

# WATER USE IN THE SUPPLY CHAIN

*Highways Agency*

Work Package Order: 068 (4/45/12) WSP

*Final*



# **Water Use in the Supply Chain**

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<b>Report Title</b>	:	<b>Water Use in the Supply Chain</b>
<b>Package Order</b>	:	<b>068 (4/45/12) WSP</b>
<b>Report Status</b>	:	<b>Final</b>
<b>Job No</b>	:	<b>3511985H-SSR</b>
<b>Date</b>	:	<b>March 2013</b>

#### DOCUMENT HISTORY AND STATUS

Document control			
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<b>Approved by</b>	Jonathan Ralph	<b>Checked by</b> <i>(quality assurance)</i>	Ola Holmstrom (WSP)
Revision details			
Version	Date	Pages affected	Comments
1.0	March 2013	-	First issue
2.0	March 2013	Multiple	Report updated following HA review



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**EXECUTIVE SUMMARY**

Work package 068(4/45/12)WSP 'Water Use in the Supply Chain' recognises the increasing water stress experienced within the UK and globally and the risk that this presents to Highways Agency non-office based operations.

The study forms part of the Highways Agency's goal to understanding risks associated with water stress, how these risks could affect Highways Agency operations and what measures could be taken to mitigate these risks.

The study highlighted that the volumes of water typically consumed by Highways Agency operations are likely to have little impact on water stress within the UK. However, the study has the potential to raise awareness of water stress throughout the construction industry and the wider population. This in turn may encourage a larger number of organisations to complete similar studies and the cumulative impact could be significant.

The Highways Agency has played a significant role in raising the profile of carbon management in the construction industry in recent years and can potentially do the same in terms of water use and management. The study is also considered important in assisting the Highways Agency in meeting their corporate sustainability targets.

Summary of water stress

The greatest levels of water stress are located within the South East and East of England, predominantly as a result of low average rainfall and high population densities. However, the study has highlighted that a drought situation can occur anywhere in the UK.

Summary of measures implemented to control water stress

Water resources are managed by the EA and water companies. During a drought situation, restrictions may be applied to the volume of water that can be consumed or the types of activities that can be undertaken. The majority of these restrictions are applied to non-essential domestic water uses and typically occur no more than once every ten years.

If a drought worsens, a greater range of non-essential water consuming activities may be restricted such as cleaning commercial vehicles and plant, dust suppression and cleaning external areas. This would typically occur no more than once every 20 to 40 years.

Summary of non-office based water use

The study identified that the most common uses of water at construction sites and depots included:

- |                     |  |
|---------------------|--|
| o Office facilities | o Concrete batching                      |
| o Wheel washing     | o Water specific construction activities |
| o Road sweeping     | o Vehicle washing                        |
| o Dust suppression  | o Salt brine                             |
| o Plant washing     | o Irrigation                             |

The majority of water for site office facilities and construction/maintenance activities is sourced from potable mains supplies. Some activities were identified to be sourced from water bowsers, although it is likely that these are also filled from mains water supplies.

Direct abstraction of water was identified as an alternative water supply on some sites, although none of the sites audited to inform this study sourced water from direct abstraction.

Some sites collect surface water runoff and rainwater for use within non-potable applications. Concerns have been raised regarding the quality of water collected from surface water runoff for certain applications (such as spray applications).

Many sites record the total volume of water obtained through the mains water supply. However, there is often no differentiation between the volume of water used in site office facilities and the volume of

water used for construction/maintenance activities.

#### Impact of water stress on Highways Agency operations

During a severe drought (i.e. once every 20-40 years or so) certain Highways Agency operations may be affected if a greater range of water use restrictions is implemented following approval of a Drought Order. The following water consuming activities may be affected :

- o Wheel washing
- o Road sweeping
- o Dust suppression
- o Plant washing
- o Vehicle washing
- o Irrigation

Restrictions will be exempt if they pose environmental, health or safety risks. Similarly, restrictions may not apply if it can be demonstrated that activities use water efficient technology.

The cost of potable and abstracted water may increase to encourage efficiency and fund investment in infrastructure.

#### Embodied water

Embodied water is a significant contributor towards the total volume of water consumed directly and indirectly by the Highways Agency. Initial investigations suggest that indirect water consumption associated with the procurement of Highways Agency materials for non-office based activities is in the region of 3-4 million m<sup>3</sup> per year. This estimate is approximately 7 times greater than direct annual water consumption in non-office based applications.

#### Opportunities for Highways Agency operations

The key benefits of improving water use efficiency and identifying more sustainable sources of water include:

- o Reducing the risk of water stress on Highways Agency operations and reducing the impacts of Highways Agency operations on water stress and the water environment;
- o Raising awareness of water stress throughout the construction industry and the wider population, thus encouraging a larger number of organisations to consider and reduce water consumption;
- o Reducing the indirect impacts of water consumption, such as associated energy demands, environmental impacts and social impacts;
- o Reducing the need for costly infrastructure works that will ultimately be reflected in the cost of water and subsequent water charges;
- o Raising awareness of embodied water impacts and the need to consider local water stress as part of responsible procurement.

Some of the opportunities that could be pursued by the Highways Agency to reduce risk and maximise opportunities associated with direct and indirect water use have been identified to include:

- o Raising awareness amongst Highways Agency staff, subcontractors and suppliers regarding water stress and the importance of water efficiency;
- o Metering and recording of water use to differentiate between water used for office/welfare facilities and water used for construction/maintenance activities;
- o Leak detection;
- o Use of water efficient fixtures and appliances;
- o Use of appropriate water efficient construction techniques and water efficient plant.
- o Investigating alternative sources of water where possible and where appropriate;
- o Preparing for a drought situation and responding to EA and water company awareness campaigns.

SECTION 1

**INTRODUCTION**



**1 INTRODUCTION****1.1 Purpose of this study**

1.1.1 Work package 068(4/45/12)WSP 'Water Use in the Supply Chain' recognises the increasing water stress experienced within the UK and globally and the risk that this presents to Highways Agency non-office based operations. These risks can be in terms of the effects that the Highways Agency's water use can have on water stress, as well as the effects of water stress on the Highways Agency.

1.1.2 Risks can be associated with direct or indirect water use. Direct water use typically includes the water directly consumed by the Highways Agency in offices, construction sites, outstations and depots that may be sourced from a mains water supply, distribution main, tankered supply or private abstraction. Indirect water use typically relates to the Highway's Agency supply chain and includes the water embodied within materials and products associated with the extraction, processing or manufacture of those materials and products.

1.1.3 The study forms part of the Highways Agency's goal to understanding risks associated with water stress, how these risks could affect Highways Agency operations and what measures could be taken to mitigate these risks. The study builds on previous studies undertaken to date (specifically Research into the Highways Agency's Water Footprint, Task 636/387, 2010) to continue to develop the story of water use and water risk. The information collected will assist in understanding how Highways Agency operations fit into the overall water cycle, but it also provides a bank of information that could be used to inform future detailed water footprinting studies.

1.1.4 The study was broadly split into three tasks as follows:

- Task 1: Identification of water stress, the causes of water stress, actions taken by the Environment Agency and water companies to mitigate water stress, and the risks that this may pose to Highways Agency operations.
- Task 2: Understanding of water use in non-office based applications, specifically where water is sourced from and how this water is used.
- Task 3: Consideration of embodied water associated with the key products and materials used by the Highways Agency in non-office based applications.

1.1.5 Based on the information gained through these three tasks, recommendations have been made as to how to use this information to reduce risk – both to Highways Agency operations in terms of water availability and to future water stress in terms of availability for others.

**1.2 Methodology**

1.2.1 The study has been informed through literature review and direct consultation with the Highways Agency, selected site environmental managers, the Environment Agency (EA) and relevant water companies. A detailed description of the methodology adopted for each task is provided below.

Task 1: Water stress

- 1.2.2 The majority of information regarding current and future water stress within the UK, the causes of water stress and actions taken to manage water stress has been obtained through literature review, predominantly of reports published by the EA.
- 1.2.3 Regions considered to be at significant risk of water stress were compared against the location of construction sites, depots and outstations obtained through direct consultation with the Highways Agency Project Sponsor at the project inception meeting.
- 1.2.4 The review of measures adopted by water companies to manage water resources and drought scenarios was informed through review of Water Resource Management Plans and Drought Plans published by selected water companies including those published by Thames Water, South East Water, Southern Water and Bristol Water.
- 1.2.5 The data obtained through literature review was supplemented and reaffirmed through direct consultation with the EA and the selected water companies. Details of direct consultation are provided below.
- 1.2.6 Information regarding current water stress, future water stress and the measures implemented to manage these risks was used to gain an understanding of potential impacts to Highways Agency non-office based operations. This was informed by review of information gathered as part of Task 2 of this study, specifically the types of activities undertaken at construction sites, depots and outstations that require a water supply.

Task 2: Water use

- 1.2.7 Suitable construction sites, depots and outstations were identified through consultation with the Highways Agency Project Sponsor. A generic questionnaire was prepared and issued to the selected sites to ascertain key information such as activities that require a water supply and the sources of water used to supply these activities.
- 1.2.8 The questionnaire was verified and augmented through a visit to each of the selected sites and direct consultation with the relevant site environmental managers. During these visits, a review of potential opportunities was undertaken to reduce water consumption and identify more sustainable sources of water.
- 1.2.9 The questionnaire and site visit enabled identification of knowledge gaps and the development of recommendations to address these gaps.

Task 3: Embodied water

- 1.2.10 Key materials and products were identified through review of data reported within the previous Highways Agency study "Major project, managing agent and private finance initiative materials purchases from 2009 to 2012" that captured data on the quantities of construction materials purchased by the supply chain across all construction, maintenance and improvements works for Major Projects, Managing Agent Contractors (MAC) and Design-Build-Finance-Operate (DBFO) schemes.
- 1.2.11 Embodied water associated with the most significant materials identified by this study was estimated based on literature review of available published data. This allowed

the most significant materials in terms of their embodied water content to be identified.

- 1.2.12 The study identified knowledge gaps and uncertainties associated with published data. The identification of these gaps and uncertainties has subsequently informed recommendations to address some of the issues, as well as opportunities to maximise the use of the collected data.

### 1.3 Consultation

- 1.3.1 Direct consultation has been held with the EA, selected water companies and appropriate contacts for Highways Agency sites. A total of four sites were selected and audited to inform this study - comprising two major project sites and two depots. The sites were selected based on their location and suitability to inform the study.
- 1.3.2 A summary of consultation is provided in Table 1.1.

*Table 1.1 Summary of consultation*

Organisation / Site	Details
Environment Agency	Initial discussion with the Head of Water Resources regarding the purpose of the study.
Environment Agency	Detailed discussion with a Senior Advisor in Water Resources Resilience regarding current and future water stress, water management measures and restrictions, and potential impacts to HA operations
South East Water	Discussion with Water Resource Planner regarding Water Resource Management Plan, Drought Plan, associated demand management measures and restrictions, and potential impacts to HA operations
Thames Water	Discussion with Water Resource Planner regarding Water Resource Management Plan, Drought Plan, associated demand management measures and restrictions, and potential impacts to HA operations
Southern Water	Discussion with Water Quality and Strategy Manager regarding Water Resource Management Plan, Drought Plan, associated demand management measures and restrictions, and potential impacts to HA operations
Bristol Water	Discussion with Water Resource Planner regarding Water Resource Management Plan, Drought Plan, associated demand management measures and restrictions, and potential impacts to HA operations
Major Projects site: M4/M5	Discussion with Site Environmental Manager regarding M4 Junction 19-20 and M5 Junction 15-17 managed motorway scheme
Major Projects site: A23 Handcross	Discussion with Site Environmental Manager regarding A23 Widening Handcross to Warninglid
MAC: Area 4, Stanford Depot	Discussion with Site Environmental Manager regarding Stanford Depot. Representative of best practice in terms of water conservation measures
MAC: Leatherhead Depot	Discussion with Site Environmental Manager regarding Leatherhead Depot. Representative of 7 other Connect Plus M25 DBFO depots
Balfour Beatty Major Civil Engineering	General discussion with Head of Environment & Sustainability regarding typical site water use, sources of water supply and opportunities.



SECTION 2

**TASK 1: WATER STRESS**



**2 TASK 1: WATER STRESS****2.1 Introduction**

2.1.1 Water resources in the UK are under significant pressure to meet all environmental and human demands. The balance between environmental and human demands under 'normal' climate conditions is managed by the EA and relevant water companies through the abstraction licensing system and demand management measures. However, the availability of water resources varies throughout the country and throughout the year, with long term changes forecast as a result of a growing population and changing climate.

2.1.2 Long term solutions for sustainable water management are required to address the issues affecting us now and in the future. However, it is often short term water stress and droughts that attract the greatest attention. Control measures are instigated by the EA and water companies during periods of drought that may have an impact on water users, such as volumetric restrictions and temporary use bans. Restrictions to the direct abstraction of water from a surface water or groundwater body (including water abstracted by water companies) are imposed and managed by the EA. Restrictions to the use of potable water supplied through the mains water supply are imposed by the incumbent water authority in accordance with national legislation.

2.1.3 Water use restrictions are often met with confusion and criticism from the public, particularly when the UK experiences rainfall every three days, on average<sup>1</sup>. However, water stress is not unusual, particularly in the south and east of England, and is predicted to increase in the future principally as a result of population growth and climate change effects.

2.1.4 This section of the report provides a summary of existing and future pressures on water resources, current actions taken to manage water stress, and additional actions that are proposed to manage increasing pressures in the future. The potential impacts and subsequent opportunities for Highways Agency sites and operations have been considered and a summary of this assessment is provided within Section 2.10.

2.1.5 Information has been obtained from the following sources:

- Reports published by the EA;
- Reports published by Ofwat, Thames Water, South East Water, Southern Water and Bristol Water;
- Direct consultation with the EA Water Resources Resilience Department;
- Direct consultation with the Water Resource Planning Departments of Thames Water, South East Water, Southern Water and Bristol Water;
- Data published by the Met Office.

2.1.6 Footnotes are provided where appropriate and a full list of referenced documents is provided in Section 6.

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<sup>1</sup> Met Office: UK mapped climate averages 1981-2010,  
<http://www.metoffice.gov.uk/climate/uk/averages/19812010/>

**2.2 Water supply**

2.2.1 The vast majority of our water resources are sourced from non-tidal surface water bodies or from groundwater aquifers. This is typically determined by the particular geology within each region. Within England, approximately one third of public water supplies are sourced from groundwater and two thirds from surface waters. The percentage of public water supplies sourced from groundwater varies throughout England and Wales, generally increasing from approximately 3% in Wales and 11% in the north of England up to approximately 74% in the South East<sup>2</sup>.

2.2.2 The principal aquifers of the UK are found within the lowlands of England and comprise chalk (predominately within East Anglia, South and South East), sandstone (predominantly in the West, Midlands and North) and limestone geological formations. These aquifers are capable of supporting public water supplies. Figure 2.1 illustrates the location of principal chalk, sandstone and limestone aquifers throughout the UK.

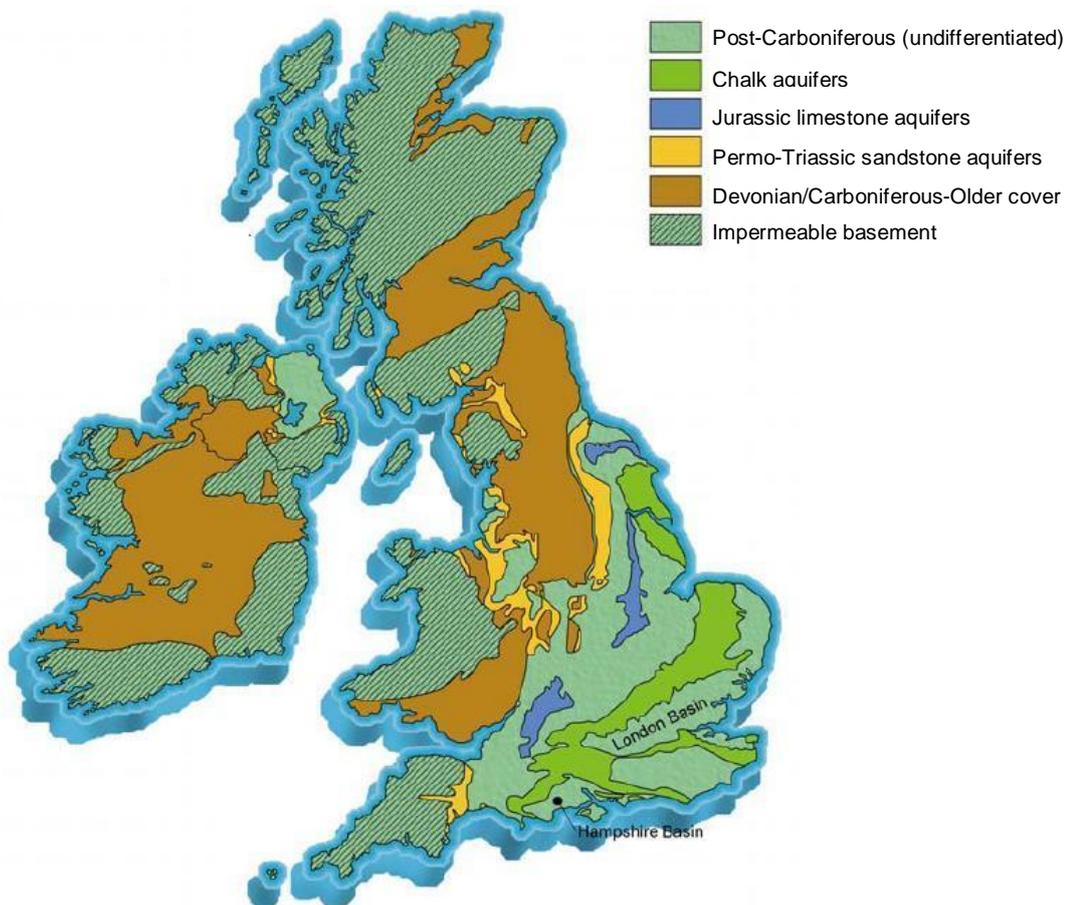


Figure 2.1 Principal aquifers in the UK (Reference: *The Aquifers of the UK*, UK Groundwater Forum, British Geological Society - UK Groundwater Forum, 2011)

2.2.3 Groundwater is also available within other aquifers throughout the UK, but these do not tend to be as porous and permeable and therefore do not offer as much groundwater yield potential as the chalk, limestone and sandstone formations

<sup>2</sup> Underground, Under Threat - The State of Groundwater in England and Wales, Environment Agency.

discussed above. However, these minor aquifers can still support smaller private supplies from springs, wells and boreholes.

**2.3 Water use**

2.3.1 Total annual abstraction from non-tidal surface water and groundwater resources in England and Wales was estimated to be in the region of 11,399 million m<sup>3</sup> of water per year (in 2011)<sup>3</sup>.

2.3.2 The vast majority of water abstracted from our ground and surface water resources throughout England and Wales is used for water supply and electricity generation, as illustrated in Figure 2.2. The percentage of total water used in these different applications varies across England and Wales. For example, over 80% of water abstracted in Wales is used to support electricity generation, with less than 15% taken for public water supply. However, in East Anglia, a comparatively negligible volume of water is used for electricity generation, yet over 80% is used for public water supply<sup>4</sup>.

2.3.3 The net volume of water in many process applications such as electricity generation can be negligible. For example, if water is abstracted for cooling purposes and then put back into the water body with little impact on flow and volume. It is difficult for the EA to account for these returned volumes of water within abstraction and resource availability calculations.

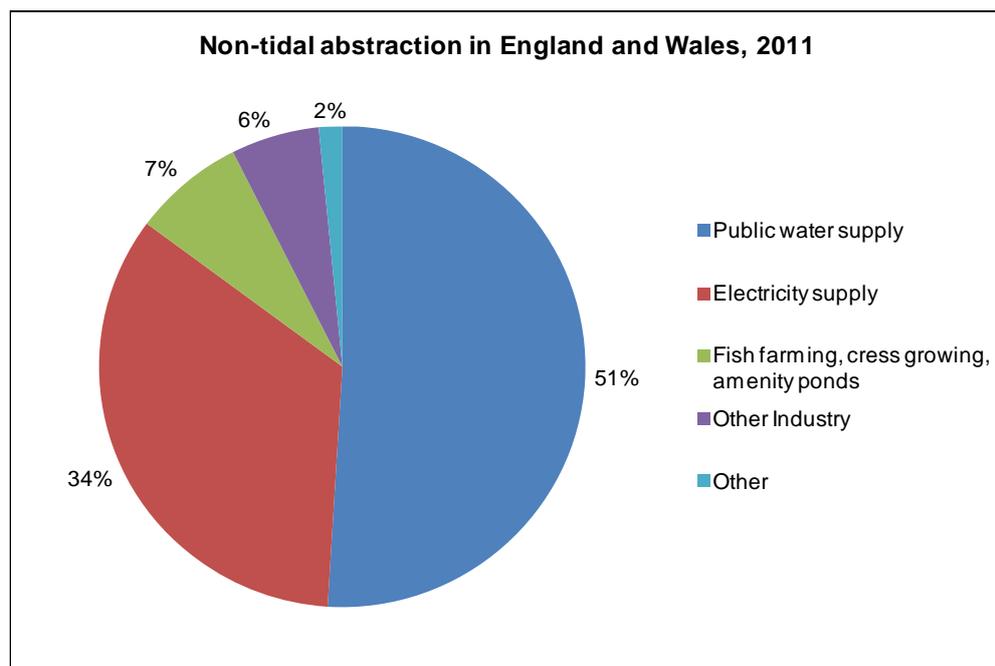


Figure 2.2 Abstractions from non-tidal surface water and groundwater by use: England and Wales<sup>3</sup>

2.3.4 Surprisingly, agriculture only accounts for approximately 1% of total annual abstracted water, although this is highly dependent on location with the greatest demand (approximately 4%) in East Anglia allocated to spray irrigation<sup>4</sup>. However, this

<sup>3</sup> Water Abstraction Estimates, Defra – ([www.defra.gov.uk/statistics/environment/inland-water/iwfg12-abstrac/](http://www.defra.gov.uk/statistics/environment/inland-water/iwfg12-abstrac/))

<sup>4</sup> The Case for Change – Current and Future Water Availability, Environment Agency.

demand is concentrated into only a few months of the year when water is most scarce and little is returned to the environment. The impact of this relatively small averaged annual percentage on water resource availability is therefore potentially significant.

- 2.3.5 Research undertaken by the Strategic Forum for Construction estimates that the construction industry uses approximately 14 million m<sup>3</sup> of water per year in England and Wales<sup>5</sup>. This accounts for approximately 0.12% of total annual water use. This estimate is based on an agreed 2008 baseline water use of 148m<sup>3</sup> per £million contractor output at constant price, and a calculated contractors output value for England and Wales in 2008 at constant price of £95,890 million.
- 2.3.6 Water uses can be broadly categorised within a hierarchy of essential to non-essential uses when considered in regard to the management of water resources. This hierarchy is set out within the Code of Practice and Guidance on Water Use Restrictions (11/WR/33/3), Water Use (Temporary Bans) Order 2010, and the Drought Direction 2011 supplement to the Flood and Water Management Act 2010.
- 2.3.7 In summary, the first tier of non-essential use typically comprises domestic activities such as watering a garden or cleaning a car using a hosepipe. The second tier incorporates other non-essential domestic water uses such as window cleaning and patio cleaning. The third tier requires approval by the EA and Secretary of State and allows water restrictions to be placed on certain commercial activities such as dust suppression, using mechanical vehicle washers and cleaning industrial plant. A description of non-essential water uses and the actions taken by the EA and water companies during periods of drought are discussed in more detail in Section 2.7 and Section 2.8 respectively.

## **2.4 The causes of water stress**

- 2.4.1 The UK typically experiences sufficient rainfall to meet all of its human and environmental demands. However, rainfall does not fall in the locations where it is needed the most (i.e. in areas of greatest population density) or during the time of year when it would be most beneficial (i.e. the hotter summer months). This can put stress on our available water resources, lead to water shortage issues and cause environmental damage.
- 2.4.2 The nature and scale of water stress differs across the UK and is influenced by several key factors including:
- Rainfall and climate;
  - Population growth and population density;
  - Pollution of available resources; and
  - Where water supplies are sourced from.
- 2.4.3 It is important to appreciate the difference between long and short term water stress as their impacts and management methods will differ considerably. Long term water stress is affected predominantly by population growth, climate change and other behavioural factors that change water demand.
- 2.4.4 Short term water stress that can lead to a drought situation is caused by uncharacteristically low rainfall that causes a short term impact on water availability,

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<sup>5</sup> Water: An Action Plan for Reducing Water Usage in Construction Sites, Strategic Forum for Construction, June 2011

although short term water stress can often be fuelled by climate change and other long term factors. The EA and relevant water companies instigate measures to manage and reduce the effects of drought situations. Each drought is different, with some droughts affecting a large area whilst others are concentrated in only few catchments.

2.4.5 A summary of the key factors that influence water stress is provided below.

#### Rainfall and climate

2.4.6 Average annual rainfall in England is estimated to be approximately 854.8mm, with rainfall experienced, on average, every three days. However, the distribution of rainfall varies considerably with the west of England generally experiencing more rainfall than the east. The majority of Cumbria and parts of Lancashire and Cornwall can experience an average annual rainfall of over 2000mm per year. In contrast the east of England (most notably Nottinghamshire, Leicestershire, Lincolnshire, East Anglia, Essex and Kent) can experience less than 600mm of rainfall per year<sup>6</sup>. Our current climate is changing and is predicted to exacerbate existing water stress throughout the UK, as discussed in Section 2.6.

#### Population growth and population density

2.4.7 One of the biggest pressures on water resources is the growing population. The rate of population growth is increasing, with the total population of England and Wales rising at a faster rate over the past 10 years than it did over the previous 20 years. Population is forecast to increase at an even greater rate over the next quarter of a century.

2.4.8 The greatest population densities are experienced within London and the South East, where rainfall is least, and within and around the cities of Birmingham and Manchester. Dense populations put the greatest pressure on local water resources as potable demand is typically the largest user of abstracted water in England and Wales. Population density is predicted to increase in some areas in the future exacerbating existing water stress, as discussed in Section 2.6.

#### Pollution of available resources

2.4.9 Increasing urban development (intrinsically linked to population growth and density) can adversely affect groundwater recharge and further deplete available groundwater resources. Impermeable surfaces do not promote infiltration of rainwater to ground and therefore water is diverted to surface water bodies instead of assisting with groundwater recharge. Not only does this reduce the volume of groundwater available for abstraction, but it also removes potential water supplies from the catchment. Groundwater aquifers provide a natural storage system for water supplies that do not respond as quickly to summer droughts. Groundwater also provides an essential base flow to surface water bodies to maintain surface water abstractions and the needs of the environment.

2.4.10 Surface water runoff from highways and urban areas is often polluted and can pollute water bodies used for water supply. Similarly, spillages and infiltration of contaminants can pollute water bodies and groundwater supplies. The pollution of water resources can significantly increase treatment costs for both groundwater and

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<sup>6</sup> Met Office: UK mapped climate averages 1981-2010,  
<http://www.metoffice.gov.uk/climate/uk/averages/ukmapavg.html>

surface water abstractions, as well as cause ecological damage to the water environment. However, significant pollution can cause a public water supply to become unusable and redundant, subsequently increasing pressure on alternative supplies. Inadequate and poorly maintained drainage systems that capture highways runoff are a contributing factor to the pollution of water resources, particularly in dense urban areas where water resources are likely to be most stressed.

#### Where water supplies are sourced from

- 2.4.11 Groundwater aquifers and surface water bodies respond differently to rainfall events and periods of water stress, which in turn can influence water availability in a catchment depending on the primary sources of water within that catchment.
- 2.4.12 Most rivers rely on surface water runoff (in full or in part) to maintain river flows. Rivers typically respond much more quickly to reduced rainfall and can become more vulnerable earlier on it a drought situation. However, they also recover relatively quickly once the drought is over.
- 2.4.13 Many rivers rely on groundwater base flows (some almost entirely) which can provide a more reliable flow than surface water runoff from the land. This in turn can make the river more resilient to short term changes in rainfall (particularly during the summer months when runoff is typically less) to maintain surface water abstractions and meet environmental requirements. Maintaining groundwater levels is therefore important not only for maintaining groundwater abstractions, but also for maintaining river flows during periods of low rainfall.
- 2.4.14 Groundwater aquifers rely heavily on winter recharge to restore depleted groundwater levels, in particular steady rainfall events that occur over a long duration. During the summer months, a lot of rainfall (and subsequently water that would infiltrate to the ground) is lost through evaporation or taken up by vegetation. However, during the winter a lot less water is lost through evaporation or taken up by vegetation and a lot more water can permeate through the soil to below ground aquifers. Failure of winter rainfall over one or more years can lead to shortages in groundwater and subsequently to water stress. Groundwater aquifers may also take longer to recover from a prolonged period of low rainfall even after rainfall has increased.
- 2.4.15 The information provided above demonstrates that both surface water bodies and groundwater aquifers are equally susceptible to unusual climate conditions and changes in rainfall and can both be at risk of water stress. The nature and timing of water stress within a catchment will be influenced by the primary source of water within that catchment (i.e. if a catchment relies more on water sourced from groundwater aquifers or surface water reservoirs) and the specific conditions that have contributed to water stress (i.e. low winter rainfall or low summer rainfall).

## **2.5 Current water resource availability and current water stress**

- 2.5.1 The EA has published a significant volume of data on current water stress within England and Wales. The greatest levels of water stress are experienced within the South East and East of England predominantly as a result of low average annual rainfall and high population densities. However, a review of selected historic droughts highlights that a drought situation can occur anywhere in the UK:

- 1975 – 1976: Widespread drought throughout the UK caused by a dry winter followed by an intensely hot dry summer.

- 1989 – 1990: Low winter rainfall that caused a deficit in groundwater recharge, causing a major impact on water resources in the east of England.
- 1995 – 1996: A dry winter in the Pennines that led to very low reservoir levels in parts of Yorkshire.
- 2005 - 2007: Severe drought within the south east of England.
- 2010: A short spring/summer drought that affected the north west of England.
- 2011: Driest spring on record in the Anglian region and the second driest on record across the rest of England and Wales, predominantly affecting Lincolnshire and East Anglia, but with near drought conditions stretching from Cornwall in the south west, to Derbyshire in the north and to Norfolk and Essex in the east.

2.5.2 The EA has completed detailed catchment wide water resource availability studies through their Catchment Abstraction Management Strategies (CAMS). CAMS consider how much freshwater resource is readily available, how much water the environment needs and the amount of water already licensed for abstraction. This subsequently identifies where water is potentially available for abstraction and where water resources are over committed (and therefore at greatest risk).

2.5.3 CAMS show that many parts of the South East and East Anglia are over licensed or over abstracted during periods of low flow, as illustrated in Figure 2.3.

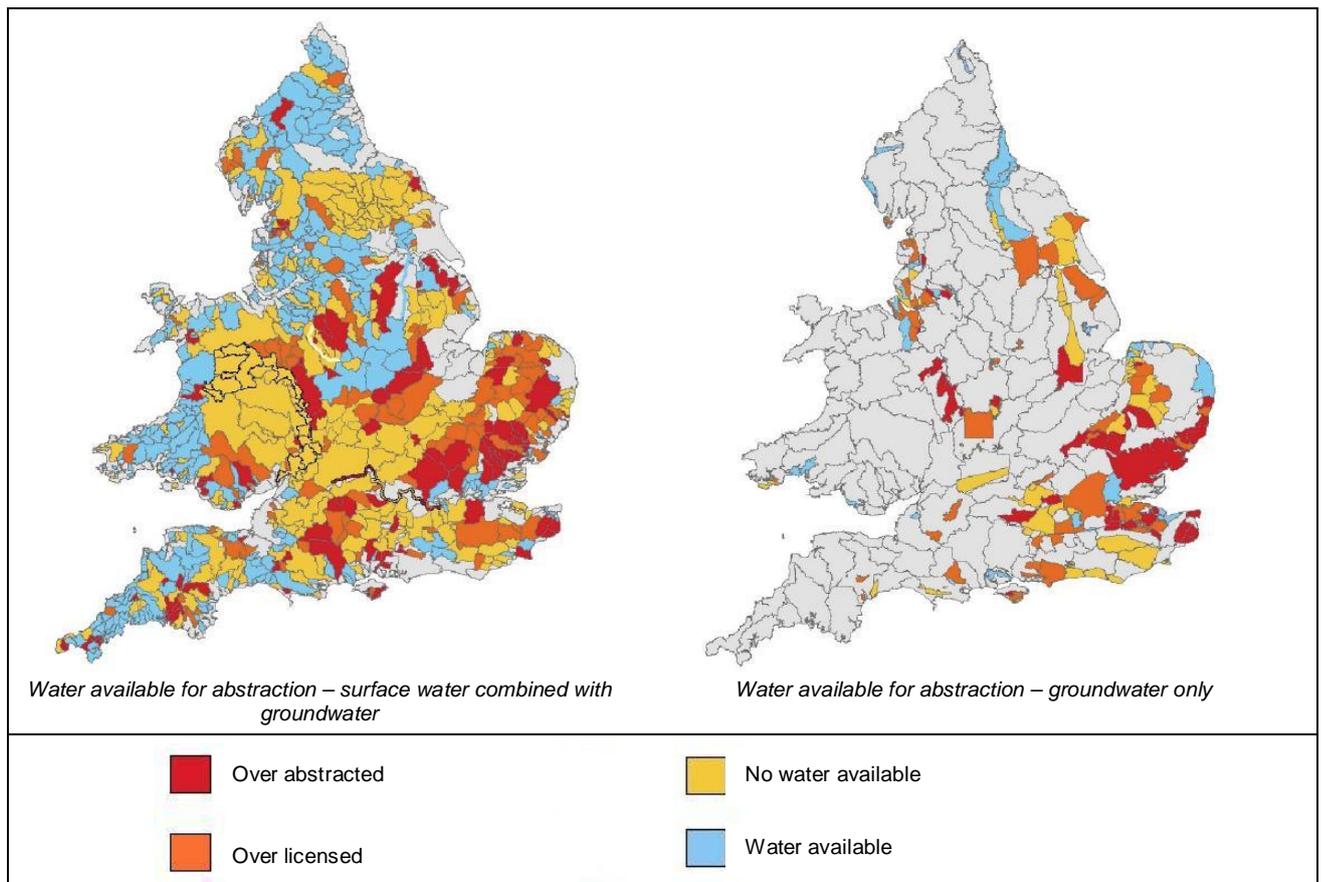


Figure 2.3 Water available for abstraction (Reference: Water Resources in England and Wales - Current State and Future Pressures, Environment Agency, December 2008)

- 2.5.4 Figure 2.3 identifies areas at risk from long term water stress to enable long term planning. The analysis considers typical low flow scenarios to predict the magnitude and location of water stress during drier periods (noting that 'low flows' represent usual periods of low rainfall and not prolonged periods of uncharacteristically low rainfall that could lead to a drought situation).
- 2.5.5 A large proportion of the South East (particularly the Thames River basin and down to Maidstone) is estimated to only have reliable resources available less than 30% of the time<sup>7</sup>. However, the studies also show that there are considerable pressures on water resources throughout England and Wales and not just within the South East and East Anglia.
- 2.5.6 In summary:
- Over abstracted:** These catchments show where current actual abstraction (i.e. the volume of water actually abstracted rather than the volume of water that could be abstracted under existing licences) is already causing damage to the environment during periods of low flow. These catchments are likely to have the greatest restrictions placed on the abstraction and use of water, particularly during a drought.
- Over licensed:** These catchments show where current actual abstraction will take all available water during periods of low flow and that full use of these existing licenses (i.e. when the full volume of licensed water is abstracted) could cause damage to the environment during periods of low flow.
- No water available:** These catchments show where the abstraction of all water allocated under existing licenses would remove all available water during periods of low flow. However, the current abstraction licensing system does not always provide an accurate reflection of the total volume of water currently abstracted or the total volume of water potentially available for further abstraction. It is therefore likely that water may still be available within these areas, particularly if licenses are reviewed or shared in the future.
- 2.5.7 Only approximately 45% of licensed water is currently abstracted by license holders<sup>8</sup>. A simple review of licensed water can indicate that a catchment is at water stress when water resources may still be available.
- 2.5.8 The inclusion or exclusion of return flows can also affect estimates of water availability. A large percentage of abstracted water (including approximately 70% of public water supplies) is returned to the environment as effluent, for example water used in toilets and showers that is treated at a wastewater treatment works and discharged to an adjacent watercourse. It is difficult to include these returned volumes in abstraction and water stress calculations (partly because they are often returned to a different catchment or at a different point in time) and therefore reported water stress may not always take these return flows into account.
- 2.6 Future water resource availability and future water stress**
- 2.6.1 Water stress is predicted to increase in future years. This could mean a reduction in the availability of water to meet long term predicted water demands, as well as a possible increased risk of drought.

<sup>7</sup> Managing Water Abstraction, Environment Agency, June 2010.

<sup>8</sup> A Case for Change – Current and Future Water Availability, Environment Agency

2.6.2 The key contributors to future water resource availability are:

- Population growth and increased population density, particularly in those areas that already experience significant water stress;
- Changes in lifestyle and a growing demand for water;
- Climate change.

Population growth and population density

2.6.3 The population of England and Wales is predicted to increase by 10 million by 2030 and 20 million by 2050<sup>9</sup>. The greatest population growth is expected within the East and South East of England, where water resources are already significantly stressed. Significant population growth is also expected within the South West and in the North throughout Yorkshire and Lancashire. Current population densities and future population growth is illustrated in Figure 2.4.

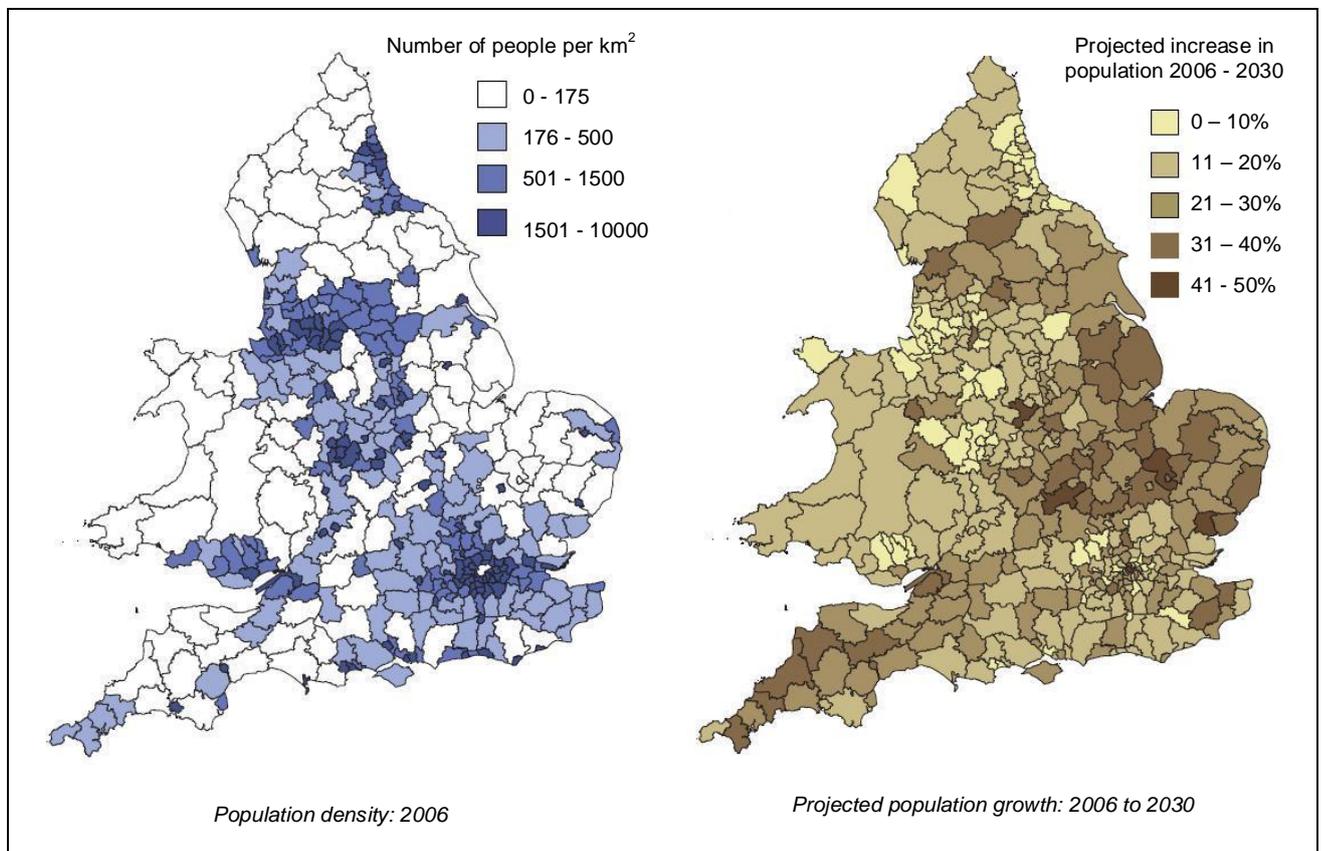


Figure 2.4 Current and future population statistics (Reference: Water Resources Strategy for England and Wales, Environment Agency, March 2009)

<sup>9</sup> Water Resources in England and Wales – Current state and future pressures, Environment Agency, December 2008.

Changes in lifestyle

- 2.6.4 The number of smaller households will continue to increase and this will contribute to an increase in water demand. Some scenarios suggest a growth in domestic water demand of about 5% by 2020 and as much as 35% by 2050<sup>10</sup>. The predicted increase in water demand from population growth and an increase in per person water use will be somewhat offset by improved efficiency measures, more extensive metering and reduced leakage from mains supplies. Schemes to achieve 'water neutrality' within all new development in the South East are being promoted by local authorities.

Climate change

- 2.6.5 Water demand within the agricultural sector is predicted to increase by 25% by 2020 as a result of climate change. The greatest demands are currently within East Anglia and parts of the Midlands and these will increase, adding to existing summer pressures in these regions. By 2020, central England and the eastern margins of Wales could experience conditions similar to those currently faced in the South and South East<sup>11</sup>.
- 2.6.6 An increase in summer temperatures is likely to significantly increase the demand for water across all sectors and water lost through evaporation. It is predicted that the UK will experience more short duration yet high intensity rainfall events, potentially leading to droughts and floods occurring in close succession.
- 2.6.7 The greatest risk to future water availability is likely to be a result of predicted climate change effects, partly because of the severity of the predicted effects and partly because of the uncertainty that surrounds climate change predictions. There are a number of differing models for predicted climate change within the UK, but overall it is considered likely that summers will become hotter and drier and winters will become warmer and wetter.
- 2.6.8 Reduced rainfall in the summer months could lead to reduced river flows and an overall reduction in the availability of surface water resources. The EA has shown that by 2050 river flows in late autumn could decrease by over 50%, and up to as much as 80% in some places (particularly the west of England and into Wales)<sup>12</sup>. Reduced rainfall could consequently lead to more frequent and/or extensive droughts and the need to apply restrictions to allowable abstraction of surface water. Reduced rainfall could also add to existing pressure on groundwater resources that will be relied upon to maintain a base flow within surface water bodies.
- 2.6.9 Wetter winters could improve groundwater aquifer recharge and the availability of groundwater for abstraction. However, the groundwater recharge season may be shortened if more rainfall is absorbed by overlying soils with a lower moisture content following a warmer summer. If the UK experiences more intense winter rainfall events within a shorter duration, winter recharge of groundwater aquifers might reduce. This may lead to a long-term reduction in groundwater availability and could consequently lead to more frequent and/or extensive droughts and the need to apply restrictions to the abstraction of groundwater.

<sup>10</sup> Water White Paper - Water for Life, Defra, December 2011

<sup>11</sup> Water Resources Strategy for England and Wales, Environment Agency, March 2009

<sup>12</sup> Water Resources in England and Wales – Current state and future pressures, Environment Agency, December 2008.

- 2.6.10 An overall decrease in groundwater recharge is predicted by 2025 as a result of predicted climate change. The sandstone aquifers in the West, Midlands and North are predicted to experience a 9% reduction in long term average recharge. The chalk aquifers in East Anglia, South and South East are predicted to experience a 3% reduction in long term average recharge<sup>11</sup>.

#### Summary

- 2.6.11 The East and South East of England are considered to be at the greatest risk from an increase in water shortages due to predicted increases in population and climate change effects. However, modelling of future scenarios does also suggest that other areas of England, specifically the South West and North, will also be at risk from having insufficient water resources to meet current and future demands.

## **2.7 Management of water resources: current Environment Agency actions**

- 2.7.1 The EA is ultimately responsible for the sustainable management of water resources in England and Wales. They decide how much water can be taken from surface water and groundwater resources without causing damage to the natural environment and subsequently regulate the abstraction of this water.

- 2.7.2 Water resource availability is informed through UK Climate Impacts Programme (UKCIP) modelling that is used to predict future rainfall, river flow and temperature. This data, along with future population growth and water demand predictions, is used to predict water resource availability to meet all long term environmental and human needs. The EA use this information to assess the long term sustainability of current and future abstraction from surface waters and groundwater and plan the allocation of water accordingly. This includes the allocation of water to water authorities for potable supply.

- 2.7.3 The EA also monitors and reports on the state of the environment and is responsible for communicating this information to all stakeholders. This includes monitoring for the potential onset of drought and taking the necessary action to mitigate for the potential impacts of drought.

#### Abstraction licenses

- 2.7.4 The EA controls and monitors how much water is taken from the environment through the use of abstraction licenses and associated license conditions. The EA can grant a license for the abstraction of water after considering the amount of water available (assessed through review of CAMS) after the needs of existing abstractors have been met and whether the justification of the license is reasonable.

- 2.7.5 Abstraction licenses for direct abstraction from a groundwater or surface water source for volumes greater than 20m<sup>3</sup> per day are currently allocated on a first come first served basis. It is important to note that a license is not required for direct abstraction from a groundwater or surface water source for volumes less than 20m<sup>3</sup> per day. This process includes licenses that are granted to water companies for the abstraction of surface water and/or groundwater for the supply of public water through the mains distribution system. Licences are also granted to private companies, landowners and other organisations for direct abstraction from groundwater or surface water sources for personal use, for example for agriculture, industry or domestic supply.

- 2.7.6 Many historic licenses do not have time bound controls and the EA is unable to modify these licenses without following slow regulatory processes (including for

restrictions during periods of water stress). Abstractions are also currently charged for the maximum agreed volume of water that can be abstracted, rather than the actual volume of water abstracted, and regardless of the time of year. The EA currently licenses 75,000 MI/d in England and Wales, of which just under 34,500 MI/d is actually abstracted (about 45%)<sup>13</sup>.

- 2.7.7 This approach does not give the abstractor any incentive to innovate or use water efficiently, or facilitate the EA in reducing abstractions during periods of water stress and drought. It is also difficult to bring unused license volumes back into the 'pot' for allocation elsewhere. This can subsequently make it difficult for the EA to assess the real impact of abstraction on water availability and the scope for additional abstraction.
- 2.7.8 The Water Act 2003 brought in time limits for new abstraction licenses to address the issue of the EA not being able to modify or revoke unsustainable or unused licenses. To date only approximately 20% of all abstraction licenses in England and Wales have a time limit. Licenses for the permanent abstraction of water are now generally granted for a duration of 12 years after which time the conditions of the license are reviewed and the license can be amended or revoked accordingly. Licenses can also be granted for the temporary abstraction of water, for example during a set construction period of a known number of months.
- 2.7.9 The EA have launched a programme for Restoring Sustainable Abstractions (RSA) in England and Wales. The RSA programme prioritises where existing licences are causing damage to sensitive water environments and allows the EA to work with the license holders to agree suitable solutions and subsequently meet the requirements of the Water Framework Directive (WFD). The RSA programme typically targets sensitive areas such as SSSI or Ramsar sites.
- 2.7.10 It is essential that water resources are managed more efficiently in the future to meet the growing demand for water as well as prepare for the potential effects of climate change. Proposals are being put forward by Government and the EA to reform the current abstraction licensing system, particularly those licenses that were granted prior to 2003. Abstraction licences that are located in close proximity to sensitive water environments are likely to be targeted first as part of the RSA programme and to meet WFD requirements. The proposed measures are discussed in more detail in Section 2.9.

#### Drought plans

- 2.7.11 The EA prepares drought plans that set out a flexible framework for managing water resources during drought events depending on their extent and severity. Drought plans set out the actions that will be taken by the EA prior to, during and after a drought, as well as the triggers that determine which actions need to be taken. Unfortunately the current abstraction licensing system makes it difficult for the EA to make changes or apply short term restrictions to abstraction licenses.
- 2.7.12 Actions taken by the EA during a drought may include promoting water efficiency measures and encouraging a voluntary reduction in abstraction to conserve water resources, especially for non-essential uses of water. If necessary, the EA may be able to make modifications to newer abstraction licenses granted since the Water Act 2003. These licenses can have conditions embedded within them that allow the EA to modify the abstraction during periods of drought when a river flow or level falls

<sup>13</sup> The Case for Change – Current and Future Water Availability, Environment Agency.

beneath a specific point in order to protect the natural environment. These are known as 'hands off flow' and 'hands off levels'.

- 2.7.13 During a drought, the EA is responsible for monitoring the drought actions taken by water companies and for making sure that water companies prepare and follow their own drought plans (discussed in Section 2.8). In more severe droughts, the EA may be responsible for approving Drought Permits that allow water companies to temporarily increase/amend existing abstractions, or suspend restrictions such as hands off flow conditions. These measures are extremely important for managing water resources during a drought as the majority of water used in England is for public water supply.

#### Augmentation schemes

- 2.7.14 A number of augmentation schemes are located throughout the UK. Augmentation schemes take water from one source of supply to improve river flows elsewhere. Schemes are either operated by the EA or a water company. They can be divided into schemes which are aimed at protecting the environment when low water levels threaten plants and wildlife particularly during drought, and schemes which allow public water supply abstractions to continue throughout the year including during periods of low flow.
- 2.7.15 During a drought, the EA may make changes to existing augmentation schemes, such as reducing or increasing the flow of water from one catchment to another, or temporarily creating new augmentation schemes. These modifications may help mitigate a localised drought, but the environmental impacts of any changes must be assessed fully prior to any changes being made.

## **2.8 Management of water resources: current water company actions**

- 2.8.1 Water companies prepare a number of plans that set out their proposed methods and actions to sustainably manage water resources in order to meet customer demands and remain within the EA abstraction licence requirements. These include long term water resource management plans and short term drought plans.

#### Water resource management plans

- 2.8.2 Water companies prepare long term water resource management plans that show how they intend to manage their water resources and supplies over the next 25 years to meet their customer's needs whilst protecting and enhancing the environment. These plans are produced every five years and reviewed annually.
- 2.8.3 The water management plan calculates the predicted volume of water likely to be required during the 25 year plan period and summaries the measures that will be put in place by the water companies to meet forecast demand within allocated water supplies and without causing damage to the natural environment. Measures typically include demand management measures, such as increasing the number of properties with a water meter and promoting greater efficiency, as well as supply-driven measures such as reducing leakage and improving connectivity of supplies. The plans also set out planned and proposed infrastructure works, such as new augmentation schemes or reservoirs.
- 2.8.4 Each water company sets out its proposed level of service that the company commits to supply to its customers during the period of the plan. The water company must demonstrate that the measures proposed to manage water resources and water

supplies will provide the necessary security of supply to meet the agreed level of service. However, it is accepted that the water company may not be able to meet all its demands all of the time and therefore the water company includes the likelihood of possible restrictions to customer water use within its proposed level of service.

2.8.5 Typically a water company's level of service will include a commitment to enforce a temporary water use ban (previously known as a hosepipe ban) no more than once every ten years (i.e. a 10% annual probability of occurring). For more extreme events, the water company may commit to enforcing other non-essential use bans. The level of service is decided by the water company and agreed with the EA, but is likely to comprise enforcing a non-essential use ban no more than once every 20 to 40 years (i.e. a 2.5% to 5% annual probability of occurring). The likely frequency is dependent on many factors including customer feedback. For example, surveys may have found that customers would prefer a ban on non-essential uses every 20 years instead of an increase in water rates that would be required to pay for the investment in infrastructure required to reduce the likelihood to every 40 years.

2.8.6 The level of service that a water company commits to during the period of the plan takes into account the potential effects of climate change and predicted increases in water demand within the region. Theoretically, population growth and the potential effects of climate change should therefore have little impact on the level of service committed to by the water company as these effects were considered during the preparation of the plan. The plan sets out the measures that will be required to manage future water resource availability conditions and predicted growth in water demand.

#### Drought plans

2.8.7 All water companies have a statutory requirement to prepare a drought plan to respond to the levels of service as set out in the water resource management plan. Drought plans show what operational steps the water company will take to manage their water resources and water supplies before, during and after drought events. It is important to note that these are short term measures to manage water resources during a drought situation, and are not long term measures to manage the effects of climate change and population growth.

2.8.8 The plans contain the actions that a water company can take to help reduce demands (and potentially increase supply) depending on the severity and extent of the drought. These will range from temporary restrictions on water use during a relatively minor drought, to increasing supplies through the application of a Drought Permit or Drought Order during more severe droughts. A summary of typical actions taken depending on the severity of a drought is provided in Figure 2.5.

2.8.9 The decision to implement restrictions under the Water Use (Temporary Bans) Order 2010 is taken by individual water companies in line with their drought plans and do not require EA or Secretary of State consent. The measures taken under the Water Use (Temporary Bans) Order 2010 are directed predominantly at domestic customers to minimise any economic impacts to business and industry. However, if the drought continues some restrictions to commercial activities may be required, particularly if these activities use a hosepipe.

2.8.10 If the extent or severity of the drought worsens, a water company can apply to the EA for a Drought Permit or to the Secretary of State for a Drought Order when the water resources available for abstraction are still insufficient to meet demand. These can only be applied for after the implementation of all other acceptable temporary water

use restrictions as set out by the Water Use (Temporary Bans) Order 2010, as discussed above.

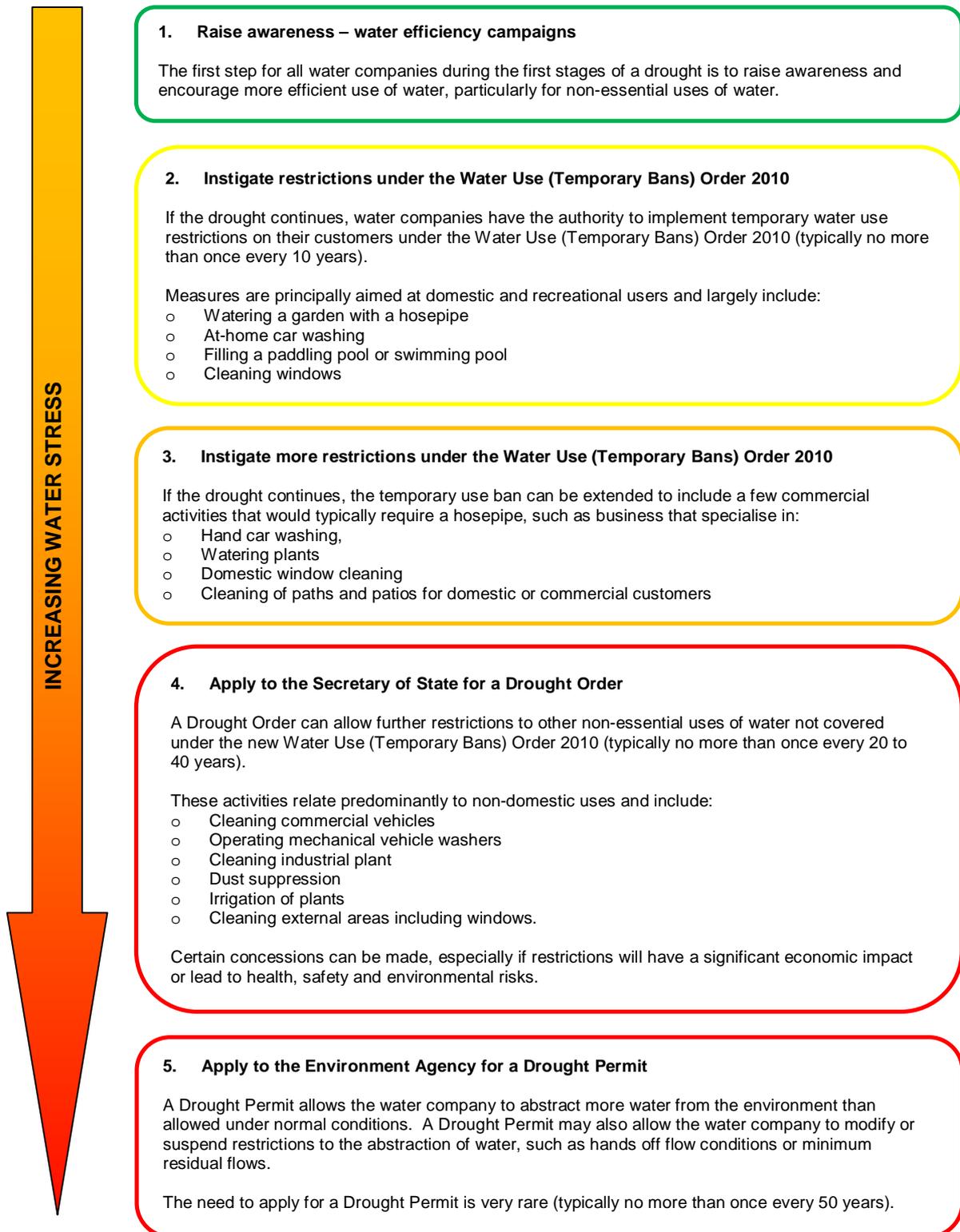


Figure 2.5 Actions taken by a water company to respond to increasingly severe drought conditions

2.8.11 It is recognised that the measures instigated through a Drought Order will potentially have more of an economic impact on businesses and therefore are only applied for once other temporary water use bans to reduce demand have been implemented. There are a number of concessions that can be made to the enforced restrictions if deemed necessary, for example if low water use technologies are used to clean vehicles, plant and external surfaces, or if dust suppression is required for nuisance control. However, these concessions can be removed by the water company if the drought worsens.

2.8.12 Activities that are required for environmental, health and safety reasons are exempt from restrictions.

## **2.9 Management of water resources: future actions**

2.9.1 Sections 2.7 and 2.8 set out the measures and methods currently implemented by the EA and incumbent water authorities to manage the abstraction and supply of surface water and groundwater during normal conditions and drought conditions. This section discusses how the management of water resources may change in the future to manage future water stress as discussed in Section 2.6.

2.9.2 The majority of these measures apply to long term changes in available water resources as a result of an increase in water demand and the predicted effects of climate change. It is unlikely that the proposed measures for controlling droughts will change from those discussed in Sections 2.7 and 2.8, although there may be amendments to these measures such as further research into augmenting existing river flows.

2.9.3 The measures discussed below will be similar throughout England regardless of location. However, the likelihood of these measures being required and implemented will be dependent on the local conditions within the catchment. For example, the severity of predicted water stress in the South East of England may dictate that more of these measures are required when compared to the North West that typically experiences more rainfall and lower population density.

### Improving resilience

2.9.4 The EA proposes to work with Ofwat and water companies to increase the connectivity of water supply infrastructure and improve the resilience of existing resources. This will promote the sharing of water resources between suppliers and between catchments to better respond to water resource availability and demand conditions.

2.9.5 The EA are also looking to identify opportunities for bulk supplies between water companies and identify where water resources need to be reallocated between water companies to better reflect the demands within each region. This may also include more augmentation schemes where water is taken from one source of supply to improve river flows elsewhere.

### Abstraction licensing

2.9.6 Currently only 20% of all abstraction licenses in England and Wales have a time limit and can be amended during periods of water stress. The Water White Paper<sup>14</sup> is the

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<sup>14</sup> Water White Paper - Water for Life, Defra, December 2011

Government's response to predicted water resource issues and it sets out proposals to reform the abstraction regime.

- 2.9.7 The EA is proposing that all existing permanent licenses are converted to a time limited status and a review of existing licenses is currently underway, particularly in catchments that are already over committed and sites that form part of the RSA programme. These amendments would allow changes to licenses to be made and modified as necessary, including an inclusion of operating conditions such as hands off flow that will allow the EA to more easily restrict abstractions during low flow or droughts. It would also allow the EA to better tailor the actual need for water against the volume that can be abstracted. As discussed in Section 2.5, only approx 45% of water that is currently committed to an abstraction license is actually abstracted.
- 2.9.8 The EA would like abstraction licenses to respond to water resource availability, rather than allow a fixed volume of water to be abstracted regardless of how much water is currently available. A more flexible approach should make more water available at high flows and ensure that the environment is protected at low flows, leading to a more efficient allocation of water. This may lead to abstractors having to accept a reduction in the reliability of supply. However, the EA hope that this will be mitigated by users considering alternative sources, building storage capacity to store water when it is available (i.e. during high flows) and trading abstraction licenses (discussed below).
- 2.9.9 The actions discussed above will be supported by the EA providing abstractors with more information on the availability of water within the different catchments. This in turn can be used by the abstractor to make more informed decisions about where their water is sourced from and how it is used.
- 2.9.10 The EA are also proposing changes to the current 'first come first served' basis of abstraction licensing. This may include greater flexibility in the way water resources are allocated so that water is more effectively accessed by those who have legitimate need, including new provisions to prioritise water use in severe drought<sup>15</sup>.
- 2.9.11 License trading may become more common (and encouraged) in the future. This is the transfer of the rights of the license, and not actually the trading of actual water. The EA are currently only considering this approach for full licenses rather than temporary licenses. However, it may be possible to have short term trades with existing license holders in the future when a temporary license is only required for a short time.
- 2.9.12 To promote the sharing of licenses, the methods for obtaining an abstraction license may be revised, with applications encouraged to consider sharing a license with an existing abstractor rather than being granted a new license. The EA are currently revising their processes to remove barriers to license trading and encourage better use of existing licenses.
- 2.9.13 There are currently no proposals to change temporary abstraction licenses or for the unlicensed abstraction of less than 20 m<sup>3</sup>/day.
- Increasing resource availability
- 2.9.14 Water company water resource management plans set out the measures proposed by water companies to ensure security of supply over the 25 year plan period to meet

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<sup>15</sup> Water Resources Strategy for England and Wales, Environment Agency, March 2009

their committed level of service. These measures typically include proposals to increase water resource availability through investment in supply infrastructure, water storage and transfer schemes to ensure security of supply even beyond the 25 year plan period. The construction (or expansion) of new infrastructure is seen as a last resort after the benefits of demand management, leakage control and improved connectivity have been considered, but these measures could include the construction of a new reservoir, expansion of existing storage facilities or investment in a new augmentation or water transfer scheme.

- 2.9.15 Investments in infrastructure will ultimately increase security of supply and potentially mitigate the effects of climate change and population growth. This in turn would reduce the risks of drought and consequently reduce the risk of non-essential use bans. However, any investment in infrastructure may result in higher water rates for users within the water company's administrative boundary.

#### Water tariffs

- 2.9.16 The trading and sharing of abstraction licenses, as discussed above, could also have benefits to abstractors as they would only be charged for the volume of water they abstract, rather than the maximum volume of water that can be abstracted under an abstraction license. The EA are proposing to amend the abstraction charges system to reflect the volume of water abstracted to encourage more efficient use of water resources. Charges for water obtained through direct abstraction are currently very low compared to water sourced from the public mains supply. New charges may also consider whether the abstracted water is returned to the environment (e.g. for cooling) or if it is removed permanently from the water body. There are currently no proposals to change licensing or charges for abstractions of less than 20 m<sup>3</sup>/day or temporary abstractions, but this may change in the future.
- 2.9.17 The EA, Ofwat and water companies are considering changes to the pricing of potable water supplied through the mains distribution system. If implemented, this is likely to take the form of a rising block tariff that ensures water required for basic needs is provided at an affordable rate, but increased water use would be charged at a higher rate. Consideration is also being given to seasonal tariffs. These measures aim to encourage improved water efficiency and investment in alternative water supplies. It would apply to domestic and non-domestic customers and would be coupled with the widespread installation of smart water meters. However, a pilot study was recently carried out by Wessex Water that suggested that seasonal or variable tariffs did little to encourage reduced water use, and that the biggest reduction in potable water use was as a result of increased metering.
- 2.9.18 The direct impact of changes to existing water rates is that the cost of water could significantly increase for high-volume water users or for applications that are considered wasteful.

#### Demand management

- 2.9.19 Demand management can take many forms, but typically includes the encouragement of improved water use through raising awareness, improved efficiency measures, metering and incentives such as increased water rates. Demand management will become particularly important in the future to make more efficient use of the available water resources and mitigate the effects of population growth and climate change. Demand management is considered particularly important in the South and East of England where high levels of growth are planned and water resources are already stressed.

2.9.20 Demand management measures will ultimately improve the security and availability of water resources by improving the way in which water is used, thus helping to reduce the need for restrictions during periods of drought.

## **2.10 Risks and opportunities for Highways Agency operations**

2.10.1 This section has highlighted that the regions of the UK at greatest risk of water stress are located within the South East and East of England, predominantly due to the low annual rainfall typically experienced in these regions and, in the case of the South East, the high population density. The South East and East of England are also likely to be at greatest risk in the future due to climate change effects and a growing population.

2.10.2 The South East and East may therefore experience periods of drought more often than other areas of the UK. However, it is important to appreciate that all water companies throughout the UK set levels of service that have been agreed with the EA and, typically, agreed with their customers. These levels of service take into account the factors that could affect water resource availability over the next 25 years, such as predicted climate change effects, population growth, total water demands and planned investments in infrastructure. Through direct consultation with a number of water companies, all were confident that there would be no increase in the restrictions applied to water uses beyond that set out within their water resource management plans.

2.10.3 Collection of rainwater for onsite reuse within Highways Agency operations may be affected by climate change predictions, in particular the prediction of hotter drier summers that may reduce the frequency and volume of rainfall.

2.10.4 Whilst the South East and East of England may be at greatest risk from water stress, the study has highlighted that a drought can occur anywhere within the UK and during any time of year. The agreed levels of service will also be similar throughout the UK, for example instigating measures in accordance with the Water Use (Temporary Bans) Order 2010 no more than once every ten years.

2.10.5 The study has highlighted that water used by the construction industry accounts for approximately 0.12% of total water use in England and Wales. Through direct consultation with the EA and water companies, the figure typically used by construction sites was considered to be relatively negligible when compared to the volumes of water used by domestic customers. Whilst non-essential water use should still be restricted, it is considered unlikely that Highways Agency sites would be affected by water use restrictions during the majority of drought scenarios primary because:

- Many direct abstractions will be for less than 20m<sup>3</sup>/day which do not require control under the abstraction licensing system;
- The volume of water used by construction sites is typically not regarded by the EA and water companies as being enough to significantly contribute to water stress in the region;
- Water use restrictions typically target non-essential domestic and recreational water use such as watering gardens, washing windows and filling swimming pools;

- Whilst water use restrictions may affect a greater range of activities if the drought continues, activities which are required for environmental, health or safety reasons will be exempt.
- 2.10.6 During a more severe drought, the following Highways Agency operations may be affected if a greater range of water use restrictions is implemented:
- Dust suppression;
  - Washing down external areas;
  - Cleaning windows;
  - Washing commercial vehicles;
  - Washing construction plant and other machinery;
  - Irrigation.
- 2.10.7 Depending on the agreed level of service set out within the water company's water resource management plan, these restrictions would typically be instigated no more than once every 20 to 40 years or so. Once again, restrictions will be exempt if they pose environmental, health or safety risks. Similarly, restrictions may not apply if it can be demonstrated that targeted activities use water efficient technology.
- 2.10.8 An indirect impact associated with drought conditions is the permitted quality of surface water runoff during a drought. At is not uncommon for the EA to apply more stringent water quality conditions for surface water runoff during a drought situation as the concentration of pollutants in the receiving water body will be greater. This may be particularly relevant for sites located near sensitive water environments such as SSSI or Ramsar sites.
- 2.10.9 Regardless of whether a formal water use restriction is applied to a site, depot or outstation, there are still a number of opportunities for these sites to reduce potential risks associated with water shortages and water use restrictions such as:
- Reducing wastage wherever possible;
  - Investing in water efficient technology;
  - Preparing for a drought situation and responding to EA and water company awareness campaigns during a drought situation;
  - Preparing a drought plan that can be implemented during a severe drought, for example reducing water use in non-essential applications, investigating alternate sources of water or tankering water in from an adjacent catchment that is not suffering from drought;
  - Capturing runoff and promoting settlement prior to discharge.
- 2.10.10 During consultation with the EA and selected water companies, all were very supportive of the Highways Agency's opportunity to raise awareness throughout the supply chain. Whilst the individual impacts associated with Highways Agency operations on local water stress and drought scenarios may not be significant, the cumulative benefits of multiple sites using water efficiently and the adoption of the same principles by Highways Agency suppliers could be significant.
- 2.10.11 Table 2.1 summarise the key risks and opportunities to Highways Agency operations associated with the current and proposed management measures discussed in this Section.

Table 2.1 Summary of EA and water company actions and associated risks and opportunities to Highways Agency operations

Action	Risks and opportunities
Water use restrictions in accordance with the Water Use (Temporary Bans) Order 2010	<p>Discussed in detail above. In summary, these actions encourage the efficient use of water and include water use restrictions to predominantly domestic activities. Typically instigated no more than once every 10 years.</p> <p>Opportunities to raise awareness amongst Highways Agency staff and suppliers and encourage efficient use of water resources.</p>
Water use restrictions in accordance with a Drought Order	<p>Discussed in detail above. In summary, these actions could include restrictions to activities such as dust suppression, commercial vehicle cleaning, washing down and plant cleaning. Typically instigated no more than once every 20 to 40 years.</p> <p>Opportunities for the Highways Agency to invest in water efficient technology and implement a drought plan.</p>
Proposed action by the EA and water companies to improve resilience and increase resource availability	<p>No direct adverse impact to the Highways Agency and action could improve the resilience of water supplies in the future, mitigate the effects of climate change and increased demand, and subsequently reduce the risk of drought.</p> <p>Indirect adverse impact could include an increase in the cost of water, discussed below.</p>
Proposed action by the EA to amend the abstraction licensing system to convert all licenses to a time limited status and enable a more flexible approach to abstraction licensing	<p>Potential for restrictions to be placed on the volume of water that can be directly abstracted for Highways Agency operations during periods of drought (for abstractions greater than 20m<sup>3</sup> per day).</p> <p>Opportunity for the Highways Agency to temporarily store water on site in those catchments identified to be at water stress, or instigate a drought plan if the EA notifies abstractors of potential restrictions to direct abstraction.</p> <p>Likely that this action to 'free up' licensed supplies and tailor abstraction licenses to actual needs will improve water resource availability within a catchment. This could improve the resilience of water supplies, mitigate the effects of climate change and increased demand, reduce the risk of drought and subsequently reduce the need to apply water use restrictions.</p> <p>This action could also increase the likelihood of the Highways Agency obtaining a permanent and/or temporary abstraction licence (including sharing of licenses) in catchments currently considered to be over licensed and waters stressed.</p>
Water tariffs, including a likely increase in the cost of water to encourage efficiency and fund investment in infrastructure	<p>Likely to result in an increase in the cost of water, particularly for high-volume water users. However, investments in infrastructure funded by increased water tariffs will ultimately reduce risk to Highways Agency operations.</p> <p>Opportunities for the Highways Agency to reduce water use and therefore cost through raising awareness amongst staff and suppliers, encouraging efficient use of water resources and investing in water efficient technology.</p>

**2.11 Section summary**

1. The construction industry accounts for approximately 0.12% of total water use in England and Wales.
2. Within England, approximately one third of water supplies are sourced from groundwater and two thirds from surface water bodies. Although groundwater and surface water bodies respond differently to changes in climate and rainfall, they are both at risk from long and short term water stress.
3. The greatest levels of water stress are located within the South East and East of England, predominantly as a result of low average rainfall and high population densities. However, a drought situation can occur anywhere in the UK and is often localised to certain catchments.
4. Climate change is considered to pose the greatest risk to future water resource availability, with the South East and East of England considered to be at greatest risk due to predicted population increase combined with climate change predictions.
5. Water resources are ultimately managed by the Environment Agency through the abstraction licensing system. Proposals are being put forward by Government and the Environment Agency to improve the current abstraction licensing system to provide the Environment Agency with greater flexibility to make changes to abstractions during drought conditions.
6. Changes to the abstraction licensing system will not affect small, private abstractions of less than 20m<sup>3</sup> per day.
7. Water companies are responsible for managing their allocated water supplies through the preparation of water resource management plans and drought plans. These set out the agreed level of service, the measures that the water company will take to ensure this level of service over the next 25 years, and the actions that will be taken during droughts.
8. A water company can introduce a temporary use ban on predominantly non-essential domestic water use, on average no more than once every 10 years.
9. If a drought worsens, a water company may be given approval to restrict other non-essential uses including cleaning commercial vehicles/plant and dust suppression, so long as there are no associated environment, health or safety risks. Typically a water company will implement these measures no more than once every 20-40 years.
10. Water tariffs are likely to increase in the future to encourage efficiency and fund investment in infrastructure.
11. Predicted future water stress will be managed through long term planning of water resources by the Environment Agency and water authorities, informed through consideration of future climate and population growth scenarios, to mitigate impacts to water users and the environment, develop sustainable water use practices, and to ensure long term availability of water supplies.

SECTION 3

**TASK 2: WATER USE**



**3 TASK 2: WATER USE**

**3.1 Introduction**

- 3.1.1 The focus of this task was to develop an understanding of water use in the Highways Agency’s non-office based applications, specifically where water is sourced from and how this water is used.
- 3.1.2 This information has been used to inform a more detailed assessment of the potential impact of the measures implemented by the EA and water companies during periods of water stress on Highways Agency non-office based applications. The study has also identified potential opportunities for the Highways Agency to respond to these issues to reduce risk and improve resilience.
- 3.1.3 The task was informed through direct consultation with appropriate site representatives at selected construction sites and maintenance depots. A total of four sites were selected - comprising two major project sites and two depots - based on their location and suitability to inform the study.
- 3.1.4 Further information regarding site water use, sources of water and potential opportunities was gained through direct consultation with the Head of Environment & Sustainability at Balfour Beatty Major Civil Engineering.
- 3.1.5 Details of the sites contacted to inform this study are provided in Table 3.1. Contact information was provided by the Highways Agency Project Sponsor.

*Table 3.1 Summary of consultation*

Organisation / Site	Details
Major Projects site: M4/M5	Discussion with Site Environmental Manager regarding M4 Junction 19-20 and M5 Junction 15-17 managed motorway scheme
Major Projects site: A23 Handcross	Discussion with Site Environmental Manager regarding A23 Widening Handcross to Warninglid
MAC: Area 4, Stanford Depot	Discussion with Site Environmental Manager regarding Stanford Depot. Representative of best practice in terms of water conservation measures
MAC: Leatherhead Depot	Discussion with Site Environmental Manager regarding Leatherhead Depot. Representative of 7 other Connect Plus M25 DBFO depots
Balfour Beatty Major Civil Engineering	General discussion with Head of Environment & Sustainability regarding typical site water use, sources of water supply and opportunities.

**3.2 Methodology**

- 3.2.1 A template was created for knowledge capture (Table of Knowledge) of water use in Highways Agency’s non-office based applications. The Table of Knowledge instigated discussions with appropriate representatives from active construction sites and maintenance depots and focussed on the following key questions:
  - Sources of water – where water is sourced from, whether quantities of water are measured, who is responsible for sourcing water, whether sourcing of water is

considered as a risk item, whether the cost of water is considered an important factor.

- Uses of water – where water is used, how water is used, whether quantities of water are measured, whether different sources of water are used for different uses, who is responsible for different uses of water.
- Water conservation measures – collection and re-use of water, water efficiency measures, low flow devices, etc.

3.2.2 Telephone interviews were conducted with the site contacts listed in Table 3.1 using the Table of Knowledge as a guide. The telephone interviews were followed by an audit of the four selected sites to supplement the information gained via telephone interview. The site audits comprised onsite meetings and conversations with the appropriate environmental/sustainability managers responsible for each site. The telephone interviews and audits were undertaken between December 2012 and February 2013.

3.2.3 The telephone interviews and site audits identified knowledge gaps regarding on site water use. The telephone interviews and site audits also enabled the identification of opportunities for reducing water use and saving water for each site.

3.2.4 It is important to recognise that the information provided within this report has been obtained from a small selection of audited sites and may therefore not be representative of all Highways Agency non-office based operations.

### **3.3 Overview of non-office based operations**

3.3.1 The volume of water used on major project sites is reported to vary widely between projects and from month to month within schemes, with the volume of water consumed onsite often determined by the construction phase.

3.3.2 Based on review of information provided within the previous study undertaken by Parsons Brinckerhoff on behalf of the Highways Agency "Research into the Highway's Agency Water Footprint, April 2010", direct water consumption by Major Projects, MAC and DBFO schemes was estimated to be in the region of 415,000 – 535,000 m<sup>3</sup> per annum (in 2009/10).

3.3.3 The reporting of water used within site offices and for construction/maintenance activities is often presented together with no distinction between volumes of water used for different activities. However, the volume of water used for site offices is typically considerably lower than that used at depots or for construction and maintenance activities.

#### Site offices

3.3.4 The principle use of water within site offices and associated facilities was for kitchen and sanitary use. This is predominantly sourced from potable water mains supplies with water use typically metered. Drinking water is typically provided as bottled water for use in drinks coolers.

3.3.5 Water reduction initiatives in site offices are not widely recognised, although steps have been taken at some sites such as installation of push release office taps, use of waterless urinals within site cabins, and the recycling of rainwater and grey water.

- 3.3.6 The study identified opportunities to collect and reuse rainwater, principally from site cabins. However, this is often restricted by cost and inability to make amendments to leased accommodation.

Construction sites

- 3.3.7 The majority of water used on construction sites was reported to be sourced from potable mains water supplies, from both metered and un-metered supplies (i.e via bowser with metered charges not directly related to site activities). The most significant uses of water reported during this study included road sweeping, dust suppression and wheel washing.
- 3.3.8 The volume of water used for dust suppression at the audited sites was relatively low at the time of the site visits as these were undertaken during winter months when dust suppression is not as frequent.
- 3.3.9 Discussions with the Head of Environment & Sustainability at Balfour Beatty Major Civil Engineering identified onsite concrete batching as a significant use of water, although none of the sites contacted to inform this study are undertaking onsite concrete batching. These discussions also highlighted irrigation as a potentially significant consumer of water, although this will typically be restricted to the spring/summer months (hence none undertaken within the time frame of this study).
- 3.3.10 One of the audited sites collects surface water runoff in temporary attenuation ponds. This is principally to aid surface water management, water quality and flood risk issues, but can be reused in site activities (mainly during the summer). The collection and use of surface water reduces the need for mains supplied water. As such, those activities which reuse surface water runoff within construction processes can be recognised as water reduction initiatives.
- 3.3.11 Through discussion with our selected contacts, it is understood that the direct abstraction of water is also used on some sites. However, none of the sites audited/interviewed for this study use abstracted water.

Depots and outstations

- 3.3.12 The majority of water use at the audited depots and outstations is associated with vehicle washing and salt brine, predominantly using water sourced from potable mains water supplies.
- 3.3.13 One of the audited sites demonstrates exemplar facilities that collect and reuse surface water runoff and wastewater discharge from the site.
- 3.3.14 Other uses of water are for kitchen and sanitary use associated with office facilities. This is predominantly sourced from potable water mains supplies.

**3.4 Site A: A23 Handcross**

- 3.4.1 The project comprises the widening of the A23 between Handcross and Warninglid. Approximately 2.4 miles of dual three-lane carriageway will replace the existing dual two-lane carriageway between Handcross and Warninglid junctions, generally within the existing highway boundary. Work on this scheme started in October 2011 and should be complete by autumn 2014. The approximate location of this site is shown in Figure 3.1. The principal contractor for this project is Carillion.

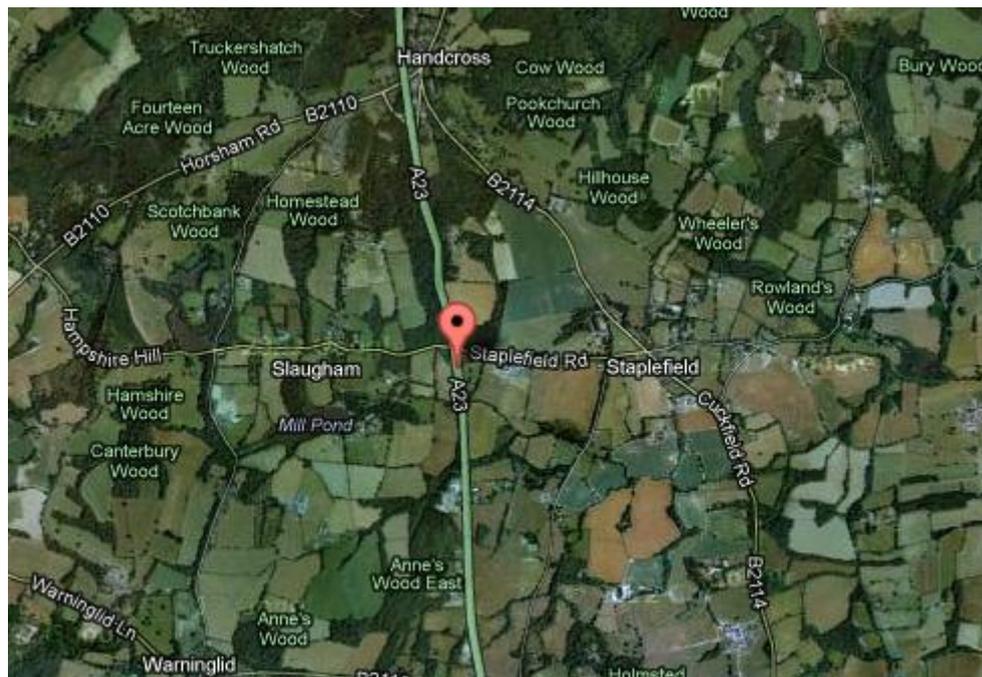


Figure 3.1 A23 Handcross project location (extracted from Highways Agency's website)

3.4.2 The majority of water use associated with this site is sourced from potable mains supplies provided by South East Water.

3.4.3 The principle water consuming activities are outlined below.

Wheel Washing

3.4.4 The site operates six tankers of approximately 1,000 litres each for wheel washing. These tankers are filled on average once a day (Figure 3.2) with water currently sourced from mains water supplies.



Figure 3.2 Wheel washing activity using jet wash at A23 Handcross project site

3.4.5 Runoff water from this activity flows to the site drainage system and is discharged to onsite attenuation ponds. Due to excessive amounts of rain in 2012 and in January

2013, access to the ponds is currently saturated with water. Despite efforts made to stabilise this access, access to these ponds is considered unsafe (Figure 3.3).



Figure 3.3 A23 Handcross site attenuation ponds on the left and access on the right

#### Road sweeping and dust suppression

3.4.6 Road sweeping and dust suppression typically requires relatively high volumes of water. The site operates three road sweepers, each with an approximate capacity of 1,500 litres that are filled every day (Figure 3.4) with water currently sourced from potable mains supplies.

3.4.7 As with wheel washing, runoff water from this activity flows to the site drainage system and is discharged to onsite attenuation ponds.



Figure 3.4 Road sweeper washing the road at the A23 Handcross site

#### Site offices

3.4.8 The principle use of water within site offices and associated facilities is typically for kitchen and sanitary use. This is sourced from potable water mains supplies and is metered. Drinking water is typically provided as bottled water for use in drinks coolers.

Other uses of water

3.4.9 Occasional concrete wagons to the site get washed by the subcontractors' own water supply. This is conducted offsite and is most likely sourced by potable mains supplies due to water quality issues affecting the quality of the concrete.

Volume of water consumed and efficiency measures

3.4.10 Figure 3.5 illustrates the available water meter readings for this site. Water used for site offices and construction activities are reported together.

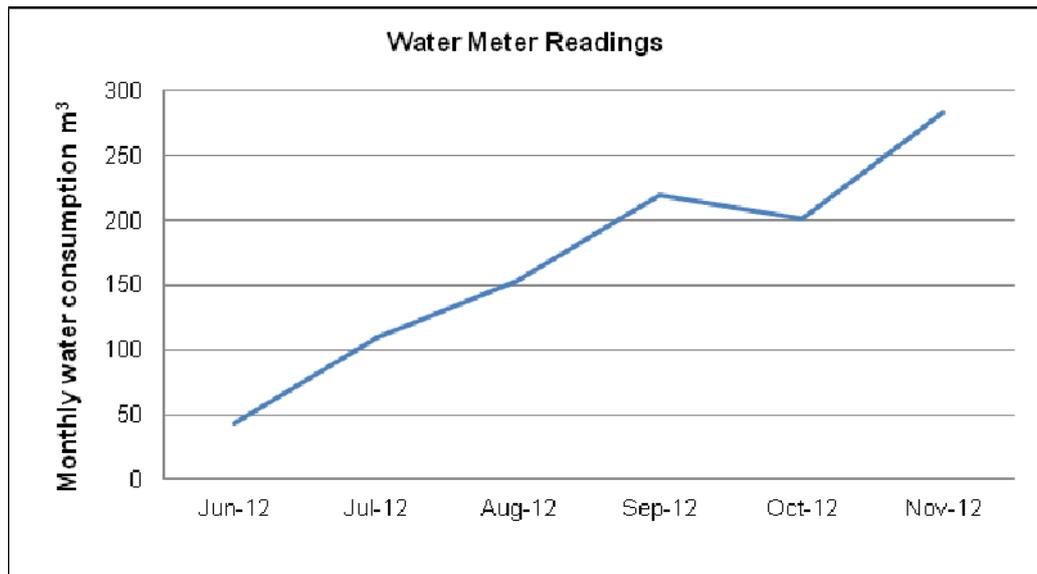


Figure 3.5 A23 Handcross site available water meter readings

3.4.11 Figure 3.5 illustrates a continuous increase in the volume of water used between June and November 2012. This is chiefly due to the phasing of the project moving from site preparation to construction which involved more frequent wheel/vehicle washing.

3.4.12 Runoff from wheel washing, road sweeping and dust suppression flows through the site drainage system and is discharged to onsite attenuation ponds. The site environmental manager confirmed that this water can be reused for certain site activities. However, the site environmental manager raised concerns regarding the quality of captured water and the potential health implications for certain uses (in particular spray applications such as jet wash wheel washing).

3.4.13 Leak detection is carried out on a monthly basis and no leaks have been reported to date.

3.4.14 Carillion operate a sustainability tool that includes consideration of water consumption and the monitoring of water consumption onsite.

3.4.15 Within office facilities, the site operates push release taps for wash hand basins and a low flush system for toilet cisterns. Urinal cisterns have no sensors but are timed so that they do not run constantly.

3.4.16 To date, operations at this site have not been affected by water stress.

3.4.17 Environmental, health and safety issues are captured within a site register and include the water environment. Mitigating actions are allocated to the appointed responsible person as required.

**3.5 Site B: M4 Junction 19-20 and M5 Junction 15-17 Managed Motorways**

3.5.1 The project comprises improvement works between the M4 Junctions 19-20 and the M5 Junctions 15-17 and making these stretches a 'managed motorway'. This is to allow the hard shoulder to be used as a running lane to create additional capacity at peak times. Works started in January 2012 and the scheme is planned to be open to traffic in 2014. The approximate location of this site is shown in Figure 3.6. The principal contractor for this project is Balfour Beatty.

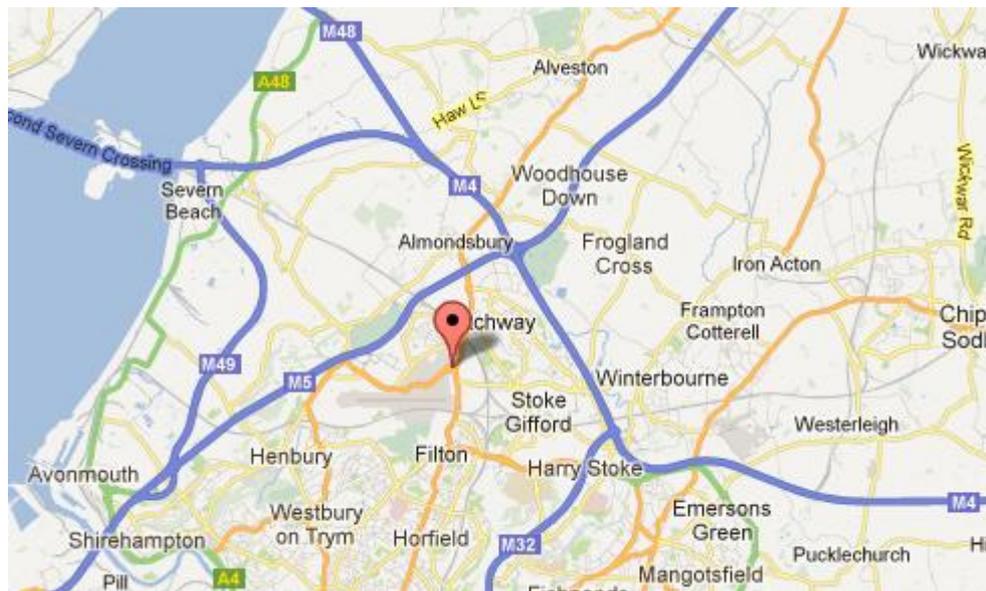


Figure 3.6 M4-M5 approximate project location (extracted from Highways Agency's website)

3.5.2 The majority of water use associated with this site is sourced from potable mains water supplies provided by Bristol Water. Water used during construction activities has typically been provided by the relevant subcontractor using their own water bowsers.

3.5.3 Three water meters are located within this site: at the site office; at the site compound (warehouse); and at the recovery centre. Water used for construction activities is not metered by the principal contractor.

Site offices

3.5.4 Water used within the site office is predominantly for kitchen and sanitary use, and is sourced from potable mains supplies.

Site compound

3.5.5 Water used within the site compound is predominantly used for the kitchen, lavatories, washing machine and supplying water for the welfare vans.

- 3.5.6 Water is also used for washing vehicles and wheel washing and this is obtained from a standpipe (Figure 3.7 and Figure 3.8)



Figure 3.7 Standpipe in the M4-M5 site compound used for washing vehicles and wheel washing



Figure 3.8 Vehicle washing area within the M4-M5 site compound

#### Recovery centre

- 3.5.7 Water used within the recovery centre is predominantly used for the kitchen corner and lavatory, and is sourced from potable mains supplies.

#### Construction works

- 3.5.8 It is understood from the site environmental manager that the majority of construction activities on this site do not require a significant amount of water.
- 3.5.9 Construction works that have required water supply are reported to have included the demolition of a small bridge using hydro-demolition and directional drilling and piling for gantry bases.
- 3.5.10 Both activities have been undertaken by subcontractors with their own water bowsers. The source of this water is unknown but is likely to have been sourced from a Bristol Water potable supply or distribution main. There are no records of water volumes used for these activities.

Other uses of water

3.5.11 Occasional concrete wagons to the site get washed by the subcontractors' own water supply. This is conducted offsite and is most likely sourced by potable mains supplies due to water quality issues affecting the quality of the concrete.

Volume of water consumed and efficiency measures

3.5.12 Figure 3.9 illustrates the available water meter readings for this site - currently only for the site office, site compound and recovery centre. Water used for construction activities is not metered by the principal contractor.

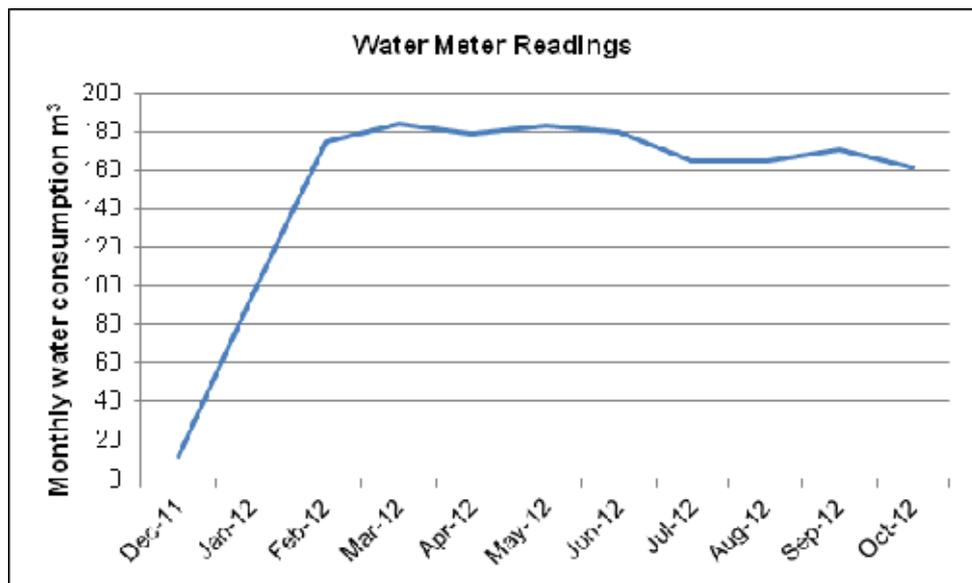


Figure 3.9 Available water meter readings for the M4-M5 site compound

3.5.13 Figure 3.9 indicates that water use increased significantly at the start of the project during which time the site offices were being set up. The main water consuming activities are wheel washing and vehicle washing which have remained relatively constant since the project started. However, Figure 3.9 indicates a slight reduction in water consumption during the summer period that could be attributed to reduced vehicle washing and wheel washing during this time.

3.5.14 The site office facilities use short-flush/long-flush systems and push-release taps.

3.5.15 The office units within the site compound are leased and therefore have standard showers and wash basin taps with limited scope for using low water consumption taps etc. A number of the office units appear suitable for rainwater harvesting systems (Figure 3.10), but as these buildings are rented it has not been possible for the contractor to install any such systems.



Figure 3.10 Rented site offices considered suitable for rainwater harvesting

- 3.5.16 Leak detection is carried out on a regular basis and no leaks have been reported to date.
- 3.5.17 To date, operations at this site have not been affected by water stress.

**3.6 Site C: Connect Plus Depot – Leatherhead**

3.6.1 The operation and maintenance of the M25 network is undertaken by Connect Plus Services (CPS). This is a joint venture between Balfour Beatty, Atkins and Egis that commenced in May 2009 for a duration of 30 years. CPS operates from eight dedicated depots namely: Leatherhead, South Mimms, Swanley, Scratchwood, Denham, Sunbury and Blunts Farm. The sustainability manager for all these depots suggested the Leatherhead depot (Figure 3.11) as a representative of others and therefore a site audit was conducted at this site.



Figure 3.11 Leatherhead depot site location

3.6.2 The majority of water use associated with this site is sourced from potable mains water supplies provided by Sutton and East Surrey Water.

3.6.3 The main water consuming activities are outlined below.

#### Vehicle washing

3.6.4 Water required for vehicle washing is sourced from the mains water supply (Figure 3.12). Runoff from vehicle washing discharges to the drainage system and is not stored for reuse.



Figure 3.12 Vehicle washing at Leatherhead depot

#### Salt brine

3.6.5 During wintry conditions, salt brine is sprayed directly onto the pavement or onto rock salt as it is being applied. The salt brine systems (Figure 3.13) typically consume a considerable volume of water to produce water saturated with sodium chloride. Water required for these systems is sourced from the mains water supply.

3.6.6 In the region of 20,000 tonnes of salt is stored within seven salt barns located at the CPS depots (Figure 3.14). The site operates approximately 38 gritting vehicles (Figure 3.15) to apply the salt brine. Additional water is consumed for washing the gritting vehicles and their tankers.



*Figure 3.13 Salt brine tank connected to the mains at the Leatherhead depot*



*Figure 3.14 Salt storage at the Leatherhead depot*



Figure 3.15 Washed gritting vehicle at the Leatherhead depot

Site offices

3.6.7 The principle use of water within site offices and associated facilities is typically for kitchen and sanitary use. This is sourced from potable water mains supplies. Drinking water is typically provided as bottled water for use in drinks coolers.

Volume of water consumed and efficiency measures

3.6.8 Figure 3.16 illustrates the available water meter readings for this site. Water consumption volumes for site offices and highway operation and maintenance activities are reported together.

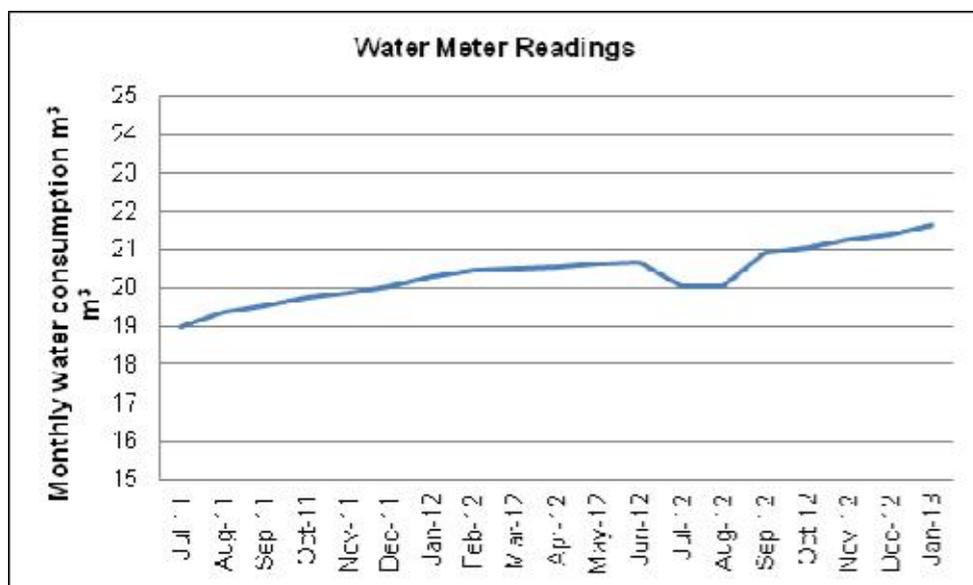


Figure 3.16 Available water meter readings for the Leatherhead depot

3.6.9 Figure 3.16 indicates a constant yet slight increase in water use at this depot, with a lower consumption during the summer months. This reduction could be attributed to less water used for the salt brine and less vehicle washing.

- 3.6.10 Push release taps have been installed in site offices for wash basins. Urinal cisterns have no sensors but are timed so that they do not run constantly.
- 3.6.11 The CPS sustainability team are considering opportunities for instalment of rainwater harvesting systems at some of the sites including the Leatherhead depot (Figure 3.17). The roof structure and collection area are considered suitable for collecting rainwater.



Figure 3.17 Site buildings considered suitable for rain water harvesting

- 3.6.12 To date, operations at this site have not been affected by water stress.

**3.7 Site D: Stanford Depot**

- 3.7.1 A Balfour Beatty-Mott MacDonald Joint Venture (BBMMJV) is responsible for the management of the Highways Agency's Area 4 network. One of the depots operated by BBMMJV is Stanford Depot at Junction 11 of the M20 (Figure 3.18).



Figure 3.18 Stanford depot site location

- 3.7.2 Water use associated with this site is sourced from potable mains water supplies in conjunction with a rainwater harvesting and grey water recycling system. Surface

water runoff is collected from the onsite buildings, workshops and external areas (Figure 3.20) by the yard drainage system prior to storage for recycling. Grey water is sourced from the site offices. An illustrative summary of the source and use of collected and recycled water is provided in Figure 3.19.

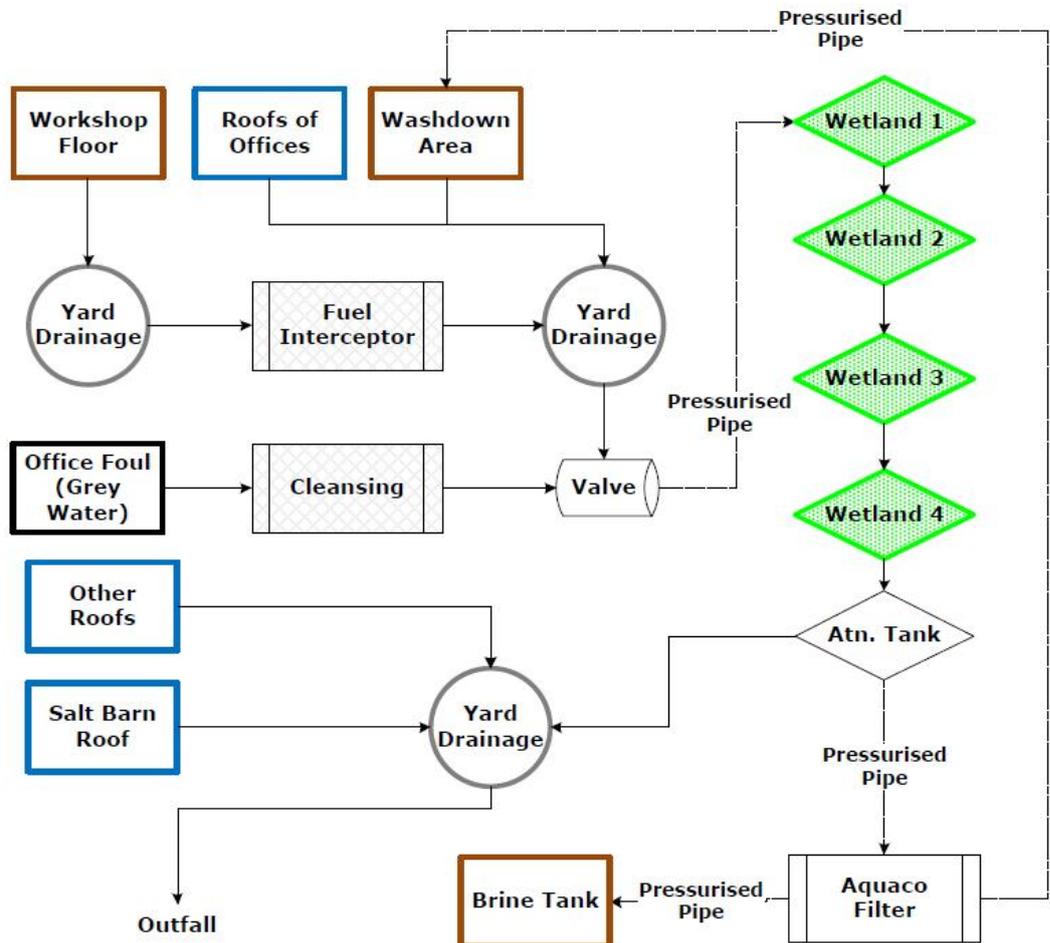


Figure 3.19 Stanford depot simplified water recycling diagram



Figure 3.20 Water from workshop roofs and external areas collected through yard drainage

- 3.7.3 Foul water discharge from the site offices is pumped (after initial cleansing) together with other recycled waters to four onsite wetlands (Figure 3.21). The wetlands are ecological systems used to treat the wastewater flows. The quality of treated water complies with the EA's discharge standards.



*Figure 3.21 Wetland ecosystems to treat wastewater at Stanford depot*

- 3.7.4 The main water consuming activities are outlined below.

Vehicle washing

- 3.7.5 A considerable volume of water is consumed for vehicle washing at this site (Figure 3.22). The facility is shared with other small offices (KCC/Enterprise).
- 3.7.6 The site environmental manager estimates that each washdown consumes between 0.5m<sup>3</sup> and 1m<sup>3</sup> water. The frequency of washdown varies from once a week to a worst case scenario of 7 washes per night (in particular during winter when vehicles are washed more frequently).
- 3.7.7 The majority of water used for vehicle washing is recycled water that is pumped from the onsite attenuation tank back to the wash down area. Runoff from this area is subsequently collected through the yard drainage system for recycling.



Figure 3.22 Stanford depot vehicle washing area

Salt brine

3.7.8 The salt barn located at this depot is one of the largest in the UK (Figure 3.23). During winter maintenance periods, a brine tank is used to produce water saturated with salt. The capacity of this tank is 20m<sup>3</sup> and filled once every two days at busy times. The majority of water required for this activity is sourced from the onsite attenuation tank (i.e. recycled).



Figure 3.23 Salt barn and the brine tank onsite at Stanford depot

Site offices

3.7.9 The principle use of water within site offices and associated facilities is typically for kitchen and sanitary use. This is sourced from potable water mains supplies.

Volume of water consumed and efficiency measures

- 3.7.10 Recorded meter readings for this site were unavailable at the time of completing this study. However, it is believed that water consumption volumes for site offices and highway operation and maintenance activities are reported together and that meter readings only account for water sourced from the mains water supplies (i.e. they do not consider the volume of water recycled within the site).
- 3.7.11 Push release taps have been installed in site offices for wash basins. Urinal cisterns are modern systems and funding is being made available for waterless urinals. All toilet cisterns are modern dual flush systems.

**3.8 Summary of audited sites**

3.8.1 Table 2.2 provides a summary of data captured through the site interviews and audits.

*Table 2.2 Summary of site interviews and audits*

Site	Primary uses and source of water	Indicative volume of water use, if known	Comments
Major Projects site: A23 Handcross	Site offices - mains supply. Wheel washing – mains supply. Road sweeping and dust suppression - mains supply.	Combined office and construction use approx 200m <sup>3</sup> per month. Wheel washing approx 6m <sup>3</sup> per day. Road sweeping and dust suppression approx 4.5m <sup>3</sup> per day.	Push release and low flow appliances in office facilities. Run off from wheel washing, road sweeping and dust suppression stored on site. Scope for reuse, although health risks associated with spray applications.
Major Projects site: M4/M5	Site office, compound and recovery centre facilities - mains supply. Wheel washing and washing vehicles at site compound – mains supply. Onsite construction works – bowser, most likely from distribution main.	Meter readings for site office, compound and recovery centre approx. 260-180m <sup>3</sup> per month. Onsite construction works not metered by principal contractor.	Surface water runoff not stored for reuse. Leased office facilities – no opportunity to change fixtures.
MAC: Leatherhead Depot	Site offices - mains supply. Vehicle washing – mains supply. Salt brine – mains supply.	Meter readings for all site water use approx. 20m <sup>3</sup> per month.	Push release taps and timed urinals in office facilities. Surface water runoff not stored for reuse. Consideration being given to rainwater harvesting.
MAC: Area 4, Stanford Depot	Site offices - mains supply. Vehicle washing – recycled and mains water. Salt brine – recycled and mains water.	Meter readings for potable water use currently unknown. Wheel washing approx 7m <sup>3</sup> – 35m <sup>3</sup> per week. Salt brine approx 10m <sup>3</sup> per day.	Push release taps and modern urinal systems in office facilities. Exemplar site for onsite collection and treatment of water.

**3.9 Gap analysis**

3.9.1 The study provided a considerable amount of data regarding the primary uses of water for non-office based operations. However, the study also identified a number of knowledge gaps including:

- A general lack of awareness of the need to consider water efficiency, the use of more sustainable sources of water and the drivers to reduce water use (noted to be particularly difficult to appreciate when onsite attenuation ponds are full and access to the ponds is unachievable due to saturated ground conditions). This awareness is considered particularly important for depots and DBFO contracts as their operations are fixed for long periods of time.
- Knowledge of the total volume of potable water used by the sites was good, although volumes of water could not be differentiated between that used for office/welfare facilities and that used for construction/maintenance activities.
- Volumes of recycled water collected and reused in site operations were unrecorded.
- Volumes of water used for different activities is currently not recorded for construction based activities, although one site did have a fairly good understanding of the typical volumes of water used for wheel washing and road sweeping.
- Volumes of water used for different activities is currently not recorded for depot based activities, although one site did have a fairly good understanding of the typical volumes of water used for vehicle washing and salt brine.

**3.10 Risks and opportunities for Highways Agency operations**

3.10.1 The study has identified the most common uses of water at the selected construction sites and depots to include:

- Office facilities, principally kitchen and sanitary use;
- Wheel washing;
- Road sweeping;
- Dust suppression;
- Plant washing (e.g. concrete wagons);
- Concrete batching;
- Irrigation;
- Water specific construction activities (e.g. hydro-demolition and directional drilling/piling);
- Vehicle washing;
- Salt brine.

3.10.2 The majority of water for all uses stated above is currently sourced from potable mains supplies.

3.10.3 As discussed in Section 2.10, it is unlikely that the majority of Highways Agency operations will be affected by water stress (and the subsequent measures implemented by water companies to manage water stress) due to the potential

environmental, health and safety risks associated with the above activities. A limit to the volume of water that can be used by the Highways Agency in non-office based applications may also have a significant economic impact (for example delay caused to the construction programme) that would warrant exemption from restrictions applied by the relevant water company.

- 3.10.4 All Highways Agency sites may be affected by more stringent conditions applied to the permitted quality of surface water discharge during a drought situation as the concentration of pollutants in the receiving water body will be greater. This may be particularly relevant for sites located near sensitive water environments such as SSSI or Ramsar sites.
- 3.10.5 However, with reference to Figure 2.5 and the types of non-essential measures considered under a Drought Order, the following water consuming activities may be affected:
- Wheel washing;
  - Road sweeping;
  - Dust suppression;
  - Plant washing;
  - Irrigation;
  - Vehicle washing.
- 3.10.6 As these activities are some of the greatest water uses identified through audit of the selected sites, there is a risk that restrictions may be applied to these activities if not required for environmental, health or safety reasons. The frequency of which a Drought Order is likely to be implemented is dependent on the characteristics of the specific catchment and on the agreed Level of Service as set out within the relevant water company Water Resource Management Plan and Drought Plan. This would typically be no more than once every 20 to 40 years.
- 3.10.7 None of the sites audited as part of this study use water directly abstracted from surface water or groundwater resources. If sites were to use these sources of water, it is possible that the EA would apply a temporary restriction to the volume of water that can be abstracted – either through volumetric restriction to the volume of water that can be abstracted or an activity-specific restriction on the permitted use of the abstracted water (similar to the measures implemented by water companies).
- 3.10.8 Through discussion with the EA and selected water companies, it was suggested that the volumes of water used by Highways Agency non-office based applications are unlikely to have a significant impact on local water stress. The impact to Highways Agency operations could be reduced further if abstractions are kept below 20m<sup>3</sup>/day (below which an abstraction licence is not required and restrictions would not be applied) or an abstraction licence is shared with an existing license holder (new proposals that are currently being put forward by Government and the EA).
- 3.10.9 The site audits identified that water use and water efficiency was not of great concern to site operatives, particularly considering the very wet conditions that the UK has experienced in 2012. However, there is an opportunity to raise greater awareness of the need to conserve the direct use of water. This could be achieved through greater auditing of site water use and setting targets for what would be considered efficient use for a particular site. The Strategic Forum for Construction has also published data regarding water use in construction and is in the process of finalising a water use

plan. There is an opportunity for the Highways Agency to use this plan to promote water efficiency amongst suppliers and subcontractors.

- 3.10.10 A number of the sites audited collect surface water runoff and rainwater for use within non-potable applications. The dual use of attenuation ponds/tanks required for drainage purposes as an alternative water supply offers a relatively economic alternative water source. Concerns have been raised regarding the quality of this water for certain applications (such as spray applications) and it is recommended that this is given further attention. However, the temporary storage of water should be considered – particularly for large construction sites that will be operational for some time, as well as for permanent sites such as depots.
- 3.10.11 The use of rainwater harvesting systems for reuse with site office facilities is likely to require more investment than the collection of surface water runoff in attenuation ponds. The cost of these systems may be too great for temporary sites to justify their use in economic terms, but it is likely that these systems would soon become economical for permanent depot and outstation sites. Consideration could also be given to the use of onsite renewables to power these systems, thus contributing to the Highways Agency's carbon reduction targets.
- 3.10.12 The water use and water recycling diagram prepared for the Stanford depot provided an excellent illustrative summary of how water can be collected and reused on site. Not only does this diagram highlight opportunities, but it is also a clear way of communicating these opportunities to site staff and raising awareness. However, it is important to note that the collection of rainwater for onsite reuse will be dependent on available rainfall and may be affected by climate change predictions, in particular the prediction of hotter drier summers that may reduce the frequency and volume of rainfall.
- 3.10.13 Metering of water used for different activities would provide greater clarity regarding the volume of water used for different applications – in particular the difference between construction (wheel washing, dust suppressions etc) and office/compound applications (kitchens and lavatories etc). Developing a greater understanding of water use would enable targets to be set and monitored more easily, as well as enable easier identification of opportunities.
- 3.10.14 The Highways Agency could consider developing a set of tools for the regular auditing of water use, similar to the existing carbon calculator tools. The tools could provide a consistent and transparent method for recording and analysing water use. This in turn could be used to inform and track progress against objectives and targets.

### **3.11 Section summary**

1. Four sites were audited to inform this study – two major project sites and two depots.
2. The primary source of water for office-based applications and construction/maintenance activities is from potable mains supplies. The use of bowsers was identified for some activities, most likely filled from mains supplies.
3. The reporting of water used in office-based applications and construction/maintenance activities is often presented together, with little understanding of water use associated with key water consuming activities.
4. The study has identified that some of the greatest uses of water, such as dust suppression and vehicle washing, may be affected during periods of severe water stress if these activities

are not required for environmental, health or safety reasons.

5. The study identified some consideration given to the efficient use of water resources, in particular sanitary applications in office facilities.
6. The study has highlighted opportunities for the collection and reuse of surface water runoff, both at construction sites and depot sites.

SECTION 4

**TASK 3: EMBODIED WATER**



## **4 TASK 3: EMBODIED WATER**

### **4.1 Introduction**

4.1.1 Indirect water consumption through the procurement and use of materials and products is often overlooked when considering the impacts of certain operations and activities on the water environment. However, indirect water consumption can often outstrip direct water consumption. This is particularly true in the UK as many of our consumables are imported from elsewhere in the world. The UK is the 6<sup>th</sup> largest net importer of water in the world, and only 38% of total indirect water use comes from within the UK<sup>16</sup>.

4.1.2 Indirect water consumption comprises water that has been consumed in the extraction, processing or manufacture of materials and products, similar in concept to embodied carbon. Unlike direct water use, the impact associated with embodied water could either be felt within the UK (associated with materials and products fully or partly manufactured in the UK) or internationally (associated with materials and products manufactured outside of the UK). Similarly, unlike direct water use, the risk will typically not be experienced in the catchment where materials and products are ultimately used (i.e. at a construction site or depot), but where they were extracted, processed and manufactured.

4.1.3 The assessment of embodied water therefore has two key considerations:

1. The total volume of water consumed in the extraction, processing or manufacture;
2. The availability of water and associated water stress within the catchments where the materials and products are extracted, processed and manufactured.

4.1.4 The combined consideration of the volume of embodied water (known as the water footprint) and the location of where this water is consumed is known as the Water Impact Index. The Water Impact Index not only quantifies the impact in terms of volume consumed, but also in terms of the impact that the volume of water consumed could have on local water stress. For example, timber used in temporary works may have an embodied water content of 60 litres per tonne. However, the impact of this water consumption in a low-stressed country such as Sweden is far less than the impact that would be experienced in a high-stressed country such as India.

4.1.5 This study considers the volume of water consumed in the extraction, processing and manufacture of key materials and products associated with Highways Agency non-office based operations. At this stage, consideration has not been given to where these materials and products are sourced from and the water stress experienced in those regions. However, if this study will ultimately inform the responsible sourcing of materials and products, it is essential that local water stress and the Water Impact Index is considered during procurement alongside the other responsible sourcing considerations.

### **4.2 Methodology**

4.2.1 There is currently no International or UK standardised methodology for calculating the direct and indirect water consumption associated with materials and products. There are a number of tools and methods in circulation, although all have their strengths and weaknesses and none offer a robust and inclusive method that can be applied

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<sup>16</sup> Water Resources Strategy for England and Wales, Environment Agency, March 2009

universally. The methods and approaches vary significantly between the organisations and individuals undertaking embodied water studies. This in turn makes it very difficult to fully understand and compare published data.

- 4.2.2 The International Organization for Standardization (ISO) is currently preparing a standard for the calculation of embodied water in all applications, to be entitled "ISO/DIS 14046 Environmental management - Water footprint - Principles, requirements and guidelines". Through discussion with ISO and Defra, it is considered likely that the ISO standard will incorporate the guidelines set out within "The Water Footprint Assessment Manual: Setting the Global Standard, February 2011". The ISO standard is due to be published in 2014.
- 4.2.3 A literature review has been completed of available published data for key construction materials. There is not a considerable amount of published data regarding embodied water, and of the data that has been published the methodology that has been used is not clear. There are a wide range of factors that can effect the calculation of embodied water and that subsequently add uncertainty to the figures that have been published. This makes it difficult to compare the embodied water of different products as well as provide certainty in the values that are being generated. For example, one source suggested that aluminium had an embodied water footprint of 10 m<sup>3</sup>/tonne, where as another source suggested that aluminium had an embodied water footprint of 35 m<sup>3</sup>/tonne.
- 4.2.4 The uncertainties that must be taken into consideration when estimating embodied water could include:
- How far up the supply chain and manufacturing process does the methodology go? For example, does the embodied water of virgin aggregate include groundwater that may have been removed from the environment by the extraction of saturated stone?
  - The methodology used in the calculation of embodied water. For example, did the calculation consider water lost through evaporation or the impacts of pollution?
  - The definition of embodied water, specifically the difference between water use and water consumption. For example, does the calculation method include the volume of water used to wash sand even though this water may be captured and stored for reuse?
  - The method used in the manufacture of the material. Two very similar products could use very different techniques in the manufacture of that product.
  - Variations in the type of material. For example, it would be difficult to obtain differing data for ready-mixed concrete used for general purposes and ready-mixed concrete used for roads and pavements. Similarly, there is currently very little data available regarding recycled products.
- 4.2.5 The data that has been obtained through literature review has been used to provide a broad estimate of the volume of embodied water associated with the key materials and products used by the Highways Agency in non-office based applications. Due to the uncertainties associated with this data, it is important to recognise that this study can only provide an indication of embodied water and an indication of those materials and products that typically have the greatest embodied water. For this reason, the sources of embodied water data have not been provided.

4.2.6 Information regarding key Highways Agency materials and products has been sourced from a study previously completed by the Highways Agency: "Major project, managing agent and private finance initiative materials purchases from 2009 to 2012". The information sourced from this study is summarised in Section 4.3.

**4.3 Key products and embodied water**

4.3.1 The study previously completed by the Highways Agency "Major project, managing agent and private finance initiative materials purchases from 2009 to 2012" captured data on the quantities of construction materials purchased by the supply chain across all construction, maintenance and improvements works for Major Projects, Managing Agent Contractors (MAC) and Design-Build-Finance-Operate (DBFO) schemes.

4.3.2 It is unlikely that all materials used in Highways Agency operations were included in the study as the study only extracted data on materials listed in the Highways Agency's carbon calculation tool and is reliant on information reported by suppliers. However, the study provides a very good indication of the key materials used in Highways Agency operations and the likely quantities of these materials.

4.3.3 The top 17 materials are listed in Table 4.1. These materials account for 75.34% in terms of weight of all of the 51 materials reported by the supply chain. The vast majority of these materials comprise quarried source materials such as aggregate, asphalt, bitumen, stone and sand.

4.3.4 As discussed above, there is currently very limited available data regarding the embodied water of construction materials. The figures for embodied water that are provided in Table 4.1 are based on review of published data (where available) and based on judgement and review of similar products. It is important that this data is not used for any other purpose than providing an indicative estimate of embodied water associated with key materials used in Highways Agency construction and maintenance operations for the sole purpose of informing this study.

*Table 4.1 Summary of key materials, tonnage and indicative embodied water 2009 - 2012*

	<b>Material type</b>	<b>Tonnes 2009 - 2012</b>	<b>% of top 17 total</b>	<b>Embodied water (m<sup>3</sup>/tonne)</b>	<b>Total embodied water (m<sup>3</sup>)</b>
1	Virgin aggregate	5,739,083	34.96 %	0.11 <sup>(1)</sup>	631,299
2	Asphalt	3,534,047	21.53%	0.6 <sup>(2)</sup>	2,120,428
3	Recycled aggregate	3,283,219	20.00%	0.0005 <sup>(3)</sup>	1,642
4	General ready-mix concrete	1,150,130	7.01%	0.408 <sup>(4)</sup>	469,253
5	Road salt	783,682	4.77%	0.0058 <sup>(5)</sup>	4,545
6	ITS system - misc cable	259,268	1.58%	2.34 <sup>(6)</sup>	606,687
7	High strength ready-mix concrete	255,664	1.56%	0.408 <sup>(4)</sup>	104,311
8	VRS - barrier	250,891	1.53%	2.90 <sup>(7)</sup>	727,584
9	ITS system - power cable	204,589	1.25%	14.64 <sup>(8)</sup>	2,995,183
10	Lighting system - main cable	151,275	0.92%	14.64 <sup>(8)</sup>	2,214,666
11	Quarried general stone	149,601	0.91%	0.11 <sup>(1)</sup>	16,456
12	Sand	138,147	0.84%	0.07 <sup>(9)</sup>	9,670

	Material type	Tonnes 2009 - 2012	% of top 17 total	Embodied water (m <sup>3</sup> /tonne)	Total embodied water (m <sup>3</sup> )
13	Bitumen	132,062	0.80%	10 <sup>(2)</sup>	1,320,620
14	Stone gravel/chippings	131,298	0.80%	0.04 <sup>(9)</sup>	5,252
15	All cement	97,447	0.59%	1.33 <sup>(10)</sup>	129,605
16	Ready-mix concrete - road & pavement	82,814	0.50%	0.408 <sup>(1)</sup>	33,788
17	All steel	71,973	0.44%	2.90 <sup>(7)</sup>	208,722
	<b>Total</b>	<b>16,415,190</b>	<b>100%</b>		<b>11,599,711</b>

Key materials, tonnage and embodied water 2009-2012

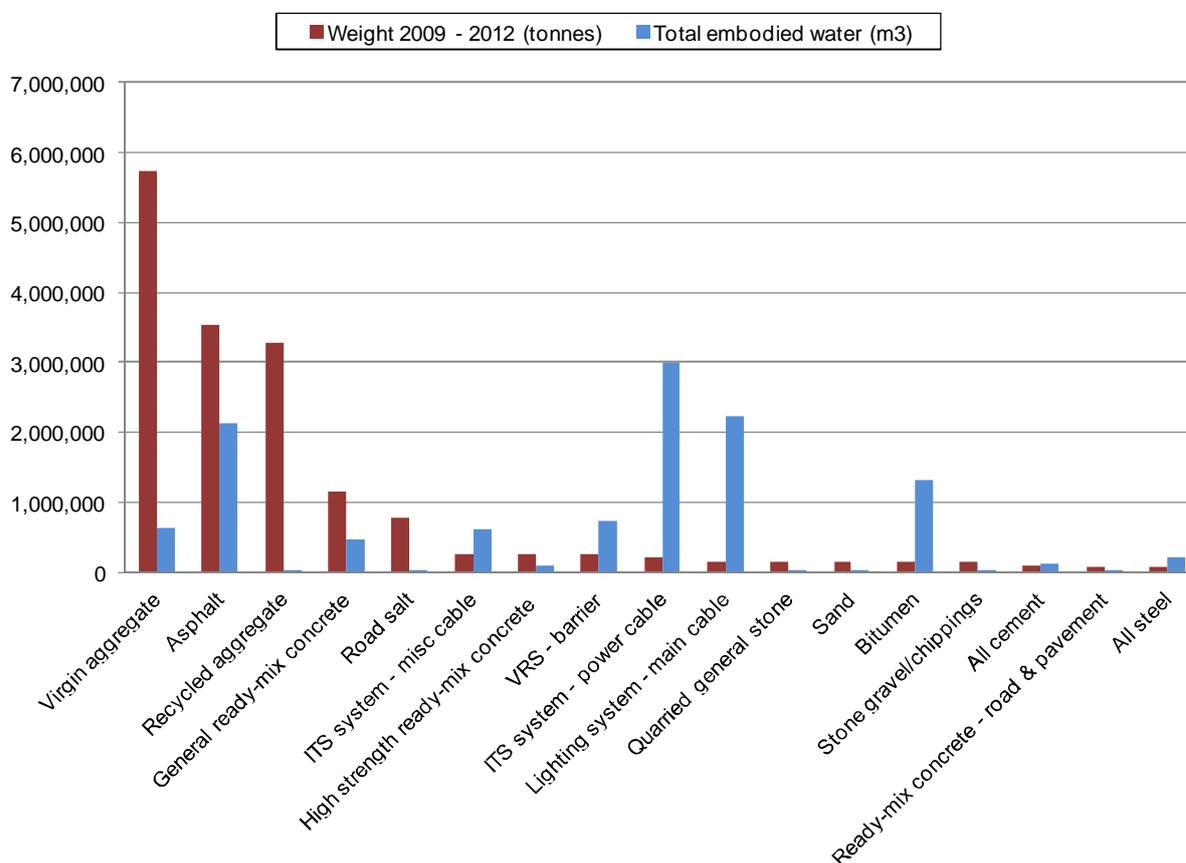


Figure 4.1 Summary of key materials, tonnage and indicative embodied water 2009 – 2012

4.3.5 The figures provided in Table 4.1 and Figure 4.1 are total figures for the financial years between 2009 – 2012 as captured by the study: “Major project, managing agent and private finance initiative materials purchases from 2009 to 2012”. Over this period:

- 26 Major Projects were on site at some phase of construction work;

- The MAC supply chain maintained and operated approximately 6,920 kilometres of network whilst also delivering small improvement schemes; and
- The DBFO supply chain maintained and operated approximately 2,270 kilometres of network, and also delivered 3 major projects on the M25 network.

4.3.6 The figures summarised in Table 4.1 suggest a total embodied water consumption in the region of 11.5 million m<sup>3</sup> between 2009 – 2012. If split equally across the three years, this equals approximately 3.8 million m<sup>3</sup> per annum.

4.3.7 Based on review of information provided within the previous study undertaken by Parsons Brinckerhoff on behalf of the Highways Agency “Research into the Highway’s Agency Water Footprint, April 2010”, direct water consumption by Major Projects, MAC and DBFO schemes was estimated to be in the region of 415,000 – 535,000 m<sup>3</sup> per annum (in 2009/10). Direct and indirect water consumption will be strongly influenced by the amount of construction and maintenance work undertaken within the reported year and by the nature of activities undertaken. However, these figures demonstrate that embodied water consumption is in the region of 7 times that of direct water consumption.

#### **4.4 Gap analysis**

4.4.1 Whilst a significant amount of data is available, the study has highlighted the uncertainties associated with this data.

4.4.2 The upcoming ISO standard “ISO/DIS 14046 Environmental management - Water footprint - Principles, requirements and guidelines” will hopefully provide a consistent methodology for the calculation of a product’s water footprint and the associated Water Impact Index. This in turn will hopefully lead to the publication of data that will provide some certainty in the figures generated and enable comparison of data published by different sources.

4.4.3 As discussed in Section 4.2, it is considered likely that the ISO standard will be based on the methodology set out in “The Water Footprint Assessment Manual: Setting the Global Standard, February 2011”. To address the identified data gaps and provide some certainty in the embodied water of key materials used in Highways Agency operations, the Highways Agency could undertake its own studies using this published methodology to address identified data gaps. This would be a similar endeavour to the Highways Agency’s initiative to develop a carbon calculator tool.

4.4.4 Priority could be given to those materials that constitute the greatest percentage (by weight) of materials procured by the Highways Agency, suppliers and sub-contractors. For example, a water footprint study could focus on quarried source materials such as aggregate, asphalt, bitumen, stone and sand that are most likely extracted and processed within the UK.

#### **4.5 Risks and opportunities for Highways Agency operations**

4.5.1 Embodied water is clearly a significant contributor towards the total volume of water consumed directly and indirectly by the Highways Agency in non-office based activities. The key drivers to consider and manage indirect water use include:

1. To reduce total water consumption and the impact that Highways Agency operations could have on water stress both within the UK and internationally;

2. To make informed choices about where materials and products are sourced from based on water stress and the impact on local environments in the country of extraction and/or manufacture.
3. To reduce risk to Highways Agency operations associated with water stress within the country of extraction and/or manufacture and any subsequent impact on product quality, availability and/or cost.
4. To enable publication of the Highways Agency water footprint, provide a benchmark from where targets can be set, and inform documents such as the Sustainable Development Plan, EMS, annual reports and related publications.

4.5.2 At this stage it is difficult to use embodied water to inform product selection because of the uncertainties associated with the data as discussed in Section 4.2. Also, as discussed in Section 4.1, it is also not enough to just consider embodied water in isolation without also considering water stress within the country(s) of extraction/manufacture and other guiding factors such as embodied carbon. However, there are a number of reasons as to why considering embodied water is still important:

1. It raises awareness of the importance of indirect water use and embodied water amongst Highways Agency employees, suppliers and sub-contractors. This in turn can help promote the need to use materials and products more efficiently to reduce unnecessary wastage.
2. It puts the Highways Agency in a good position to gather relevant data and develop its understanding of embodied water in readiness for the publication of a standard methodology and comparable data that can subsequently aid product selection.

#### **4.6 Section summary**

1. Indirect water consumption is often greater than direct water consumption.
2. Many of the materials and products consumed in the UK are manufactured abroad and therefore the impact of indirect water consumption is often felt abroad and not within the UK.
3. There is currently no International or UK standardised methodology for calculating indirect water consumption. This adds uncertainty to published figures.
4. The indirect water consumption associated with the procurement of Highways Agency materials for non-office based activities is estimated to be approximately 3.8 million m<sup>3</sup> per annum. This estimate is approximately 7 times greater than direct annual water consumption.

SECTION 5

**CONCLUSIONS, RECOMMENDATIONS AND  
OPPORTUNITIES**



**5 CONCLUSIONS, RECOMMENDATIONS AND OPPORTUNITIES****5.1 Summary**

5.1.1 This report has provided the following information:

- Current and future water stress and the measures typically implemented by the EA and water companies to manage water stress;
- Typical water use for non-office based Highways Agency operations, informed through an audit of two major project sites and two depots;
- How these operations may be affected by water stress and the measures implemented by the EA and water companies;
- Embodied water associated with the key products and materials used by the Highways Agency in non-office based operations;
- Opportunities for addressing and/or reducing identified risks associated with water stress for the direct and indirect use of water.

5.1.2 The risks associated with water stress, both from direct and indirect water use, are not only concerned with the potential impacts to Highways Agency operations, but the potential impact of Highways Agency operations on the water environment.

5.1.3 The study has highlighted that the volumes of water typically consumed by Highways Agency operations are not of great concern to the EA or water companies consulted to inform this study. However, the study has received great support from the EA and selected water companies because of the wider implications of this study and potential opportunity for the Highways Agency to take a leadership role within the construction industry.

5.1.4 By undertaking this study and subsequently implementing some of the opportunities identified by the study, the Highways Agency is raising awareness of water stress throughout the construction industry and the wider population. This in turn may encourage a larger number of organisations to complete similar studies and the cumulative impact could be significant. Studies such as this will slowly but surely help change the way in which we view water within the UK and internationally. The Highways Agency has played a significant role in raising the profile of carbon management in the construction industry in recent years and can potentially do the same in terms of water use and management.

5.1.5 Efficient use of water is considered vital to reducing water consumption and therefore risk, but it is important to appreciate the wider benefits of efficient water use that go beyond reducing water stress. These can include:

- Reducing the volume of water that requires abstracting, treating and pumping, thus reducing energy demands and chemical treatment;
- Reducing the need for costly infrastructure works that will ultimately be reflected in the cost of water and subsequent water charges;
- Reducing the social and economic impacts associated with water shortages, for example reduced agricultural productivity or a ban on cleaning public open spaces;
- Reducing environmental impacts and enhancing our natural environment.

5.1.6 The study is also considered important in assisting the Highways Agency in meeting their corporate sustainability targets. The Highways Agency has invested a great deal into measuring and managing its carbon footprint and waste generation. Water is considered to be the next step in understanding, managing and reducing environmental impacts and improving overall sustainability.

## **5.2 Summary of water stress**

5.2.1 The greatest levels of water stress are located within the South East and East of England, predominantly as a result of low average rainfall and high population densities. The South East and East are also identified to be at greatest risk from future water resource availability caused by climate change effects and a growing population. However, the study has highlighted that a drought situation can occur anywhere in the UK and is typically localised to certain catchments.

5.2.2 Within England, approximately one third of water supplies are sourced from groundwater and two thirds are sourced from surface waters. The study has highlighted that whilst groundwater and surface waters respond differently to changes in climate and rainfall, they are both equally at risk from long term and short term water stress.

## **5.3 Summary of measures implemented to control water stress**

5.3.1 Water resources are ultimately managed by the EA through the abstraction licensing system, including the volume of water that can be abstracted by water companies for potable mains water supply. However, direct abstractions of less than 20m<sup>3</sup> per day from surface waters or groundwater do not require an abstraction license.

5.3.2 During a drought situation, the EA may apply conditions to an abstraction license to reduce the volume of water that can be abstracted. However, the majority of existing licenses were granted without time limits and without conditions. This can make it difficult for the EA to apply short term restrictions. Proposals are being put forward by Government and the EA to reform the current abstraction licensing system to enable greater flexibility. This may have a beneficial effect to Highways Agency operations as it will 'free up' available water resources and promote the temporary sharing of licensing.

5.3.3 Potable mains water supplies are managed by the relevant water company. During a drought situation, the water company can apply a range of restrictions to mains water supplies that are dependent on the severity of the drought. The majority of these restrictions are applied to non-essential domestic water uses and typically no more than once every ten years.

5.3.4 If a drought worsens, a water company may apply to the Secretary of State for a Drought Order to gain approval to restrict other non-essential uses including cleaning commercial vehicles and plant, dust suppression and cleaning external areas. This would typically occur no more than once every 20 to 40 years or so.

## **5.4 Summary of non-office based water use**

5.4.1 The study identified that the most common uses of water at the selected construction sites and depots included:

- Office facilities, principally kitchen and sanitary use;

- Wheel washing;
- Road sweeping;
- Dust suppression;
- Plant washing;
- Concrete batching;
- Water specific construction activities (e.g. hydro-demolition and directional drilling/piling);
- Vehicle washing;
- Salt brine.

5.4.2 The majority of water for all site office facilities and construction/maintenance activities is currently sourced from potable mains supplies. Some activities were identified to be sourced from water bowzers, although it is likely that these are also filled from mains water supplies.

5.4.3 Through consultation with relevant site contacts, direct abstraction of water was identified as an alternative water supply on some sites, although none of the sites audited to inform this study sourced water from direct abstraction.

5.4.4 A number of the audited sites collect surface water runoff and rainwater for use within non-potable applications. The dual use of attenuation ponds/tanks required for drainage purposes as an alternative water supply offers a relatively economic alternative water source. Concerns have been raised regarding the quality of water collected from surface water runoff for certain applications (such as spray applications).

5.4.5 The majority of sites audited to inform this study record the total volume of water obtained through the mains water supply (although not if this water is provided by sub-contractors). However, there is no differentiation between the volume of water used in office facilities and the volume of water used for construction and maintenance activities. Some of the audited sites did have a good appreciation of the likely volumes of water used in certain construction and maintenance activities.

## **5.5 Impact of water stress on Highways Agency operations**

5.5.1 It is possible that the South East and East may experience periods of drought more often than other areas of the UK due to the high water stress identified in these regions. However, it is important to appreciate that all water companies throughout the UK set levels of service that have been agreed with the EA and, typically, agreed with their customers.

5.5.2 Levels of service take into account the factors that could affect water resource availability over the next 25 years, such as predicted climate change effects, population growth, total water demands and planned investments in infrastructure. Theoretically, there should be no greater risk of water shortage issues as a result of climate change and population growth as these risks will have been considered as part of the long term management strategy.

5.5.3 During a severe drought (i.e. once every 20-40 years or so) certain Highways Agency operations may be affected if a greater range of water use restrictions are implemented following approval of a Drought Order. Based on review of the types of non-essential measures considered under a Drought Order and the types of activities

typically undertaken at Highways Agency non-office based sites, the following water consuming activities may be affected:

- Wheel washing;
- Road sweeping;
- Dust suppression;
- Plant washing;
- Vehicle washing.

5.5.4 It is important to note that these restrictions will be exempt if they pose environmental, health or safety risks. Similarly, restrictions may not apply if it can be demonstrated that these activities use water efficient technology.

5.5.5 For sites that abstract water directly from groundwater and surface water resources, the EA may apply a temporary restriction to the volume of water that can be abstracted during periods of drought. Under the current abstraction licensing system, sites may also struggle to obtain an abstraction licence as all available water within a water stressed catchment may already be allocated. However, the proposed changes to the abstraction licensing system are likely to make abstraction licenses (particularly for relatively low volumetric demands) easier to obtain.

5.5.6 Investment in infrastructure, such as new augmentation schemes or reservoirs, is one way in which the EA and water companies ensure the security of supplies. The use of demand management measures, which include pricing schemes, is another way. Although there are no published plans to increase the cost of water within the UK, water tariffs are likely to increase to encourage efficiency and fund investment in infrastructure.

5.5.7 The use of more sustainable supplies of water, in particular the collection and reuse of rainwater and surface water runoff, should be promoted where feasible and where appropriate. However, collection of rainwater for onsite reuse within Highways Agency operations may be affected by climate change predictions, in particular the prediction of hotter drier summers that may reduce the frequency and volume of rainfall.

## **5.6 Embodied water**

5.6.1 Embodied water is a significant contributor towards the total volume of water consumed directly and indirectly by the Highways Agency in non-office based activities. At this stage it is difficult to accurately quantify the volume of water or risks associated with embodied water as there is no standardised methodology available. However, consideration of embodied water will help raise awareness and set the foundations from which decisions can be made regarding sustainable procurement.

5.6.2 Initial investigations suggests that the indirect water consumption associated with the procurement of Highways Agency materials for non-office based activities is approximately 3.8 million m<sup>3</sup> per year. This estimate is in the region of approximately 7 times greater than direct annual water consumption in non-office based applications.

## **5.7 Opportunities for Highways Agency operations**

5.7.1 The study has identified potential risks to Highways Agency non-office based operations as a result of current and future water stress in the UK and abroad. The study has also identified a large number of indirect benefits associated with improving water use efficiency and identifying more sustainable sources of water, such as:

- Raising awareness of water stress throughout the construction industry and the wider population, thus encouraging a larger number of organisations to consider and reduce water consumption;
- Reducing the indirect impacts of water consumption, such as associated energy demands, environmental impacts and social impacts;
- Reducing the need for costly infrastructure works that will ultimately be reflected in the cost of water and subsequent water charges;
- Raising awareness of embodied water impacts and the need to consider local water stress as part of responsible procurement.

5.7.2 Some of the key opportunities that have been identified through completion of this study that could be taken forward by the Highways Agency include activities such as:

- Raising awareness amongst Highways Agency staff, subcontractors and suppliers regarding water stress and the importance of water efficiency;
- Metering and recording of water use to differentiate between water used for office/welfare facilities and water used for construction/maintenance activities;
- Leak detection and
- Use of water efficient fixtures and appliances, and use of appropriate water efficient construction techniques and plant.
- Investigating alternative sources of water where possible and where appropriate;
- Preparing for a drought situation and responding the EA and water company awareness campaigns.

## **5.8 Section summary**

1. This study recognises the increasing water stress experienced within the UK and globally and the risk that this presents to Highways Agency non-office based operations.
2. The study has highlighted that the volumes of water typically consumed by Highways Agency operations are likely to have little impact on water stress within the UK. However, the study has identified the potential to raise awareness of water stress throughout the construction industry and the wider population. This in turn may encourage a larger number of organisations to complete similar studies and the cumulative impact could be significant.
3. The Highways Agency has played a significant role in raising the profile of carbon management in the construction industry in recent years and can potentially do the same in terms of water use and management.
4. The study is considered important in assisting the Highways Agency in meeting their corporate sustainability targets. Practical and achievable opportunities have been identified to reduce the impact of Highways Agency operations on water stress and reduce the potential risks that water stress could pose to Highways Agency operations now and in the future.



SECTION 6

**REFERENCES**



**6****REFERENCES**

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