South Staffs Water

Climate Change Adaptation Report 2011

SOUTH STAFFORDSHIRE WATER Plc

CLIMATE CHANGE ADAPTATION REPORT

Contents:

1. Executive Summary

1.1 Information on Organisation

The vision at South Staffs Water is to be seen as a highly respected and caring water supplier, offering the highest standard of service to customers, at the lowest possible price.

At the heart of this vision and key to maintaining it in the long-term in an ever-changing environment, are three key areas, referred to as the 3Cs. This embodies the need to minimise the Company's **C**arbon footprint, continue to provide excellent service to **C**ustomers and to deliver this at the lowest possible **C**ost. Of the Company's total carbon emissions 94% are as a result of grid electricity consumption[1] so any reduction in energy use will also reduce the cost of carbon.

The Company produced a Strategic Direction Statement outlining its 25 year long term strategy as part of the 2009 Periodic Review. The long-term objective with regards to climate change is to reduce the carbon footprint which is supported by policies on metering, leakage control, conjunctive use of water resources, water efficiency and pumping efficiency.

The Company will continue to monitor and appraise the impact of climate change on the levels of water available from its sources and the volumes of water its customers will use if the climate does change as predicted. Also, the potential impact of extreme events on bursts, leakage levels and flooding events on supply resilience will be monitored.

The Company's Strategic Direction Statement can be found on its website.

http://www.south-staffs-water.co.uk/publications/community_environment

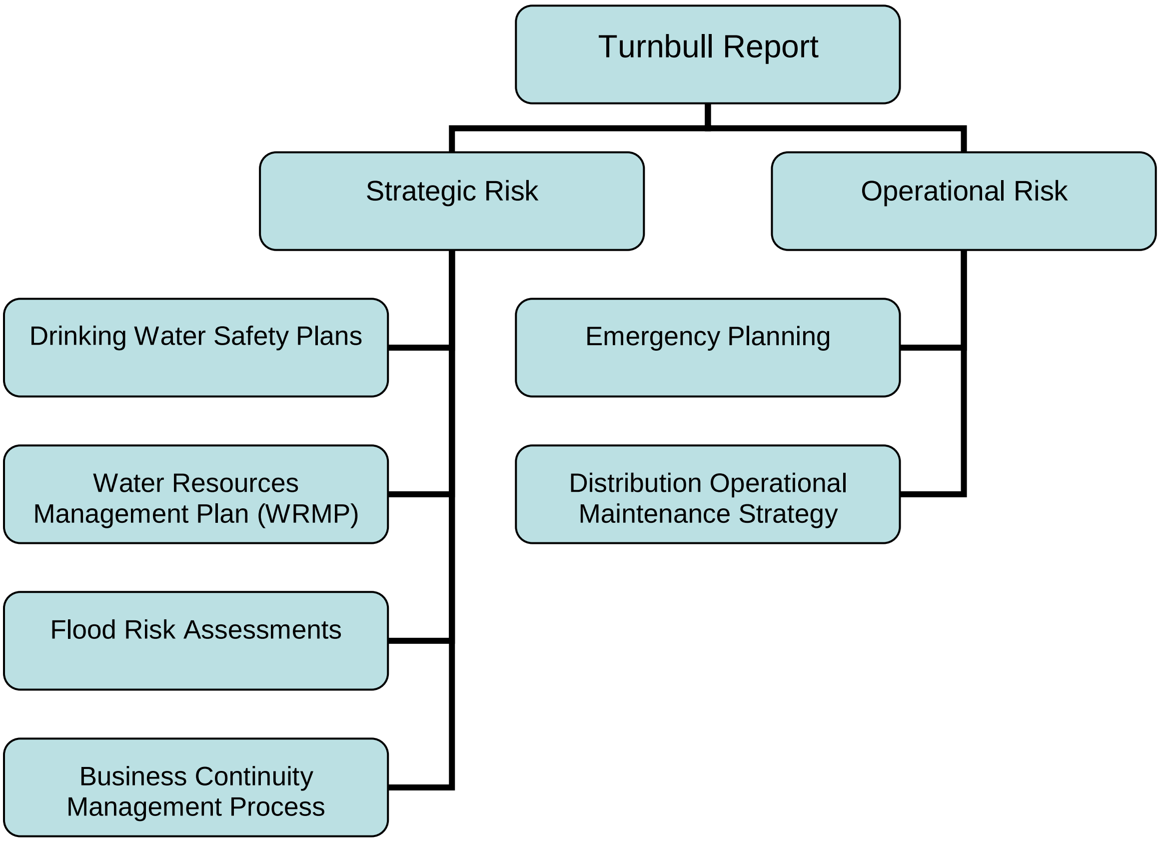
1.2 Business preparedness before direction to report was issued

The Company undertakes assessment of many risks within the execution of its normal business. Indeed, regulators of the water sector require a number of processes to be undertaken and submissions to be made which incorporate assessment of a variety of risks. Some of these processes incorporate a consideration of the risks presented by climate change. This section describes the main processes on internal control and risk management.

The Company adheres to the guidance given in the Turnbull Report[2] on internal control and risk management. The Company carries both strategic and operational risk; the measures in place to manage these are shown in Fig 1.

[1] Company June Return Data 2010
[2] Guidance for Directors on the Combined Code (1999) known as the "Turnbull Report" revised 2005

Fig 1 – Risk Management Structure



1.2.1 Drinking Water Safety Plans (WaSP)

The WaSP calls for the need to identify and manage risk from abstraction through treatment, storage and distribution to the point of use by the customer, complying at all stages with the statutory requirements of the Water Supply (Water Quality) Regulations 2007; consideration is given to both normal and abnormal operating conditions throughout the supply chain i.e. from source to tap.

The aims of the WasP are consistent with that of the Water Quality Policy as shown below:

“The Company will ensure that all drinking water production is risk assessed in accordance with the Water Safety Plan strategy. As a minimum all water shall be treated and monitored in accordance with the Water Supply (Water Quality) (Amendment) Regulations 2007. Associated with these Regulations, all Guidance and Information Letters issued by the Drinking Water Inspectorate shall also be complied with. Additionally, all drinking water will be fluoridated in accordance with the agreement with the West Midlands Strategic Health Authority”.

The WaSP therefore draws together many well-established operational policies, processes and procedures that hitherto have performed and provided SSW customers with a high quality and reliable potable water supply. The production of a WaSP will therefore make reference to these accordingly whilst gaining a full and comprehensive appreciation of risks and mitigation processes associated with the whole water supply chain, summarised in Risk Assessment Reports (Company Declaration), Regulation 27 and 28.

Inherent within the operational monitoring processes is the inclusion of early warning or 'Trigger Measures' to assist in monitoring and where necessary the timely and pre-emptive actions to safeguard the continued supply of high quality water. Early warning of any impacts from climate change that might be predicted would be evident within this monitoring process.

1.2.2 Water Resources Management Plan (WRMP)

It is a statutory requirement of the Company to produce a WRMP every five years. The plan examines in detail the balance between the water resources available to the Company and for use in turn by customers and projected demand for drinking water over a 25 year planning horizon. Central to the development of the plan are sophisticated models which look at uncertainty and risk within the supply demand balance. One of the key areas of uncertainty is the impact of climate change on both the amount of water available for use by customers and the amount of water they will use.

The Company last completed this review in 2009 and published its 2009 Water Resources Management Plan (WRMP) as part of the 2009 Periodic Review.

The 2009 WRMP continues to project a sufficiency of water in the South Staffs Water supply area, both over the course of future dry years and during the peak demand weeks within them, over the next 25 years.

Further detail on the WRMP is provided in Section 6.1.1.

1.2.3 Flood Risk Assessments

The Company has undertaken flood risk assessments of all its water production assets where uncontrolled risks exist. The source data for this was the Environment Agency's flood maps.

Detailed flood risk assessments are provided in sections 6.2.1 and 6.4.1. They primarily conclude that at present the risk from fluvial flooding at pumping stations is not significant. The flood risk assessment will be reviewed periodically and may change as up dated data becomes available.

1.2.4 Business Continuity Management Process (BCMP)

The BCMP provides a strategic approach and the processes through which the Company implements and administers effective Business Continuity Planning thereby ensuring that the Company can continue to deliver its critical activities in the event of an emergency or other scenario.

The BCMP aims to mitigate the impacts of a disaster by ensuring that alternative mission-critical capability is available when a disaster strikes. The BCMP is the framework used to ensure that Business

Continuity Planning is supported at a senior level in the organisation and that Business Continuity Plans (BCPs) are embedded into the culture of the organisation and are regularly reviewed, updated and exercised. The BCMP also provides the framework for effective disaster management through the provision of Incident Management and Recovery Management Teams.

The aim of Business Continuity Planning is to ensure, that following a disruption, essential services are maintained whilst normal services are resumed. Essential in this context is: the provision of customer support activities, including billing and telecommunications; defined IT systems; financial and procurement services (to ensure ongoing essential supplies); staff sufficiency; security of sites and assets; the continuation of Control Room facilities.

Business Continuity Planning does not include responses to a water supply incident. The responses to water supply incidents and events are covered by Emergency Plans.

The overall objectives of the Business Continuity Strategy are to:

- establish a framework for evaluating business processes within each unit allowing a focused approach to develop a Company Business Continuity Plan through a well structured and comprehensive methodology;
- develop continuity plans to enable the Water Company to carry on with essential business elements in the event of a major disruption;
- minimise the impact of a disaster; and
- develop an effective recovery plan to ensure that activities are returned to normal as soon as possible after an event.

It is not clear whether climate change would impact on the Company's ability to provide continuity of its operations. However, any risks that may come to light would be identified through this process.

1.2.5 Emergency Planning

The principal objectives of emergency planning are to mitigate the effects to customers of a major emergency and to bring about a swift return to normal activity. There is also a legal requirement under the Security and Emergency Measures Direction (SEMD) 1998 to provide a minimum daily volume of drinking water to customers during a major event.

In order to achieve these objectives emergency plans are in place that ensure that a team dedicated to resolving all difficulties presented by a major emergency, including command and control arrangements and structures, is well established and responsibilities for each role in the team are clearly identified.

Emergency plans also identify stocks of emergency water held in readiness for an event and details of mutual aid which may be requested from other water companies should additional resources be required.

Outside organisations that can offer additional resources during an event are also identified and co-operation is actively encouraged with all other responders through attendance at Local Resilience Forums.

The plans are rehearsed through a series of planned regular training events and emergency team members are provided with ample opportunity to practice throughout each year in a safe environment within their own selected roles.

Extreme weather events are aspects of climate change which could trigger the implementation of emergency plans. The Company is confident that it is well prepared for such events but will continue to monitor, review and improve its Emergency Plans.

1.2.6 Distribution Operational Maintenance Strategy (DOMS)

The purpose of DOMS is to provide a documented methodology through which the operation and maintenance of the water distribution system can achieve consistent or improving water quality to customers in the most cost-effective manner and will make use of:

- forward looking risk-based analysis leading to proactive maintenance (both operational and capital) and inspection of asset;
- monitoring of water quality by company and customers, leading to timely and effective responses to current or impending water quality problems; and
- control and operation of the network to manage identified risks to water quality.

Any work on the distribution system either planned or as a consequence of an operational event is subject to a DOMS risk assessment. For planned work the risk assessment forms part of the planning process and is included in the approved permit to work. The risk score is based on the number of customers potentially affected by an event; the potential nature of the event; and the likely duration of the event.

A DOMS steering group meet bi-monthly to review and monitor performance against the policy. The policy is agreed with the Drinking Water Inspectorate (DWI) which has powers to randomly sample data at any time. The DWI is sent annual performance updates.

The above risk management processes are all considered in detail as part of the Company’s strategic business planning process which is undertaken as part of the quinquennial periodic review. This is a statutory obligation and is a fundamental part of the regulatory process. The plans produced are subject to close scrutiny by the Regulator to ensure that not only do they represent value for money to the customer but that they also enable the Company to deliver sustainable levels of service

All of the above risk based measures can generate investment needs and so are integral to the production of the business plan. The periodic review process ensures that risks are reassessed against the most up to date data which enables both adaptation or mitigation measures to be identified and planned well in advance.

The Company does not consider climate change risk assessment to be a wholly additional process but more as one that predominantly informs and improves existing risk assessment methodologies. These are embedded in the Company's management systems and demonstrate that it is well placed to meet the challenges that climate change may pose to its operations and that there are systems in place to support the need for any adaptation measures.

1.3 Identifying risks due to the impacts of climate change

A number of climate change impacts have been assessed as part of existing business processes.

1.3.1 Flood Risk Assessments

Flood risk assessments were carried out internally by operational staff as part of the last periodic business planning process completed in 2009. The assessments were based on the EA flood plans available at the time. Detailed flood risk assessments are provided in sections 6.2.1 and 6.4.1.

1.3.2 Water Supply

The impact of climate change on water available for use by customers was assessed as part of the preparation of the 2009 Final WRMP. The Company has a water resources model to determine deployable output from its sources and therefore the amount of water customers can use. Consultants were engaged to assist in the use of this model to assess the predicted impacts of climate change.

1.3.3 Water Demand

The Company's Water Delivery Analyst followed the guidance from the DEFRA report, Climate Change and the Demand for Water (CCDeW) February 2003, to calculate the impact of climate change on demand which was included in the 2009 Final WRMP. The report details the predicted impacts on components of demand from climate change in percentage terms. The Company has applied the percentages to customer groups as highlighted in the report with the resulting additional allowances applied to demand.

Other impacts have been considered by expert panels made up of key experts within the Company specifically for the production of this report. In particular, impacts on raw water quality and water treatment processes were assessed in this way. The impact on burst rates was evaluated by the Company's specialist in this field and the overflow capacity from the Company's surface water reservoir is reviewed as part of the 10 year statutory inspection. The impact of projected temperature rise on mechanical and electrical plant but was considered minimal as it is unlikely that the design maximum will be exceeded.

Given the existence of risk management processes and analyses the Company has been able to deal with the production of the Climate Change Adaptation Report within ‘business as usual’.

The Climate Change Adaptation Report has been compiled by a senior member of staff who has coordinated contributions from other senior staff. Where appropriate task specialists have been involved in detailed risk assessments. The process has been managed by the Head of Water Strategy with final review at director level.

1.4 Assessing Risks

For systematic risk assessments scoring of impact and likelihood is based on a five by five matrix with an overall risk score being the product of the two elements. Low, medium and high risks are classified as those with scores of less than or equal to 10; greater than 10 and less than or equal to 20; and greater than 20 respectively. Items categorised as being at medium risk will be subject to monitoring and more frequent review. If an item is categorised as being at high risk, this will trigger an action plan which would include detailed investigations into the most appropriate mitigation or adaptation measure and a plan to deliver a solution. None of the identified risks are in the high category

1.5 Uncertainties and Assumptions

Assessment of the potential impacts of climate change is based on the use of projected climate change scenarios. The main uncertainties come from the wide variation in the climate scenarios and robustness of data used to assess how these scenarios may impact on the Company’s operations. At present the data can only be used to undertake qualitative risk assessments. Climate change data and the accompanying analysis tools need to develop so that a greater proportion of quantitative assessment can be made to a higher degree of confidence.

The recent sequence of cold winters has contributed additional uncertainty to projections with some commentators[3] suggesting that such events will occur more often and may even become the norm. Paradoxically, therefore, whilst climate change may warm the planet as a whole, local conditions unique to the United Kingdom, possibly driven by climate change elsewhere, may result in harsher winters. This serves to highlight the difference between weather and climate with the general rule being that the Company reacts to the weather but needs to plan for climate.

If winters are going to be on average colder this is of concern to the water industry as not only would incidences of burst pipes increase but colder winters tend also to be dryer which would impact on water availability. There are currently no projections for occurrence of harsher winters and therefore, no means to assess any impact. If further data or guidance becomes available the Company will assess it fully.

The impact of climate change on surface water temperature is uncertain. Water temperature has a significant impact on treatment processes: if it is too warm algae and bacteria can grow; too cold and coagulation is affected. The data projections do not indicate the impact of climate change on surface water temperature.

It is assumed that the water industry will continue to be structured broadly in its present form with regulation from an independent authority. It is also assumed the regulator will continue to ensure that companies maintain or improve levels of service based on the wishes of customers and key stakeholders.

It is assumed that the emissions reduction targets set out in the Climate Change Act 2008 will be met and the accompanying legislative framework will remain in some form. Consequently, the Company will be required to maintain, review and update climate change adaptation plans.

Since the Company has not assessed any impacts as high risk and there is no immediate requirement for action the impact of these uncertainties is minimal at this stage.

The Company will continue to monitor the issues associated with climate change and will utilise the most up to date projections in future assessments in order to continually reduce the level of uncertainty.

[3] Article in Science Daily (Apr. 22, 2010) and American climate researcher Dr. James Overland speaking to the International Polar Year Oslo Science Conference 11th June 2010

1.6 Addressing current and future risks due to climate change

Business function	Climate variable (e.g. increase in temperature)	Primary impact of climate variable (e.g. health)	Threshold(s) above which this will affect your organisation	Likelihood of threshold(s) being exceeded in the future and confidence in the assessment	Potential impacts on organisation and stakeholders	Proposed action to mitigate impact	Timescale over which risks are expected to materialise and action is planned
Water Resources	Increase in temperature	Resource restriction			Higher daily & peak demand for garden watering Increase in Evaporation	None currently required as fully assessed as part of 2009 WRMP and no deficit forecast in the next 25 yrs	Will be reviewed as part of 2014 WRMP
	Reduction in precipitation	Resource restriction			Low levels in Blithfield Reservoir		
Raw Water Distribution	Increase in temperature	Mechanical failure	Equipment can operate in 40°C ambient	Data projections give <10% likelihood of threshold being breached,	None	None required	Review within asset replacement cycle
	Storms	Interruption of power supply			None	None required as the Company has sufficient embedded generation	N/A
	Increase in precipitation	Flooding		No asset is at high risk of flooding	Capacity of Blithfield spillway may need to be reviewed in light of UKCIP data	Will be included in 10 year inspections	Flood risk will be reviewed as part of existing processes
Water Treatment	Increase in temperature	Algal growth in surface water reservoir	No quantitative measure	Impacts are already being experienced	No direct impact	Improve destratification in the reservoir	2020
		Increased growth of bacteria	No quantitative measure	Impacts are already being experienced	No direct impact	Existing disinfection systems are adequate	2050
	Increase in	Pollution	No quantitative			Managed through	2050

Business function	Climate variable (e.g. increase in temperature)	Primary impact of climate variable (e.g. health)	Threshold(s) above which this will affect your organisation	Likelihood of threshold(s) being exceeded in the future and confidence in the assessment	Potential impacts on organisation and stakeholders	Proposed action to mitigate impact	Timescale over which risks are expected to materialise and action is planned
	precipitation		measure			normal processes or subject to monitoring and review	
Treated Water Distribution	Increase in temperature	Mechanical failure	Equipment can operate in 40°C ambient	Data projections give <10% likelihood of threshold being breached,	None	None required	Review within asset replacement cycle
	Increase in precipitation	Flooding		No asset is at high risk of flooding	Capacity of Blithfiled spillway may need to be reviewed in light of UKCP data	Will be included in 10 year inspections	Flood risk will be reviewed as part of existing processes
			No quantitative measure		Increase in burst rates due to ground movement	Increase mains replacement activity	Reviewed every 5 years based on evidence

The Company has undertaken comprehensive risk assessment of the impacts of climate change on its business functions. This process has identified a number of low risks, some medium risks but no high risks. , therefore no, immediate action is required. Monitoring and further evaluation will be undertaken for a number of risk areas. Some investment requirements may be identified for inclusion in the next periodic review cycle and the Company will build as robust a case as possible to ensure acceptance by the Regulator.

The Company believes it has the process of climate change risk assessment embedded within the organisation as ‘business as usual’. As such it is well placed to plan and react as necessary.

1.7 Barriers to implementing adaptation programme

Barriers to implementing an adaptation programme arise from the challenge presented to the industry by regulation and uncertainty around climate change data projections. Effectively the water industry needs to agree funding requirements with its economic regulator. Therefore, implementation of an action plan will be dependant on agreement over funding.

An adaptation programme will consist of a number of schemes phased over a period of time and would form part of the Company’s overall investment programme. For a scheme to be included in the programme it must first be developed through a process. The process begins with the identification of a need which could be in response to a particular event or as a result of a risk based evaluation. Once the need is established a number of possible solutions are devised for which the costs and benefits of each are assessed and compared to ascertain the preferred option. A detailed justification is then prepared for this scheme prior to its inclusion in the draft adaptation programme which is then prioritised to form the final adaptation programme. This final plan is then combined with the overall investment programme which itself is then prioritised. This whole process is subject to close scrutiny by Ofwat to ensure investment decisions are sound and that they deliver value for money to customers.

In addition to detailed study from Ofwat, involvement from the Environment Agency, Consumer Council for Water and other stakeholders is sought. Furthermore, the programme is also measured against customers’ willingness to pay which, for adaptation schemes, may be affected by the widely reported scepticism to climate change of a significant proportion of the population at large.

The climate change data provided by UKCIP is probabilistic in nature so has inherent uncertainty around confidence limits. This data is discussed in detail in section 4 and, whilst it gives trends going forward the limits around the central estimate widen with time. Furthermore, there are shortcomings in the applicability of the data to the water industry, particularly with regards to the impact of climate change on surface water temperature. All of this leads to a high degree of uncertainty in quantifying the need for investment in adaptation measures and justifying this against other more tangible needs.

The Company's ability to overcome significant elements of these barriers may be limited. However, it can influence outcomes by continuing to develop better ways of interpreting data with an ever more robust project appraisal process.

Since the Company has not identified an action plan with significant areas of investment required, the Company believes this barrier to be manageable.

1.8 Report and review

The Company has identified a limited action plan with no risks requiring immediate action. In this context, the Company believes that adequate monitoring and evaluation will continue within its existing risk management processes. The regulatory regime ensures that all risks are formally reviewed every five years and long term investment plans are laid. This process of regular review will allow flexibility in adaptation so that measures can be reassessed for effectiveness and predicted impacts can be continually updated.

A temperature threshold of 40°C has been set as that above which electro-mechanical plant is at risk of increased failure. From the mean summer daily maximum temperature data this threshold will not be exceeded before 2080. The wide variability in the data projections and the fact that only mean temperatures are given render it impossible to state with any accuracy if or when this threshold could be breached on a single day.

1.9 Recognising opportunities

The projected increase in winter rainfall could extend the scope for the Company to operate its sources conjunctively. In this arrangement surface water would be predominantly used in the winter period and ground water would be conserved. This would increase the Company's resilience to single season drought events and bring benefits to the aquatic environment. However, this would be at the expense of increased energy consumption which would result in greater cost and higher carbon emissions.

The recognition of climate change, production of accepted national data and its inclusion in business planning processes mean that this Company and the water industry as a whole will be better prepared to cope with a greater range of possible impacts and, therefore, more able to continue to supply safe drinking water their customers.

2. Introduction

In its approach to assessing climate change risk South Staffs Water has considered its impact across its five constituent business units as prescribed by Ofwat in their rules on accounting separation, namely:

- Water resources;
- Raw water distribution;
- Water treatment;
- Treated water distribution; and
- Retail.

This approach was taken to ensure that all aspects of the business were included in the risk assessment. The prime function and boundary of each business unit is described later in the report.

Over the past 20 years the Company has delivered through a series of five year business plans capital works which, whilst not directly considering climate change risk, have delivered outputs which provide some elements of adaptation: full details of these are referenced within the relevant sections of this report. Where new specific risk assessments have been undertaken in support of this exercise the methodology and outcomes are described in detail in this report.

The current 2010-15 business plan includes schemes which will also provide a degree of climate change adaptation as a consequence of normal capital maintenance activity.

The climate change scenarios used for the specific risk assessments have been developed from UKCP09 and Met Office 1961 – 1990 baseline data.

3. Background

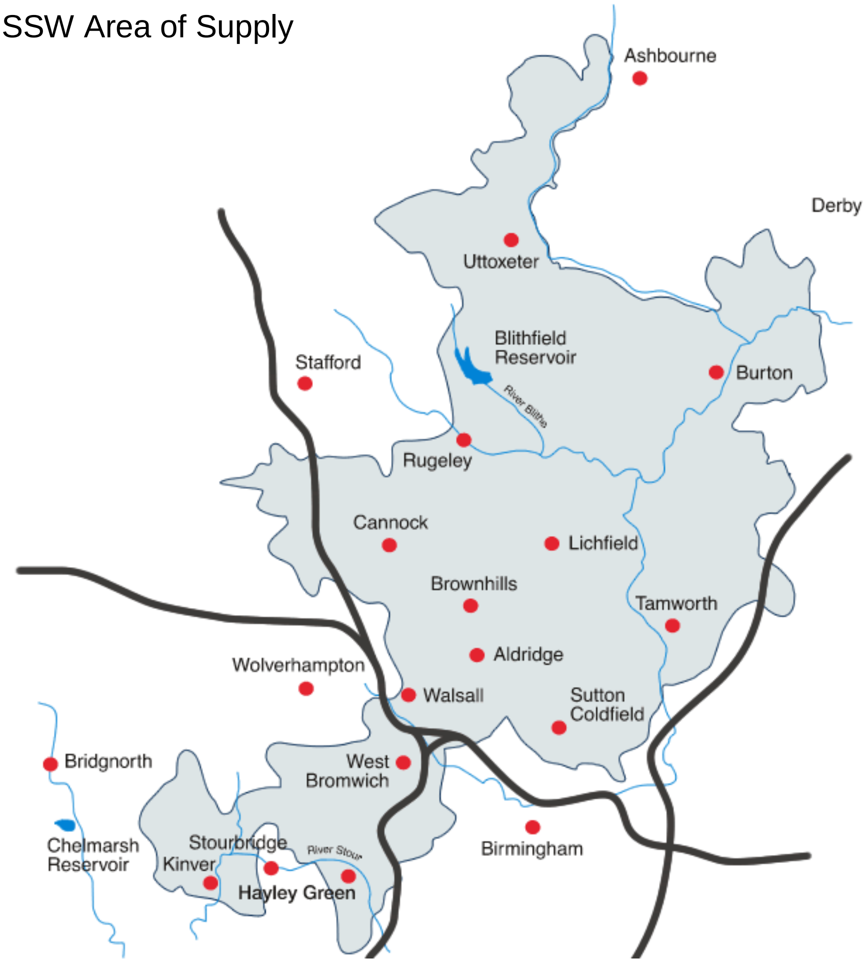
South Staffs Water was formed in 1853. It has expanded over the intervening years such that it is a now the fourth largest water only company in England and it supplies an area of almost 1,500 square kilometres with a population of nearly 1.29 million. The Company's area of supply stretches from the edge of Ashbourne in the north, to Halesowen in the south, and from Burton on Trent in the east to Kinver in the west. The Company's area of supply is shown in Fig 2 contains 515,000 domestic households and 35,000 institutional, industrial and commercial properties.

Groundwater is abstracted from over 60 boreholes at 27 source pumping stations. Two large surface water treatment works, one of which takes water from the River Severn and the other from an impounding reservoir at Blithfield provide about half of the Company's supply. Water is then delivered to customers via 6,000km of water distribution pipe work; 51 booster pumping stations; and 33 drinking water storage reservoirs. The total average demand from its customers, including a large bulk supply to an adjacent water company, is around 335Ml/d and this is forecast to remain reasonably stable over the next 25 years.

The Company overcomes considerable challenges in supplying water to its customers, mainly from topography and the extent of urbanisation. Approximately 50% of the Company's source water comes from outside its area of supply and its water production sites lie within largely rural regions. The majority of customers live within the area to the north of Birmingham known as the Black Country on an elevated part of land known as the Midlands Plateau, which is between 100m and 300m above sea level.

The plateau is flanked by ridges 230m above sea level over which the majority of water produced has to be pumped. This gives the Company the highest average pumping head of any UK water company yet, in spite of this, it delivers drinking water to its customers more efficiently than any other company[4]. The Company has never missed a leakage target, achieves a 100% security of supply index and last imposed a hosepipe ban in 1976.

Fig 2 - SSW Area of Supply



The Company believes it has a duty of care to both its present and future customers to ensure that everything economically practicable is done to meet the challenge presented by climate change in order to continue to provide an acceptable level of service to its customers.

[4] Calculated from industry data submitted for June Return 2010

The electricity and transport sectors are vital to the operation of a water company. Electricity is needed at all stages of the potable water production process and a reliable road and rail infrastructure is essential for dependable deliveries of water treatment chemicals to operational sites.

This report does not consider the impact of climate change on the electricity and transport infrastructure as it is expected that organisations in these other key sectors will be formulating their own adaptation plans. Once these plans are available the Company will consider them in future climate change impact assessments.

The regulatory process subjects the Company to a periodic review every five years. As part of this the Company assesses in detail its capital investment requirements across all of its assets for the succeeding years. The Company views climate change adaptation as an integral, and increasingly important, driver in identifying and supporting those investment needs.

It is envisaged that climate change risk assessment and adaptation will itself become embedded as a process in the water industry with formal reviews at periodic intervals. Advancing scientific analysis will provide better data which, coupled with an evolving understanding of climate change, will support more robust risk assessments.

4. Climate Change Scenarios

Since 1997 UK Climate Impacts Programme (UKCIP) has been working with the public, private and voluntary sectors to assess how a changing climate will affect:

- construction;
- working practices;
- demand for goods and services;
- biodiversity;
- service delivery; and
- health.

Staff work closely with stakeholders to provide information and support, and to co-ordinate regional and national work into the impacts of climate change. The team's role is to:

- identify common research priorities;
- facilitate interaction within and between studies;
- offer expertise on impacts assessment and independent advice on the most appropriate methodologies and research approaches; and
- communicate results from the assessments to a wide audience to inform decision-making.

The probabilistic climate change projections (UKCP09) are the result of an innovative modelling approach from the Met Office Hadley Centre climate model. The projections also include the results of other International Panel on Climate Change climate models, and are constrained by observations of past climate. They provide projections of changes in the climate, based on 1961–1990 baseline data for:

- annual, seasonal and monthly climate averages;
- individual 25 km grid squares, and for pre-defined aggregated areas;
- seven 30 year time periods; and
- three emissions scenarios.

The benefits of the models are:

- they assign probabilities to different future climate outcomes;
- they reflect uncertainties within the Met Office Hadley Centre's global climate model, including the most important known climate feedback processes;
- they include information from other global climate models;
- the output can be used in different ways. The UKCP09 User Interface allows the probabilistic projections to be visualised and interrogated to produce images (e.g. maps and graphs) or download the data as numerical outputs. Output for several variables and temporal-average periods is available. See the UKCP09 User Interface;

- they are available for 25 km grid squares and for pre-defined aggregated area; and
- aggregated area projections are provided for administrative regions and river basins. Probabilistic projections over the oceans around the UK are provided for a number of marine regions.

The main assumptions of the models are:

- that known sources of uncertainty not included in UKCP09 are not likely to contribute much extra uncertainty;
- that structural uncertainty across the current state of the art models is a good proxy for structural error;
- that models that simulate recent climate, and its recent trends well, are more accurate at simulating future climate;
- that single results from other global climate models are equally credible;
- that projected changes in climate are equally probable across a given 30 year time period; and
- that local carbon cycle feedbacks are small compared to the impact of the carbon cycle via change in global temperature;

The uncertainties of the models are:

- modelling uncertainty – arising from incomplete understanding of the climate system, and our inability to model it perfectly;
- natural climate variability – arising from both internal and external factors on the climate system; and
- emissions uncertainty – arising from not knowing the amount of future global greenhouse gas emissions.

Unless otherwise stated the scenarios used by the Company are based on UKCP09 data for the West Midlands as this covers the majority of the Company's area of supply. The data are projections of changes in temperature and precipitation over three time horizons of 2020, 2050 and 2080 against low, medium and high emissions scenarios for three probabilities, central being the most likely.

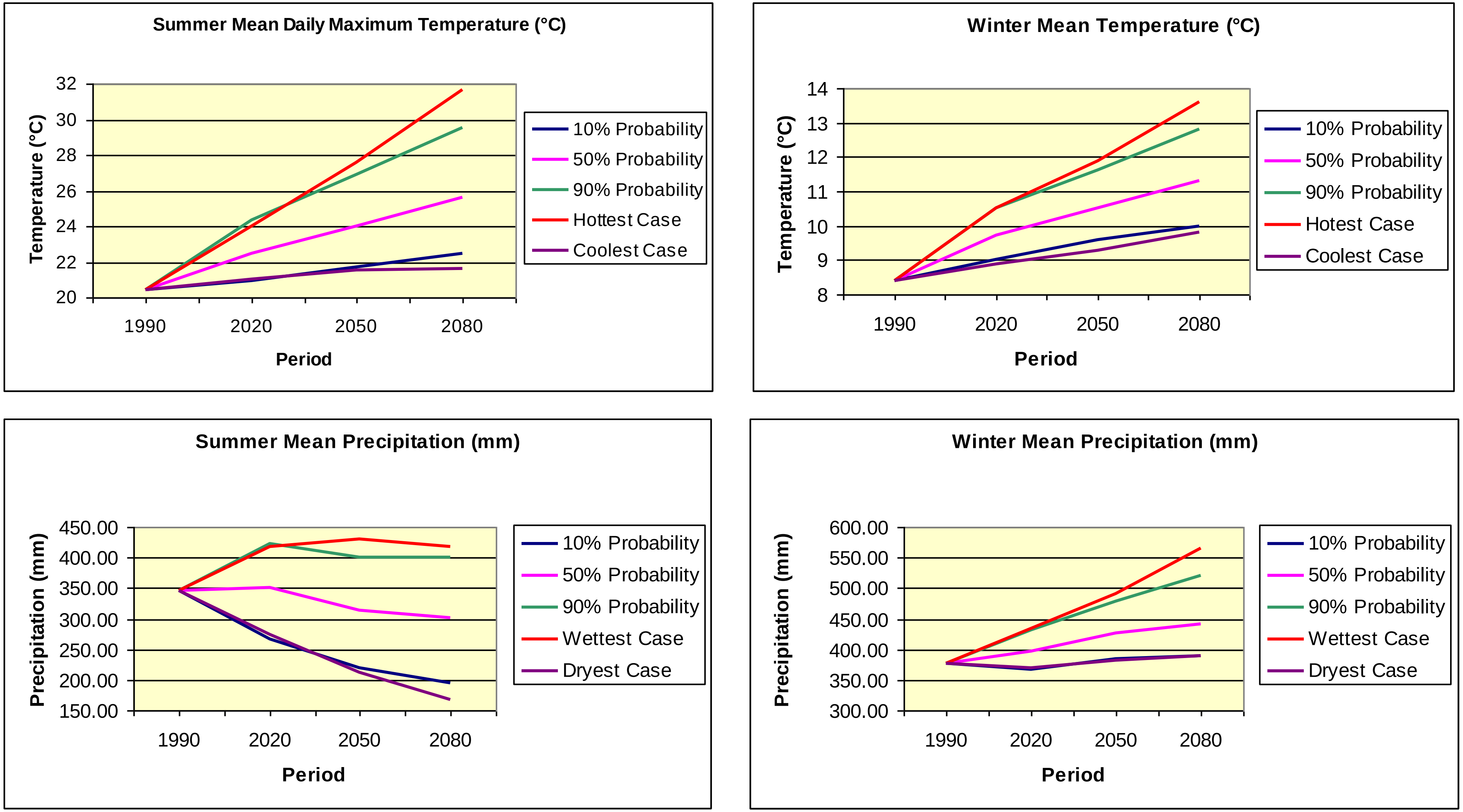
The data has been combined with Met Office baseline data for the West Midlands of mean daily maximum temperature and mean daily precipitation to give absolute values of temperature and precipitation over the time horizons against the variables of emission levels and probabilities. The Met Office data on temperature and precipitation (Appendix 6) has been averaged over April to September and October to March to give summer and winter means respectively. This approach was adopted as it was judged that, by presenting data in this absolute way, the impact of climate change could be better understood.

The climate change projections indicate that, in future, warmer, dryer summers and milder, wetter winters will occur more often; weather events will be more extreme so storms will be more severe and flooding will occur more often; but overall rainfall will not change. However, there is inherent uncertainty in the data so it cannot be taken to mean that every winter will be mild and wet and will always be followed by a hotter, dryer summer or that there will never be another cold winter or wet summer.

The UKCP09 data also gives projections on sea level rise but as the Company is landlocked its impact is judged to be significantly less than that from temperature and precipitation and so is not considered by the Company to be material. Therefore, the impact of sea level rise has not been included in the climate change scenario.

The data is presented graphically in Fig 3 and clearly shows how variability in temperature and precipitation increases with time. Medium emissions scenario data has been used for the 10%, 50% and 90% probability lines with high or low emissions scenario data being used for the extreme cases as appropriate. It is important to bear in mind that these graphs do not give a definitive view of the future, merely that there is an 80% probability that temperature and precipitation will lie within the boundaries shown.

Fig 3 - Climate Change Scenarios



5. Limitations of the Data

UKCP09 gives climate scenarios for the 21st century which indicate that hot '1995-type' Augusts and warm '1999-type' years will occur with increasing frequency. This general synopsis coupled with mean temperature projections do not necessarily provide the water industry with the most appropriate data to enable it to correlate possible demand patterns with its experience. Whilst it is true that hot days can cause a sudden spike in demand warm weeks will have a more significant impact on demand for water. The rise in demand over a hot week tends to be linked to rise in temperature but this can be significantly moderated by the degree of cloud cover.

A short term increase in demand does not cause problems because, as will be seen from the water resources risk assessment, the Company possesses sufficient spare capacity to meet any such likely events. However, supply stress occurs when demand in an area exceeds the ability to bring water into the area as quickly as it is being used which then generally causes low pressure.

The pressure available to push water through a water distribution system is largely determined by the capability of pumping plant and height of any reservoirs that support the system. As more water is drawn from a local distribution system the head loss across that system increases and this can reach a level at which insufficient pressure remains to deliver water to customers who are farthest from the source of supply.

Supply stress can occur at any time but this has tended to be either during hot summers or cold winters. Summer peak demand tends to occur either in June or early July as high temperature is not normally experienced prior to June and demand reduces slightly once school holidays begin. During the winter rapid diurnal changes in temperature, known as freeze thaw events, cause ground movement which can result in additional numbers of burst mains. As a consequence some customers may suffer inadequate pressure but others may lose water supply altogether for short periods.

6. Risk Assessments

The Company delivers a level of service to its customers through a series of assets performing to an acceptable level. Climate change will, in time, have either a direct or indirect impact on the ability of some of the Company's assets to perform. For example, changing climate conditions may cause assets to fail prematurely or in ways not previously experienced. It may also cause interruptions in energy supplies or impact on the supply chain in general.

The aim of the Climate Change Risk Assessment (CCRA) is to undertake an assessment of the risks (including both threats and opportunities) posed by the impacts of climate change that may affect the ability of the Company to meet its statutory obligations. This will allow adaptation measures to be developed for inclusion in long term strategic planning decisions.

For systematic risk assessments scoring of impact and likelihood has been based on a five by five matrix with an overall score being the product of the two components. Low, medium and high risks are classified as those with scores of less than or equal to 10; greater than 10 and less than or equal to 20; and greater than 20 respectively. Items categorised as being at medium risk will be subject to monitoring and more frequent review. If an item is categorised as being at high risk, this will trigger an action plan which would include detailed investigations into the most appropriate mitigation or adaptation measure and a plan to deliver a solution.

6.1 Water Resources

Water resources comprise sources of raw water, the permission for their use and input into the raw water distribution system. The raw water can be obtained from aquifers, lakes, reservoirs, rivers or third parties. Raw or partially treated water is supplied through a pump or gravity fed through a valve into the raw water distribution system.

The features of climate change which may impact on water resources are higher temperatures and lower precipitation. The impact of these in the context of water resources planning is considered in this section.

6.1.1 Summary of Water Resources Planning

The Company has a long tradition of meeting all of the water supply needs of its customers. A hosepipe ban has not been imposed since the record breaking drought of 1976 and there are no plans to impose restrictions on water use more frequently than 1 in 40 years.

The critical planning case for maintaining unrestricted supplies is an exceptional period of low winter rainfall when surface water supplies from the River Severn and Blithfield Reservoir are low followed by an exceptionally hot and dry summer where demand is known to rise sharply, primarily from household garden watering. These conditions occurred in 1975/6 and in 1995/6 but since then both the Company's infrastructure and the ways in which customers use water have changed.

All water companies examine in detail every five years the balance between supply (water available for use by customers) and demand (projected water consumption plus a margin of safety, called headroom) over a 25 year planning horizon. This five year review allows changes in both sides of the balance to be accounted for.

The Company last completed this review in 2009 and published its 2009 Water Resources Management Plan (WRMP) as part of the 2009 Periodic Review. This document is available on the Company's website at:

http://www.south-staffs-water.co.uk/community_environment/wrmp.asp

The elements of supply that have been looked at over the next 25 year planning horizon include:

- the volume that individual water treatment works can abstract and treat for distribution under dry year conditions;
- planned reductions in licence volumes for environmental reasons;
- temporary loss of deployable output due to planned and unplanned events (outage);
- the impact of our investment programme on deployable output; and
- future water transfers to and from neighbouring water companies.

The elements of demand that were looked at over this period are:

- changes in population;
- changes in the number of households;
- improvements in water efficiency in new homes through the Code for Sustainable Housing;
- the future availability of lower water-using household appliances;
- the influence of economic factors on non household water consumption;
- the impact of meter installation policies on household water use;
- the impact of water efficiency policies; and
- the impact of leakage management policies.

The uncertainty in calculation of key parts of the supply demand balance to ensure that adequate headroom is maintained over the 25-year planning period was also considered.

Key risks of climate change to water resources

The impact of climate change has been assessed by a large number of organisations using global and regional climate models which have forecast a number of different future scenarios.

Where these scenarios predict more extreme events including warmer summers and milder winters than historically observed the risk is that the water available for recharge of surface water and groundwater catchments will be reduced. This means that the low flow scenarios observed in 1975/76 and 1995/96 will be more common and more severe reducing the Company's deployable output.

Most model scenarios predict warmer summers and the likelihood is that the periods of hot dry weather during summer will become more frequent and of longer duration. Consequently, there is a risk of an increased household demand due to greater frequency of personal washing, garden watering, car washing and miscellaneous uses of water. There is also a risk of greater commercial and industrial use of water in the drinks manufacturing, hotel and leisure industry.

The risks that climate change poses to water resources have been assessed as follows.

Supply

The 2009 WRMP assessed climate change impacts using the UKCP02 scenarios as these were the most up to date available. The UKCP09 scenarios will be included in assessments made as part of the next periodic review.

Risk to water supply has been assessed using best practice techniques developed by government in conjunction with industry experts. These techniques provide a way of applying output from the global climate models to water resources planning problems. Guidance on which techniques to use in which situation has been provided by the English environmental regulator the Environment Agency in their Water Resources Planning Guidelines (2008).

The potential impacts on surface water sources from the River Severn and Blithfield Reservoir have been assessed using Method 2 from the report "Effects of Climate Change on River Flows and Groundwater Recharge: Guidelines for Resource Assessment and UKWIR06 Scenarios. Report ref. No. 06/CL/04/8" produced by UK Water Industry Research (UKWIR) in 2007. These are based on climate projections from six global climate models. Method 2 requires that three different climate change scenarios are run (mid, wet and dry). These scenarios are statistically derived from the six climate model outputs for the river catchment in question.

The mid, wet and dry scenarios generate rainfall and potential evaporation factors which are used to perturb historic data in water company hydrological models. As these same hydrological models are used to determine the deployable output of surface water sources the relative impact of the climate change scenarios on deployable output can be measured.

In the case of the River Severn source at Hampton Loade, the Company has agreed with its neighbouring water company, Severn Trent Water, and the Environment Agency that the AQUATOR hydrological model owned and used by Severn Trent Water can be used when examining flow constraints.

In the case of Blithfield Reservoir the Company used a HYSIM hydrological model to determine flows under climate change conditions. The flows at the two sites were then used within a WRAPSIM deployable output model to determine the change in supply capability.

The impact of climate change on groundwater sources in contrast was not modelled as their output is not currently controlled by water levels but by pumping or treatment capacity. The Company believes that it is more likely for any future changes in recharge to impact on the Environment Agency's licensing policy (by reducing licence availability and hence introducing the need for sustainability reductions in licences). However, there is no agreed method to predict these policy changes.

The WRAPSIM model calculated a range in deployable output values between the wet and dry scenarios in the year 2025 of 37.6 Ml/d for a dry year and 44.4 Ml/d for peak week. However the central "Mid" scenario was little changed from the present day (2007) calculation of deployable output with a change of just -0.6 Ml/d in dry year and peak week for the year 2025. Minor adjustments were made to assign forecast supply values across the 25-year planning period. As there was such a range in calculated values between the different climate change scenarios, its uncertainty was incorporated into a revised calculation of headroom allowance for planning purposes.

Demand

The potential impacts of climate change on demand for various customer groups were calculated following guidance from the 2003 research report "Climate Change and the Demand for Water" produced by Defra. This study forecasts that domestic demand in the Midlands as a result of climate change will be 1.8% by 2025 and 3.7% by 2055 for average demand situations. Predicted impacts to overall industrial demand for the Midlands region are 1.7% by 2025 rising to 3.4% by 2055 although climate change impact factors for the most sensitive industrial sectors are up to 6% by 2025.

The Defra study predicts significant changes in agricultural demand, mainly for spray irrigation, up to 23% increase by the 2025 in the Midlands. Nevertheless, this has been excluded from the forecast as only a small proportion of agricultural demand has been met from the public water supply.

The total impact of climate change on demand has been calculated as an additional 5.58 Ml/d at the end of the planning period (1.22 Ml/d for non-household demand and 4.36 Ml/d for household demand). This central estimate has been applied to the baseline and final demand forecasts, and the uncertainty around these forecasts is included in our headroom allowance.

6.1.2 Section Conclusion

The 2009 WRMP continues to project a sufficient surplus of water in the South Staffs Water's supply area, both over the course of future dry years and during the peak demand weeks within them, over the next 25 years. This is constantly under review and undergoes a systematic re-evaluation and audit every five years to support the wider business planning process.

6.2 Raw Water Distribution

Raw water distribution entails the transport of raw or partially treated water from the point of abstraction to a treatment works.

The features of climate change which may impact on raw water distribution are flooding, higher temperatures and storms. The impact of flooding and higher temperatures on the Company's source stations and Blithfield Reservoir are considered in this section.

6.2.1 Flood Risk Assessment

Following the recommendation in the Pitt[5] report and Cave[6] review the impact of flooding on the Company's sites of potable water production was assessed in early 2008. Risks were assessed against the 0.1% (1 in a 1000) Environment Agency flood maps for England and Wales March 2008.

The risk assessment recorded the approximate distance of the site from the nearest watercourse and gave details of any previous flood events. The known risks for which no control systems existed were scored according to the table below.

Score	Severity	Likelihood
0	None	<1 in 1000 years
1	insignificant	rare
2	minor	unlikely
3	moderate	possible
4	major	likely
5	catastrophic	certain

The outcome of the assessment for each site was recorded on a form, a sample of which is given in appendix 4.

In summary, 29 sites associated with raw water distribution were assessed with 21 being scored as low risk and 8 as medium risk. No sites were identified as being at high risk from flooding. The summary of the full risk assessment is given in appendix 2.

The Environment Agency is working with Defra to 'translate' UKCP09 into a form which can be used by reporting authorities and other practitioners. This will inform updated guidance on the climate change allowances. The flood risk assessment for the source stations will be reviewed once this guidance is available.

Pluvial flooding can be caused by run off from surrounding land or overflow from sewers. The Company has only experienced pluvial flooding at one of its sites, Mayfield pumping station. The land surrounding this station drains into a brook that is culverted under

[5] The Pitt Review: Lessons learned from the 2007 floods
[6] Cave Review *www.defra.gov.uk/.../water/.../cavereview/.../cavereview-finalreport.pdf*

the roadway adjacent to the station. During periods of high rain fall the culvert was unable to take the water away and the site flooded.

In 2002 works were undertaken to reduce the risk from pluvial flooding. These included improving the site drainage and raising the borehole head works above ground level.

The Company will be consulting Severn Trent Water as part of the preparation for next periodic review in 2014 (PR14) to obtain data on the risk of flooding from major sewers in proximity to its pumping stations. However, the Company does not believe this will present a major risk in the short-term as there has currently been no experience of sewer flooding.

6.2.2 Impact of temperature

The Company's pumping assets typically consist of rotodynamic pumps driven by squirrel cage induction motors. In many cases the electrical feed to the motor is made via a solid state electronic frequency converter, known as the inverter drive, which enables the pumpset to operate over a range of rotational speeds. Overall control of the plant is provided by a programmable logic controller (PLC) which may also interface with computer based supervisory control and data acquisition (SCADA) system.

In general all of the Company's electrical drive and control equipment is suitable for continuous operation in an ambient temperature of at least 40°C, which is above the highest projected summer mean maximum temperature.

Although it is not envisaged that higher temperatures will impact widely on the Company's source stations some sites have given cause for concern. For example, the temperature in the HV sub-station at Seedy Mill Treatment works had, on occasion, exceeded 40°C. Therefore, a scheme was developed to take air from an adjacent basement that is kept cool by the treated water being piped through it to ventilate the HV sub-station. This adaptation measure has been in place since June 2009.

At Kinver pumping station the inverter drives are due for replacement. The large windows there coupled with the waste heat from the inverters can raise the ambient temperature within the building during the summer. Therefore, the replacement inverters will have their waste heat ducted from the building in the summer. This will reduce heat input to the building and thus reduce maximum temperatures.

6.2.3 Impact of Storms

The Company has a number of source stations which can lose their supply of grid electricity in the event of severe storms. These events tend to be infrequent and at worst may last up to six hours. The Company has embedded generation which can be remotely started at nine sites, including the two surface water treatment works. Generation will support a combined output from these sites of around 400Ml/d.

If the weather forecast is predicting storms then, to mitigate their effect, generators can be started in advance so that the site is not affected by any failures in the electrical distribution system.

6.2.4 Impact on Blithfield Reservoir

Blithfield Reservoir is the Company's only impounding reservoir and is located near Rugeley, Staffordshire. It was completed in 1953 and its principal feature is a 900m long earth embankment, with puddle clay core, behind which up to 18,146 Ml of water is retained. The Reservoir is the source of water for Seedy Mill Treatment Works which is located some 9½km south east.

This reservoir has been assessed as Category A in accordance with the 3rd edition of the Floods and Reservoir Safety: An Engineering Guide, published in 1996. This concluded that the design flood should be the Probable Maximum Flow (PMF) event and the flood was calculated using the Flood Studies Report method. The flood review determined that the existing spillway had insufficient capacity to pass the PMF.

Following this review other studies were commissioned, including one for the construction of a physical model to determine the most appropriate solution. The key requirements of the dam are that the overflow must be capable of discharging the PMF and the crest level and wave wall should be suitable to prevent overtopping of the embankment under the combined action of the PMF and wave action.

The studies concluded that whilst there was sufficient wave surge allowance an auxiliary spillway with a capacity of approximately 45m^3/s was needed. This was completed in 1999. The next Periodic Inspection under Section 10(5) of the Reservoir Act 1975 is due in November 2013.

The auxiliary spillway has a capacity of 45cumecs. This is in addition to the capacity of the main spillway at 292cumecs giving a total capacity of 337cumecs. This is equal to the calculated PMF flow routed through the reservoir.

The Company has been advised by the Inspecting Engineer that there is no firm guidance on an allowance to be made for climate change but the Babtie Climate Change Report suggested that an additional allowance of 10% be made on top of the calculated flood rise. This is allowed for in the current calculation of PMF.

Reviewing the UK Climate Projections UKCP09 suggests an average probability of 10-20% increase in wettest day winter and 0-10% wettest day summer to 2080 in the area of Blithfield. The projected increases in the shorter term are less and largely match with the Babtie figure. However the UKCP09 does not specifically cover storm or flood rainfall and the wettest day may not be reflected in the flood change. Since the projected change in the shorter term (to 2030) is 0-10% for the Blithfield area this largely matches the Babtie Climate Change Report figure of 10%.

The EA are suggesting that for new reservoirs a global UK additional 20% allowance be made for design floods to allow for changes due to climate change. But this is a global UK figure and appears to be a conservative approach as it does not give a time horizon.

In a supplementary note to UKCP09 on wind speed only minor changes in average wind speed are predicted and that these can largely be ignored. Thus, it is not necessary to allow for increased wave run up to account for climate change.

A list of documents relating to the design of the auxiliary spillway and inspection of the reservoir is given in appendix 5. These documents are available for inspection at the Company's head office.

6.2.5 Section Conclusion

It is not envisaged that projections of higher temperature will have a material impact on the operation of the Company's raw water distribution assets.

At present the risk from fluvial flooding at source stations is not considered significant so no adaptation measures are required. However, the assessment is reviewed periodically and may change as better data becomes available. Pluvial flooding will be considered as part of PR14.

Flood adaptation measures have already been implemented at Blithfield Reservoir. For the moment, and probably for the next 20 years, Blithfield meets the recommended additional flood rise capacity arising from climate change, with more than 10% spare flood rise capacity. This will be sufficient for the next Statutory Inspection and probably for some time beyond that. This may change at a later date once the flood analysis methodology is reviewed and the climate change models are reviewed.

6.3 Water Treatment

Water treatment covers the receipt of raw or partially treated water from the raw water distribution system into treatment processes. Water treated to potable standard is delivered via a pumped or gravity fed system to the treated water distribution system.

The features of climate change which may impact on water treatment are higher temperature, changes in precipitation and storms. The impact of these in the context of water treatment is considered in this section.

6.3.1 Risk Assessment Methodology

Given the fundamental importance of water quality to the Company and that the potential impact of climate change on water quality had not hitherto been considered, implicitly or otherwise, in previous pieces of work it was decided to hold a workshop. The objective of the workshop was to assess the risk arising from the climate change scenarios on the Company’s raw water sources and the ability of treatment processes to produce potable water to the prescribed standard.

The workshop was facilitated by the Carbon & Energy Manager with the following officers providing technical input:

- Director of Water Quality;
- Regulatory Compliance Manager;
- Water Treatment Manager;
- Regulation Compliance Scientist;
- Seedy Mill Treatment Chemist; and
- Hampton Loade Treatment Chemist.

At the workshop the scenarios were explained to the participants who were then tasked with assessing how they translate into risk. It was agreed to consider the two surface water treatment works first as these sites contain complex multi-stage treatment processes and their combined output accounts for just over half of the Company’s deployable output.

Each site was broken down into assets or systems (amalgamations of assets). The impact of climate change on the asset or system was then examined against three scenarios:

- temperature;
- changes in precipitation; and
- storms.

As well as the impact climate change may have on the above issues the workshop also considered more general questions, including:

- will higher ambient air temperature raise surface water temperature and could this impact on existing coagulation and filtration processes?
- will higher ambient air temperature affect service reservoir turnover?
- how may potentially more frequent and vigorous storms affect Blithfield or, possibly, coagulation?
- how could more frequent fluvial flooding affect river water quality Hampton Loade?
- is there a threshold above which existing processes or systems can no longer perform?

The workshop considered the impact of climate change on the following key parameters:

- pesticides - this is a generic term for any substance or mixture of substances intended for preventing, destroying, repelling or mitigating any pest. In the water industry, for convenience, the term tends to be colloquially applied to herbicides as well. These substances are complex organic compounds which are toxic to pests such as insects, plant pathogens, weeds, molluscs, birds, mammals, fish, nematodes (roundworms), and microbes. Contamination of water sources arises from field run off into streams or percolation down to aquifers. Pesticides are potentially toxic to humans and other animals and, therefore, their levels in drinking water are controlled. The limit for an individual pesticide in potable water is 0.1µg/l. Increased precipitation could exacerbate this issue;
- total organic carbon (TOC) - this is the amount of carbon bound in an organic compound and is often used as a non-specific indicator of water quality. The regulations stipulate that there shall be no abnormal change in TOC at the point of supply. Increased precipitation could exacerbate this issue;
- trihalomethane (THM) - this is produced by the action of chlorine on organic carbon compounds. Reaction times can be quite long so levels can increase as the water travels through the distribution system. The limit on THM in potable water is 100µg/l. Increased temperature could exacerbate this issue;
- turbidity - this is caused by the presence of particulate matter or dissolved material that imparts colour and thus makes the water opaque. The limit on turbidity in potable water is 1 NTU at source and 4 NTU at customers' taps. Increased precipitation could exacerbate this issue;

- bacteriological growth - this occurs naturally in water and if left unchecked can present a danger to human health. There are many different types of bacteria most of which are relatively benign at low levels but there should not be any faecal coli forms in drinking water. Increased temperature could exacerbate this issue;
- cryptosporidium (crypto) - this is produced in the intestines of mammals, particularly cattle and sheep, and if ingested by humans, often through contaminated water, can cause cryptosporidiosis. The main symptom is self-limiting diarrhoea but in immunocompromised individuals the symptoms are particularly severe and often fatal. Any detection of crypto in potable water must be reported to the DWI and the local Health Authority. Single events are not cause for concern. However, repeated detections would prompt action. Increased precipitation could exacerbate this issue;
- Algae - these are a large and diverse group of simple organisms, ranging from unicellular to multicellular forms. In the water industry algae presents particular problems in surface water reservoirs where large volumes of relatively static water exist. Algae take nutrients from the water and in the summer large blooms can develop making treatment difficult. By-products from the decomposition of dead algae can be toxic or impart an unpleasant taste or odour to the water. Increased temperature could exacerbate this issue; and
- nitrates are produced naturally in the environment but the addition of fertilisers has greatly increased their level in some water sources. In rare cases high levels of nitrate can be deleterious to human health and can cause eutrophication in the marine environment. The limit on nitrate in potable water is 50mg/l. Increased precipitation could exacerbate this issue.

The Company employs a variety of treatment processes to deal with the above issues. At the two surface water treatment works the primary physical treatment is clarification followed by filtration. In clarification a coagulant is added which causes suspended solids in the water to bind together to form a sludge which can then be removed. The water is then passed through granular activated carbon (GAC) as the filter media which not only complete the removal of suspended material but also take out taste, odour and some pesticides. The two process stages together can remove a sufficient proportion of any crypto present in the water. Chlorine is added during the process and exit from the works to disinfect the water.

Where possible, nitrate levels are kept below the prescribed threshold by blending waters with complementary nitrate concentrations. This is usually done within the distribution system. However, the Company has at three of its sources treatment processes for removing nitrates which make use of specialised resins in an ion exchange process.

Two of the Company’s sources were previously identified as being at risk from crypto contamination. Process plants that employ membrane technology have been installed at these sites. The membranes provide an effective 1µm barrier which prevents crypto entering the potable water supply.

The severity and likelihood of the impacts were then scored according to criteria described in the table below.

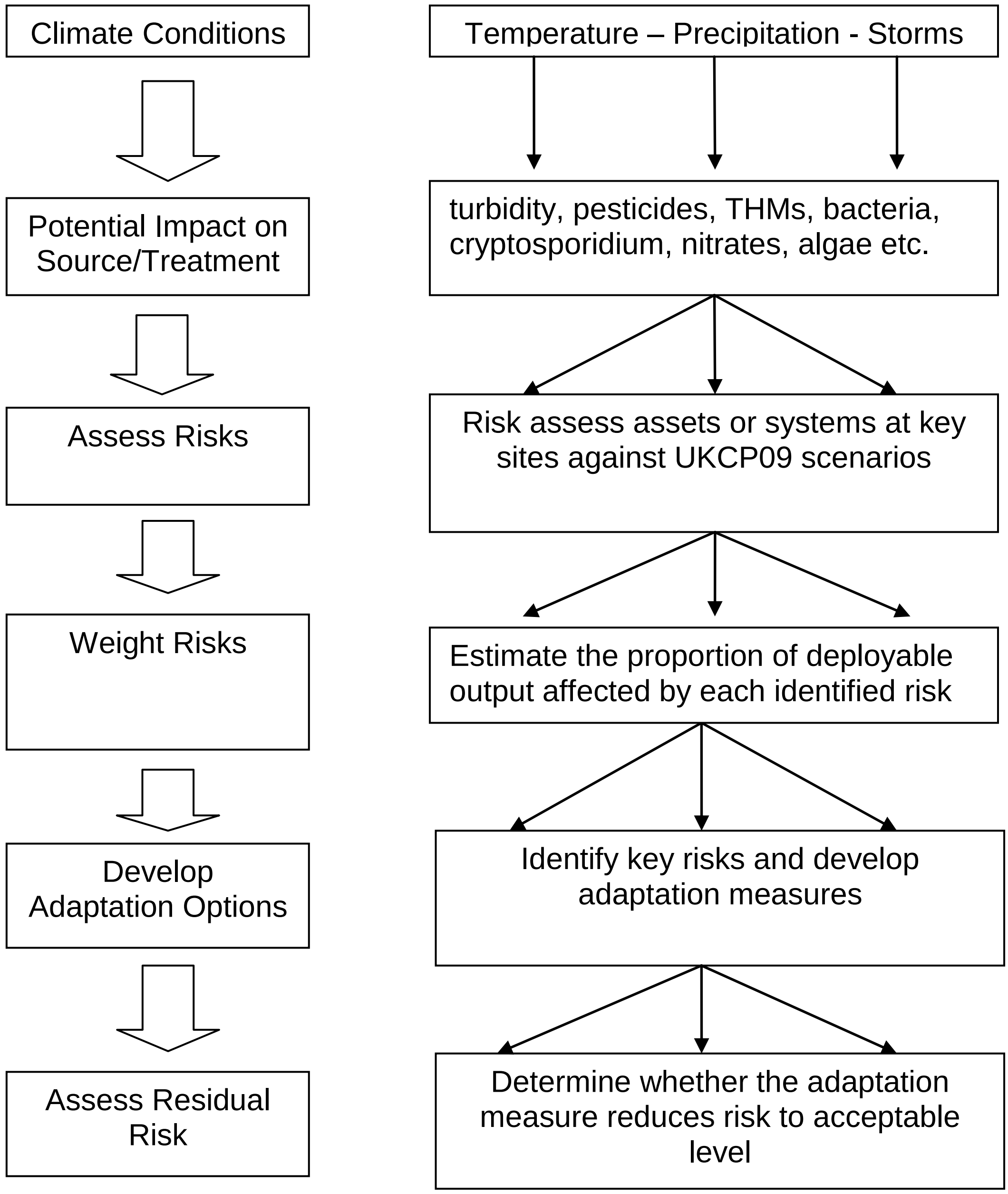
Score	Severity	Likelihood
1	No impact water quality or treatment	None
2	Existing treatment will cope but at increased cost or with additional maintenance	Possible
3	Asset cannot perform whilst climate condition prevails	Presumed
4	Progressive deterioration in source quality	Probable
5	Treatment not possible or rendered uneconomic	Certain

In many instances the chosen scenarios are being experienced already and current processes or operational practices are able to mitigate their impact. So, the participants were asked to judge at which of the three time horizons given in the UKCP09 projections could the designated scenarios materially affect the asset or system.

The influence each impact could have on the Company’s deployable output was assessed which was then used to weight the risk score.

This risk methodology is based on DEFRA’s guidance which advocates a top down approach. A flow chart of the risk assessment process is shown in Fig 4.

Fig 4: Risk Assessment Process



6.3.2 Discussion

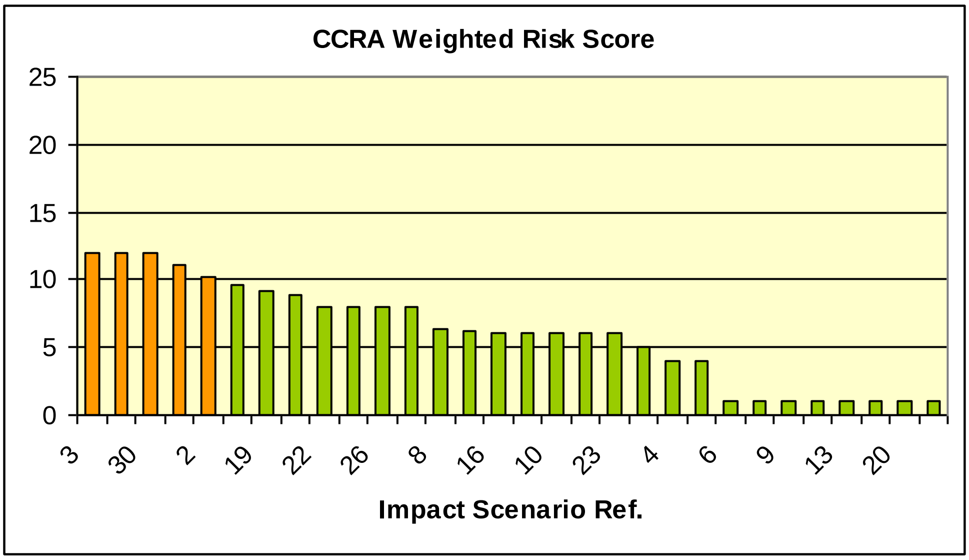
The identified climate change scenarios of elevated temperature, vigorous storms and extremes of precipitation have all been experienced at some time and in some measure across the Company. In general, any impact these have had on the quality of water received by customers has been mitigated primarily through management of the treatment processes.

Over the years the Company has invested in new water treatment process plants in order to maintain compliance with European standards. In some cases these provide varying degrees of adaptation to climate change. For example, in response to increasing levels of algae in Blithfield reservoir a dissolved air flotation (DAF) plant was installed at Seedy Mill in 1996 as the existing upward flow clarifiers were less able to cope with algae. The original peak capacity of the works was 100Ml/d but this was later increased to 120Ml/d in 2003.

More recently, work has been carried out at Seedy Mill treatment works to enable two filters to be washed concurrently. This has reduced the minimum filter run time from 20 hours to nine hours which allows the plant to cope with higher solids loading arising from algae growth or high inflows into Blithfield.

The risk assessment identified 30 separate impact scenarios. The detailed output from the risk assessment workshop is given in appendix 1. The weighted risk score for each impact scenario is summarised graphically in Fig 5.

Fig 5.



Risk Rating	≤ 10 Low Risk	>10≤20 Medium Risk	>20 High Risk

The impact scenarios scored as medium risk are tabulated below:

Ref.	Asset or System	Climate Condition	Impact Scenario	W'ted Score
3	River Severn	More Precipitation	River in spate leading to increased levels of metaldehyde	12
17	Blithfield	More Precipitation	Increased run off brings more pesticide, possibly metaldehyde, into reservoir	12
30	Treatment Works	Temperature	THMs	12
15	Blithfield	Temperature	High temperature promotes algal growth and can induce turnover	11.04
2	River Severn	More Precipitation	River in spate already gives high bacti counts, turbidity, TOC levels, cryto. risk and pH	10.14

Metaldehyde

Contamination from metaldehyde (items 3 & 17) results from residues in slug pellets applied to fields running off into water courses and is giving increasing cause for concern. The limit in potable water is 0.1µg/l and levels in raw water supplies can reach 2µg/l. At present the only available treatment process is UV/Ozone followed by GAC adsorption. Metaldehyde degrades to CO_2 and water in contact with soil but is extremely persistent in water. Improved farming practices in the catchment may help in the long term. It is envisaged that a solution to this issue will be required by 2050.

The Company is currently operating under an undertaking from the DWI on metaldehyde which incorporates the general limit on all pesticides of 0.1µg/l in drinking water supplies. However, if the level exceeds 10µg/l the Company has to take measures to mitigate risk which include taking transgressing sources out of supply and initiating a programme of mains flushing. If levels in supply reach 200µg/l the water is deemed unfit for human consumption. Levels in supply rarely exceed 0.2µg/l.

In 2009/10 five compliance failures for metaldehyde were reported and during this year date there have been fewer failures. The Company is required to report to the DWI on the effectiveness of measures to date every six months. A final report will be submitted in March 2015 when the undertaking expires.

Metaldehyde contamination is an industry wide problem. At present the solution is being pursued through catchment management and measures to raise awareness. However, the impact of a total ban is being investigated. It is accepted that whatever the final outcome it must be cost beneficial.

THM

Climate change will increase the risk from THM contamination. Whilst the problem is currently managed the long term solution may be to remove organic carbon from the raw water. UV/Ozone followed by GAC adsorption would provide a suitable treatment option. The Company has adopted a trigger level for THMs in potable water reservoirs of 70µg/l. At this point remediation measures to improve turnover are instigated. The Company also introduces enhanced monitoring for THM during the summer period when the risk of failure is greatest.

The Capital cost of a UV/Ozone/GAC adsorption treatment plant has been calculated using TR61 V10. TR61 is a software package developed by WRc for estimating the capital costs of new works build using models based on industry data. The estimated capital cost for such treatment at Hampton Loade and Seedy Mill is £26 million and £18.5 million respectively. In addition the energy consumption for this would be substantial as would the associated CO_2 emissions.

Algae

Algae in Blithfield reservoir and, to a lesser extent, Chelmarsh reservoir will remain a problem. Algal growth is normally confined to the surface of a reservoir with the waters beneath forming discrete layers. At Blithfield reservoir prevailing winds tend to drive algae towards the outlet tower. Under certain conditions the algae can sink causing an influx of algae onto Seedy Mill treatment works which can overwhelm the clarification process there. In 2000 an extended draw off was installed to enable water to be extracted from the central body of the reservoir. This takes water from the bottom of the reservoir where it is less likely that algae will be present, however, the additional head loss limits gravity output. An enhanced destratification system would improve the situation by dispersing algae around the inlet tower. The workshop judged that this may need addressing by 2020 so further assessment needs to be undertaken to determine whether the work is justified and whether the scheme should be included in the next business plan.

The Company will continue to monitor and assess risk in these areas and seek to ensure that any adaptation measures identified and justified deliver sufficient risk reduction to ensure the ability of the Company to serve its customers is unaffected.

There is currently an UKWIR funded project under way to examine the impacts of climate change on water treatment. The project aims to assess the impact of climate change on catchment water quality and environmental conditions. It will also consider the implications that it may have for water quality, treatment and treatment processes, optimisation / rationalisation strategies and source protection (quantity and quality). The project plans to develop a framework for “no / low regrets”, sustainable asset strategies in the context of developing carbon constraints. The conclusions of this project will be closely considered by the Company when formulating future adaptation plans.

6.3.3 Section Conclusion

Generally, the Company’s water treatment process will be able to cope with the projected impact of climate change with the notable exception of metaldehyde. This is an industry wide problem and there is appreciable work being done to mitigate this issue. Therefore, it is too early to know whether adaptation measures will be needed.

The need to improve the destratification of Blithfield reservoir has been highlighted. A process of determining a design, establishing the costs and assessing the benefits will be initiated in order to determine whether there is sufficient justification for including the scheme in the next business plan in 2014.

6.4 Treated Water Distribution

Treated water distribution encompasses the transfer of potable water from treatment sites to customers' properties or new appointees. This activity includes intermediate storage facilities, e.g. reservoirs and storage towers, with possible further treatment taking place within the network.

The features of climate change which may impact on treated water distribution are changes in precipitation and higher temperatures. The impact of these in the context of treated water distribution is considered in this section.

6.4.1 Flood Risk Assessment

The flood risk assessment for the booster stations was carried out using the identical methodology to that used for the source stations.

In summary, 51 sites were assessed with 44 being scored as low risk and seven as medium risk. No sites were identified as being at high risk from flooding. The summary of the full risk assessment is given in appendix 3.

The Environment Agency is working with Defra to 'translate' UKCP09 into a form which can be used by reporting authorities and other practitioners. This will inform updated guidance on the climate change allowances. The flood risk assessment for the source stations will be reviewed once this guidance is available

The risk of pluvial flooding of treated water distribution assets will be considered alongside and using the same methodology as that for raw water distribution assets.

6.4.2 Impact of temperature

The same design criteria applies to the Company's booster pumping stations as do to their source pumping stations so again it is not envisaged that higher temperature will have a significant impact. However, Two Gates booster in Tamworth has been identified as one site where poor ventilation may cause temperature within the building to exceed 40°C. Therefore works to improve its ventilation will be complete by March 2011.

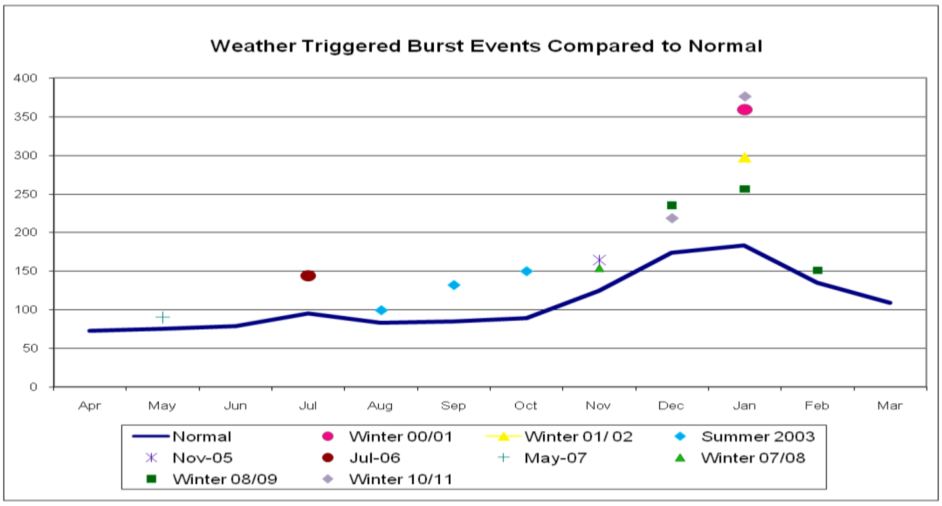
6.4.3 Impact on Distribution System

Analysis of burst rates related to weather events, based on the last 10 years indicate that severe winters and sustained dry warm summers influence the rate of bursts.

Severe winters, whereby temperatures drop quickly to and below zero degrees, coupled with the subsequent thaw, such as the winters experienced in 2000/01, 2001/02, 2008/09 & 2009/10 can add on average an additional 200 bursts to the annual total. However, the expectation is that winters such as 2009/10 can add c. 600 bursts.

Bursts peak in the summer months when soil moisture deficit is high. Analysis points to a trigger level of 100mm which leads to ground movement and the two exceptionally dry warm summers of 2003/04 and 2006/07 on average increased mains bursts by 120. This is demonstrated in Fig 6 below.

Fig 6



Occurrences of these events, as projected in the UKCIP scenarios are likely to increase asset failure, and therefore increase leakage levels, customer contact and customer disruption during repairs.

There is a risk that dryer hotter summers would impact upon serviceability both in regulatory terms and service to customers. In an average year the Company experiences between 1210 to 1250 mains bursts: the control limit is around a reference level of 1210. If the number of times that bursts were above the reference level increased and there was a rising trend in the year on year data, Ofwat could potentially change the Company's serviceability assessment from stable to marginal or even deteriorating.

The Company gathers and maintains detailed records of its burst history and correlation between soil moisture deficit and bursts has been proven. If the Company was experiencing an increase in burst numbers due to the impact of climate change it would need to make the case for increasing levels of mains renewals to maintain a stable serviceability position of 1210 bursts per annum. This would be the adaptation plan which would be subject to Ofwat approval.

6.4.4 Section Conclusion

It is not envisaged that projected higher temperatures will have a material impact on the operation of the Company's treated water distribution assets.

At present the risk from fluvial flooding at booster stations is not considered significant so no adaptation measures are required. However, the assessment is reviewed periodically and may change as better data becomes available. Pluvial flooding will be considered during the next review.

The mechanism for climate change to increase the number of bursts is understood and the adaptation plan known. However, the scope of the adaptation plan can only be assessed once the extent of the impact can be modelled which can only be done when data is available. The process exists for capturing and assessing this data and for developing and implementing the plan. It is not envisaged that further adaptation measures would be needed.

A significant proportion of investment in the distribution system over the years has been targeted at improving security of supply. This has delivered a highly integrated system through which large volumes of potable water can be transferred across the Company's area of supply. As there is a cost associated with this it is not the normal mode of operation, however the resilience it provides reduces the likelihood of customers being affected by any localised impacts of climate change. For example, if the output of Seedy Mill Treatment Works is reduced because of algae in Blithfield water can be transferred from Hampton Loade to compensate for the shortfall.

6.5 Retail

Retail captures the management and delivery of water services to the final customer including customer sales, billing, payment handling and provision of customer services liaison.

It is not envisaged that climate change will directly impact on the retail activities of the business which are largely office based. However, some ways in which it may affect its administrative functions; employees and customers include:

- air conditioning systems may become prohibitively expensive or totally inadequate which could in turn affect productivity;
- for periods during the summer it may become too hot to carry out manual labour;
- customers may choose to use less water i.e. not use garden sprinklers. Experience from Australia where restrictions have been in force for long periods shows customers are prepared to purchase water efficient white goods and install rain water harvesting; and
- working patterns may change and people may want to migrate north from the south east of the country.

The above is mainly conjecture but it serves to indicate that it is difficult to predict how climate change may affect the behaviour of employees, customers and other stakeholders.

6.6 Overall Summary of Risk Assessments

The table below summarises the outputs of the risk assessments for each of the Company's constituent business unit.

Bus. Unit	CLIMATE CHANGE FEATURE	Potential Impact	MITIGATION MEASURES Required	Further Work Required
Water Resources	Lower summer rainfall – drought Higher temperatures.	Higher daily & peak demand for garden watering	None currently required as fully assessed as part of 2009 WRMP and no deficit forecast in the next 25 yrs	Will be reviewed as part of 2014 WRMP
	Lower summer rainfall – drought Higher evaporation from surface water reservoirs	Lower River Severn yields due to river regulation restrictions. Low levels in Blithfield Reservoir	None currently required as fully assessed as part of 2009 WRMP and no deficit forecast in the next 25 yrs	Will be reviewed as part of 2014 WRMP
Raw Water Distribution	Flooding	Fluvial flooding at source station	Risks all assessed as low or medium.	To be reviewed when EA guidance becomes available.
		Pluvial flooding at source station	Risk not assessed but no occurrences experienced	To be reviewed as part of PR14
		Blithfield spillway capacity	Auxiliary spillway will cope with PMF over next 20 years.	Flooding will be reviewed at next inspection in 2013
	Higher temperatures	Buildings with pumping plant can exceed to operating limit of equipment.	None required as equipment can operate in 40°C ambient	Where plant is refurbished potential to duct heat away to be considered.
	Storms	Loss of electricity supply	None currently required as the Company has sufficient embedded generation	Monitor plant failures
Water Treatment	Higher temperatures	More THM formation	Issue managed through flushing operational measures to promote turnover.	None
		More algal blooms	Improved destratification of Blithfield	Investigation required and justification established
		Increased bacteriological growth in the treatment process	Additional chlorine dosing required	None
Water Treatment	Rainfall intensity – storms and flooding	Raw water quality effected by runoff unto surface water sources causing higher pesticide levels	Metaldehyde is subject to a DWI undertaking which will be reviewed in 2015. Catchment management or total ban my provide the solution	Continued monitoring and reporting

Bus. Unit	CLIMATE CHANGE FEATURE	Potential Impact	MITIGATION MEASURES Required	Further Work Required
		Raw water quality effected by runoff into surface water sources causing higher turbidity	Managed through normal operational measures	None
		Borehole water quality effected by surface water ingress causing coliform contamination	Can be addressed by higher chlorine dose but if faecal then station pumped to waste until clear	None
		Raw water quality effected by runoff into surface water sources causing higher cryptosporidium	At risk sources already have treatment plant.	None
		High wind could disturb floc blankets on clarifiers	Does not affect the DAF plant and pulsators. Projections do not suggest wind speed will be high enough to cause a problem	None
Treated Water Distribution	Flooding	Flooding at booster station	Risks all assessed as low or medium.	To be reviewed when updated EA guidance becomes available.
		Pluvial flooding at booster station	Risk not assessed but no occurrences experienced	To be reviewed as part of PR14
		More extreme wetting and drying cycles result in greater soil movement, more pipe movement and bursts	If burst increase case to be made to increase replacement activity	Continue to monitor and gather data
	Temperature	Buildings with pumping plant can exceed design operating limit of equipment.	One site identified where improved ventilation is needed	Monitor plant failures
Retail		Difficult to assess due to high degree of uncertainty. Could affect working environment, working practices and customer behaviour.	None identified	To be reviewed for next climate change report

6.7 Conclusion

Following an assessment of the risk posed to all aspects of the business based on the best evidence currently available South Staffs Water Plc does not expect climate change to have a major impact on its operations or that major adaptation measures will be needed for the foreseeable future.

This conclusion is based on a comprehensive risk assessment of the impacts of climate change on the Company's business functions. This process has identified a number of low risks, some medium risks but no high risks. Immediate action is not required for any impacts. Monitoring and further evaluation will be undertaken for a number of risk areas. Some investment requirements may be identified for inclusion in the next periodic review cycle and the Company will build as robust a case as possible to ensure acceptance by the Regulator.

The regulatory regime under which the Company is required to review and submit investment plans every five years means that risk from climate change will be periodically assessed using the latest data and analytical techniques. In particular, it is a statutory obligation to update the Water Resources Management Plan every five years in accordance with national guidance in place at that time. The Company will continue to gather data develop techniques and improve procedures to improve future risk assessments. Therefore, the Company believes it has the process of climate change risk assessment embedded within the organisation as 'business as usual'. As such it is well placed to plan and react as necessary.

7. Appendices:

Appendix 1 - Water Quality Risk Assessment outputs

Appendix 2 - Summary Flood Risk Assessment for Source Stations

Appendix 3 - Summary Flood Risk Assessment for Booster Stations

Appendix 4 - Typical flood risk assessment

Appendix 5 - Blithfield Documents

Appendix 6 – Met Office Baseline Data

Appendix 1: **Water Quality Climate Change Risk Assessment**

Item	Asset/System	Location	Climate Condition	Impact Scenario	Impact Severity	Likelihood	Risk	Earliest Occurrence	Impact on Output (Ml)	% of Dry Year Deployable Output affected	Weighted Risk	Ranking	Comments
1	River Severn	HLTW	Temperature	None	1	5	5	N/A	0	0%	5	20	Ability to treat the river water is adversely affected by low temperature.
2	River Severn	HLTW	More Precipitation	River in spate already gives high bacti counts, turbidity, TOC levels, crypto and pH	2	5	10	N/A	5.2	1%	10.14	5	When this occurs water is taken from Chelmarsh. If condition persists existing treatment can cope by increasing chemical dose rates and filter run times can be reduced where necessary if poor WQ has detrimental impact
3	River Severn	HLTW	More Precipitation	River in spate leading to increased levels of metaldehyde	3	4	12	2050	0	0%	12	1	The impact can be ameliorated by dosing powdered activated carbon. There is no economic treatment process for this at present. There is a risk that if occurrence increased DWI would look to impose an undertaking. Mitigation needed at source through catchment management.
4	River Severn	HLTW	Other	None	1	4	4	N/A	0	0%	4	21	
5	Chelmarsh	HLTW	Temperature	High temperature promotes algal growth	2	4	8	2050	40	11%	8.84	8	Algal growth is being observed but does not cause problems. Existing levels can be dealt with be increasing pre-chlorination and reducing filter run times. If levels began to affect operability the reservoir could be drained and silt removed. HLTW would continue to operate by abstracting water straight from the River Severn.
6	Chelmarsh	HLTW	Other	None	1	1	1	N/A	0	0%	1	23	
7	Clarifiers	HLTW	Temperature	None	1	1	1	N/A	0	0%	1	23	Low temperature can affect treatment
8	Clarifiers	HLTW	Storms	High winds can disturb floc blankets	3	2	6	2020	20	5%	6.32	13	Excessive wind cab break up floc blankets on the clarifiers. The two accentriflocs would be the worst affected. The Pulsators are considered to be more resistant to this as the floc blanket is lower. Clarifiers could be adapted with some sort of barrier to reduced impact of wind.
9	Clarifiers	HLTW	Other	None	1	1	1	N/A	0	0%	1	23	
10	Filtration	HLTW	Temperature	High temperature promotes bacti growth	2	3	6	2050	0	0%	6	17	This can be treated by increasing the chlorine dose.
11	Filtration	HLTW	Other	None	1	1	1	N/A	0	0%	1	23	
12	Sludge Treatment	HLTW	Temperature	High algal loading on works could overload sludge process	2	2	4	2050	0	0%	4	21	Process could be helped by reducing flow.
13	OSEC	HLTW	Other	None	1	1	1	N/A	0	0%	1	23	Not considered a water quality issue but needs to be considered under operational risk.
14	Blithfield	SMTW	Temperature	Reservoir turns over causing high levels of turbidity and manganese	2	4	8	2020	80	21%	9.68	6	The likelihood of this occurring is greater if the reservoir is low so is linked to low precipitation. An adaptation measure would be to improve the destratification/aeration system.
15	Blithfield	SMTW	Temperature	High temperature promotes algal	2	5	10	2020	40	11%	11.05	4	Algae growth is currently a problem with the reservoir. A DAF plant was constructed in 1996 As this technology was better able to remove algae than the existing clarification process. Improvements to the destratification/aeration

Item	Asset/System	Location	Climate Condition	Impact Scenario	Impact Severity	Likelihood	Risk	Earliest Occurrence	Impact on Output (Ml)	% of Dry Year Deployable Output affected	Weighted Risk	Ranking	Comments
				growth and can induce turnover									system would provide additional adaptation.
16	Blithfield	SMTW	More Precipitation	Sudden inflows to the reservoir can cause high turbidity	2	3	6	2050	8	2%	6.13	15	The filtration plant and sludge handling system has been modified to enable minimum filter run times to be reduced from 20 hours to nine hours. Works output would be maintained but at a lower level.
17	Blithfield	SMTW	More Precipitation	Increased run off brings more pesticide, possibly metaldehyde, into reservoir	3	4	12	2050	0	0%	12	1	The existing treatment process can cope with current risk from pesticide, however, metaldehyde is recognised as a problem. Compared to Chelmarsh the capacity of Blithfield is six times greater and draining it is not an option.
18	Blithfield	SMTW	Other	None	1	1	1	N/A	0	0%	1	23	
19	Clarifiers	SMTW	Storms	High winds can disturb floc blankets	3	3	9	2020	10	3%	9.24	7	This only applies to accelators as the DAF plant is covered.
20	Clarifiers	SMTW	Other	None	1	1	1	N/A	0	0%	1	23	
21	Filtration	SMTW	Temperature	High temperature promotes bacti growth	2	3	6	2050	0	0%	6	17	This can be treated by increasing the chlorine dose.
22	Chlorination	SMTW	Temperature	The concentrated sodium hypochlorite gasses off	2	4	8	N/A	0	0%	8	9	This can be addressed by increased levels of maintenance.
23	Coagulant Storage	SMTW	Temperature	The potential for crystalline deposits of the coagulant chemical to build up in the storage tank has been highlighted by the supplier	2	3	6	N/A	0	0%	6	17	Monitoring and cleaning would address this issue.
24	Sludge Treatment	SMTW	Temperature	High algal loading on works could overload sludge process	2	3	6	2050	8	2%	6.13	15	
25	Distribution System	Company Wide	Temperature	Can lead to increased dissolution of metals, generally for communication pipes.	2	4	8	2050	0	0%	8	9	The failures are detected at the customer tap through routine maintenance and sampling. If a failure is detected the communication pipe is replaced. Other plumbing metals e.g. copper, nickel can be leeched from fittings.

Item	Asset/System	Location	Climate Condition	Impact Scenario	Impact Severity	Likelihood	Risk	Earliest Occurrence	Impact on Output (Ml)	% of Dry Year Deployable Output affected	Weighted Risk	Ranking	Comments
26	Potable Reservoirs	Company Wide	Temperature	Lower chlorine retention time can lead to raised bacti levels.	2	4	8	2020	0	0%	8	9	This is an existing issue and is currently managed through regular monitoring coupled with increased flushing or chlorination where required. All booster pumping plant in distribution has tapping points fitted to allow temporary chlorination plant to be fitted. Four potable water storage reservoirs have auxiliary chlorination plant permanently fitted.
27	Source Stations	Company Wide	More Precipitation	Increased levels of non-faecal coli form in groundwater	2	4	8	2020	0	0%	8	9	Additional chlorine dosing applied at source. Stations at risk include Hopwas, Bourne Vale, Chilcote, Seedy Mill Borehole, Crumpwood and Moors Gorse.
28	Source Stations	Company Wide	More Precipitation	Increased levels of faecal coli form in groundwater	3	2	6	2020	17	4%	6.27	14	Source must be taken out of supply and pumped to waste until contamination cleared. Stations at risk include Hopwas, Bourne Vale, Chilcote, Seedy Mill Borehole, Crumpwood and Moors Gorse.
29	Source Stations	Company Wide	Other	None	1	1	1	N/A	0	0%	1	23	Impact of storms and temperature to be considered in raw and treated water distribution assessment.
30	Treatment Works	HLTW & SMTW	Temperature	THMs	3	4	12	N/A	0	0%	12	1	THMs are produced by the action of chlorine on the organic carbon content of the water. High levels are experienced when the water temperature exceeds 16 - 17°C which tend to occur when peak day temperature is higher than 24°C for a number of days. Issue currently managed by flushing mains and increasing reservoir turnover. UV-Ozone + GAC adsorption will remove the organic carbon.

Appendix 2: Summary Flood Risk Assessment for Source Stations

Source	Type	Strategic ranking	Supply Zone	Lost Volume (Ml/d)	No of Customers	Risk Score	EA Likely return period in Years	EA Likely return period expressed as a %age	Date reviewed
Blithfield	Fishfarm					13.60	1 in 75	1.30%	29/03/2008
Brindley Bank	Borehole	29	Northern Sources	1.8	0	1.00	1 in 1000	0.10%	29/03/2008
Bourne Vale	Borehole	17	Barr Beacon	5.9	13007	1.00	1 in 1000	0.10%	29/03/2008
Chilcote	Borehole	19	Winshill	7	16786	14.40	1 in 75	1.30%	29/03/2008
Crumpwood	Borehole	14	Uttoxeter	6.2	18333	16.80	1 in 75	1.30%	29/03/2008
Fradley	Borehole	10	Outwoods	11	28798	7.60	1 in 1000	0.10%	29/03/2008
Hopwas	Borehole	22	Hopwas	2.4	5616	5.60	1 in 1000	0.10%	29/03/2008
Little Hay	Borehole	25	Barr Beacon	5.5	2989	6.40	1 in 1000	0.10%	29/03/2008
Maplebrook	Borehole	15	Cannock High	7.2	21681	6.40	1 in 1000	0.10%	29/03/2008
Mayfield	Borehole	26	Uttoxeter	0.5	1641	6.00	1 in 1000	0.10%	29/03/2008
Moors Gorse	Borehole	7	Cannock High	13	18419	5.20	1 in 1000	0.10%	29/03/2008
Pipehill	Borehole	11	Barr Beacon	11	20928	5.20	1 in 1000	0.10%	29/03/2008
Sandhills	Borehole	20	Barr Beacon	7	24458	6.40	1 in 1000	0.10%	29/03/2008
Seedy Mill WTW	WTW	2	BB GS OU HO	146	207205	6.40	1 in 1000	0.10%	29/03/2008
Seedy Mill Borehole	Borehole	8	Seedy Mill	7	18024	6.40	1 in 1000	0.10%	29/03/2008
Shenstone	Borehole	24	Barr Beacon	5.6	2989	10.40	1 in 75	1.30%	29/03/2008
Slade Heath	Borehole	18	Cannock Low	8	10158	8.00	1 in 1000	0.10%	29/03/2008
Slitting Mill	Borehole	12	Cannock High	5	17817	10.20	1 in 200	0.50%	29/03/2008
Somerford	Borehole	23	Cannock Low	3	4503	6.40	1 in 1000	0.10%	29/03/2008
Trent Valley	Borehole	4	Northern Sources	11	34408	7.20	1 in 1000	0.10%	29/03/2008
Ashwood	Borehole	5th	Sedgley	14.44	45,966	4.20	> 1 in 1000	< 0.1%	22/04/2008
Chelmarsh	Reservoir	1st	Hampton Loade Complex	181.93	579,249	4.00	> 1 in 1000	< 0.1%	03/06/2008
Churchill	Borehole	13th	Hayley Green	9.82	31,280	4.20	> 1 in 1000	< 0.1%	22/04/2008
Cookley	Borehole	3rd	Shavers End	12.69	40,393	12.60	1 in 200	0.50%	22/04/2008
Hagley	Borehole	21st	Sedgley	0	0	4.20	> 1 in 1000	< 0.1%	22/04/2008

Source	Type	Strategic ranking	Supply Zone	Lost Volume (Ml/d)	No of Customers	Risk Score	EA Likely return period in Years	EA Likely return period expressed as a %age	Date reviewed
Hampton Loade	WTW	1st	Hampton Loade Complex	181.93	579,249	7.33	1 in 200 (Intake); > 1 in 1000 (HV)	0.5% (Intake); <0.1% (HV)	29/04/2008
Hinksford	Borehole	16th	Sedgley	5.52	17,586	12.60	1 in 200	<0.50%	22/04/2008
Kinver	Borehole	9th	Shavers End	12.89	41,026	16.80	1 in 75	1.33%	22/04/2008
Prestwood	Borehole	6th	Shavers End	16.98	54,068	4.20	> 1 in 1000	< 0.1%	22/04/2008

Risk Rating	**≤ 10 Low Risk**	**>10≤20 Medium Risk**	**>20 High Risk**
N° of Sites	**21**	**8**	**0**

Appendix 3 - Summary Flood Risk Assessment for Booster Stations

Booster Pumping Station	Strategic ranking	Supply Zone	Lost Volume (Ml/d)	No of Customers	Risk Score	EA Likely return period in Years	EA Likely return period expressed as a %age	Date Assessed
Blounts Green	21st	Uttoxeter	1.5	3818	14.00	1 in 75	1.3%	07/05/2008
Bramshall	29th	Uttoxeter	1.4	1145	1.00	>1 in 1000	0.01%	07/05/2008
Bretby	6th	Winshill	1.6	1145	1.00	>1 in 1000	0.01%	07/05/2008
Castleway	1st	Castleway	9.1	13745	1.75	>1 in 1000	0.01%	07/05/2008
Clifton Campville	24th	Winshill	2	5345	1.00	>1 in 1000	0.01%	07/05/2008
Combridge	37th	Uttoxeter	4.3	19091	15.00	1 in 75	1.3%	07/05/2008
Croxden	33rd	Uttoxeter	0.5	496	2.00	>1 in 1000	0.01%	07/05/2008
Dodsleigh	25th	Uttoxeter	0.3	1336	1.75	>1 in 1000	0.01%	07/05/2008
Ellastone	22nd	Uttoxeter	1	955	1.75	>1 in 1000	0.01%	07/05/2008
Gentleshaw	11th	Cannock High	1.5	2596	15.00	>1 in 1000	0.01%	07/05/2008
Glascote	2nd	Glascote	6.5	12218	15.00	> 1 in 1000	0.01%	07/05/2008
Harlaston	30th	Winshill	0.9	4582	10.00	1 in 75	1%	07/05/2008
Heatly Green	35th	Hanbury	0.2	878	1.75	>1 in 1000	0.01%	07/05/2008
Holly Grange	16th	Uttoxeter	1.3	3818	15.00	> 1 in 1000	0.01%	08/05/2008
Lime Pit Lane	23rd	Cannock High	2	3436	1.75	>1 in 1000	0.01%	08/05/2008
Marquis Drive	44th	Cannock High	1.7	0	1.00	>1 in 1000	0.01%	08/05/2008
Mayfield	40th	Uttoxeter	0.6	2673	1.75	>1 in 1000	0.01%	08/05/2008
Newbrough	31st	Hanbury	0.9	3818	1.75	>1 in 1000	1.00%	08/05/2008
Nethertown booster		Seedy Mill	120		15.00	1 in 100	0.10%	08/05/2008
No Mans Heath	28th	Winshill	1.4	2520	10.00	1 in 75	1.30%	08/05/2008
Outwoods	14th	Outwoods	4.4	11703	1.75	>1 in 1000	0.01%	08/05/2008
Overseal	4th	Winshill	5	8018	1.75	>1 in 1000	0.01%	08/05/2008
Penkridge Bank	42nd	Cannock High	0.2	878	1.75	>1 in 1000	0.01%	08/05/2008
Pye Green	18th	Cannock High	1.3	5727	1.75	>1 in 1000	0.01%	08/05/2008
Saxon Street(oseal)	13th	Winshill	10	9545	1.75	> 1 in 1000	0.01%	08/05/2008
Saxon Street(whill)	6th	Winshill	2.2	611	1.75	> 1 in 1000	0.01%	08/05/2008
Spath	43rd	Uttoxeter	605	8782	1.75	>1 in 1000	0.01%	12/05/2008
Stanton	27th	Uttoxeter	0.4	611	1.75	> 1 in 1000	0.01%	12/05/2008

Booster Pumping Station	Strategic ranking	Supply Zone	Lost Volume (Ml/d)	No of Customers	Risk Score	EA Likely return period in Years	EA Likely return period expressed as a %age	Date Assessed
Toyota	1st	Castleway	14.4	0	1.75	>1 in 1000	0.01%	12/05/2008
Tutbury	36th	Hanbury	0.8	76	15.00	>1 in 1000	0.01%	12/05/2008
Two Gates	5th	Glascote	4.3	6873	6.00	>1 in 1000	0.01%	12/05/2008
Wigginton	26th	Glascote	1.8	4200	1.75	>1 in 1000	0.01%	12/05/2008
Wimblebury	32nd	Cannock High	0.3	585	1.75	>1 in 1000	0.01%	12/05/2008
Winshill	6th	Winshill	2.2	4200	1.75	> 1 in 1000	0.01%	12/05/2008
Wylde Green	39th	Sutton	1.7	7636	1.75	>1 in 1000	0.01%	12/05/2008
Yoxall	15th	Hanbury	3.1	9927	4.00	>1 in 1000	0.01%	12/05/2008
Blackheath	8th	Cawney Hill	1.296	5,727	4.00	> 1 in 1000	< 0.1%	22/04/2008
Cawney Hill	8th (WSZ)	Cawney Hill	0.864	3,818	4.00	> 1 In 1000	< 0.1%	24/05/2008
Chapel Street	34th	Springsmire	0.691	3,055	4.00	> 1 in 1000	< 0.1%	22/04/2008
Clent Hills	45th	Hayley Green	6.05	26,727	4.00	> 1 in 1000	< 0.1%	22/04/2008
Coneygrey	4th	Cawney Hill	10.8	47,727	4.00	> 1 in 1000	< 0.1%	22/04/2008
Hayley Green	11th (WSZ)	Hayley Green		34,000	4.00	> 1 in 1000	< 0.1%	22/04/2008
Himley	45th	Shavers End	39.74	175,636	4.00	> 1 in 1000	< 0.1%	22/04/2008
Langley	10th	Cawney Hill	4.32	19,091	4.00	> 1 in 1000	< 0.1%	24/04/2008
Romsley	20th	Hayley Green	0.648	2,864	4.00	> 1 In 1000	< 0.1%	22/04/2008
Sedgley	7th	Sedgely	1.296	5,727	4.00	> 1 in 1000	< 0.1%	24/04/2008
Shavers End	8th (WSZ)	Shavers End	2.592	11,455	4.00	> 1 in 1000	< 0.1%	24/04/2008
Smethwick	6th	West Bromwich	2.16	9,545	4.00	> 1 in 1000	< 0.1%	22/04/2008
Springsmire	6th (WSZ)	Springsmire	1.55	6,873	4.00	> 1 in 1000	< 0.1%	24/04/2008
Warley	41st	Cawney Hill	1.99	8,782	4.00	> 1 in 1000	< 0.1%	24/04/2008
West Bromwich	6th	West Bromwich	79.92	353,182	4.00	> 1 in 1000	< 0.1%	22/04/2008

Risk Rating	**≤ 10 Low Risk**	**>10≤20 Medium Risk**	**>20 High Risk**
N° of Sites	**44**	**7**	**0**

Appendix 4 - Typical flood risk assessment

Site Name		**Area assessed :**		
Cookley		Flooding Risk		
Stategic ranking		**No of customers affected**	**Supply Zone**	**Booster/Borehole**
3rd		40,393	Shavers End Supply Zone	Borehole
Address				**Postcode**
8, Caunsall Road, Caunsall, Kidderminster				DY11 5YB
Grid Ref	384381567, 280713439	**Nearest Watercourse**	Unnamed	
AOD	45.26m	**Watercourse AOD**	approx 42m	
		Distance from Station	approx 130m	
Level of raised water at which flooding of station would occur			approx 3m	
Highest historical recorded flood level & year recorded			Not known	
Flood frequency experienced			Never seen	
Assessed by		**Date of assessment**		
Mark Watson		22 April 2008	22 April 2011	
Description of hazard			**Comments**	
1	Flooding to Site		Never witnessed	
Identification of existing Risks with no Control Systems in place		**Likelihood**	**Severity**	**Risk**
1	Flooding of booster site and grounds	3	5	15
2	Contamination of Borehole	3	5	15

3	Access to site affected by flood conditions	3	4	12
4	Duration of flood	3	3	9
5	Loss of M&E	3	4	12
			Average Risk Score	**12.60**
Description of existing Workplace Precautions & Risk Control Systems				
	None			0
			Residual Risk Score	**12.60**
Likely return period from EA data				
Score				
5	**< 1 in 75**			
4	**1 in 75**			
3	**1 in 200**			3
2	**1 in 1000**			
1	**> 1 in 1000**			
Overall Risk Scoring for Site				**12.60**

Appendix 5 - Blithfield Documents

Documents relating to the design of the auxiliary spillway and inspection of the reservoir

Author	Title	Date
Halcrow	Blithfield Reservoir Physical Model Study Brief for Model Testing Programme	July 1994
Halcrow	Spillway Outlet Study and Flood Routing	April 1995
Halcrow	Proposal for Study and Detailed Design of Works to Increase Spillway Capacity at Blithfield Reservoir	January 1996
University of Southampton, Department of Civil and Environmental Engineering	Blithfield Reservoir Report on the Hydraulic Model Investigation for Spillway Channel	Revised September 1996
Mott MacDonald	Blithfield Reservoir Flood Study Report	December 1996
Halcrow	Blithfield Reservoir Report on the Results of a Periodic Inspection under Section 10(5) of the Reservoir Act 1975 on 13 November 2003	April 2004

Appendix 6 – Met Office Baseline Data

Baseline data 1961 - 1990 for West Midlands - Source Met Office

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
	30	31	30	31	31	30	31	30	31	31	28	31
Mean Daily Maximum Temperature °C	11.67	15.37	18.49	20.4	19.99	17.37	13.63	9.06	6.89	6.04	6.18	8.85
Mean Daily Precipitation mm	1.74	1.9	1.9	1.66	2.08	2.08	1.97	2.21	2.38	2.18	1.82	1.86