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By email

Date 26.01.2016

Environmental Information Regulations –Request For Information

Reference: EIR 08012016

Dear [redacted]

Thank you for your email in which you request:

> Copies of Ofwat's climate change adaptation report, technical paper and supporting process document.

Your request has now been considered and the information requested is enclosed.

If you have any queries or concerns with regard to the content of this email please do contact me, quoting the reference number.

If you are unhappy with the service you have received in relation to your request and wish to make a complaint or request a review of the decision, please contact:

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Centre City Tower
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or

The Information Commissioner's Office
Wycliffe House
Water Lane
Wilmslow

Yours sincerely,

Christine Manise
Senior Associate, Freedom of Information
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Water today, water tomorrow

Ofwat's climate change adaptation report

www.ofwat.gov.uk

OFWAT

About this document

On 3 March 2010, we were directed by the authority of the Secretary of State to provide a report on climate change adaptation. This document, and the technical report which accompanies it, is our response. We set out the key risks of climate change to our functions and explain what we are doing to deal with those risks.

Adaptation means making changes that help us cope with the effects of climate change. It can be used to describe institutional as well as physical adjustments. It is different from mitigation, which means action to reduce greenhouse gas emissions.

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1. Introduction

We are the economic regulator of the water and sewerage sectors in England and Wales. Our duties are laid out in statute, primarily in the Water Industry Act 1991 (as amended). The companies we regulate are responsible for delivering water and sewerage services to consumers.

Climate change presents serious challenges to the water and sewerage sectors. These range from changes to the balance of supply and demand from warmer, drier summers, to more frequent overwhelming of drainage systems because of heavy rainfall.

Our role is not to deliver adaptation on the ground. The companies we regulate must understand the risks of climate change themselves and plan to deal with those risks to service in a sustainable way. As an economic regulator we can:

- enable adaptive action – by setting the right regulatory incentives to bring about effective, efficient and equitable adaptation;
- build adaptive capacity – by improving our own understanding and the evidence base available to the companies; and
- monitor and evaluate – by measuring outcomes in the sectors and the companies' performance to inform our regulatory actions.

Our most important role is to provide the right regulatory incentives to enable the companies to adapt to climate change, and take action if they fail to meet their obligations.

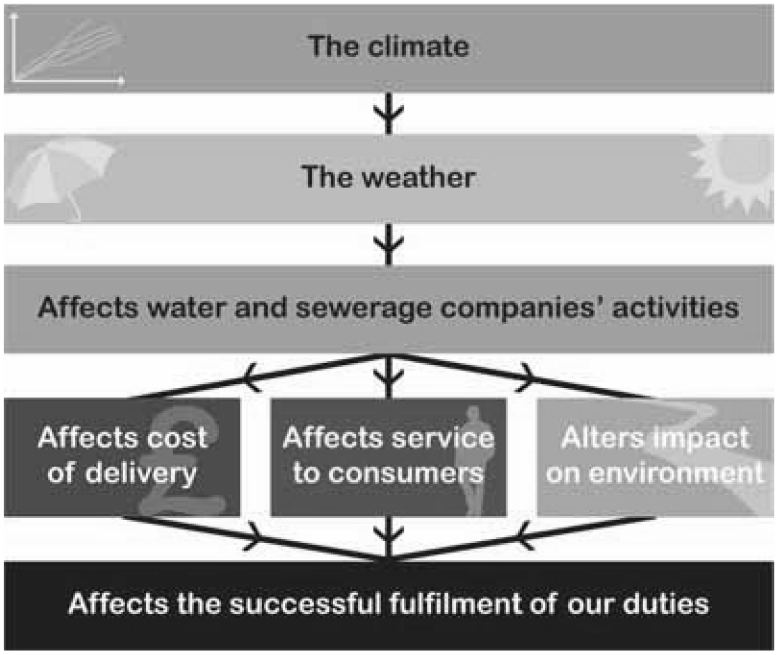
This document explains how we do this and how our work to reform the way that we regulate will further enable climate change adaptation. More information and detail can be found in the technical report which accompanies this report.

Our strategic aim is sustainable water – or 'water today, water tomorrow'. In order to achieve this, we have to consider the long-term risks to service. Our strategy includes climate change as one of the key challenges that we must address.

We set out the risks to the sectors from climate change in our climate change policy statement, which we published in July 2008. This adaptation report, which follows Defra's guidance, is based on a robust re-evaluation of the risks, and how our regulatory system encourages effective adaptation and reflects the greater understanding that we now have. While our regulatory process incentivises adaptation, there are also some barriers that need addressing to enable adaptation that is effective, efficient and equitable. Change will be required by companies, regulators and wider stakeholders. In this document, we explain the part we will play.

2. What are the risks to us?

Because it is the companies we regulate that are primarily responsible for responding to climate change risks, our relationship with climate change is inherently indirect. The diagram below illustrates the relationship between climate and our functions.



We recognise the need to understand the biggest risks that climate change poses to the sectors, in order to inform our regulatory approach. So, to improve our understanding we carried out an assessment of climate change risks in the sectors and used this to determine which might affect the successful operation of our functions.

Climate change can adversely affect our functions in three ways.

1. Directly (by hampering our day-to-day functions). Our assessment has concluded that these risks are very minor.

2. Indirectly, by affecting the views and decisions of stakeholders in a way that influences our work. These risks relate to our internal resources and capacity. They are managed as part of our corporate processes.

3. Indirectly, by affecting the ability of the sectors we regulate to deliver sustainable water and sewerage services over the long term.

This last category is by far the most significant and this document focuses of these risks. We can only fulfil our functions successfully if the companies we regulate are able to adapt to climate change.

In recognition of the long-term nature of the sectors, we focused our assessment on risks up to the 2050s. We utilised the UKCP09 scenarios, which represents the best available science and is consistent with the approach that others have taken in their own assessments. We prioritised all the climate change risks we identified in this period as high, medium and low based on the probability of the risk materialising and the magnitude of the impact in terms of cost or service. These are shown below.

High-priority risks	Medium-priority risks	Low-priority risks
Reduction in surface water resource yields in summers	Increased demand for potable water	Increased odour problems
Reduction in groundwater resource yields in summers	Increased risk of coastal flooding of company assets	Changes in water available for hydro power generation
Increases in multi-year droughts	More soil moisture deficit (SMD) driven leaks and bursts	Increases in fires
Increases in single-year droughts	Increased raw water demand	Increased pollution in raw water
Increased risk of company assets flooding	Increased sewer blockages because of low flows	Increased algal blooms
Reduced river flows require increased discharge constraints	Increases in waterborne diseases	
Increases in combined sewer overflow (CSO) discharges	Increased risk of power outages	
Increased sewer flooding	Accelerated asset deterioration	

We also identified some opportunities. These include:

- fewer frost driven bursts and leaks;
- increased potential for storage of surface water in winters; and
- increases in sewage treatment efficiency.

In the short term, we do not expect the low-priority climate change risks to drive any significant changes in service, investment or operational expenditure. Medium- and high-priority risks are those that may cause a significant cost or service impact on customers in some areas, particularly if they are combined. So, we have focused on these.

The most important risks relate to:

- water supply and demand;
- asset resilience;
- discharge of wastewater to the environment; and
- the coping capacity of sewer systems.

The significance of these risks over the next few decades cannot be underestimated. There are likely to be financial costs associated with climate change if negative impacts on customers and the environment are to be avoided. The actual timing and impact of these costs on customers' bills will depend on:

- the efficiency of the companies;
- the magnitude of climate change; and
- other future circumstances.

3. How do we enable adaptation?

In line with Defra's statutory guidance on adaptation, we carried out a detailed assessment of the underlying regulatory framework to understand how it enables adaptation. This work built on the risk assessment we carried out and explored barriers and interdependencies. It also explored the role we play as an economic regulator.

Our regulatory system enables adaptation in a number of ways. We have set out examples below.

- The system of price reviews provides a set of incentives for the companies to plan effectively and efficiently to deal with risks to service (including climate change) over the long term. This has worked well since privatisation to improve service and address emerging risks in the sectors.

- The cyclical nature of price reviews allows for regular reappraisals of performance and activity, which can take account of improved information and emerging risks such as climate change.

- Mechanisms such as the change protocol ensure that we have flexibility to react to significant changes that occur between price reviews (for example, updates to climate change projections).

- We monitor the service companies provide and we have enforcement powers to secure compliance if they fail to meet their obligations. This provides continual incentives for the companies to adapt to cope with risks to service, such as those from climate change.

- Key performance measures we use allow us to monitor adaptation progress. For example, serviceability indicators tell us how the networks are coping with climate change and other threats. Service indicators and measures of customers' satisfaction will show how successful the companies are in adapting to climate change.

And we have taken a number of steps over recent years that better enable adaptation. For example, in 2009 we introduced the revenue correction mechanism to remove a disincentive for the companies to reduce overall demand.

We identified a range of interdependencies that will influence adaptation in the sectors. Other regulators cover drinking water and environmental quality regulation and legal requirements, such as the water resource management planning process. So, we rely on the UK and Welsh Governments, the Environment Agency and the Drinking Water Inspectorate (DWI) in particular to continue to manage their policies and regulation in a way that enables adaptation.

4. What needs to change?

We have identified a number of potential barriers and constraints that might mean adaptation is not as efficient or effective as it could be.

- Uncertainty. We face significant and unavoidable uncertainty about climate change impacts in the UK. This could result in wasted resources, ineffective solutions or paralysis. It can also make it difficult to produce robust, long-term business cases for adaptation.

- Justification. It is difficult to define and measure adaptation outcomes and arrive at economic justifications for adaptation actions because it is difficult to quantify and value benefits that will occur far in the future. This is a problem for the companies when preparing their business plans and a problem for us when we consider policy options, our incentive framework and the companies' investment proposals.

- Cost. Adapting to climate change will mean additional investment in some areas. As customers will pay for this investment we have to make sure that it delivers legitimate benefits to those customers. Adaptation must be efficient in order to ensure it is socially and economically sustainable. The overall affordability of water and sewerage bills is likely to influence the pace of adaptation.

- Competing objectives. Our risk assessment indicates that climate change is likely to exacerbate conflicts of interest between society, the economy and the environment. In these cases, careful balancing of social, environmental and economic interests and trade-offs will be required.

- Changing circumstances. Other future changes that are unrelated or only partially related to climate change (such as demographic shifts) will also have an impact on adaptation in the sectors, add further uncertainty and can exacerbate the risks.

These barriers can only be fully addressed by actions across stakeholders. We can help to address some of them with the changes we are making to the way we regulate.

5. What are we doing to meet future challenges?

We have three main areas of response to the challenges and barriers associated with climate change adaptation.

1. Our future regulation programme will define the part we can play in helping the sectors tackle the challenges they face.

2. Further actions, which focus specifically on adaptation.

3. Highlighting interdependencies where others need to act.

5.1 Future regulation programme

We are reforming our regulatory framework to build on the successes of the existing system while addressing the challenges of the future. This work is known as the future regulation programme.

The programme should help enable better adaptation. For example, the aim of our future price limits project is to establish a price limit framework that encourages:

- more innovation, including to tackle challenges posed by climate change;
- greater efficiency in delivering solutions such as more resilient infrastructure;
- the right investment at the right time and place to ensure the most appropriate and cost-effective response; and
- better use of water resources.

The framework needs to be flexible enough to enable the companies to finance the investment they need to deliver sustainable services; this means being able to cope with the challenges of the future, including climate change.

Similarly, our regulatory compliance project aims to establish a risk-based approach to monitoring and securing compliance that reduces the overall regulatory burden and focuses regulatory effort on areas of high risk. We will regulate differently in a risk-based approach, depending on:

- the materiality of the risks; and
- how successfully companies are at managing them.

This fits well in the context of climate change.

Other projects in the programme help address particular barriers and interdependencies we have identified. For example, our future water charging project helps address issues of affordability and bad debt. It also considers what we can do to reduce waste of water, and so has significant potential to help to address the risks from climate change to the balance of supply and demand. Another key project seeks to enable more sustainable solutions to drainage, which is an area where there are a range of interdependencies and significant uncertainty.

Market reform has potential to deliver further adaptation benefits. For example, introducing more competition into the retail markets should increase the incentives on retailers to work with their customers so that they need to buy less water from wholesalers. Similarly, stimulating more abstraction and water trading should incentivise more efficient use of water resources by helping to reveal the value of water.

5.2 Further actions

Our future regulation programme will help enable adaptation and is an important part of our response to the risks from climate change. We have also identified a range of more specific actions. Over the next two years we will:

- improve our internal knowledge and understanding of climate change adaptation;
- assess the companies' progress based on their adaptation reports and focussing on the biggest areas of risk and uncertainty;
- update guidance for improving service resilience to natural hazards;
- review serviceability measures and look at how the capital maintenance planning common framework works for climate change risks;
- revise our climate change policy statement to reflect our improved understanding; and
- set out our expectations for adaptation investment at future price reviews.

We will monitor progress on adaptation in the sectors using existing performance measures (in line with the risk-based approach being developed as part of our regulatory compliance project). We will reappraise our risk assessment and action plan periodically to reflect changing knowledge and circumstances.

5.3 Interdependencies

There are a number of areas where other stakeholders need to act so that adaptation is effective, efficient and equitable.

- We need more sustainable solutions to urban drainage in order to cope with climate change. We are helping to do this in our sustainable drainage project.

- We will continue to need an up-to-date, independent and credible underpinning evidence base that is accessible to stakeholders.

- The future impact of climate change on the environment needs to be understood. This is particularly relevant for abstraction and water quality.

- Suppliers and infrastructure operators across all sectors need to play their part in adapting to climate change so that critical services such as water supply can be maintained.

Many of these issues are led by other parties who are also our stakeholders. Others are led by us but require collaboration or support from stakeholders. So we are engaging with our stakeholders to make sure our work and theirs is optimised to deliver the best outcomes.

5.4 Summary of actions

The table below illustrates the main regulatory mechanisms and future work that help enable the companies to manage the high- and medium-priority climate change risks we have identified. Some actions, such as the price review framework and improving understanding in the sectors, will influence responses to all of the risks.

Risk	Existing measures managed by us	Future work	Measures managed by others
Reduction in surface water resource yields in summers Reduction in groundwater resource yields in summers Increased demand for potable water Increased potential for storage of surface water in winter	Security of supply index Notified item for water resources and climate change Revenue correction mechanism Water efficiency targets Sustainable economic level of leakage Metering policy	Establish our approach for the next price review Valuing water Future water charging Wholesale market development	Water resource management plans (Environment Agency) Abstraction licensing framework (Environment Agency)
Increases in single-year droughts Increases in multi-year droughts	Security of supply index Notified item for water resources and climate change	Future water charging Valuing water Service resilience guidance	Water resource management plans Drought plans (Environment Agency)
Increased raw water demand	Supply/demand balance measures	Valuing water	Abstraction licensing framework (Environment Agency
Increased risk of company assets flooding Increased risk of coastal flooding of company assets	Provision for resilience	Service resilience guidance	Resilience of critical national infrastructure (Cabinet Office)
Increased sewer flooding Increased sewer blockages because of low flows	Serviceability Service incentive mechanism Measurements by service outcomes (sewer flooding)	Establish our approach for the next price review Sustainable drainage project	Provisions of the Flood and Water Management Act 2010 (Defra/local authorities)
Increases in combined sewer overflows (CSO) discharges Reduced river flows require increased discharge constraints	Wastewater quality programme (in price reviews)	Sustainable drainage project	Quality regulation (Environment Agency) Quality directives (EU)

More soil moisture deficit (SMD) driven leaks and bursts Fewer frost driven busts and leaks	Serviceability Sustainable economic level of leakage	Look at how the capital maintenance common framework operates with climate change risks	Building regulations
Accelerated asset deterioration Increased sewerage treatment efficiency	Serviceability	Look at how the capital maintenance common framework operates with climate change risks	Quality regulation (Environment Agency and Drinking Water Inspectorate)
Increased risk of power outages	Provision for resilience	Service resilience guidance	Resilience of critical national infrastructure (Cabinet Office) Energy sector resilience measures Security and Emergency Measures Directive
Increases in waterborne diseases	Water quality programme (in price reviews)		Drinking Water Inspectorate Health and safety standards (Health and Safety Executive)

6. Conclusions

To achieve our aim of sustainable water, we must consider all the future challenges facing the sectors. This means that we must take into account in the way we regulate the significant risks that climate changes poses.

We want to have a set of incentives in place that enable effective, efficient and equitable adaptation. Our existing regulatory framework already enables and incentivises the companies to adapt. But we are also making changes to the way that we regulate to ensure that the right level of adaptation takes place in an efficient way. Our future regulation programme will:

- improve incentives;
- develop understanding; and
- address barriers.

We will also carry out further actions that help to build our internal capacity to adapt and better enable adaptation within the sectors.

The companies we regulate must understand the risks from climate change on their services and take action where appropriate. Other regulators and wider stakeholders also have important parts to play in adapting to climate change.

We will use this report, and the adaptation reports others have produced, as a basis for discussion with stakeholders. By doing this, we hope to identify further areas in which we can improve our approach to adaptation.

We welcome views on our report and the actions we have outlined. We will continue to work with all our stakeholders as we address the risks from climate change in the sectors and work towards sustainable water.

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Water today, water tomorrow

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www.ofwat.gov.uk

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About this document

This document provides more detail about our processes required in order to fulfil the requirements of the direction.

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1. Our approach to adaptation

1.1 Corporate structure

We explain our overall corporate structure – including where responsibility for climate change policy lies – on our website. We have dedicated climate change policy staff, whose remit includes climate change adaptation issues.

Our strategy and forward programme contain more information on our corporate processes. Every year, we report on the work we have done in our annual report.

1.2 Relationships with stakeholders

We do not act in isolation. The response of our stakeholders to climate change adaptation has an impact on us. The means that engagement and collaboration with our stakeholders is central to an effective response to climate change adaptation. Figure 1 (see page 4) provides a simple illustration of the key relationships across stakeholders in the water and sewerage sectors in England and Wales.

It is the companies we regulate that deliver water and sewerage services to consumers. Physical adaptation to climate change will only occur if the regulated companies identify their own risks proactively and accurately, and take appropriate adaptation actions.

Our job is to:

- set an effective and efficient regulatory framework;
- promote competition where appropriate; and
- hold the companies to account if they fail to meet their obligations.

If the companies' objectives are not fit for purpose, if they fail to assess risks correctly and fail to consider adaptation as an embedded part of their business or they cannot make adequate business cases, it affects our success.

The decisions of the UK Government – Defra in particular – are very important for us. The Government will continue to set the policy context and boundaries under which we regulate to deal with future climate change risks. We think our legal functions are generally fit for purpose under a changing climate. But the nature and implementation of existing and future legislation will have a large influence on how well the sectors adapt. For example, the way the provisions of the Flood and Water Management Act 2010 are implemented will influence how well the sewerage system will cope with climate change.

The companies we regulate also operate under the regulation of other organisations, primarily the Drinking Water inspectorate (DWI) and the Environment Agency. The decisions of these regulators can influence strongly successful adaptation in the sectors. Examples of these issues include:

- changes in policy on coastal and flood defences;
- implementation of European directives;
- the ownership and maintenance of sustainable urban drainage systems; and
- the abstraction licence system.

We consult with all our stakeholders on major regulatory issues. For example, before starting this risk assessment, we organised a three-day seminar with the Met Office that focused on collaborative adaptation in the sectors. Representatives from almost every water and sewerage company, Defra, the UK Climate impacts programme (UKCIP), the DWI, the Met Office and the Environment Agency attended the event. The discussions and presentations were a key starting point for this report. We were also part of Defra's working group, which considered how the Reporting Powers were to be applied.

Figure 1 Stakeholders in the water and sewerage sectors

We carry out various degrees of consultation with stakeholders for different decisions and proposals. In most cases, we consult stakeholders informally. For example, we have recently published a number of discussion papers, with the aim of getting feedback on how we might set future price limits. In general, we will base formal consultations around a proposal – such as our proposed framework for the next price review. When we formally consult, we do so in line with our code of practice on consultations. We will also consider our policy on impact assessments. The actions we describe in our report will be subject to different degrees of consultation as they progress.

While a formal consultation on this report was not appropriate, we engaged a range of organisations on our intended approach. For example, we have discussed, and provided comments on, the adaptation report assessment framework with Cranfield University's risk assessment team, and discussed parts of our approach at the National Climate change Risk Assessment workshops held in 2010. We have also discussed our approach in meetings with Defra's Adapting to Climate Change team and the Adaptation Sub-Committee of the Committee on Climate Change.

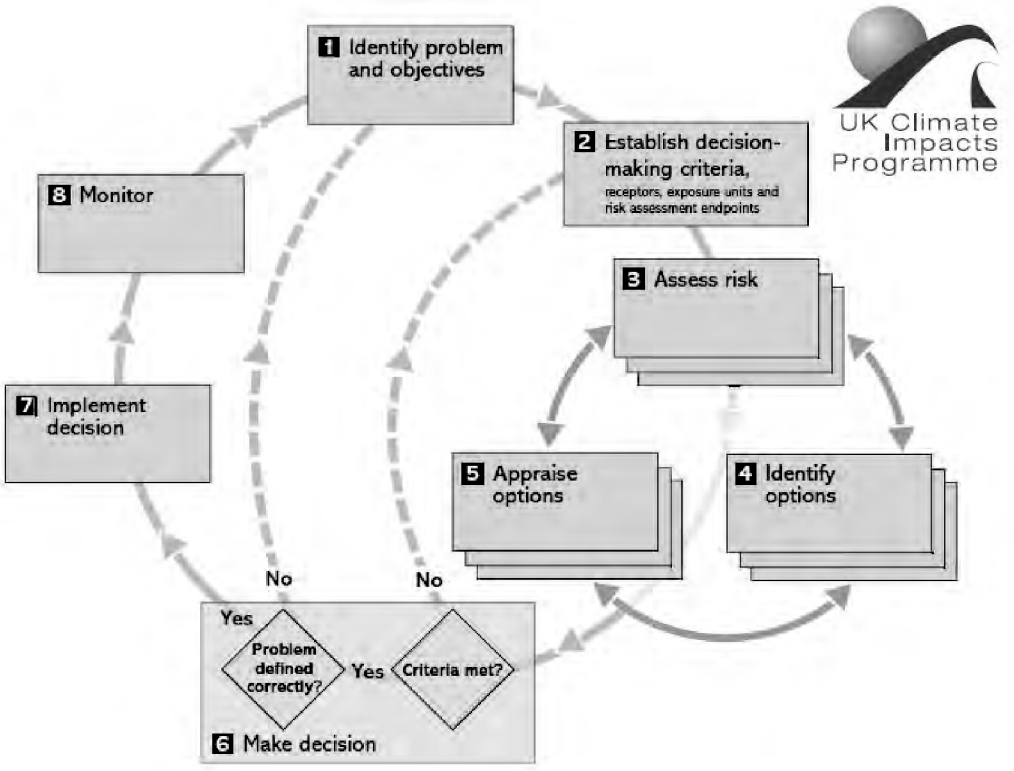
We engaged with the water companies on our approach to this report, for example at meetings of the Water UK Adaptation Network. We have also made an open offer to the companies to discuss their adaptation reports – which some of them took up.

1.3 Our overall approach to climate change risks

The approach we have used to assessing risks and determining actions is based on 'Climate adaptation: risk, uncertainty and decision-making process'[1], developed by UKCIP (UK Climate Impact Programme) and advocated in the statutory guidance. This approach was designed specifically to support good decision-making in the face of climate change risks. The approach is illustrated in figure 2 below.

[1] 'Climate adaptation: risk, uncertainty and decision-making', UKCIP technical report, May 2003. Available from http://www.ukcip.org.uk.

Figure 2 Framework to support decision making in the face of climate change risks



A key feature of this process is that it is designed to be flexible. For example, it is possible to revisit previous steps as new information becomes available. We have retained this flexibility in applying this process. We also plan to reassess our conclusions and actions over time as information improves.

A second reason why we employed this approach is that it can be applied for climate-influenced actions; as well as purely climate-driven actions. Most of our decisions are likely to be climate-influenced, rather than climate-driven. We make decisions in circumstances of significant uncertainty on many things, not just the future climate.

Our overall approach to climate change risks needs to be sustainable and flexible. We explain what we mean by this below.

1.4 Sustainable adaptation

Without sustainable adaptation to climate change, it would be impossible to achieve our strategic vision. It is clear that adapting to climate change is a long-term process, and many of the actions needed to deal with the risks will have significant, wide-ranging, and long-term consequences.

In order to help achieve sustainable adaptation in the sectors, we have had regard to our five principles of sustainability in determining our action plan. These five principles help us guide our decisions to help meet our strategic vision.

1. A safe and reliable water and sewerage service for consumers that minimises the impacts on the environment now and in the future.
2. Consumers continue to get a fair deal and receive a level of service that consistently meets their needs.
3. Financially robust sectors that are able to meet consumers' needs at a fair cost, into the future.
4. Companies that remain accountable to their consumers.
5. Using the best available information to support decision-making.

We set out these principles and discussed our approach to ensuring sustainability in more detail in 'Water today, water tomorrow – Ofwat and sustainability', which we published in March 2009.

We want adaptation actions that minimise their overall environmental impact – for example, any impacts on water quality or greenhouse gas emissions resulting from adaptation measures must be considered. Adapting in the context of reducing emissions is a particular problem, because nearly all construction and operational activity in the sectors will cause some emissions. We explained our overall approach to reducing emissions in the sectors in 'Playing our part – how can we cut greenhouse gas emissions in the water and sewerage sectors', which we published in July 2010. We made it clear that the sectors we regulate must play their part in mitigating climate change by reducing their emissions.

We expect the companies to take the impact of emissions into account across all their activities, including adaptation. We recognise that in some cases adaptation and mitigation are complementary actions – catchment management solutions, for example. We are developing our policy on mitigation further ahead of the next price review.

1.5 Flexible adaptation

Our approach to regulation must take into account the:

- long lifetimes associated with many assets in the sectors;
- long timescales over which climate change will occur; and
- inherent uncertainty about the future impacts of climate change.

Decisions on adaptation investments can leave the companies locked in to a particular approach for a long time. For this reason, our regulatory framework and future regulation programme aim to promote measures that are either robust to the range of potential future climates, or flexible enough so that we can respond as the climate changes.

2. Risk assessment process

Under our direction to report, we must show:

"the methodology used to assess the current and predicted impacts of climate change in relation to [our] functions"

In this chapter, we explain the methodology we used to do this, from identifying potential impacts on our functions to the assessment of the risks.

Our risk assessment decision-making criteria were based broadly on those given in UKCIP's 'Climate adaptation: risk, uncertainty and decision-making process,. We also built on our existing internal risk management processes.

It is important to note that our risk assessment has assessed the risks to us, as economic regulator for the sectors across England and Wales. This means that we have not made distinctions in our assessment between different areas of the country on the basis that if one or more regions are materially affected, then this will affect our functions. It is not our role to carry out individual assessments for each area. Different companies will bear different levels of climate change risk – it is for the individual companies to understand what those risks are.

We have assessed the probability and impact of each of the risks we identified for three different timescales. To do this, we relied on the information provided by UKCIP in the UKCP09 scenarios. So, a key assumption is that this is a reliable basis for a risk assessment.

In assessing risks, we usually focus on a 25-year time horizon. Because of the nature of climate change impacts, the timescales of this risk assessment go much further into the future than we typically consider. The timescales we have used for our risk assessment align with the decadal projections available from the UKCP09 projections.

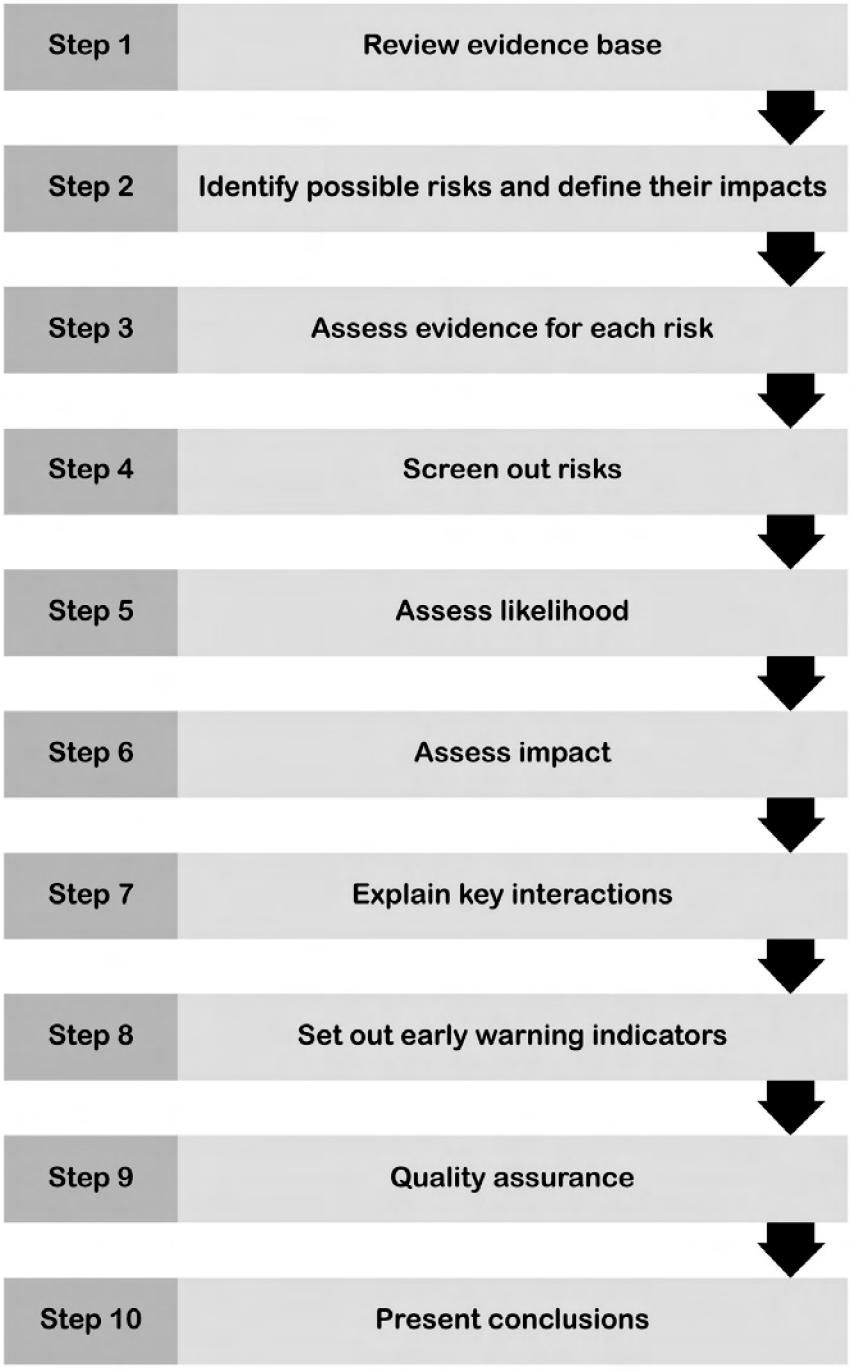
The periods we have considered represent three different 30-year climate averages, centred on the 2020s, 2050s and 2080s. This allowed us to base our assessment on the UKCP09 key findings. We also considered the fact that many of the key sources used in our assessment are based on these timescales.

The timescales we considered are 2010 to 2040, 2040 to 2070 and 2070 to 2100. It is necessary to focus on these long timescales as the operational lifespan of many assets in the sectors can be in the region of 100 years or more. It can take decades to complete some schemes. In some cases, it is difficult to quantify accurately effects without long periods of monitoring. Also, regulatory incentives and reforms can take time to have the desired effect. For these reasons, it is important to consider as far

ahead as possible. Not doing this could present a threat to service and increase costs unnecessarily.

We have set out a summary of the process we applied in the diagram below. We describe each step in turn in the sections that follow.

Figure 3 Risk assessment process



2.1 Step 1 – reviewing the evidence base

The statutory guidance states that our risk assessment should be "based on the current best evidence and projections". To ensure we did this, the first stage of the process involved researching available evidence on potential climate change impacts to produce a bibliography of useful sources that we could use throughout the risk assessment. This is the underpinning evidence for the risk assessment.

As an economic regulator, we conduct little primary research on climate change impacts ourselves. Instead, we rely on work that other organisations have carried out. It is important that we have a good understanding of the available evidence and its depth and quality in order to regulate effectively. Our review covered a range of sources, including:

- work on climate change impacts from other public sector bodies (such as Environment Agency science reports and Defra publications);
- relevant academic research papers;
- research and work that the companies commissioned;
- commercial research (primarily from the UKWIR research programme, such as the Water UK climate change planning tool[2]); and
- available adaptation frameworks and approaches (such as those produced by UKCIP).

The bibliography (see page 41) is a key resource used in the assessment and has been updated throughout the process. It includes a list of the key sources we used.

2.2 Step 2 – identifying possible risks and defining their impacts

To identify the possible climate change risks to achieving our objectives, we began by considering and listing out all the possible risks of climate change associated with the sectors that we and our stakeholders have identified. We based this, in the first instance, on the risks identified in our climate change policy statement and in an internal risk scoping exercise carried out in 2009.

[2] WaterUK, 2008; available at: http://www.water.org.uk/home/policy/publications/archive/industry-guidance/asset-management-planning

We then considered:

- possible threats and opportunities raised in meetings and presentations, including the workshop we ran with the Met Office in 2010;
- risks raised in the companies' strategic direction statements and business plans, and from the literature; and
- the list of risks identified by the National Climate Change Risk Assessment team and shared with us as part of their stakeholder engagement.

We then consulted internally with the aim of capturing all credible possible risks.

We assessed as a risk any plausible means by which the projected changes in climate could impact upon our ability to successfully fulfil our functions. For each possibility identified in this way, we first set out a brief explanation of what that risk would entail and then collated together the available information relevant to that risk.

We then defined more clearly the causal relationship between the relevant climate change variables, the water and sewerage services and Ofwat. Almost all of the identified risks do not affect Ofwat directly, but will impact upon the companies or other stakeholders, which has a resulting consequence for us.

2.2.1 Defining the causal relationships

To define the precise causal relationships between climate change and a risk to our functions, we began by identifying the basic climate variables that drive each identified risk. This includes temperature changes, sea level rises or changes in rainfall patterns. We then identified the specific relevant effect that the climate variables were expected to have in each case – such as reducing flow levels in rivers, or reducing the number of days of sub-zero temperatures.

The next step was to identify how this specific effect impacted on the companies' operations. For example, reduced river flow threatens a company's ability to abstract water from rivers while reduced frost days affect the pattern of pipe bursts and leaks.

The final step was to determine how the impact on the companies would cause a resultant impact on Ofwat and our functions. A consequence for Ofwat will occur where there is a material change in the companies' ability to provide existing levels of service or a change in the economic or environmental cost of providing those services. When we had established in what ways this impact might be felt, we tested this against our defined impact threshold, which we discuss later in the document.

2.2.2 Grouping

In some cases, we grouped a number of risks together where the nature of the consequence was similar. We did this to ensure that our assessment was proportionate to our needs. For example, for raw water quality issues, there are potentially separate risks associated with levels of phosphorus, nitrogen, toxins, soil content and dissolved oxygen. We have chosen to assess these together. Identifying the nature of different threats to water quality will be critically important for a company and will impact directly on its business plans. But the precise cause of the issue will have a smaller impact upon whether or not and how our functions are affected.

We maintained distinctions between risks where the consequences or magnitudes related to each risk are markedly different. As an example, the overall balance of supply and demand could be defined as a single risk. But we have chosen to separate risks to a limited degree according to how different sources of supply may be affected by climate change. We would expect the companies to carry out analysis on a more detailed and granular level than we have. This is appropriate because the specific details of how a risk impacts on a company's operations is less important to us than to a water and sewerage service provider.

2.2.3 Threats/opportunities

Most of the risks we identified are threats to the successful achievement of our functions. But we have also assessed risks where a climate variable may result in beneficial impacts. The type and nature of the opportunity was identified in each case and assessed in the same way.

2.3 Step 3 – assessing evidence for each risk

For many of the risks there was significant uncertainty regarding the level of probability and/or the extent of the impact. This was often because of the limited evidence available on the risk, which prevents us from having high confidence in the resulting assessment. In other cases, although the evidence was stronger, there was significant uncertainty about how readily the companies can deal with the risk, and how this would translate to an impact upon us as a result. Considering the nature of the uncertainties associated with a risk is useful in the process of identifying and evaluating adaptation options.

For each of the risks we assigned a pedigree score based on the nature of the evidence available to assess that risk. Our scoring system is a simplified version of the system employed in the National Climate Change Risk Assessment. The score reflects the amount and quality of supporting evidence. It also takes into account the degree of agreement in the sources. We have set out the pedigree scoring system we used in the table below.

Table 1 Scoring system for risk pedigree

Score	Description
4	Strong evidence base comprising multiple peer-reviewed sources and strong agreement on the nature of the risk.
3	Multiple reliable sources. Evidence of peer review. General agreement on the nature of the risk.
2	Based on expert testimony, but there is a lack of academic rigour or peer review; or there are multiple reliable sources, but significant disagreements or uncertainties in the evidence base.
1	Non-expert opinions or suggestions.

We recognise that for many risks there may be significant additional research that we have not had the resources to cover or which is unavailable to us. It is partly for this reason that no risks were given a pedigree score of 4. We expect the companies to explore the impacts upon their own systems in detail, and to consider the best available evidence. We will consider new information in future where it is proportionate to do so.

The pedigree score gives us a sense of the levels of uncertainty inherent in each of our assessments. This has informed the actions that we take in response to each of the risks. For example, where risks have very low pedigree scores the most appropriate actions are likely to be about improving understanding, including by recommending and supporting areas for research. We have set out the pedigree scores we have assigned to each risk in the table below.

Table 2 Pedigree scores for each risk

Risk	Pedigree
A1 Reduction in surface water resource yields in summers	3
B1 Increases in single year droughts	3
B3 Increased risk of company assets flooding	3
E2 Increased sewer flooding	3
A2 Reduction in groundwater resource yields in summers	2
A3 Increase in demand for potable water	2
B2 Increases in multi-year droughts	2
C1 More soil moisture deficit (SMD) driven leaks and bursts	2
C2 Fewer frost-driven bursts and leaks	2
C4 Increased risks of coastal flooding of company assets	2
C5 Reduced river flows require increased discharge constraints	2
D1 Increased pollution in raw water sources	2
E1 Increases in combined sewer overflow (CSO) discharges	2
F1 Increased risk of power outages	2
F2 Increased raw water demand	2
D3 Increased algal blooms	2
C6 Accelerated asset deterioration	1
C3 Increase in sewage treatment efficiency	1
D2 Increases in diseases	1
E3 Increased sewer blockages due to low flows	1
C9 Increased risk of fires	1
C8 Changes in water available for hydropower generation	1
C7 Increased odour problems	1
A4 Increased potential for surface water storage in winters	1

Significant uncertainty remains for all the climate change risks we identified, not all of which can be attributed to the inherent uncertainties associated with the climate projections. All stakeholders across the sectors need to continue to develop their understanding.

To understand fully the climate change risks to service and cost requires a detailed understanding of the relationship between weather and the system of assets and processes involved in delivering the service. More than this, those relationships need to be explored with the projections for climate change in the specific geographic regions concerned. We cannot replicate this understanding and we have not tried to. The companies must develop this understanding themselves.

2.4 Step 4 – risk screening

We removed a number of possible risks from the final assessment. The reasons for this included:

- if there is no reliable basis on which to assess the risk;
- if the risk might be affected by climate change but will be primarily driven by other factors; and
- if the risk assessment showed the risk was below our impact threshold.

2.4.1 Impact threshold

An impact threshold is the level of impact above which a materialising risk will have a noticeable effect on an organisation. This level will differ from organisation to organisation depending on its objectives. For us, the threshold above which our functions are noticeably affected is where one or more of the companies we regulate are affected by climate change in a way that has a material effect on service or cost.

Where a risk, if it materialised, could affect service or cost to the extent to which we have to make or alter regulatory decisions and establish or reappraise regulatory approaches; that risk surpasses our impact threshold. We take cost to mean primarily financial cost to existing and future customers; but also the cost to the environment, for example in greenhouse gas emissions. We take service to mean not only the reliable supply of clean water and the removal of wastewater, but also the services to society and the environment that the companies are legally required to provide. For example, sewerage companies must treat effluent adequately before it is discharged to the environment.

2.4.2 Risks which were excluded

We excluded the following risks from our assessment.

- Potential for low flows into wastewater treatment facilities disrupting their operation. We removed this risk because of the lack of any supporting evidence.
- Climate change driven demographic change – for example, where climate change directly encourages migration to the UK, increasing pressure on resources. This risk is too unpredictable and reliant on external factors to bear sensible assessment alongside other climate change risks.
- Changing agricultural patterns driven by climate change with impacts on raw water quality – for example, because of changing pesticide use. This is similar to many other risks in that it is highly reliant on external factors (such as commodity prices or technological changes), but remains too unpredictable to be assessed sensibly.
- The impact of climate change on dam risk and reservoir operation – for example, through increased siltation. Currently, we have found no evidence that climate change presents a significant additional problem in this area, but there is evidence that extreme rainfall events can cause dam failure. This is mainly because of design shortcomings and is an existing asset management issue. Design standards and asset management in this area is based on a conservative approach to risk.
- Hotter, drier conditions may lead to increased demand for water by fire fighting services, especially during long-term droughts. It is very unlikely that this will have a material impact on total demand under the range of climate scenarios investigated. The impacts of this can be integrated into the assessment of aggregate demand change rather than as a separate risk.

For many of these risks, there is no appropriate way to assess the additional climate change risk to our functions. But as time goes on and we improve our knowledge, we will continue to consider these risks. We will assess the validity of any new evidence that arises. We will also consider any suggestions that arise using the same process applied in this risk assessment.

We have taken these possibilities into account in deciding our action plan. Our plan for re-evaluating risks is set out in the main report.

We also considered the risk to company financeability. We excluded this from the full risk assessment because it is determined inherently by relatively short-term changes to regulatory decisions and economic circumstances, rather than longer-term changes in any particular climate variables. But risks associated with financeability remain a very important consideration for us, and we discuss this issue in more detail in the main report.

After screening out these risks, we then assessed the likelihood and impact of each of the remaining risks.

2.5 Step 5 – likelihood

Climate change will only have an impact in the sectors if the climate variable that drives the risk changes to such an extent that our impact threshold is surpassed. As the UKCP09 projections give a probabilistic range of possible climate impacts, we have based our assessment of likelihood on an assessment of the range of scenarios for each time period where the impact threshold may be surpassed.

Our assessment of likelihood for each risk is based on the scenarios under which the relevant climate variables for that risk change to a material extent. The UKCP09 key findings we used present changes in climate variables in terms of a range for a given probability level, rather than a value. For example "a rise of between 0 and 1°C".

For each risk, we assessed the range of scenarios for that time period under which the relevant climate variables that are identified as having an effect on service or cost, change significantly. In most cases, this is the point at which some additional impacts on us in terms of necessary decisions should be seen. Many risks are driven by multiple climate variables. In these cases, we considered the scenarios under which all of these variables changed significantly and in the relevant direction.

Some changes, such as an increase in annual average temperature, are supported by almost all of the climate projections, with different projections differing only in the degree of the increase. Others have a much wider range of potential changes. For example, under the medium emissions scenario, some of the climate models predict small increases in summer rainfall by the middle of the century, which most of them predict a decrease.

We have used the ranges of UKCP09 probabilities as the basis of our scoring of the risk likelihoods. We considered each of the three emissions scenarios for the 10%, 33%, 50%, 66% and 90% probability levels for each relevant variable for the 2020s, 2050s and 2080s.

We used the categorisations presented in the table below to score the likelihood of each risk.

Table 3 Scoring system for risk likelihood

Score	Description
4	Impacts predicted even below the 10% probability level (very unlikely to be less than).
3	Impacts predicted at or above the 33%-66% probability level.
2	Impacts predicted only at or above the 90 % probability (very unlikely to be more than) or only under high emissions scenarios.
1	Impacts predicted only under high++ scenarios

It is not appropriate for us as an economic regulator to carry out a more detailed and complex analysis of the climate scenarios. This is because our precise knowledge of the types of possible failures and existing thresholds present in the water and sewerage systems is inherently incomplete. The companies have the knowledge and understanding in these areas. So, we used broad categorisations of probability based on the UKCP09 key findings. There are a number of advantages to this approach.

- It gives us an appropriate level of understanding for our decision-making on the relative likelihood of different consequences.
- It allowed for a relatively efficient assessment process.
- It allows for straightforward replication of our assessment – aiding transparency.
- Broader conclusions reduce our margin for error.
- It minimises false expectations about the levels of certainty we have.

Because our impact threshold will be exceeded in cases where one or more companies are affected, it may be passed even when only parts of England and Wales are likely to see significant climate change impacts.

In some cases, the UKCP09 projections do not give sufficient information to judge the likelihood of an impact. As an example, droughts are caused by long periods with little or no rainfall. The UKCP09 projections themselves do not give direct information about how the frequency of these dry periods is expected to change. In these cases, we have used specific supplementary work on the effects of climate change rather than relying on the UKCP09 projections themselves. Often this supplementary work is not probabilistic in its conclusions. For these, we replaced the categorisations in table 3 with the broader categorisations outlined in the table below.

Table 4 Alternative scoring system for risk likelihood

Score	Description
4	Almost certain – all or almost all projections indicate impacts will occur in the period.
3	Likely – most projections indicate impacts will occur in the period.
2	Possible – some of the projections indicate impacts may occur in the period.
1	Only the most extreme projections indicate impacts will occur in the period.

2.5.1 Relationships between impact and likelihood

In some cases, our subsequent assessment of the magnitude of impact indicated that even though some impact is likely, those impacts would be marginal. For example, the fire risk at company assets is unlikely to be substantially greater even though summers are quite likely to be drier and hotter. Where this is the case, it is reflected in a low impact score rather than the probability score.

2.6 Step 6 – impact

To assess the magnitude of the impacts for each risk we considered both the magnitude of the possible financial impacts and the impacts on service. We also considered the possible extent of environmental impact.

For financial impacts, we have generally assumed that the impact on us and our duties (especially our role to protect the interests of consumers) will be roughly proportional to the magnitude of the financial impact on a company. But it is worth reiterating here that we have assumed that external circumstances other than climate remain broadly the same. Not doing so would go beyond the scope of our assessment. For example, we have assumed there will be no dramatic change in the economics of leakage control through radical technological innovation. In these circumstances, it is unlikely that adaptation measures that require additional activity in order to maintain the same levels of service will be possible without additional cost.

In judging the nature of the impact we considered:

- the financial size and historic scale of investment in each of the relevant activities;
- regional differences in the projections;
- the nature of the service affected by each risk;
- estimates from relevant sources and academic studies; and
- indicative costs of potential solutions where possible.

Collating and discussing this information allowed us to establish a general assessment of the impact for each risk. The scale of the impact was subject to sense-checking across the organisation.

We have set out the scoring system we used for magnitude of impacts in the table below.

Table 5 Scoring system for risk impact

Score	Description
4	Some companies may fail to be able to supply clean drinking water or dispose of sewage, or may significantly damage the natural environment, even with emergency measures. Catastrophic financial impacts – that is, significant affordability/financeability issues would arise to address the impacts (>20% total annual turnover in a five-year period).
3	Some companies cannot meet serviceability/environmental standards or must carry out significantly more reactive work than planned. Service may be substantially affected. Significant capital works or increases in operational or maintenance costs may be required (>10% total annual turnover in a five-year period).
2	Marginal deterioration in service or increased reactive cost relative to business-as-usual. Non-trivial capital works or increases in operational or maintenance costs (>2% total annual turnover in a five-year period).
1	Minor impacts that do not affect day-to-day business substantially. No significant alteration in budgets or planning because of climate change is necessary (<2% total annual turnover in a five year period).
0	Trivial impacts that Ofwat is unlikely to see any noticeable effect of in cost or service terms. Impacts typically can be accommodated by existing systems and assets or with investment or additional costs well below 1% of total annual turnover in a five-year period.

We have sought to align the measures of impact with those used in our existing organisational risk assessment process. We have also considered the thresholds used in the interim determination process[3] on triviality and materiality.

The 'type' of impacts actually incurred resulting from the risk (that is, whether they are service impacts, environmental damages or additional financial costs to customers) will be hugely dependent on actions of companies in the sector. Broadly, costs could be either:

- additional costs incurred directly because of climate change; or
- additional costs incurred in order to pre-emptively deal with an expected climate change impact.

In most cases, we have made a judgement based on current understanding and circumstances about whether the costs are likely to be in terms of:

- actual harm;
- reactive costs;
- pre-emptive protective measures; or
- a mixture of these.

We have usually scored according to whichever of the two (cost to mitigate or impact of not mitigating) has the highest associated risk magnitude and so represents the greatest potential effect. For risks that involve potential additional environmental damage, we have focused on the costs of maintaining current levels of environmental impacts.

In the long term, there will be an increasing difference between the impacts of a risk depending upon whether any action has taken place to mitigate it. The impact of risk mitigation costs spread over 50-70 years may not be too severe. But if no risk mitigation was carried out before then, the potential impacts in 2060-90 could be very large. We cannot predict the extent and effectiveness of the adaptation that will actually occur. So, for longer-term risks, we have assumed that there has been little or no mitigation of the risk in the preceding periods.

[3] Our latest guidance on this subject is set out in 'RD 13/10: Interim determinations 2010-15' (October 2010) available at: http://www.ofwat.gov.uk/publications/rdletters/ltr_rd1310idok

Because we have assumed no change in external circumstances and no significant advances through technological innovation, in some key respects our assessment of impact may over-estimate the risks. In reality, we expect the sectors to take efficient, incremental action to deal with climate change risks. But we think that this is an acceptable approach to assessing risk given the nature of our duties and the importance of the services we are dealing with. Our approach allows us to identify and prioritise the key risks.

It is important to reiterate that because of the nature of our assessment, the sum of these magnitudes will not represent the total potential impact to the sectors as a whole. Most of the risks have significant regional variations. Because of this, a risk that has a high impact in one region of the country may have less or no discernible impact elsewhere.

We multiplied the likelihood and impact scores together to calculate a gross risk. We have used this as a preliminary indication of priority – in determining adaptation responses we have considered the impact, pedigree and probability of each risk rather than the gross score alone.

2.7 Step 7 – external interactions

Climate change is not the only risk faced by the sectors. There are a number of other short- and long-term risks that will affect the sectors and our ability to fulfil our functions. A good example is demographic change. We and the companies are already aware of many of these risks and most are incorporated into planning.

In order to meet the requirements of the guidance, in assessing risk we have focused on the **additional** risks that climate change presents. In many areas, this has been difficult because the effect of climate change is to exacerbate weather-related risks that already exist (such as the risk of droughts and extreme precipitation events).

Other circumstances will also change in the future. These add even greater uncertainty to our assessment. As an example, we do not know the extent to which population growth will increase the demand for water in different areas. Population projections themselves are highly uncertain and we do not know how effective demand management actions will be. The structure of the sectors and expectations of service might also change.

In assessing the risks from each climate variable, we have assumed little or no change in these key interactions. For example, we have assumed that increased costs to deliver the service are ultimately passed on to customers in some way and that planning objectives are to maintain service at current levels. We recognise that future reforms and changes could affect the validity of this assessment.

For each risk, we have set out the key interactions that might affect it. Consideration of these key interactions features in our monitoring plan, which is set out in the main report. So, the assessments of climate change risk need to be set alongside comparable assessments of different risks that also impact on our decision-making. We recognise that in some areas, climate change is not the biggest risk to our functions.

2.8 Step 8 – early warning indicators

For each risk we also set out a number of early warning indicators that we can use to re-evaluate our risk assessment in the future. These indicators comprise both monitoring actions that we can carry out and the results of work that external groups have carried out. These early warning indicators form a part of our monitoring plan.

2.9 Step 9 – quality assurance

In order to ensure our assessment of risks was robust, we carried out each one separately, twice (although the second assessor had sight of the previous assessment). The assessors then discussed the differences between assessment scores, and further investigation was carried out if needed. We then consulted internally on the full assessments made for each risk.. In particular, we made sure that individuals from the most relevant policy area considered each risk. We discussed any issues and questions before reaching our conclusions. By the end of the assessment, the assessors and other teams had reached a full agreement.

We reinforced this at an internal seminar for Ofwat staff. Here, we presented our conclusions to the whole organisation. We also made the assessment freely available on our intranet. Executive team had sight of the risk assessment at an early stage. This process served two purposes. We used it as a method of improving the accuracy and robustness of the risk assessment, and to raise awareness of the climate change risks across the organisation. We subjected our processes to internal audit. Following submission of the companies' reports, we also sense checked the conclusions of our assessment with the companies' own adaptation reports.

2.10 Step 10 – conclusions

The final step was to present our conclusions and then prioritise the risks. We discuss our risk assessment in more detail in the following chapter.

We have plotted the climate change risks into three matrices, one for each time period, using the impact and probability scores assigned to each risk. The higher a score, the more serious its impact and the more likely it is to occur.

The completed risk matrices are given in figures 4, 5 and 6 below. We have colour-coded the risks by category. We have also highlighted areas of the grid in accordance with our prioritisation of the risks into high, medium and minor risks.

Figure 4 Climate change risks 2010-40

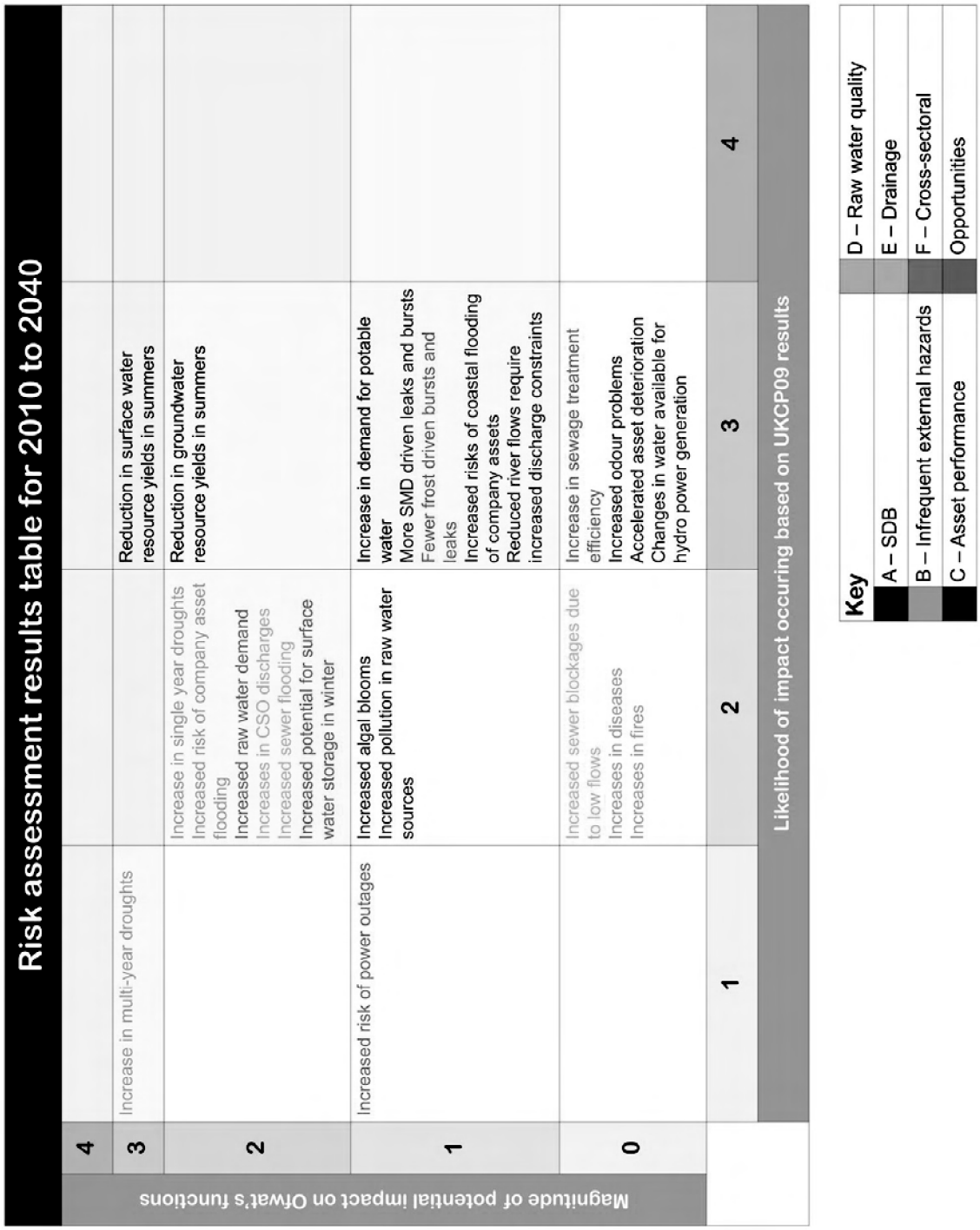


Figure 5 Climate change risks 2040-70

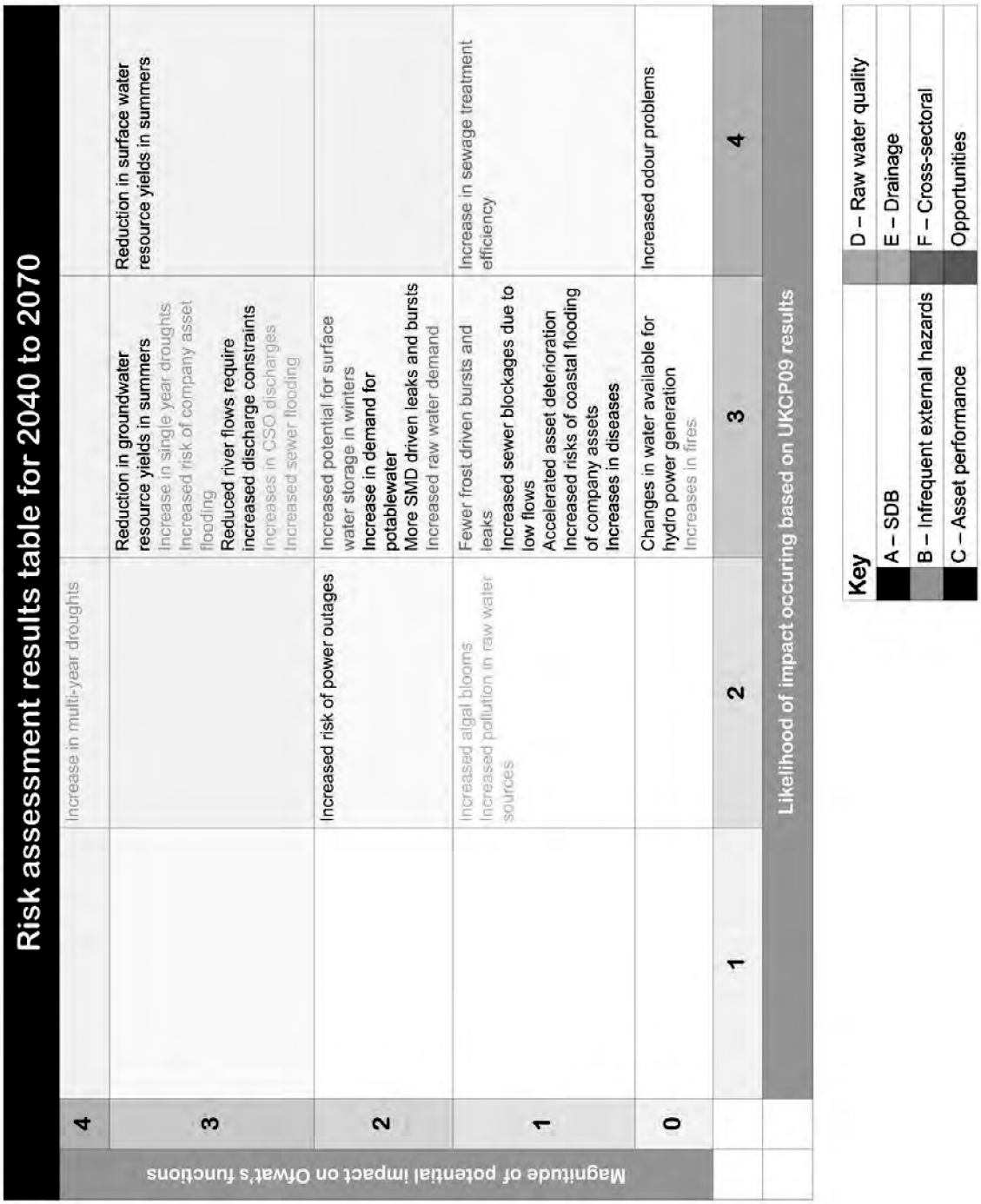
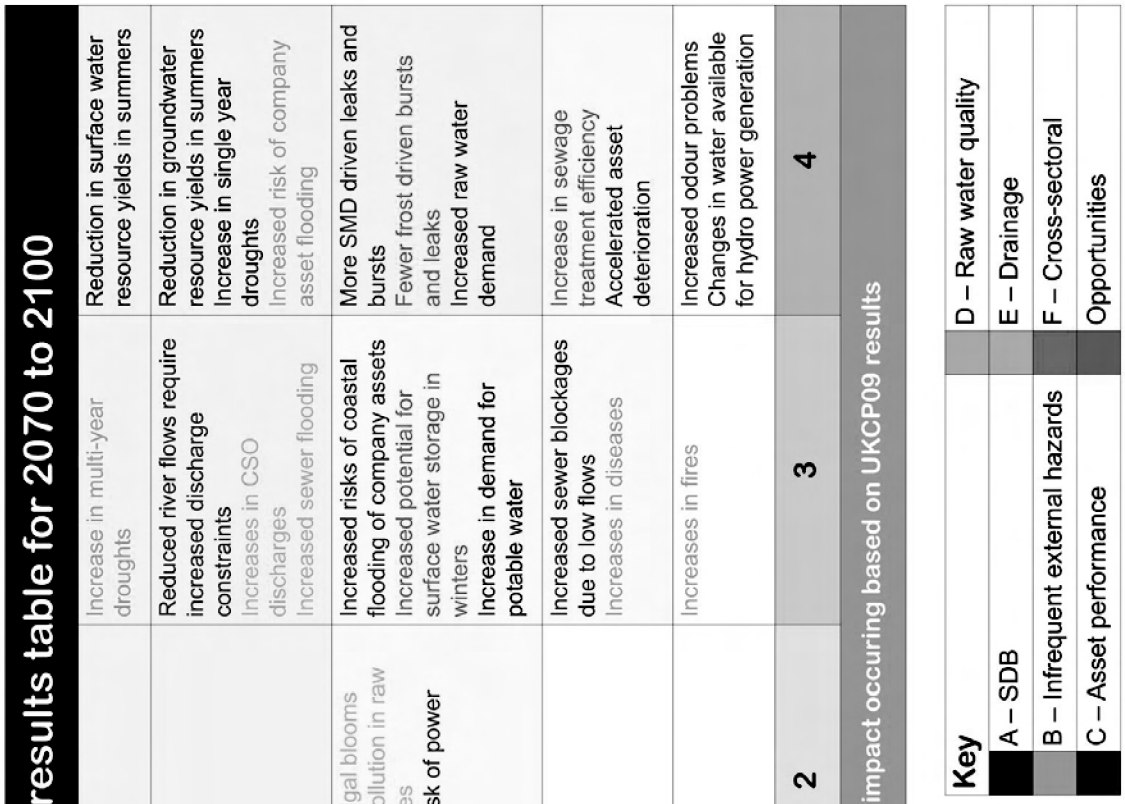


Figure 6 Climate change risks 2070-2100



2.11 Residual risks

The assessments presented above represent the gross, additional climate change risks to the successful achievement of our functions. As such, it does not present a picture of 'residual risk' remaining after existing and future regulatory actions are taken into account. In practical terms, we make a judgement on residual risk at each price review. At each review, we consider all the risks the companies face and arrive at price limits that reflect the level of residual risk we believe is appropriate over the price limit period.

At this point, we have judged the residual risks in a qualitative way as part of our process to establish our adaptation action plan. We did not calculate the residual risks on the same basis as the gross risks because we have no reliable assessment of how effective our future regulation and the companies' plans will be in mitigating each of those risks. This is mainly because of the long timescales and the fact that climate change is just one of the risks that the sectors face. We set out our current qualitative assessment of residual risks in our summary of actions in the main report. We will update our understanding as information improves and circumstances change.

2.12 Corporate risk assessment process

Organisational risks are those that are driven partly or in whole by the actions of other stakeholders, and that may affect our work within the next five years. Many of these risks arise from the response of other organisations to climate change impacts and their perceptions of risk. Neither the likelihood nor the magnitude of these risks can be assessed in the same way as the longer-term indirect climate change risks.

We have also assessed our organisational risks using our existing corporate risk assessment process. This process is designed to assess these types of risks and is applied to other, similar risks we face. Tables 6 and 7 below present the scoring system we used to assess organisational risks.

Table 6 Scoring system for organisational risk likelihood

Likelihood	
Likelihood	**Criteria**
High 4	Almost certain (the risk is likely to occur this year or at frequent intervals).
Medium 3	Likely (the risk is likely to occur more than once in the next three years).
Low 2	Possible (the risk may occur in the next three years).
Very low 1	Rare (the risk may occur in exceptional circumstances).

Table 7 Scoring system for organisational risk impact

Impact	
Magnitude	**Criteria**
High 4	Huge financial concern; death; key deadlines missed; very serious legal concerns (for example, high risk of successful legal challenge, with substantial implications for Ofwat); major environmental impact; loss of public confidence.
Medium 3	Major financial concern; significant public health effects; outputs cancelled or delayed; potentially serious legal implications (for example, risk of successful legal challenge); significant environmental impact; longer-term damage to reputation.
Low 2	Medium financial concern; minor or reversible health effects; reprioritising of outputs required; minor legal concerns raised; minor impact on the environment; short-term reputation damage.
Very low 1	Low financial concern; no public health effects; service delivery unaffected; no legal implications; unlikely to affect the environment; unlikely to damage reputation.

We completed an assessment of organisational risks based predominantly on internal consultation. In some cases, our assessment is quite robust, based on our understanding of stakeholders' attitudes and timescales. But in others our assessment is necessarily quite speculative. The risks we identified in this process have informed our corporate risk management and are included in our internal risk register.

3. Detailed assessment of each risk (zoom for detail; not printable)

									2010-40			2040-70			2070-2100					
High level risk area	Code	Climate variable	Specific effect of variable	Impacts on water companies	Possible consequences for Ofwat	Likely future threats/opportunities	Key information used in assessment	Pedigree	Likelihood of impact	Magnitude of consequence	Gross Risk	Likelihood of impact	Magnitude of consequence	Gross Risk	Likelihood of impact	Magnitude of consequence	Gross Risk	Early warning indicator(s)	Consequence entails regulatory policy decision?	Key interactions
MANAGING THE SUPPLY/DEMAND BALANCE	A1	Increased annual temperatures Changing precipitation patterns. Rise in potential evapotranspiration which follows from a temperature rise.	Impacts on surface water resources (rivers and reservoirs). Reduced yield, particularly in summer. Impacts on the environment drive action from companies and regulators. Focus on incremental effects here rather than the changing risk of drought frequencies (explored as a separate risk.)	Reduced WAFU threatens supply/demand balance. Decreased security of supply and erosion of existing headroom - making service more vulnerable. Increasing risks of necessary supply restrictions or even service failures. System solutions necessary - drive changing opex costs (e.g. for increased abstraction) and/or capital solutions (e.g. to develop new water resources). Increases risk of breaching existing environmental limits; also may prompt more stringent limits in future. 2/3 of supply from these sources, lesser proportion in the south-east, can identify the companies most vulnerable from this risk]	Companies progressively fail to meet security of supply targets and outputs. Customers see more restrictions and/or interruptions. Damage to the environment from over-abstraction. **Companies propose significant additional activity to increase headroom or reduce risk of SO deficit.** **Necessitates policy decisions - including on how best to incentivise companies to deal with the problem and how to balance the service risks and costs between company and customers. Many of these are existing challenges.** Political and public pressure (e.g. on the environmental damage of over abstraction or arising from supply restrictions). Note primary responsibility for managing national water resources sits with EA.	Predominantly threat. May provide more impetus for greater water efficiency (with multiple other benefits including for co-mitigation)	Many sources: 401, 304, 303, 105, 106, 402, 403, 206, 107, 110, 411, 309, 311, 323, 123, 316, 315, 130 FBP information, supplementary information from companies. Existing SOS information.	3	3 towards the end of this time-frame it is highly likely to have an impact such that some of the identified consequences are seen for one or more companies. It may be difficult to separate climate change driven impacts from other pressures and factors in supply and/or demand.	3	9	3 Judging from provisional projections made by several companies on the possible extent of work necessary and the numbersize of companies affected. Costs could manafest in various measures e.g. more leakage control, more resources, more metering. The costs to develop resources would be very high in some regions and leakage control costs diverge from linear.	12	4 All projections show some impact on rainfall and temperature in this period during summers.	3 Assuming existing capital and operating costs to maintain supply demand balance, slope with growth and manage leakage remain stable cost will be expected to increase, particularly where forecasts indicate demand exceeding supply without additional pre-emptive measures. There is also a possibility of costs increasing non-linearly where solution options are more constrained, for example if absolute environmental limits become more stringent.	12	4 Additional impact by this period if there is no incremental adaptation in preceding periods could be very high.	16	Company SOS issues arising and service levels tracked at least annually. Water resource management plans. Companies flag concerns in Business Plans and ad-hoc. Tracking of numbers of events such as drought orders. Monitoring of weather data, hydrological summaries and longer-term trends.	Likely.	Interacts with other SOS risks. Existing 'over-abstraction' and 'over-licensing' already presents a problem. Primarily interacts with drought risk - actions to manage aggregate SOS are with reference to dry year and security of supply targets. Population change (growth and movement) and demand fluctuation. Success and economics of solutions - particularly the economics of leakage reduction and demand management. EA's approach to water resources - e.g. licence changes, actions on WRMPs. Any EA abstraction consistency (e.g. sustainability reductions as part of the Restoring Sustainable Abstraction project). Changes in raw water quality or quality standards also affects supply availability and cost. Increased surface water abstraction will have some impact on river water quality also.
	A2	Increased annual temperatures Changing precipitation patterns. Rise in potential evapotranspiration which follows from a temperature rise. Sea level rise	Impacts on groundwater resources; shortened recharge periods and increased potential for saline intrusion reduces total yields. Focus on incremental effects here rather than drought frequencies (explored as separate risk.)	All the above risks. 1/3 of supply from these sources. (and a larger proportion in south east, most small WOCs in SE rely on groundwater predominantly)			322, 419, 402, 403, 406, 414, 417 FBP information, supplementary information from companies. Existing Security of supply information.	2	3 As above UKCP09 scenarios and available evidence suggest that some impacts in this area are likely.	2 This is assigned a lower score than impact for surface water resources due to the relatively less marked impacts of weather on groundwater responses. Impact is on recharge. Increased saline intrusion risk in the medium term is expected to be low.	6	3 Available research suggests groundwater impacts could be significant from 2050s to the end of the century. This would significantly affect some companies.	9	3 Under "High" emission scenario, modelling predicts reductions in groundwater recharge of up to 7-40% depending on the region (SD2).	12	As above, also: Quality indicators have some bearing. Potential for tipping points from saline intrusion into some groundwater sources. Others such as estuary sources will be able to monitor a gradual change to brackish water.	As above	
	A4	Changing precipitation patterns. Winter winters and possibility of wetter autumns. Greater frequency of extreme rainfall events.	Changing precipitation patterns increase potential and severity of storage.	Systems alterations to store more water in winter to deal with drier summers. Changes are required to cope with extreme events in winter whilst coping for drier summers.	Possible investment cases e.g. for increased storage capacity or network alterations.	Presents an opportunity to offset negative impacts to the SOB but a cost.	NCCRA, 315	1 Logical. Recognised by some sources but little research directly on this.	2 Some increase in winter mean is forecast but this could also be negative.	2 not in itself a significant danger to service and can be seen as an opportunity, but could drive investment proposals and reasonable decisions.	4	3 Likely increase in mean precip in winter by 2050s but could be a marginal change.	2	6	3 Highly likely by 2080s but could still be marginal change.	2 Increases in winter rainfall of 10 to 30% are predicted across most of the UK. This represents a significant increase in the amount of water that could be stored during winters without adversely impacting the environment.	6	Company plans and business cases.	Possibly	Interacts with nature of other SOB problems and visibility of solutions as above. Not possible in some regions. Increased temperatures increase the rates of evaporation from unpowered surface water storage systems Increased winter storage may have additional benefits to downstream flooding control. Storage of water to release in summers helps to address some environmental problems and increases the potential for dilution of pollutants by rivers
	A3	Increased annual temperatures. Increased summer peak temperature. Reduced precipitation in summer	Impacts on patterns of demand for PW.6 from water customers (domestic and non-domestic). Primarily the expectation is that demand will increase due to temperature increases and reduced precipitation in summer. Industries most important are soft drinks and breweries. Drier, hotter conditions will likely lead to increases in water required for fire fighting activities.	Increases to demand threaten the supply/demand balance, particularly at peaks. Environmental pressure from increased abstraction.	Threatens achievement of primary and secondary duties. Necessary activity on SOB is be looked at/funded. More pro-active demand management necessary. Policy decisions to make on how to handle demand rise and particularly peaks - e.g. through tariffs. Political and public pressure. May offset the benefits of demand reduction programmes. More difficult to meet target of reducing household consumption to 130 l per day.	Predominantly a threat	105, **308**, 206, 110, 211 WRMPs; SPN; JR Data	2 Many sources conclude the general relationship will occur but future attributes/gaps and demand is highly unpredictable.	3 Some increase is likely since some level of temperature increases are predicted under all scenarios by 2020s.	1 Roughly calculated to have up to 2-3% increase in demand by this period. This is assigned a lower score because the effects of climate change are strongly outweighed by the effects of population change and changes in PCC. Potential for increasing efficiency in the non-domestic sectors and the existing drive to reduce demand through more metering and other means. Fire fighting represents around 1% of demand for potable water in a typical year. Increased fire fighting demand is unlikely to have a significant impact on total demand.	3	2 Impacts by 2050s are higher but the effects of mitigating measures and social/demographic changes by this time make this impact highly uncertain. Upper limits of the estimates indicate a 5% increase in demand due to climate.	6	3	2	6	SOB issues arising (tracked annually through JR Table 10 particularly). WRMPs Companies flag concerns in BPs and ad-hoc. Research activity - e.g. by wholesalers.	Unlikely in isolation - demand fluctuates severely and for other reasons.	Vital interaction with other pressures on SOB. Demand changes are broadly assessed as of less importance than CC perspective but without dealing with all the SOB issues any increase in demand could cause significant impacts. Most sources recognise key demand drivers are population and behavioural change rather than climate change drivers. Incidental adaptation is likely to be most important to manage this risk. Demand also driven by changing technology trends and will be affected by trends in the replacement of housing.
INFREQUENT EXTERNAL HAZARDS	B1	Changing precipitation patterns. Increases in average temperature	Increased severity and frequency of single-year hydrological droughts (alone and beyond the problems of maintaining average year balance of supply and demand, coping with incremental climate change).	CC exacerbates existing drought risk. Impacts companies' ability to maintain balance of supply and demand during a drought. Higher frequency of supply restrictions, planned and unplanned. Short term emergency measures are necessary and/or long-term planning and investment is necessary to mitigate the risk. Environmental damage resulting from maintaining the public supply during droughts.	Threatens service. Prospect of increased drought frequency necessitates emergency planning and headroom building or increase in risks of supply interruptions for consumers. Decisions to make about acceptability of risk and companies' approaches and proposals. Criticism in the event/necessary reactions. Note direct role for us during drought events is relatively minor.	Threat	401, 301, 302, 104, 110, 104, 405, 127, 314, 316, 129, **328**	3	2 Drought risk already exists and it is not clear that climate change will materially drive this up within the next 20 year period. Note some models (3/4) predict a decrease in drought risk in some areas (N).	2 Service disruption and additional cost of droughts can be substantial but it's not clear we will see any more of these due to CC in the short term. Increasing risk of drought in the medium term is likely to drive some pro-active measures. Combines with the risk of additional demand. Increases in floodplanting should not materially impact demand even during droughts.	4	3 There is likely to be some increase in single-year hydrological drought frequency by 2050s considering the precipitation decreases in and above the 30% probability level and models for 3-12 month droughts. More certainly for SE than other regions.	9	4	3	12	Drought orders and supply restrictions. Weather forecasting and hydrological summaries.	Possible - few significant decisions are required from us during a drought.	risk determined by sdb situation and system resilience. Increases in drinking water demand from households, non-household water customers and from other users of raw water will increase the severity of drought impacts on supply security.
	B2	Changing precipitation patterns. Increases in average temperature	More frequent severe hydrological droughts (droughts lasting over 12 months).	As above but with longer-lasting and more serious consequences.	As above. Threatens service over a long period.	Threat Some models predict that multi-seasonal droughts will reduce in frequency, which would represent an opportunity rather than a threat	As above	2 A problem lies in the fact that we don't understand low-frequency variability. Best estimates indicate a range of possible situations ranging from no change in frequency to 1/100-> 1/10 projections by 2100. Some older sources predict a reduction in frequency	1 No clear certainty on multi-year drought frequencies (particularly ahead of 2080s). Rarity makes these difficult to predict in any case. There already is the existing possibility of severe drought - CC is unlikely to be an additional change above the current probability in this period. Some sources predict multi-year events become less severe by the middle of the century due to progressively wetter winters but this is by no means certain.	3	3 Multi-season drought has potential to disrupt service substantially and/or require very significant mitigation measures such as developing new water resources. Particularly two consecutive dry winters - this significantly impacts ground and surface water resources. Costs will escalate with the length of the drought.	3	2 No clear certainty on drought frequencies and not an output of UKCP09. Rarity makes these difficult to predict in any case. More existing models than not project more frequent droughts by 2030s but this is not to the levels as probabilities	4	8	3 More likely than not (judging from spread of model results considered to be of equal probability) that multi-year drought frequency is higher by end of the century.	4	12	Single-year droughts and forecasts indicate these continue.		
	B3	Precipitation patterns - specifically more high intensity rainfall events. Heavy winter rainfall events are projected to become more frequent than currently. Impact on summer rainfall events however remains a large area of uncertainty.	Flooding of water company assets.	Flooding of company assets or other disruption (such as flooding of crucial suppliers or transport links that threaten the operation of company assets) which creates risks to supply. (note we cover the risks associated with sewerage and sewer flooding separately).	Incidents of supply disruption for consumers increase. Quality threats. Potential (but empirically minimal) impacts on the environment of sewage works failure. Companies increasingly bear repair, remediation and cleanup costs. Companies propose capital solutions to reduce risk. (asset led network resilience) Criticism and political pressure on the sectors. Potential for excessive de-risking at customer expense. Serviceability issues.	Threat	324, 209, 104, 103, 202, 101, 110, 408, 119, 318, 323, 136 MG return periods project for Ofwat	3 Strongly recognised by most as a current and future risk. Credible investigations into low-return periods may change do exist (applying a range of scenarios including UKCP09). But fundamental uncertainties around climate impacts on extreme weather events remains. Many companies have undertaken flood risk screening of their assets already - we have some of this information.	2 There is likely to be some change in the likelihood of extreme events due to climate change, but in this period the changes are unlikely to be noticeably 'additional' above the current levels of variation.	4	2 Projections for changes in flows of the same return periods are up to 5% for 2020s, 50% of company assets are in natural flood plains (previous reasons). Indications are that expenditure on resilience solutions may remain significant within this period but note this investment and/or damage costs are unlikely to be entirely climate change driven. Political impetus has kept this on the agenda. Therefore assessed as material but not significant.	4	3 Likely in most of the scenarios.	9	3 Likely impacts on service without mitigating measures to the extent could be significant from the 2050s, the extent of climate change may begin to exceed current precautionary planning assumptions. We can assume that resilience activity and incorporation of consideration of flooding into asset management will work to mitigate the impact (in terms of necessary work and costs and service impacts) in the long term. However this is highly uncertain because it is difficult to ascertain the efficacy of resilience investment	9	4 Central estimates are for heavy rain days (rainfall greater than 25 mm) over most of the lowland UK to increase by a factor of between 2 and 3.5 in winter, and 1 to 2 in summer by the 2080s under the medium emissions scenario. Best estimates show even precautionary planning assumptions are exceeded from this period	3	12	Company risk assessments (business plans and elsewhere). Warnings. Actual impacts of extreme events on service.	Yes - on approach to resilience, balance of risk and investment cases. More towards looking at resilience of networks as opposed to individual assets.	Primarily with existing flood risk. Decisions about defences and response (e.g. EA flood defence budgets) Policy decisions (from us and others e.g. the EA/Cabinet office) on resilience approaches (absolute standards, precautionary planning approaches etc).

Detailed assessment of each risk continued (zoom for detail; not printable)

ASSET PERFORMANCE	C9	Increases in average annual temperature Changing precipitation patterns.	Reduced rainfall and increased temperatures increase fire risks.	Harm and costs to consumers where emerging threats are not identified and dealt with by companies. Increased threat of fires to company assets, (but note in most cases companies have robustly reduced fire threat).	Fires temporarily interrupt water company services or uncontrolled fires require partial/total rebuild of company asset.	Threat	No research on this. Some risk assessments by e.g. local authorities and fire services.	1	2 Small increases in temperature are highly unlikely to have a material affect above the current impacts in either case. Large natural variability in these threats will mean small average increases will be lost in the 'noise' of yearly change.	0 Fires are an existing threat that companies are prepared for under the current climate. There are currently few major incidents and costs of these incidents are a small fraction of cost. Countries with comparable climates for possible futures manage without everything catching on fire all the time. Largest risk may be secondary fire risk in some areas (e.g. grasslands).	0	3	0	0	3	0 Increased temperatures will still be well below those faced in comparable European countries under the current climate. Their clear ability to withstand the additional risks of fires and disease imply the UK should manage.	0	Increases in health and safety incidents. increases operating costs for companies (e.g. for insurance).	None	Climate is only one element of these risks. Increased digestion and use of bio-gas and increased use of advanced treatment such as ozone from pure O_2 driven by quality requirements will affect the potential for fires and explosions at assets.
	C1	Changing precipitation patterns. Increase in average annual temperature and increase in summer temperatures. - Affects SMD.	Reduction in soil moisture levels in summer and increases in winter. More soil movement.	Distribution system impacts - more bursts and leaks	Increased levels of company service failures Exacerbates any existing and future climate change pressures on balance of supply and demand in all regions. May affect leakage targets and business case assumptions. Changes the targetting patterns and affects optimal level of leakage control. May affect the validity and cost of maintenance assumptions (e.g. on pipe materials). Companies will need to understand effects when looking at infrastructure renewal and construction.	Threat	410, 107, company information	2	3 Not seen under 'wet' scenario	1 Magnitude is not well understood according to EA. Systems are already well in place to deal with bursts & leaks. Impact changes depending on soil type - SE more vulnerable where movement is already more of a problem.	3	3	2 Estimates from expert opinion put the potential impact of SMD on bursts/leakage at around 20-50% which impacts SDB and mains replacement strategies	6	4	2	8	Changes in historic trends in leakage expenditure and achieving leakage targets Reductions in summer rainfall volumes	CM implications. Affects optimal leakage and may affect targets.	Location. Less frost days decrease leakage while increased soil moisture extremes increases it. Overall balance of supply and demand Company pipe replacement strategies - The impacts will be different depending upon materials and location. Surface cracking can also increase the amount of pollutants entering groundwater sources.
	C2	Increased annual temperatures.	Fewer frost days	Distribution system impacts - less bursts and leaks. Note: many of the significant unplanned supply interruptions >12 hours over the last few years have been due to frost-related bursts in winters. Impact in 09-10, 10-11 winters suggests companies are able to cope but service and supply can be impacted; particularly where vulnerable supply pipes are affected.	Fewer service failures (DG3/DG2) due to frost impacts. Reduction in company leakage Impacts context for decisions on leakage management spending by companies and on supply demand balance issues.	Opportunity	410, 420, weather data, DG data back to 90s	2	3 Minimum temperature increases in all scenarios. Company specific study sees reductions in frost days under all climate change scenarios	1 UKWIR modeling of bursts approximately predicts a 10% reduction in total bursts if all frost days are eliminated and in the absence of other changes. In this time period frost day reductions will be much smaller than this.	3	3	1 Frost days have reduced over the last 40 years. Continuing this trend will give around a halving of frost days during this period - Rough macro-estimates indicate this could lead to a material decrease in bursts/leaks (particularly on vulnerable supply pipes) with no other external changes.	3	4	2 broad estimates from recent data indicate average number of frost days could be reduced by 2/3 meaning a material reduction.	8	Changes in historic trends in leakage expenditure and service targets. Reductions in the numbers of days of sub-zero temperatures.	CM implications. Re-assessment of approaches to leakage and supply.	Location. Less frost days decrease leakage while increased soil moisture extremes increases it. Overall balance of supply and demand Company pipe replacement strategies - The impacts will be different depending upon materials and location.
	C3	Increases in average temperature	Affects the operation and efficiency of treatment processes which are temperature sensitive [e.g biological filtration, ion exchange, AD] and water stability.	Impacts treatment process operation and cost and design. Predominantly the impact of temperature rise is positive (i.e. will tend to increase efficiency of existing process).	Potential savings windfalls for companies. Impact may figure in long term business planning.	Opportunity: Reduced company expenditure on treatment.	404, 118 literature on treatment processes	1 No specific study of the climate change impacts is known but biological and chemical reaction rates increasing with temp is well understood.	3 Temperature increases are found under all scenarios although the difference at 2020 is likely to be minimal	0 Water and sewage treatment account for about a quarter of all annual expenditure, but there is no clear indication that temperature will affect this cost above or below the current in the short term. Likely to be in the noise in terms of impact for us.	0	4 Material mean temperature rise by 2050s is highly likely.	1 In the longer term we may see some impact on operation and cost in longer-term trends.	4	4	1	4	This should be a continuous increase with no particular tipping points or jumps to indicate the effect is beginning.	On whether this is a company efficiency - how should any savings resulting be passed on to customers?	Highly dependent on external factors. Other impacts on water treatment costs and processes are likely to affect or offset the extent of this saving.
	C7	Increases in average temperature	Temperature impacts upon sewage treatment processes - increased rate of biological processes	Odour problems Increased pests such as flies	Customer complaints and other pressure (e.g. from MPs) Increased odour control spend in business plans Companies have more difficulties getting planning permission for new treatment facilities	Threat: To consumer satisfaction and may impact bills.	None	0 Issue has been suggested from several sources and general effect of temperature on odour is understood, but no study of potential changes with climate change are known.	3 Temperature increases are found under all scenarios although the difference at 2020 is minimal	0 Odour complaints are a tiny fraction of customer complaints and are very localised. Solutions exist and recent price reviews have included ongoing work to solve existing problems. Yearly expenditure on odour control is currently around £25m across the sector. Additional cost on top of this due to climate change is assessed as very low.	0	4 The climate driver (temp) will certainly increase, although whether this will cause a noticable impact on odour is unknown	0	0	4	0	0	Volume of odour related compalints. Business cases for odour control.	No	Odour control issues relate to people's willingness to pay to address them, hence the state of the economy is likely to influence customers demand for odour reduction Demographic change may increase the number of odour control projects
	C6	Changing precipitation patterns. Increases in average temperature	Higher temps increase asset deterioration (affecting life of plant) Reduced rainfall drives increase in buildup of H_2S and sediments in sewers and pumps. Reduced extemes in cold weather could reduce asset deterioration (e.g. of electronics).	Increased asset deterioration. Requires appropriate asset management responses.	Increased rate of asset replacement may impact both future business plans and require re-assessment of existing asset management strategies	Threat: Increased asset failure Opportunity: Some asset lives may increase (e.g. due to reduction in frost days)	109, 404	0 Issue has been suggested from several sources, but few studies of CC impacts on maintenance regimes exist.	3 Temperature increases are found under all scenarios although the difference at 2020 is minimal.	0 Reductions in asset lifetimes have a potential to increase costs on companies, and increase service failures if impacts are not forseen. Increases in temperature in this period are low so impacts on asset lifetimes are not expected to be significant. Given uncertainty this is unlikely to be a significant driver in maintenance regimes.	0	3	1 Warmer countries can deal with this issue without incurring large additional costs , but there is a potential for some additional costs over the medium-term, especially as assets have life-times up to 100 years.	3	4	1	4	Serviceability monitoring. Drivers in capital maintenance. Comparison to water industry asset lifetimes and replacement strategies in countries with higher average temps than the UK could be undertaken now and should give an indication of the severity of this impact	Possibly - If impacts on asset management are significant.	Other maintenance drivers are by far more important (e.g. fundamental breaking points) Changes in rainfall and water demand may also have some impact on asset deterioration as assets come under increasing or decreasing useage
	C4	Sea level rise Changing precipitation patterns Changes in wind patterns	Coastal changes: Sea level rise, changes in storm surges, changes in coastal erosion patterns etc.	Increased risks to water sector infrastructure near the coast.	Service failures and complaints where impacts are in terms of low-frequency events (such as flooding). Risk to assets due to coastal erosion may require urgent action and investment to reduce. Assets may require relocation (at a cost). Companies may include increased erosion and potential for storm surges as reasons to replace infrastructure before the end of its operational life as a resiliance measure as erosion conditions change.	Threat: Service failures and reputational consequences could result. Necessity for increased cost to solve/prevent (e.g. non-optimal replacement or relocation).	109, 408	2 UKWIR study indicates increases in the threats from storm surges. The CCRA water sector pilot rank the pedegree as 3 out of 4	3 UKCP09 predicts some rise in sea levels under all climate change scenarios. Climate change impacts on wind speeds and storms are not understood sufficiently in UKCP09 to determine their impacts	1 Most water industry assets are away from the coast although there are around 1,100 outflow pipes and several sewage treatment works at some potential risk of coastal flooding or erosion. Coastal erosion and flooding is already an issue, climate change will add to this existing risk. Also some sources flag boreholes as at risk of saline intrusion - substantive evidence that this is a very material problem is lacking though.	3	3 UKCP09 predicts rises in sea levels under all climate change scenarios. Climate change impacts on wind speeds and storms are not understood sufficiently in UKCP09 to determine their impacts	1	3	3 UKCP09 predicts rises in sea levels under all climate change scenarios. Climate change impacts on wind speeds and storms are not understood sufficiently in UKCP09 to determine their impacts	2 Impacts more severe by this period.	6	EA consultations on flood defence policies will give warnings of potential changes in coastal defense strategies. EA coastal flooding maps	No	The EA currently determine coastal defense policies. They may decide to abandon some defenses that protect water company assets for various economic, social and environmental reasons. Links with risk to effectual drainage, particularly CSOs on the sea. If the customers that are served by coastal assets are forced to relocate, destroyed assets may not require replacement.
	C8	Precipitation and temperature	Reduced flows available for hydropower generation in summer. Increased in winter.	Changing patterns of hydro-power outputs	Impacts on opex efficiency and viability of hydro schemes. Impacts to energy generation outputs.	threat/opportunity	Company information.	1	3	0 Hydro is only a very small proportion of energy generation. Costs associated are low and companies are expected to deal with this in operational.	0 Likely to see some effects but low impact for us.	3	0	0 Likely to see some effects but low impact for us.	4	0	0	Reports in JR GHG reporting.	Unlikely - unless its on the viability of hydro as regulated business (since it affects risk balance).	Extent to which companies prioritise hydro options. Carbon mitigation policies and the strength of incentives. Demand level, population increase and volume of run-off entering sewers may impact the number of high volume-low head hydro generators at WWTW outflows.
	C5	Increases in average temperature, Changing precipitation patterns (particularly drier summers)	Reduced flow in rivers reduces ability to dilute pollution	Increased levels of Ww treatment required and/or increased number of pollution incidents	Companies wastewater treatment costs increase as the discharge constraints become higher. Increased failures of environmental standards have reputational impact on Ofwat	Threat.	121, 105, 408, 321	2 Reduced river flows is a widely accepted impact of reduced rainfall with consequent impacts on pollution levels. Impact of this on required effluent treatment is not as well understood, but it is expected to increase.	3 Likely to see some impact on river flows in summer by 2020s.	1 The actual reduction in precipitation is low in this time period and it is unclear what the impact of this on river flows ability to cope with pollution would be.	3	3	2/3 EA predicts drops in summer flows of up to 80% in some areas and the combined water and sewage treatment is 23% of industry turnover. Environmental protection could be a big driver for spend on this issue if a demonstrable problem materialises.	6 / 9	3	3 EA predicts drops in summer flows of up to 80% and the combined water and sewage treatment is 23% of industry turnover	9	EA water resource information is expected to monitor trends in river flows. Changes in the numbers of environmental consent failures Increases in industry expenditure on treatment above expected levels	Ofwat may need to be involved in policy decisions with the EA/Defra on discharge consents, catchment management and abstraction policies to cope with this risk	Decreases in raw water quality from changes in micro-bildlogy, run-off from agriculture and urban areas. Reliant on compliance limits and whether these alter to include some climate change assumption. Changes in levels of abstraction due to changing demand (population and agriculture changes) UK and EU drivers to improve water quality

Detailed assessment of each risk continued (zoom for detail; not printable)

RAW WATER QUALITY	D3	Increases in average temperature Changing precipitation patterns Sea level rise	Direct ecological changes significantly alter raw water quality - e.g. Increased algal blooms.	Increased raw water treatment required. Primarily affects surface water resources. Increased algal blooms may increase threats of pumps being blocked	Companies ask for money (capital or operational) to increase raw water treatment processes to deal with reduction in raw water quality. Potential for drinking water quality issues which hold a reputational impact on Ofwat or require a reactive policy response.	Threat: 1) Increased costs for consumers. 2) Increased industry GHG emissions from increased treatment. 3) Potential impact on drinking water quality	121, 309, **320**, 321	2 Several studies have been carried out The general conclusion is that temperature rises and reduced flow rates will promote algal blooms	2 Blooms are seen to increase with temperature and reduced flows, but when this begins to have a noticed impact on companies is unknown	1 Water treatment is around 8% of industry spend. This is one of many existing water quality issues that has moderate to little predicted increase in the short term	1	2 Blooms are seen to increase with temperature, but when this begins to have a noticed impact on companies is unknown	1 Water treatment is around 8% of industry spend. This is one of many existing water quality issues that has moderate to little predicted increase in the short term	2	2 Blooms are seen to increase with temperature, but when this begins to have a noticed impact on companies is unknown	2 Water treatment is around 8% of industry spend. This is one of many existing water quality issues that has moderate predicted increase in the long term as total blooms are ultimately limited to nutrient levels	4	DWI or Companies raise as an issue.	Potentially yes. Primarily relating to catchment management and funding routes and validity of various quality drivers and schemes.	Algal blooms depend upon levels of N & P in watercourses which means runoff will influence this risk as will the EA response to the WFD limits Residence time is the other influence on this risk which has some dependence on abstraction
	D2	Increases in average annual temperature Changing precipitation patterns. Reduction in frost days (rising average minimum temperatures in winter)	Increased biological activity increases prevalence of disease (particularly water bourne diseases). Increased runoff can increase the amount biological agents such as cryptosporidium in raw water which is difficult to remove.	Harm and costs to consumers where emerging threats are not identified and dealt with by companies. Increasing operating costs to cope (e.g. through rising levels of sickness or necessary health and safety measures)	Increased staffing and Health and Safety costs in business plans Failure of duties to ensure safe service if sicknesses of company staff increase, especially in the case of a major disease outbreak.	Threat	210	1	2 Small increases in temperature are highly unlikely to have a material affect above the current impacts in either case. Large natural variability in these threats will mean small average increases will be lost in the 'noise' of yearly change.	0 Water bourne diseases are an existing threat that companies are prepared for under the current climate. There are currently few major incidents and costs of these incidents are a small fraction of industry turnover.	0	3 Some increase more likely	1 Assume within existing coping standards and risk averse approach in this area should minimise threat.	0	3	1	0	Increases in health and safety incidents. Increases operating costs for companies (e.g. for insurance).	None	
	D1	Changing precipitation patterns, specifically more heavy rainfall events (in winter and possible in summer).	Changes runoff patterns (more dry weather buildup washed off during rainfall periods): Increases in N, P, toxins, dissolved organic material and suspended solids washed into raw water sources.	Increased raw water treatment required. Primarily affects surface water resources.	Companies ask for money (capital or operational) to increase raw water treatment processes to deal with reduction in raw water quality. Potential for drinking water quality issues which hold a reputational impact on Ofwat or require a reactive policy response. Achieving our duties requires us to get increasingly involved in diffuse pollution legal issues.	Threat: 1) Increased costs for consumers. 2) Increased industry GHG emissions from increased treatment. 3) Raises risk to drinking water quality	121, 126 408, 321, 309, 317	2 Several studies have been carried out. Generally conclusions agree that water quality will decline, but results are very location specific.	2 Although impacts are widely predicted, the magnitude will be regionally varied and difficult to predict. Few significant impacts are forecast in by 2020s.	1 This is an existing issue that, while uncertain, is expected to see at most a small increase under short term climate changes impact of runoff on WwT is currently assessed as limited. This is likely to be more important in terms of companies' own operating procedures and practices - less so in terms of an impact on our functions.	1	2 Although impacts are widely predicted the magnitude will be very regionally varied and is difficult to predict	1 Water treatment is around 8% of industry spend. The decreases in quality are fairly unknown but companies typically have reasonable treatment headroom to cope with minor changes under BAU. Modelling shows changes in pollutions loads of around 5-10%, but results depend strongly upon the specific catchment area. Changes in water quality (N & P) are expected to be generally below 5% in 2050.	2	2 Although impacts are widely predicted the magnitude will be very regionally varied and difficult to predict	2 Water treatment is around 8% of industry spend. The decreases in quality are fairly unknown but companies typically have reasonable treatment headroom to cope with minor changes under BAU	4	Changes in OPEX spent on treatment processes over time, especially processes that are only used when needed such as ozone treatment. Companies or DWI raise as an issue.		Dependent on changes in diffuse pollution from agriculture. Implementation of the WFD & EA approach. Changes in industrial discharges Significant influence from reduction in river flow volumes Changes in CSO spills number and volumes may have a direct impact on water quality in some areas. Surface soil cracking may increase infilatration of pollutants into groundwater sources.
DRAINAGE	E1	Wetter winters. More extreme rainfall events.	Increased occurances of heavy downpours, Increased rainfall in winters, more surface water enters combined sewer systems.	More difficult to manage surface water within the existing sewer network. Increased pumping costs. Increased CSO spill volumes and to a lesser extent, increases in CSO spill frequency. Increased occurances of heavy downpours after prolonged dry periods lead to 'first flush' CSO spills which can carry a higher pollution load.	Increased pollution incidents as combined sewers overflow into watercourses - reputational impact for Ofwat. Potential political pressure as CSO discharges impact on WFD targets. Increased company spend to address issues, cope with increased flow and adapt the network to cope.	Threat: 1) Increased pollution incidents 2) Increased company spend to address problems	206, 107, 209, 202, 110, 121, 318, **408**	2 An existing threat. UKCP09 scenarios show the causes of CSO discharges will increase. UKWIR research project is the main study of these impacts	2 In winter rainfall when CSO outflows are most often UKCP09 predicts 20% increases in rainfall in some regions at 90% probability level. Greatest impact of CSO discharges are in summer when river flows are lowest. UKCP09 predicts increases in rainfall intensity in summers, but a reduction in total rainfall, so the summer impacts will be fewer but bigger overflows	2 Pollution impacts are difficult to estimate as CSO outflows are not directly measured in terms of frequency or volume and their importance is highly dependant on the nature of the receiving water. 'Additional' CC impact is therefore hard to guage. The costs associated with climate change impacts will depend upon EU legislation over what levels of outflows are acceptable, currently there is little or no impact on companies if their CSO discharge more frequently that expected. Number of CSO discharges will not vary linearly with changes in rainfall, it will depend upon the available headroom in each area.	4	3 Winter increases in rainfall are predicted, but summer increases in rainfall intensity are only predicted at 90% proability under medium emissions scenario	3 Based on EU enforcing more stingent regulation of CSO discharges - this will cause increased environmental consent failures and require very significant costs to solve. 2 Based on current UK policy towards CSO discharges. UKWIR research predicts that even small increases in rainfall can require significant works in order for sewerage system to maintain LOS.	6/9	3	2/3 CSO spill volumes predicted to increase 2.8 times current levels by 2080 in some areas (408). To maintain current levels of spill volume will require up to 10 times more storage volume than maintaining the levels of spill frequency. Maintaining current numbers of spills could require up to 7 fold increases in storage volume.	6/9	Decision by the EU on CSO discharges is likely to occur well before the impacts of climate change are seen. EA's Sewerage Management and Intermittent Discharges Project	Sustainable drainage project is investigating policy issues relating to drainage.	Sewer serviceability and maintenance regimes. Feasibility and cost of solutions such as upsizing/interception. Increases in river flooding and sea level rises at storm surges may increasingly block sewer outflows, causing additional sewer flooding. Increased population will both increase the volume of sludge flushed into the system and more importantly may increase the area of impervious land from new developments. Changes in demand for drinking water will have some impact on maximum sewer flows. Reaction of developers and urban planning bodies to this threat. The extent to which surface water into sewers (particularly at key points) can be reduced. SUDs uptake and [illegible]
	E3	Changing precipitation patterns.	Decreases in summer rainfall and the amount of surface water entering combined sewer systems.	Impacts the operation of sewer systems (e.g. by resulting in blockages from decreased flow in summer)	Increased sewer blockages generate complaints and increased company service failures. Increase in operating activity and investment to deal with issues reactively and proactively.	Threat: increased service failures and generated complaints	206, 408	1 No reliable study of this effect has been identified	2 Some decrease in rainfall is predicted but no significant change	0 Blockages are current and temporary issues - additional effects are unlikely to require significant additional expenditure to solve. Groundwater infiltration into sewers is not expected to significantly change	0	3	1 Groundwater infiltration is not expected to significantly change (408)	3	3	1	3	None	No	Changes in demand for potable water will impact upon sewer flows Also offset by population increases, which will increase sewer flows Increased temperatures and CO2 may promote tree growth and lead to more blockages being caused by tree roots.
	E2	Wetter winters. More extreme rainfall events. Sea level rise	Increased occurances of heavy downpours and increased rainfall in winters results in more surface water entering combined sewer systems. Sea level rise and high river flows in winters increase the frequency of sewer outflows being blocked (This particularly magnifies problems where this is at the same time as heavy downpours).	Increased risk of sewer flooding, both external and internal.	Sewer flooding incidents - a serious service failure. Increases sewer flooding risks to consumers - companies fail to meet outputs or maintain standards. Increased company spend to remove properties from risk register. Reputational impact and increased political pressure.	Threat	206, 107, 209, 202, 110, 121, 318, 408	3 UKCP09 predicts heavier downpours and sewer flooding is an existing problem; particularly during extreme rainfall events. UKWIR modelling suggests this is a likely impact.	2 Extreme downpours are mentioned specifically by UKCIP as increasing. Changes in wettest days of winter are not seen under most scenarios in the near term though	2 Although sewer overflows are a serious threat, the additional impacts due to climate change in this period are expected to be relatively small due to the small changes predicted by UKCP09. It is noted that the costs of flooding are not linearly dependent upon flooding magnitude. Increased severity of flooding can rapidly increase costs. Proactive expenditure to resolve potential future issues is expected in this time period but is not entirely climate change driven.	4	3	3 Although in terms of population affected additionality due to CC may be relatively small SF is a very severe service failure. Yearly expendature on sewer flooding is currently around £230 m per year. This is a significant cost (2.9% of industry CAPEX+OPEX). This cost is almost certain to increase as rainfall in winters and intensity of downpours increase. UKWIR modelling suggests that even small increases in winter rainfall will require significant works to maintain current levels of service. Again, not all the cost in this area would be driven by climate change.	9	3	3 The issue is likely to be exacerbated by changes in population number, migration and demand. UKWIR modelling suggests that storage volumes may need to increase by 100% in the long term to avoid additional property flooding.	9	Increases in at risk flooding registers in JRs Increased sewer flooding incidents reported, GSS payments. Stakeholder input during sustainable drainage project.	Likely	
CROSS-SECTORAL	F1	All In all of these risks the predominant driver for risks is the effect of and response to climate change in other sectors. The risks presented here are therefore highly dependent on future courses in other sectors, which we cannot reliably assess. We have attempted to set out our understanding on the degree to which the water and sewerage activities are affected by potential changes in other sectors.	All climate change related risks to the energy sector (e.g. storm and temperature impacts on the distribution system, political drivers on the generative capacity). See Ofgem-provided list for all basic risks.	Reduces the security of supply of energy. Failing energy supplies can seriously threaten a water or waste company's ability to provide services.	Risk of service failures as a direct result of outages. Increased costs to companies and consumers to provide backup generation or react to outages.	Threat	Ofgem feedback.	2 Good evidence that risks to the energy sector have been investigated but this has not been the subject of our review. Understanding of risks to companies' service from power outages is not clear to us.	1	1	1	2	2	4	2	2	4	Energy failures, press and media attention. Ofgem warning.	Possible - dependent on success in other sectors.	All massively reliant on external changes Energy sector resilience. [judging from adaptation reports in that sector they are confident - main risk in the long term might be generating capacity - assume water is prioritised] Resource availability and speed of transition to renewable generation. Rate at which companies can increase their generation of renewable energy (note there are fundamental limits associated with this).
	F2		Increase in the demand on water resources or other temporal or regional changes in demand for water from energy, industry, agriculture, firefighting and the environment (as represented by the EA).	Environmental damage of over-abstraction. Possibility of 'demand-led droughts'. Companies have to restrict their abstraction or pay more to abstract in the face of increased competition for resources. Requires operational changes, development of resources or more stringent demand management measures.	Erosion of headroom in supply-demand balance - increased risk of supply interruptions and increased costs to companies or consumers. Damage to the environment from over-abstraction.	Threat Does present a driver for more efficient allocation and use.	agriculture: 105, 305, 325 energy: 206, 305	2 Mentioned and explored in limited papers.	2 Likelihood uncertain due to dependence other factors. Relationship between demand for irrigation is generally clear and projected as + up to 20% by 2020s under medium scenarios. *where nothing else changes.*	2 Potentially commensurate to the impact from 'pure' climate impacts on customer demand, but significantly more uncertain and subject to political and social changes. of all regions, ANH is apparantly highest risk. Increased consumption is concentrated in summer when SD balance is already stressed under current climate Impact in UK is generally lower than other countries because of relative proportions of water used for public supply vs energy/agricultural uses and power station locations near the sea.	4	3 Likelihood fairly high of some changes to competing direct demand on water resources.	2 Energy - over the long term we should see reduced demand on water resources (excepting the sea). However this is uncertain and some studies (SNIFFER) suggests relocating new/replacement power generation away from coastlines to mitigate risks of sea level rise. This could increase resource stress. Agriculture highly unpredictable and reliant on external factors. Projected increases in agricultural use of up to 20%-26% from current by 2050s	6	4	2	8	Annual monitoring, headroom against licences. EA should raise concerns and engage with the water sector when significant changes begin to occur. WRMPs should raise. SDB impacts	Likely - nature of SDB cases and WR planning.	Material changes in the agricultural sector e.g. crops grown, regional shifts in farming types. Political changes which affect this. Material changes in the energy sector which affects demand for cooling water such as move towards renewable generation - more likely acting to reduce demand. Political decisions on hierarchy of needs/compensation is vital. If reform resolves abstraction rights into an economic competition this will mean increased cost to customers. Changes in abstraction costs will impact the economic level of leakage.

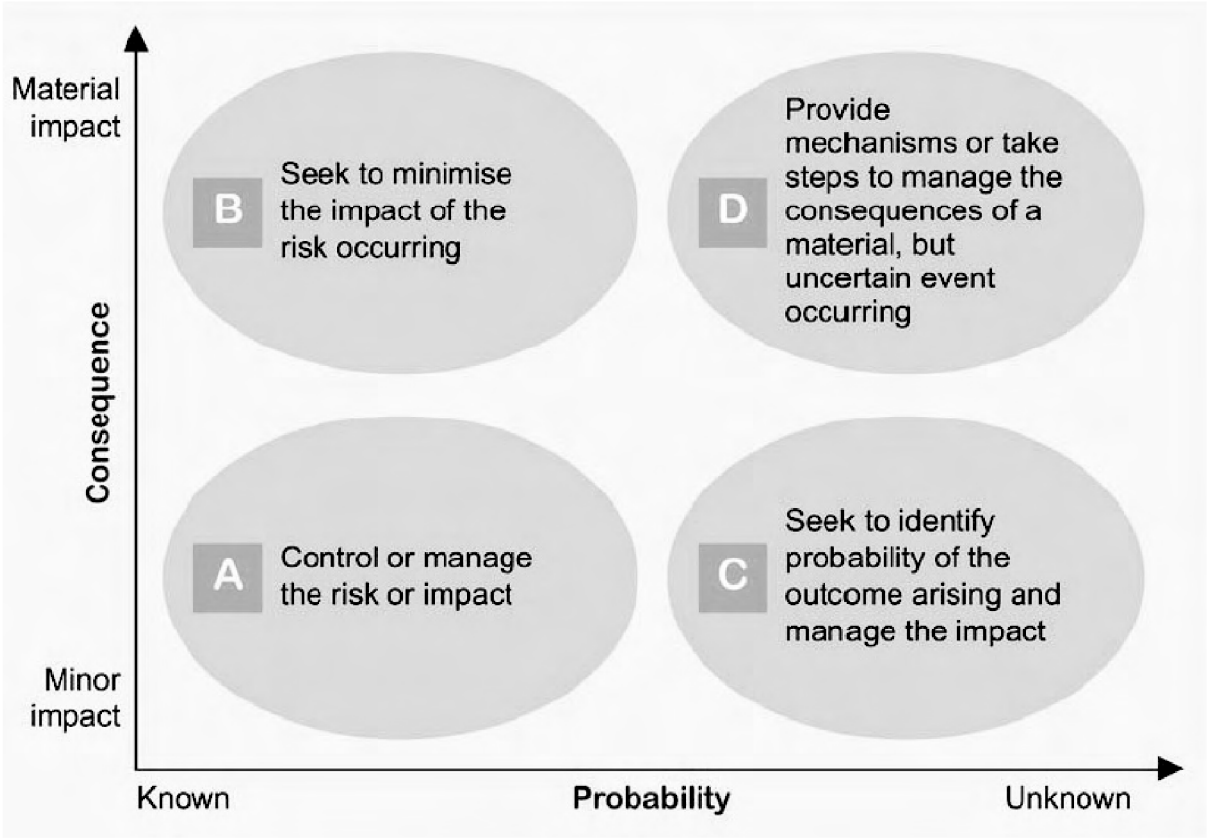
4. Method for determining priority risks

4.1 Risk appetite

Understanding risk appetite is important in order to prioritise risks. For example, a tolerant approach to risks (that is a high-risk appetite) might mean we need take no further actions.

In 'Allocating risk and managing uncertainty in setting price controls for monopoly water and sewerage services – a discussion paper', which we published in October 2010, we explained that a range of factors need to be considered in order to determine how to deal with specific risks. For example, the consequence of some risks is so material that, even though there is a great deal of uncertainty about how likely the risk is, action still needs to be taken. This is represented in the diagram below.

Figure 7 Overall spectrum between risk, uncertainty and materiality



Our prioritisation should reflect the risk appetite among our stakeholders and particularly consumers. We operate in an industry where the repercussions of service failures, such as customers experiencing extended periods of restricted water supplies or river pollution, can be very significant for society and the environment. For this reason, we think that planning for climate change risks in the water and sewerage sectors is more long term relative to other sectors of the economy. As an example, it is appropriate that the companies plan to manage their supply/demand balance over at least a 25-year timescale and that they clearly present their overall strategic direction over the same period. Many other sectors do not carry out this kind of long-term risk planning systematically.

The regulatory framework as it stands, already has significant capacity to deal with some of the risks. Existing mechanisms already provide incentives (and reduced uncertainty) to encourage companies to adapt. As a result, the companies we regulate already have the capacity to deal with many low impact risks without it affecting our duties.

4.2 Risk priorities

Our climate change risk appetite distinguishes between three types of risk.

- High risks – which we believe require mitigation.
- Medium risks – which should be minimised as far as possible.
- Minor risks – which we are willing to accept at the current time.

We used the basic probability impact grid shown in figure 8 below to categorise the risks we identified. Each cell in the grid contains a value calculated by considering the impact and probability assessments for each risk (derived from the definitions explained in chapter 3). We did not use the simple 0-4 scoring system shown in figures 11-13 as this did not represent accurately the changes in scale between impact categories. Instead, we mapped the 0-4 scale onto a non-linear scoring system. The combined risks scores in figure 5 are multiplied by 100 for presentational reasons.

Figure 8 Probability impact grid used for prioritisation

Magnitude of Potential impact on Ofwat					
	0.25	1.25	2.5	12.5	22.5
	0.15	0.75	1.5	7.5	13.5
	0.02	0.1	0.2	1	1.8
	0.01	0	0.1	0.5	0.9
	0	0	0	0	0
		0.05	0.1	0.5	0.9
		Likelihood of impact occurring based on UKCP09 results			

Many of the risks we have identified are either highly unlikely to occur or have such a low predicted impact that we do not believe it is proportionate for us to take adaptation action. We have included risks with a probability impact score of 0.1 or below in this category. We consider such risks to be minor and do not prioritise them in the adaptation action plan. We consider risks with scores above 0.1 but below or equal to 1 to be medium risks. These are risks that have the potential to affect the achievement of our duties if not dealt with properly. Risks with scores higher than 1 are considered high-priority risks.

Unless there are obvious and low-regret risk mitigants, we expect the companies to be able to deal with minor risks within their capacity. For medium and high risks, we judge that we should have some policy or action in place that helps mitigate that particular risk.

As well as threats, we have considered potential opportunities from a changing climate. In the case of opportunities, we judged that we would simply accept them in all cases but not rely on them. As with other risks, any material benefits from these opportunities will be shared between customers and companies through the regulatory system.

We applied this approach to each of the three time periods in order to determine which risks move from minor to medium or from medium to high in the future. This helps us to determine which adaptation actions need to be implemented now, within the next five years or where we are likely to need to take action over a longer period of time. We have used the results from the 2050s risk assessment as the main indication of priority risks for our organisation.

4.3 Risk allocation

Identifying and understanding where risks should be allocated is an important step in understanding what adaptation actions to take. We seek to set an appropriate balance of risk between consumers and the companies we regulate.

For efficient and effective management of risks, the impacts should rest with the party most able to manage them. And adaptation is more likely to be most effective and efficient when actions are made by those with the best information on the systems concerned and the local circumstances and challenges. The nature of the risks we identified means that these risks should sit with the companies.

Identifying who is best able to control or manage the likelihood or consequence of a risk is an important part of our role as economic regulator. But it is not straightforward. In 'Allocating risk', we explained that the ability to manage or control a risk may lie with one party (for example, the agricultural or water and sewerage sectors) but the consequences of the risk fall elsewhere (for example, on the environment or on water customers). In these cases, incentives are needed which encourage the party that is best placed to control that risk to act. Equally, it may be that more than one party has a role to play in managing a risk. We need to understand this in each case in order to identify what actions need to be taken to ensure that adaptation is effective, efficient and equitable.

4.3.1 Low-regrets actions

The UK Government's Adaptation Sub-Committee has stated that the minimum it expects from organisations that are adapting well is that they are implementing low-regrets adaptation options.

In the near term, we expect the focus of adaptation actions to be in areas where there are existing weather-related risks – such as flooding and to the supply of water available for use, or clear benefits to reducing the risks – such as reduced resource requirements through demand reduction. These are the areas where low-regrets actions are most likely to be found. In many of these areas, we have already seen progress in the sectors over the past 20 years. Such areas include:

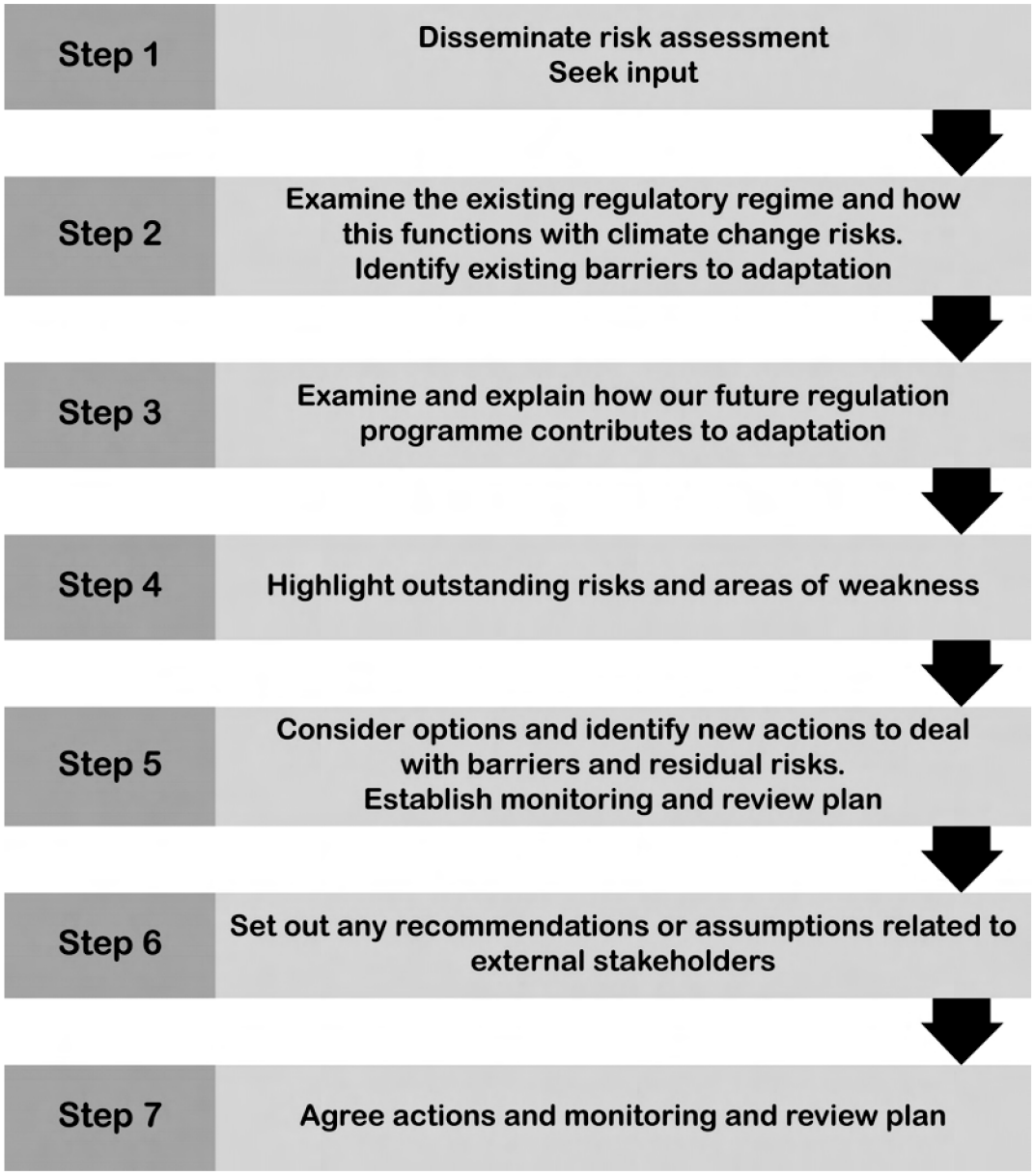
- reducing the amount of water wasted;
- increasing the amount of water available for use;
- increasing resilience of service;
- increasing network interconnection;
- increasing the flexibility of and control over networks;
- reducing, or slowing down, surface water going into the sewers;
- reducing diffuse pollution; and
- planning for emergencies.

These help to set our agenda and understand low-regrets options. They also provide an indication of the types of areas to consider when assessing how well-adapted the sectors are. Choosing the right adaptation actions is always a context-specific process.

5. Process for identifying adaptation actions

In order to arrive at an adaptation action plan that addresses the priority risks we identified, and that meet the aims and principles of adaptation outlined above, we followed the process illustrated below.

Figure 9 Process for identifying adaptation actions



The aim of this process was to ensure we appraised our current approach to regulation critically and could arrive at improvements where necessary. We explain the conclusions of this process and our action plan in the main report. We explain each of the steps in turn below.

5.1 Step 1 – disseminate risk assessment

Our first step was to disseminate the conclusions of the climate change risk assessment and develop ideas on how we can mitigate those risks with others across Ofwat. We did this at both a policy and project level, and overlapped it with the risk assessment quality assurance process. At this point, we also used a decision flowchart to help our thinking on climate change risks and adaptation in different policy areas.

5.2 Step 2 – examine the existing regulatory system and identify barriers

We then examined in detail how the existing regulatory system does and does not enable or incentivise adaptation. This included identifying existing barriers to adaptation in the sectors caused both by our existing system of regulation and by other regulatory and legislative constraints.

We identified these through consultation across the organisation and by considering the views of our stakeholders expressed in workshops, conferences and published documents. As part of this, we also considered our own adaptive capacity and areas where this could improve. 'Adaptive capacity' means the extent of our understanding about climate change risks and our ability to respond to these. This step included further discussions with all relevant policy teams. We then listed and examined the barriers we identified.

5.3 Step 3 – examine and explain our future regulation programme

As part of our future regulation programme, we have a number of projects under way that are considering topics such as future price limits, sustainable drainage and market reform. These projects all have climate change as a key driver and consideration in their work programmes. But as with all our work, climate change is not their only consideration. So, for the purposes of our adaptation report, we explained in detail how the products of those projects may affect (both positively and negatively) the ability of the sectors to adapt to climate change.

5.4 Step 4 – highlight outstanding risks and areas of weakness

Following our review of existing systems and future regulation, we then considered the areas in which further action was required. This meant considering the barriers to adaptation we had identified and understanding which of the priority risks are not dealt with adequately through existing mechanisms.

5.5 Step 5 – establish action plan

We then considered a range of options and established a list of actions to address barriers and outstanding risks. This included a number of internal actions that were driven in part by a self-assessment on adaptive capacity which we carried out. At this point, we also established our plans to monitor and review adaptation in the sectors and to keep the risks under review.

5.6 Step 6 – recommendations or assumptions related to external stakeholders

The penultimate step was to explain our assumptions with regard to other regulators and legislative bodies. In some cases, we also identified specific areas where we rely on the actions of other stakeholders. We identified this as a necessary step because of the complex and inter-related nature of the sectors.

5.7 Step 7 – agree actions

The final stage involved agreeing our report and actions with each of the policy and project teams and with our Board and Executive team.

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Water today, water tomorrow

Ofwat's climate change adaptation report – technical paper

www.ofwat.gov.uk

OFWAT

About this document

On 3 March 2010, we were directed by the authority of the Secretary of State to provide a report on climate change adaptation. This technical report and the supporting process document provide more detail to support our response and fulfil the requirements of the direction.

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1. Aims and objectives

This chapter explains our duties and functions, and our overall strategy to achieve them. We also explain:

- our objectives for this document;
- how climate change fits into our organisation; and
- our overall approach to climate change risks.

1.1 Our organisation's functions, mission, aims and objectives

We are the economic regulator of the water and sewerage sectors in England and Wales. We regulate the 10 water and sewerage companies and 11 water only companies in England and Wales. We also regulate 6 local service providers and 7 water supply licencees[1]. The companies we regulate are responsible for delivering water and sewerage services to consumers.

Our duties are laid out in statute, primarily in the Water Industry Act 1991 (as amended) ("WIA 1991"). When exercising certain powers or discharging certain duties under the WIA91 (the "relevant powers and duties")[2],we must comply with our main duties to:

- further the consumer objective (protect the interests of consumers, wherever appropriate by promoting effective competition);
- secure that the functions of each undertaker are properly carried out in every area of England and Wales and that they are able to finance their functions, in particular by securing reasonable returns on their capital; and to
- secure that companies with water supply licences (that is, those selling water to large business customers, known as 'licensees') properly carry out their functions.

Subject to our main duties, we also:

- promote economy and efficiency by companies in their work;
- secure that no undue preference or discrimination is shown by companies in fixing charges;
- secure that consumers' interests are protected where companies sell land;

[1] Throughout this report, we refer to all these organisations as "the companies".
[2] See sections 2(2A), 2(3) and 2(6) of the WIA91.

- ensure that consumers' interests are protected in relation to any unregulated activities of companies;
- contribute to the achievement of sustainable development; and
- have regard to the principles of best regulatory practice.

It is important to note that, by law, "consumers" includes both existing and future consumers.

When exercising the relevant powers and duties, we must have regard to the principles of best regulatory practice, including the principles under which regulatory activities should be:

- transparent;
- accountable;
- proportionate;
- consistent; and
- targeted at only cases where action is needed.

These principles underpin the approach we are taking to the way in which we regulate the sectors.

In 'Delivering sustainable water – Ofwat's strategy', which we published in March 2010, we explain how we will regulate the sectors in a way that fulfils our duties. It sets out our vision, goals and values. Our vision, which we derive from our duties, is:

"A sustainable water cycle in which we are able to meet our needs for water and sewerage services while enabling future generations to meet their own needs"

We cannot achieve this vision without adequate consideration of climate change adaptation. Our strategy explains how adapting to climate change is one of a number of major challenges that we face. It sets out the following goals for how we aim to address these.

- Ensuring a fair deal for customers.
- Keeping companies accountable.
- Making monopolies improve.
- Harnessing market forces;
- Contributing to sustainable development.
- Delivering better regulation.

Our programme of work is organised around achieving these goals.

We set out our overall policies with regard to climate change in our 2008 climate change policy statement, which covers both adaptation and mitigation issues. We highlighted the expected impacts of climate change on the water and sewerage sectors, and explained the actions and approaches we would adopt in order to deal with those challenges. Examples of the ways in which we have applied those policies can be seen in the outcome of our 2009 price review, which considered climate change risks and adaptation measures.

1.2 Key objectives of this document

The primary objective of this document is to satisfy the requirements of the statutory direction by providing:

- an assessment of the current and predicted impact of climate change in relation to our functions (including a summary of our functions, the methodology used for the assessment and our findings); and
- a statement of our proposals and policies for adapting to climate change in the exercise of our functions and timescales for introduction.

We also:

- present a reliable prioritisation of climate change risks to the sectors that we can use to inform our work;
- promote sound science by highlighting key uncertainties and areas for improvement in understanding;
- explain the ways in which we currently incentivise and enable the companies to cope efficiently with a changing climate;
- identify barriers and explain our response to them, and make recommendations for further work where appropriate;
- establish an internal process we can use in future to evaluate climate change risks and monitor how these change over time; and
- Inform our next climate change policy statement and our methodology for the next price review.

As specified under the Climate Change Act 2008, we will have regard to this report when carrying out our functions in the future.

We do not prescribe specific adaptation actions for the companies we regulate. They are responsible for delivering water and sewerage services now and in the future; our role is to protect consumers and incentivise the companies to deliver the service sustainably and efficiently.

There are limits to the robustness of any climate change risk assessment. Ours focuses on prioritising climate change risks relative to each other. It cannot be used as an indication of how much the companies are expected to spend on adapting to climate change. Nor can it be used to determine what the specific scale of impact on service will be. This is because of inherent uncertainty about the future that is not only related to climate change, but also in other drivers that will affect the sectors. For the purposes of this document, we have assessed additional climate change impacts and have generally assumed external circumstances remain static.

1.3 Our overall approach to adaptation

Adaptation is action that helps an organisation cope with the effects of climate change. It can take the form of delivering solutions on the ground to protect services directly, or institutional change. In our case, adaptation means institutional change. We would fail to achieve our strategic vision of sustainable water if we did not consider the risks from climate change when we made our regulatory decisions.

In the water and sewerage sectors, it is the companies that must adapt in order to meet their obligations. As the economic regulator, our role is to provide the right regulatory incentives to enable them to do this in an effective, efficient and equitable way, and to take action if the companies fail to meet their obligations.

We set out our approach to adaptation and explain who our key stakeholders are in this area in more detail in the supporting process document.

2. Risk assessment

2.1 Focus of the assessment

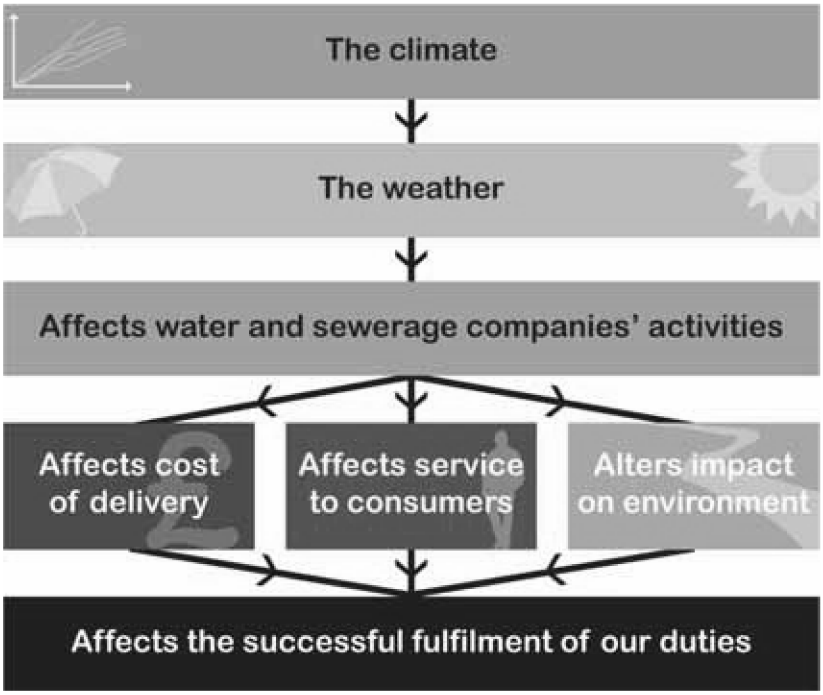
Under our direction to report, we have been tasked to produce "an assessment of the current and predicted impact of climate change in relation to [our] functions"

To do this, we have developed our understanding of how changes in the climate affect our regulatory functions. This requires an understanding of how the weather affects service, and how climate change will affect future weather patterns.

For the purposes of this document, we have taken our functions to mean all the actions that we carry out in order to contribute towards achieving sustainable water and hence fulfil our legal duties.

Because it is the companies we regulate that are responsible for delivering services, the relationship between the weather and our functions is indirect. We illustrate this in the diagram below.

Figure 1 How the climate affects us



As the diagram shows, the main ways in which the weather, and hence climate change, affects us is by having an impact on the companies' service, cost or environmental impacts.

In 'Allocating risk and managing uncertainty in setting price controls for monopoly water and sewerage services – a discussion paper', which we published in October 2010, we identified eight broad categories of risk in the sectors. This assessment builds on these categories. Of the eight that we outlined, environmental and operational risks are most affected by weather and climate. Climate change may also influence political and regulatory risks.

We have identified three main ways in which the weather (and hence climate change) can adversely affect the successful operation of our functions. These are:

- directly by hampering Ofwat's day-to-day functions. We explain these risks in the text box below;
- indirectly, by affecting the ability of the sectors we regulate to deliver water and sewerage services over the long term; and
- indirectly, by affecting the views and decisions of stakeholders in a way that influences our work.

Direct weather risks to Ofwat

We include in our internal processes the direct risks from climate change to our organisation's day-to-day work.

Currently, and in the medium term, we have assessed the direct weather risks to our work as low. This is primarily because of the very low likelihood of significant impacts, given the nature of our working practices and our existing capacity. Most of our work is desk or communication based. So, the main threats are to staff getting to the office and widespread communication system failures.

Our Birmingham office is at little risk of fluvial flooding, but there is some potential direct threat to our smaller office near to the Thames in London. In case of significant disruption to our main office, we have access to a disaster recovery centre. From this site, we can continue to operate until the main office becomes useable again.

We have provision for home working, directly mitigating many weather risks – especially the risk of disruptions to the transportation system. Also, much of our work has relatively long lead times. This means that temporary disruptions caused by extreme weather are unlikely to pose a significant threat to our duties. This gives us substantial capacity to cope with the weather.

We recognise that climate change is a major risk to the sectors on which we rely to carry out our day-to-day activities (such as the rail network and electricity distribution). But assessing these risks is beyond the scope of this document. In the near term, we operate on the assumption that these services will remain predominantly reliable. We review the risks to our organisation periodically.

The table below summarises the three main types of climate change risk that our organisation faces, and the assessment approaches we adopted for each type.

Table 1 How we have assessed different types of risk

Risk type	Primary risk bearer	Description	Response characteristics	Assessment approach
Direct operational and environmental	Ofwat	Risks of weather directly affecting our day-to-day work	Business operations – short-term management (<5 years)	Corporate planning – see text box on page 7
Indirect operational and environmental	Companies	Affects the water and sewerage operations and networks, which affects the companies' ability to deliver services. This in turn affects whether our functions are achieved successfully	Regulatory decisions affecting both the short and long term	Specific climate change risk assessment
Indirect political and regulatory risks	Stakeholders	Changing views and decisions of key stakeholders, which influence our work	Business decisions – short-term management (<5 years)	Organisational risk assessment, which is incorporated into our risk register

In terms of our duties, the two indirect categories of risk are by far the most important. We can only achieve our functions successfully if the sectors we regulate can systematically cope with the weather. So, we have focused on these risks. But we also recognise that climate change is likely to affect the views and decisions of other stakeholders. This can have a significant impact on the successful operation of our functions in terms of resources and processes.

To reflect the differences between the two types of indirect risk we have outlined above, we have carried out two risk assessments.

The first seeks to understand the indirect risks from climate change to our functions, based on assessing the relationships between weather, the water and sewerage companies' activities and us (as illustrated in figure 1). This is our most important risk assessment. We have set out our process for doing this, together with a detailed description of the risks and how we assessed them in the supporting process information that accompanies this document.

We have also considered the indirect political and regulatory risks associated with climate change issues. Impacts of these risks will usually be in the form of internal resource requirements. We have used our corporate risk assessment process to assess these risks.

We have incorporated the indirect political and regulatory risks we have identified into our organisational risk register. Our priority organisational risks are managed as part of our business.

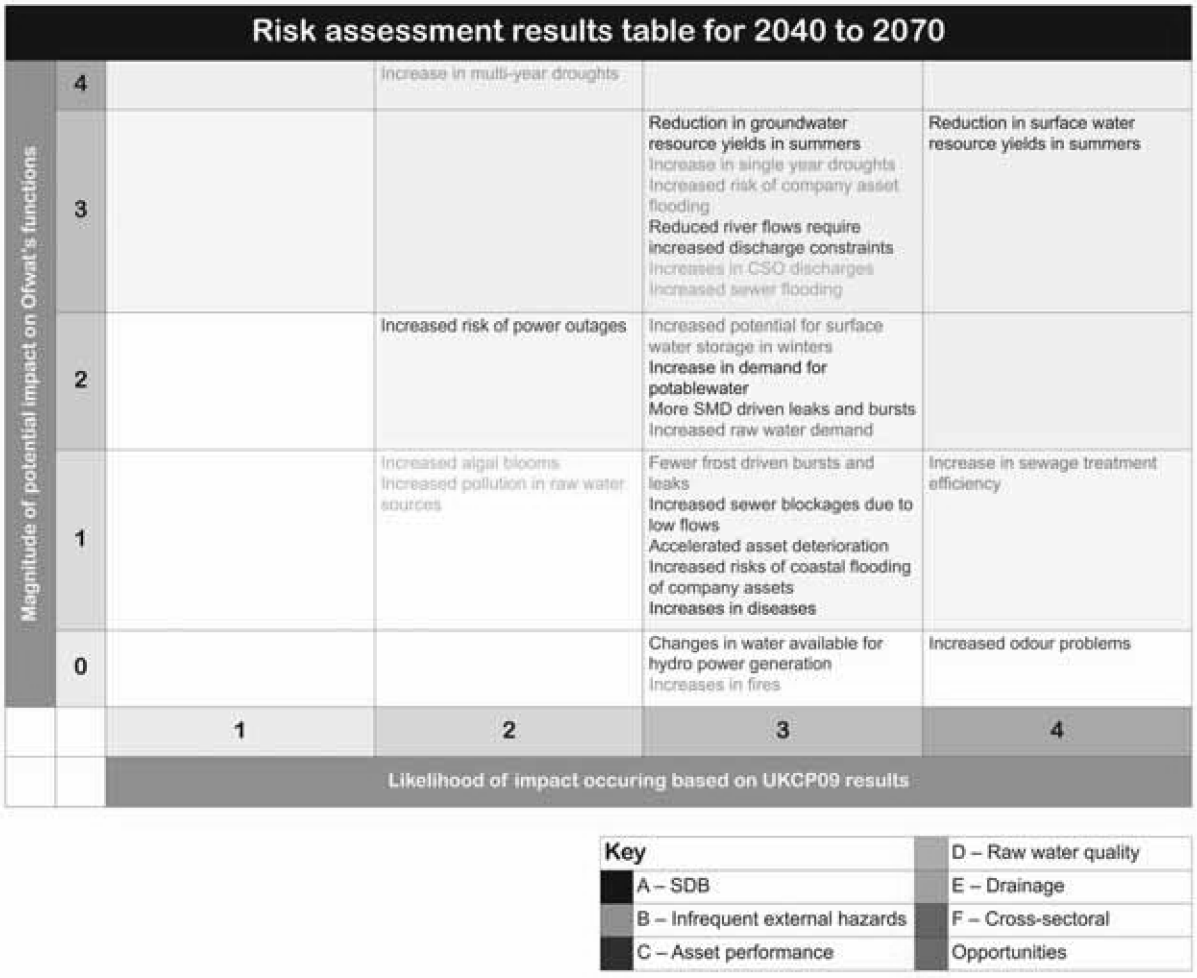
2.2 Climate change risks

Figure 2 below sets out the main indirect operational and environmental climate change risks to us by the 2050s. This shows the relative likelihood and impact of each risk. We give brief descriptions of each of these risks below. This includes the opportunities we identified.

Each of these risks has a potential impact on the successful achievement of our functions. This will typically manifest itself through increases in environmental damage, service failures or through customers' bills.

We have grouped the identified risks into categories where the nature of the impacts are closely related. For example, changes in surface water flows, groundwater supplies and domestic demand all have an impact on a company's supply/demand balance and are therefore grouped under one heading.

Figure 2 Risk assessment results



2.2.1 Category A – Managing the supply/demand balance

- A1 Reduction in surface water resource yields in summers. Changing rainfall patterns and increased temperatures are likely to reduce the surface water available for abstraction throughout the year, and particularly in summer. This increases conflicts between meeting demand and protecting the environment.

- A2 Reduction in groundwater resource yields in summers. Groundwater sources are more resilient to climate change than reservoirs and materially more resilient than rivers. However, changes in rainfall volume and intensity are expected to reduce groundwater recharge rates, as well as increase the risks of saline intrusion into coastal aquifers.

- A3 Increase in demand for potable water. Increasing temperatures and reduced rainfall is expected to lead to increased demand for water from household and non-household consumers, and particularly affect demand peaks. However, the forecasts in this area remain highly uncertain.

- A4 Increased potential for surface water storage in winters. Increased rainfall in winter will present an opportunity for water resource planners as it increases the amount of water that can be captured and stored in winter.

2.2.2 Category B – Infrequent external hazards

- B1 Increases in single year droughts. Reductions in rainfall during summer months increase the risks of droughts, especially where the companies rely heavily on abstracting surface water.

- B2 Increases in multi-year droughts. Changing rainfall patterns increase the chances of several consecutive seasons of below-average rainfall. If winter rainfall fails to recharge aquifers and surface water resources, this can lead to significant reductions in the water available for use.

- B3 Increased risk of company assets flooding. On average, rainfall is expected to increase in winter and heavy downpours will be more frequent. This will increase the chances of the companies' assets becoming flooded because about 55% of them are on flood plains. Flooding can cause serious supply failures, lost revenue and reactive costs.

2.2.3 Category C – Asset performance

- C1 More soil moisture deficit (SMD) driven bursts and leaks. Soils will increasingly dry out in the summer, causing ground movement and cracking. In winter, soils will more often become waterlogged, which will also increase ground movement. Both of these effects increase the stresses on underground pipes, increasing the levels of leaks and bursts. This is exacerbated where changes in soil moisture content occur rapidly, rather than gradually.

- C2 Fewer frost-driven bursts and leaks. Milder winters are likely to result in fewer pipes busting. This is because the ground around the pipes – or the water in them – will freeze less frequently. This effect is beneficial in that it will mean fewer leakage and bursts during winters, when maintenance and planning can be more difficult.

- C3 Increase in sewage treatment efficiency. The biological and chemical processes involved in many sewage treatment processes work more efficiently at higher temperatures. So, increases in average temperatures may reduce treatment costs to a limited extent.

- C4 Increased risks of coastal flooding of company assets. Rising sea levels and changes in rainfall patterns will increase coastal erosion in many places. They will also increase the risk of flooding to coastal company assets. There is a strong interaction with coastal defence policies on this risk.

- C5 Reduced river flows require increased discharge constraints. Reduced summer rainfall will have significant impacts on river flow levels. This reduces the capacity of rivers to dilute pollution. Increased treatment or changes to operational procedures for releasing effluent will be required in order to maintain river water quality.

- C6 Accelerated asset deterioration. Changes in average temperatures and volumes of water, particularly in the sewers, can put increased stress on assets, affecting asset lifetimes. This can cause increases in costs, as assets need replacing or refurbishing more often.

- C7 Increased odour problems. Higher temperatures, particularly in summer, may drive increased septicity problems and result in more odour nuisance near treatment works. Odour problems can be expensive to solve.

- C8 Changes in water available for hydro power generation. Changes in the patterns of rainfall in particular may affect the operation of hydropower generation assets. But the net effect over a year is likely to be small.

- C9 Increases in fires. Warmer, drier summers may increase fire risk marginally. But the additional effect is likely to be low.

2.2.4 Category D – Raw water quality

- D1 Increased pollution in raw water sources. Increases in extreme rainfall events can reduce water quality by washing more agricultural and urban pollution into raw water sources, particularly during 'first flush' events. This can either increase the costs of treating raw water or cause drinking water quality problems.

- D2 Increases in waterborne diseases. Higher temperatures, reduced numbers of frost days and more heavy downpours can increase the prevalence of waterborne diseases. This is especially important as it can lead to more cryptosporidium washed into raw water sources, which is particularly difficult to remove.

- D3 Increased algal blooms. Climate change may increase the occurrence of algal blooms, which can cause water treatment issues and environmental problems.

2.2.5 Category E – Drainage

- E1 Increases in combined sewer overflow (CSO) discharges. Increased rainfall in winters and increases in the frequency of heavy downpours will increase the number of CSO discharges. In some circumstances, they can cause environmental damage, particularly if the dilution capacity of the receiving water is low.

- E2 Increased sewer flooding. Increases in the frequency and intensity of rainfall will increase the risks of combined sewers not being able to cope with the volume of water entering them. This can contribute to surface water and sewer flooding in and around properties. Blocked CSOs because of high river flows or rising sea levels can further exacerbate this problem. These issues can be very expensive to solve, particularly if no action is taken to tackle drainage in the wider urban environment.

- E3 Increased sewer blockages due to low flows. Reduced summer rainfall leads to lower flows within sewers. This increases the amount of suspended solids that settle inside the pipes, leading to more sewer blockages.

2.2.6 Category F – Cross-sectoral

The companies we regulate depend on a range of other services and products, including:

- communications;
- chemicals; and
- transport infrastructure.

They rely on a range of sectors across the economy being able to cope with climate change risks. We have set out the most important such risks below.

- F1 Increased risk of power outages. The energy sector faces significant risks from climate change, such as increased risk of asset flooding and changes to demand. Interruptions to energy supply prevent the effective operation of the assets of many water companies. More risks to energy supply will result in service failures, increased cost and/or increase the importance of backup arrangements.

- F2 Increased raw water demand. Public water supply is not the only reason for abstraction of raw water. Agriculture may react to climate change in a number of ways that could have a material impact on demand for raw water resources, especially during the summer months. Power stations also use sea and river water as a coolant for nuclear, coal and gas power stations. As surface water temperatures increase, they require a larger volume of water to achieve the same cooling effect, which may increase competition for abstraction.

2.2.7 Category G – Finance

Where climate change has an impact on the companies' operations or costs, this could affect their ability to finance necessary investment. There are two main risks in this area.

- The risk that climate change affects the cost of finance in the sectors.
- The risk that the companies are unable to finance the additional investment necessary to deal with the risks presented by climate change.

We screened these out from the full risk assessment as they are inherently determined by relatively short-term changes to regulatory decisions and economic circumstances rather than long-term climate change. The approach we take to regulation in the context of climate change can affect the cost and feasibility of raising finance on reasonable terms. The most significant risks in this area will only occur if we fail to remunerate the companies appropriately for necessary investments (either through our cost assumptions, the cost of capital or through changes to our price limits) or if we fail to balance risk adequately. This not a climate change-driven risk in its own right.

It is possible that additional costs required to deal with the climate change risks may be so large as to be unfinanceable, or financeable only at very high cost. This risk is related particularly to the 'lumpiness' of any necessary investment and the importance of other competing drivers. This risk is assessed as low in the short to medium term, provided the companies adapt to climate change in a stable and efficient way. We describe this issue in more detail in 'Financeability and financing the asset base', a discussion paper that we published in March 2011.

3. Prioritising risks and identifying actions

So that we can regulate in a proportionate way, we need to focus on areas that carry the most material risks to the delivery of our duties. In order to determine whether we should take action, we need to establish which risks our regulatory framework needs to be able to cope with and which we can ignore.

3.1 Priority risks

The supporting process document that accompanies this paper sets out the method we have used to prioritise climate change risks. Using this method, we have separated the risks into three broad categories.

- High-priority risks, which have the potential to drive significant increased future costs and/or service failures. These risks will be the focus of our actions to enable adaptation.
- Medium-priority risks, which have the potential to drive non-trivial increased future costs and/or service failures. So, we should help to manage these risks by enabling adaptation to deal with them.
- Low-priority risks, which are considered to be minor because of very low impact or likelihood or, more usually, both. We expect these risks to be dealt with within existing capacity.

Table 2 below shows how we have categorised risks into different priority categories. This document concentrates on the high and medium risks. We have summarised how we have dealt with each of the medium and high risks in section 5.5.

Low-priority risks are of marginal impact to us and the successful operation of our duties. In most cases, they are risks over which we have very little influence. We expect the companies to treat these as normal business risks.

In the case of opportunities, we judged that we would simply accept them in all cases but not rely on them. As with other risks any material benefits from these opportunities will be shared between customers and companies through the regulatory system.

Table 2 Prioritisation of climate change risks

High-priority risks	Medium-priority risks	Low-priority risks
A1 Reduction in surface water resource yields in summer	A3 Increased demand for potable water	C7 Increased odour problems
A2 Reduction in groundwater resource yields in summer	C4 Increased risk of coastal flooding of company assets	C8 Changes in water available for hydropower generation
B2 Increases in multi-year droughts	C1 More soil moisture deficit (SMD) driven leaks and bursts	C9 Increases in fires
B1 Increases in single-year droughts	F2 Increased raw water demand	D1 Increased pollution in raw water sources
B3 Increased risk of company assets flooding	E3 Increased sewer blockages because of low flows	D3 Increased algal blooms
C5 Reduced river flows require increased discharge constraints	D2 Increases in waterborne diseases	
E1 Increases in combined sewer overflow (CSO) discharges	F1 Increased risk of power outages	
E2 Increased sewer flooding	C6 Accelerated asset deterioration	
	C2 Fewer frost driven busts and leaks	
	A4 Increased potential for storage of surface water in winters	
	C3 Increase in sewage treatment efficiency	

3.2 Identifying actions

The risk assessment enables us to prioritise the risks from climate change to the successful operation of our functions. We have used the findings of our risk assessment to identify which further actions we need to take.

The first step was to identify the types of action we, as an economic regulator, can take. This is important because we are not a delivery body of adaptation on the ground. We need to do this in order to understand how we can, as the guidance states, "set the right underlying framework for adaptation" and "create the information needed to make effective decisions".

There are three main types of actions that an economic regulator can take to enable adaptation. We have set these out (with examples) in the table below.

Table 3 The types of adaptation action we can take

Type of action	Aims	Examples of actions
Enabling adaptive action	Set the right regulatory incentives and outputs for effective adaptation	• Existing and establishing incentives • Setting outcomes and outputs • Specific regulatory decisions • Investigating reforms • Compliance and enforcement activity
Building adaptive capacity	Improve our own understanding and the evidence base available to the companies	• Recommend or promote research • Business case expectations • Direct support for research or investigations
Monitoring and evaluation	Monitor the risks and the companies' performance to inform our own and others' actions	• Indicators of the companies' performance • Targeted investigations and studies • Reappraisal of our own risks and plans

Having identified the actions we can take, we went through several steps to arrive at our adaptation action plan. We describe these steps in more detail in the process document that supports this paper. In summary, we considered:

- the existing regulatory system;
- existing barriers; and
- our ongoing programme of work.

After understanding how these interacted, we developed an action plan.

Adaptation is a continual process and there are no actions that we can take to eliminate completely the priority risks we have identified. The most important thing we can do to enable adaptation is to establish the right incentives. We need to think about climate change as part of our core activity if we are to do this effectively.

4. The underlying framework for adaptation

This chapter summarises the findings from our review of our regulatory framework. It also explains our future regulation programme. We summarise:

- how our regulation operates in relation to climate change risks;
- some of the key barriers to adaptation in our sectors that we identified;
- how our future regulation programme of work contributes to adaptation.

4.1 Adaptation and the existing regulatory framework

This section considers the regulatory framework that operated in the last price review (PR09). We are currently re-examining this framework, which may result in significant changes.

We do not have specific adaptation incentives. So to understand how we enable adaptation, we identified how the companies are incentivised to adapt to the climate change risks we have identified. We also needed to understand any gaps in the regulatory framework or perverse incentives that may impede the companies from adapting successfully.

Here, we explain the main mechanisms and regulatory policies that are relevant to climate change risks. These include both direct and indirect incentives. We have indicated which climate change risks each one helps to address.

4.1.1 Price reviews

Covers all risks

We set price limits to protect customers. The price review framework means that there are regular reappraisals of performance that take account of improved understanding and future risks. The framework also provides a set of incentives for the companies to plan effectively and efficiently and the means to finance necessary investment. The approach we take is designed to allocate risks efficiently and incentivise the companies to find solutions to mitigate risks and carry out activity as efficiently as possible. This general model has worked well over the past twenty years to improve service and address emerging risks in the sectors.

As part of the last price review, the companies also had to produce long-term strategic direction statements. These plans described how they planned to deal with future challenges. This has helped shift focus away from the five-year horizon of price limits and encouraged the companies to communicate their long-term plans to customers. Strategic direction statements included specific consideration of climate change.

Further information: http://www.ofwat.gov.uk/pricereview/

4.1.2 Measurement by service outcomes

Covers all risks

Following a price review, we monitor the companies' performance. This allows us to track progress regularly and take action if they fail to deliver the service customers have paid for. Guaranteed service standards also mean that compensation is provided to customers who do not receive adequate service. The service customers receive will be the primary measure of whether or not adaptation is successful. It will remain important to understand whether customers receive adequate service in a changing climate so that we can take appropriate and proportionate action.

Further information: http://www.ofwat.gov.uk/publications/los/rpt_los_2009-10

4.1.3 The service incentive mechanism

E2 – increased sewer flooding

C7 – increased odour problems

This mechanism focuses on customer service. It provides direct financial incentives for the companies to provide service that meets their customers' expectations. Because it operates irrespective of external risks – meaning there are no exemptions for extreme weather events – it incentivises the companies directly to be resilient to climate change.

Further information: http://www.ofwat.gov.uk/publications/prs_web_1003sim

4.1.4 Monitoring serviceability

E2 – increased sewer flooding	E3 – increased sewer blockages due to low flows	C2 – fewer frosts-driven bursts and leaks	C1 – more SMD-driven bursts and leaks	C6 – accelerated asset deterioration

Serviceability is a measure of the companies' asset and service performance. It can be used to provide early warnings of problems that might be driven by climate change. The measures can also be used to track the ultimate success of adaptation measures.

Further information: http://www.ofwat.gov.uk/publications/los/rpt_los_2009-10 (in chapter 6 of the supporting information).

4.1.5 The security of supply index

A1 – reductions in surface water resource yields	A2 – reduction in groundwater resource yields	A3 – increased demand for potable water

The security of supply index comprises a number of measures that give a picture of current risks and should reveal emerging supply/demand balance issues, including those driven by climate change. While the specifics of this measure and how it is reported might change over time, some indicator of the companies' ability to meet demand is needed. This is so that we and customers can know whether or not the companies have adapted adequately to meet demand.

Further information: http://www.ofwat.gov.uk/publications/los/rpt_los_2009-10 (in chapter 5 of the supporting information).

4.1.6 The change protocol

Covers all high-priority risks

The change protocol provides specific mechanisms that enable the regulatory framework to react flexibly to significant changes that occur between price reviews and hold the companies to account for failing to deliver outputs.

Further information:
http://www.ofwat.gov.uk/pricereview/pr09phase3/gud_pro_ddchgprotocol2010.pdf

4.1.7 Notified item for climate change

All category A supply/demand risks

At PR09, we included a notified item that will allow the companies to apply for an interim determination of price limits (IDoK) if they can provide evidence that they need to make significant new investments before the next price review to cope with the impacts of climate change on the balance of supply and demand.

Further information: http://www.ofwat.gov.uk/publications/rdletters/ltr_rd1310idok

4.1.8 Leakage and water efficiency targets

A1 – reduction in surface water resource yields | A2 – reduction in groundwater resource yields | C1 – more SMD-driven bursts and leaks | C2 – fewer frost-driven bursts and leaks | A3 – increased demand for potable water

We set specific targets on leakage and water efficiency to promote increased demand reduction activities. This is part of a twin-track approach to incentivising a secure supply/demand balance in the future. We set the targets in the context of long-term water resource management planning, which includes consideration of climate change.

Further information: http://www.ofwat.gov.uk/publications/los/rpt_los_2009-10

4.1.9 Metering

A1 – reduction in surface water resource yields | A2 – reduction in groundwater resource yields | A3 – increased demand for potable water

We think that metering is the fairest method of charging customers. We also recognise that it helps to reduce demand. This is because metered customers are incentivised directly to reduce waste and charges can be tailored more specifically to influence their behaviour. This is particularly important in areas that might be subject to future water stress because of climate change. We advocate increased metering where this is the most economic way to balance supply and demand for the future.

Further information: http://www.ofwat.gov.uk/sustainability/waterresources/metering/

4.1.10 Resilience to external hazards

B3 – increased risk of company assets flooding

C4 – increased risk of coastal flooding

It is important that the water and sewerage services are resilient to external hazards such as floods. We recognise the importance of resilience and the companies are already delivering greater protection to customers and the environment. We have encouraged best practice in this area, which includes the consideration of climate change within resilience proposals.

Further information:
http://www.ofwat.gov.uk/sustainability/climatechange/prs_web_1011resilience

4.1.11 Revenue correction mechanism

A3 – increased demand for potable water

Adapting to climate change risks in an efficient way is likely to require water efficiency measures to reduce demand as part of a twin-track approach to balancing supply and demand. We introduced the revenue correction mechanism so that the companies were not perversely incentivised to increase demand. This means that they will not recover less money through price limits if customers reduce their consumption.

Further information:
http://www.ofwat.gov.uk/pricereview/pr09phase3/ltr_pr0931_revcorrectmech

4.1.12 Enforcement

Covers all risks

We have a range of enforcement powers that we use to hold the companies to account. If they fail to adapt – and fail to meet their obligations as a result – we will take action to secure compliance where it is proportionate to do so. The threat of enforcement actions is a powerful incentive for the companies to meet these obligations.

Further information: http://www.ofwat.gov.uk/regulating/enforcement/

4.2 Key regulatory mechanisms operated by other regulators

As well as our own regulation and the legal obligations in place, we also rely on other regulators to act in a way that enables the sectors to adapt. We have set out below the most important mechanisms that other regulators operate, together with the relevant stakeholders and the main climate change risks that they should help to manage.

Table 4 Key areas where we rely on other regulators

Regulatory mechanisms	Key stakeholders	Relevant climate change risks	Further information
Water resource management plans	Environment Agency, Defra, Welsh Government	• All category A supply/demand risks (high) • B1, B2 – single- and multi-year drought risks (high)	http://www.environment-agency.gov.uk/business/sectors/32425.aspx
Drought management plans	Environment Agency, Defra, Welsh Government	• B1, B2 – single- and multi-year drought risks (high)	http://www.environment-agency.gov.uk/business/sectors/123024.aspx
Surface water management planning	Local authorities, Defra, Welsh Government, Environment Agency	• E1 – increases in CSO discharges (high) • E2 – increased sewer flooding (high)	http://archive.defra.gov.uk/environment/flooding/manage/surfacewater/plans.htm
Abstraction licensing	Environment Agency, Defra	• A1 – reduction in surface water resource yields (high) • A2 – reduction in groundwater resource yields (high) • B1, B2 – single- and multi-year drought risks (high) • F2 – increase demand for raw water (medium)	http://www.environment-agency.gov.uk/business/topics/water/32026.aspx
Environmental quality regulations	Environment Agency,	• C5 – reduced river flows (high)	http://www.environment-agency.gov.uk/business/

	Defra	• E1 – increases in CSO discharges (high) • F2 – increased demand for raw water (medium)	regulation/31833.aspx
Drinking water quality regulations	Drinking Water Inspectorate	• D2 – increase in waterborne diseases (medium) • D1 – increased pollution in raw water sources (low)	http://www.dwi.gov.uk/
Coastal flood and erosion management	Environment Agency, Local authorities	• C4 – increased risk of coastal flooding (medium)	http://www.environment-agency.gov.uk/homeandleisure/107621.aspx
Security and Emergency Measures Directive	Defra	• B3 – increase risk of company assets flooding (high) • E1 – increases in CSO discharges (high) • C4 – increased risk of coastal flooding (medium)	http://www.defra.gov.uk/corporate/about/how/contingency/topics/water-supply.htm

4.3 Barriers and interdependencies

In this section, we set out the primary barriers that we have identified and explain how we seek to overcome them. We also discuss the interdependencies. Where we consider a barrier presents a material problem for adaptation, we have explained how we seek to address it. But overcoming many of these barriers – particularly on capacity – requires action across the sectors.

4.3.1 Uncertainty

Adaptation to climate change will always be subject to uncertainty. This is because of the complex nature of the climate system and feedback mechanisms and the long timescales.

This uncertainty can be in the form of actual 'randomness' and natural variability or uncertainty in data, modelling or assumptions. The UKCP09 scenarios present this as an inherent part of the scenarios, making it possible to build the uncertainty into a risk-based approach.

As well as the scale and impact of climate change itself, there are a range of other future uncertainties that are unrelated or only partially related to climate change, but which will have an impact on adaptation in the sectors. These include the following.

- Demographic change, the future projections for which indicate a significant challenge to the companies and increase the uncertainty.
- Historic and future increases in the amount of hard-standing area ('urban creep') presents significant problems for ensuring that the sewer and surface water drainage systems can cope with existing pressures and climate change.
- Meeting requirements of European legislation, such as the Water Framework Directive, needs careful prioritisation of investment and requires balancing of both mitigation and adaptation drivers.

Uncertainty can result in wasted resources, ineffective solutions or paralysis. Dealing with it requires effective risk management by the companies, based on a clear set of objectives and a proportionate use of the best available information. Similarly, we will regulate based on a balanced appraisal of the risks, taking into account the best available evidence. We can help to reduce the problem of uncertainty by improving our knowledge and understanding. We discuss actions to improve adaptive capacity in the sectors in section 5.2.

4.3.2 Information asymmetry

A problem for us in making regulatory decisions is our position of information asymmetry. While we can provide guidance and direction to the companies, we can only make decisions based on the quality of the information and business plans they provide to us. Addressing this barrier does not mean simply collecting more information. It means improving our understanding as a regulator and incentivising the companies to reveal information. As we explain in section 4.4, ensuring we have the right information is a major aim of our regulatory compliance project.

4.3.3 Cost

To protect the services that customers receive, there are likely to be costs associated with adapting the sectors to climate change. This means the incentives for investment must remain strong. As customers will pay for this investment we have to make sure that it delivers legitimate benefits to those customers. The actual impact on bills will depend on:

- all the different cost drivers;
- the degree of climate change, and
- other future circumstances.

We have to regulate in a way that incentivises the companies to adapt in an efficient manner that reflects their customers' needs.

The level of customers' bills will influence the pace of adaptation. For some people, the affordability of their water and sewerage bills is already a problem. The national context is also important – other prices and bill increases are placing additional pressure on household budgets. For example, rising energy bills to finance low-carbon energy generation may exacerbate affordability problems in the water and sewerage sectors. In order to fulfil our functions, customers' bills must be affordable and represent value for money. We work with the companies, customers and their representative bodies to find ways to enable this.

4.3.4 Economic justification for adaptation

It is difficult to define and measure adaptation outcomes and arrive at economic justifications for adaptation actions. The key challenges relating to economic justification for adaptation are:

- valuing and including future uncertainty in a quantitative cost-benefit analysis;
- assigning values to adaptation benefits that usually occur far in the future or are environmental in nature (this includes the difficulties in applying willingness to pay methods); and
- the use of discount rates, which reduce the relative value of long-term adaptation benefits.

This presents an issue for the companies when preparing business cases. It is also an issue for us when we consider:

- policy options;
- our incentive framework; and
- the companies' investment proposals.

Related to this is the inherent difficulty in monitoring success. Both we and the companies need to seek ways to address these problems. We are currently considering these issues as part of our future regulation programme, including how we should take customers' views into account when we set price limits in the future. We also have several actions relating to this, which we explain in chapter 5. Ultimately, effective adaptation will require some degree of judgement and assumption. We recognise that it is necessary to make some assumptions in long-term planning.

4.3.5 Corporate memory

Corporate memory is important for climate change adaptation because there is likely to be a significant time-lag between when solutions are implemented and when benefits are realised. This applies both to the effectiveness of our regulatory framework and the actions of the companies. Without good corporate memory, information on adaptation actions can be lost over time. We need to have good internal systems and processes in place.

4.3.6 Balancing the needs of the environment

There are occasions when conflicts between policy objectives arise and our risk assessment indicates that climate change will exacerbate some of these conflicts. For example, there is increasing tension between the need to abstract water for public use and the need to prevent environmental damage. This requires balanced analyses of social, environmental and economic considerations. It can be very difficult to do this if environmental impacts and tolerances are not clear. If environmental limits are overly onerous or based on poor evidence, this can cause significant social and economic problems.

Where environmental limits are involved, it is helpful for an authoritative body to establish robust boundaries based on the best available evidence. This provides a more certain context for decision-making and – as long as the limits are well-set – reduces the risk of environmental damage. Market mechanisms may be used within the context of these environmental limits to help achieve the most efficient solutions.

In many areas, including water resources, regulating environmental limits is the role of the Environment Agency. Where those environmental limits are set and understood, it becomes easier for us and the companies to find and execute the most efficient solutions to achieve sustainable water and sewerage services.

4.3.7 Interdependencies

The extent to which climate change has an impact on us fulfilling our functions successfully will depend – in part – on the actions of others. This creates additional uncertainty for us. The most important interdependencies identified in our risk assessment relate to the companies we regulate, but also to:

- the other regulators;
- the supply chain;
- non-public water supply consumption; and
- the various agencies involved in managing surface water.

There are also clear interdependencies in terms of the resilience of other critical infrastructure providers. Stable service in the future depends upon the energy and communications sectors in particular managing the climate change risks to their functions. We discuss this further in chapter 5.

4.4 Future regulation

To deliver our strategy, we are currently carrying out several projects on the future of regulation in the sectors. These projects form our future regulation programme. They consider issues such as how price limits will work in future and how regulatory compliance will operate.

This section discusses the key areas of focus for the future regulation programme and explains how our work relates to adaptation. As in 4.1, we have highlighted the priority risks each area of work is expected to help manage.

4.4.1 Future price limits

Covers all risks

With this project, we are reviewing the way we set price limits. We are investigating how we carry out price controls in the future to better meet our strategic aims. This means creating a flexible framework that enables the companies to finance investment needed to deliver sustainable services efficiently.

This includes investigating options such as changing the length of the price control period and setting separate price controls for different business activities in the sectors. We are also considering how we can incentivise the companies to achieve higher-level outcomes rather than specific outputs. We are also investigating other issues, including:

- financeability;
- customer engagement; and
- approaches to the assessment and recovery of operating and capital expenditure.

We will formally consult on our approach to future price limits later this year.

The way we set price limits will affect both the allocation of climate change risks and the incentives to adapt. For example, we could consider longer price control periods. This might promote more innovation and phased adaptation. But it may mean that we have fewer opportunities to take account of unexpected changes, materialising risks and improved knowledge. We are considering the approaches we can take to allocate and incentivise the companies to manage risks such as climate change as part of our work.

Further information: http://www.ofwat.gov.uk/future/monopolies/fpl/

4.4.2 Regulatory compliance

Covers all risks

Our regulatory compliance project focuses on improving the way we monitor and secure compliance. We intend to do this by developing a risk-based approach that reduces the overall regulatory burden and focuses regulatory effort on areas of high risk. We want the companies to be directly accountable to their customers, but – at the same time – we need to understand the companies' success in dealing with significant risks such as climate change, so that we can act where it is necessary and proportionate for us to do so. The project includes work to develop some key performance indicators for the sectors. This may include one for adaptation.

The aims of the project fit well in the context of climate change. In areas of low risk or where a company has proven able to adapt successfully, we will expect the companies to understand and manage those risks, without being subject to significant regulatory scrutiny. But in areas where there is a high risk – for example, in the area of water resources – or where a company cannot demonstrate that it is adapting well, we will continue to use a broad range of regulatory tools to monitor and incentivise compliance.

Further information:
http://www.ofwat.gov.uk/publications/focusreports/prs_web_1011regcompliance

4.4.3 Sustainable drainage

E1 – Increases in CSO discharges	E2 – increased sewer flooding	E3 – increased sewer blockages due to low flows

Given the range of pressures over the next few decades, the existing drainage system will not be able to cope with the climate change risks we have identified. Simply upsizing the sewer system in response to this threat is unsustainable, not least because it would be prohibitively expensive. For this reason, adaptation in this area will require multiple organisations to work together. This project helps develop understanding and considers how we can incentivise more sustainable solutions to drainage.

Further information: http://www.ofwat.gov.uk/future/sustainable/drainage

4.4.4 Future water charging

A1 – reduction in surface water resource yields	A2 – reduction in groundwater resource yields	A3 – increased demand for potable water

This project is driven by concerns about affordability, bad debt and future challenges such as climate change. It also considers what we can do to reduce waste and manage demand. So, it has significant potential to help to address the supply/demand balance risks from climate change. For example, the project explores how far and how best metering can play a part in reducing demand, and how charges could be arranged to incentivise reductions in demand.

Further information: http://www.ofwat.gov.uk/future/customers/metering/

4.4.5 Valuing water

A1 – reduction in surface water resource yields	A2 – reduction in groundwater resource yields	A3 – increased demand for potable water	F2 – increased demand for raw water

Currently, customers pay for the cost of delivering the service rather than the water itself. This means that we do not know the value of water. This may be a barrier to adaptation because it means that there is a lower incentive to reduce the extent to which water is wasted. The lack of geographic and temporal differences in the value of water can lead to over-abstraction in locations and at times where water is scarce and a surplus in other areas and at other times. This is because the value of water has not been appropriately taken into account in decisions over where and when to abstract or use water.

We are investigating means by which we can reveal a value for water and enable and incentivise its use in the companies' decision-making. This has the potential to promote more efficient adaptation by reducing the amount of water wasted and maximising supply in areas where the value is higher and the risks from climate change are greater. One way that the value of water might become visible is if more trading – both of abstraction licences and of water through bulk supplies – takes place. We are working with the Environment Agency, Defra and the Welsh Government on this subject to see how we can further promote trading of abstraction licences and water.

Further information: http://www.ofwat.gov.uk/competition/review/prs_web_1007value

4.4.6 Retail market reform

A1 – reduction in surface water resource yields	A2 – reduction in groundwater resource yields	A3 – increased demand for potable water

The independent review of competition and innovation in water markets (the 'Cave review') made recommendations to the UK Government about promoting retail competition and separation of the retail functions of water and sewerage services from the rest of the regulated business. We are considering how retail market arrangements could operate.

Retail market reform is not expected to drive significant adaptation, but it could drive more customer water efficiency measures. This is because the structure of separated retailers will mean that it is likely to be more profitable for them to sell services (such as water efficiency services) than to re-sell water purchased at the wholesale level.

Further information: http://www.ofwat.gov.uk/future/markets/retail

4.4.7 Wholesale market development

A1 – reduction in surface water resource yields	A2 – reduction in groundwater resource yields	A3 – increased demand for potable water	F2 – increased demand for raw water

We are also investigating wholesale water market reform, building on the recommendations from the Cave review. Introducing upstream markets in the sectors could help allocate water more efficiently between consumers and the environment. This would help deal with the most material risks to supply and demand from climate change.

We want to encourage those companies that have spare water, or that can develop water resources at low cost or are in areas where the value of water is relatively low, to sell their excess water to regions where the demand for water is higher. If we combine this system with a clear set of enforced environmental limits, this could also reduce over-abstraction in water-stressed areas.

We are considering the risks and benefits for adaptation as part of our work. We are considering in detail the mechanisms that might best enable co-ordination so that long-term adaptation benefits will be realised.

Further information: http://www.ofwat.gov.uk/future/markets/upstream

5. Further actions and our monitoring plan

This chapter sets out what further actions we will take to deal with the risks we have identified. These actions complement our future regulation programme. We also highlight what we are doing to encourage adaptive capacity, both within the sectors and across our own organisation. Finally, we set out our monitoring plan and outline recommendations for other stakeholders.

5.1 Further actions

Where we have identified medium and high risks to our functions that our existing regulatory framework or future regulation programme may not address adequately, we determined what further actions we should take before 2014.

5.1.1 Improve our understanding of adaptation in the sectors

We will consider the companies' adaptation progress, building on conclusions from their adaptation reports. If it is necessary and proportionate for us to do so, we will investigate further any material areas where there are shortcomings, or where we need more understanding. The findings will help inform the decisions we make on adaptation at the next price review.

5.1.2 Revise our climate change policy statement

We published our last climate change policy statement in July 2008. Circumstances have changed since then, and we have better information and understanding. We also expect to see changes when the projects in our future regulation programme are complete.

In 2012, we will reappraise our existing approach to both mitigation and adaptation. We will also make our expectations and general principles clear in a revised climate change policy statement. Developing and communicating our approach ahead of the next price review:

- reduces the risks of making poor decisions;
- aids transparency; and
- encourages consistency and better business planning.

The policy statement will build on this document and gives us an opportunity to take stock on how we have progressed the actions highlighted here.

5.1.3 Improve our approach to service resilience investment proposals

In recent years, we have been working with the Cabinet Office as part of its critical infrastructure resilience programme. This work has led to the recent publication of 'Keeping the country running: natural hazards and infrastructure', which is a guide to building resilience.

We are also involved with an academic research project to evaluate current levels of resilience in the sectors. We will build on this work and will clarify our regulatory approach to the companies' proposals to improve resilience of service to external hazards. This is crucial in enabling us to promote efficient and equitable solutions to protect service against extreme weather events. We discussed this subject in more detail in 'Prevention, protection and preparedness – how should resilient supplies be achieved?', which we published in November 2010.

5.1.4 Review our approach to investment appraisal for adaptation

We need to develop an approach that incentivises the companies to propose efficient and equitable adaptation investment. A number of barriers arise from the difficulty of determining the costs and value of adaptation actions because of the long timescales involved. We can help to address these barriers by minimising uncertainty and making our expectations clear. In particular, where cost-benefit analysis is not possible or would be overly onerous, we need to clarify what other approaches can be taken.

5.1.5 Consider how the capital maintenance common framework operates in the context of climate change risks

The companies use the common framework to plan and prioritise capital maintenance investment. It is a long-term, risk-based approach. So, it is well suited to incorporate climate change risks. But evidence of this actually occurring is minimal and the framework draws heavily on experiences of the past to predict most likely future service performance. Because several of the asset risks we have identified are priority risks, we plan to explore if it is fit for purpose and develop examples of how the common framework principles could be employed to incorporate climate change risks into maintenance planning.

5.1.6 Consider serviceability indicators

This work will build on the UKWIR review of serviceability, which includes a consideration of how climate change might affect these indicators. Based on the conclusions of this work and our ongoing regulatory compliance project, we will consider whether regulation in this area needs to change over time to cope with climate change – for example, to include new indicators.

5.1.7 Carry out research on consumers' attitude to climate change adaptation

Our research will explore consumers' views and attitudes towards climate change and its impact upon the water and sewerage services they receive. We aim to gauge their:

- understanding of climate change risks to service;
- attitudes towards sustainability; and
- preferences regarding future service.

By doing this, we can better design policies and incentivise the companies to deliver outcomes that meet consumers' wants and needs. This work will inform how we will communicate in future and help us understand attitudes to behavioural change.

5.2 Improving adaptation capacity

Good adaptation requires an understanding of:

- the ways in which climate change could have an impact; and
- how the existing regulation and incentives can deal with these risks.

Both the magnitude of the impacts set out in our risk assessment and the uncertainties we have identified show that everyone across the wider water and sewerage sectors – including us – needs to improve understanding.

Below, we outline (with examples) the main ways we can help build adaptive capacity in the sectors.

- Sharing data and information that we hold, and which may help the sectors to adapt to climate change. For example, in March 2010 we published case studies of effective adaptation actions in 'Climate change – good practice from the 2009 price review'.

- Directly commissioning applied research. For example, we commissioned and published a study on how the return periods of extreme daily precipitation events might change this century.

- Providing input into research projects and policy groups and providing comments, data and ideas.

- Using regulatory guidance or business planning requirements to establish expectations on the companies. For example, at PR09 we developed an analytical framework for resilience that helped to promote good practice.

- Highlighting areas where we consider research in the sectors should focus – with the aim of encouraging work in that area.
- Bringing stakeholders together to discuss climate change issues. For example, in early 2010 we organised (jointly with the Met Office) a three-day workshop on adaptation.

5.2.1 Internal adaptive capacity

We carried out a self-assessment of our internal capabilities on climate change adaptation using the PACT assessment tool. One key recommendation from this assessment was the need to take action so that non-specialists in the organisation understand the risks from climate change. Another was that we should have a process by which we can address climate change-related training and information needs.

As an organisation, we think that we have a good basic understanding of climate change issues. We also have dedicated climate change specialists. But we need to make sure that the key messages on adaptation are clear and communicated across the organisation, particularly when our understanding improves or where actions progress or change.

We have identified several internal actions that aim to improve our organisational capacity. Examples include:

- embedding consideration of climate change risks into our internal processes (for example, our process for carrying out impact assessments); and
- establishing a cross-divisional climate change group to share knowledge across the organisation.

5.3 Measuring progress

This section describes how we will measure progress on adaptation and update our assessments of risk.

We will rely primarily on existing measures to help us track the companies' ability to deliver service in a changing climate and to ensure our risk assessment and adaptation action plan remain up to date.

- We will re-evaluate our climate change risk assessment internally by May 2016. This will reflect the five-year cycles of the Climate Change Act 2008. There are also external triggers that will initiate a re-evaluation – including, for example, if a new set of climate change scenarios are released or the findings of the National Climate Change Risk Assessment differ substantially from our own assessment.

- We will consider any future adaptation reports that the companies provide in response to Defra's directions to report, or submit voluntarily, on adaptation. As with this round of reporting, we will use the reports to inform our decisions.

- We are working with the Environment Agency on the climate change guidance for the companies' water resource management plans. These plans are an important means of assessing risk on water resource issues. We will review the companies' water resource management plans and use the findings to inform our regulatory decisions.

- We have identified some early warning indicators for each of the high- and medium-priority risks, which will help us understand how the risks change over time. These indicators may evolve as risks and understanding change.

- We will continue to monitor the overall security of supply (currently through the security of supply index or 'SoSI') as a key means to check whether the companies are able to meet demand with available supply. Because this indicator is forward looking, we should be able to take pre-emptive regulatory action if risks begin to materialise and threats are not dealt with adequately.

- We will continue to use serviceability as a key method to assess whether the companies are able to provide their services to customers and the environment in changing circumstances. This enables us to take a proactive regulatory approach where service may be under threat, before significant service failures materialise. Provided the measures remain fit for purpose over time, the success of adaptation action can be assessed using serviceability measures.

Climate changes risks will not be treated in isolation. We aim to regulate in a way that places these risks in the context of others. Fundamentally, it is the overall services levels that are important. We will monitor service outcomes as part of the risk-based approach to compliance which we are developing.

5.4 Where others need to act

In this section, we include some recommendations for other stakeholders that can help promote good adaptation in the sectors. We are engaging with our stakeholders to make sure our work and theirs is optimised to deliver the best outcomes.

5.4.1 Independent advice

Successful adaptation in the sectors relies on sound science. Ultimately, the companies we regulate must understand the risks to their systems and take effective and efficient action to deal with them. But a common underpinning evidence base, coupled with readily available independent advice is an essential starting point. Over the past few years the advice, products and tools delivered by UKCIP, under contract from Defra, have played a significant role in helping stakeholders to understand and prioritise adaptation in the water and sewerage sectors. Free access to the underpinning climate change scenarios, and independent advice and expertise on adaptation should be maintained so that adaptation is equitable and efficient.

5.4.2 Urban drainage

There is a need to develop more sustainable planning, drainage and land management solutions to reduce the demand we place on the sewerage system. The Flood and Water Management Act 2010 includes several provisions targeted to improve drainage in the future. If these provisions are implemented well, this should prompt action that will help the drainage system cope with future climate change. In particular, local authorities must have the expertise and resources necessary to oversee sustainable drainage on new developments and maintain them in the future.

5.4.3 Environment

For adaptation to be successful, it is vital to understand the needs of the environment in a changing climate. It is also important that environmental interests are represented adequately. Where climate change risks to the environment materialise – for example, if there abstraction levels become unsustainable – we rely on the Environment Agency to understand and communicate these fundamental natural limits so that the companies can plan activity to act within those limits.

In order for adaptation to be efficient, environmental regulation needs to be risk based and focused on those activities that do the most damage. For example, the implementation of the Water Framework Directive and the National Environment Programme should be sensitive to the impacts of climate change and the costs of adaptation.

5.4.4 Interconnectivity

One response to some of the high-priority risks from climate change is greater interconnectivity so that water can be moved from areas where there is a surplus to those where it is scarce (or 'water stressed'). Defra and other stakeholders have identified the physical, institutional and regulatory barriers in this area. We will continue to work with Defra, the Welsh Government and the Environment Agency on abstraction licence reforms to help address these concerns.

5.4.5 Interdependencies

Successful adaptation to climate change will require action, both from the companies and their essential suppliers. While we have mechanisms to encourage the companies to adapt, we have little influence over other sectors of the economy. Work is being done to address interdependencies at a national level. For example, the Cabinet Office's work on improving resilience to critical national infrastructure encourages interdependencies to be considered. We recommend that national policy continues to work to encourage sectors across the economy to deal with long-term risks to their functions, particularly where failure in one area could cause knock-on side effects to critical services such as water supply.

5.5 Summary of climate change risks and actions

Table 5 below presents the priority climate change risks alongside the regulatory mechanisms that enable the companies to adapt to those risks. This is illustrative of how our regulation and future work should help manage each risk. Some overarching measures – such as our future price limits work – will influence adaptation to all of the risks. Similarly, work to build capacity in the sectors covers all of the risks.

We have also included some of the key mechanisms related to each risk that other regulators own. This is to highlight the important interdependencies.

The table shows that there are regulatory measures in place that enable the companies to adapt to the most important risks we have identified. This is not a reason for complacency. Successful adaptation in the sectors will depend on the decisions that are made within the context of these mechanisms.

Table 5 Summary of priority risks and regulatory measures which help manage them

Risk	Regulatory tools managed by us	Future regulation	Measures managed by others
A1 – reduction in surface water resource yields in summers A2 – reduction in groundwater resource yields in summers A3 – increased demand for potable water A4 – increased potential for storage of surface water in winter	Security of supply index Notified item for water resources and climate change Revenue correction mechanism Water efficiency targets Sustainable economic level of leakage Metering policy	Establish our approach for the next price review Valuing water Future water charging Wholesale market development	Water resource management plans Abstraction licensing framework
B1 – increases in single-year droughts B2 – increases in multi-year droughts	Security of supply index Notified item for water resources and climate change	Future water charging Valuing water Service resilience guidance	Water resource management plans Drought plans
F2 – increased raw water demand	Supply/demand balance measures	Valuing water	Abstraction licensing framework
B3 – increased risk of company assets flooding C4 – increased risk of coastal flooding of company assets	Provision for resilience	Service resilience guidance	Resilience of critical national infrastructure (Cabinet Office)
E2 – increased sewer flooding E3 – increased sewer blockages because of low flows	Serviceability Service incentive mechanism Measurements by service outcomes (sewer flooding)	Establish our approach for the next price review Sustainable drainage project	Provisions of the Flood and Water Management Act 2010

E1 – increases in CSO discharges C5 – reduced river flows require increased discharge constraints	Wastewater quality programme (in price reviews)	Sustainable drainage project	Quality regulation (National) Quality directives (EU)
C1 – more soil moisture deficit (SMD) driven bursts and leaks C2 – fewer frost-driven busts and leaks	Serviceability Sustainable economic level of leakage	Review the capital maintenance common framework	Building regulations and quality standards
C6 – accelerated asset deterioration C3 – increased sewerage treatment efficiency	Serviceability	Review the capital maintenance common framework	Building regulations Quality regulation
F1 – increased risk of power outages	Provision for resilience	Service resilience guidance	Resilience of critical national infrastructure (Cabinet Office) Energy sector resilience measures Security and Emergency Measures Directive
D2 – increases in waterborne diseases	Water quality programme (in price reviews)		Drinking Water Inspectorate Health and safety standards (Health and Safety Executive)

6. Conclusions

Our overall strategic aim is sustainable water. To achieve this, we must consider all the future challenges facing the sectors. This means that we must take the significant risks that climate change poses into account in the way we regulate.

This document represents our view of the risks that climate change presents to the successful operation of our functions. We set out our regulatory tools and further actions that enable adaptation to the priority risks.

The approach we have applied to produce this document has been subject to an audit by our internal audit team. Recommendations from the audit have been incorporated into the processes and conclusions in this document. It has been subject to internal consultation across the organisation. It has been agreed by our Board of directors and signed off by our Chief Executive.

Our report is underpinned by a thorough assessment of the climate change risks to the successful achievement of our functions. Our risk assessment highlights that there are a large number of possible impacts from climate change. We prioritised the risks in order to establish where we should focus our attention.

We used our risk assessment to identify whether the regulatory framework addresses the priority climate change risks. We have concluded that companies are already enabled and incentivised to adapt. But our analysis has identified a number of barriers and interdependencies which mean that – without change and further action – we cannot be sure that the right level of adaptation takes place.

We have also explained our future regulation programme in the context of adaptation. The programme aims to address the challenges of the future including (but not only) climate change. Our analysis shows this contributes towards effective adaptation by:

- improving incentives;
- developing understanding; and
- addressing barriers.

We will carry out further specific actions that help to build capacity to adapt, address some of the barriers, and better enable adaptation within the sectors. This has already led to changes within Ofwat. As specified under the Climate Change Act 2008, we will have regard to this document when carrying out our functions in the future.

We recognise that many of the wider reforms we are working on have uncertain outcomes. So, it is crucial that we reappraise our approach to climate change risks regularly in the future. As well as the impacts of these changes within our organisation, we recognise that as new information about climate change impacts arises and the interactions between climate change and other risks change, our existing adaptation plans may become outdated. So, we will reappraise our approach to ensure it remains fit for purpose.

Our actions alone will not be enough. The companies, other regulators and the wider stakeholder group will all have to play their part in adapting to climate change. The adaptation reporting power process, coupled with the forthcoming national climate change risk assessment, presents an important opportunity for learning, collaboration and the delivery of effective solutions. We look forward to working with Defra and the Adaptation Sub-Committee in making sure that this opportunity is realised.

We welcome views on our report and the actions we have outlined. We will continue to work with all our stakeholders as we address the climate change risks in the sectors and work towards sustainable water.

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