required at the planning application stage for development sites which are allocated within a Local Plan.

2.1.8 Community Infrastructure Levy (CIL)

The Community Infrastructure Levy (CIL) came into effect in April 2010. It allows local authorities in England and Wales to raise funds from developers undertaking new building projects in their area. The money can be used to fund a range of infrastructure needed as a result of development, including helping areas adapt to climate change by enhancing the provision of flood defences and green infrastructure.

Figure 2.1 Flood Risk Zones

Flood Zones show the areas potentially at risk of flooding from rivers or the sea, ignoring the presence of defences, based on data produced by the Environment Agency.



- **Flood Zone 3b** = The Functional Floodplain - annual probability of 1 in 20.
- **Flood Zone 3a** = High Probability, 1 in 100 or greater annual probability.
- **Flood Zone 2** = Medium Probability, between 1 in 100 and 1 in 1000 annual probability.
- **Flood Zone 1** = Low probability, 1 in 1,000 annual probability.

Source: WDC Strategic Flood Risk Assessment for Local Development Framework – Level 1 (January 2008)

2.1.9 Nottingham Declaration

In addition to these central government initiatives, the Nottingham Declaration on Climate Change has been developed by Councils in partnership with various climate change agencies. Over 90% of local authorities in England, including Warwick District Council, have now signed up to the Declaration, pledging their authority to adapt to the impacts of climate change and to take action to reduce greenhouse gas emissions. The declaration commits Local Authorities to develop climate change action plans, including on adaptation.

2.2 LOCAL POLICY CONTEXT

Recent weather events in Warwick district, such as the floods in April 1998 and summer 2007, have highlighted the importance of effective plans and actions to minimise the impacts of extreme weather events on local communities and WDC's service delivery and assets.

In addition, a range of strategic documents exists which are relevant to this climate change adaptation study, including:

- **Strategic Flood Risk Assessment for Local Development Framework - Level 1** (2008) – which identifies the areas at greatest risk of river flooding across the district. During 2011 Warwickshire County Council will also produce an assessment of surface water flooding risks.
- **Warwickshire sub-regional Water Cycle Study - Warwick District Council Final Report** (March 2010), which provides the evidence base for the Core Strategy / new Local Plan in examining whether development will have a detrimental effect on the water based environment and whether the necessary water infrastructure can be provided in a timely manner to support development.
- **Warwick District Local Plan 1996-2011** –includes climate change related policies on renewable, energy efficiency, building design and open space provision, including policies DP11 Drainage, DP12 Energy Efficiency and DP13 Renewable Energy Developments.

- **WDC Sustainable Buildings Supplementary Planning Document (SPD)** (2008) – provides more detailed guidance on Sustainable Urban Drainage Systems, building design and orientation and expands on Local Plan policies such as DP11 Drainage, DP12 Energy Efficiency and DP13 Renewable Energy Developments.
- **Renewable and Low Carbon Energy Resource Assessment and Feasibility Study** (2010) – considers the viability and deliverability of renewable and low carbon options across Warwickshire.
- **WDC Emergency Plan** –has been prepared by WDC to respond to emergencies such as floods, pandemics and terrorist attacks and includes protocols and priorities for the work of emergency teams.
- **WDC Business Continuity Plan** –provides details of how each WDC service area will respond to a crisis, such as damage to buildings, operating systems or staff or clients unable to access WDC buildings, so that staff can continue to deliver key services.
- **WDC Corporate Risk Register** –identifies key risks for WDC across all departments and services in a '5 by 5' risk assessment matrix and identifies how the most significant risks will be managed. Each service area reviews the risk register with the WDC Corporate Risk Manager on a regular basis.
- **Warwick District Green Infrastructure Study** (2010) which identifies the important function of green infrastructure in helping to adapt to the impacts of climate change.

2.3 SUMMARY

A combination of national and local drivers has led Warwick DC to develop plans for responding to extreme weather events in areas such as the Emergency Plan. The assessment provided in *Section 4* provides a systematic review of climate change risks and recommended mitigation actions across all WDC service areas. Prior to that, *Section 3*, provides more detail on the expected changes in climate which WDC will need to address.

3 THE CHANGING CLIMATE

3.1 CHANGES TO THE GLOBAL CLIMATE

3.1.1 What is the evidence for climate change?

There is now broad consensus among the international community that the world is warming and that this is mainly the result of human activities. The UN Intergovernmental Panel on Climate Change (IPCC), a body set up by the World Meteorological Organisation (WMO) and the United Nations Environment Programme (UNEP), has been reviewing worldwide research on climate change since 1988. In its latest *AR4 Synthesis Report* for the IPCC meeting in Valencia in November 2007, it concluded that

> *'warming of the global climate system is unequivocal, with global average temperatures having risen by nearly 0.8 ^{o}C since the late 19th century, and rising at about 0.2 ^{o}C per decade over the past 25 years'.*

According to the IPCC:-

- Eleven of the twelve years (1995-2006) rank among the twelve warmest years in the instrumental record of global surface temperature (since 1850).
- Global average sea level has risen since 1961 at an average rate of 1.8 mm/year, and since 1993, at 3.1 mm/year.
- Satellite data since 1978 shows that annual average Arctic sea ice extent has shrunk by 2.7% per decade. Mountain glaciers and snow cover on average have declined in both hemispheres.
- From 1900 to 2005, precipitation increased significantly in eastern parts of North and South America, northern Europe and northern and central Asia, but declined in the Sahel, the Mediterranean, southern Africa and parts of southern Asia.

Climate versus weather - 'Weather' is what we experience over a short period of time – over an hour or a day. 'Climate' is the average weather and its variability over a long period of time (at least 30 years). It is important not to confuse short term weather events (for example, the cold winters of 2010), with long-term trends (for example, winters warming by over 2˚C by the mid century). Cold spells of weather in the UK and parts of Europe do not mean that climate change has stopped. In the UK, 2009 was in fact the 15th warmest year on record and, taking the globe as a whole, 2009 was the fifth warmest year on record. Cold weather events will continue to occur in the future, but are projected to become increasingly less common.

3.1.2 Why is climate change happening?

There is broad consensus among the international community that human (anthropogenic) activities are the main cause of the recent global warming. In its latest *AR4 (2007) Synthesis Report*, the UN Intergovernmental Panel on Climate Change (IPCC) concludes that:-

"Most of the observed increase in globally-averaged temperatures since the mid-20th century is very likely[4] *due to the observed increase in anthropogenic (man-made) global greenhouse gas (GHG) concentrations".*

According to the IPCC:-

- GHG emissions due to human activities have grown since pre-industrial times, with an increase of 70% between 1970 and 2004.
- Global atmospheric concentrations of CO_2, methane (CH_4) and nitrous oxide (N_2O) have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values determined from ice cores spanning many thousands of years.
- Atmospheric concentrations of CO_2 (379ppm) and methane (1774 ppb) in 2005 exceed by far the natural range over the last 650,000 years.
- Global increases in CO_2 concentrations are due primarily to fossil fuel use, with land-use change providing another significant but smaller contribution.
- There is general agreement and much evidence that with current climate change mitigation policies and related sustainable development practices, global GHG emissions will continue to grow over the next few decades.

3.1.3 What is likely to happen to the global climate?

With the current level of greenhouse gas emissions, the global climate will continue to change, and there is now a better understanding of how the impacts of climate change will vary across the globe. In its latest *AR4 (2007) Synthesis Report*, the UN Intergovernmental Panel on Climate Change (IPCC) concludes that:

- For the next two decades a warming of about 0.2°C per decade is expected.
- From 2030 onwards, temperature projections increasingly depend on the levels of emissions. The IPCC has projected the average surface temperature of the Earth is likely to increase by 1.1 - 6.4°C by the end of the 21st century, relative to 1961-1990, with a best estimate of 1.8 - 4.0°C.

There is growing understanding of how climate change might have variable impacts across the globe. The IPCC predicts:

- Warming will be greatest over land and at most high northern latitudes and least over the Southern Ocean and parts of the North Atlantic Ocean, continuing recent trends in contraction of snow cover area, increases in thaw depth over most permafrost regions, and decrease in sea ice extent.
- Increase in frequency of hot extremes, heatwaves, and heavy precipitation (rain and snow).
- Increase in tropical cyclone intensity.
- Poleward shift of extra-tropical storm tracks with consequent changes in wind, precipitation, and temperature patterns.

[4] The IPCC definitions of likelihood are used, i.e.: very likely means: more than 90 per cent probability of occurrence; likely means: more than 66 per cent probability; unlikely means: less than 33 per cent probability, very unlikely means: less than 10 per cent probability.

- Precipitation (rain and snow) increases in high latitudes and decreases in most subtropical land regions.

3.2 THE UK'S CLIMATE

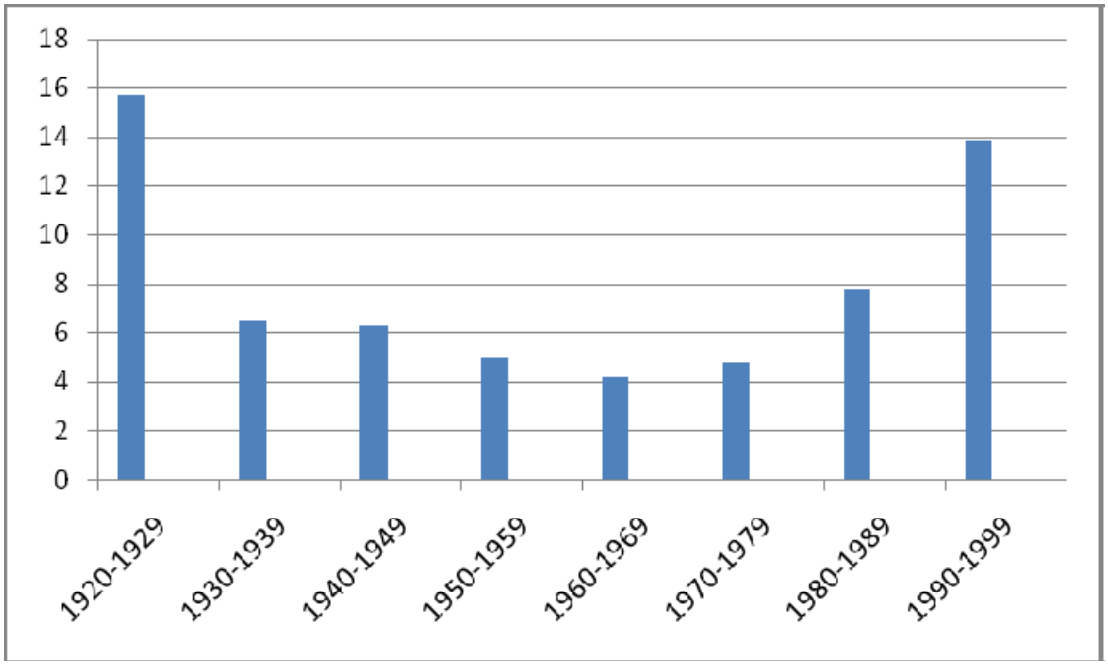
3.2.1 Observed changes in the UK climate

The 'climate of the UK and recent trends' report from the UK Climate Projections (UKCP09) identifies the following climate change effects to date for the UK[5]:

- In Central England temperature has risen by about a 1.0 ^{o}C since the 1970s, with 2006 being the warmest on record. It is likely that there has been a significant influence from human activity on the recent warming.
- Annual mean precipitation (rain, hail, snow etc) over England and Wales has not changed significantly since records began in 1766. Seasonal rainfall is highly variable, but appears to have decreased in summer and increased in winter, although with little change in the latter over the last 50 years.
- All regions of the UK have experienced an increase over the past 45 years in the contribution to winter rainfall from heavy precipitation (rain, hail, snow etc) events.
- Severe windstorms around the UK have become more frequent in the past few decades, though not above that seen in the 1920s (see *Figure 3.1*). There is not yet a scientific consensus about how this effect relates to climate change.
- Sea-surface temperatures around the UK coast have risen over the past three decades by about 0.7 ^{o}C.
- Sea level around the UK rose by about 1mm per year in the 20th century, (corrected for land movement). The rate of sea level rise for the 1990s and 2000s has been higher than this.

[5] Jenkins G.J., Perry M.C. and Prior M.J.O., 2009. The Climate of the United Kingdom and Recent Trends, Revised Edition, Jan 2009, Met Office Hadley Centre

Figure 3.1 Number of severe storms per decade over the UK and Ireland during the period October to March



Source: Met Office Hadley Centre

3.2.2 What is likely to happen to the UK's climate in the Future?

UKCP09 Scenarios for Future Climate Change (June 2009) presents climate change projections in probabilistic form based on models of the climate system. It presents projections for three different greenhouse gas emission scenarios: 'low', 'medium' and 'high'. UKCP09 projections are provided at seven 30-year time periods covering the period from 2010 to the end of this century – thus the '2050s' represents the average across the time period from 2040-2069. The changes are described relative to a 1961 to 1990 baseline. Further information, including other significant variables (e.g. humidity, rainfall intensity, maximum and minimum temperatures), additional timescales and alternative probability levels is available from the UKCP09 website (http://ukcp09.defra.gov.uk/).

The UK climate is expected to become warmer, with wetter winters, drier summers, and more extreme weather events, such as heavy rain and high winds. UKCP09 identifies the following likely changes:

Long-term / seasonal averages

- Warmer, drier summers (spring and autumn too).
- Milder, wetter winters.
- Rising sea levels.

Extremes

- More very hot days.
- More intense downpours of rain (predominantly in winter, but modelling suggests that rainfall events will tend to intensify throughout the year).
- Fewer snowfalls and frost nights.

- Possible increase in storms (high winds), although there is greater modelling uncertainty associated with storm estimates.
- Climate changes are likely to be most pronounced in the south and east of the country due to proximity to the continental land mass, and rather less pronounced in the north and west due to the thermal buffering of the Atlantic Ocean.

3.3 FUTURE CLIMATE PROJECTIONS FOR WARWICK DISTRICT

Consideration of future climate change in Warwick District is based on scenarios of future global emissions of greenhouse gases. The scenarios reported by UK Climate Projections 2009 (UKCP09)[6] describe three alternative emissions scenarios for the UK: 'low emissions', 'medium emissions and 'high emissions'. In this report we have largely presented results for the medium emissions scenario. All projected changes in climate are given relative to the baseline period of 1961 to 1990.

The Met Office Hadley Centre has developed a methodology for providing probabilistic climate projections to describe the future climate for each 25 x 25 km grid square in the UK.

A summary of the modelled climate predictions for Warwick district, according to UKCP09 (released June 2009), is shown in *Table 3.1* – giving predicted changes in temperature and precipitation to 2020, 2050 and 2080, compared with the 1961–1990 baseline.

Table 3.1 Predictions for climate change in Warwick District based on the medium emissions scenario and central estimates for 2020, 2050 and 2080s

Climate Variable	2020s	2050s	2080s
Winter Mean Temperature	+1.3°C	+2.1°C	+2.9°C
Summer Mean Temperature	+1.5°C	+2.6°C	+3.7°C
Summer mean daily max	+2.1°C	+3.6°C	+5.2°C
Summer mean daily min	+1.5°C	+2.7°C	+3.9°C
Annual mean precipitation	0%	0%	+1%
Winter mean precipitation	+5%	+13%	+17%
Summer mean precipitation	-7%	-17%	-20%
Source: UKCP09 http://ukclimateprojections.defra.gov.uk/			

In addition, it is forecast that there will be more very hot days, fewer very cold days, more frequent heavy winter precipitation and more frequent winter storms.

The potential effects of these changes are outlined in *Table 3.2* below:

[6] Available from the UKCP09 website http://ukclimateprojections.defra.gov.uk

Table 3.2 Expected Climate Changes by 2020 and Potential Impacts

LONG TERM WEATHER IMPACTS	
Hotter, drier summers and mean temperature rise of 0.5-1.5°C Summer precipitation fall by up to 20% Decease in soil moisture	**Drier warmer summers:** In the West Midlands average temperatures have risen by nearly 1°C since the 1970s. Temperatures in urban areas can be several degrees higher than those in surrounding rural areas, particularly during summer nights. High temperatures in unsuitable buildings can cause discomfort to staff, clients and residents and extreme temperatures can cause illness and death for very vulnerable groups.
Milder, wetter winters. Winter mean temperatures rise by 0.5-1.0°C Winter precipitation increases by up to 10%	**Increased Winter rainfall:** Winter rainfall is increasing, particularly in Autumn with more rain falling in intense rainfall events. Wetter winters can lead to waterlogging, exacerbate subsidence on clay soils and cause damp related problems for buildings and occupants.
EXTREME WEATHER IMPACTS	
Flooding Increase in the number of very intense precipitation events, especially in winter. Greater percentage of annual rainfall as heavy precipitation	**Flooding:** As a significant proportion of Warwick District's built up area is situated on the floodplain of the River Leam and River Avon, heavy rain can lead to flash-floods from tributaries, especially if culverts are blocked. Poorly maintained or overwhelmed drains can lead to flooding in basements and low lying areas, and foul water entering properties.
High Winds More gales and high winds	**High winds:** Storms and periods of high winds or flying debris can cause damage to infrastructure including corporate buildings, homes, overhead power lines and railway stations, and make travel hazardous. During 2007 Warwickshire County experienced disruption to road and rail services from fallen trees and power outages to 1,000 homes. There was a huge increase in emergency service call outs.
Heatwaves and Drought: Increase in the number of very hot days. Heatwaves more frequent and intense.	**Heatwaves and drought:** High temperatures can result in health problems and are particularly hazardous for older and vulnerable people leading to excess heat related deaths. Severe dry weather can lead to water shortages in areas where aquifers are already being over-abstracted and subsidence and drainage problems in the vicinity of large trees. High temperatures can also lead to tarmac and rail melt causing transport disruption. Drought can lead to increased demands on the fire service and increased fire risks in dry wooded areas and due to overloading of electrical systems in older buildings.
Snowfall, ice and low temperatures	The winter of 2010 was the harshest winter in 31 years with a period of 3 months of snow, sleet, rain and freezing temperatures. Low temperatures can result in hazardous, icy conditions with the power to disrupt staff access to work and disable delivery of regular and emergency services across the district. The transport network can be seriously disrupted during heavy snow. For a number of days in Jan 2010 only primary roads were gritted, schools were closed and bin collections postponed. There were surges in demand for gas as the elderly tried to stay warm and more house fires associated with old paraffin and gas heaters. Additional road maintenance to repair pot holes cost Warwickshire County Council £0.5mn.

3.4 WEATHER EVENTS IN WARWICK DISTRICT

3.4.1 Historic Data

Data from the Bablake Weather Station in Coventry indicates that by the end of the 20th century the local climate had been getting progressively warmer. *Table 3.3* shows the changes in annual average temperatures for each decade, and for each 30-year climatological normal of the century. It reveals evidence of warming over the past 20 years.

Table 3.3 Average Annual Temperatures for Warwick District 1901-2008

Bablake Average Annual Temperatures- decade	Bablake Average Annual Temperatures- 30 year periods
1901-1910 = 9.33°C 1911-1920 = 9.49°C 1921-1930 = 9.51°C 1931-1940 = 9.55°C 1941-1950 = 9.46°C 1951-1960 = 9.35°C 1961-1970 = 8.96°C 1971-1980 = 9.44°C 1981-1990 = 9.92°C 1991-2000 = 10.28°C 2001-2009 = 10.60°C (9 years)	1901-1930 = 9.44°C 1911-1940 = 9.52°C 1921-1950 = 9.51°C 1931-1960 = 9.45°C 1941-1970 = 9.26°C 1951-1980 = 9.25°C 1961-1990 = 9.44°C 1971-2000 = 9.88°C 1981-2008 = 10.27°C (29 years)

Source: Bablake Weather Station, 2010

Data from the Bablake Weather Station also shows that in the past 24 years, only 2 years have recorded below average temperatures in Coventry (1993 and 1996). Of the top thirty-nine warmest years since 1892, 23 of these have been since 1981 – these are ranked below:

Table 3.4 Highest Average Annual Temperatures for Warwick District 1901-2008

Average Annual Temperatures:	Years:
11.1°C	1990, 2006
10.9°C	2002
10.8°C	1989, 2004, 2007
10.7°C	1921, 1995, 1997, 2003, 2005
10.6°C	1998, 1999
10.5°C	1911, 1994, 2000
10.4°C	2009
10.3°C	1959
10.2°C	1914, 1933, 1982, 2008
10.1°C	1898, 1983, 1988, 1992, 2001
10.0°C	1899, 1913, 1938, 1949, 1961
9.9°C	1906, 1918, 1926, 1928, 1945, 1984, 1991

Source: Bablake Weather Station, 2010

3.4.2 Local Climate Impacts Profile

To explore the potential impacts of extreme weather events that are likely to accompany climate change, Warwickshire Council has been undertaking a 'Local Climate Impacts Profile' (LCLIP) for Warwickshire. This involved a review of media records and departmental records from 1997 to

2010 about extreme weather events and their implications for the Council and the wider community.

The LCLIP approach is advocated by the UK Climate Impacts Programme (UKCIP) and has been followed by many local authorities in the UK. Although its focus is on looking back at past weather events, the aim is to raise awareness of the potential for future changes in climate and weather-related events, and the issues that Councils and partners are likely to face in future.

The LCLIP found that Warwickshire had been influenced by over 30 extreme weather events between 1997 and 2010 of which:

- 46% of related to heavy rain events
- 27% related to high winds
- 10% related to heavy snow and cold spells
- 7% related to heatwaves
- 7% related to lightning
- 3% related to hailstorms.

Prolonged heat above 30°C - During the summers of 2003 and 2006, prolonged high temperatures created difficulties for a number of service areas (particularly in the area of health), and highlighted the need for adaptation in areas such as the use of materials in road surfaces.

The heatwave of 2003 affected many European countries, including the UK where records were broken as temperatures in some regions climbed to 38°C. In Warwickshire, temperatures lingered around 32-34°C, with a high of 35°C (National Statistics, 2007), causing health issues associated with pollution as well as heat.

Summer 2006 saw temperatures of 34°C across Warwickshire, creating uncomfortable working conditions and impacting on a number of services, such as the NHS and the fire and rescue service. The preceding very dry winter added to the problems of drought. Bans on use of hosepipes were put in place across the UK to help conserve water supplies for drinking.

Flooding – In Warwick district, the Easter floods of April 1998 and the summer flooding in July 2007 resulted from intense, persistent rainfall falling onto river catchments after periods of generally wet weather. In 1998 the River Leam burst its banks flooding offices, commercial buildings, parks and houses. Access to the town centre for businesses and residents was seriously disrupted. Flooding also occurred in summer of 2007, from the rivers, as well as drainage problems in areas such as Cubbington where 42 properties were flooded. During the winter of 2009/10, following the thaw after snow during December and January there were flood warnings on the River Leam between Marton and Leamington.

The total cost to Warwickshire County Council services of responding to the floods was over £1.7 million. This included £800,000 damage to highways and bridges, £500,000 in insurance claims and £350,000 following the forced temporary closure of a care home. The potential economic cost to the whole of Warwickshire as a result of the floods was estimated at £90 million. The 2007 floods resulted in WDC making insurance claims totalling approx £78,000, including £66,000 for repairs to the Pump Rooms.

Warwickshire - Key Facts about 2007 Floods:

- 120mm rain in 5 hours
- 60 roads closed across the county
- 20 damaged bridges
- Over 4000 telephone calls to County Highways
- 2,000 properties flooded – including homes, businesses, care homes and a school
- Flooding across 75 Communities which experienced 5 to over 100 properties with internal flooding.
- 5 market towns suffered significant flooding:
  - Shipston(69), Wellesbourne (70)
  - Henley(42) , Alcester(150), Bidford (95)
  - Leamington(6) and Warwick (10) and wider areas very close to experiencing much more significant flooding.

Source: Warwickshire County Council, 2010

3.4.3 Sudden winter cold spells

The winter of 2009/2010 was officially recognised as the coldest in 31 years. Snow falls during January 2010 and December 2010 caused severe disruption across Warwickshire and affected many services. Waste collections were suspended because conditions were too treacherous for the vehicles to be deployed. At times, all state schools were closed due to the hazardous road conditions, causing a huge demand for information at call centres and on websites. In January 2010, problem was exacerbated by a national shortage of grit with only primary routes being gritted by the WCC Highways team. Bin collections were cancelled across Warwickshire. The Fire Service had to deal with an increase in the number of house fires as people tried to keep warm with older paraffin and gas heaters, and many problems were reported with freezing of domestic combi-boiler heating systems. Following the snow in early 2010 many potholes had to be repaired in roads with a cost to the County of over £0.5 mn.

3.4.4 Storms

8 out of 30 extreme weather events between 1987 and 2007 in Warwickshire County have involved high speed winds. During 2002 there were a record 8 days of gales (more than 32mph continuously) and during two events thousands of houses were blacked out as very high winds brought down power lines and trees blocked roads. In January 2005 wind speeds reached record levels of 60.3 mph with trees uprooted and poorly attached roofing shingles blown off.

3.5 SUMMARY

UKCP09 scenarios predict that future climate in Warwick District will lead to:

- Warmer, wetter winters with average temperatures 1.3^{o}C higher by the 2020s and 2.1^{o}C higher by the 2050s and with 5% more rain
- Hotter, drier summers with average temperatures 1.5^{o}C higher by the 2020s and 2.6^{o}C higher by the 2050s with 7% less rain. Mean daily summer temperatures could be more than 5^{o}C higher by the 2080s.
- More frequent extreme events including flooding, drought, high winds and sudden cold snaps.

There is growing evidence that both gradual climate change and more frequent extreme events (flooding in 1998 and 2007, gales in 2005, heatwaves in 2003 and 2006, cold periods in 2009 and 2010) are already being experienced. The impacts across Warwickshire County have already led to significant disruption and costs in dealing with emergencies and repairing the damage.

In the face of these recent events and projections, there is a need to identify key risks to WDC's services and assets and ensure that adaptation actions are integrated in corporate planning processes. Assessment of risks and recommended actions are described in *Section 4*.

4 CLIMATE CHANGE RISK ASSESSMENT OF WDC SERVICE AREAS

This section presents the findings of the climate change impact assessment for WDC Service Areas and identifies actions to mitigate these impacts.

4.1 CLIMATE CHANGE RISK ASSESSMENT PROCESS

Climate change impacts are increasingly being addressed through conventional risk assessment methodologies, consistent with approaches used in the WDC corporate risk register. Risk types used in these methodologies cover:

- risk to service delivery;
- risks to partners;
- financial risk; and
- reputational risk.

The risk assessment matrix (*Figure 4.1*) provides a mechanism for assessing and ranking risks and potential impacts on WDC service delivery. This approach is consistent with the approach developed by Warwickshire County Council, as well as good practice from across the UK. **Likelihood** of an impact is assessed on a range from 'almost certain' to 'rare'; and the **severity** of the impact ranges from 'insignificant' to 'major'. The **risk score** is the product of the *Likelihood* and the *Severity* scores, and ranges from 1 to 25, using the following four bands:

- Very High (score 15-25);
- High (score 8-14);
- Medium / Tolerable (score 4-7); and
- Low (score 1-3).

The risk assessment was undertaken through discussion with service area heads and officers.

Figure 4.1 Climate Change Risk Assessment Matrix

Risk Rating Matrix

Likelihood of Impact			1 Insignificant	2 Minor	3 Moderate	4 Significant	5 Major
	Almost certain 0-1 year	5	5	10	15	20	25
	Likely 1-5 years	4	4	8	12	16	20
	Moderate 5-10 years	3	3	6	9	12	15
	Unlikely 10-20 years	2	2	4	6	8	10
	Rare 20-30 years	1	1	2	3	4	5
			Severity of Impact				

Risk score response:

Very high	**Consider immediate risk action, review regularly and report upwards to senior management.**
High	**Consider risk action and review regularly.**
Med-ium	**Consider risk action and review periodically.**
Low	**No action required. Review annually to ensure risk level does not change.**

	Threat Impact Descriptions				
	1 Insignificant	**2 Minor**	**3 Moderate**	**4 Significant**	**5 Major**
Service, Partnership & Project Delivery	Minor errors in systems and processes handled within normal daily routine.	Short term disruption and action required. Managed by intervention from Head of Service/ Block Leader or Project Manager.	Noticeable disruption affecting customers. Intervention and management by local management team.	Disruption of core activities. Key targets missed, some services compromised. Intervention by LAA senior managements or Project Board	Loss of core activities. Strategic aims compromised. Intervention required at the highest level-LAA public service board
Financial	<1% negative variance against annual revenue budget or capital budget	2% negative variance against annual revenue budget or capital budget	3% negative variance against annual revenue budget or capital budget	4% negative variance against annual revenue budget or capital budget	5% negative variance against annual revenue budget or capital budget
Reputation	Event or decision not in the public domain that has little impact outside of services	Event or decision in the public domain that receives minimal negative coverage by local media	Event or decision in the public domain that receives significant negative coverage by local media and/or pressure groups	Event or decision in the public domain that receives significant negative coverage by national media and/or pressure groups	Event or decision in the public domain that receives extensive negative coverage by national media and/or pressure groups
Environmental	Inconsequential environmental impact if any	Minor short term environmental damage	Manageable environmental impacts. No long term effects	Reversible environmental degradation over a number of years	Irreversible environmental degradation with severe legal consequences

4.2 RISK ASSESSMENT FINDINGS

The risk assessment scores across the different WDC service areas are summarised in *Figure 4.2* and *Table 4.1* and presented in more detail in *Section 4.4,* along with recommended mitigation actions by service area.

4.3 OVERVIEW OF RISK ASSESSMENT FINDINGS

The assessment found that flood and high wind/storm events have the highest number of medium to very high potential impacts, and that the service areas with highest potential impacts include: Community Protection, Housing and Property, Cultural Services, Asset Management within Development Services and Neighbourhood Services.

Figure 4.2 Summary of Climate Change Risk Assessment Scores

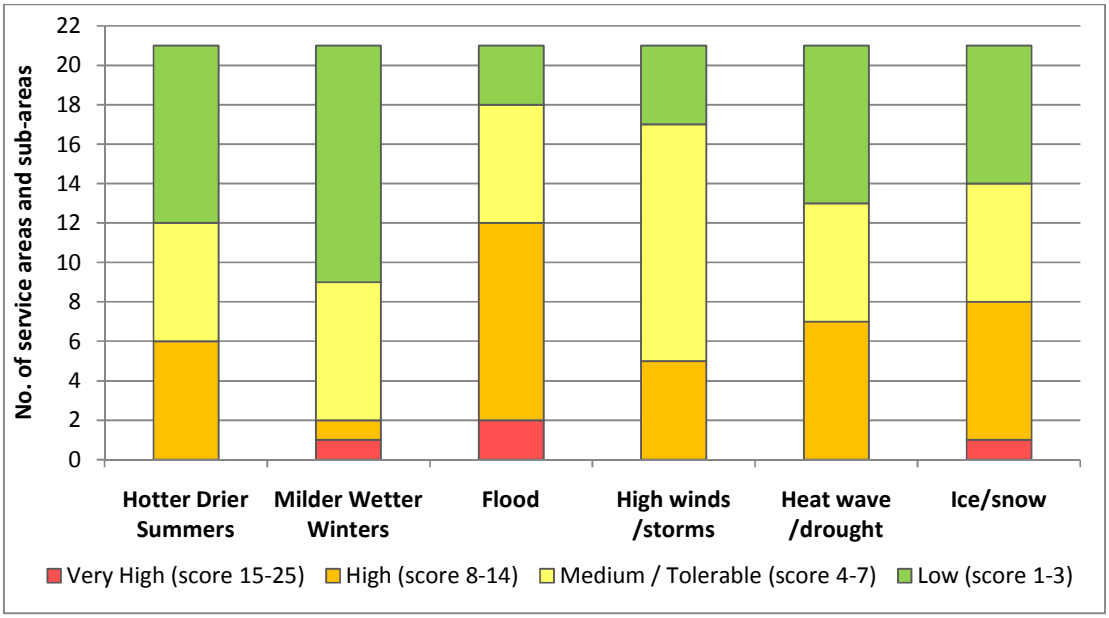


Table 4.1 Summary of Climate Change Risk Assessment Scores across WDC Service Areas

WDC Service Area:		LONG TERM WEATHER CHANGES:		EXTREME WEATHER EVENTS:				Average score
		Hotter Drier Summers	Milder Wetter Winters	Flood	High winds /storms	Heat wave /drought	Ice /snow	
Development Services	Development control, building control, planning policy	2	0	6	6	2	12	4.7
	Asset Management - business premises, tourist info centre etc	9	3	12	6	9	6	7.5
	Economic Development, Town Centre Management	2	0	12	4	2	2	3.7
Environmental Services	Environmental H&S, Food Safety, cooling towers etc	6	1	2	1	6	4	3.3
	Bereavement Services	2	6	9	6	2	4	4.8
Housing and Property	WDC Housing and Corporate Property Repair / Maintenance	6	6	12	4	6	12	7.7
	Strategy, Home Choice, Private, Warwick Response, Energy Mgt	3	3	12	4	6	12	6.7
Community Protection	Community Safety - CCTV and Licensing and registration.	6	3	3	3	4	2	3.5
	Flood Alleviation	8	16	16	8	8	6	10.3
	Civil emergencies and business continuity	6	6	16	14	9	9	10.0
	Engineering services - external assets	9	9	6	6	9	16	9.2
	Building maintenance and cleaning of WDC buildings	9	0	6	6	9	9	6.5
Customer and Information Services	Benefits and Revenues Service	3	1	6	4	3	3	3.3
	ICT	2	1	6	4	3	3	3.2
	One Stop Shops, Call Centre and Communications	2	1	12	8	2	12	6.2
Cultural Services	Parks, grounds and golf course	12	6	12	9	12	4	9.2
	Leisure Centres	6	3	9	6	6	3	5.5
	Cultural facilities	3	6	9	6	3	6	5.5
Neighbourhood Services	Trees, Grounds and Parks Maintenance	10.5	3	6	12	12	2	7.6
	Street Cleaning, Refuse and Recycling	6	6	12	2	6	12	7.3
Finance	Insurance, Accountancy, Payroll, Procurement, Audit, Risk, FAST	1	2	3	3	2	3	2.3

Key:

Very High (score 15-25)	Medium / Tolerable (score 4-7)
High (score 8-14)	Low (score 1-3)

4.4 HOUSING AND PROPERTY SERVICES

4.4.1 Services Provided

Housing and Property Services provide the following services:

- **Warwick Landlord** – management of WDC's social housing stock of 5,640 properties including high, medium and low rise flats, houses and bungalows. The stock includes a small number of listed buildings and 'hard to treat' (for energy efficiency) brick buildings in rural and urban areas. By December 2010 WDC had completed its Decent Homes programme including installation of double glazing, roof insulation to 150 mm, cavity wall insulation, new kitchens and bathrooms to all suitable properties.

- **Corporate Property Repairs and Maintenance -** survey and budgeting of routine maintenance and planned improvements to corporate properties including Riverside House, the Spa Centre and Pump rooms. The assets are held and managed on a day to day basis by Community Safety, Cultural Services and the Economic Regeneration teams.

- **Warwick Plant Maintenance -** a small engineering team which looks after water quality in pools, fountains and water features and central heating and boiler maintenance in corporate properties. The Energy Management team is responsible for maintenance of all building energy management systems in corporate properties and shared boilers in Landlord properties.

- **Warwick Response** is a team responding to alarms for those living in sheltered housing.

- **Housing Strategy , Private Housing, Home Choice and Homelessness services** are responsible for developing the Housing Strategy, coordinating and setting standards for Housing Associations, administering grants (such as Disabled Adaptation Grants and WarmFront) and running the Home Choice tool to help tenants identify available WDC or social housing for rent. These services are expected to coordinate closely with the WDC planning department in identifying the need, location and applicable standards for private and housing association homes.

4.4.2 Climate Change Risk Assessment

The greatest climate change related risks to WDC housing and property service are associated with:

- **Flooding – riverine:** As shown in *Figure 4.3* and *Table 4.2* below, there are approximately council owned 150 residential properties in Warwick, around 'Poets' Corner' and south west of Warwick hospital, which are within Zone 3a and 3b according to the Strategic Flood Risk Assessment maps for riverine flooding; another 42 council owned properties are on these same roads and may become vulnerable in the future.

  A number of the WDC corporate properties are also within the flood risk zone, including the Pump Rooms and leisure centres in Leamington Spa, Warwick and Kenilworth (see Cultural Services *Section 4.8* below) and Spencer's Yard, Leamington Spa (see Development services, *Section 4.7* below).

  Flood events would result in increased demands on WDC housing department from tenant call outs, including out of office hours; possible emergency evacuation of residents;

requirements for providing longer term support to those affected; as well as disruption to staff travel during flood events.

- **Flooding – drainage:** In addition to fluvial flood risk, other council owned properties may be at risk of flooding from poor drainage (eg. properties in the Saltisford area of Warwick which in the past has experienced flash flooding as a result of blocked culverts running into Budbrooke; and some basement properties in Landsdowne Crescent in Leamington Spa). Over the next 12 months, the Environment Agency and WCC are expected to complete an assessment of drainage related flood risks and mapping of hollows where waters may sit in the event of extreme rainfall events (eg. parts of Cubbington flooded in summer 2007). This assessment will form the basis for identifying future flood alleviation schemes to protect properties at risk.

- **Winter ice and snow.** During very cold winter periods, there is a risk of failure of Combi Condensing boilers, frozen pipes and water mains, as well as increased demands on emergency response teams for housing maintenance, and potential travel disruption for staff attending to housing repair call-outs.

- **Subsidence during hotter, drier summers**. A few older properties with poor foundations in the area around Warwick Hospital are on clay soils susceptible to swelling and shrinking and therefore subsidence. The regular inspection regime has identified properties with signs of subsidence and underpinning has been carried out as part of planned works where appropriate.

- **High wind events** (greater than 55 mph) can uproot trees and cause damage to roofs of buildings. WDC has a proactive roofing repair programme to replace or strengthen flat roofs and all roofs currently meet building regulations in terms of wind risks.

Table 4.2 WDC Council dwellings within the Flood Risk Zone (Zone 3a and 3b)

Location	No. of WDC properties in road	No. of properties within 3a flood zone
Burns Ave	9	3
Kipling Ave	9	9
Milton Ave	20	18
Shakespeare Ave	29	20
Shelly Ave	17	15
Tennyson Ave	4	4
Percy Road	14	8
Longfellow Ave	29	29
Goldsmith Ave	7	2
Byron Ave	12	6
Browning Ave	9	3
Masefield Ave	15	15
St Lawrence Ave	14	14
	188	146

Also, potential flood risk to properties in:

- *Fishers Court, Warwick*
- *Bridge St, Warwick (south of Portobello Bridge)*
- *Sharpe Close (south of Warwick Hospital)*
- *Avon St, Pickard St, Coton End (south side),*
- *Packmore St and Percy Road*
- *Trueman Close (south of Hospital)*
- *Wathen Road, Warwick (south of Hospital)*

4.4.3 Mitigation Measures

Existing mitigation measures for impacts on WDC Housing and property Services include the following:

- The Business Continuity Plan enables WDC staff home working in the face of an event which prevents staff getting into work and was reviewed in 2010 in response to the Swine Flu threat.
- The contract for maintenance and repairs to gas boilers allows for flexible coverage for emergency call out and managed to address the high number of call outs during the cold winter of 2009/2010 by operating 3 shifts.
- The corporate Insurance Policy covers costs of repairing damage to Council owned properties.
- Ongoing internal insulation and cladding programmes and replacement of flat roofs and guttering which is intended to increase energy efficiency at the same time as reducing vulnerability to extreme cold and heavy rainfall; and
- An ongoing survey and maintenance programme addresses properties affected by subsidence.

Potential further mitigation actions in relation to WDC housing and property services include:

- Identifying WDC properties at risk of surface water flooding or drainage problems and investigating costs and benefits of retrofitting vulnerable properties with flood resistance (preventing or limiting amount of water entering) and resilience measures (reducing the time and cost of recovery from flood events). *Table 4.3* below provides examples of potential actions that tenants and residents can take to protect their homes from flooding. Measures are ranked from 'no cost' (informing themselves about potential flood risks), through 'low cost' measures (eg bungs, airbrick covers and sealing holes) to 'medium cost' measures (eg. raising electrical circuits, thresholds and appliances), to 'high cost' measures such as rendering walls, replacing gutters and removing impermeable surfaces.
- Identify which of these measures can be integrated into renovation or retrofitting works or as part of reinstatement following on from flood events.
- Any new WDC housing properties constructed in the future should be located outside of flood risk areas, or – in exceptional cases where development is permitted in flood risk zones 2 and 3 – should include flood resistance and resilience measures.
- Examine opportunities for grants and financial support for households in flood zones for installing flood resilient measures and products, including use of the Community Infrastructure Levy.
- Ensure emergency plans identify flood risk properties, including vulnerable households and elderly tenants in flood risk areas, as well as identifying vulnerable and elderly in buildings potentially at risk of wind damage.
- Ensure housing maintenance contractors will continue to provide flexible emergency cover and prioritise assistance to vulnerable households and the elderly.
- Ensure WDC insurance continues to repairs and cover loss of income from rentable property due to flood damage.
- Assist tenants to help themselves, eg. help tenants to access information on the risk of flooding to their home and on measures to increase resilience, what to do in the event of a flood and advice on making sure they are insured. WDC could also help to set up

Neighbourhood Flood Fora in areas at high risk to help identify flood alleviation measures over wider areas and to assist the vulnerable at times of flood.

Table 4.3 Adaptation Measures Tenants and Residents Can Take to Increase Flood Resistance and Resilience *(Low cost = <£100, Medium = £100-1000, High = >£1000)*

ADAPTATION MEASURES	Relative cost (Free, Low, Medium, High)
Resistance Measure:	
Check Flood map (Zone 2, 3a, 3b)	F
Register with EA Flood Warning Scheme	F
Drainage bungs for drains, sinks and toilets	L
Install re-useable air brick covers/smart air bricks	L
Seal gaps around pipe and cable entries, windows and doorframes	L
Fit non-return valves on main drains	M-H
Install demountable door guards, flood skirts	M-H
Move meters and electrical sockets above flood levels	M-H
Install a 'sump and pump' below ground level	H
Raise door thresholds	H
Repair damaged mortar and re-point brickwork on external walls	H
Apply waterproof render to external walls	H
Install waterproof membrane on external walls (eg from 0.6m below ground to 1m above)	H
Upsizing of gutters, down pipes, etc. to cope with more intense rainfall	M
Replacement of impermeable surfaces by use of permeable materials for roads, paths, parking areas, etc where possible	M
The use of green roofs to lessen the rate of runoff from large roof areas.	M-H
Resilience Measures:	
Check Flood map (Zone 2, 3a, 3b)	F
Register with EA Flood Warning Scheme	F
Store Valuables and paperwork on upper floors	F
Turn off gas, water and electricity mains	F
Fit rising hinges so doors can be removed	L
Use dry bags to protect soft furnishings	L
Use water resistant paint for lower portion of internal walls	L-M
Rewire, raising electrical points above flood level (with wiring drops from above)	M
Relocate meters and boilers above flood level	M
Relocate computers, white goods, machinery etc above flood level	M
Replace carpets with vinyl, ceramic or solid concrete flooding	M-H
Replace chipboard with solid pressure treated timber	H

Low = <£100, Medium = £100-1000, High = >£1000

Source: Your Home in a Changing Climate: Retrofitting Existing Homes for Climate Change Impacts, 2008, London, South East and East of England Climate Change Partnerships

4.5 NEIGHBOURHOOD SERVICES

4.5.1 Services Provided

WDC Neighbourhood Services include street cleaning, grounds maintenance, tree maintenance, public conveniences, car parks, on street parking enforcement, refuse collection and recycling. The principal service areas are delivered through two major external contracts:

- **Refuse Collection and Recycling**. An external contract, currently with Biffa Waste, has been in place for two years. The contract covers fortnightly household collection of waste for landfill and an alternative fortnightly collection for recycling and composting (garden and kitchen waste). Waste going for final disposal is sent to Warwickshire County Council landfill sites or to a WCC incinerator in Coventry. Sorted recycling material is held at a depot in Warwick. Compostable material goes to a WCC compost facility which operates year round, but currently with lower volumes in winter. The contractor is also responsible for litter picking on hard surfaces (not in parks or on green space) and public bin collection. The contract requires flexible working in order to catch up with delays in collections resulting from extreme weather (eg. ice and snow), which has meant only temporary disruption to waste collection services during the prolonged freezing periods in the winters of 2009 and 2010.

- **Trees and Parks maintenance**. The service manages an external contract with Glendale, due for renewal in 2013, for grass cutting, floral displays (bedding plants and hanging baskets) and arboricultural services. The contract covers some 4 km^2 of grass in parks, verges and greenspace around housing including some 0.9 km^2 of highway verges and roundabouts derogated from Warwick County Council. The contract also includes 18-19,000 of WDC's own park and street trees and floral displays, including hanging baskets, and litter picking on green space. (WDC is also responsible for maintenance of 9,000 WCC Highway trees). The contract is performance based (ie. based on an agreed grass length rather than number of annual cuts). Contractors have proved flexible in responding to weather related needs such as reallocating time when they are unable to carry out routine maintenance during ice, snow, flooding and high winds to other priorities such as removing debris and gritting of town streets.

- **The WDC Car Park Service** is responsible for WDC owned off and on street parking sites, including some within or near the flood risk zone.

4.5.2 Climate Change Risk Assessment

Refuse Collection and Recycling:

- **Flooding.** Flood events were identified as posing the highest potential impacts on refuse services because of disruption to waste collection services, increased volumes of construction and demolition and household waste for disposal from repaired / refurbished buildings, and possible loss of containers and debris from flooding in streets and parks.

- **Ice / snow.** Based on the experience of recent winters there is high potential for prolonged snow/icy conditions to disrupt collection, potentially limiting access to waste disposal sites, increasing the build up of large volumes of waste on residential streets and increasing the volume of enquiries from the public about collection services.

- **Hotter, drier summers -** No high risks to refuse services, but lower potential impacts resulting from increased litter associated with increased outdoor activity by the public during hot

summer periods and potential increased odour problems and fire risk (eg in waste bins and dry woody areas).

- **Milder, wetter winters -** No high risks to refuse services, but lower potential impacts resulting from greater potential of stored recyclate (card and paper) becoming water logged, which would reduce the value and revenue from recyclate; and potential increased tonnages of garden waste for composting over a longer period because of expected longer growing seasons.

- **High winds/ storms –** no high risks to refuse services, but some potential impacts associated with increased wind blown litter and increased volumes of green waste (from wind blown trees and vegetation) requiring disposal.

Additional Mitigation measures required:

- Maintain flexibility in the refuse contracts to switch staff to clean up debris after flooding or high wind events, eg. in the riverside parks, and to catch up on collections when conditions improve after prolonged snow/icy periods.
- Examine whether insurance or contingency can be put in place to cover the costs of clearing additional waste tonnages after flood events.
- Continue to educate public about weekly collection of kitchen waste if snow/icy conditions delay fortnightly collections.
- Gritting of vulnerable areas for waste management, eg. access to landfill sites.
- Require contractors to investigate the costs and benefits of storing recyclate materials under cover to avoid water logging during wetter winters and intense summer rain.
- Ensure that effective controls are in place for minimising fire risk in waste storage and disposal facilities. Public awareness and education, for example, in the use of portable BBQs.

Trees and Parks maintenance - The greatest climate related risks are expected to relate to:

- The impact of **hotter drier summers and droughts** on the required frequency of watering plants – which is currently specified in the contract – and will push up costs of bedding/floral element from £200k to £270k pa, effectively a 5% increase in the overall costs of £1.5 mn annual contract. The business case for a move towards more sustainable, drought resilient planting needs to be presented to elected members and incorporated in the green space maintenance contract by 2013.

- **High wind** impacts on the ageing stock of highway and street trees could cause serious injury or fatalities from falling branches. This risk is currently managed through a regular inspection and monitoring regime and pruning of vulnerable trees. WDC is negotiating with WCC to move to a three year inspection and pruning regime for Highway trees. If funds were available for a tree planting programme then the most vulnerable trees could gradually be replaced with native, easily maintained trees (see *Table 6.7* below). Information on tree vulnerability to high winds needs to be integrated into the Emergency Plan coordinated with other agencies to ensure identify priorities for clearing and removal of trees and debris from key routes for emergency services and to hospitals, and contractors could be requested to provide additional tree clearance teams when needed.

- As a result of these increased requirements for tree maintenance/replacement there is also a risk that WDC or the WCC will decide to reduce the number of trees they maintain. This

would reduce the benefits of trees in climate regulation, mitigation and for biodiversity and quality of life.

Additional Mitigation measures required:

- Maintain flexibility in the grounds maintenance contracts to switch staff to clean up of debris after flooding or high wind events, eg. in riverside parks, and continue to have flexible mowing regimes if growing seasons lengthen.
- Continue the move to more drought tolerant planting and continue to educate public about why planting schemes have changed.
- Share information on the value of trees as a means of reducing climate impacts, and particularly, persuade the Budget committee that maintaining trees is an important to summer cooling and to building local resilience to climate change.
- Establish contingency plans for grounds maintenance during periods of low water supply.
- Deliver public awareness and education on the use of portable BBQs to reduce risk of fire during hot, dry summers.
- Develop corporate plans for dealing with impacts of high wind / storms (eg. when Force 8 winds are forecast, put 2 clearance teams on standby).
- Increase inspection and pruning regime for WCC trees from 5 to 3 years if the frequency of high wind storm events increase.
- Gradual replacement of highway and older trees with suitable species (eg. native species with smaller canopy).
- Advice to staff on protection from sun.

Car Parking Service – The most significant risks to the service are:

- **Flood risks** at the following sites in Leamington Spa (St Peters Multi Storey Car Park, Bedford Street, Adelaide Road Car Park, Packington Place and Bath Place); and Myton Fields in Warwick which is closed September to March and would be closed immediately during the summer months in the event of an EA Flood Risk Warning or very heavy rain.

- **Heatwaves**. All car parks have recently been resurfaced and are at little risk of tarmac melting during hot weather.

- **Snow and ice** which can cause slipping hazards for staff or visitors with associated health and safety and risks of liabilities. Gritting for snow and ice can also damage multi storey car park structures, making concrete more susceptible to water ingress or cracking. A recent risk assessment identified a policy of only gritting vulnerable areas in car parks after 3 days of freezing temperatures.

Car parking policy is currently being reviewed but no major actions are required to adapt to climate change**.**

4.6 ENVIRONMENTAL SERVICES

4.6.1 Services Provided

The directorate has a staff of 33 covering:

- **Environmental Health, Infectious Disease Notification/Control and Food Safety** - A team of 26 staff based in Leamington Spa are responsible for Health and Safety and Food inspections

of some 3,500 premises and 1,800 food related businesses. They are also responsible for registration of cooling towers; and comments on planning applications and licenses on behalf of Development Control and Community Protection.

- **Occupational Health and Safety**
- **Pollution Control, Noise Control, Air Pollution Control and monitoring.**
- **Bereavement Services** - operates the Crematorium at Oakley Woods in Bishops Tachbrook and four cemeteries (including chapels, some stores and external walls and residential lodges) at Oaks Road, Kenilworth; Brunswick Street and Old Milverton Road in Leamington Spa; and Birmingham Road in Warwick; and also maintains 5 closed churchyards.
- **Private water supplies** - WDC regularly monitors water quality at some 40 premises with private wells.
- **Pest Control, Animal welfare licensing and Dog Warden services.**

4.6.2 Climate Change Risk Assessment

Potential impacts of climate change on WDC Environmental Services include:

- **Environmental Health, Occupational Health and Safety and Food Safety, and Pollution control:** The main risks of climate change and extreme weather events on these services relate to increases in food poisoning, infectious diseases and pest vectors associated with warmer weather, extreme heat and drought; and potential water shortages for flushing out cooling tower storage tanks, increasing the risk of a legionella outbreak; and staff access to work and business premises to carry out inspections in the event of major flood, wind or snow events. There are also risks of potential increases in low level ozone pollution during hot sunny periods, and smog pollution during winter cold spells.
- **Bereavement services**. Some parts of the Warwick Cemetery are low lying and were under water in 2010. The risk of water logging is likely to increase with warmer wetter winters and intense rain events in summer months, making water logged prone areas increasingly unsuitable. In the future it may be necessary to find alternative cemetery sites outside flood risk zones and poor drainage areas, or to encourage a shift towards cremation. A lesser risk relates to potential tree falls around cemeteries and the crematorium during extreme wind events.
- **Private Water Supplies.** WDC regularly monitors water quality at some 40 premises with private wells. So far there have been no problems with water quality as a result of warmer summers, winters, drought or flooding events. Higher water tables resulting from flooding could however lead to contamination, but this is considered a low risk.
- **Pest control and dog warden services**. The demand for these services is expected to increase during hotter, drier summers and warmer wet winters, but will not be significantly affected by other climate related changes.

4.6.3 Mitigation Measures

The Business Continuity Plan covers all of the service's statutory functions (Food, Health, and Safety and Environment inspections) and allows for key staff to work from outside the office if an extreme event such as flooding or fallen trees prevents them from reaching the office. Flexible working is already in place to allow for out of hours responses.

Potential further mitigation actions for the future include:

- Acquiring more land for cemeteries in less waterlogged sites over the next five years.
- Increasing the frequency of tree checks around cemeteries and crematoriums if high wind /storm events become more frequent.
- Increasing monitoring of local air quality for low level ozone and smog pollution and taking mitigating action, if the need arises.

4.7 DEVELOPMENT SERVICES

4.7.1 Services Provided

The WDC Development Services team is responsible for a number of statutory functions including:

- **Development control** – two teams based at Riverside House cover the East and West of the district and deal with planning applications, appeals, enforcement and technical and administrative functions.
- **Building control** – a team of 11 including technical officers and administrators provide statutory building control services from Riverside House.
- **The conservation team** provides advice and information on listed buildings, conservation areas and historic buildings grants.
- **Land charges** – a two person team is responsible for land searches.
- **Town Centre Management, Estates management and Asset management -** Three town centre managers are based in Leamington, Warwick and Kenilworth respectively. They work with other agencies to keep the district's town centres attractive and competitive. The Tourist Information Centre has 4 FTE staff based in the Pump Rooms.
- **Planning policy** - responsible for developing the Policy Planning Framework including the new Local Plan which will integrate corporate policy issues, such as climate change mitigation and adaptation, into planning policies for new development.
- **Economic development and Enterprise team** - responsible for economic development and asset management, including strategic responsibility for WDC operational buildings (such as Riverside House) and day to day management of non-operational buildings. The latter includes commercial premises such as:
  - Althorpe Enterprise Hub (Leamington Spa);
  - Court Street Creative Arches (Leamington Spa);
  - Spencer Yard and the United Reformed Church in the cultural quarter (Leamington Spa);
  - North Hall;
  - Brunswick Enterprise and Employment Zone; and
  - Neighbourhood shopping areas across the district.

4.7.2 Climate Change Risk Assessment

Potential impacts of future climate change on WDC Development Services include:

WDC Development control, building control, planning policy:

- Extreme weather events such as snow and ice, flooding or wind blows are likely to both increase demand for building inspection services and disrupt staff travel to work. However, the Business Continuity Plan for the department enables key staff to work from home to minimise such impacts on service delivery.

- The demand for planning and building control functions is also likely to increase in the face of future hotter drier summers, as a larger number of applications are registered for change in use for external spaces and for external adaptation to buildings such as installing air conditioners, external louvres and green roofs.
- There is also an increased risk that WDC will grant planning permission for developments which are not well adapted to climate change or are at risk from events such as flooding. This could have negative impacts on residents and businesses, and damage the Council's reputation.

Town Centre Management and Asset management

- Hotter drier summers are likely to lead to an increase in demand for tourist information services, and the major threat to service continuity is likely to be flooding, since the Pump Rooms are in Flood Risk Zone 3a/3b.
- Town centre management employees based in Leamington, Warwick and Kenilworth are already set up for hot desking and the service is unlikely to be significantly affected by staff access issues during extreme weather events.

Economic Development and Enterprise team

- The main impact of climate change on economic development and enterprise services is the risk of flooding, with some sites – such as Spencer Yard and the United Reformed Church in the cultural quarter in Leamington Spa – being within flood zone 2 (which is assumed will become flood zone 3B in the face of future climate change).
- Other buildings not within the flood zone (eg. the Althorpe Enterprise Hub, Leamington Spa) may be affected by high summer heat or snow / icy periods during winter.

4.7.3 Mitigation Actions

The Business Continuity Plan for Development Services is already in place and allows for key staff to work from outside the office in case of extreme events (eg. flooding or storms) disrupting staff travel to work. Flexible working is already in place to allow for out of hours responses.

Potential further mitigation actions for the future include:

Development Services:

- Integrate planning policies for climate change adaptation and resilience into the forthcoming new Local Plan, with policies, supporting evidence and guidance contained in a new Supplementary Planning Document (SPD) on climate change adaptation (which could also potentially include mitigation issues).
- To encourage the use of the guidance in appropriate developments, training should be provided in WDC development control and building control staff. WDC should look into whether the DCLG funded Climate Change Skills programme (managed in the West Midlands by Sustainability West Midlands) could be used to resource this training.
- Examine whether there is adequate resource available to meet increases in demand for development and building control services resulting from climate change.

Asset Management - business premises:

- Monitor whether cooling systems are required in WDC owned properties during hot spells.

- Review how refurbishment programmes for WDC owned properties can include low carbon air cooling / ventilation.
- Consider benefits and costs of flood resilience measures, materials and products for vulnerable properties.
- Review how refurbishment programmes for WDC owned properties can include flood prevention measures.
- Ensure that flood insurance cover is in place for non operational properties owned by WDC.

4.8 CULTURAL SERVICES

4.8.1 Services Provided

The WDC Cultural Services team covers:

- Management of parks, grounds and golf course, including flagship parks, local parks and children's playgrounds;
- Leisure and Sports Centres, such as Newbold Comyn, Abbeyfields, St Nicholas Park leisure centre and Castle Farm (including leisure centres, swimming pools, courts and pitches);
- WDC owned allotments;
- Sports outreach – support to community based sport projects and clubs; and
- Cultural facilities such as the Spa Centre, Town Hall, Jephson Gardens Glass House and Pump Rooms (museum, art gallery, library).

4.8.2 Climate Change Risk Assessment

Potential impacts of projected future climate change on WDC Cultural Services include:

Parks, grounds and golf course

- New pests and diseases affecting tree species (eg. Oak Processionary Moth, Bleeding Canker which may be linked to climate change).
- Increased demand for water for planting schemes and for mature trees and potential water shortages and supply interruptions during warmer / dry summers. Increased risk of fire in dry woody areas is also a risk.
- Park closure during and after flood events, flood damage and costs of clean up and repairs and loss of revenues from any hire of grounds and cancellation of outside events. Damage to pitches or loss of revenues is also likely to be an issue for waterlogged pitches during warmer, wetter winters.
- During high wind / storms - risk of tree and branch falls, injury to public and staff and litigation and increased needs and costs of fallen tree clearance work required (including roads and emergency routes). This is the responsibility of the contractor for greenspace maintenance but increased frequency of wind events could lead to increased contract costs.

Leisure Centres

- Potential flood risk and damage to Newbold Comyn, St Nicholas, Abbeyfields and Castle Farm leisure centres during severe flood events.
- Potential wind damage to leisure centre buildings.
- Potential closure of facilities during flood and snow / ice periods leading to loss of revenues and increased heating costs.
- Potential interruptions to water supply during hot / dry summers.

- Heat stress leading to discomfort for staff and visitors at leisure centres and swimming pools with extensive glazing during hotter summers.
- A potential benefit of climate change will be increased revenue and use of leisure facilities during hotter, drier summers.

Cultural facilities - Pump Rooms, Museum, Library, Spa Centre, Glass House

- Fluvial flood risk to Pump Rooms, Museum, Library, and drain flooding risks to other buildings (eg. the Spa Centre, though subject to recent drain improvement works) leading to damage to buildings and their contents.
- Potential wind damage for instance to the old glass ceiling within the Pump Rooms and glass house in Jephson Gardens.
- Damage to delicate building fabric and paving during icy periods (eg paving in front of the Pump Rooms).

4.8.3 Mitigation Measures

Hotter, drier summers:

Existing mitigation measures include: tree inspections; a move away from tree species that are more susceptible to disease; planting drought tolerant plants in bedding schemes to reduce watering needs and awareness raising amongst public about why planting schemes have changed; public awareness and education about the use of portable BBQs to reduce fire risk and about damage caused by using sports pitches during very wet periods; and advice to staff on protection from sun.

Further Mitigation Actions for the Future: Examine arrangements for securing supplies of water during dry periods; and examine measures to reduce internal temperatures within buildings if needs arise, with examples shown in *Table 4.4*.

Flood:

Existing mitigation measures include: Park design to avoid impacts (eg. Jephson Gardens glasshouse is raised); ensuring that insurance covers costs of flood clean-up; building modifications such as flood barriers and redesign of drains (eg. drains already redesigned in the Spa Centre and internal flood barriers fitted in the Pump Rooms); ensuring valuable items are kept in safe areas; and plans are made to ensure an adequate supply of sand bags and emergency plans in face of flood warnings.

Further Mitigation Actions for the Future: Continuing to monitor flood risk to parks, leisure centres and cultural amenities to identify further building modifications if need arises (eg. flood barriers at Newbold Comyn Leisure Centre).

High winds/ storms:

Existing mitigation measures include: periodic tree and roof inspections to minimise potential wind damage (eg. glass ceiling in Pump Rooms);

Further Mitigation Actions for the Future: Integrate plans for dealing with impacts of high wind and storms into the Corporate Emergency Plan, with potential actions such as putting two clearance teams on standby when winds of Force 8 and above are forecast. Increase the frequency of the inspection regime for vulnerable trees if the frequency of high wind events increases.

Ice / Snow:

Existing mitigation measures include: gritting of footpaths and roads accessing cultural facilities.

Further Mitigation Actions for the Future: Investigate how the risk of freeze/thaw damage could be minimised to the delicate building fabric and paving in front of the Pump Rooms.

Table 4.4 Potential Adaptation Measures for Heat Stressed Buildings

Type of heat gain	Cause	Potential Adaptation Measures
Internal heat gains	Waste heat from equipment and lights	• Low energy light bulbs • Passive cooling (Natural ventilation, wind cowls) • Low energy equipment • Ground source cooling (eg from aquifers or surface water)
Heat gain through glazing	Solar gain will depend on building orientation, season and daily changes to sun angles	• Changes to the size and position of glazed areas • Smart glazing materials eg low-e coatings/solar reflecting film • Roof overhangs, awnings or brise-soleil to minimise solar gain at high sun angles • Solar controlled automated shading systems • Tree planting for shading (deciduous trees near buildings to allow winter solar gain)
Heat gain through warming of external surfaces	Roofs and walls absorb heat which passes through to internal spaces	• Minimise radiant gain by painting external walls light colours/coatings or using • Reflective paint on walls and roofs (cool roofs) • Improved roof insulation to reduce heat penetration (especially slate) also reduces winter heat loss • Cavity wall insulation where appropriate to reduce heat penetration through walls. • Use of green walls and climbing plants on external walls to produce shade and evaporative cooling • Thermal storage or thermal mass to cool buildings
External air temperature (exacerbated by Urban Heat Island effect)	Higher outside temperatures are transmitted to internal spaces	• Drought tolerant vegetation and tree planting • External water features for evaporative cooling • Bars over windows to allow them to be left open at night

4.9 COMMUNITY PROTECTION

4.9.1 Services provided

WDC Community Protection service area provides the following services:

- **Flood Alleviation** - Proactive works under the Land Drainage Act, including enforcement. Advice to local residents and liaison with partners including the Environment Agency on reducing flood risk.
- **Emergency Planning -** preparedness and resilience planning for civil emergencies (including extreme weather events).
- **Business Continuity** - business continuity management for WDC services, including in relation to extreme weather events.
- **Engineering Services and Facilities Management** - Maintenance of Council assets: external community assets such as rural footways, footways in parks, car parks, bus shelters, street name plates, civil design work and Council offices and buildings.
- **Community Safety, CCTV, Licensing -** tackling antisocial behaviour, crime and general community safety initiatives.

4.9.2 Climate Change Risk Assessment

Potential impacts of projected future climate change on Community Protection services include:

- **Flood Alleviation**: Increased demand and enquiries to the WDC flood risk management team during flood and storm events, to support community recovery, provide rest centres and support the work of the emergency services; disruption to staff getting to work during flood, storm and snow events.
- **Emergency Planning and Business Continuity -** Increased demand and enquiries to the team during flood, storm/wind and heatwave events; and disruption to staff getting to work during these events.
- **Engineering Services –** impacts of ice/snow, floods, storms, heatwaves and wet winters on Council properties and structures (eg. freeze thaw damage to concrete structures, and heat damage to tarmac); but also opportunities for extended periods for maintenance work during drier / hotter summers and warmer winters.
- **Facilities Management –** potential overheating of buildings and staff discomfort during heatwaves; potential wind damage to Council offices; potential slip injuries to public and staff visiting Council premises during ice/snow events.
- **Community Safety CCTV and Licensing and registration** – potential increases in antisocial behaviour and crime during hotter/ drier summers.

4.9.3 Mitigation Measures

Existing Mitigation Measures by Community Protection to minimise these risks include:

- Well developed Emergency Plans, Flood Response Plans and Service Continuity Plans for major events such as floods;
- WDC business continuity plans for ensuring continuation of service delivery during extreme weather events, including systems for remote working;
- Maintenance regimes to avoid clogging and blockages of screens and culverts, including 'hot spot' checking after storms;

- Monitoring of weather events and catchment to provide early warning of events such as flood and high wind;
- Gritting of WDC premises to prevent slip injuries; and
- Inspection of buildings and surrounding trees to check for potential risk of wind damage.

Further Mitigation Actions for Community Protection Services:

- Work is underway to identify areas at risk of flooding from poor drainage (non-fluvial flooding) and hollows in association with WCC and the Environment Agency - and in the light of this to identify appropriate mitigation measures for high risk neighbourhoods (eg. Cubbington which flooded in June 2007).
- Develop a multi-agency flood plan with key partners (emergency services, EA, WCC, and other Districts).
- Develop Emergency and Service Area Crisis / Continuity Plans to deal with high wind / storm events - for all service areas.
- Ensure that a heatwave recovery plan forms part of the Council's emergency plan (eg. for air pollution).
- Horizon scanning and engagement with partners such as the Met Office to monitor any future increases in extreme weather events (eg. high wind / storms, flood).
- Revise tarmac materials and specifications to cope with higher summer temperatures.
- Potential changes to drainage in car parks to cope with increasingly intense rainfall events.
- Work with WCC to include gritting of key car parks within WCC road gritting activities.
- Provide natural cooling, fans, water coolers, window blinds, flexible working times or remote working to overcome risk of overheating in current WDC offices. In the event of a major refurbishment or move to other offices, investigate opportunities for retrofitting measures such natural ventilations/mechanical cooling systems, increasing thermal mass and recycling of grey water to cope with summer heatwaves and droughts (see *Table 4.4* above).

4.10 CUSTOMER SERVICES AND INFORMATION

4.10.1 Services provided

The Customer Services department is responsible for:

- IT and communications systems for all WDC service areas except those shared with WCC (call centre and one stop shops in WCC buildings). The ICT system is housed in the basement at Riverside House.
- Benefits and revenue processes, council tax collection, housing benefit payments and enquiries by phone and in person.
- Customer Services Call Centre has recently relocated to WCC offices in Warwick and shares telephony, hardware and software with WCC.
- Five One-Stop-Shops spread across the district with four sharing premises and ITC services with WCC.
- Community partnerships, Community Chest Grants and voluntary sector Service Level Agreements and works with organisations in the community. Team members are home-based and use 'agile working' from community centres. The team shares hardware and software with WCC.
- The Data management centre (DMC).

Potential climate change impacts and mitigation factors are summarised below:

- **ICT** –Although the lower sections of the car park in Riverside House were flooded during recent flood events (summer 2007 and April 1998), the building itself lies outside flood zone 2. ICT services were not disrupted during the recent flood events. Other potential climate change risks relate to summer overheating and wind / tree fall damage.

  Mitigation. The Council has taken the precaution of establishing a third party Continuity Contract[1] as part of a Recovery Plan for the ICT system – the system has been 'virtualized' and can be maintained remotely. This will provide full server infrastructure with full service coverage, including remote communications, in the event of mechanical or climate related disruption to the service with 48 hour delivery of replacement hardware. In response to the 2009/10 swine flu risk the Business Continuity Plan enabled everyone in the IT team who has to travel from outside Leamington and all specialist functions to work from home. Critical IT staff can access the building through several different floors. WDC's ICT system is set up to allow 100 staff from across the Council to work remotely and has been proven for 50 people logging on simultaneously. Cooling systems are in place in the IT server room.

  Further mitigation required: continue to monitor the effectiveness of IT server room cooling systems during periods of hot weather.

- **The Benefits and Revenues team**. Any climate event leading to loss of access to Riverside House (for staff or clients), or loss of ICT or power could potentially cause significant service disruption.

  Mitigation. A Business Continuity Plan is in place which ensures that a number of locally based staff can walk into work and all critical staff can work from home and write cheques by hand. No further mitigation measures are required, beyond monitoring the effectiveness of these existing measures.

- **Call Centre.** The Business Continuity plan for the call centre is integrated with that of the Revenue and Benefits service, since the latter accounts for the major volume of calls. The major climate related threats to the service are likely to be from snow and ice, flooding or high winds preventing staff getting to work. This could cause significant short-term disruptions to the service, particularly in the face of likely increased volume of calls (eg. reporting damage, fallen trees, vulnerable people needing assistance etc) and demand for services including outside office hours.

  Further mitigation required: A joint business continuity plan needs to be developed with WCC for the call centre.

- **One-Stop-Shops.** The major risk to service continuity is snow and ice or flooding preventing access to one-stop-shops; however, for all centres other than Riverside House a rota allows staff to switch to the centre closest to their homes or those unaffected by weather.

  Further mitigation required: A joint plan business continuity plan needs to be developed with WCC for one-stop-shop services.

[1] A Continuity Contract is being negotiated with an Emergency Data Centre in Aston (Birmingham) and awaiting signature (Nov 2010).

- **The Community Partnership team**. Since this is not a front line service, snow and ice, flood or wind might cause a disruption to services but the impact would be low.

- **Mail** is handled at Riverside House and a large percentage relates to housing benefit and council tax. The impact of climate change / extreme weather events is not considered to be high. The mailroom does not need ICT to function and staff are mainly locally based. Service continuity is only likely to be affected by very severe flooding (which would need to exceed Flood Zone 2 levels) and the service could be relocated to alternative sites.

4.11 FINANCE

4.11.1 Services Provided

The WDC Finance team provides the following services:

- Insurance
- Accountancy
- Pay roll
- Procurement
- Audit
- Risk management
- FAST (Finance & Admin Support Team).

4.11.2 Climate Change Risk Assessment and Existing Mitigation

Potential impacts of projected future climate change on Finance services are expected to be low, but these may include:

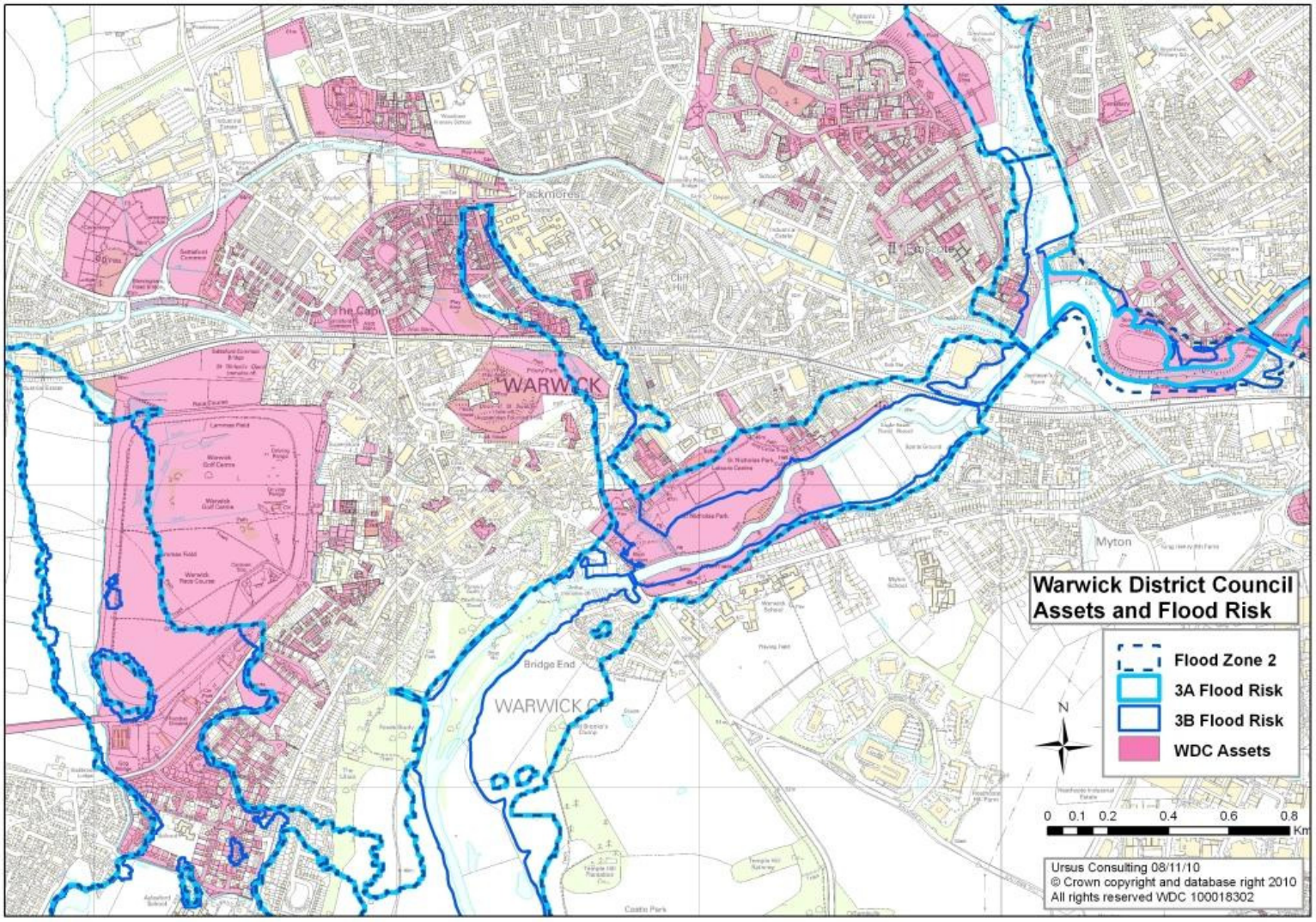
- Temporary reduction in demand and associated revenue from WDC services and town centre income (car parking etc) due to extreme events such as flooding and snow and ice events.

- Potential increases in insurance costs relating to events such as floods, storms, snow and ice – but the marginal cost increase is considered minor in the context of service area budgets and the Finance team undertakes competitive tendering processes to minimise the costs of insurance.

- Potential disruption for Finance team staff in getting to work during extreme events such as flooding, storms, snow and ice – but these risks are offset by Business Continuity Plans in place such as home or remote working. In addition, the Finance function's IT based systems are considered secure from the effects of extreme weather events because Riverside House is outside the flood zone (outside Flood Zone 3 and 2) and because of contingency measures in place for WDC's IT systems.

Further Mitigation Actions Required **-** In view of the risk assessment and existing mitigation measures in place, no further mitigation actions for required, but it will clearly be important to ensure that adequate insurance cover is maintained for extreme weather impacts.

Figure 4.3 Warwick DC assets and Flood Zones - Warwick



Note on Flood Zones: *Flood Zone 3b* = The Functional Floodplain, with annual probability of flooding of 1 in 20; *Flood Zone 3a* = High Probability, 1 in 100 or greater annual probability; *Flood Zone 2* = Medium Probability, between 1 in 100 and 1 in 1000 annual probability. *Flood Zone 1* = Low probability, 1 in 1,000 annual probability.

Figure 4.4 Warwick DC assets and Flood Zones – Leamington Spa

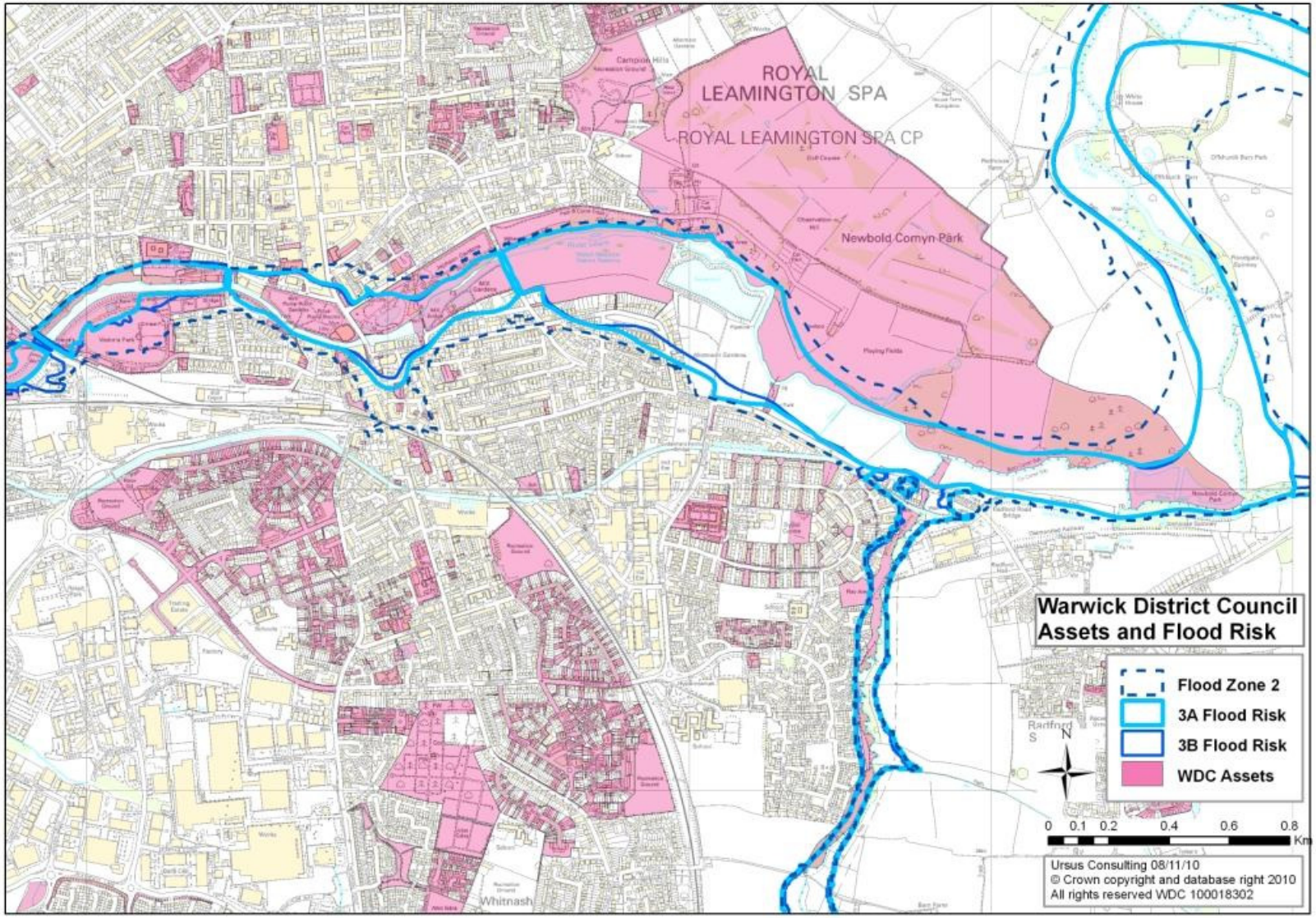
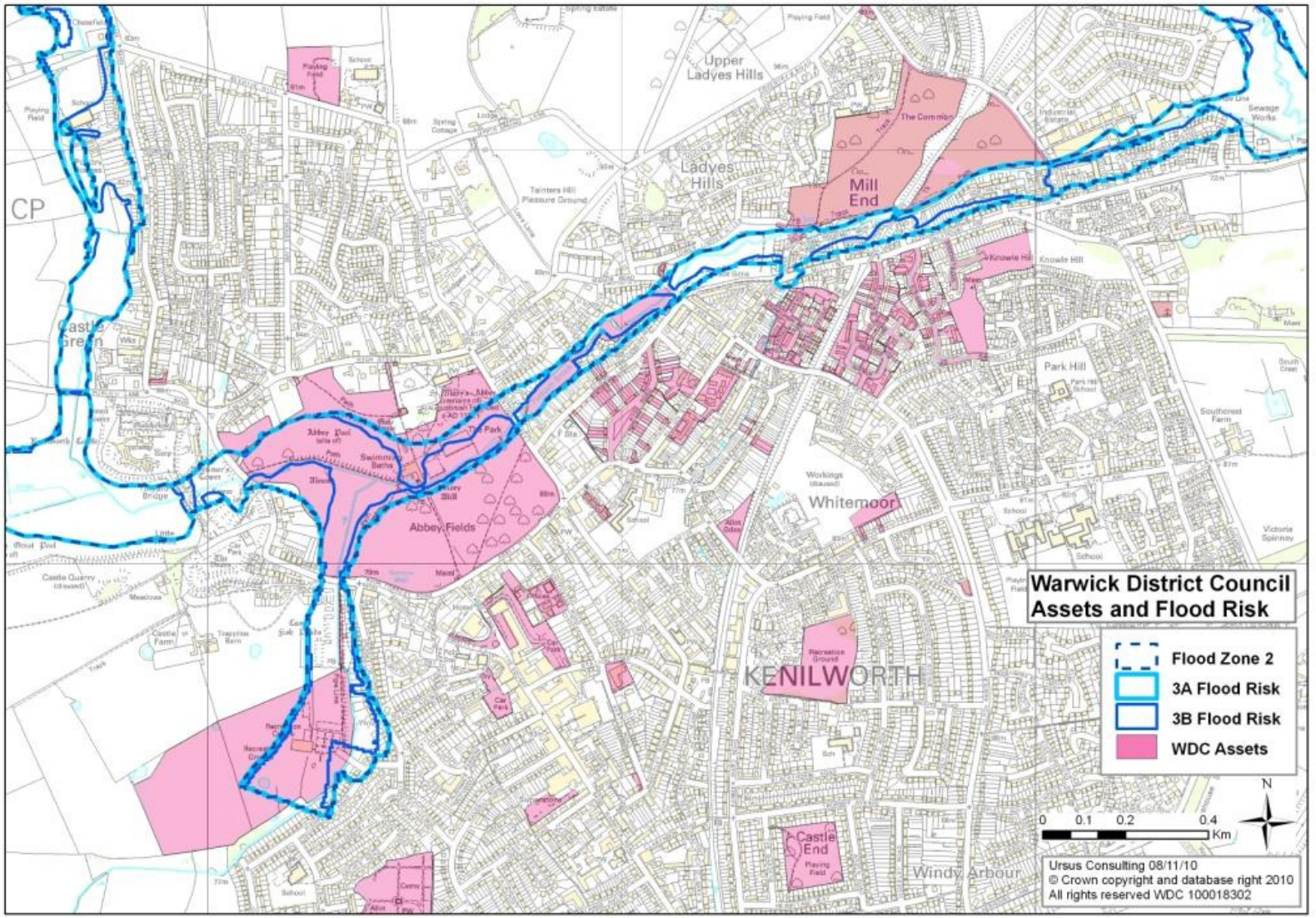


Figure 4.5 Warwick DC assets and Flood Zones - Kenilworth



4.12 SUMMARY – RECOMMENDED ADAPTATION ACTIONS

Warwick DC already has a number of plans in place which provide a strong basis for addressing the greatest risks from climate change. These include the Emergency Plan and Business Continuity Plans for each service area. Further Council actions on climate change adaptation will help to:

- save the Council money by, for example, reducing damage to Council property from severe weather and reducing the risk of potential liabilities associated with extreme weather;
- reduce business and household costs by improving buildings so that they can withstand severe weather;
- reduce disruption of local services to households and businesses by preparing Council services for climate change and helping them become more resilient;
- create local jobs – the Local Government Association (LGA) estimate that 150,000 new jobs could be created from developing climate change measures, including building resilience; and
- access new resources – there is a range of support and funds for councils for working on climate change, including the DCLG funded Climate Change Skills fund managed in the West Midlands by Sustainability West Midlands.

A systematic approach is required to identifying adaptation actions and to strengthen the resilience of Council services and local communities to the impacts of climate change. Based on the assessment of potential climate change impacts on WDC Service Areas, (detailed in *Annex B)*, key adaptation actions for the Council include the following:

Overarching Corporate processes

- Continue the on-going process of reviewing Service Area Risk Assessments and Business Continuity Plans to mitigate climate change impacts on WDC service delivery.
- Develop Business Continuity Plans in shared service areas with WCC – eg. call centres and one-stop-shop advice services.

WDC Assets

- Identify opportunities for incorporating climate adaptation measures into refurbishment programmes for WDC owned properties (corporate, operational, commercial and housing) – eg. heat and flood resilience measures.
- Ensure that any future WDC office moves or new premises are not susceptible to climate change related risks such as flooding, overheating or water stress.
- Increase the inspection regime for trees which are vulnerable to climate change (eg. high wind events, disease from milder winters and damage during drier summers) and shift towards planting resistant native species which provide summer shade.

Planning

- Develop a planning policy on climate change adaptation and supporting guidance which ensures that new developments in the district are designed to be resilient to and minimise the negative impacts of climate change. These policies will need to be integrated into the forthcoming new Local Plan and could be contained in a new Supplementary Planning Document (SPD) on climate change adaptation or be integrated into the existing SPD on Sustainable Buildings.

- Provide training on building adaptation issues and new adaptation planning policies / SPDs to WDC development control and building control staff, potentially making use of the regional Climate Change Skills fund managed nu Sustainability West Midlands.

Working with partners and contractors

- Work on horizon scanning and monitoring of weather events with partners such as the Met Office, WCC and Environment Agency (EA) to identify any significant changes in climate related risks.
- Ensure that external contracts, in areas such as refuse, grounds maintenance and housing maintenance, are sufficiently flexible to take account of climate change adaptation and, where appropriate, can provide flexible emergency cover (eg. for snow/ice and tree clearance after high wind events).

Flooding - Protecting WDC assets

- Identify WDC properties in the flood risk zone and investigate costs and benefits of retrofitting vulnerable properties with flood resistance and resilience measures – particularly for vulnerable households / tenants (such as elderly or disabled tenants).
- Ensure that flood resilience measures are phased into regular maintenance and repair schedules in premises such as the Pump Rooms and leisure centres.
- Ensure that adequate insurance is in place to cover financial impacts of flood damage to WDC properties and assets.
- Continue to ensure that valuable assets in buildings are safe from potential flood damage (eg. in the Pump Rooms and ICT systems in Riverside House). Check that the WDC's ICT remote continuity contract is in place.
- Any new WDC developments, properties and major projects should include a risk assessment of the impacts of future climate change at the project design / early stages to enable resilience measures to be integrated into projects.
- Examine the case for acquiring more land for cemeteries in less flood prone sites.

District wide flood protection

- Develop a multi-agency flood plan with key partners (emergency services, EA, WCC, and other Districts). This should include both engineering works and helping the community and businesses increase their resilience.
- On-going monitoring of district wide flood risks, working with partners such as the Environment Agency, WCC and other Districts including reviewing the findings from the 2011 WCC/Environment Agency study on areas susceptible to flooding from poor drainage (eg. Cubbington) and identify appropriate actions to reduce this flood risk.
- Examine the benefits and costs of flood resilience or resistance measures versus flood alleviation schemes for vulnerable properties not owned by WDC.
- Examine opportunities for grants and financial support for installing flood resilience measures and products in flood risk zones and mechanisms – such as the Community Infrastructure Levy and parish precepts – to help pay for them.
- Examine the feasibility of creating a fund for retrofitting properties, potentially linked to the Community Infrastructure Levy on new development. (Government guidance indicates that

the Community Infrastructure Levy could be used to fund climate change adaptation work, such as flood defences and green space improvements[1]).

Summer Heatwaves

- Ensure that Major Emergency Plan and Service Area Crisis Plans cover heatwaves - eg. water shortages, fires, legionella or food poisoning outbreaks.
- Monitor whether WDC properties, offices and housing require enhanced cooling systems (particularly low carbon, natural cooling or blinds) or other heat resilience measures during hot spells.
- Monitor the need to revise tarmac materials and specifications if damaged during heatwaves.
- Raise public awareness about reducing risk of fires (eg. use of portable BBQs).

High Wind / Storms

- Develop Emergency and Service Area Crisis / Continuity Plans to deal with high wind / storm events - for all service areas – eg. if a Force 8 wind is forecast, put 2 clearance teams on standby.
- Work with WCC to ensure adequate tree inspection regimes to minimise risk of injury and damage from windblown trees.
- Undertake periodic checks to ensure that WDC owned premises are not susceptible to wind damage (eg. roof inspections and possible renovation of glass ceiling in the Pump Rooms).

Snow/ice

- Continue to grit in high risk areas, and ensure adequate supplies of grit and urea beads (for concrete structures).
- Monitor whether WDC properties are susceptible to ice / freeze thaw damage.
- Work with WCC to examine opportunities for including gritting of key car parks within WCC road gritting activities.

[1] The Community Infrastructure Levy – An Overview, DCLG March 2010.

Part B

Planning for Climate Change Adaptation

5 PLANNING FOR CLIMATE CHANGE ADAPTATION

5.1 INTRODUCTION

The study aims include assessing the impacts of climate change on future development not within WDC's ownership, but within the District, and to make recommendations for adaptation measures which can be incorporated within these developments.

Part B of this report provides information on adaptation for buildings and assets which could be incorporated into the forthcoming new Local Plan and a WDC Supplementary Planning Document. This would help ensure that developments within the District are designed to be resilient to the impacts of future climate change and to reduce the vulnerability of communities to the effects of climate change. The following sets out:

- the planning policy context and guidance;
- existing *Warwick District Local Plan 1996 – 2011* policies relating to climate change adaptation;
- potential content for a Supplementary Planning Document (in *Section 6*); and
- measures for adapting new and existing development to climate change (in *Section 6*).

5.2 PLANNING POLICY CONTEXT AND GUIDANCE

In response to the evidence base for a changing climate in the UK, there are an increasing number of policy drivers for using the planning system to encourage adaptation of new and existing buildings. A number of local authorities are already using Supplementary Planning Documents to set out approaches for integrating adaptation measures into new developments.

5.2.1 Planning Policy

The relevant national guidance includes:

- **Planning Policy Statement 1 (PPS 1): Delivering Sustainable Development** (January 2005) which sets out the Government's overarching planning policies on the delivery of sustainable development through the planning system.

- **Planning Policy Statement: Planning and Climate Change. Supplement to Planning Policy Statement 1** (December 2007): The PPS1 supplement on Climate Change identifies how planning, in providing for the new homes, jobs and infrastructure needed by communities, should help shape places which have low carbon emissions and are highly resilient to climate change. PPS 1 focuses on mitigation but also covers:
  - the use of open space and green infrastructure for urban cooling, promoting sustainable drainage and for conserving and enhancing biodiversity;
  - approaches for addressing known physical and environmental constraints on development of land, such as sea level rise, flood risk and instability, and
  - the need to take a precautionary approach in the face of risks arising from likely changes to the climate.

  PPS 1 specifies that local Supplementary Planning Documents (SPDs) can be developed to provide further locally relevant guidance but should not set new policies.

- **Planning Policy Statement 25 (PPS 25): Development and Flood Risk** (March 2010) is the key planning policy document relating to flooding and has introduced a sequential, risk-based approach to planning for new development to avoid and manage flood risk. Consideration of drainage and flooding issues is required in all locations, not just within the floodplain. PPS 25 steers new development to areas of low flood risk (Zone 1 – see *Figure 2.1*). Where, in exceptional circumstances, new development is considered in areas of significant or moderate risk (Flood Zones 2 and 3) applicants should apply a 'Sequential Test' to demonstrate that the development could not be built elsewhere in a lower flood risk area. Where development in flood risk zones is permitted, the development must be appropriately protected or resilient to flooding. The PPS25 sequential approach underpins the development of Local Development Frameworks (LDF) / Local Plans and as such the sequential test will not be required at the planning application stage for development sites which are allocated within a Local Plan.

5.2.2 Building regulations

For specific buildings adaptation is likely to be addressed through:

- **Building regulations** which are progressively revised every three years. New Building Regulations Part F, Part J and Part L, came into effect 1st October 2010 and revisions are planned for 2013 and 2016. Part L of the Building Regulations already focused on energy efficiency and carbon emissions, i.e. climate change mitigation, but new measures introduced in 2010 also allow for the use of harvested and grey water (subject to a risk assessment), and require a water efficiency certificate for new dwellings. There is also a move to include further adaptation measures on flood risk and overheating in the future. The 2010 review of Part L committed to look at the flood performance of new and refurbished buildings. This will include consideration of whether the regulations should also apply to building repairs after a flood.
- **Energy Performance Certificates and Display Performance Certificates** are now required for all public and commercial buildings. As well as energy efficiency, certificates may in the future also need to show how adapted and resilient buildings are to water stress, flooding and overheating.

5.2.3 Government strategies

Government recognises the need to consider climate change mitigation and adaptation simultaneously. This is reflected in a chapter on each issue in the *UK Sustainable Construction Strategy 2008*, the focus on adaptation in the *Climate Change Act 2008*, the cross-government *Adapting to Climate Change Programme* and the work of the *Adaptation Sub-Committee* of the statutory Climate Change Committee.

A recent report by the *Adaptation Sub-Committee* (ASC, Sept 2010)[1] of the statutory Climate Change Committee identifies the need to:

[1] How well prepared is the UK for climate change?, Adaptation Sub-Committee September 2010

- take a strategic approach to land use planning to ensure that new buildings and infrastructure are sited in areas that minimise exposure to flood risk, do not increase flood risk for others, and do not create a legacy of flood defence or water supply costs;
- enhance green space, where effective, in the design of towns and cities to help manage surface water drainage and cope with rising temperatures and heatwaves. The ASC also identifies the need to design and renovate buildings – for example to ensure they can cope with rising temperatures and floods and minimise water use through appropriate use of construction materials and through better design.

5.2.4 Professional industry guidance

The Chartered Institute of Building Services Engineers (CIBSE) recommends the use of future climate change scenarios in building design, while the Association of British Insurers (ABI)[1] urges property developers to design and build new developments in a 'climate-aware way' to secure future insurability and warns that climate change impacts may make certain buildings uninsurable. Insurers will only be able to insure buildings if climate change risk is managed to acceptable levels. If insurance is not provided, buildings may not be sellable. Insurance costs relating to buildings are expected to increase significantly as the climate becomes more volatile.

5.2.5 Guidance from other bodies

The Planning and Climate Change Coalition[2] (PCCC) recently published guidance for planners which recommends that Local Development Plans (LDPs) should set out how the local authority area will be planned to adapt to the opportunities and impacts arising from changes in the climate. For specific planning applications the PCCC recommends that the Local Development Plan should:

- Set out how new development should be planned to avoid significant vulnerability to impacts arising from changes in the climate.
- Ensure that when new development is brought forward in areas with significant vulnerability to impacts arising from changes in the climate, risks can be managed through suitable and sustainable adaptation measures so as to provide sufficient resilience. In areas of water stress, and in order to secure development that would otherwise be unacceptable for its proposed location, resilience should be provided by setting standards for water usage in new development.
- Bring forward adaptation options for existing development in areas with significant vulnerability to impacts likely to arise from changes in the climate.
- Pay particular attention to vulnerable groups, as different impacts (and options to manage impacts) will affect parts of the community differently; and
- Plan green infrastructure in order to optimise its many benefits and, as part of wider green infrastructure networks, to support local biodiversity and healthy living environments,

[1] Climate Adaptation Guidance on Insurance Issues for New Developments. Association of British Insurers (2008)

[2] Guidance and model planning policies for local authorities, (Nov 2010), Planning & Climate Change Coalition. The PCC brings together non governmental organisations across the planning, built and natural environment sectors.

including through providing urban cooling, local flood risk management, and local access to shady outdoor space.

5.2.6 Planning Advisory Service

The Planning Advisory Service (PAS) report *Using Supplementary Planning Documents to Address Climate Change Locally* (May 2010) describes how local authorities are developing policies and guiding development to build resilience to climate change. Increasingly this is through the use of Supplementary Planning Documents (SPDs) in which planners explain and promote approaches such as the use of green infrastructure, passive design and ventilation, water efficiency and sustainable drainage to build resilience to climate change in local developments.

Giving guidance to applicants in the form of an SPD can provide the basis for pre-application discussions that will help applicants submit proposals in line with the authority's policies. SPDs can give a clear expectation of what information applicants will need to supply, and also provide information to planning and building control officers and councillors to inform them about potential responses to local climate change adaptation issues.

5.3 WARWICK DISTRICT LOCAL PLAN POLICIES AND ADAPTATION RELATED DOCUMENTS

5.3.1 Existing Policies and Documents

The 'new Local Plan for Warwick District' is being prepared but in the meantime Warwick District Local Plan (1996-2011) adopted in 2007 is being rolled forward. A number of the Local Plan policies expired (including DP10 on Flooding) on September 20th 2010, but remaining policies are 'saved' for use by the Council in taking planning decisions until such time as they are replaced. The Local Plan has a number of policies relating to climate change with a focus on mitigation but also covering a number of aspects of adaptation. These policies include:

- DP11 Drainage *(Box 5.1 below)* ;
- DP12 Energy Efficiency *(Box 5.2 below);*
- DP13 Renewable Energy Developments *(Box 5.3 below); and*
- SC13 Open Space and Recreation Improvements *(Box 5.4 below)*

The policies are supported by the Supplementary Planning Document on *Sustainable Buildings* (2008). Guidance from this SPD with relevance to climate adaptation is summarised in *Box 5.5* below. Applicants for planning are also expected to complete a *Sustainable Buildings Statement* for which the key questions are summarised in *Box 5.6.*

5.3.2 Strengthening WDC Policies and Documents for Climate Change Adaptation

To ensure that the new Local Plan is effective in helping to shape developments which are more resilient to climate change, we recommend that:

- **DP11 Drainage** - further information is provided on increasing flood resistance and resilience of existing buildings and retrofitting of buildings which have been flooded – potential information to include is provided in *Section 6*.

- **DP12 Energy Efficiency** - additional information is provided on adapting new and existing buildings to future climate and in particular hotter, drier summers through the use of natural ventilation and cooling, cool materials, roofs and vegetation – potential information to include is provided in *Section 6*.
- **DP13 Renewable Energy Developments** - This policy has limited implications for adaptation, although the opportunities for new developments or major refurbishments to consider ground source and water cooling, heat exchangers and tri-generation[1] where appropriate should also be included.
- **SC13 Open Space and Recreation Improvements –** further information is provided on the role of greenspace in combating climate change, and on the design of greenspace, particularly in the light of additional demands on it as a result of hotter drier summers, and the role that vegetation – including carefully chosen tree species - can play in providing summer cooling while allowing winter solar gain.

Box 5.1 DP11 Drainage

DP11 Drainage - *Development will be encouraged to incorporate sustainable drainage systems which provide for the disposal of surface water. Where this is not possible, it will be necessary to demonstrate:-*

a) Why it is not possible to incorporate sustainable drainage systems, and

b) That an acceptable means of surface water disposal is provided which does not increase the risk of flooding or give rise to environmental problems. The re-use and recycling of surface water and domestic waste water within new development will be encouraged.

The objective of this policy is to incorporate sustainable drainage systems into new developments as an integral part of their layout and design. Sustainable drainage systems aim to use a variety of techniques to control surface water run-off as close to its origin as possible by engineering solutions that seek to mimic natural drainage processes. These will help to protect against flooding and pollution of water resources as well as enabling opportunities for benefits in terms of nature conservation and the landscape value of the site and surrounds.

This policy is relevant to the siting of new development and adaptation to higher winter rain and increased likelihood of extreme events and flooding in the future. Guidance on how to apply the policy is provided in the Sustainable Buildings SPD (2008) (see *Box 5.5*) which describes how SUDS can be incorporated in new developments or on individual buildings. Applicants are expected to complete a Sustainable Building Statement answering questions on design and layout (see *Box 5.6*). **We recommend that further information is needed on increasing flood resistance and resilience of existing buildings and retrofitting of buildings which have been flooded -** potential information to include is provided in *Section 6 (below)*.

1 *Tri-generation* takes co-generation one-step further. Co-generation is the simultaneous production of electricity and useful heat, usually in the form of either hot water or steam, from one primary fuel, such as natural gas. Tri-generation involves the production of electricity, heat and chilled water. Chilled water is produced by incorporating an absorption chiller into a co-generation system, which takes the waste heat from a co-generation plant to create chilled water for cooling a building.

Box 5.2 DP12 Energy Efficiency

DP12 Energy Efficiency *- The layout and design of development will be encouraged to promote energy efficient buildings. Where appropriate, development proposals will be expected to demonstrate that they have considered:-*

a) opportunities to maximise passive solar gain, minimise heat loss and wind tunnelling and eddying;
b) opportunities to limit overshadowing of buildings to minimise loss of useful solar gain;
c) opportunities for landscaping to provide shelter belts to improve energy conservation;
d) the use of materials with a reduced energy input, such as recycled products; and
e) the use of sustainable and renewable forms of heating such as solar panels and CHP (Combined Heat and Power) schemes.

The objective of this policy is to design new developments which make the most of opportunities to reduce energy consumption and carbon emissions. Additional guidance is provided in the Sustainable Buildings SPD (2008) (see *Box 5.5*) and applicants are required to address how they have maximised energy efficiency in their Sustainable Building Statement (see *Box 5.6*). **This policy is also highly relevant to adaptation but additional information is needed on adapting new and existing buildings to future climate and in particular hotter, drier summers through the use of natural ventilation and cooling, cool materials, roofs and vegetation**. Potential information to include is provided in *Section 6*.

Box 5.3 DP13 Renewable Energy Developments

DP13 Renewable Energy Developments *- A. Planning permission will be granted for developments which generate energy from renewable resources where they do not have an unacceptable impact on:-*

a) local amenity including visual appearance, noise, dust, odour, and traffic generation;
b) public health and safety;
c) townscape and/or landscape character;
d) the natural environment; or
e) interests of archaeological or historic importance

In the case of all applications for renewable energy projects, the following will apply:

i) the wider environmental and economic benefits of the proposals will be a significant material planning consideration; and
ii) provision should be made for the removal of the facilities and the reinstatement of the site should it cease to be operational.
In the case of large scale renewable energy projects, there should be community involvement in developing the proposals.

B. In appropriate residential and non-residential developments, including conversions, the Council will require 10% of the predicted energy requirements to be produced on site, or in the locality, from renewable energy resources.

The objective of policy DP13 is to provide clear criteria for consideration of development proposals for renewable energy developments and to promote the use of small scale, on-site, renewable energy technology in developments. This policy has limited implications for adaptation, although the **opportunities for new developments or major refurbishments to consider ground source and water cooling, heat exchangers and tri-generation where appropriate should also be included.**

Box 5.4 SC13 Open Space and Recreation Improvements

SC13 Open Space and Recreation Improvements - *Contributions from residential and commercial developments will be sought to provide, improve and maintain appropriate open space, sport or recreational facilities to meet local needs. The exact level and form of contributions required will have regard to the location, nature and size of development. Where appropriate, applicants will be required to ensure that provision is made for:*

a) well designed informal open space for quiet relaxation on site;

b) appropriate children's play facilities which are visible from nearby houses but not so close they would cause disturbance, and

c) outdoor or indoor sport accessible by walking, cycling and public transport. Developments will be expected to provide a proportion of the site as recreational facilities, except where it would be more appropriate to provide, improve or enhance recreation facilities off-site but within the catchment area of the site.

The Council has prepared SPDs for developers on how new housing and commercial developments will be required to provide or enhance open spaces for leisure and recreation through the Warwick District Open Space SPD. The focus is on the quantity of greenspace and how it should be funded. **The role of green space in combating climate change is only mentioned once in the SPD, and no mention is made of the design of greenspace, particularly in the light of additional demands on it as a result of hotter drier summers or the role that vegetation can play in providing summer cooling while allowing winter solar gain.** Relevant questions on grey water recycling and SUDS in the Sustainable Buildings SPD summarised in *Box 5.6*. Additional information which would be useful to developers is summarised in *Section 6*.

Box 5.5 Guidance Relevant to Climate Adaptation in the WDC Sustainable Buildings SPD

Natural Ventilation and Cooling

- Good natural ventilation can reduce the need for mechanical forms of ventilation such as air conditioning which require significant amounts of energy. The design, and location of windows and the orientation of the building according to wind direction can encourage natural air circulation. For example, positioning windows on opposite walls can draw air through the building.
- The use of fountains and pools can have a cooling effect as air moves over the water and retains moisture. Shading south facing elevations with adjustable awnings or shutters can provide shelter from the sun, particularly during the summer months.
- Green spaces around buildings can provide opportunities for biodiversity and climate change adaptation such as the provision of wildlife corridors and the use of landscaping features such as trees to shade buildings. These features can also serve as amenity space, particularly in constrained town centre locations.

Sustainable Drainage Systems (SUDS)

In accordance with policy DP11, the Council encourages the use of sustainable drainage systems for the disposal of surface water. There is also potential to improve biodiversity using sustainable drainage systems such as through the delivery of wetland habitats. SUDS can take various forms depending on the location, size and type of development:

- **Green roofs** use vegetation and other organic matter to absorb rainwater and reduce run off from the building's roof. This can also act as insulation and in some cases provide open space for the development.
- **Permeable paving** such as pebbles, gravel or crushed stones can be used on hard surfaces such as car parks as these allow surface water to infiltrate into the ground. This does not however, negate the need to provide disabled access to comply with building regulations. It should be noted that the Government has recently removed permitted development rights to pave over front gardens using impermeable paving.
- **Soakaways** allow storm water to drain away from buildings and paved areas and permeate into adjacent soil.
- **Balancing ponds** provide a temporary storage facility to reduce the risk of flooding. They are particularly useful in larger developments where there is likely to be an excess of surface water at certain times.

- **Swales and basins** reduce and manage peak water flows, provide temporary storage for storm water, assist in filtering pollutants and aid the infiltration of water into the ground.

In all cases the applicant should indicate where applicable, who will be responsible for the management of these systems and how they will be maintained. Where SUDs are not used the applicant will be expected to fully justify why this is the case and that all options have been thoroughly explored. Failure to fully justify this could result in the application being refused. Instances where SUDs may not be appropriate include:

- where there is no accessible outdoor space such as a garden or roof area;
- where it can be demonstrated that it would not be financially viable, eg. for small developments (such as extensions);
- where it can be demonstrated that there would be no increase in the volume of surface water (such as a change of use proposal).

Water Conservation Measures

Design measures can also help in reducing demand for water by encouraging greater efficiency. The Council encourages greywater recycling such as the reuse and recycling of domestic waste water and the use of rain harvesting systems. In residential developments water butts, dual flush toilets and energy efficient showers should all be considered as standard.

Box 5.6 WDC Sustainable Buildings Statement

Applicants are expected to submit a Sustainable Buildings Statement along with their planning application to demonstrate how the requirements of the Sustainable Buildings Supplementary Planning Document (SPD) have been met. Following the guidance set out in the SPD the statement should cover the following climate-related issues:

- **Implementing Renewable Technologies** – outlining how at least 10% of the predicted energy demand of the development will be provided through renewable sources.
- **Low Carbon Technologies** – demonstrate whether Combined Heat and Power (CHP) has been considered and incorporated in developments of 10 dwellings or 1000 sq m or over.
- **Design and Layout** – demonstrate how buildings are designed to operate efficiently and to adapt to the potential impacts of climate change. This also needs to cover the orientation of buildings and their location within flood risk sites, if appropriate.
- **Maximising Energy Efficiency** – describe how the design, layout and orientation of the development maximises energy efficiency eg through optimizing passive solar gain and encouraging natural ventilation and other energy efficiency measures such as energy efficient lighting and cavity wall insulation. These issues are all relevant for summer cooling of heat stressed buildings.
- **Water Conservation** – describe measures that have been included to encourage water conservation such as grey water recycling.
- **Preparing for Climate Change** – describe what consideration has been given to ensuring that the development will be capable of adapting to the future impacts of climate change eg by ensuring that the potential for overheating is limited through the choice of materials.
- **Flooding and Climate Change** – address the impact of the development on flooding
- **Sustainable Urban Drainage – address how the** development been designed to incorporate Sustainable Urban Drainage Systems such as porous paving and soakaways and justification of why SUDS have not been included, if relevant.

Section 6 provides additional information on climate change adaptation for new developments and buildings, and for retrofitting of existing buildings based on the adaptation risks identified in *Sections 3 and 4* (above) and best practice developing in other local planning authorities. The information is provided in a form which could be included in a future SPD.

6 DRAFT CONTENT FOR A SUPPLEMENTARY PLANNING DOCUMENT

6.1 OVERVIEW

Effective planning and building design can bring about successful responses to climate change mitigation and adaptation. As well as reducing greenhouse gas emissions that are a cause of climate change, planning policy can help ensure that developments, and the communities that they support, are resilient to changes in climate expected during the lifetime of a building. Cross-cutting actions are required, spanning a broad range of design topics and spatial scales. The following sets out a proposed overarching policy which could be included in the new Local Plan, together with information on adaptation measures that could be included in a Supplementary Planning Document (building on the existing SPDs for *Sustainable Buildings, 2008* and *Open Space, 2009*).

6.1.1 Proposed Overarching Policy

Based on an assessment of current policies and guidance in the *Warwick District Local Plan 1996 – 2011* we consider that an additional policy will be needed specifically on adaptation. This would have some overlap with current policies on drainage, energy efficiency and open space, but should apply to both new developments and renovation of vulnerable existing buildings.

Adapting to a Changing Climate – Proposed Overarching Policy

All residential and non residential development should be built to allow for adaptation to Climate Change. The methods and materials used to renovate existing buildings should also encourage adaptation. Potential adaptation measures that could be taken in this area include:

- Wherever possible, new development should be located in areas of low flood risk. Where in exceptional cases development in flood zones is permitted, it should be for the least vulnerable uses and appropriately protected or resilient to flooding.
- Flood damaged buildings should be repaired to standards that improve their resilience to future floods.
- Where vulnerable buildings in the flood zone undergo major refurbishment or change of use, they should be retrofitted to improve their resilience to flooding and extreme weather events.
- Improving the water efficiency of plumbing, appliances and water features, and encouraging rainwater harvesting and re-use of grey water where appropriate.
- Incorporating sustainable drainage systems into new developments; and
- Ensuring that buildings can cope with rising temperatures through the use of layout, design, construction materials, ventilation systems that do not increase carbon emissions and appropriate design and use of vegetation and open space.

Table 6.1 summarises relevant measures at a range of spatial scales which would help to deliver these adaptation objectives, and the sections below provide more detail on the following aspects of planning for climate change adaptation:

- Locating development outside of flood risk areas;
- Designing new developments and buildings for a changing climate;
- Retrofitting existing commercial buildings for a changing climate;
- Flood resistance and resilience;
- Minimising the urban heat island effect and heat stress;
- Minimising water stress; and
- Using street/shade trees to adapt to a changing climate.

Table 6.1 Overview of Adaptation Measures at Different Spatial Scales

Aspect of climate change:	Conurbation/catchment scale	Neighbourhood/major development scale	Building scale
Flood risks	• PPS 25 Sequential approach to development. • Set back permanent and hard flood defences. • Diversion or dualling of flood flows away from affected areas. • Flood alleviation and temporary water storage (eg using greenspace and carparks). • Source control (eg in upstream, upland land management). • Change of use for particularly vulnerable properties	• Managing flood pathways to cope with heavy rainfall events – removing pinch points. • Sustainable Urban Drainage Systems. • Green roofs to reduce rate of runoff. • Widening drains to increase capacity.	• Raising floor levels. • Rain proofing walls and roof overhangs. • Using flood resilient materials (eg concrete, vinyl, ceramic, glass block, metal doors, pressure treated timbers). • Raise electric circuits. • Temporary freestanding barriers. • Removable products (floor boards, airbrick covers, flood skirts). • Green roofs to reduce run- off & pressure on drainage systems. • One way valves on drains/sewers. • Design to ensure safe access and egress in times of flood.
High temperatures – during hotter summers and heatwaves	• Green infrastructure. • Use of open water and water features. • Increasing evaporative cooling. • Shade providing street trees. • Cool pavements which reduce solar energy absorbed and encourage water storage.	• Cool or reflective building materials on roofs and facades. • Cool pavement materials. • Increased ventilation through orientation. • Shade providing planting.	• Orientation. • Surface water or aquifer cooling. • Thermal storage/ mass to cool buildings. • Building envelope insulation or shading. • Low carbon mechanical cooling. • Solar controlled shading.
Water shortages – during hotter summers and drought events	• Abstraction controls and licensing. • Managing point source pollution. • Well designed greenspace maximises infiltration of rainfall.	• Separate drainage systems for surface and foul waters. • SUDS. • Use of low grade aquifers for irrigation of trees and urban greenspace. • Water reclamation and reuse. • Rain water harvesting and storage. • Grey water recycling for irrigation. • Drought proof planting schemes.	• Water efficient fixtures and fittings. • Rain water harvesting and storage from roofs. • Grey water recycling for irrigation. • Building scale SUDS. • Green roofs to slow evaporation. • Drought proof planting schemes.
Subsidence and heave – from hotter drier summers and wetter winters	• Strategic monitoring. • Land use management. • Managed realignment.	• Surface erosion control. • Location and operation of soakaways. • Control and maintenance of drainage systems. • Choice and location of appropriate street trees.	• Moisture control systems or soil rehydration. • Vegetation management. • Infill of foundations. • Underpinning. • Deeper, stronger foundations.

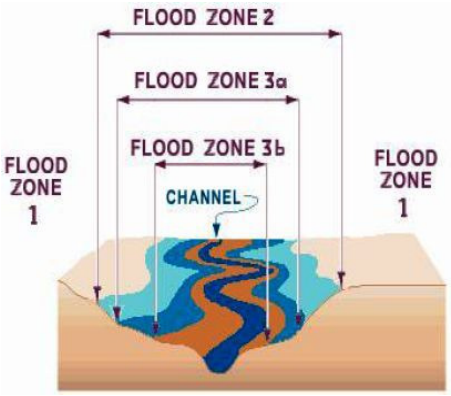
6.1.2 Locating Development Outside of Flood Risk Areas

The projected increases in winter precipitation and the likely rise in the frequency of extreme weather events mean that climate change is forecast to increase the risks of flooding to development in Warwick District. Flood risk should be appraised at the earliest stages of the design process and the full range of potential flood sources need to be considered. While the River Leam and River Avon and their tributaries are the principal considerations, significant risks can also occur from other sources such as surface water drainage systems. Further information on flood risks from these non-riverine sources will be available from Warwickshire County Council and the Environment Agency during 2011.

Planning Policy Statement 25: Development and Flood Risk focuses on flood risk as a material consideration in the determination of planning applications (in other words if it is not taken into account, planning decisions are open to legal challenge). The overall aim of the policy is to keep all development (except water compatible development) out of medium and high flood risk areas (Environment Agency Flood Zones 2, 3a and 3b) and other areas affected by other sources of flooding. Wherever possible, new development should be located in areas of low flood risk (Zones 1 and 2). *Figure 6.1* and *Table 6.2* summarise what these flood risk zones mean and WDC's Strategic Flood Risk Assessment Map (and *Figures 4.3, 4.4, 4.5* above) show their location. (It should also be noted that WDC, the EA and WCC are currently preparing additional information on the location of flood risk resulting from poor drainage and hollows in the landscape). The SFRA should be used as the basis for site-specific FRAs, and in assessing the suitability of sites for the type of development proposed.

Figure 6.1 Flood Risk Zones

Flood Zones show the areas potentially at risk of flooding from rivers or the sea, ignoring the presence of defences and are based on data produced by the Environment Agency.



- **Flood Zone 3b** = The Functional Floodplain - annual probability of 1 in 20.
- **Flood Zone 3a** = High Probability, 1 in 100 or greater annual probability.
- **Flood Zone 2** = Medium Probability, between 1 in 100 and 1 in 1000 annual probability.
- **Flood Zone 1** = Low probability, 1 in 1,000 annual probability.

Note: PPS 25 provides guidance for changes to flood risk as a result of climate change: with increases in peak river flow of 10% from 1990 to 2025; and 20% from 2025 to 2055, 2055 to 2085 and 2085 to 2115. The WDC *Strategic Flood Risk Assessment* (p.30, January 2008) adopts a precautionary approach by assuming a future climate change scenario of:

- Flood Zone 2 (1/100 to 1/1000 year return period) becoming 'high probability' Flood Zone 3a (1 in 100 year return period).
- The current Flood Zone 3a (1 in 100 year return period) becoming the Functional flood plain 3b (1 in 20 year return period).
- ie. many of those areas currently situated within Medium Probability Zone 2 could become part of the High Probability Zone 3 in the face of long-term climate change.

Source: WDC Strategic Flood Risk Assessment for Local Development Framework – Level 1 (January 2008)

PPS25 requires a 'Sequential Test' which aims is to steer new development to Flood Zone 1. Where this is not possible, reasonably available sites within Flood Zone 2 should be considered. However, only where there are no reasonably available sites within Flood Zones 1 or 2 should sites within Flood Zone 3 be considered. The aim is to ensure that all opportunities are explored to locate new water-incompatible developments in reasonably available areas of little or no flood risk, prior to any decision to locate them in areas of higher risk. *Table 6.2* summarises the vulnerability of different uses to flood risks. More vulnerable uses such as housing should not be located within areas at high risk.

Where it is not possible to identify alternative sites within zones at a lower risk of flooding, the applicant/developer will be required to carry out an 'Exception Test'. For the Exception Test to be passed:

- It must be clearly demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk based on the SFRA. (In assessing the sustainability of a proposal, applicants/developers should clarify the extent to which their proposal supports/ conflicts with other sustainability objectives in the Local Plan).
- The development should be on developable previously-developed land, or if it is not on previously developed land, demonstrate that there are no reasonable alternative sites on developable previously-developed land.
- The Site Specific Flood Risk Assessment (required for all developments within Zones 2 or 3 and for those of over 1ha in Zone 1) must demonstrate that the development will be safe, without increasing flood risk elsewhere and, where possible, will reduce flood risk overall.

For many developments a key flood risk issue to consider will be the management of surface water run-off. As development often reduces surface permeability by replacing permeable ground with impervious roofs and paved surfaces, there can be significant increases in surface run-off, leading to increases in flood risk. Surface water run-off should be controlled as near to its source as possible through Sustainable Urban Drainage Systems (see the WDC *Sustainable Buildings SPD, 2008*). The *Sustainable Buildings Statement* should make clear how the design of development proposals has been adapted to reduce the risks of flooding.

The national publication, *Planning Policy Statement 25: Development and Flood Risk: Practice Guide* is a useful source of information and case studies on the interpretation of national flood policy. The 2009 version also covers the Application of the Sequential and Exception Tests, including 'what is safe' (safe access and egress in times of flood) and guidance on surface water flood management, including sustainable drainage systems (SUDS).

Table 6.2 Flood Zones, probability of flooding and types of development allowed

Flood Risk Zone	Probability	Development Allowed (see *Table 6.3* for definitions)	Development Not Allowed
Flood Zone 1 (low probability - 1 in 1,000 annual probability)	This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).	Essential infrastructure, highly vulnerable (e.g. hospitals and mobile home sites), more vulnerable (e.g. dwellings and landfills), less vulnerable (e.g. general industrial and transport infrastructure) and water compatible infrastructure (e.g. water based recreation, amenity open-space and flood control infrastructure).	No constraints due to river flooding.
Flood Zone 2 (medium probability - between 1 in 100 and 1 in 1000 annual probability)	This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% – 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% – 0.1%) in any year.	All uses subject to a Site Specific Flood Risk Assessment but highly vulnerable (only if Exception Test can be met).	Highly vulnerable developments are not permitted where Exception Test cannot be met, or if there are alternative sites in Flood Zone 1.
Flood Zone 3a (high probability - 1 in 100 or greater annual probability)	This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.	All uses subject to a Site Specific Flood Risk Assessment but highly vulnerable (only if Exception Test can be met).	Highly vulnerable developments are not permitted; more vulnerable and essential infrastructure not permitted where Exception Test cannot be met, or there are alternative sites in Flood Zones 1 or 2.
Flood Zone 3b The Functional Flood Plain (annual probability of 1 in 20)	This zone comprises land where water has to flow or be stored in times of flood	Water compatible, plus essential infrastructure if Exception Test can be met.	Highly vulnerable, more vulnerable, less vulnerable not allowed; essential infrastructure not allowed where Exception Test cannot be met, or there are alternative sites in Flood Zones 1 or 2 or 3a.

Source: Based on PPS25, DCLG

Table 6.3 Vulnerability of Different Types of Development to Flood Risk

Type of development	What is included
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.
	Emergency dispersal points.
	Basement dwellings.
	Caravans, mobile homes and park homes intended for permanent residential use. Installations requiring hazardous substances consent.
More Vulnerable	Hospitals.
	Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels.
	Buildings used for: dwelling houses; student halls of residence; drinking establishments; nightclubs; and hotels.
	Non–residential uses for health services, nurseries and educational establishments.
	Landfill and sites used for waste management facilities for hazardous waste.
	Sites used for holiday or short-let caravans and camping subject to a specific warning and evacuation plan.
Less Vulnerable	Buildings used for: shops; financial, professional and other services; restaurants and cafes; hot food takeaways; offices; general industry; storage and distribution; non–residential institutions not included in 'more vulnerable'; and assembly and leisure.
	Land and buildings used for agriculture and forestry.
	Waste treatment (except landfill and hazardous waste facilities).
	Minerals working and processing (except for sand and gravel working).
	Water treatment plants.
	Sewage treatment plants (if adequate pollution control measures are in place).
Water Compatible Development	Flood control infrastructure.
	Water transmission infrastructure and pumping stations.
	Sewage transmission infrastructure and pumping stations.
	Sand and gravel workings.
	Docks, marinas and wharves.
	Navigation facilities.
	MOD defence installations.
	Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location.
	Water-based recreation (excluding sleeping accommodation).
	Lifeguard and coastguard stations.
	Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms.
	Essential ancillary sleeping or residential accommodation for staff required by uses in this category, **subject to a specific warning and evacuation plan**.

Source: PPS25 Annex D Table D2

6.2 ADAPTING NEW AND EXISTING DEVELOPMENT TO CLIMATE CHANGE

6.2.1 Designing new developments and buildings for a changing climate

Planning's role in ensuring that communities can adapt to climate change is described in PPS 1 supplement on climate change. This highlights the need to ensure resilience of new development, minimise the risk to existing development, promote green infrastructure and consider the disproportionate effect of climate change on vulnerable members of the community. The 2010 Planning Regulations include new provisions for water efficiency and use of grey and harvested rainwater.

New developments and buildings in Warwick District need to demonstrate that they have understood the likely effects of climate change – including heat and water stress and increased risks of subsidence during long hot summers and risks of flooding, wind and extreme weather events - and that, where appropriate, they have addressed them or built in adaptive capacity for the future.

Table 6.4 below summarises some of the measures which can be applied to individual developments based on the checklist for development[1] prepared by climate change partnerships in the Southern England and Town and Country Planning Association (TCPA)[2].

[1] Adapting to Climate Change: A Checklist for Development. Guidance on Designing Developments in a Changing Climate, 2005, South East Climate Change Partnership, Sustainable Development Roundtable for the East of England, London Climate Change Partnership.

[2] Climate Change Adaptation by Design, TCPA and Building in Climate Change, A Guide for Sustainable Communities, Town and Country Planning Association, 2007

Table 6.4 Summary of options for adapting to different aspects of climate change in new developments

Planning aspect	Climate adaptation issues	Principles for ensuring climate proofed development	Examples of adaptation techniques
Location	• Flooding. • Higher temperatures (heat island effect in urban areas can be 5-6^{o}C higher summer night temps than surrounding countryside). • Water resources. • Subsidence (clay soils particularly susceptible to hot summers).	• Check EA flood risk designation for the site and ensure design accords with it. • Check WDC SFRA. • Undertake flood risk assessment and evaluate flood risk over the design life of the development. • Demonstrate flood risk is acceptable for proposed use(s). • Help reduce temperatures by planning green space and offsite street trees and appropriate shading.	• Design suitable foundations to cope with increased subsidence risk. • Include soil maps (eg of clay soils and those susceptible to water logging). • Availability of water for development should be covered in LDF.
Site Layout	• Flooding (fluvial & flash). • Heat gain. • Increased demand for outdoor spaces. • Subsidence (especially of clay soils).	Ensure the overall layout and massing of the development: • Does not increase the flood risk and where possible reduces risk. Space should be left for existing flood prevention measures to be enhanced & for new flood defences to be added in the future; • Use site landform and landscape to minimise solar gain in summer and minimise heat loss in winter; • Maximises natural ventilation; • Maximises natural vegetation; • Takes account of the increased risk of subsidence; • Provides homes and other appropriate uses with a private outdoor space wherever possible.	• Use flood prevention/mitigation techniques including building bunds, designing higher defensive road systems and landscape features such as wells and ponds. • Use ground floor space for flood compatible uses eg car parking or raise the ground floor above likely flood level. • Reduce ratio of building height to spacing between buildings to optimise natural ventilation. • Use green roofs to insulate against heat gains, absorb rain and provide useable outdoor space. • Arrange gardens down slopes so that available water can be used more than once. • Use deciduous trees to provide summer shade while allowing winter solar gain. Balance with subsidence risks. • or use solar shading which allows lower sun angles in winter through. • Deeper foundations to reduce subsidence (dependent on site, type of soil and proximity, size & species of adjacent trees). • Use root barriers to deal with risks of subsidence from existing mature trees. • Include balconies, roof gardens or green links to nearby greenspaces in higher density developments.
Buildings: Structure	• Wind speeds (may be higher with impacts for high buildings). • Soils. • Higher temperatures. • Heat loss and gain.	Ensure structures are: • strong enough or able to be strengthened if wind speeds increase in the future and to avoid movement due to increased levels of subsidence and heave. • Able to incorporate appropriate ventilation and cooling techniques/mechanisms. • Appropriate thermal mass for intended use and occupancy.	• Use alternative methods to traditional air conditioning, eg larger floor-to-ceiling heights will allow later addition of any cooling mechanisms. Higher ceilings trap hot air above the heads of users making room feel cooler. • Where necessary consider mechanical ventilation and cooling. eg 'Chillable beams' in new buildings. • Lightweight (eg. pre-fabricated) buildings heat and cool more quickly; heavy construction can help regulate temperatures.

Planning aspect	Climate adaptation issues	Principles for ensuring climate proofed development	Examples of adaptation techniques
Physical Envelope of Structure	• Rainfall (more intense) • Heat gain • Air tightness • Wind speed	Ensure the envelope of the buildings is designed so that: • Roof and drainage systems and entrance thresholds can cope with more intense rainfall. • There are opportunities for incorporating green roofs or walls. • Exterior of buildings reduces heat gain in the summer. • The overall envelope avoids infiltration from increased wind and temperatures. • Cladding materials and tiles are able to cope with higher wind speeds.	• Increase size of guttering and down pipes or use spouts and gargoyles and storm drains on the ground. • Reduce use of secret and parapet gutters and internal downpipes. • Heat gain could be reduced by more thermally reflective surfaces, especially roofs. • Openings facing the sun should be shaded from summer sun eg by trees, recessed or given overhangs, blinds or shutters & reflective glass. • Greenery such as vertical gardens, climbers and green roofs reduce heat gain in summer. • Insulation helps to keep out summer heat as well as keeping in winter warmth.
Materials	• Walls built with brick or concrete retain heat and let it out slowly. • Concrete strength affected by curing at high temperatures. • Lime, mortar & stone affected by increased CO2 and driving rain. • Plastics and roofing felt affected by increased UV. • MDF/Chipboard not suitable in flood risk areas.	• Ensure materials will perform adequately in the climate over building lifetime. • Ensure construction methods are suitable for weather conditions at time of construction.	• Buildings should have the optimum thermal mass to maintain comfortable internal environment with least energy use (generally high thermal mass for houses and hospitals). • Explore opportunities for more adaptable materials (eg glass cladding replaced with insulated aluminium cladding).
Ventilation and Cooling	• Hotter summers • Droughts	• Ensure that ventilation brings clean air into the building and does not compromise noise levels, air quality or security. • Building should have or be capable of having a ventilation system delivering comfortable temperatures (>28^{o}C for <1% of the time and >25^{o}C for <5% of the time) throughout the design life of the building. • Cooling/ ventilation systems should be as energy efficient as possible using renewables where practicable.	• Reduce solar gains in summer by using shading external louvres or internal blinds. • Design secure ventilation so that users can close ventilation easily in high temperatures and open in cooler temps eg at night • Cooling technologies include: free cooling; slab cooling; night cooling; evaporative cooling; chilled ceilings with displacement ventilation; ground cooling. • Link into tri-generation – district cooling and combined heat and power – if available.
Drainage	• Increased surface run off (leading to flash floods in periods of intense rainfall) • Foul flooding from inundation of sewerage system • Traditional drainage pipes can lead to flooding and pollution downstream	• Carry out a site survey to determine appropriate SUDS techniques (eg filter strips, swales, soakaways, storm water tanks, permeable and porous pavements, basins, reed beds and ponds). • Comply with requirements of Groundwater Regulations. • Ensure responsibilities for future maintenance of SUDS and space for removal of silt is built into initial design	• Shallow, extensive infiltration systems will minimise risks to groundwater • Consider rainwater harvesting, green roof systems & opportunities for permeable paving • Consider using permeable paving anywhere that loadings will not cause structural failure (eg pavements, driveways, footpaths, car parking and access roads)

Planning aspect	Climate adaptation issues	Principles for ensuring climate proofed development	Examples of adaptation techniques
Water	• Water services. • Water efficiency. • Rainwater collection and grey water recycling.	• Estimate net water consumption under normal use and drought conditions over the buildings life time with Water Company. • Discuss existing sewerage infrastructure and sewage treatment capacity with local sewerage provider • Minimise water use in buildings through design and water efficiency measures	• Reduce water use by installing ultra low flush or variable flush toilets, waterless urinals, water efficient showers, 'A-rated' appliances, low flow taps and showerheads etc • Minimise piping between boiler/hot water tank and taps. • Install leak detection systems for major supplies. • Consider rainwater harvesting • Consider greywater recycling
Outdoor Spaces	• Increased demand for outdoor spaces. • Harder wearing surfaces. • Need for natural shade. • Loss of soil functions. • Water stress to vegetation.	• Include a range of public and private outdoor spaces with appropriate shade, water features & vegetation • Ensure surfaces account for more intense use, permeability, and reduce potential dust/soil erosion • Ensure plantings with longer life (eg over 10 years) adaptive to future climate • Ensure water features have minimal net water use • Provide rainwater collection systems/grey water recycling for watering gardened areas. • Ensure arrangements for storing waste allow for separation and prevent excessive odours in hot summers.	• Consider gravelled or paved areas as long as a high proportion is permeable • Provide deciduous vegetation for summer shade, but suitable for soils, winter solar gain and wind and subsidence risks • Introduce soil management strategies to mitigate against flooding and subsidence • Water running through water features should be recycled or reused (eg for watering vegetation) • Use solar energy to power pumps to recirculate water in water features • Compost green waste
Infrastructure resilience	• Wind and flood risks to development's infrastructure. • Areas liable to flood risk will require better protection (gas mains, electricity & telephone cables, electricity sub-stations). • Underground pipes, cables, bridge, tunnels & other earthworks will be more vulnerable to damage from wetting/ drying cycle of soils. Pylons carrying electricity & telecoms cables may be vulnerable to higher winds.	• Ensure there are safe access routes above likely flood levels & routes are clearly marked (eg by poles). • Coordinate with utilities over the resilience of services & infrastructure to the development.	• Including local renewable energy may enhance resilience to power shortages and outages.
Impact on neighbours	• Development could impact on neighbours through increasing surface run-off, changing flood or groundwater regimes down river, increasing land instability, changing provision of wind protection, ventilation and shade etc	• Developers should identify immediate neighbour impacts and mitigate against them.	

6.2.2 Retrofitting existing buildings to increase their adaptive capacity

Adapting to climate change should also be a fundamental consideration in the design and refurbishment of existing buildings and in business continuity planning. Since the vast majority of the commercial and residential building stock is already in place it is important to build in adaptive capacity into building systems, facades and services when they are being refitted during major refurbishments or for change in use.

The two most significant risks to premises are likely to be flooding and overheating, but refurbishment projects should aim to take account of all threats and opportunities arising from climate changes over their design lifetime, such as subsidence.

Many of the adaptation design options summarised in *Table 6.4* can be as relevant to existing buildings as they are to new developments. Such measures will enable buildings to cope with the effects of current and projected changes in weather and climate over a building's lifetime.

Retrofitting is likely to be most cost-effective as an integral part of major maintenance or refurbishment programmes. However, there may be instances where risks are such that *ad hoc* retrofits need to be considered. In either case the aim should be that all major retrofits have design lifetimes appropriate to the investment involved, taking into account site specific issues and projected climate changes over the period over the next 10 to 30 years.

Recent work on retrofitting commercial buildings in London[1] has identified a useful hierarchy of adaptive actions:

- Consider low cost quick wins for adapting to higher summer temperatures such as green roofs and louvres for existing buildings in the short term.
- Consider more strategic interventions such as installing mixed mode ventilation and cooling and well insulated facades if major refurbishment or a move to new premises is planned.
- Think about adaptation and mitigation in parallel: Improvements made in water and energy efficiency will have a direct financial benefit through reductions in both water and energy bills, plus the ability to report the associated carbon emission reduction from water heating savings – highlighting a dual benefit of tackling adaptation and mitigation agendas in parallel.

Generally, specifying effective retrofitting measures will require specialist knowledge. Therefore, if the project is being undertaken by an in-house team it will be important to ensure that sufficient technical knowledge is available, or that advice is sought from suitably qualified professionals, such as building services engineers. If the work is being contracted out, the requirement for premises to be well-adapted to climate change should be clearly specified as part of the tendering for architects and contractors.

Box 6.1 shows some possible solutions to adapting existing commercial buildings for climate change. All of these options will be building and site specific therefore professional design advice is required to ensure the most appropriate solution.

[1] London's Commercial Building Stock and Climate Change Adaptation, (Sep 2009) London Climate Change Partnership

Box 6.1 Guidance for retrofitting of existing commercial buildings for climate change

1. When retrofitting and refurbishing buildings, consider whether options for new developments are also applicable to existing buildings. The orientation of the building will be key in determining what retrofit options are most appropriate.

2. Install a mixed mode ventilation and cooling strategy. This combines an automated natural ventilation system which should be adequate for most of the year with low carbon automated mechanical cooling system only used when temperatures are too high for the natural ventilation system to cope.

3. Optimise solidity in the elevation to reduce the amount of heat getting into the building and improve thermal performance of the building during the heating season.

4. Reduce solar gain and solar glare through external louvres, or fit internal blinds to prevent solar glare.

5. Optimise daylight control by adding light shelves, which even out the diffusion of daylight into the room, and can increase the penetration of daylight into more central areas so reducing the need for artificial light in deeper plan office space.

6. Assess and alter total glazed area of the facade, then minimal external and internal shading is required. Ensure standard quantities of daylight reach the perimeter area of office space up to 4m from façade of office depth. Office space beyond that should have enough daylight for perception only, with very low energy, controlled task lighting where required.

7. Vegetate the building with green roofs, green walls, trees and green spaces. This helps to keep the building and surrounding air cool and increases thermal insulation. Trees and vegetation at ground level also help with storm water attenuation and help prevent flooding.

Source: based on London Climate Change Partnership, 2009

6.2.3 Retrofitting buildings for Flood Resistance and Resilience

An increased risk of flooding presents the greatest climate change related challenge for buildings in Warwick District. This risk is not confined to flooding from rivers, flooding can also come from surface water, sewer overflows or groundwater. For example, an annual probability of flooding of 0.5% (1 chance in 200 in any given year) may not seem high, but if an average home were to flood to a depth of 0.5 metres the damage likely to be caused (£30,000 - £40,000) is still equivalent to average damages of £150 - £200 every year, requiring a considerable increase in the average premium, typically about £350. Damage to commercial buildings could be even higher.

Areas at risk of flooding need to be audited for present capacity of both on- and off-site rainwater systems to ensure that they can cope with projected increases in the frequency and intensity of rainfall. In the light of this audit, retrofitting options could include:

- Upsizing of gutters, down pipes, etc. to cope with more intense rainfall;
- Use of SUDS techniques (see *Box 5.5*) to manage on site water and minimise off site impacts from runoff;
- The use of green roofs to lessen the rate of runoff from large roof areas; and
- Replacement of impermeable surfaces by use of permeable materials for roads, paths, parking areas, etc where possible.

For individual properties, ensure that the use of areas within the premises and location of equipment minimises risks in the event of flooding (for instance, moving computers out of basements and white goods on to plinths). Measures can then be designed for resistance

(preventing or limiting amount of water entering) or resilience (reducing the time and cost of recovery) to flood events.

Flood resistance measures need to be applied as a comprehensive package in a building because they are only effective if all entry points are blocked. If a building is at risk of deep flooding events (>0.9m) it may not be desirable to prevent water entering since this can cause structural damage to the building. It may therefore be better to plan for resilience.

Resilience measures can be applied sequentially with cumulative benefits: each measure will reduce the costs and time required for recovery. Potential costs of resistance and resilience measures for an average house are shown in *Table 6.5*.

The benefits of flood resistance and resilience measures are that they: keep insurance premiums lower; keep properties in flood risk areas insurable; or reduce the financial impacts of flooding for uninsurable properties. Payback times can be minimised if measures are incorporated into planned routine maintenance and refurbishment or reinstatement of flooded buildings.

There are currently no national grant schemes for retrofitting of flood resilience or resistance measures. However, during 2008 DEFRA funded a pilot project[1] to test four different models of flood resilience and resistance in six high flood risk areas. Grants were taken up by around 75% of residential and 25% of commercial properties within the six areas with the average cost of works per property of approximately £2,900 - within a range from £300 to £13,000. The Defra project found that measures costing £4,500 per dwelling would provide adequate flood protection in most instances.

6.2.4 Addressing Overheating

Climate change is already leading to increasing temperatures with mean seasonal increases of about 1.3°C in winter and 1.5°C in summer expected by 2020. Higher average temperatures are already being experienced and also many more extremely hot days. Summer heatwaves are becoming more frequent and more intense, along with less severely cold winter weather. Climate change predictions suggest that temperatures experienced in the summer 2003 heatwave will be typical by the 2040s and will be considered 'cool' by the 2060s.

Adaptation measures should be considered both at the wider urban and individual building scale since higher temperatures are likely to cause overheating in buildings which have not been designed for them. Simply installing air conditioning will increase energy use and associated CO_2 emissions.

Individual buildings where heat stress is likely to be an issue – such as leisure centres and those with a high percentage of glazing - should be audited in order to develop an approach which maximises solar gain during cooler seasons and minimises gain during the summer. A menu of potential measures is shown in *Table 6.6*.

[1] DEFRA made £500,000 available for a pilot grant scheme for the implementation of property-level resistance and/or resilience measures. A funding limit of £5,000 per property was set. The funds were administered by local authorities – Nottingham, Cumbria, Lancaster City Council, Leeds, and East Sussex – and covered 6 flood risk areas. Lancaster City Council.

Table 6.5 Adapting to Climate Related Flood risks

Adaptation Measure	Relative cost (Free, Low, Medium, High) (F = free; Low = <£100; M= £100-1,000; H=£1,000+)
Resistance Measures:	
Check Flood map (Zone 2, 3a, 3b)	F
Register with EA Flood Warning Scheme	F
Drainage bungs for drains, sinks and toilets	L
Install reuseable air brick covers/smart air bricks	L
Seal gaps around pipe and cable entries, windows and doorframes	L
Fit non-return valves on main drains	M-H
Install demountable door guards, flood skirts	M-H
Move meters and electrical sockets above flood levels	M-H
Install a 'sump and pump' below ground level	H
Raise door thresholds	H
Repair damaged mortar and repoint brickwork on external walls	H
Apply waterproof render to external walls	H
Install waterproof membrane on external walls (eg from 0.6m below ground to 1m above)	H
Resilience Measures:	
Check Flood map (Zone 2, 3a, 3b)	F
Register with EA Flood Warning Scheme	F
Store Valuables and paperwork on upper floors	F
Turn off gas, water and electricity mains	F
Fit rising hinges so doors can be removed	L
Use dry bags to protect soft furnishings	L
Use water resistant paint for lower portion of internal walls	L-M
Rewire, raising electrical points above flood level (with wiring drops from above)	M
Relocate meters and boilers above flood level	M
Relocate computers, white goods, machinery etc above flood level	M
Replace carpets with vinyl, ceramic or solid concrete flooding	M-H
Replace chipboard with solid pressure treated timber	H

Source: Your Home in a Changing Climate: Retrofitting Existing Homes for Climate Change Impacts, 2008, London, South East and East of England Climate Change Partnerships

Building design can assist in reducing temperatures. Shading windows by installing shutters or blinds reduces solar gain and so internal heat build-up is reduced. Extending roofs can also provide shading to a building. Heavier weight building materials like concrete and stone which provide a thermal mass help to keep buildings cooler during the day. Chilled ceilings and chilled beams can also be used.

For many buildings increasing insulation in roofs and cavity walls will be a win-win approach which also reduces winter heating requirements. However, poorly designed insulation can exacerbate overheating if it limits opportunities for cooling during periods of excessive heat,

particularly where light-weight materials are used for reasons of cost. Combining insulation with high thermal mass can be very effective.

Ground source heat pumps are an energy efficient means of heating and cooling, but require extensive groundwork for installation and large internal radiating surfaces, typically floors, and so are difficult to retrofit. However, there may be cost-effective opportunities for installation of ground source heat pumps on major refurbishment projects requiring groundworks and significant structural work for other purposes.

Table 6.6 Adapting to Climate Related Overheating in Buildings

Type of heat gain	Cause	Potential Adaptation Measures
Internal heat gains	Waste heat from equipment and lights	• Low energy light bulbs • Passive cooling (Natural ventilation) • Low energy equipment • Ground source cooling (eg from aquifers or surface water)
Heat gain through glazing	Solar gain will depend on building orientation, season and daily changes to sun angles	• Changes to the size and position of glazed areas • Smart glazing materials eg low-e coatings/solar reflecting film • Roof overhangs, awnings or brise-soleil to minimise solar gain at high sun angles • Solar controlled automated shading systems • Tree planting for shading (deciduous trees near buildings to allow winter solar gain)
Heat gain through warming of external surfaces	Roofs and walls absorb heat which passes through to internal spaces	• Minimise radiant gain by painting external walls light colours/coatings or using • Reflective paint on walls and roofs (cool roofs) • Improved roof insulation to reduce heat penetration (especially slate) also reduces winter heat loss • Green roofs can help keep buildings cool as well as other adaptation benefits (storm water runoff, air quality and nature conservation). • 'Cool' or 'white roofs' can be created on flat or sloping roofs by applying a coating of light-coloured water sealant. This reflects and radiates heat and by limiting daily temp fluctuations and UV exposure can last 10 to 20 years and are proven in the US to be cooler. Cheaper than cool roofs and good for high roof-to-volume ratios, such as one or two storey buildings. • Cavity wall insulation where appropriate to reduce heat penetration through walls. • Use of green walls and climbing plants on external walls to produce shade and evaporative cooling • Thermal storage or thermal mass to cool buildings
External air temperature (exacerbated by Urban Heat Island effect)	Higher outside temperatures are transmitted to internal spaces	• Drought tolerant vegetation and tree planting • External water features for evaporative cooling • Bars over windows to allow them to be left open at night

6.2.5 Design to minimise water stress

Predicted climate change for Warwick District includes a likelihood of an average drop of 7% in summer rainfall by 2020 and 17% less by 2050. The likelihood of very hot drought years will also increase. There is therefore likely to be an increased demand for water for vegetation, cooling and water based recreation at the same time as increased demands for new housing and an overall fall in available water availability. The Building Regulations 2010 have increased requirements for water efficiency in new buildings in response to the evidence base for water stress across the South and midlands. In areas of water stress both new developments and refurbishment projects can reduce, reuse and conserve water through:

- **Reducing water use –** using a range of efficiency measures:
  - ultra low flush or variable flush toilets. This can save more than half the water used for flushing toilets and cut household water use by up to 20%;
  - waterless urinals;
  - water efficient showers and smaller baths;
  - water-efficient devices, such as 'A-rated' washing machines and dishwashers;
  - low flow taps and showerheads;
  - minimising the amount of piping between boiler/hot water tank and tap, to reduce the need to 'run' the water,
  - installing leak detection systems for major supplies.

- **Greywater recycling -** water from washbasins, baths, showers and clothes washing can be re-used for non potable uses such as toilet flushing but requires filtration and disinfection. The benefits include reducing household water demand and easing pressure on the mains water supply, reducing upstream energy and environmental costs.

- **Rainwater harvesting -** The captured water can be used for irrigation purposes, toilet flushing and water features and is beneficial because it reduces water demand and eases pressure on the mains water supply, reducing upstream energy and environmental costs. It also helps to reduce the risk of flooding during storms by storing rainwater and slowing the rate of runoff before it reaches the drainage system. Typically, rainwater is collected from rooftops and is diverted into barrels or large storage tanks. The amount of rainwater collected from a rooftop can be significant. A 93 m2 (1,000 square feet) roof can catch 568 litres of water from rainfall of just 6 mm. Systems installed on high use buildings have demonstrated savings of around 50% per year.

Vegetation and Trees to adapt to a changing climate - Trees can provide significant benefits in urban areas as they not only provide shade but can also reduce air pollution and the Urban Heat Island (UHI) effect associated with hotter, drier summers. Trees and vegetation are natural cooling systems as they convert water contained within their foliage into water vapour which is released into the atmosphere by evapotranspiration. There is a substantial body of evidence to show that well maintained larger trees can help to reduce localised peak summer temperature extremes by 1 – 5^{o}C and provide shade, making streets and buildings cooler in summer. Street and shade trees can also improve the environmental performance of buildings thereby reducing heating and cooling costs.

Trees can also help to lessen the impacts of extreme events by helping to reduce local wind speeds and reducing the effects of flash flooding by rainfall interception. Trees also have wider sustainability benefits by helping to: improve air quality by reducing dust, particulates and ozone

associated with hotter drier summers; increase biodiversity and provide food and shelter for wildlife; and provide a potential long term renewable energy resource.

Urban trees also provide a number of economic and social benefits. Trees can increase the value of properties as they grow: studies have estimated that the proximity of trees can increase residential and commercial property values by between 7% and 15%. Trees can also improve the quality and perception of the environment and confer a premium for development sites and positive perceptions for prospective purchasers.

Trees also have social benefits including creating community focal points and landmark links and a sense of place and local identity, helping to instil pride in an area and having positive impacts on physical and mental well-being.

However, street and shade trees around buildings and developments can also exacerbate climate change risks through:

- Subsidence and structural damage to buildings on shrinkable (clay) soils if they are planted too close to buildings with inadequate foundations. This problem will be aggravated where dry summers follow very wet winters;
- Structural damage to drains and infrastructure during long hot summers when roots grow down to find water; and
- Risks of injury or fatalities where trees or branches fall on pedestrians, cars or buildings during high wind extreme events.

Ensuring safety and avoiding damage to people or property are, of course, paramount but with careful selection and a sensible arboricultural regime (monitoring and maintenance) these problems can be overcome. Street and shelter trees need to be very carefully selected to ensure that they are resistant to drought (able to withstand at least a month of drought) and potential water-logging (eg floods of up to a week). Sufficient rooting space and an adequate water supply also need to be considered.

Where shelter, street, specimen and background trees are included in new developments monitoring and maintenance and costs for the whole life time of the development also need to be built in and planned for.

A useful database tool Right Trees [1] enables planners, landscape designers, developers and other professionals to decide what types of tree are suitable for a changing climate. The database lists the characteristics of tree species that will be suitable for the urban areas in future climatic conditions for the rest of this century. *Table 6.7* summarises a few species likely to be suitable for Warwick District. However, expert advice should also be sought on existing tree requirements, choice of new species, supply and planting, pit preparation and aftercare.

[1] The underlying database was prepared by Forest Research in collaboration with the Greater London Authority, the Forestry Commission, Natural England, the Tree Council and the Royal Horticultural Society.

Table 6.7 Suitable Trees for Streets and Shade in Urban areas in the face of climate change

Common name	Latin	Use in urban setting	Native	Deciduous (D) or conifer (C)	Size S/M/L (Note 1)	Drought tolerance	Water-logging tolerance	Soil type
Midland Thorn	*Cratageaus laevigata*	Street, specimen, background	Yes	D	S	Medium	Very Low	All
Whitebeam	*Sorbus alba*	Street, specimen, background	Yes	D	M	Medium	Very Low	All
Wild Service Tree (poisonous)	*Sorbus torminalis*	Street, specimen, background	Yes	D	M	Medium	Very Low	All but dry
Small-leaved Lime (hayfever)	*Tilia cordata*	Street, specimen, background	Yes	D	M	Medium	Very Low	All but dry or wet
Norway Maple	*Acer Platanoides*	Shelter, street, specimen, background	N Eur	D	M, L	Medium	Low	All
Aspen	*Populus tremula*	Shelter, background, specimen	Yes	D	M	Medium	Low	All
Common Hornbeam	*Carpinus betulus*	Shelter, street, specimen, background	Yes	D	M	Low	Very Low	All but wet
White Poplar	*Populus alba*	Shelter, background, specimen	South Eur	D	L	Medium	Very Low	All but wet
Black Poplar	*Populus nigra*	Shelter, background, specimen	Yes	D	L	Low	Medium	All

Source: www.right-trees.org.uk

Note 1. Tree size: S = <10 metres; M = 10-20 m; L = >20 m.

6.3 TOOLKITS AND OTHER USEFUL SOURCES OF ADVICE

Additional sources of useful information on climate change adaptation measures for new and existing buildings are shown in *Table 6.8.*

Table 6.8 Toolkits and Sources of Advice on Climate Change Adaptation in Buildings

Organisation	Reference	Description
CABE	Sustainable Places Climate change and public space.	Sustainable Places gives expert advice on planning, designing and managing a sustainable place. Includes guidance on adaptation to space and buildings, green infrastructure, building design, energy efficiency, renewables etc.
Royal Town Planning Institute (RTPI)	Climate Change Compendium.	Website listing other key web sites, guidance, research and case studies on climate change.
TCPA	Climate Change Adaptation by Design.	Design guide for planners and developers on climate change adaptation.
Planning Advisory Service	Using supplementary planning documents to address climate change locally, May 2010	Good practice guide and examples of local authorities using SPDs for climate change adaptation (and mitigation).
Climate South East	Your Home in a Changing Climate: Retrofitting Existing Homes for Climate Change Impacts. TRCCG, Feb 2008.	Likely climate impacts on homes and what can be done to adapt, including costings
UKCIP	Beating the Heat – Keeping UK buildings cool in a warming climate (2005).	Implications of heat for existing buildings and what can be done to adapt
English Heritage	Climate Change & Your Home.	Interactive web portal to help traditional house owners adapt to climate change.
Adaptation and built environment	Design for future climate: opportunities for adaptation in the built environment.	Technology Strategy Board (very large file)
Three Regions	Adapting to climate change: a checklist for developers.	Developers checklist
Three Regions	Adapting to Climate Change: A Case Study Companion to the Checklist for Developers.	Companion case studies for developers
NHBC Foundation	NHBC Foundation Climate Change and Innovation in House Building: Designing out Risk.	Adaptation design and specification tips for house builders
London Climate Change Partnership	London's Commercial Building Stock and Climate Change Adaptation. Design, Finance and Legal Implications.	Guidance and case studies on adapting commercial buildings in London
South East Climate Change Partnership	South East Water Management Climate Change Adaptation Planning Toolkit,	Case studies on managing water stress
GRaBS	Green and Blue Space Adaptation for Urban Areas.	EU Interreg project on integrating climate change adaptation into regional planning and development. Includes case studies on incorporating adaptation into local planning policies.
AMGA Green Roofs	Greater Manchester Green Roof Programme.	Guidance report from Greater Manchester (AGMA) project on green roofs.

Annexes

Annex A **Glossary**

Annex B **Risk Assessment Matrices for WDC Service Areas**
(provided in a separate file)

- **Adaptation** - Adjustment of behaviour to limit harm, or exploit beneficial opportunities, arising from climate change.
- **Adaptive capacity** - The ability of a building to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences over the buildings lifetime.
- **Cool Pavement** – comprised of light coloured material with high solar reflectivity and good water permeability, they reduce solar heat absorbed, encourage water storage and encourage evapotranspiration.
- **Energy Performance Certificate** – reports how energy efficient a building is on a scale of A to G with A being the highest.
- **Extreme weather event** - An event that is rare at a particular place and time of year. Definitions of 'rare' vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile of the observed probability density function. By definition, the characteristics of what is called extreme weather may vary from place to place in an absolute sense. Single extreme events cannot be simply and directly attributed to anthropogenic climate change, as there is always a finite chance the event in question might have occurred naturally. When a pattern of extreme weather persists for some time, such as a season, it may be classed as an extreme climate event, especially if it yields an average or total that is itself extreme (for example drought or heavy rainfall over a season).
- **Exception Test-** where a development is – exceptionally – allowed in a high flood risk area it needs to demonstrate that it delivers wider sustainability benefits, is on developable previously developed land and that it will be safe without increasing flood risk elsewhere**.**
- **Flood Plains** – areas of land over which river or sea water flow or are stored in time of flood. Flood plains usually extend beyond the land immediately next to a watercourse.
- **Flood Resilience** – reducing the time and cost of recovery from flooding of a property
- **Flood Resistance** - preventing or limiting the amount of water that can enter a property Retrofitting is the term used to describe the fitting of climate adaptation measures to existing premises.
- **Greywater recycling** – greywater is water produced by hand basins, baths, showers and clothes washing. Greywater is lesser quality than potable water. Filtration systems and reed beds can produce water suitable for watering trees, vegetation and gardens. Complex filtration systems are required to produce potable water.
- **Ground Source Heat Pumps** – transfer heat from one place to another. The temperature of the ground and groundwater at moderate depths are typically 10-14^{o}C in the UK and this temperature remains fairly constant. This heat can be passed through a heat exchanger and used for heating during the winter. In the summer the ground can be used for cooling.
- **Passive design** - If designed correctly a building can use certain aspects of climate to offset others, such as using direct solar radiation to heat space or channelling cool breezes when temperatures are higher.
- **Passive or natural ventilation** – ventilation which uses non mechanical means.
- **Sequential Test –** is a decision making tool designed to ensure that sites at little or no risk of flooding are developed in preference to areas at higher risk**.**

- **Strategic Flood Risk Assessment –** is an assessment of risks from river and coastal flooding based on modelling of river flows, topography and the probability of flood events. Flood risk areas are categorized as 1, 2, 3a and 3b with 1 being lowest risk and 3b the functional flood plain.
- **Urban cooling** Moderating high summer temperatures, through for example the layout of urban open space and shading from trees.
- **Urban Heat Island Effect** – a major urban area can be significantly warmer than its surrounding countryside, particularly at night and during the summer. The main cause is modification of urban land surfaces and waste heat generated by energy use**.**
- **Whole Life Costing –** the cost of every part of a buildings lifetime from planning and design, through construction, use and decommissioning**.**