The state of water in Kent

Kent Water Summit

26 June 2012

Introduction

Water is essential for human life and to sustain a diverse and thriving natural environment. It is important to our economy as an essential requirement for industry, power generation, commerce and agriculture. We need it to support our growing population and to maintain and improve our standard of living.

There are significant pressures on water resources which affect both the water environment and water supplies. In Kent there are many catchments where there is little or no water available for abstraction during dry periods. Pressures are particularly notable in Kent as it is one of the driest parts of England and Wales, coupled with high population density and household water use. Over the next few decades, there will be increasing pressures from the rising population and associated development. Looking further ahead, climate change could have a major impact on the water that will be available for consumption.

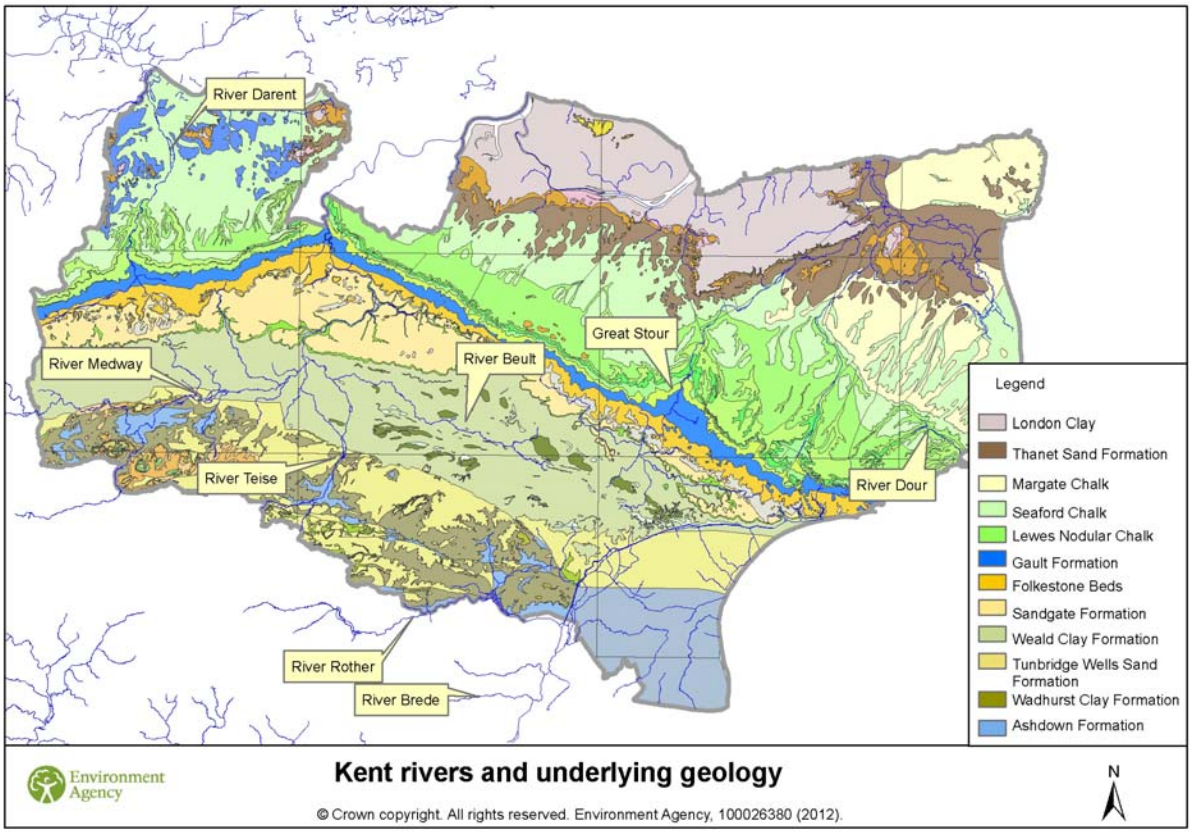
This report summarises the water position in Kent using data from supporting studies for the Water Framework Directive and the Habitats Directive as well as population records held by Kent County Council. The supporting studies include Catchment Abstraction Management Strategies and River Basin Management Plans.

Kent rivers

All Kent rivers have different flow characteristics. Chalk rivers such as the Stour tend to have more baseflow in dry years, whereas more clay based rivers such as the Rother or Beult can experience very sudden changes in flow rates.

The Kent County Council boundary does not align with the river catchment boundaries. Some of the rivers in Kent have sections that flow outside the county. Abstractions in these river catchments have been included in the statistics in this paper because of their relationship with Kent. These rivers are the Cray, Shuttle, Eden Brook, Upper Medway, Upper Rother and the lower Rother estuary and its tributaries the Brede and Tillingham.

Map 1 Kent rivers and geology

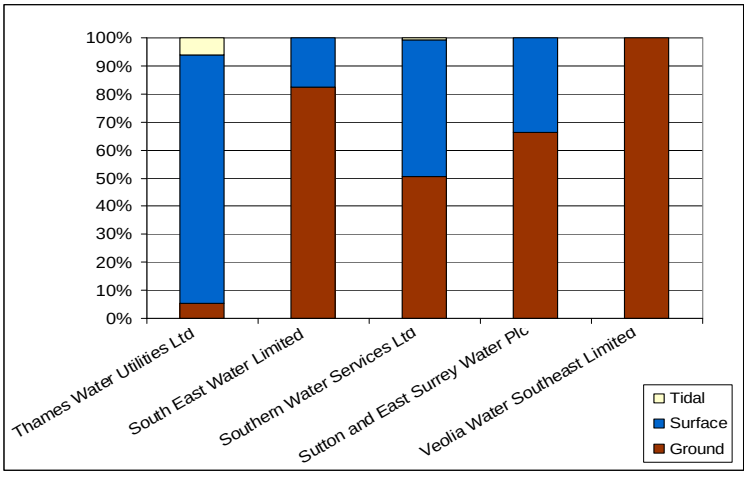


Sources of abstraction

In Kent, 73% of public water supply is taken from groundwater; most notably from chalk aquifers. The remainder of water company supply is either pumped directly to customers from rivers or into storage reservoirs.

There is a mix of supply sources across Kent and it is apparent that some water companies are more reliant on surface water than others.

Figure 1 Water company licensed sources



Groundwater abstraction is typically cleaner water, so requires less treatment, and is a reliable source in a typical two-year drought. Using surface water is generally more expensive than groundwater but there are benefits. Reservoirs allow storage of water in times when rainfall is not effective at reaching the groundwater. Some water companies are more reliant on river water abstraction, whereas others are dependent on groundwater. This disparity is primarily due to the geology, topography and river water availability within water company boundaries

Historically boreholes have been drilled in locations which yield the greatest volume of water; typically next to rivers, faults or dry valleys. However these abstractions can have the greatest impact on river flows. Now we have a better understanding of the needs of river ecology, new boreholes are often drilled further away from rivers to reduce the impact on the environment. The water yield and quality of these boreholes can be poorer in these locations. Sites of new abstractions are determined so that the needs of people and businesses are met without adversely impacting wildlife.

Our rivers and groundwater provide a finite resource. In Kent we are currently using most of this capacity and in some places, exceeding capacity. Options for increasing water supply include:

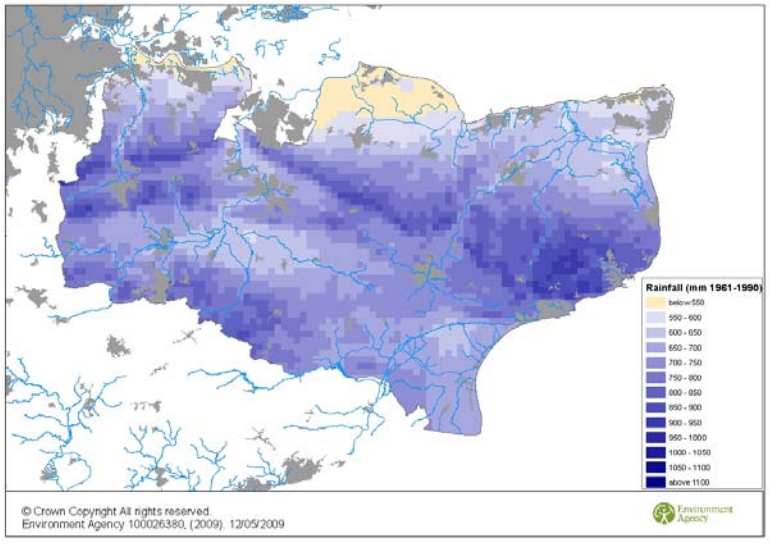
- **Licence trading** with other licence holders
- **Effluent reuse** to re-abstract downstream of a discharge
- **Desalination** of brackish water
- **Water transfers** from other catchments or between water companies
- **Conjunctive use** to seasonally vary groundwater and surface water abstraction to limit the impact on the river and maximise yield

The opportunities for increasing the use of supply sources as identified above can be more expensive in terms of cost and carbon emissions. Decreasing future water demand is a crucial part of the solution.

Rainfall

Average rainfall in Kent is around 700mm per year, typically ranging from 550-900mm. More rain falls over higher ground which pushes the prevailing south westerly winds higher. As a result much of the wetter areas of Kent are on the North Downs Chalk, where many of our groundwater abstractions are sourced. The north Kent coast experiences less rainfall as it sits in a relative rain shadow from the North Downs.

Map 2 Average annual rainfall in Kent

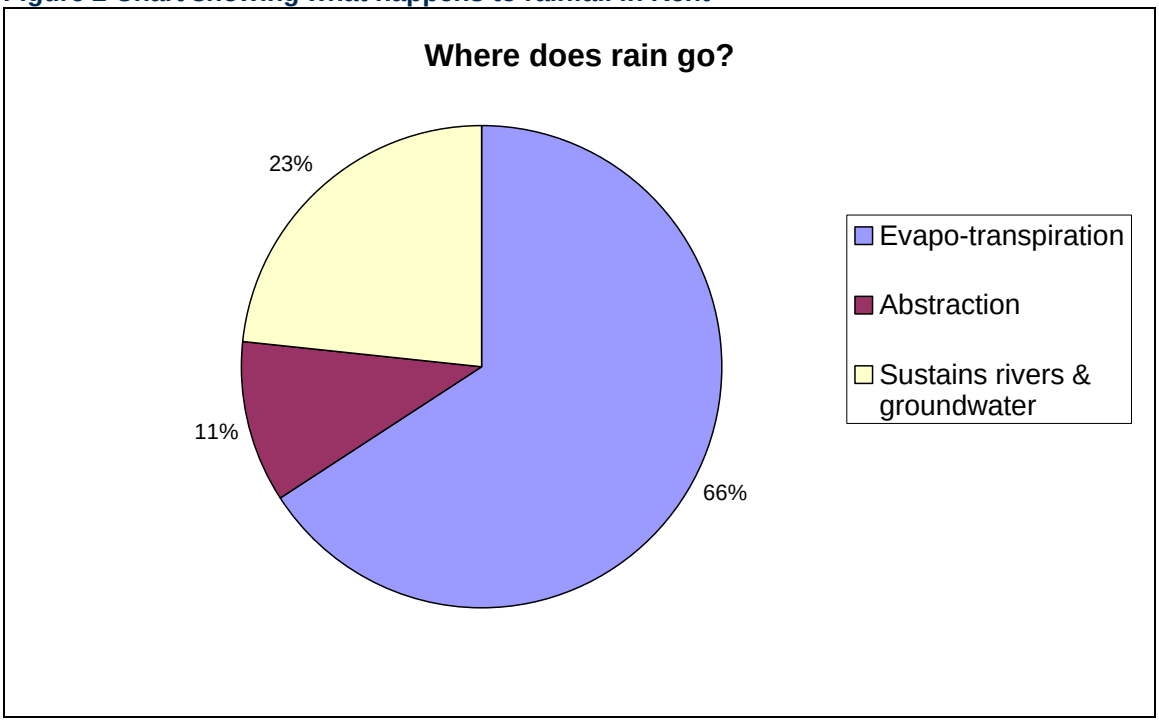


Across the whole Kent area, precipitation adds up to 2500 billion litres of water per year. 89% of this volume is lost through evaporation, plant growth, flows into our rivers or seepage into untapped aquifers. We currently abstract 11% of the rain for consumptive uses.

Two-thirds of annual rainfall is lost to evapo-transporation; combining direct evaporation and take-up by plants. Climate change models predict higher temperatures throughout the year which

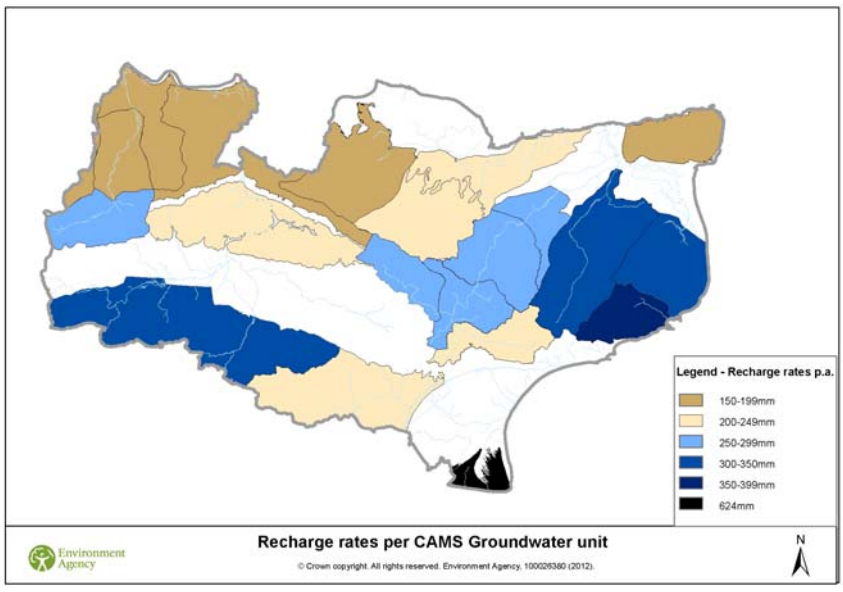
could increase evapo-transporation losses further. Increasing evapo-transporation and changing weather patterns could impact the recharge period, so it is likely that we could become increasingly reliant on winter rainfall for water supply in the future.

Figure 2 Chart showing what happens to rainfall in Kent



The proportion of rainfall which reaches groundwater aquifers will vary according to land management, soil type and underlying geology. The recharge map opposite shows that groundwater recharge and rain correspond closely but there are some exceptions. The Denge aquifer (seen as the most south easterly unit on the recharge map) has exceptionally high recharge due to lack of soil and vegetation. This allows a high proportion of rainfall to reach the gravel aquifer.

Map 3 Recharge rates per CAMS groundwater unit

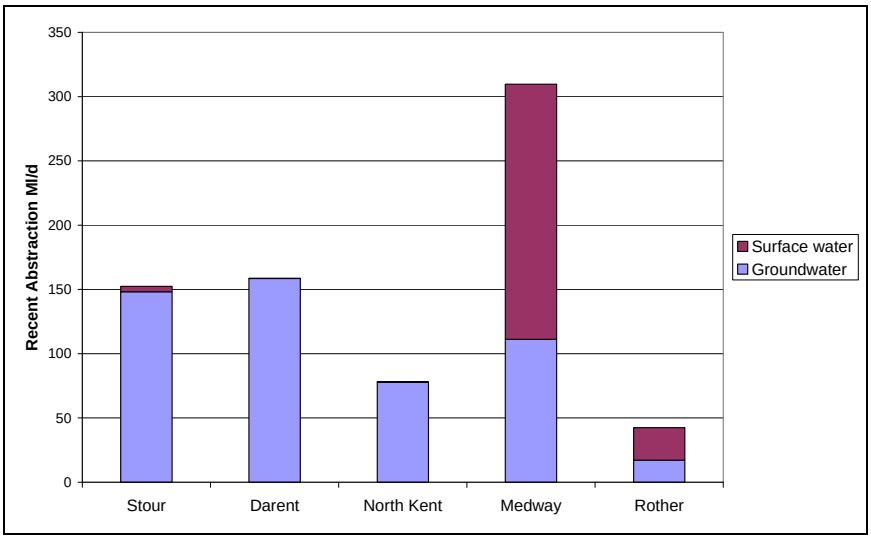


Approximately 34% of rainfall reaches the water table, and of this 'effective rain' around 23% is abstracted by groundwater abstraction. Most of the remaining water is needed to maintain groundwater levels so our rivers flow and our fresh water aquifers are protected from saline intrusion.

Water abstraction

The chart below shows a high volume of surface abstraction in the Medway compared to other catchments. This is not surprising as the Medway is the largest catchment and contains the majority of Kent's reservoirs which depend on river abstractions.

Figure 3 Recent abstraction (2006-2010) in river catchments



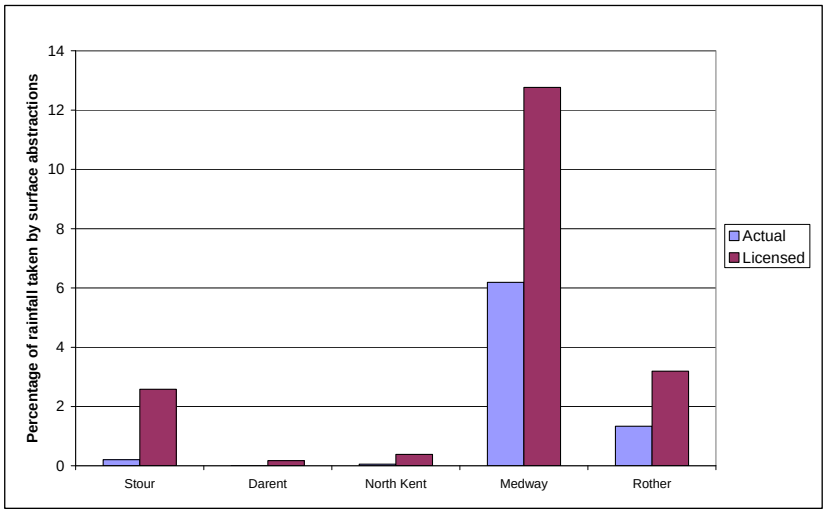
*** Recent abstraction rates are taken from abstraction returns provided by licence holders to the Environment Agency. The above chart shows average returns between 2006-2010)**

Surface water abstraction

Surface water abstraction makes up around a third of the overall water taken from the environment and is generally less consumptive. For example, much of the water is returned to the source after being used for purposes such as industrial cooling or filling of nature reserves. Although the consumed volume is significantly less than groundwater abstraction its impacts on the river are much more immediate and have consequences for local wildlife. To protect the environment, surface water licences tend to contain conditions which prevent abstractions when river levels fall to a set threshold.

Figure 4 shows the proportion of catchment rainfall abstracted by surface water licences. Most of the surface water abstraction pressure is on the Medway. This is predominantly due to the large reservoirs; Bewl, Bough Beech and Weir Wood. The Rother has a significant volume abstracted from the rivers to fill Powdermill and Darwell reservoirs.

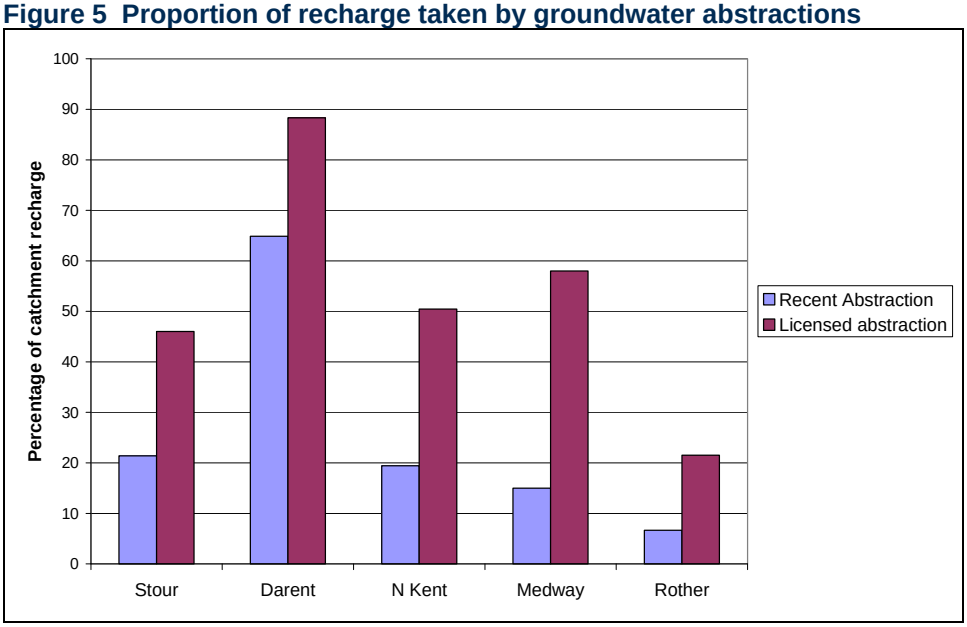
Figure 4 Proportion of rain abstracted by surface water abstraction licences



Groundwater abstraction

Groundwater abstraction is mainly used for public water supply, and the majority is only returned to the river environment through treated effluent discharges. The chart below shows that relative to catchment size, groundwater abstraction is most intense in the Darent catchment. Thames Water has reduced abstraction pressure in the last 15 years, but further reductions are being sought by Thames Water and the Environment Agency.

Figure 5 Proportion of recharge taken by groundwater abstractions

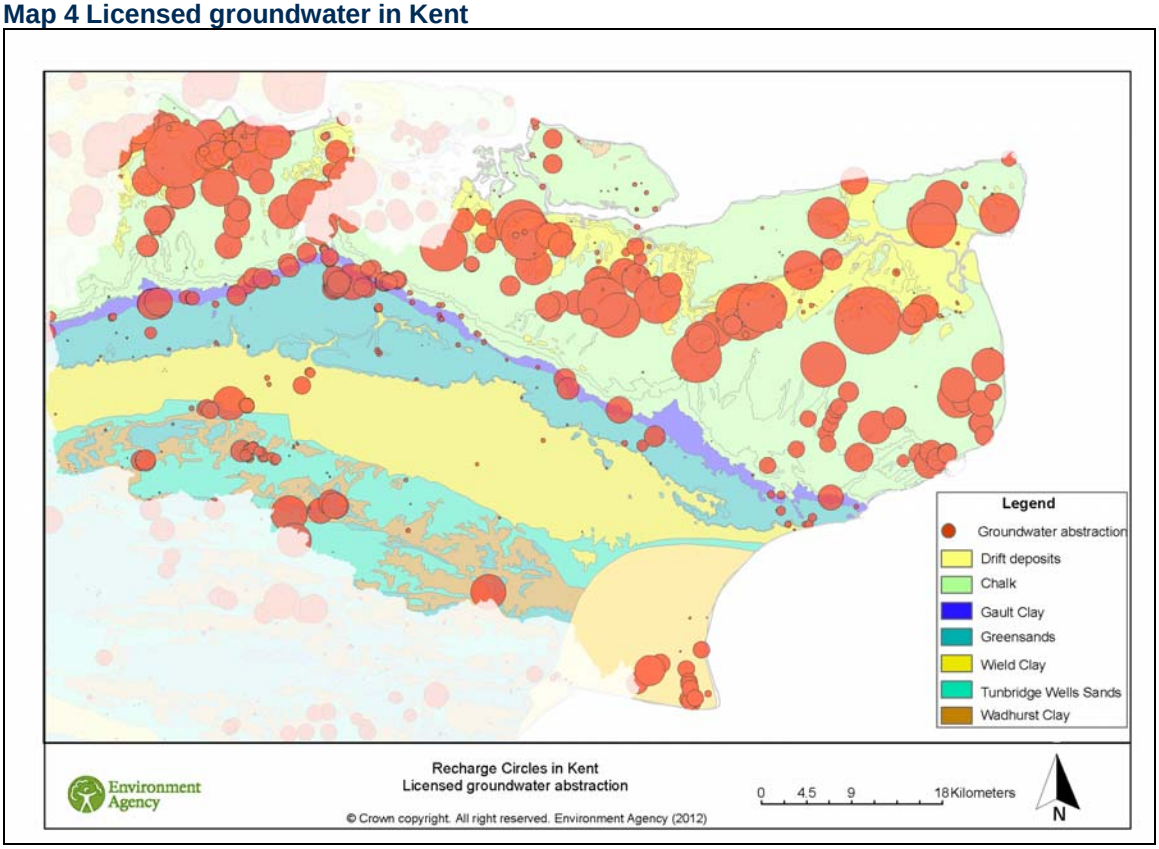


Groundwater abstraction pressure is lowest in the Rother and Medway catchments where lower yielding Greensands and clays mean that there is greater reliance on surface water.

The map below shows that the majority of groundwater abstractions are located on the north Kent Chalk block. The approximate area of rainfall recharge needed to sustain each groundwater abstraction is shown by the size of the circle; referred to as recharge circles. Where circles are closely grouped or overlapping there is greater abstraction pressure.

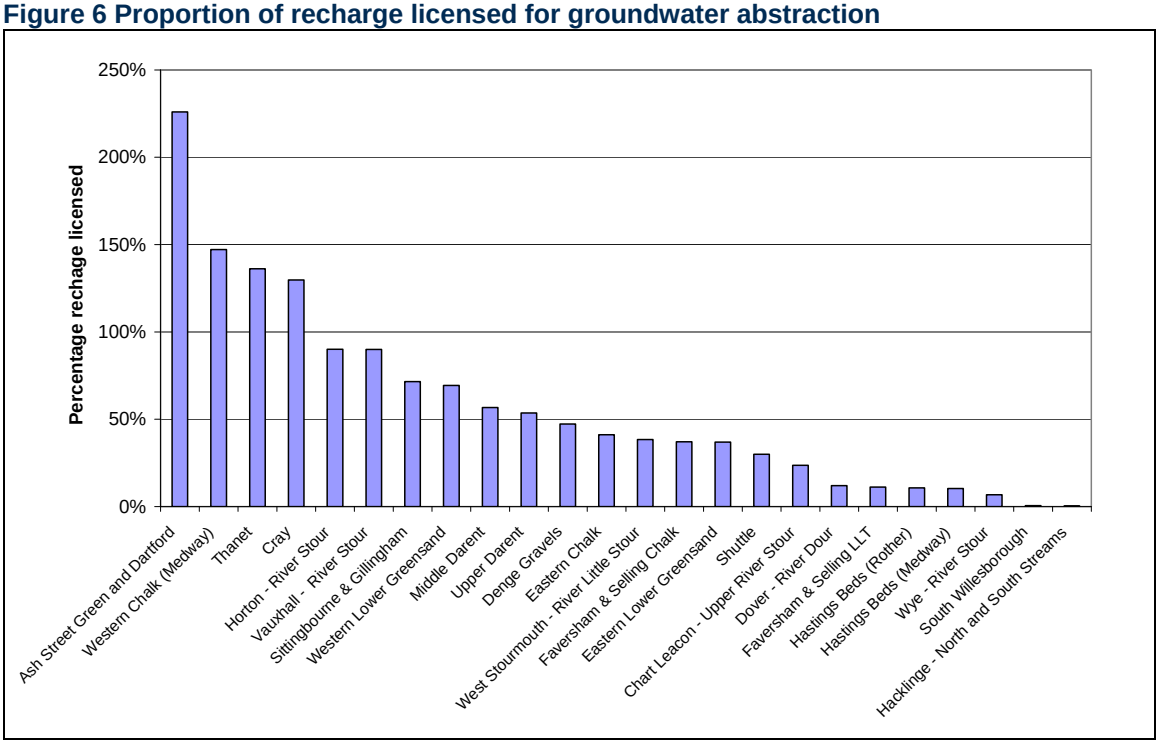
Within Kent the higher yielding, cleaner aquifers tend to have more intense groundwater abstraction pressure. The individual groundwater bodies (shown in Figure 6) which have more licensed abstraction than estimated recharge are Ash Street and Dartford, Western Chalk (Medway), Thanet and the Cray.

Map 4 Licensed groundwater in Kent



*** Data taken from licensed volumes for each groundwater abstraction. Each recharge circle is an approximation of the size of abstraction.**

Figure 6 Proportion of recharge licensed for groundwater abstraction



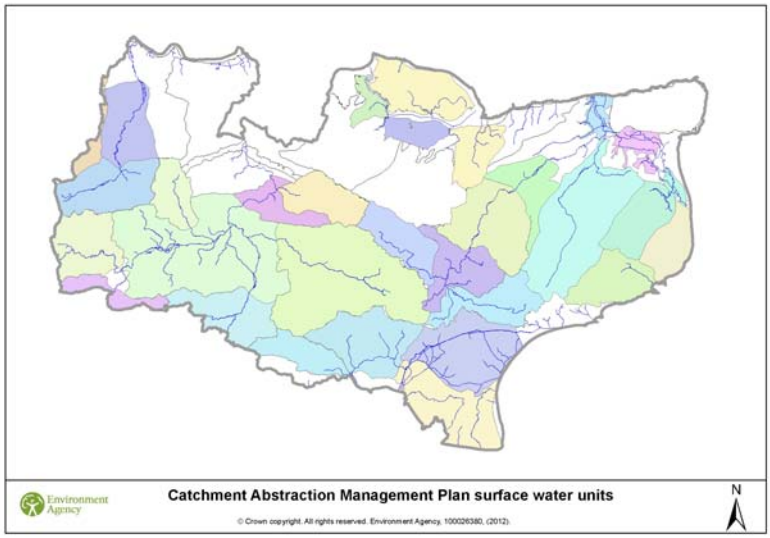
NB: Above chart shows groundwater abstraction only. Percentages over 100% means that more water is licensed for abstraction than is recharging; i.e. the water body is over-licensed. This is an approximation as recharge will be overestimated in clay dominated catchments. Note that LLT is an abbreviation for the Lower London Tertiaries geology strata.

Assessing the impact of abstractions

Abstraction quantities are carefully managed through the licensing process controlled by the Environment Agency. Several methods are available to analyse the impact of each abstraction:

- Determination for individual licences – this ensures local impacts are scrutinised.
- Catchment Abstraction Management Strategies (CAMS)– assesses the wider impact of cumulative abstractions.
- Restoring Sustainable Abstraction Programme – identify, investigate and act to reduce environmental damage caused by unsustainable abstraction. Our goal is to allow water abstraction to continue in a way that the environment can sustain.

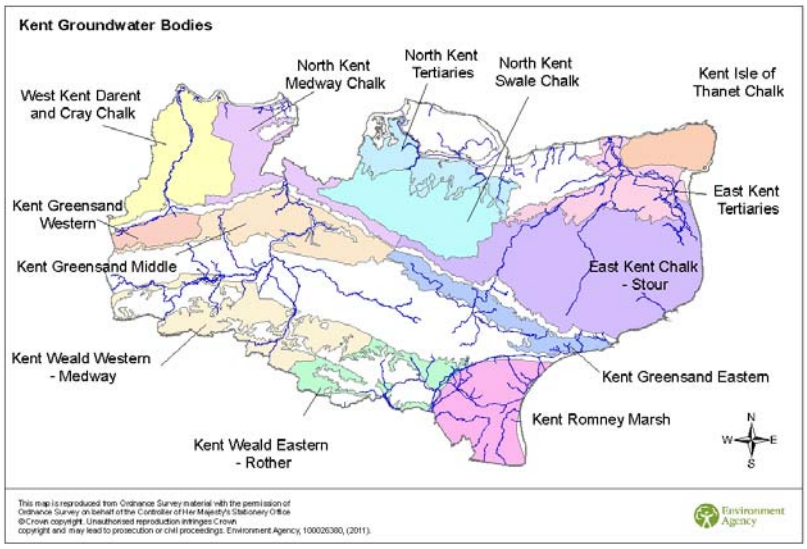
Map 5 CAMS surface water unit boundaries



All of the above tools help us manage the abstraction rates in each catchment to prevent environmental damage. This is generally based on analysis of past and present ecology and does not make any analysis of how water availability will change for different sectors in several decades.

The CAMS assesses the water availability for each river stretch and groundwater aquifer. Each catchment is broken down to sub-catchment areas referred to as Water Resource Management Units demonstrated in the maps above for surface water and below for groundwater.

Map 6 CAMS groundwater unit boundaries

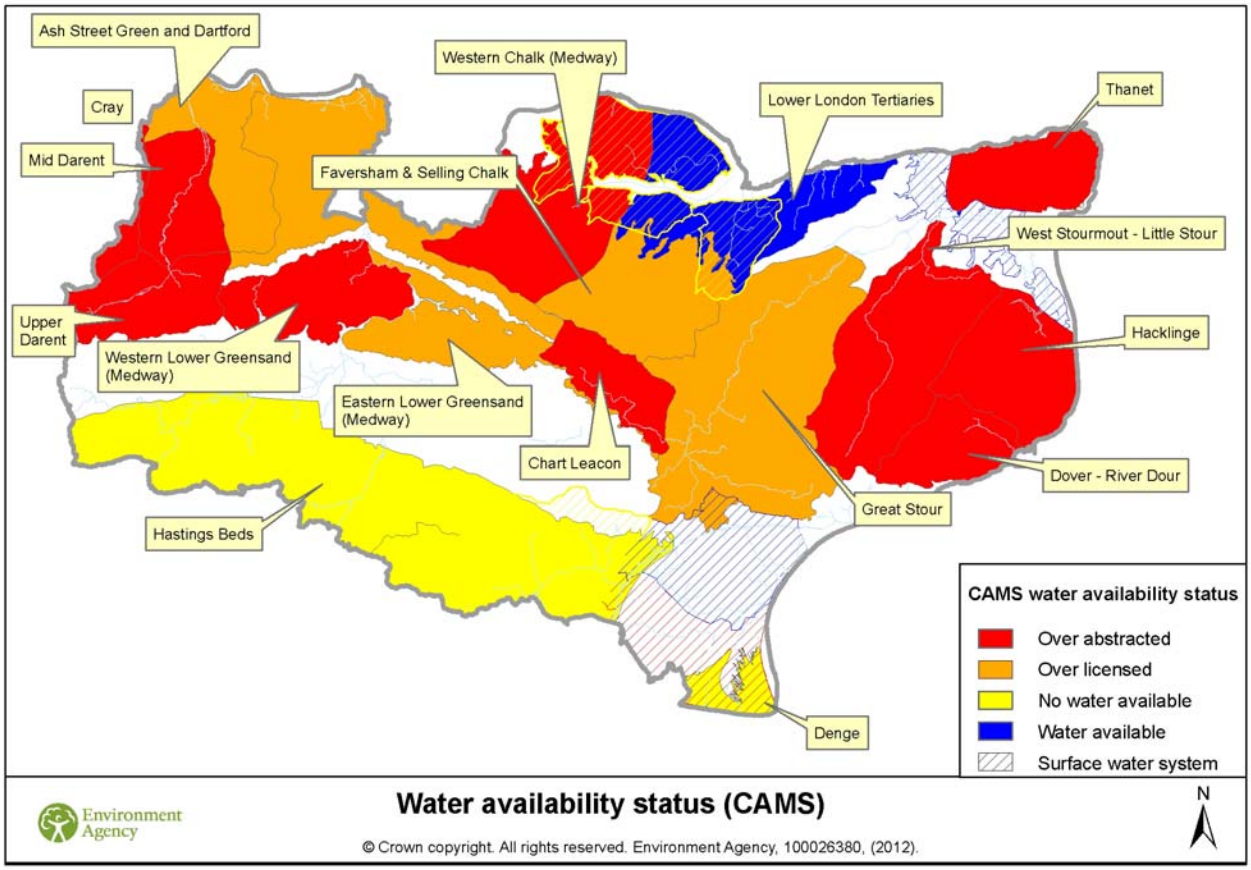


The CAMS has shown that most rivers experience flow stress in dry summers. This is apparent through impacts on flow sensitive plants such as Ranunculus and invertebrates such as River Nerite. Fish populations, such as Brown Trout, can diminish in low flows, especially in summer months when dissolved oxygen levels are lower. Higher flows are required in winter months to encourage salmonid fish migration and to flush the river through to avoid sedimentation.

The Catchment Abstraction Management Strategies show that there is greatest ecological pressure in the north Kent rivers; predominantly as a result of Chalk aquifer abstraction. The only location showing 'water available' status is in the Lower London Tertiaries in north Kent (shown in the map below), however the underlying chalk aquifer is over-licensed.

There are very few sites available for new abstraction that would not have some impact on ecology in dry years.

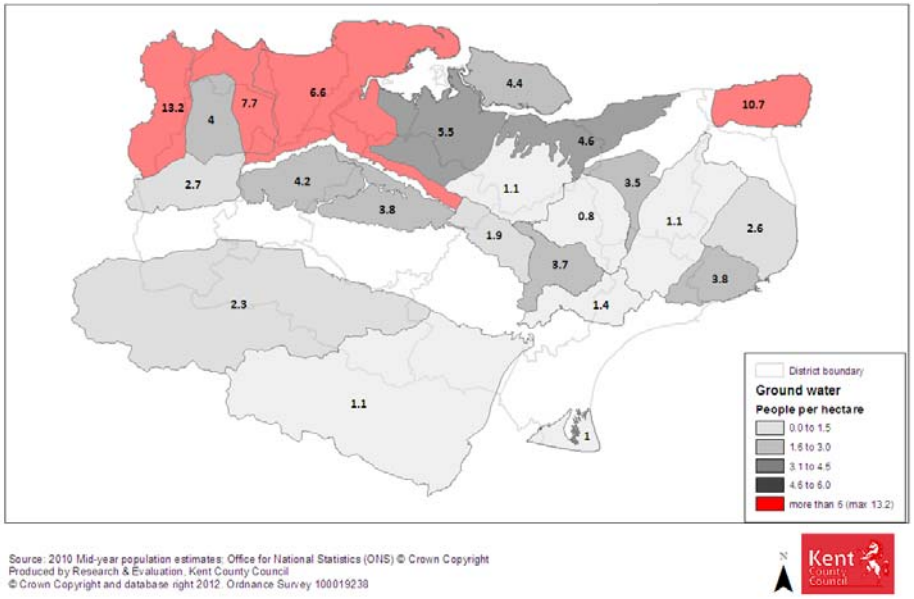
Map 7 Water availability status (CAMS)



Population

Population density tends to mirror the abstraction pressure in Kent. When abstraction points are close to demand, the need for water transport is minimised reducing the costs of water demand. However it is clear that many of the over abstracted waterbodies are close to highly populated areas.

Map 8 Population density in each groundwater unit



Source: 2010 Mid-year population estimates: Office for National Statistics (ONS) © Crown Copyright
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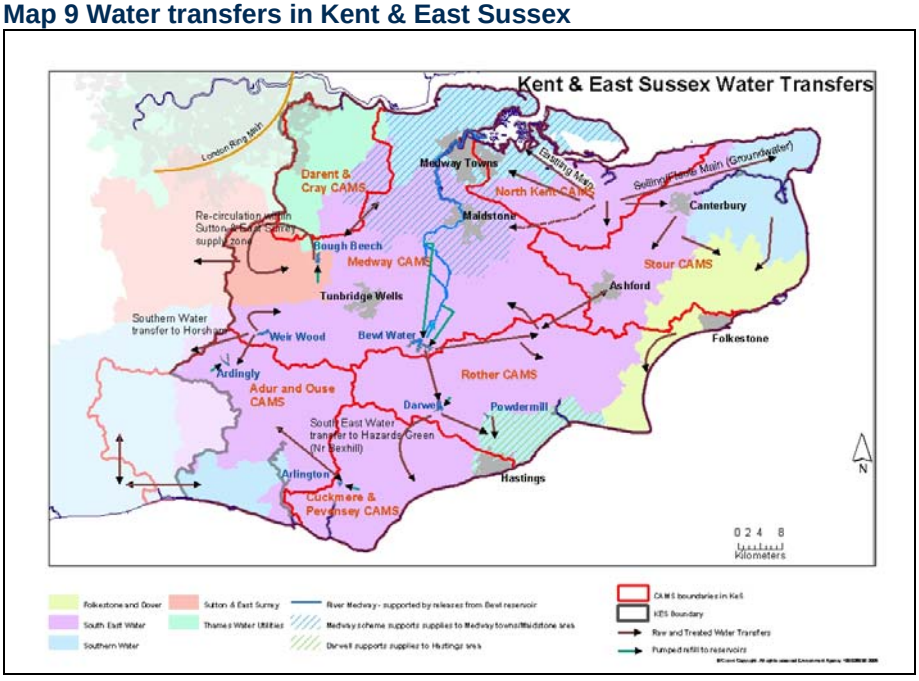
In Kent, the location of highest water demands and of water availability do not always coincide, so water transfers are needed on a large scale both within Kent and across county boundaries. Water companies are increasingly sharing water with each other to ensure that supplies are more flexible. Water transfers have a large associated carbon and financial cost.

Map 9 Water transfers in Kent & East Sussex

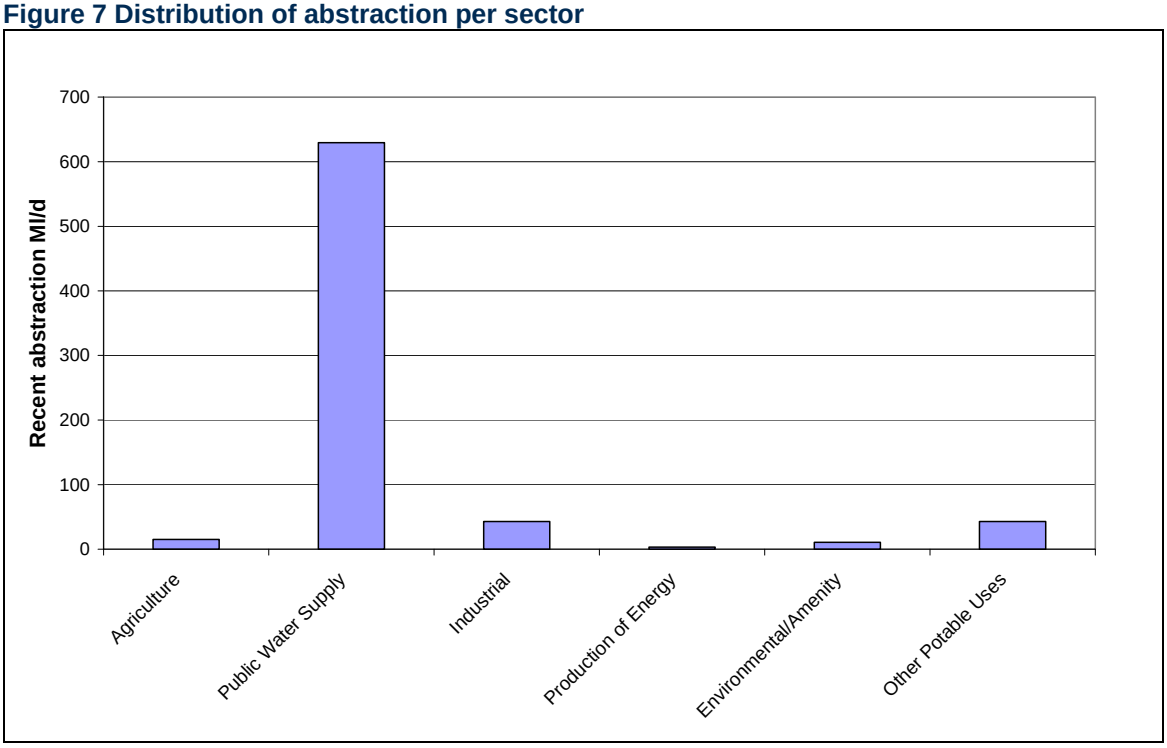


Abstraction licences in each sector

Abstraction returns between 2005 to 2011 show the overwhelming majority of water is taken from the environment for public water supply. Water companies have abstracted on average 630Ml/d, making up 85% of water abstraction in Kent.

Sectors such as agriculture and industry have a smaller proportion of the abstraction licences and can have a significant impact on a local level. Other sectors, such as amenity or recreation, need to be taken account of as they can also have a localised impact. Water abstracted by water companies is used by other sectors such as horticulture, industrial and amenity purposes. The extent to which these sectors use public water supplies is not visible in this analysis.

Figure 7 Distribution of abstraction per sector

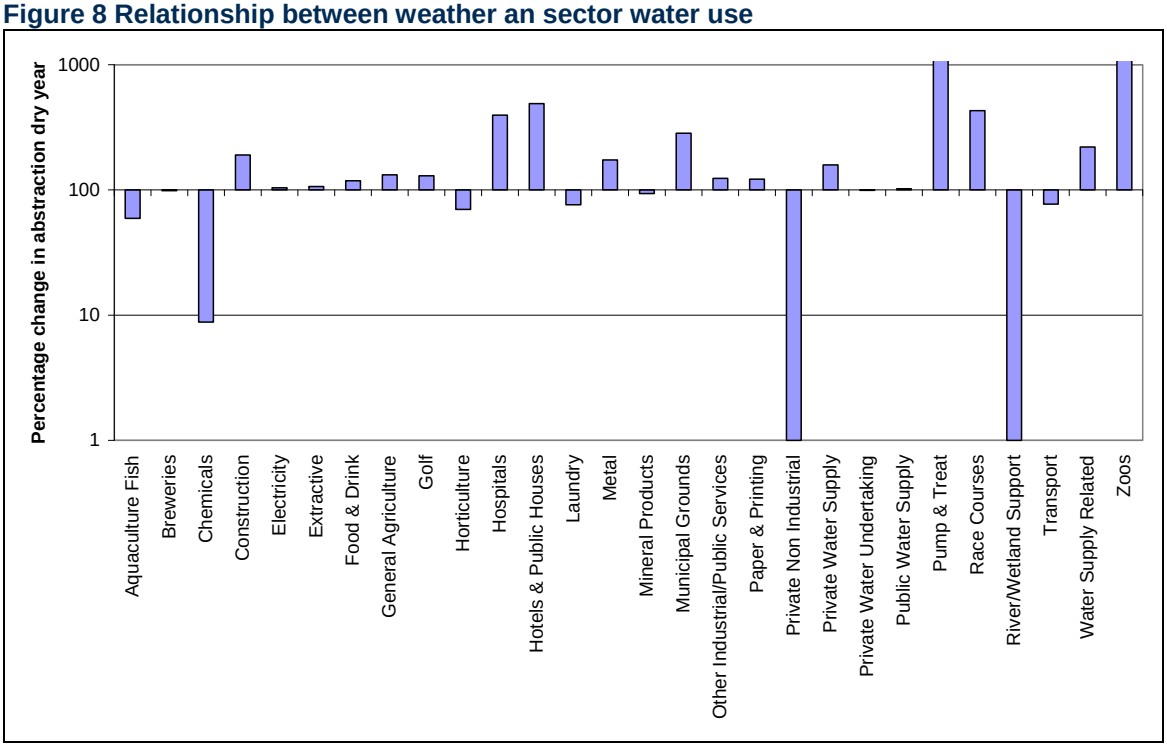


There is a distinct divide between sectors that rely on groundwater and surface water sources. Water companies and industry are heavily dependent on groundwater, whereas agriculture and amenity use more surface water. Because of this, in drought years some sectors will suffer more than others.

Abstraction dynamics in dry years

Comparing two recent years might give us an insight into which water uses would be more affected in dry years. Abstraction in a recent dry year (2006) and an average year (2008) is compared below.

Figure 8 Relationship between weather an sector water use



***The chart shows the proportional change between average year 2008 and dry year 2006**

The higher the number in the above chart, the more abstraction was taken in a dry year. In 2006, water abstraction for zoos, pump & treat (to contain groundwater contamination), race courses, hospitals, hotels and public houses increased more than other sectors. Supply also increased for agriculture, golf courses and public water supply but to a lesser extent. Wetland support decreased, which could have been because water was not available to abstract.

Agriculture is one of the most vulnerable sectors in drought years. A high proportion of farm abstractions are taken from surface water in summer months. An increasing number of winter storage reservoirs have been constructed to reduce the risk to irrigation. During the dry spring in 2010, those without winter storage reservoirs in some of the driest areas, such as in the Rother marshes, did not have as much water as they needed. Some of the most recent drought impacts in these areas were:

- Crop yields were diminished
- Livestock numbers became unsustainable due to lack of green grass
- Annual abstraction rates increased but irrigation was insufficient
- Water courses stagnated and became eutrophic
- There was not enough water in the river to pump into the marsh system

- As water levels receded plant growth accelerated within the channel, restricting the ability to feed water through the system
- River ecology suffered

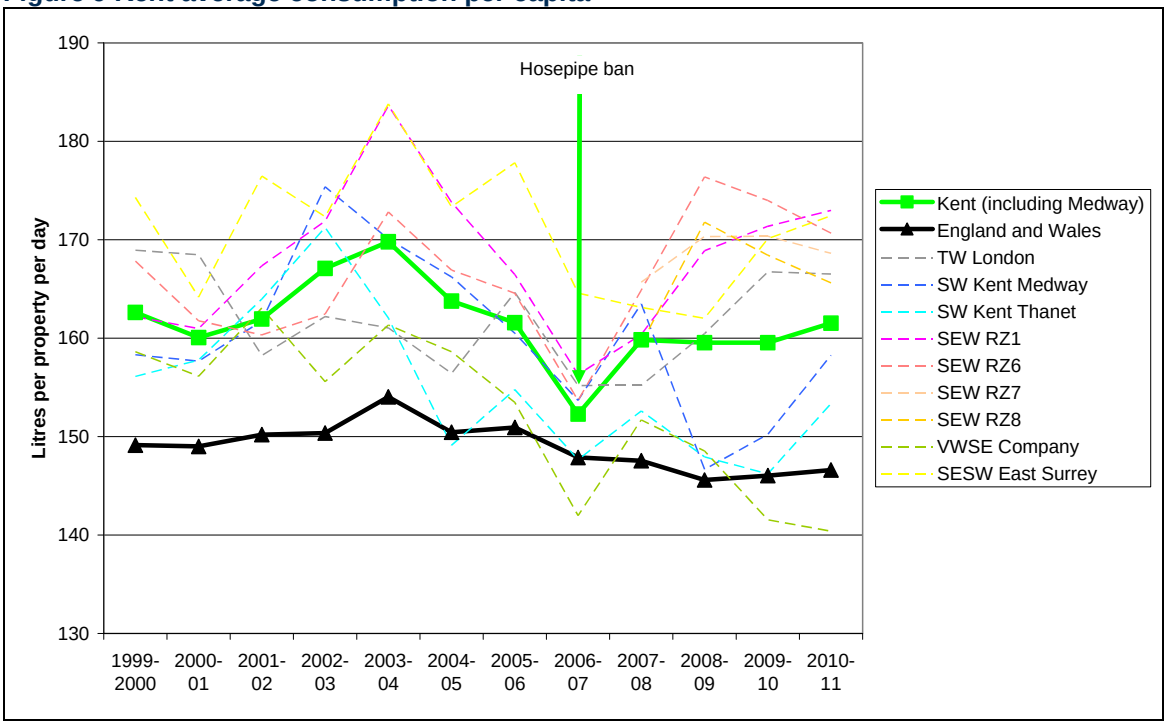
For Industry, much of the abstraction is needed for cooling purposes. Many of these are taken from estuarine waters and are not sensitive to drought conditions.

Water companies produce drought plans that set out how a company will supply water to its customers during periods of low rainfall, whilst minimising any impacts on wildlife. Recent droughts have demonstrated the water supply reliance to cope with two year droughts. However, three year drought conditions remain untested.

Abstraction volumes are closely related to per capita consumption rates. In turn per capita consumption is strongly influenced by the weather as demand notably increases in dry years.

In recent years per capita consumption has hovered around 160 litres per person with notable fluctuations in the dry years of 2003 and 2006. Comparing these two years, the figure below indicates the reduction in use that hose-pipe bans can have, although there are many other factors involved.

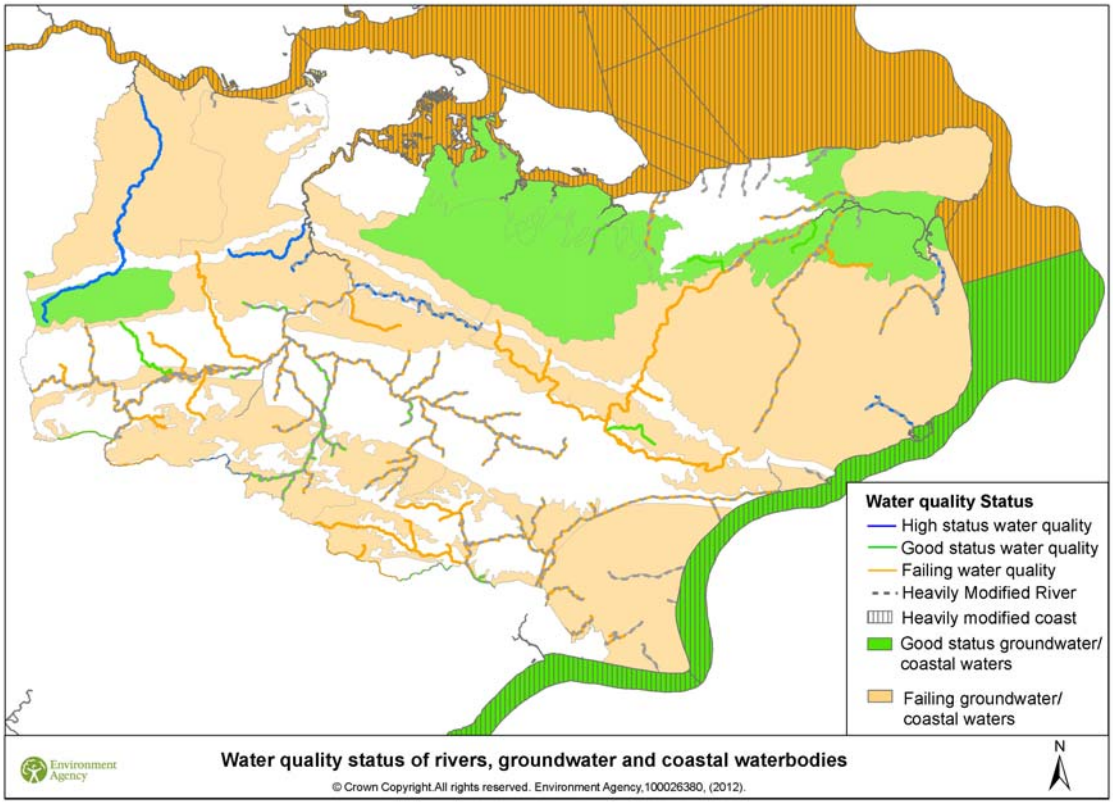
Figure 9 Kent average consumption per capita



Water quality

Water quality is important for health of people and wildlife. The poorer the quality of the water the more expensive it is to treat. We need to improve the quality of our rivers and groundwater aquifers as most of these do not currently meet water quality standards set out in the Water Framework Directive. The rivers that do pass water quality standards tend to be smaller tributaries with no waste water discharges and a good supply of baseflow from groundwater.

Map 10 Water Framework Directive water quality status



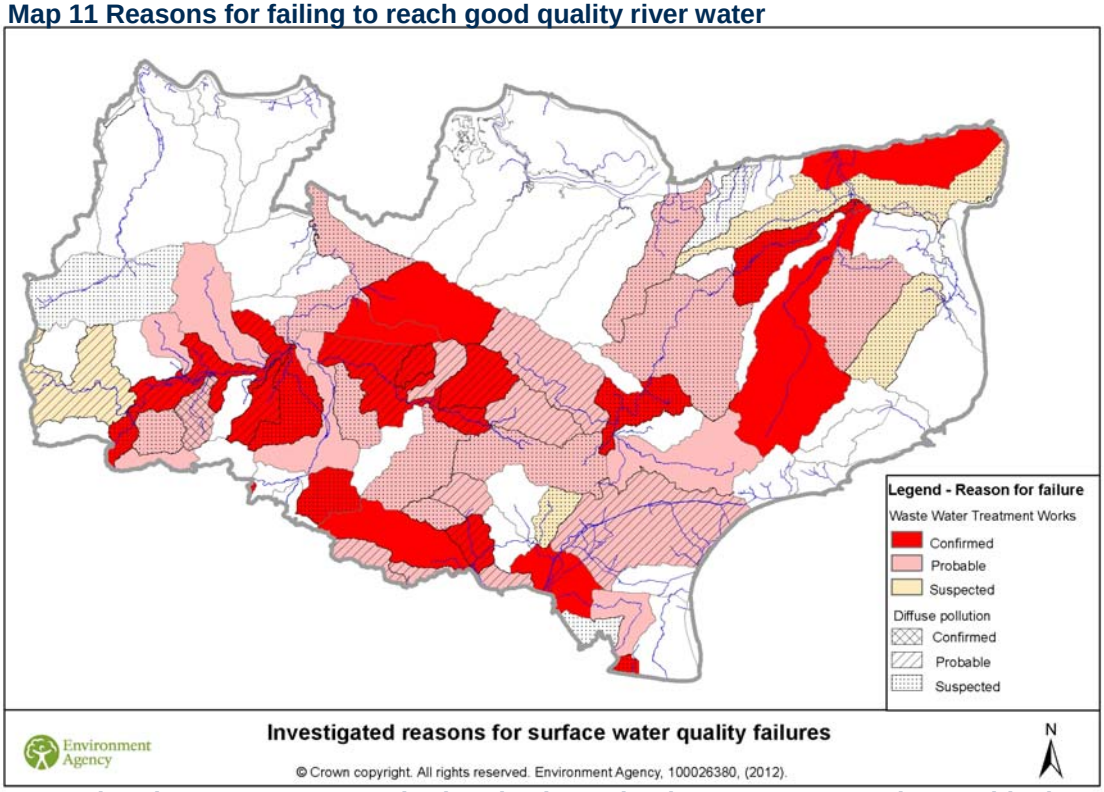
*** Note that the good status groundwater bodies may reflect lack of borehole monitoring so does not guarantee good water quality**

It is important to consider water quality of our rivers when assessing water availability for several reasons:

- As we take more water from headwaters and groundwater, there is less water available for dilution of contaminants in our rivers.
- Cleaner water can cope better in low flow conditions; for example in eutrophic rivers dissolved oxygen levels can fall in dry hot weather. There is an argument that more water can be abstracted from catchments with cleaner rivers although ecological requirements must be carefully balanced.
- Water of lower quality is expensive to treat.

The Environment Agency is currently investigating the reasons why water bodies do not reach Good Status under the Water Framework Directive. For some water bodies, there is still uncertainty regarding the sources of pollution such as where there is a combination of point and diffuse sources. The map below shows that it is likely that both sources contribute to the failing status for the majority of water bodies in Kent.

Map 11 Reasons for failing to reach good quality river water

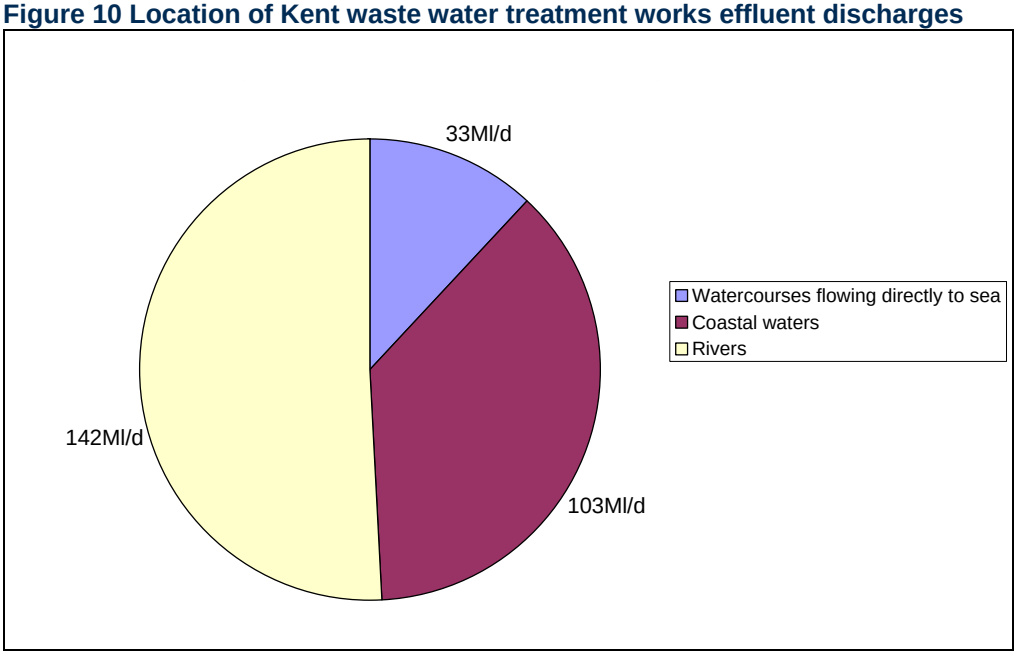


*** Note that the Water Framework Directive investigations are not complete at this time so the above map is likely to change as the investigations proceed.**

Waste water treatment works discharges

It is necessary to consider where waste-water is discharged after being abstracted to understand the water cycle dynamics in Kent. Around half of Kent's waste water treatment works discharge directly into rivers. The other half flow into coastal waters, estuaries, or tributaries flowing into the sea.

Figure 10 Location of Kent waste water treatment works effluent discharges



Most of the discharged effluent flows to sea either directly through outfalls or through the river system. Some discharge is re-abstracted by surface water abstractions like those that feed our reservoirs. Overall 278Ml/d is licensed to be discharged which, compared to abstraction at 630Ml/d, shows 44% of water company abstractions end up returned to waste water treatment works. Most of the remainder will be discharged through septic tanks either back to the river or seeping to groundwater.

The average size of treated water discharge off the coast is 8.6 million litres per day. This is significantly larger than the average river discharge of 2.5 million litres per day as the sea has a greater dilution capacity than rivers.

Leakage

Ofwat requires each company to maintain leakage at a level that provides the best value for its customers and the environment. There have been improvements in leakage in the last ten years, although the number of pipe bursts increased during the exceptionally cold winter in 2009/10. There is still an ambition to reduce leakage further and this is covered in the water resource planning process undertaken by each water company. Managing leakage is a crucial part of the solution to creating sustainable water resource management but not all leakage is 'lost' water. A portion of leaked water is returned to aquifers and consequently can be re-abstracted or feed rivers.

Figure 11 Leakage in Kent

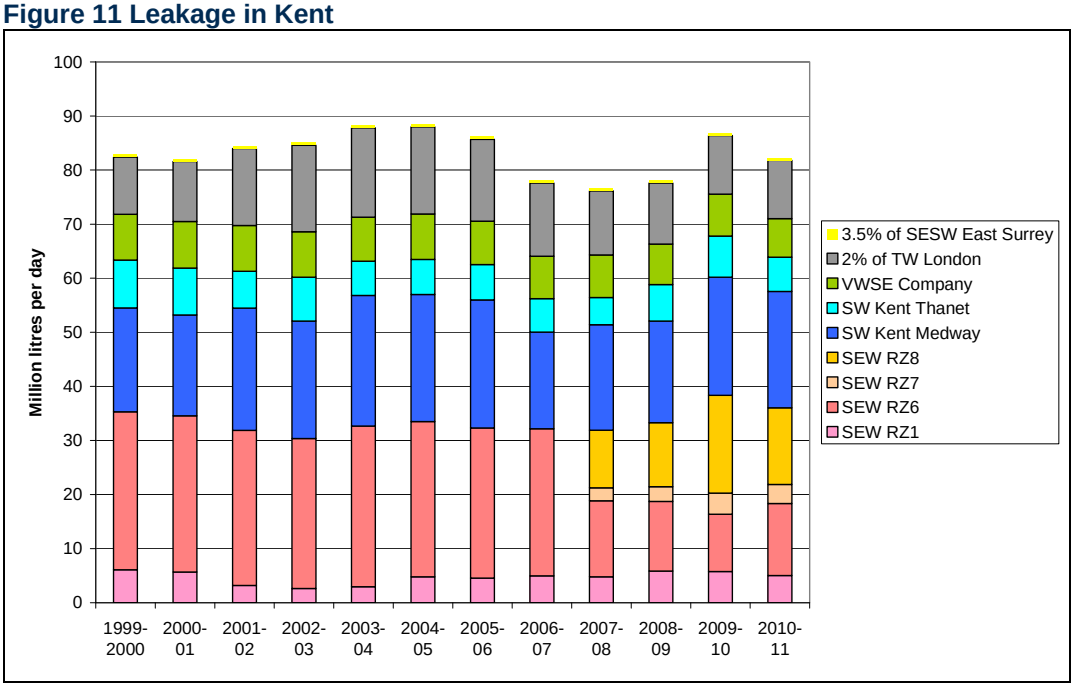
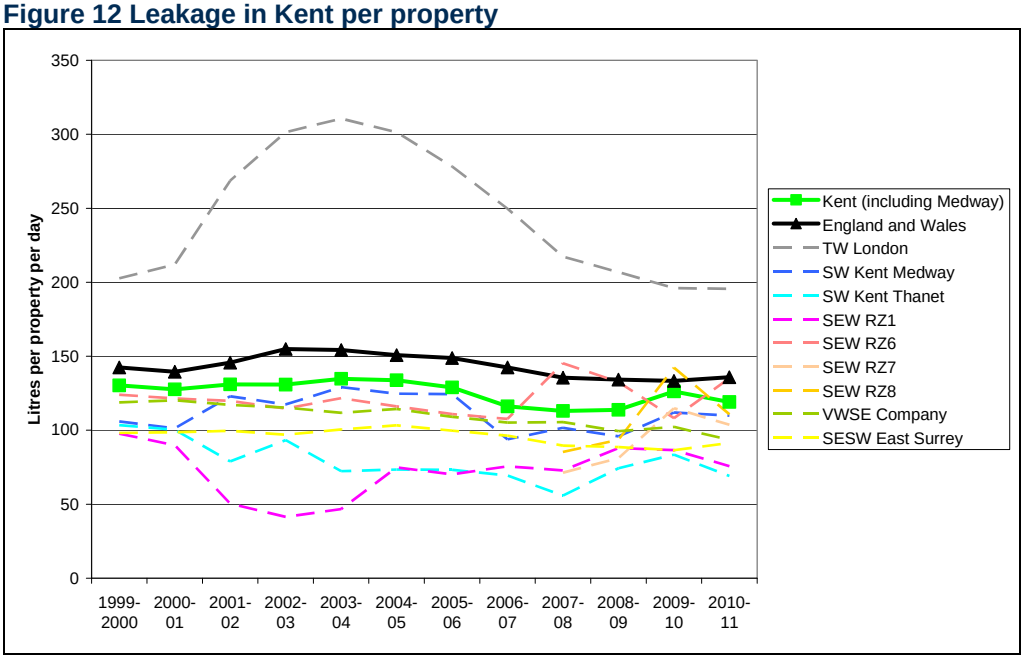


Figure 12 Leakage in Kent per property



How are these challenges being considered?

There are already several forums considering how these challenges should be met in the future. Decisions made regarding water resources have important consequences for the local economy, people's health, social wellbeing and the natural environment. The key groups and strategies are:

- **The Kent Forum** - a high-level strategic group made up of the democratic leaders of Kent.
- **Kent Resilience Forum** - brings key organisations together to plan in advance how we will respond in a major incident.
- **The Kent Environment Strategy** - part of a suite of strategies, developed in 2010 that support a revised Vision for Kent to deliver social, economic and environmental wellbeing for Kent's communities over the next 20 years. The strategy sets out how we will achieve a high-quality Kent environment, low carbon, be resilient to climate change, and that has a thriving 'green economy' at its heart.
- **Water Company Resource Management Plans** - produced by water companies every five years to secure future water resources and ultimately set the price for water. These plans look ahead 25 years and show projections of future demand for water, and how the companies aim to meet this demand.
- **Local Development Frameworks** - prepared by local authorities to set policy for developers and incorporate infrastructure plans which are needed to create sustainable new homes.
- **South East River Basin Management Plan** - sets out the environmental pressures and actions required to improve each water body to Good Status.

Summary

Water resources in Kent are already finely balanced between meeting the needs of people and the environment. With the prospect of hotter, drier summers, less water in rivers and groundwater as well as an increasing population, pressure on water is growing. These changes will affect society, the economy and the environment.

Everyone who uses water needs to recognise and plan for a challenging future. This will require a more integrated and planned approach to water resources, which manages the risks and uncertainties ahead. Solutions and actions need to be flexible and incremental, but society may also need to make some bold changes.

Security of water supply in Kent has improved greatly in the last 40 years. Improved water supply infrastructure and permitting flexibility have now given the county an improved resilience of supply but an increasingly diverse range of solutions are now needed to ensure we can meet the challenges in the next 40 years.