Affinity Water
Central Region
Drought Management Plan

February 2013

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In order to protect the security of our site we have given them security coded names throughout the document.

EXECUTIVE SUMMARY

Affinity Water in the central region provides public water supplies to a population of 3.2 million in the Home Counties to the north and west of London. The area contains a number of north London Boroughs and extends into rural parts of Essex, Hertfordshire and Buckingham shire. 60% of our resources are from the underground aquifer (groundwater) with over 250 boreholes spread across North London and the Home Counties. 40% of our resources are from river sources notably the River Thames and import of water from Anglian Water. Neither of our licences for abstraction from the Thames, or our Anglian import, are limited by flow/drought conditions and therefore our Drought Management Plan focuses on behaviour of our groundwater sources.

Our Drought Management Plan (DMP) is built on our experience of managing a range of droughts in the last 20 years, in particular the multiple year groundwater droughts of 1988 to 1992, 1995 to 1998 and 2005 to 2007. We have now updated the draft DMP to reflect recent operating experience, the latest views of our stakeholders and incorporate the new powers on restrictions according to The Water Use (Temporary Bans) Order 2010. We have a pro-active approach to managing drought and our objective is to secure public water supplies at all times. This will be achieved by:-

- Being prepared for drought at any time and having our plan ready to deal with it.
- Continuous monitoring of environmental conditions in partnership with the EA.
- Identifying the onset of drought and mobilising additional resources.
- Assessing drought duration and severity and the impact on water available to our customers.
- Minimising environmental impact of drought by optimising the use of our resources.
- Implementing measures to reduce the demand for water or increasing capacity of our assets to maintain security of supplies. Our actions will become more strenuous as drought deepens and lengthens.
- Acting and communicating with our customers and other stakeholders in partnership.

This Plan details our flowchart process that will be used to manage droughts. The process demonstrates how routine hydrological data is monitored to determine the onset of drought which triggers the formation of a Drought Management Group. From that point on this group is responsible for implementing actions to ensure public water supply is maintained through the drought conditions. The DMP process also defines individual roles within the Company, the level of interaction/liaison with third parties and the Environment Agency in particular. The plan contains details of our Environmental Monitoring and Communication Plans and how hydrological triggers are linked to actions. The plan also details a range of demand side and supply side measures that may be required to maintain the supply/demand balance. It also outlines the steps that should be followed in severe drought conditions when requirements for restrictions on use of water or additional abstraction could mobilise Drought Permits or Drought Orders. The plan indicates how the severity and duration of drought is assessed and forecasted and when and how drought actions are implemented. Finally, an outline of how and when the company will identify the end of a drought and the associated actions required at this point is provided.

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LIST OF ABBREVIATIONS USED IN THIS DOCUMENT

ADPW	Average day demand peak week
AISC	Average incremental social cost
ALF	Alleviation of low flows
CAMS	Catchment Abstraction Management Strategies
CAPEX	Capital expenditure
CLG	Communities and Local Government Department
DD11	Drought Direction 2011
DEFRA	Department for Environment, Food and Rural Affairs
DETR	Department of Environment, Transport and the Regions; (now Defra)
DoE	Department of the Environment; (now Defra)
DMP	Drought Management Plan
DMG	Drought Management Group
DO	Drought Order
DP	Drought Permit
WRMP	Water Resources Management Plan 2008
EA	Environment Agency
EIA	Environmental Impact Assessment
ES	Environmental Statement
LPA	Local Planning Authority
LTA	Long term average
GCM	Global circulation models
GCCM	Global climate change models
Ml/d	Megalitre per day; Megalitre = one million litres (1000 cubic metres)
MLE	Maximum Likelihood Estimation
NEP	National Environment Programme
OASIS	Operational Assessment of Summer Impacts and Stress
OBH	Observation Borehole
ODPM	Office of the Deputy Prime Minister (now replaced by CLG department).
Ofwat	The Water Services Regulation Authority
ONS	Office for National Statistics
OPEX	Operating expenditure
PCC	Per capita consumption - consumption per head of population
SEA	Strategic Environmental Assessment
SEMD	Security and Emergency Measures Direction
SMD	Soil moisture deficit
SRO	Source Reliable Output
SSSI	Site of Special Scientific Interest
TW	Thames Water
UKCIP	UK Climate Impacts Programme
UKWIR	United Kingdom Water Industry Research Limited
AW	Affinity Water
WAFU	Water Available for Use
WFD	Water Framework Directive
WIA	Water Industry Act 1991
WRP	Water Resources Plan 2004
WRMP	Water Resources Management Plan 2008
WTW	Water Treatment Works
WUO	Water Use Temporary Bans Order 2010

1 INTRODUCTION

Drought management plans are a statutory requirement for all water companies as prescribed under section 39B of the Water Industry Act 1991 (WIA) and as introduced by the Water Act 2003. The purpose of the Drought Management Plan (DMP) is to demonstrate how Affinity Water (AW) plans to monitor and manage future drought related events, restrain demand and mobilise extra resources, whilst minimising recourse to drought orders and permits and ensuring security of supply. The plan is agreed with the Environment Agency (EA) and approved by the Secretary of State following public consultation and provides a decision aid tool for use by our Drought Management Group (DMG) which is led by the Asset Management Director.

The DMP is subject to consultation both prior to and following the preparation of the draft plan. The pre-consultation process involved feedback from key stakeholders including the EA and Ofwat as well as other water companies. The consultation process is described in Section 1.2. This document outlines the Affinity Water Drought Management Plan for the central region in six main sections:

(i) introduction to our supply area and water resources;

(ii) a description of the drought triggers and scenarios;

(iii) a description of drought management actions;

(iv) an outline of the Environmental Monitoring Plan (EMP);

(v) a description of our Communications Plan;

(vi) an outline of post-drought actions.

A drought is a natural event that can not be prevented. As no two drought scenarios are ever the same, flexibility has been built into the plan to allow for the most efficient and effective way of dealing with different drought situations.

1.1 Objectives of Affinity Water's Drought Management Plan

The overall objective for the DMP is to establish a comprehensive set of plans and procedures that define the process for managing drought conditions. The DMP includes action plans for how the company will manage any restrictions on non-essential use as well as provisions for environmental monitoring and communications. This DMP enables us to:

- exercise new powers on restrictions for non-essential use introduced by The Water Use (Temporary Bans) Order 2010
- predict the onset of a forthcoming drought using defined drought triggers;
- monitor and assess likely drought severity;
- monitor the effects of drought and the measures taken under the DMP;
- provide drought management options based on historic experience and data to reduce demand or supplement resources and maintain security of supply to customers;
- assign roles and responsibilities within AW to manage a drought event;
- efficiently manage the communications process with customers, stakeholders, other water companies, our regulators and internally within AW by identifying target audiences and appropriate communications channels ;
- provide suitable levels of information;

- ensure a regular dialogue and close working relationships with stakeholders;
- ensure our stakeholders receive accurate information direct from us;
- ensure co-ordinated and consistent messages are disseminated to all stakeholders and affected/ interested parties;
- raise awareness of water issues and the need for ongoing water efficiency
- increase understanding of peak demand and drought scenarios
- communicate the positive steps we have taken to enable us to manage any peak demand/ drought scenario

1.2 Consultation Process

We published our draft DMP dated November 2011 for consultation in accordance with the Direction on the 21st November 2011, inviting views from individuals and organisations on our proposals. The period of consultation was 8 weeks ending on the 16th January 2012. We prepared a statement of response to the representations received and sent it to the Secretary of State for the Environment by the extended date of 23 April 2012. A copy of this statement was also sent to any person or organisation that made a representation and in addition we are required to publish the statement on our website. The Secretary of State informed us of further changes to be made with a letter dated 21st September 2012. The Plan was amended accordingly with relevant direction by the EA and resubmitted to the SoS. On 18th January 2013 we received a letter of confirmation by the SoS for the publication of the final Plan.

This section of our Plan details the consultation process for our draft DMP.

1.2.1 The Statutory Consultation

We sent pre-consultation letters to Regulators, neighbouring water companies, MPs, Local Authorities and local interest groups on 24th February 2011. This letter notified our key stakeholders of our intention to update our DMP and listed the major changes following the new powers under the Water and Flood Act 2010.

The draft Drought Management Plan was published on the Affinity Water website (www.Affinitywater.co.uk/central) on 21st November 2011. Copies of the draft DMP were sent to all the parties set out in the Regulations. This included, amongst others, the regulatory authorities (Environment Agency and Ofwat), the Secretary of State c/o Defra, the Local Authorities and Natural England. The draft DMP was sent to the Chief Executives of Anglian Water and Essex and Suffolk Water, and to the Consumer Council for Water. A letter was sent out on 21st November 2011 detailing the consultation documents and the period of consultation (21st November 2011 to 16th January 2012). A summary of the stakeholders informed by letter is shown in Table 1.1.

Table 1.1 Consultation Engagement

Group	Number sent to
Parish Councils	416
Council Leaders	40
Council Chief Executives	40
Council Environment Heads	54
Members of Parliament	52
Interest Groups	38
Regulators and other water companies	10

Key Commercial Customers	82
Total	732

Electronic copies of the Plan were made available to the general public through our website with printed copies available on request.

1.2.2 Stakeholder open events

We held open events during the consultation period in St Albans (23/11/11), Woking (25/11/11), Harlow (28/11/11) and Hatfield (8/12/11). We invited all of the stakeholders shown in Table 1.1 to these events to give them the opportunity to discuss the plan with us and view outline posters of the plan itself. The aim of the events was to encourage stakeholders to respond to the consultation. The events were setup as open forums with at least 3 representatives from Affinity Water available to answer questions, distribute copies of the plan and explain the main points of the plan to the attendees. A series of posters were displayed at the events that summarised the plan in simple non-technical language to encourage discussion of the plan with the attendees. The events ran during the late afternoon into the early evening so that people could attend after work. General comments and issues raised at these events have all been taken into account when amending our plan.

A total of 17 stakeholders attended these events comprising;

- Thames Water
- Anglian Water
- Parish Councillors
- Town and District councillors
- Special interest groups
- Customers

Comments received from customers at these events are summarized as follows;

- Two wanted to get a water meter fitted.
- One asked why we could not use the canal network to pump water from Scotland.
- Three customers asked how they could save more water in their homes and gardens - all 3 of them already had 2 water butts installed for garden use.

Comments from other water companies;

- Interested to find out details of our plan especially with regards to restrictions and exceptions.
- Discussions around implementation of the plan and the differences between the local water companies drought plans'.

Comments from town and parish councils;

- Comments around planning for increasing development in the area and concern as to why water companies are still not statutory consultees within the planning process.
- Details explained on the plan itself and questions answered around the specific impacts of the plan on local authorities.
- Queries around how water companies plan for future development.

Comments from local interest groups;

- London Colney Village Concern raised the issue of low flow in the river Colne during autumn 2011. They enquired as to the company's position on river support for the River Colne if this problem persists. These comments are expanded on in their formal response to the consultation process.

1.2.3 Stakeholder engagement

We have communicated messages relating to the DMP and the current drought through the following methods and channels;

- Jack FM (Local radio station within AW area)
- Three Counties Radio (regional BBC Radio station)
- Affinity Water Drought Website
- Customer Call centre at Affinity Water
- E-mail note for all AW staff outgoing e-mails with link to AW Drought Website
- Water Efficiency squad attending events
- Press releases
- Meetings with key commercial customers
- Area, Regional and National Environment Agency Drought Meetings
- Regional Drought meetings with Thames Water, British Waterways and the Environment Agency
- National Water UK drought meetings
- Drought tolerant garden at Chelsea Flower Show 2012
- Allotment Holders newsletter
- Dacorum Environmental Forum Water Group meetings (plan and drought presentations bi-annually)
- Ver Valley Society (quarterly meeting, newsletters, plan and drought presentations)
- Impress the Chess and the River Chess Association (Quarterly and Annual meetings plan and drought presentations)
- Chiltern Chalk Stream Projects (quarterly steering group meetings, workshops and events, plan and drought presentations)
- River Beane Restoration Association (quarterly meetings, plan and drought presentations)
- Friends of the River Mimram (ad-hoc meetings when issues arise, plan and drought presentations)
- River Misbourne Action (ad-hoc meetings when issues arise)
- Chiltern Society Rivers and Wetlands Group (ad-hoc meetings, part of Chiltern Chalk Streams Project steering group)

1.2.4 Responses

We would like to thank the following for their formal representations:

- Environment Agency
- Ashwell Parish Council
- Chesham Town Council
- Chesham and District Natural History Society
- Chalfont St Peter Parish Council
- Consumer Council for Water
- Dacorum Environmental Forum Water Group
- Heathrow Airport
- Federation of Window Cleaners
- London Colney Village Concern
- Markyate Parish Council
- Natural England
- The Watton at Stone Parish Council
- Chiltern Chalk Streams Project
- Ver Valley Society
- LB Enfield
- Ware Town Council

We have taken into account all representations made on our draft DMP and illustrate the changes that we have made in Section 3 of the Statement of Response. Where representations have not resulted in changes, we have outlined the reasons for this decision. LB Enfield and Ware Town Council made no comments on the DMP in their response letters' and so have not been included in Section 3.

1.3 Background Information

We operate in the South East of England (see Figures 1.1 and 1.2 below), a very dry region of the UK, with only half the average UK rainfall and supplies 1.1 million households.

Figure 1.1: Affinity Water within the South East of England

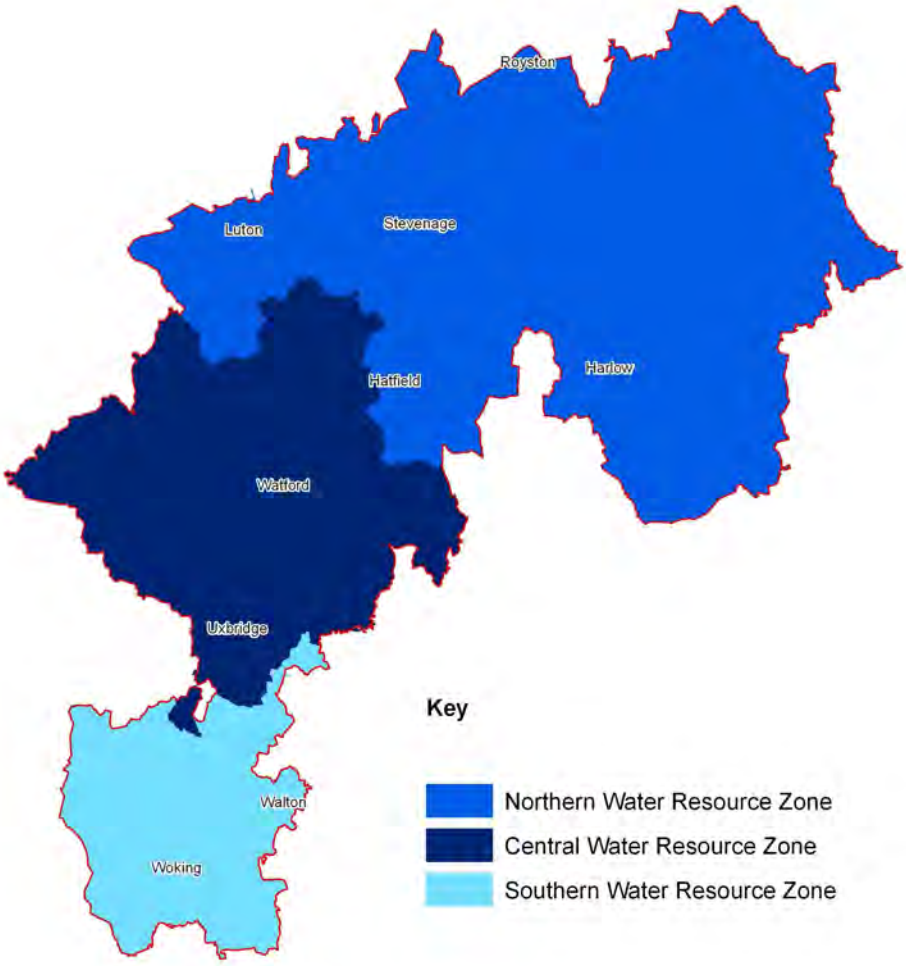


Figure 1.2: Map of AW Operating Area and Water Resource Zones

We seek to manage water resources efficiently to ensure it can secure a continuous supply of high quality water to meet the demands of its customers, while ensuring the sustainability of those resources and minimising any impact on the environment.

All water companies are required to produce a DMP to demonstrate the strategy to be followed and the measures to be taken to ensure that customers have sufficient water should a drought occur. Available data is studied to predict the onset of drought and the DMP outlines the actions to be taken to manage the various drought scenarios that could be encountered. We have developed a Communications Strategy (Section 5) to outline the key communications objectives and actions required in support of its DMP. An Environmental Monitoring Plan (Section 4) has also been developed outlining how the impact of drought and drought activities will be assessed through monitoring.

In the South East region water companies source their supplies of raw water prior to treatment in the following ways:

1) River abstraction;
2) Reservoirs filled by river abstraction or impoundment of river water;
3) Groundwater abstraction from boreholes and springs.

The percentage balance of these varies from company to company, and even within company areas and this causes variability in drought resilience and response.

Unlike unseasonably dry soil that constitutes an agricultural drought and which can arise from only a few weeks of dry and sunny weather over the growing season, it takes at least several months of below average rainfall to initiate a water resources drought. Particularly important is winter rainfall as it is this that replenishes most water resources. The low groundwater levels and river flows that result from this type of dry period reduce water availability from rivers and boreholes, and reservoir levels fall. This poses a risk to a water company's ability to supply its customers.

To manage this risk, water use restrictions are an important measure that water companies can use to reduce demand during drought. They not only enable companies to maintain essential supplies but also help to conserve water resources for later in a drought and reduce the environmental impacts of abstraction during this critical period.

Water companies will only impose water use restrictions upon their customers if they are absolutely necessary, and in accordance with their Levels of Service for water supply. Water companies fully appreciate the confusion that can be caused among some customers when one company introduces restrictions but its neighbouring company does not. Clearly from a customer point of view, if restrictions need to be imposed then a simple and consistent approach should be adopted for introducing water use restrictions across the South East. Where your water company has to appeal for restraint or impose restrictions, it will always give as much information to you as possible. The reasons why companies may have to react differently in terms of restrictions and their timing are explained below:

Differing levels of drought severity across the region: Whilst droughts across the South East will generally be caused by a regional trend of several months of below average rainfall, sub-regional differences in rainfall may cause differing levels of drought severity across the region. In other words, the need to impose restrictions for one company may not equally apply to another company in the South East.

Differing vulnerabilities at Water Resource Zone level: Due to the way the water supply system has developed over time, many water company supply areas are sub-divided into Water Resources Zones (WRZs). These are defined as the largest possible zone in which all resources, including external transfers, can be shared and hence the zone in which customers experience the same risk of supply failure from a resource shortfall. WRZs can be divided into those dependent upon:

- River abstraction only;
- Groundwater abstraction only;
- Reservoirs filled by abstracting local river water or by impounding river water;
- Various combinations of the above.

This mix of WRZ types means that even if there were not a significant difference in drought severity across the region, WRZs will tend to react differently to the same drought, with certain zones experiencing higher levels of risk to supplies than others. That means in similar drought conditions, rivers, groundwater sources and reservoirs across the region can respond differently in terms of risk to supply. For example, a WRZ dependent on combined river abstraction and reservoir storage for supply may have a different level of risk to one based on groundwater abstraction. This difference in WRZ vulnerability has an impact both at the company level and regional level. A water company may need to introduce water use restrictions preferentially in its more vulnerable WRZs while it may not need to extend the ban to the remaining zones in its area of supply. At the regional level one water company may need to impose water use restrictions earlier in a drought than its neighbours, while another water company is able to withhold the imposition of restrictions until much later or not at all.

The introduction of the new powers in the form of the Temporary Use Ban has provided an opportunity for the water companies in the South East to review their Drought Plans with a view to finding a clearer, more consistent and more unified approach to introducing water use restrictions across the region than in the past.

The water companies in the South East have had formal meetings to discuss the development of their plans and ensure that they are interpreting the new powers as consistently as possible. However, due to the local differences highlighted above, not all plans will be the same as each other.

1.4 Water Resources and Water Available for Use under Drought Conditions

Around 60% of our water is abstracted from groundwater, with the remaining 40% abstracted from surface water. In dry years the yield of the groundwater sources can reduce, and there is little raw water storage available to balance between dry and wet years.

Normal year demand of our customers is approximately 880 Ml/d average but this can increase to around 900 Ml/d in a dry year with a 7 day peak of over 1100 Ml/d. This compares with Water Available for Use (WAFU) of 1056.2 Ml/d and 1227.2 Ml/d respectively in a drought year as assessed for our Water Resources Management Plan 2009 (WRMP). Figure 1.3 below outlines how customer demand and subsequently distribution input can vary as a result of climatic variability; during a dry year (2005) Distribution Input (DI) reached 1100 Ml/d, however in contrast during a wet summer it peaked at 900 Ml/d (2007). Although the graph indicates that over time there is a natural decline rate in DI (as a result of increased efforts to reduce leakage, promotion of water efficiency and increased metering), it is important to note that during 2006 a hosepipe ban was introduced which has accelerated this rate of decline, in particular reducing summer peaks in demand. It is difficult to quantify the precise savings made directly from the restrictions themselves as the accompanying media campaign will have played a key role in reducing water usage both at the time and in future years as the seriousness of the situation is highlighted to the public.

The UK Water Industry Research (UKWIR) group measured the effect of hosepipe ban after the last drought's restrictions in 2006. The results indicated that there were savings in the order of 20% on the peak day, 15% on the peak week, &% on the peak month and 3% on the annual average. Savings from further restrictions have not been measured for the last 20 years.

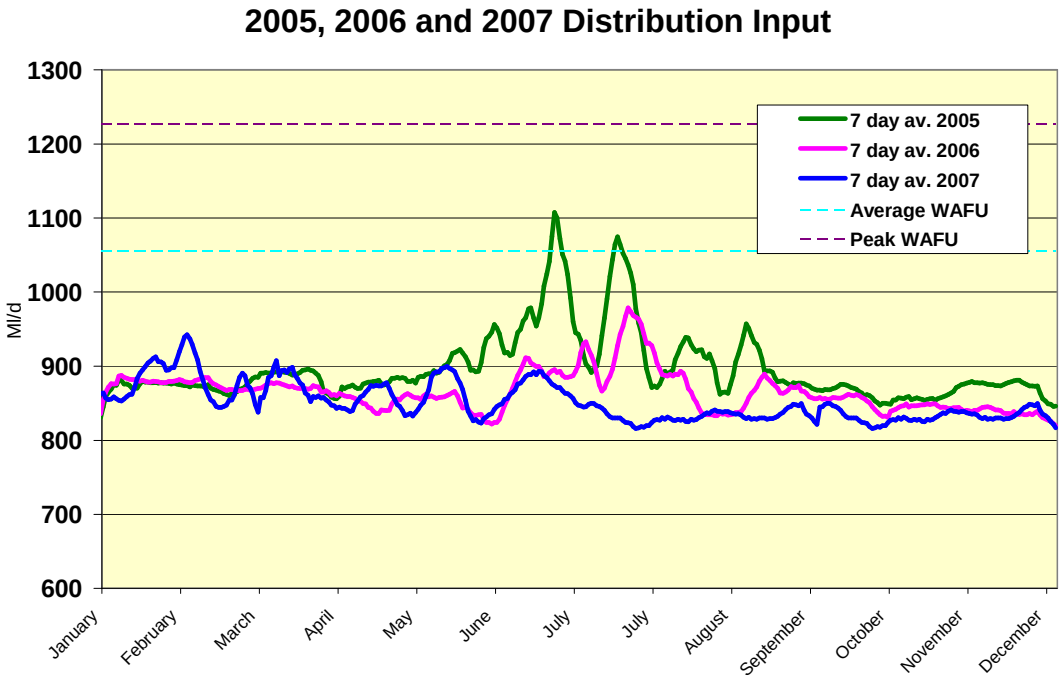


Figure 1.3: 2005 to 2007 Distribution Input Compared with Water Available for Use

1.4.1 Groundwater

Affinity Water, central region, has over 250 operational boreholes at 110 locations distributed across our operating area and in particular the unconfined Chalk aquifer that is comprised the Chiltern Hills outcrop. The boreholes range in depth and groundwater levels vary seasonally dependant on the prevailing rainfall pattern. Experience of previous droughts has shown that lowest groundwater conditions are seen only after severe multiple year drought conditions with a minimum of two dry winter seasons required. WAFU is assessed under drought conditions for the WRMP.

Our current source yield assessment methodology is based on the earlier approaches outlined by UKWIR in 1995, with subsequent modifications. This methodology is focused on determining deployable outputs for ground water sources under drought conditions only. We have also developed and applied an assessment methodology which is compliant with that of the UKWIR Unified Methodology for our four surface water sites and we have applied this to these sources to give a more robust evaluation of these run-of-river Licences. Details of these methodologies are also included in our WRMP which is available on our website.

Following the process of adjustment of the current (2007/08) deployable outputs, the results were compared with those projected for the base year in the previous Water Resources Plan 2004 (WRP). It was found that there had been several changes to deployable output with the overall company level being increased under both average and peak demand conditions.

1.4.2 Surface Water

Around 40% of the water used for potable supply is abstracted from the River Thames and the Anglian Water import. The surface water from the River Thames is treated at four river

water treatment works at HWFS, EGHS, CHERS and WALS. The treatment works are also fed by groundwater wells, principally the gravel wells at CHERS. These sources have permanent abstraction licences with no flow constraints under drought conditions and therefore combined are capable of providing sufficient quantities of raw water following prolonged dry spells, such as the dry period encountered during the long hot summer of 1995. The deployable output of the surface water treatment works is constrained marginally by licence volumes at average conditions and by treatment capacity during the critical period.

Maintaining minimum flows in the River Thames is the responsibility of Thames Water. Thames Water's abstraction licences for the River Thames are linked to a control curve that links minimum flows over Teddington Lock with drought measures such as restrictions on supply. These conditions are a result of Thames' historical responsibilities for management of the river catchment prior to the creation of the EA and these were made possible through the construction of major storage reservoirs that were built for river management on behalf of the regional community including other water companies. The reservoir storage and consequential responsibility for maintaining minimum flows was vested in Thames Water when the industry was privatised and continues to this day.

We have secured the use of some bankside storage as protection against short term pollution of the River Thames. Water stored at HERO can be transferred into QUEE. QUEE is connected to EGHS works and can be used as an emergency source for blending with river water when polluted such as at times of high nitrate concentrations in the river. The lakes can provide a substantial volume for relatively short periods by drawing down the levels and utilising the stored volume but have no significant impact on drought deployable output either at average or during critical period.

Bank-side storage at CHERS is utilised continuously. The gravel wells are operated constantly at their maximum yield, supplemented by stored raw water from the bank side reservoir. Bank side storage at WALS is utilised continuously as a balancing reservoir and is maintained by flow in the main river. Storage at WALS is modest, and is supplemented by local emergency groundwater source from the gravel. As these water bodies are integral to the function of the sites they are taken into account when assessing deployable output.

At HWFS WTW there is an option to utilise a supply from Thames Water's QMOT Reservoir under emergency conditions such as pollution of the River Thames and this is used for blending or support of water abstracted from the river at SUNN.

A link main exists between EGHS, CHERS & WALS WTW to enable water to be moved between these sources. In addition a second link main between EGHS and HWFS WTW's enables further operational flexibility of the system under periods of stress. This has provided additional transfer capacity since 2004 to improve the security of supply in each water resource zone.

In light of the robust nature of the surface water resources available to us and the responsibilities of Thames Water to maintain minimum flows in the River Thames at Teddington we do not link our drought actions to surface water conditions.

1.4.3 Imports and exports

Bulk imports of treated water are available from Thames Water (TW), Anglian Water Services (AWS) and Cambridge Water (CW). We also provide a bulk export of treated water to South East Water (SEW) from EGHS Treatment Works. Table 1.2 below includes

details of the various connections and their supply capacity under normal and drought conditions.

The shared supply from Anglian Water Services (AWS) is governed by the Great Ouse Water Act 1961 and is unrestricted under drought conditions as confirmed with Anglian Water by exchange of letters 29 & 30 April 2008. Anglian Water have also confirmed the drought draw-down curves anticipate yield up to our maximum entitlement and consequently our plan does not link drought action measures with the control curves for ANGL.

At times of drought we will enhance our regular liaison with Anglian Water to verify the continuing resource availability for the forecast duration of drought and to ensure Anglian are taking all necessary steps to protect our entitlement from ANGL.

Table 1.2 also included a number of cross-border bulk supplies that are used in normal circumstances but the specific contractual conditions for each means that the installed capacity is reduced under drought conditions.

There are no specific contractual arrangements in place for additional water supplies, beyond those stated, to be supplied between companies during a drought, however companies would undoubtedly provide mutual assistance dependent upon drought conditions and their availability of water resources.

Table 1.2: Cross-border Transfer Volumes

Cross-connection		Location	Capacity or Entitlement Ml/d		Available Drought Volume Ml/d		Notes and link to restrictions in donor company
			Av	Pk	Av	Pk	
Supply From	Thames Water	FORT	27	27	10	10	No
		QMOT	10	10	10	0	No, unless subject to drought failure
		LADY	2.3	2.3	2.3	2.3	Reduced by unusual drought
		KEMP	10	10	0	0	No
	Anglian Water	ANGL	91	109	91	109	No
	Cambridge Water	HADR	0.09	0.09	0.09	0.09	Two supplies, No
		LOWE	8	8	0	0	No, emergency supply only
Supply To	South East Water	EGHS	36	36	36	36	Reduced pro rata available output of EGHS in emergencies
	Cambridge Water	ODSC	0.04	0.04	0.04	0.04	No
	Essex Water	DODD	0.1	0.1	0.1	0.1	No

1.4.4 Strategic Mains Network

A schematic diagram of the our strategic mains network is shown in Figure 1.4.

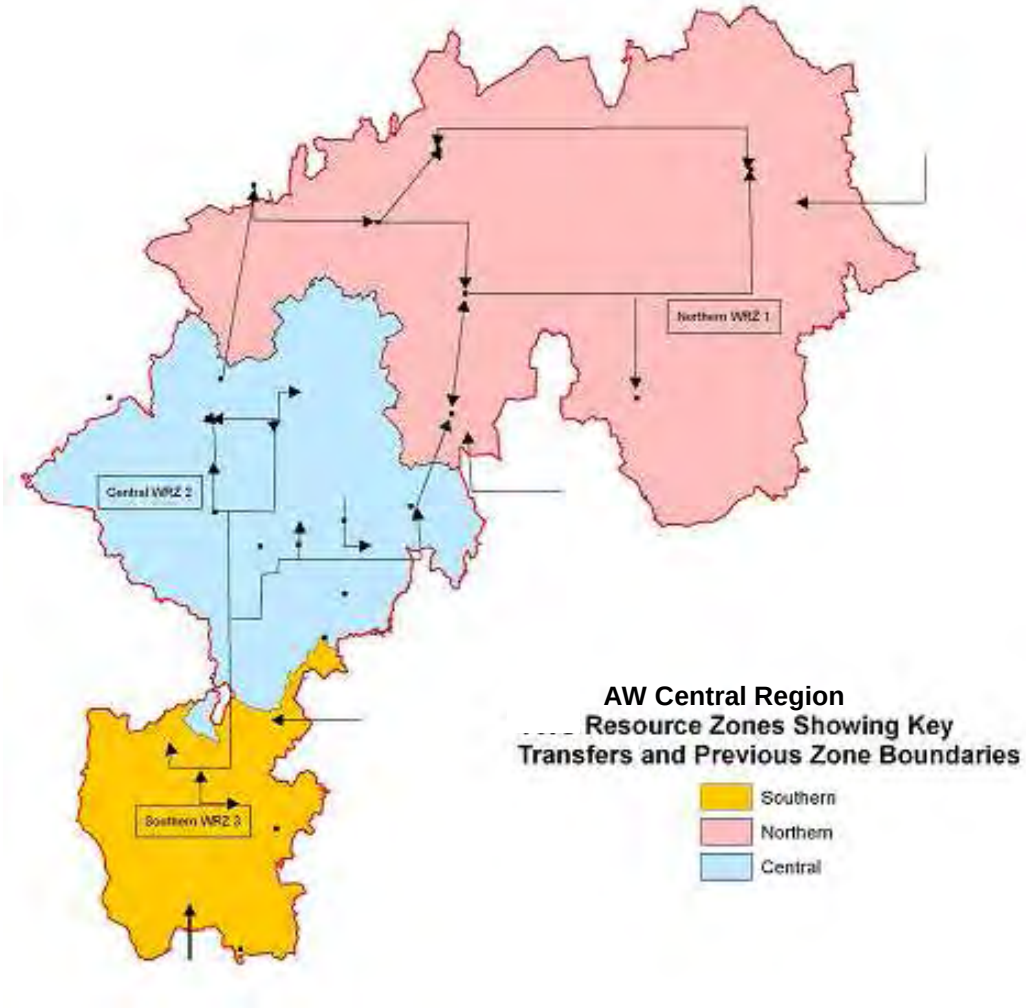


Figure 1.4: Schematic Diagram of the AW Strategic Mains Network

1.5 Emergency Storage

Emergency storage provides alternatives to sources primarily for the purposes of protection against pollution. Emergency storage is available as detailed in Table 1.3, below. The role and function of bankside storage in relation to the drought deployable output assessment of our surface water sources is described above in Section 1.3.2.

The role of HILF Reservoir is however of a different nature. This reservoir is part of the LANE complex and is currently decommissioned. However the reservoir was designed to provide strategic back-up to the LANE Treatment Works and remains connected to the raw water main system supplying the works. In extreme drought conditions and emergency loss of supplies it may be possible to re-commission access to the stored water but this will require installation of temporary treatment and pumping plant. The work necessary to re-commission the Reservoir was considered for our WRMP but investment was scheduled for after 2015.

Table 1.3: Location of Emergency Raw-water Storage

LOCATION	NAME	MAX VOLUME (ML)
EGHS	QUEE	150
EGHS	HERO	250
CHERS	Bankside Reservoir	400
WALS	Bankside Reservoir	120
LANE	HILF	1800

1.6 Water Resources Plan Levels of Service

This DMP is consistent with our Water Resources Management Plan (WRMP) 2009. The assessment for our customer Level of Service estimates that a drought scenario which requires the implementation of temporary bans on water use will occur with an average not more than 1 in 10 year frequency. In addition drought permits or drought orders will be required at a frequency no greater than 1 year in 20. We are of the opinion that the use of rota cuts and standpipes are no longer a viable drought response as they are not compatible with regulatory water quality requirements and therefore these are not considered for drought planning however they remain operational tools in case of extreme emergencies.

In April 2012 we imposed temporary use ban, as the water levels dropped in Zone 3, which was subsequently lifted in July 2012 after unprecedented rainfall. Environmental monitoring was in place in accordance with the Plan, however it was not required to apply for drought permits or orders. In the drought of 2005/06 the water levels dropped to Zone 3 and we had to impose temporary hosepipe ban until January 2007, when the water levels had sufficiently recovered. We did not need to apply for a drought permit or a drought order in 2005/06, however environmental monitoring associated with two drought permitting sites was in place. We also introduced hosepipe restrictions in 1990 but again without applications for drought orders or permits.

1.7 Security of Supply Measures

Security of supply is maintained through provision of interconnection of treatment works, pumping stations and storage reservoirs linking all groundwater and surface water sources grouped in 3 water resources zones and 33 water demand zones. The integrated trunk main network incorporates both pumped and gravitational transfers and is also connected to the principle imports and outputs from other water companies described in 1.3.3 above. The four principal surface water treatment works are also interconnected using link mains to maintain water quality and to provide operational flexibility and hence emergency support.

If a river source is compromised, for example in the case of gross river pollution, the emergency sources detailed in Table 1.3 are available and can be used in total substitution for river water.

The company is able to utilise groundwater and surface water sources conjunctively and we have the flexibility to transfer water around the supply infrastructure. This is a benefit in a drought situation by allowing surface water to support groundwater or vice-versa. Together the groundwater and surface water systems are able to meet all historic and forecast demand scenarios

1.7.1 Supply / Demand Forecast

As our groundwater and surface water sources are managed conjunctively to meet demand, during a drought demand can be transferred between adjacent resource zones. This happens under normal operating conditions but is critically reviewed during a drought.

In order to do this, a water balance model has been built based on the forecasted supply availability and demand e.g. over a third dry winter year (long term drought), for each HDZ. The supply/demand forecast is carried out for each potential drought scenario so that actions may be determined for operation under each Drought Zone Trigger (ref. Figure 1.6)

Source availability is verified by examining the actual drought conditions compared to our baseline Source Reliable Output (SRO) assessment used for our Water Resources Management Plan (WRMP). Demand is also based initially on the normal and dry year average and peak demand scenario's from our WRMP but reviewed and adjusted to reflect specific year forecasts e.g. in the current Olympic year peak demand is expected to continue for an extended period from mid July though August. The demand in each zone will be met by the source availability in that zone plus the internal or external transfers. In order to assess any potential supply deficit in a zone transfers are based initially on the capacity data from our suite of Hydraulic Models. For each zone the security of supply in the zone is then verified firstly with a simple simulation with every source taken out of supply at each step. A more complex scenario of two or more sources out of supply at the same time is then tested to identify any potential deficit and thus requirement to replace lost output either by increasing local capacity, transferring from adjacent zones or by reducing demand or any combination of these measures by considering options from our supply/demand options database (ref. Table 3.5).

1.8 Drought Management Process

The overall drought management process and decision sequence is described fully through the use of flowcharts. Figure 1.5 below shows the drought process from 'normal' monitoring conditions, via convening the DMG and use of available options and actions through to stand down. Reference is made to various roles and information that are detailed elsewhere in this plan. For example Sections 1.9, 1.10 and 1.12 describe the roles and responsibilities within AW for drought management. Figure 1.6 shows the process for assessing the severity of drought and determining which options should be used to ensure security of supply is maintained. The range of options, priority and benefits are described in detail within the Proposed Action Table contained in Section 3.

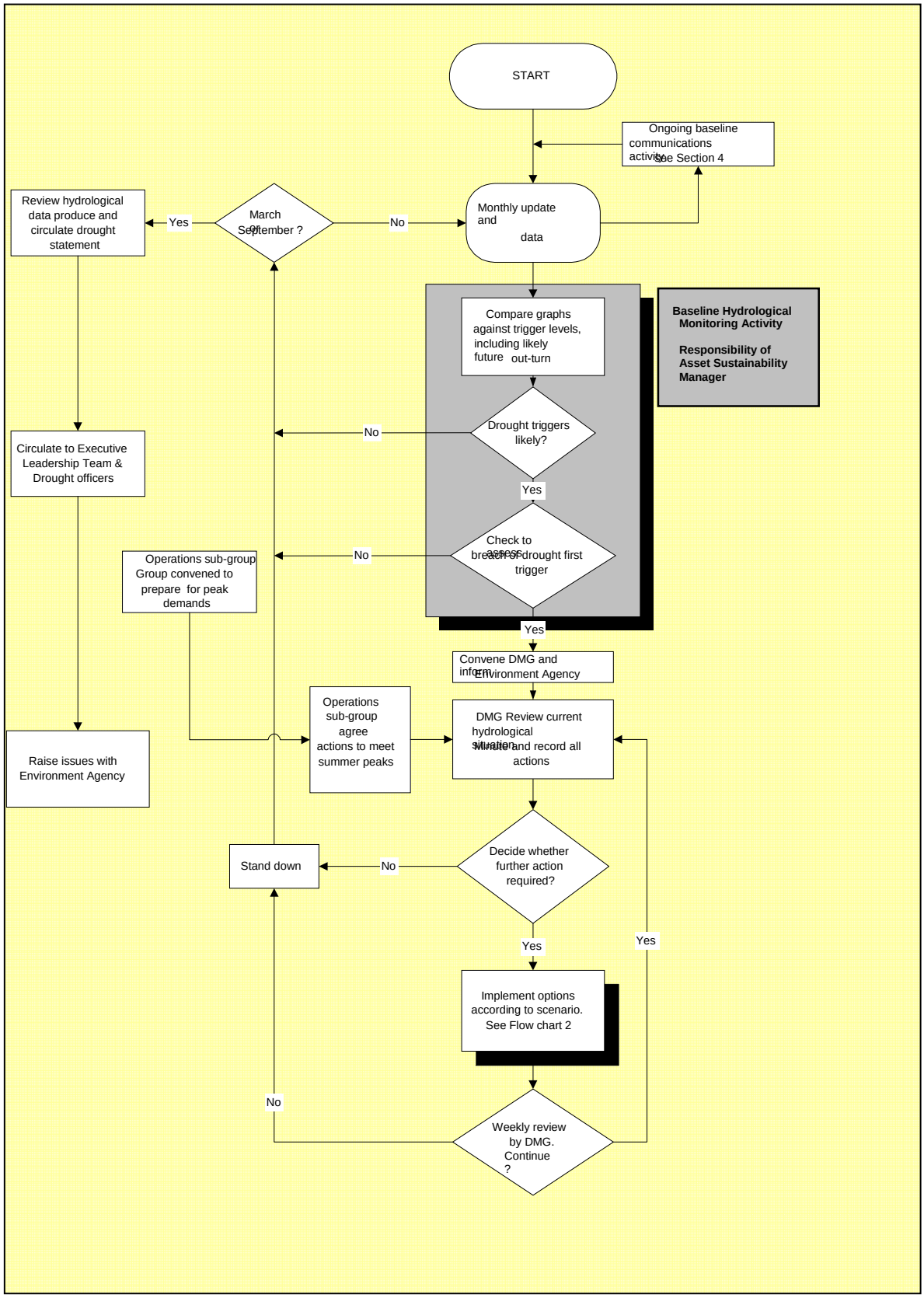


Figure 1.5: Affinity Water : Drought Management Process Flowchart

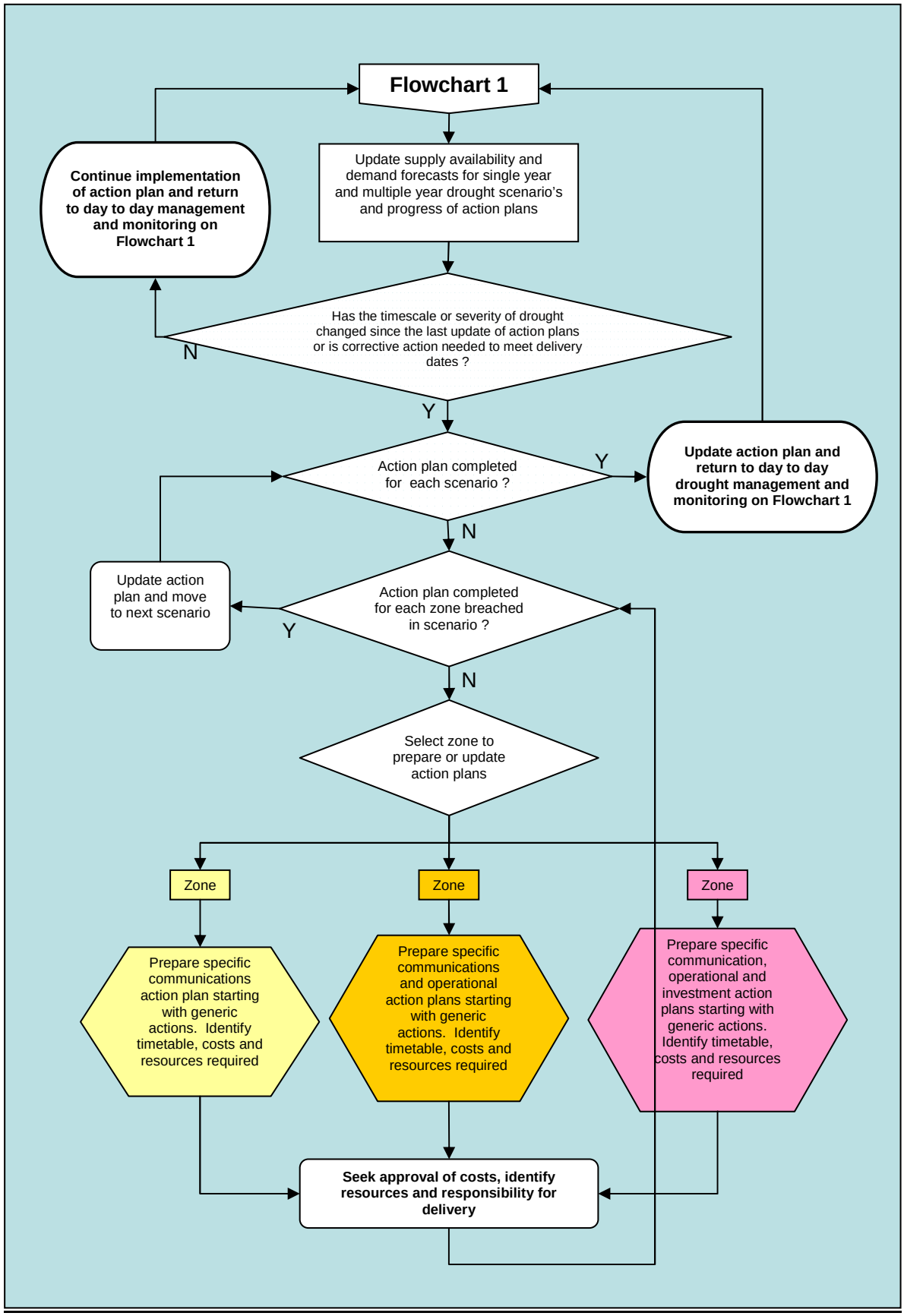


Figure 1.6: Drought Severity Assessment, Action Planning and Options Management

1.9 Responsibilities for Drought Management

The Drought Management Group (DMG) is Chaired by the Asset Management Director and consists of senior managers from relevant sectors of our organisation including:

1) **Asset Sustainability team** responsible for monitoring the state of available above & below ground water resources, drought severity and environmental impacts.
2) **Production & Supply management** with specific responsibility for ensuring that our water abstraction and production capability is at full capacity during months of low rainfall and high demand.
3) **Network Operations** to ensure that the network is operating at its most efficient when demand is highest.
4) **PR & Communications** responsible for implementing the Communications Plan; to design and produce the necessary communication materials and set in motion the agreed communications channels. The Communications Manager is a member of the DMG and directly controls the Creative Marketing / Public Relations / Communication activities to undertake the agreed actions from the DMG.
5) **Community Operations** responsible for responding to customers queries regarding the drought and restrictions

Our decisions on Drought Management are made by the DMG under delegated responsibilities from the main Board.

1.10 Responsibilities for Key Actions under DMP

Responsibilities for actions under the DMP are detailed in Table 1.4 below.

Routine hydrological monitoring, readiness of assets and general communications are continuous tasks whereas other roles are mobilised once the risk of drought conditions are identified. Responsibility for mobilising The DMP is held by the Asset Management Director. The DMP and the roles and responsibilities described are agreed and approved by the main board of Affinity Water. The Asset Management Director sits on the main board and acts as the main link and Chair of the Drought Management Group (DMG).

Table 1.4 Key Roles and Responsibilities in Managing Drought

Action	Delegation	Timescale
Drought Monitoring	Asset Specialist-Water Resources	Ongoing/Monthly. Enhanced during Drought
Review Drought Management Plan	Asset Sustainability Manager	Annually
Drought Triggers Breached	Asset Specialist-Water Resources	Upon breach of Zone 1
Convene Drought Management Group	Asset Management Director	Upon breach of Zone 2
Convene Drought Working Group	Asset Management Director	Under direction of DMG
Readiness of assets and Chair of the Oasis Group (section 2.8)	Head of Production and Supply	Ongoing
Drought Records/Filing	Asset Scientist	Under direction of DMG

Environmental Monitoring Plan (section 3 of DMP)	Asset Sustainability Manager	Under direction of DMG
Communications Plan (section 4 of DMP)	Communications Manager	Under direction of DMG
Communications **Customers, Group, Board** **EA Liaison** **OFWAT Liaison** **DEFRA Liaison** **DWI Liaison**	Communications Manager Managing Director, Director of Community Operations, Director of Community Relations Asset Specialist-Water Resources Asset Sustainability Manager Director of Finance Physical Assets Strategy Manager Head of Water Quality Services	Under direction of DMG
Capex Programme identified	Head of Physical Assets	Under direction of DMG
Opex monitoring	Director of Finance	Cost Centre set up
Capex Delivery	Asset Delivery Manager	Under direction of DMG
Water Quality	Head of Water Quality Services	Under direction of DMG
Drought Order/Permit or Restriction removal	Asset Specialist-Water Resources	Under direction of DMG
Promoting efficient use of water	Communications Manager	Under direction of DMG
Appeals for Restraint	Communications Manager	Under direction of DMG
Restrictions on Supply	Asset Management Director	Under direction of DMG
Emergency Planning	Asset Specialist-Security	Under direction of DMG
Stand down of DMG	Asset Management Director	Return to 'Normal' hydrological conditions

1.11 Environment Agency Liaison

We liaise with the Environment Agency on a regular basis on a variety of water resources, environmental impact and water quality issues. The Asset Sustainability Manager will be the primary point of contact with Environment Agency staff including their Drought Co-ordinators. The Asset Sustainability Manager will be supported by the Physical Assets Department which includes the Asset Sustainability Team.

1.12 DMG, Drought Working Group, Oasis Group and Communications Plan

The executive responsibility for managing a drought in accordance with this plan rests with the Drought Management Group as defined in section 1.9 above. During the 2005-2006 drought our experience showed the value of establishing two key supporting groups that carried out the numerous day-to-day tasks necessary to maintain security of supply and we have retained this operating structure for this plan. We have now updated this approach with four groups supporting our Drought Management Group: Restrictions, Exceptions and Responses sub-group, Monitoring and Mitigation sub-group, Communications sub-groups, and Operations and Network sub-group. Their purpose of each of the groups is outlined below:

Drought Management Group: To manage our operations and response to the threat of drought conditions in order to maintain security of supply whilst minimising environmental effects and marinating the confidence of our stakeholders.

Restrictions, Exceptions and Responses sub-group: To plan the detailed implementation of restrictions on use of water in accordance with the DMP and our legal powers and duties taking account of the affect on our customers.

Monitoring and Mitigation sub-group: To monitor the affect of continued abstraction on the local environment with a view to submission of drought permits or orders to increase abstraction.

Communications sub-groups: To implement a programme of communications with internal and external stakeholders to ensure they are aware of the drought situation as it develops and to ensure the effectiveness of restrictions to reduce demand should this become necessary.

Operations and Network sub-group: To verify the operational status and enhanced monitoring of our assets to ensure their continuing operability, to minimise the loss of capacity due to low water levels. To forecast potential drought scenarios and risk assessment of associated supply/demand conditions to predict the scale and timing of lost output capacity. To evaluate and plan for the implementation of potential further mitigation measures to maintain or substitute capacity or constrain demand including use of additional surface water and imports. The key focus in managing the operational aspects of drought is to ensure there is sufficient resource at all times to meet demand. Forecasts of the supply demand balance are reported to the Drought Management group to ensure all necessary actions are being taken to maintain security of supply. Details of the approach are included in Section 3.

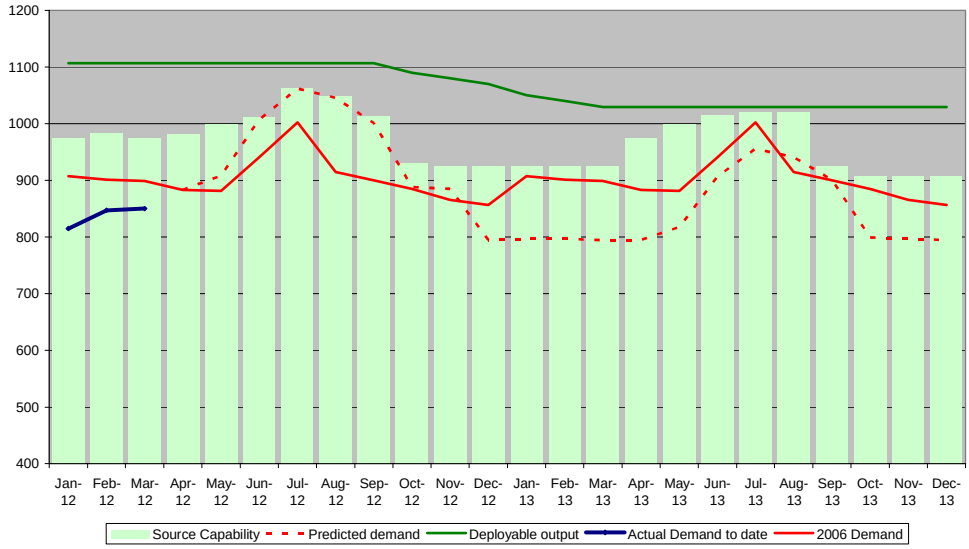


Figure 1.7 Water Availability and Demand Forecast Monitoring Tool

2 DROUGHT TRIGGERS AND SCENARIOS

2.1 Drought Triggers

Drought trigger lines have been developed to demonstrate how we propose to monitor the effect of low rainfall on groundwater levels and instigate drought management actions as

the severity of a drought increases and recedes. Trigger lines have been added to the long-term average (LTA) sequences for selected representative groundwater level observation points shown in Figure 2.1. These sequences summarise the historic observed groundwater levels under a range of rainfall conditions and correspond to the amount of water available for abstraction from the Chalk aquifer.

Name	Reference	Parameter
Chalfont Centre Observation Borehole	DT1	Groundwater level (West)
Lilley Bottom Observation Borehole	DT2	Groundwater level (Centre)
Elsenham Nursery Observation Borehole	DT3	Groundwater level (East)
River Thames flow at Kingston Lock	DM4	River Flow

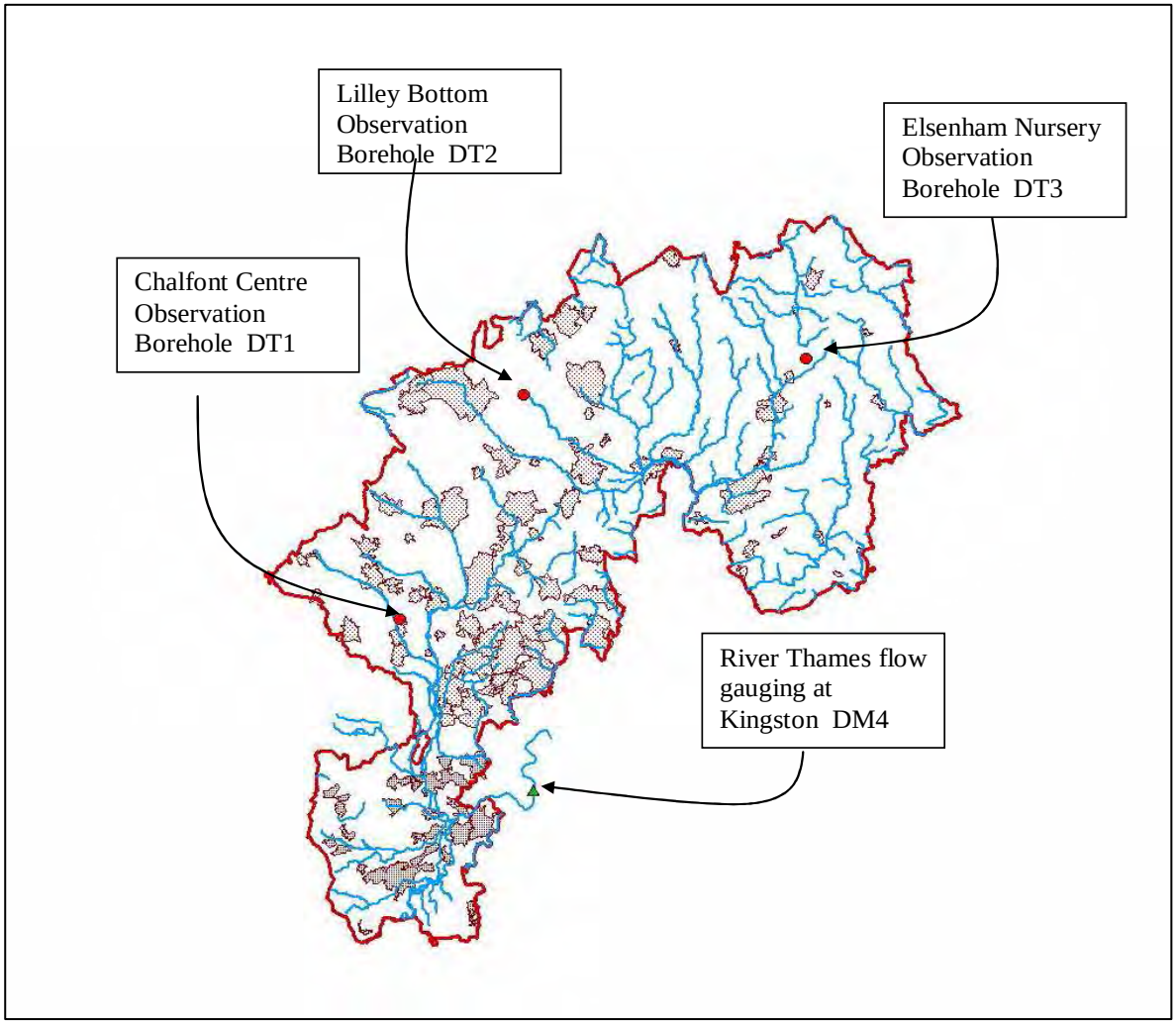


Figure 2.1 Location of Groundwater Observation Boreholes

The groundwater monitoring points have been selected to provide data to cover the three water resource zones within our operating area. The River Thames flow monitoring completes the company wide picture although drought triggers are not used in conjunction with this plot as detailed in section 1.3.2. The trigger plot for the Lilley Bottom observation borehole is shown in Figure 2.2.

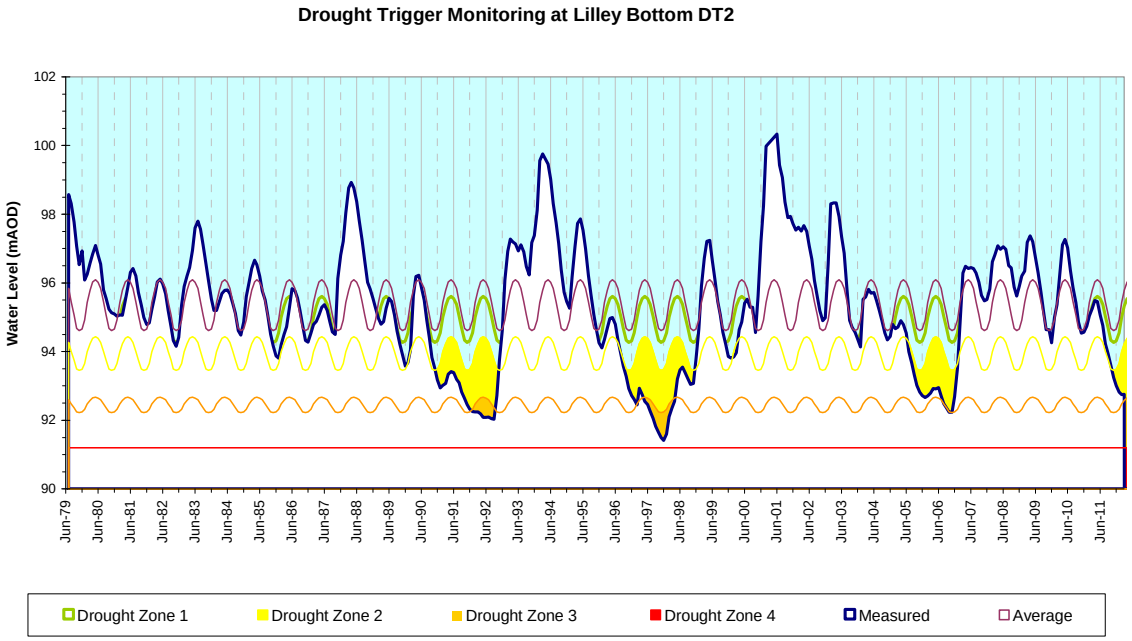


Figure 2.2: Long Term Drought Monitoring Chart with Trigger Levels

The drought triggers have been calculated using historic hydrological information during known drought periods, including data from the most recent severe groundwater drought, where record low levels were recorded for our region (1997[1]). Trigger lines demarcate drought action Zones. Graphical information dates back to 1987 in order to reflect on past trends during drought periods. Triggers will be reassessed regularly along with other details in the DMP in light of subsequent experience. Appendix 1 shows long-term control curves for the three different groundwater monitoring boreholes. These plots consist of historic measured water levels in relation to long-term average water levels, which have a seasonal variation depending upon whether the monitoring is from winter or summer months. On-to this have been placed trigger lines for Zones 1 to 4. The trigger for Zone 1 has been set at 90% of LTA groundwater levels (mAOD). The trigger for Zone 2 corresponds to groundwater levels seen in a 1 in 5 year drought event and the trigger for Zone 3 corresponding to a 1 in 10 year drought event. The trigger for Zone 4 has been set just below the lowest recorded levels (1997) as we managed that drought period without having to resort to drought orders or permits at that time. Section 3 of this plan includes details of our full range of environmental monitoring before and during a drought.

The short-term control curves shown in Figure 2.3 and contained in Appendix 2 show the trigger lines developed from the historical perspective of the long-term curves but rescaled for a shorter year for use when focussing on recent groundwater conditions and monitoring month by month changes in groundwater levels. The curves contained within Appendix 2 are those that would be utilised by the Drought Management Group to monitor water levels.

[1] Historic low groundwater levels were not seen in the most recent drought of 2006.

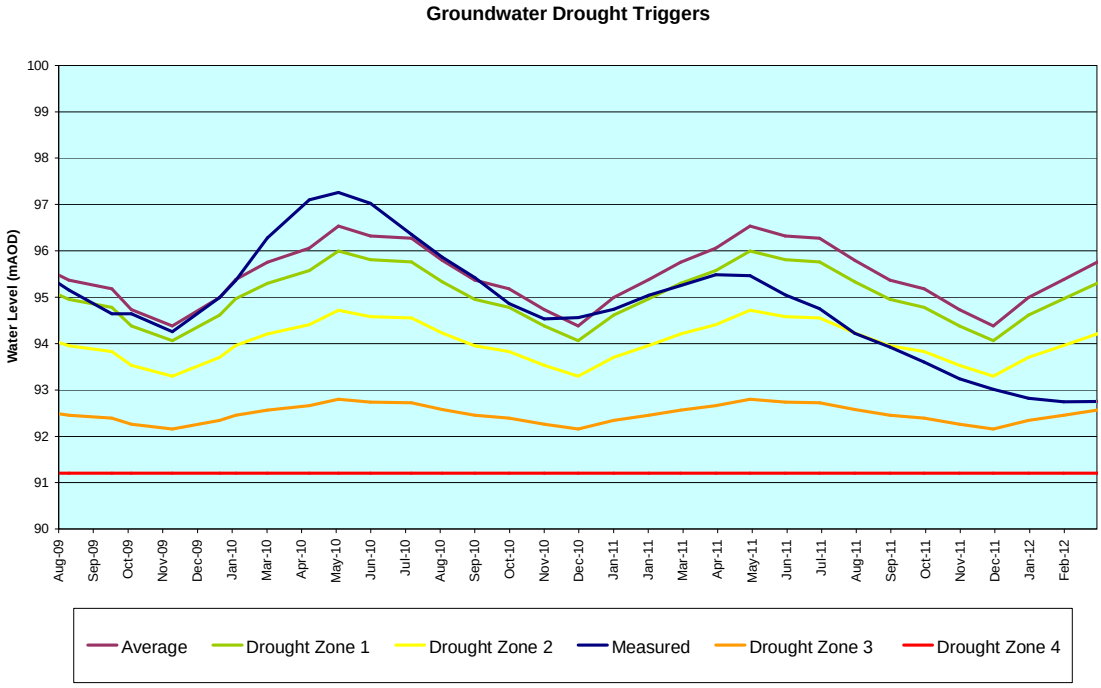


Figure 2.3 Short Term Drought Monitoring Chart with Trigger Levels

Empirical evidence from the widespread drought conditions between 2005 and 2007 enabled the drought trigger levels to be validated. Section 3 demonstrates the robustness of our DMP to historic drought events.

2.2 Drought Action Zone Framework

The trigger and Zoning framework for our DMP is consistent with that used in the WRMP 2009 and our previous drought plan. The response curves have been aligned to reflect our experience when publicity campaigns and hosepipe bans were used in the past (1991 and 2006). Although the past may not be an accurate predictor of the future, this methodology correlates with estimated return periods of 1 in 5 and 1 in 10 for drought Zones 2 and 3 respectively, in line with the basis of our WRMP. A summary of expected Zone actions include:-

Zone 1 – Drought Awareness

Occurs when groundwater levels are below the Long Term Average (LTA) triggering increased interpretation of existing monitoring. This first trigger is intended to create a state of readiness within the Company to ensure that proper consideration is given to the risk of drought occurring due to forthcoming hydro-geological conditions and the likely severity of that risk. Initial informal liaison with the EA may be set up during this period if rainfall is reduced as part of the preparation for a possible drought.

Zone 2 – Voluntary Demand Reductions

Has been set with public perception in mind and would trigger an increase in activity both in terms of supply management and public awareness of the situation (demand management). Liaison with the EA and neighbouring water companies will be put on a formal footing with the Company's Drought Management Group being convened. Beginning the planning process would include consideration of whether any additional expenditure would be required to meet the potential drought challenge. Any additional OPEX or CAPEX expenditure would need approval at this stage. The supply/ demand balance would be reviewed based on the reduced yield of 1997/98. Enhanced

environmental monitoring would be implemented in order to update assessments of effects in preparation for potential drought permits or orders.

Zone 3 – Compulsory Restrictions on Use

Defined as a 1 in 10 year event consistent with our WRMP. Entering this zone would trigger positive actions to restrain demand. The Company may choose, dependant upon timing, to implement temporary usage restrictions. Communication activity would also be raised accordingly.

Zone 4 – Unprecedented Drought Conditions

Water levels in this Zone would be at an extremely serious position. Drought permits to suspend low flow agreements would be introduced. The Company would then implement drought orders as set out in the Drought Direction 2011. All other available options and actions would then need consideration at this point as the drought becomes groundbreaking. The company would not envisage introducing rota-cuts, standpipes or tankering as they are no longer considered a viable option in response to drought, but might be appropriate in a civil emergency.

Detailed drought actions assigned to Zones are outlined in Section 3.

2.3 Drought Forecasting

Droughts are caused by insufficient rainfall leading to very dry conditions, progressing to low river flows and groundwater levels. These can occur at any time of the year, but for groundwater dominated systems are most critical during the autumn/winter months. This makes the onset and likelihood of a drought relatively straightforward to predict through regular hydrological analysis work. We continually monitor and record groundwater levels, surface water levels and rainfall within its supply area, so that the risk of drought and its influence on water resources can be assessed and forecast so that appropriate drought measures can be implemented in good time to maintain supplies to our customers.

2.3.1 Drought Records

We have developed an extensive archive of local drought activity and important information from previous droughts to aid future drought management. Hydrological information dating from 1991 is stored electronically, which include forecasts and monthly tools relating rainfall scenarios to recharge scenarios. This data is used widely for baseline hydrological monitoring and management reports. Records include relevant drought documents including the 2006 drought, the UKWIR Impact of Restrictions on Customer Demand report, drought management planning guidelines, drought monitoring data, and other related topics available for reference.

2.3.2 Drought Triggers

Short term drought trigger graphs (Appendix 2) are also used together with rainfall, recharge and SMD data to provide the business with the latest up-to-date drought position, this monitoring data is circulated to all those involved with the drought decision making process as detailed in sections 1.8, 1.9 and 1.11.

In order to supplement the Drought Triggers and support the monitoring process for drought, a detailed study of winter rainfall, recharge and soil moisture deficit (SMD) between September and April is carried out and reported. These are explained further in the sub-sections below (2.3.2.1 and 2.3.2.2). Winter rainfall is important for groundwater recharge; under normal conditions 100% of LTA winter rainfall would provide adequate effective rainfall (rainfall available for recharge) to return groundwater levels back to normal conditions. (Rainfall and SMD are measured on a weekly, year round basis.)

Table 2.1 illustrates a range of forecast scenarios of probable rainfall out-turn at the end of the winter recharge period associated with actual winter rainfall patterns in relation to an assumed negative SMD starting position. This table enables forecasts of drought severity to be made on the basis of the most reliable data available at any point in the recharge cycle.

Table 2.1: Predictive Tool for Forecasting likely 'Drought Scenario' for Drought Reporting

	DROUGHT SCENARIO			
	40% Rainfall	60% Rainfall	80% Rainfall	100% Rainfall
September	>120% LTA SMD	>120% LTA SMD	>120% LTA SMD	>120% LTA SMD
October	>120% LTA SMD	>120% LTA SMD	>120% LTA SMD	zero SMD
November	>120% LTA SMD	>120% LTA SMD	zero SMD	20% LTA Cum Rainfall
December	>120% LTA SMD	zero SMD	20% LTA Cum Rainfall	40% LTA Cum Rainfall
January	zero SMD	20% LTA Cum Rainfall	40% LTA Cum Rainfall	60% LTA Cum Rainfall
February	20% LTA Cum Rainfall	40% LTA Cum Rainfall	60% LTA Cum Rainfall	80% LTA Cum Rainfall
March	40% LTA Cum Rainfall	60% LTA Cum Rainfall	80% LTA Cum Rainfall	100% LTA Cum Rainfall
April	40% LTA Cum Eff. Rainfall	60% LTA Cum Eff. Rainfall	80% LTA Cum Eff. Rainfall	100% Cum Eff. Rainfall

Note: Values are approximate and relate to average out-turn for the month. Cumulative values are calculated from 1st September recharge period. (SMD = Soil Moisture Deficit)

2.3.2.1 Soil Moisture Deficit

Forecasting the out-turn 'drought scenario' is necessary for drought reporting and assessing the risks of drought in the following year. Table 2.1 has been designed to aid the assessment of the probable hydrological out-turn at the end of winter recharge with reference to SMD, rainfall and recharge. Expected out-turn for recharge is estimated from cumulative effective rainfall. Data used is from MORECS[2] squares 151 and 152. The table demonstrates the relationship between rainfall, soil moisture deficit and recharge as time elapses over an autumn/winter period and allows a correlation to be drawn between surface water drought conditions that are often described in terms of expected out-turn of winter rainfall and groundwater drought scenarios that relate to % recharge. This information is useful when comparing drought status information between different regions and water companies. The data reflects average conditions as the relationship between rainfall and recharge is approximately proportional (Figure 2.4) and also depends on the specific rainfall pattern of any winter cycle.

Overall the table shows that, the lower the autumn rainfall, less recharge is seen, i.e. rainfall of 60% of the long-term average (LTA) will not remove the soil moisture deficit until December. This significantly reduces the time available for rainfall to become effective recharge, as only three months would be available for recharge to occur. The likelihood of reduced recharge would remain high and as a prediction, only 60% would be expected as the out-turn value. This demonstrates that a detailed assessment of the recharge situation

[2] MORECS - Metrological Office Rainfall and Evapotranspiration Calculations System - weekly spatially averaged data from a number of observation sites for rainfall, temperature, soil moisture deficit and effective rainfall.

in January is required to provide a more reliable estimate of the out-turn value for the entire recharge period.

Table 2.1 therefore also represents a step by step predictive tool which is helpful in assessing the likely outcome of any autumn/winter cycle in terms of the best available indicator at any point in time during the winter cycle. For example if the soil moisture deficit remains greater than 120% of the long term average at the end of November then we can expect to see drought conditions no better than a '60% rainfall scenario' the following year. This is information that has been utilised in creating the control curves (see Appendices 1 & 2), where the LTA provides a basis for Zone 1 trigger and rainfall scenarios have been linked with WRP and levels of service to create the basis for Zones 2-4.

2.3.2.2 Rainfall Vs Recharge

Analysis of the historic relationship between rainfall and recharge has identified the relationship shown in the figure below. This means that significant deficits or surpluses of rainfall compared with the long term average are magnified in terms of the consequential recharge effect. Thus a winter rainfall pattern of 80% LTA correlates approximately to 60% recharge and conversely 150% rainfall indicates 200% of recharge.

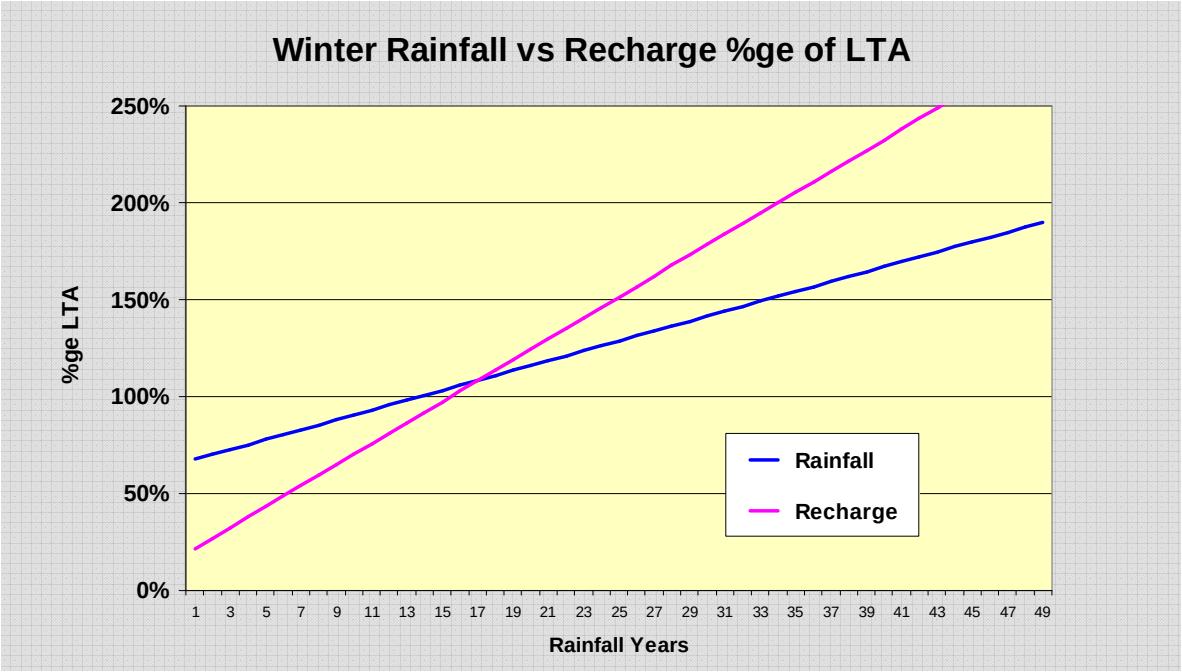


Figure 2.4: Comparison of LTA Rainfall and Recharge

2.3.2.3 Cumulative Rainfall Effect

Monitoring cumulative rainfall and effective rainfall are basic tools in assessing the probability of outcomes for a winter season, and therefore to forecast the potential loss of available resource compared to the previous year. Table 2.2 attempts to illustrate the effect of rainfall year on year. We know from experience that groundwater levels are robust to first year drought, except in extreme circumstances. Low rainfall over two consecutive winters exacerbates the situation significantly as levels reduce to extreme low levels during the second year. For example: rainfall of 80% in year 1, followed by 60% in year 2 would equate to a 2 year average of 70%, effectively placing the company in a 70% scenario in year 2 at March out-turn. This approach enables flexibility to monitor and

predict year on year rainfall impacts across our area. This tool forms the basis for the companies scenario testing explored in section 2.4.

Table 2.2 Year on Year Effect of Rainfall

% Rainfall		Year 1			
		100%	80%	60%	40%
Year 2	100%	100%	90%	80%	60%
	80%	90%	80%	70%	60%
	60%	80%	70%	60%	50%
	40%	70%	60%	50%	40%

Scenario	Likely outcomes
	Normal Conditions no additional drought activity
Zone 2	Mild-Medium Drought – 80% scenario actions
Zone 3	Medium-Severe Drought – 60% scenario actions
Zone 4	Severe-Extreme Drought – New historic low levels

This information is used to determine the range of potential drought measures that may be required to balance supply and demand during the following year. Typical graphical representations are included in Figures 2.5 and 2.6.

Comparing the cumulative rainfall and recharge trends with the long term average in order to assess the likelihood of the outcome of the winter season is enhanced by adding the envelope of the range of possible hydrological sequences for the remainder of the winter period. This representation is used as part of our internal monthly drought monitoring report. An example of forecasting is illustrated in Figures 2.5 and 2.6 using 2010/11 data to predict potential rainfall under average, best and worse case scenarios.

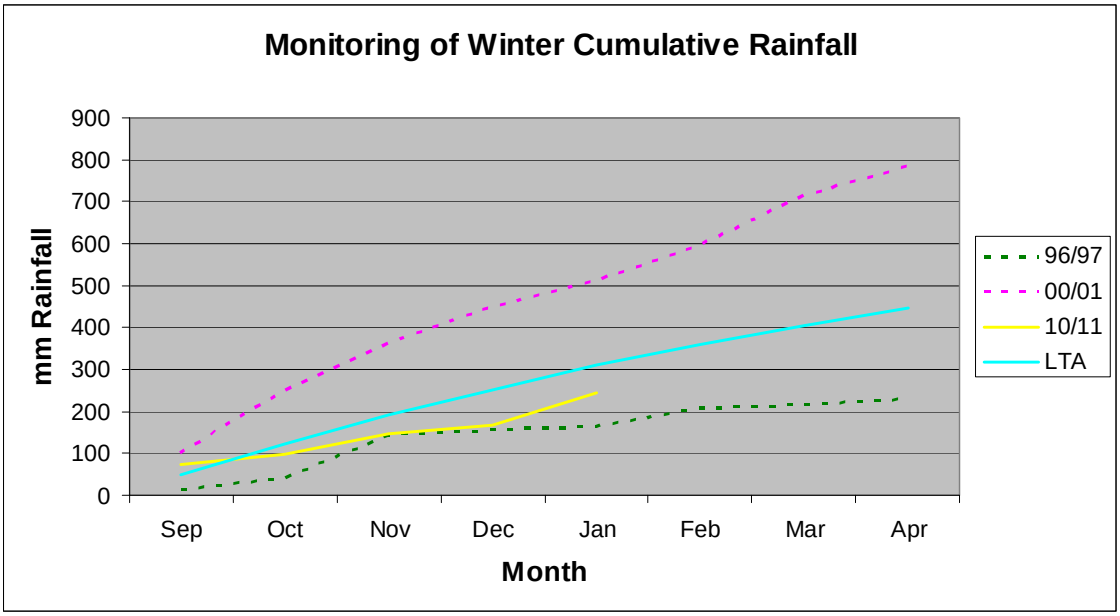


Figure 2.5: Winter Cumulative Rainfall

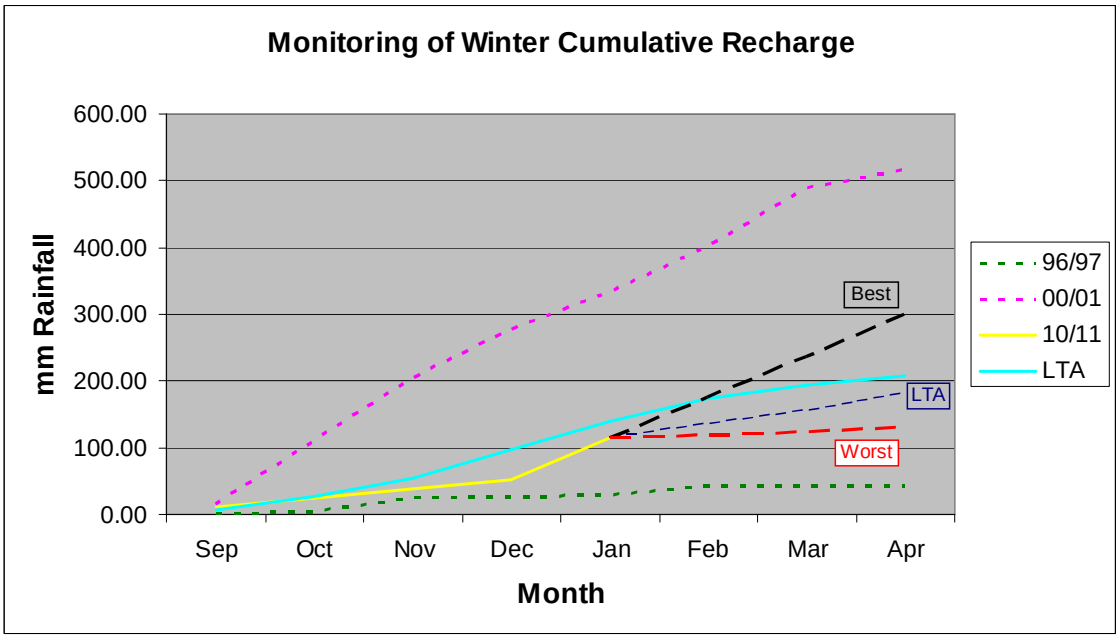


Figure 2.6: Winter Cumulative Recharge

2.3.2.4 Demand Measurement

Drought restricts the total amount of water available to us which can be exacerbated by an increased demand. We monitor daily demand on a local and company wide level. This data is also considered within the drought report updates in order to forecast the supply/demand balance at specific points in time. The impact of demand management measures can help mitigate the impacts of a drought and accordingly we regularly monitor the effect of water efficiency measures, leakage reduction and metering. The benefits are assessed on an annual basis or alternatively under the direction of the DMT during a drought.

2.4 Scenario Testing

All droughts will vary in terms of their duration and impact on the availability of water resources. The return to normal conditions is unpredictable and dependant on increasing levels of rainfall, making the duration and severity of droughts harder to forecast. It is therefore essential that Drought Plans are tested against a range of drought scenarios that could occur within the company supply area based on historic events, to ensure that the adopted measures are sufficiently robust to protect essential water supplies and minimise the environmental impact of these abstractions.

Our Drought Plan is based on historic level and rainfall data over the last 35 years from the period 1976 to 2011, during which we have gained significant experience of managing drought events encountered in the late 1980's and early 1990's together with the severest groundwater drought of 1997 which was defined as a 1 in 200 year return event, (ref. Institute of Hydrology Monthly Hydrological Bulletin). We consider that this period of historic data provides a robust basis for the development and testing of this Drought Plan.

We have tested a range of scenarios appropriate to our water resource system reflecting the variability of droughts. The three different drought durations assessed are:

- Single season droughts
- Multiple season droughts
- Long Term droughts

2.4.1 Water Resources Situation

As earlier outlined in section 1.3, 60% of our resources are derived from groundwater sources with 40% derived from river sources notably the River Thames. Our licences for abstraction from the Thames are not limited by flow conditions and therefore our Drought Management Plan focuses on behaviour of our groundwater sources. Groundwater supplies are totally dependant on local climatic conditions providing sufficient rainfall during the autumn/winter months to naturally recharge aquifers. Groundwater droughts therefore arise as a consequence of low winter rainfall.

Groundwater level is the indicator of water availability in the aquifer and we use historic water level patterns to determine current water level relative to long term averages. Unfortunately groundwater levels taken from monitoring in both production and observation boreholes are only available for 30 years, and therefore not representative in long term analysis. We have used long term rainfall sequences to establish the return period of long term droughts and to guide water availability and therefore potential water restrictions required.

Groundwater levels will normally reach lowest points around November. With low winter rainfall the lowest point may be delayed until January or even later. If this is the case then the recharge period will be shorter and groundwater rise limited. The distribution of rainfall over the recharge period also controls the effectiveness of this rainfall becoming recharge. High winter soil moisture deficits will also contribute to decreasing the amount of rainfall becoming effective recharge. Groundwater levels will normally reach their highest point around March. With low winter rainfall they may peak before this, again decreasing the length of the recharge period and therefore the amount of water level rise. Shortened recharge seasons will lower the starting point of the next years natural recession, again contributing to lower than normal levels. In most circumstances summer rainfall does not impact on groundwater levels but may support some river flows.

2.4.2 Hydrograph Analysis

Hydrograph analysis linked to rainfall return periods has enabled us to build a hypothetical water level sequence based on a variety of rainfall scenarios. This has been superimposed on the drought curves and indicates when and for how long we will be in any of the drought zones. From this we have been able to estimate when restrictions will be required and to what level and for how long. These have been used to sequence the timing of our restrictions. A record of the data analysis work undertaken to build the hydrographs is held in appendix 3.1. We have selected one of our representative groundwater level observation points (Lilley Bottom) for the purpose of this analysis.

We are assuming for the purpose of this part of the drought plan that there is no summer recharge, so March will be our end point. An average rate of decline in groundwater levels per month has been calculated (appendix 3.2) and will be applied for each scenario when there is no rise in groundwater levels. This pattern has been constructed to reflect the fact that rates of groundwater decline are dominated by natural discharge from the aquifer, and will far outweigh any differences on a yearly basis made from demand management savings.

The hydrograph analysis work applies only to recharge in chalk aquifers. For our shallow gravel aquifers summer rainfall can be effective precipitation and thus water availability will be lower with a dry summer following a dry winter. However, these sources are small in comparison with total water availability and constrained by their drought DO and are therefore not considered for this report.

The key parameters that we are trying to combine through the analysis of each drought scenario (single, multiple and long term) are:

1. Starting water levels each winter
2. Cumulative rainfall frequencies below the norm
3. The rainfall reduction over the recharge season.
4. Spread and timing of drought management actions

2.4.3 Single Year Droughts

Our hydrograph analysis forecasts two potential single year drought scenarios.

- A moderate drought – 80% below LTA rainfall
- A severe drought – 60% below LTA rainfall

The severe drought scenario has been constructed using water level changes that occurred in 1992. The moderate drought has been constructed using water level changes that occurred in 1991. For both scenarios we have assumed a starting point from the Long Term Average in year one. Our drought monitoring process will use actual start conditions for all projections, and these will be updated on a regular basis.

Using the Oxford rainfall data set, which stores records of actual levels of rainfall between 1853 and present day we have calculated the following probabilities of a moderate and severe drought situation occurring over a single year.

Table 2.3: Probability of Single Year Droughts

% of Rainfall Vs Long Term Average	Probability of Occurrence
80 and below	20%
60 and below	3%

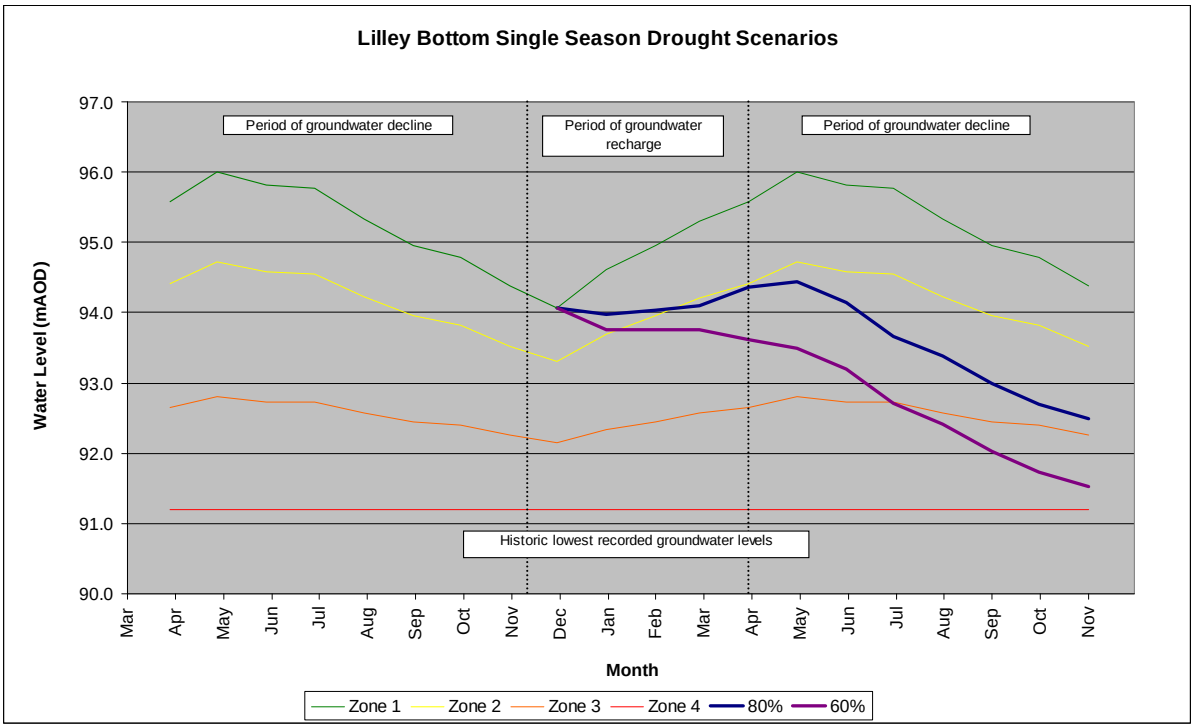


Figure 2.7: Single Year Drought Scenario

2.4.3.1 Application and Implementation of Drought Actions

In both potential scenarios the cumulative recharge and resulting groundwater levels up to the end of December will be critical in dictating actions for the next 3 months. As outlined in section 2.4.2 summer recession rates are broadly consistent, therefore from a known starting point the summer out-turn position can be calculated with associated likely drought actions determined as drought zones become breached.

In the event of a single year moderate drought scenario during the month of January a series of internal and external actions would be triggered in preparation for the expected drop into Zone 2. Initially increased liaison with the EA would begin, to discuss our water resources situation and predictions for the calendar year. A media campaign keeping customers aware of the seriousness of the water shortage situation would begin to be built and prepared to be launched to co-ordinate with entry into drought Zone 2 during the month of March. Following entry into Zone 2 we would provide alerts and regular briefings for opinion formers and regulators, and increase our liaison with other water companies, environmental groups and local authorities. Internally our Drought Management Group would convene, and regular updates and briefings given to the Board, Executive Management Committee and staff. Although we would not envisage entering into our drought Zone 3 during the remainder of the year, should a prolonged high demand period occur, calls for voluntary restraint and the implementation of possibly some restrictions may be required to decrease peak demands as instantaneous demand may exceed our ability to supply for short periods in some locations. Figure 1.3 illustrates the beneficial

impact implementing restrictions had on reducing peak demands during 2006 when compared to 2005.

In the event of a single year severe drought scenario during the month of January a series of internal and external actions would be triggered in preparation for the expected drop into Zone 3 later in the year. Initially increased liaison with the EA would begin, outlining our water resources situation and the potential severity of the challenges ahead based on our forecasts. Internally our drought management group would convene early, with regular updates and briefings given to VWUK, the Board, Executive Management Committee and staff highlighting the seriousness of the situation. An intensified media campaign keeping customers aware of the seriousness of the water shortage situation would be built during January to coincide with our entry into drought Zone 2 during the same month. Following entry into Zone 2 we would provide alerts and regular briefings for opinion formers and regulators, and increase our liaison with other water companies, environmental groups and local authorities. Between the months of February and May the company would be calling for voluntary restraints from domestic and commercial customers and would be abstracting lower volumes of water than otherwise would have done. The company would ensure that throughout the summer clear updates are provided to internal and external stakeholders outlining whether or not the situation requires escalating. We would begin our notification programme for the implementation of full use of temporary bans on water use during the month of June in preparation for our entry into drought Zone 3 during July. The implementation of these restrictions would signal a high level media campaign for press and media broadcast, designed to communicate to customers the severity of the situation and the impact demand restrictions will have on them. A summary of the actions we would undertake is outlined in section 5.7.

2.4.4 Multiple Year Droughts

The hydrograph analysis has forecast two potential multiple season drought scenarios and is shown in Figure 2.8.

- A moderate drought – 80% below LTA rainfall (Year 1) followed by 80% below LTA rainfall (Year 2). The starting point for the forecasting of the second year will be the end point of the first year scenario.
- A severe drought – 60% below LTA rainfall (Year 1) followed by 60% below LTA rainfall (Year 2). The starting point for the forecasting of the second year will be the end point of the first year scenario.

The severe drought scenario has been constructed using water level changes that occurred in 1992. The moderate drought has been constructed using water level changes that occurred in 1991. For both scenarios we have assumed a starting point from the Long Term Average in year one. Our drought monitoring process will use actual start conditions for all projections, and these will be updated on a regular basis.

Using the Oxford rainfall data set, which stores records of actual levels of rainfall between 1853-present day we have calculated the following probabilities of a moderate and severe drought situation occurring over multiple years.

Table 2.4: Probability of Multiple Year Droughts

% of Rainfall Vs Long Term Average	Probability of Occurrence
80 and below	3%
60 and below	Not occurred since 1853

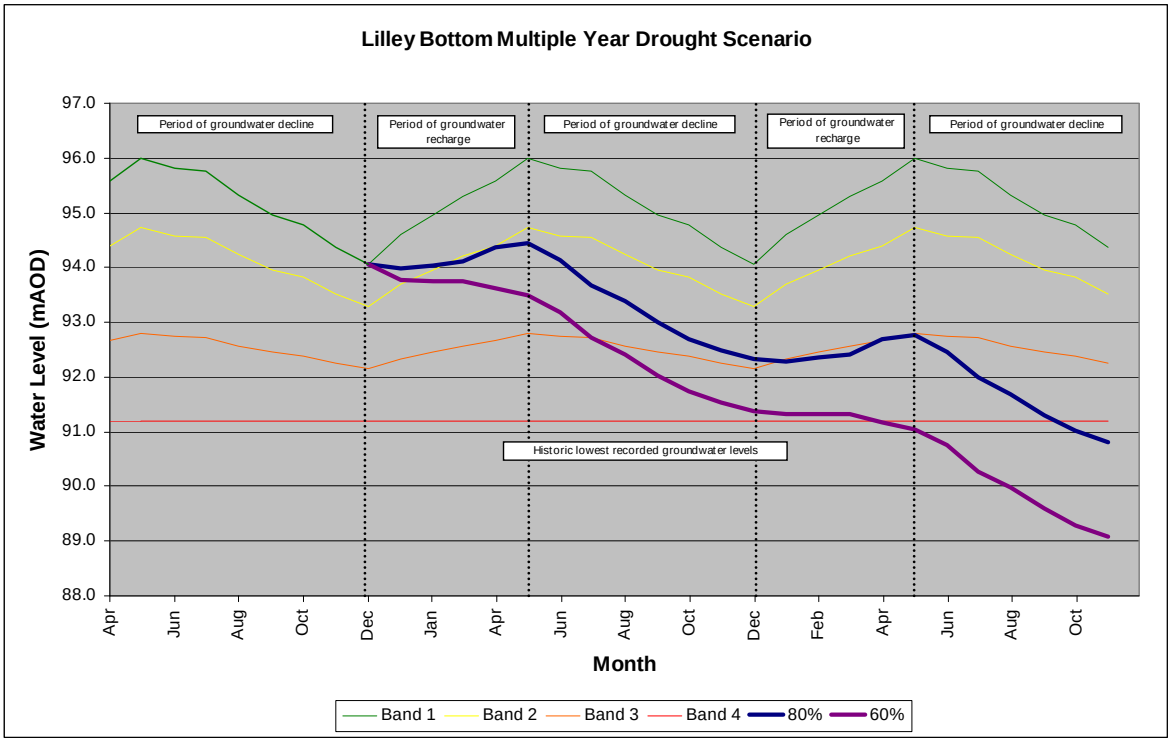


Figure 2.8: Multiple Year Drought Scenario

In the case of the 2010/12 drought, the starting conditions in December of the first year were above average, and the 2010/11 period followed the 80% scenario. This was then followed in the 2011/12 period by a 60% scenario, and the resulting actual water levels for the second year are between the 80% and 60% scenarios shown here. It is impractical to show all the different combinations of rainfall sequences without making the graph confusing.

2.4.4.1 Application and Implementation

In both potential scenarios the cumulative recharge and resulting groundwater levels up to the end of December will be critical in dictating actions for the next 3 months. As outlined in section 2.4.2 summer recession rates are broadly consistent, therefore from a known starting point the summer out-turn position can be calculated with associated likely drought actions determined as drought zones become breached.

In the event of a multiple year moderate drought scenario, during the month of December we would begin our notification programme for the implementation of full use of temporary bans on water use. These would be introduced in line with our entry into drought Zone 3 predicted from January. The implementation of these restrictions would signal a high level media campaign for press and media broadcast, designed to communicate to customers the severity of the situation and the impact demand restrictions will have on them. A summary of the actions we would undertake is outlined in section 5.7. We would be

working with local businesses to promote water efficiency. Following on from a moderate first year drought we would first inform the EA regarding the escalation of the situation and then provide alert and briefings for opinion formers and regulators (DEFRA, Ofwat, Water UK, CCW), and environmental groups regarding the severity of the situation. We would forecast our groundwater levels to decline throughout the summer, eventually crossing into drought Zone 4 during the month of October. In preparation for this, during June we would have contacted the EA and applied for drought permits outlining our intentions to use them as soon as we cross into this threshold.

In the event of a multiple year severe drought scenario, during December we would negotiate with the EA regarding our water resources situation and apply for drought permits to be implemented in line with our entry into drought Zone 4, predicted to happen in March. Immediately after crossing into Zone 4 in preparation for the summer recession in groundwater supplies we would begin our application to the Secretary of State to implement drought orders under the Drought Direction 2011. All internal and external stakeholders would be notified of the severity of the situation. The existing media campaign in place would be further promoted to heighten awareness of the situation.

2.4.5 Long Term Drought Scenarios

The absence of long term records of operational borehole performance prevents comparison with droughts before 1976. Whilst there are long term observation borehole groundwater level sequences, it is not possible to correlate these with fluctuations in levels in operational boreholes without pumping data from historic drought events.

The hydrograph analysis has forecast two potential long term drought scenarios:

- A severe drought – 80% below LTA rainfall (Year 1) followed by an 80% below LTA rainfall (Year 2), followed by an 80% below LTA rainfall (Year 3). The starting point for the forecasting of the third year will be the end point of the second year scenario.
- A very severe drought – 60% below LTA rainfall (Year 1) followed by a 60% below LTA rainfall (Year 2), followed by a 60% below LTA rainfall (Year 3). The starting point for the forecasting of the third year will be the end point of the second year scenario.

The very severe drought scenario has been constructed using water level changes that occurred in 1992. The severe drought has been constructed using water level changes that occurred in 1991. For both scenarios we have assumed a starting point from the Long Term Average in year one. Our drought monitoring process will use actual start conditions for all projections, and these will be updated on a regular basis.

Using the Oxford rainfall data set, which stores records of actual levels of rainfall between 1853-present day we have calculated the following probabilities of a moderate and severe drought situation occurring over the long term.

Table 2.5: Probability of Long Term Droughts

% of Rainfall Vs Long Term Average	Probability of Occurrence
80 and below	Not occurred since 1853
60 and below	Not occurred since 1853

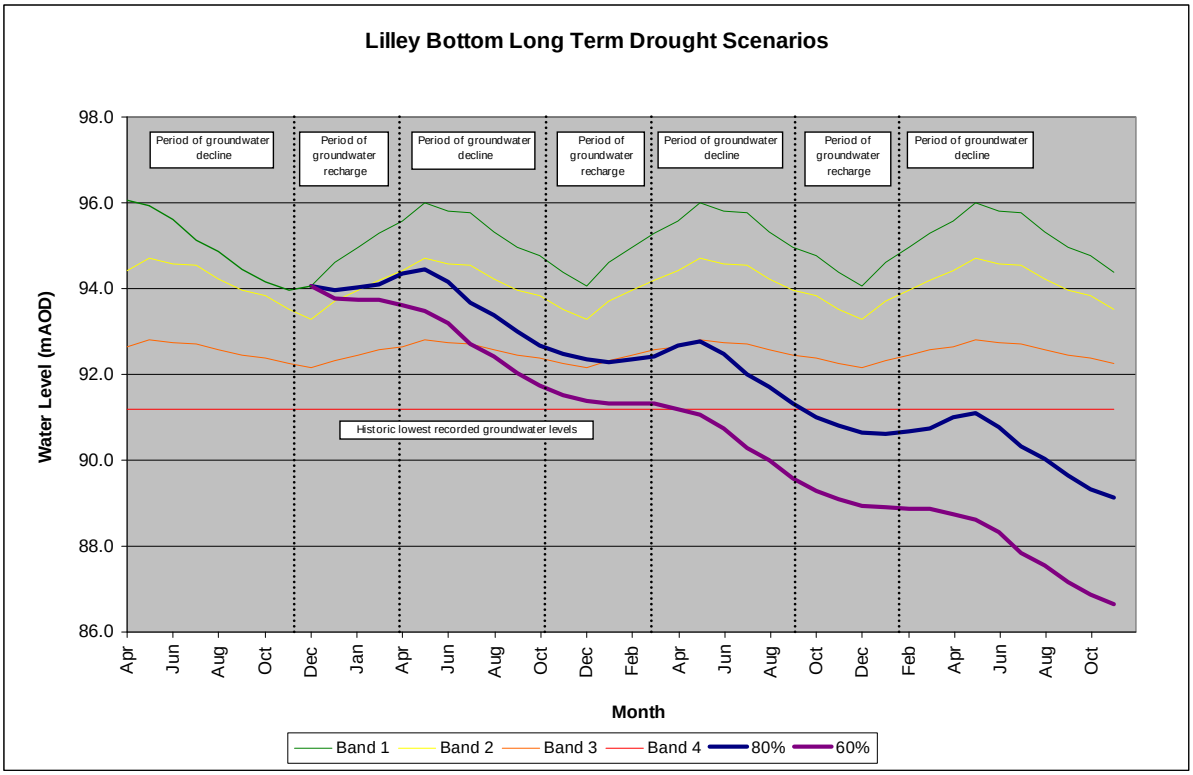


Figure 2.9: Long Term Drought Scenario

2.4.5.1 Application and Implementation

In the event of a long term severe drought scenario between the months of December and March we would be working with the EA and closely monitoring the water resources situation. After crossing into Zone 4 during April, in preparation for the summer recession in groundwater supplies we would begin our application to the Secretary of State to implement drought orders under the Drought Direction 2011. If granted these drought orders would be in place for June. A public inquiry or hearing might be required, if objections to the Drought Order application are submitted. This might delay the issue of the Drought Order up to 2 months. In case of Drought Order rejection other alternatives will be looked at. All internal and external stakeholders would be notified of the severity of the situation. The existing media campaign in place would be further promoted to heighten awareness of the situation.

In the event of a long term very severe drought scenario all domestic and commercial demand management measures would already be in place, so the company would begin its application procedure in December for all remaining Drought Orders from the Secretary of State to be implemented in preparation for the summer recession starting in March. By the end of the summer recession the company would consider calling for emergency drought orders.

2.5 Return Periods of Droughts

Using the same methodology that has been applied to calculate levels of groundwater recharge based on 80% and 60% rainfall scenarios we have been able to build a picture of rates of groundwater recovery based on 120% and 130% rainfall scenarios (figure 2.10). A record of the data analysis work undertaken to build the hydrographs is held in appendix 3.1.

The hydrograph illustrates that following on from a moderate long term drought scenario:

- A single year 130% rainfall event would restore groundwater levels into Zone 2. A second year of the same rainfall scenario would replenish groundwater levels above long term average.
- A single year 120% rainfall event would restore groundwater levels into Zone 3. A second year of the same rainfall scenario would revoke any demand restrictions on customers and move groundwater levels back into Zone 2.

The hydrograph illustrates that following on from a severe long term drought scenario:

- A single year 130% rainfall event would restore groundwater levels into Zone 3. A second year of the same rainfall scenario would replenish groundwater levels above long term average.
- A single year 120% rainfall event would be unable to restore groundwater levels out of Zone 4. If this was followed by a second year of 130% rainfall, it would be sufficient to revoke any demand restrictions on customers and move groundwater levels back into Zone 2.

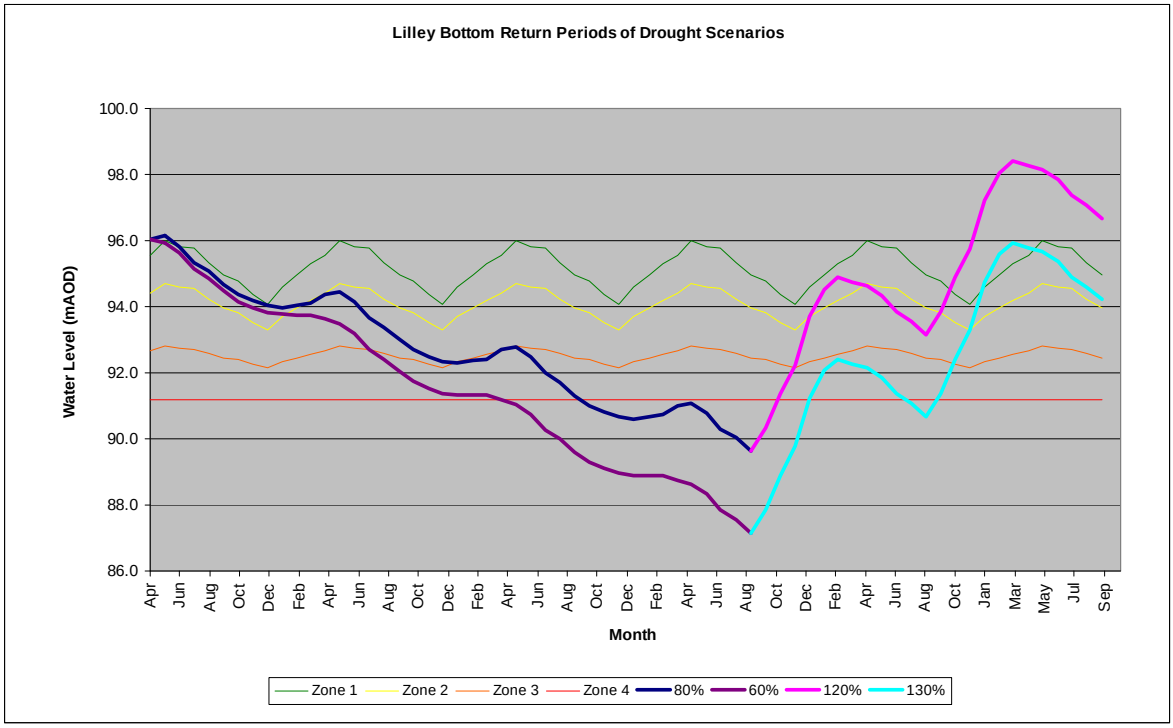


Figure 2.10: Return Periods of Drought Recovery

2.6 Strategic Environmental Assessment Directive

We have considered the requirements of the Strategic Environmental Assessment Directive (SEA) (Appendix 3.3). The DMP is not a development plan and accordingly we are of the view that an SEA is not required.

3 DROUGHT MANAGEMENT ACTION

In the previous Drought in 2005/06, we invested £35m in improvements of our network and source optimisation schemes in order to increase our resilience under drought conditions. This was successful and resulted in an improvement in reliability of our assets during drought. Many changes, such as lowering pumps in boreholes to their lowest practical position remain in place therefore our resilience is high under mild and medium drought conditions and under drought conditions since reliable operational records have been available in the 1970's (Drought Zone 3). However, we continue to examine options to optimise our supplies during drought and in particular severe drought (Drought Zone 4) and to increase our resilience through a number of different supply options.

Our Control Room and Asset Performance Teams have established contingency plans in place to replace output at all sources as a result of unplanned failure. These plans are reviewed in drought conditions to identify any amendments or investment required to ensure security of supply.

Specific drought actions will be carried out under the supervision and management of the Drought Management Group. Details of internal roles and responsibilities concerning drought are contained within sections 1.9, 1.10, 1.12 and the Communications Plan in Section 5. We plan to follow a twin track approach using both Demand Management and Supply Side options as tools to manage the drought based on risk assessment of severity. The range of options to be considered are summarised in section 3.1 and 3.2 and the range of estimated cumulative benefits are shown in Figures 3.1 and 3.2.

A number of different actions have been assessed and planned for during a drought in order to ensure security of supply. An overview of the demand side and the supply side actions is given in the Table 3.1. The detailed actions are outlined in the rest of Section 3.

Table 3.1 Overview of Drought Actions

Drought Zone Level 1			
Water efficiency campaign			
Inform the EA that Drought Zone 1 has been breached			

Drought Zone Level 2				
Demand side actions	Internal discussion on approach to restrictions and concessions	Appoint customer support advisers re restrictions, Q&As produced, website updated	Prepare for temporary use bans. Send notifications to papers and radio stations	Allow customers to request exceptions to a ban
	Enhanced leakage reduction and pressure management			
Supply side actions	Water source performance assessments	Assessment of internal and external water transfers		Run multiple scenarios of the network model
	Agree with EA increased monitoring	Amend monitoring programme associated with Drought Permits		Undertake surveys to assess state of the rivers

Drought Zone Level 3					
Demand side actions	Temporary ban restrictions in place	Lifting of any concessions (except for the frail and disabled)	Start preparing for Drought Order application for commercial restrictions	Submit Drought Order application to Secretary of State	
	Enhance leakage reduction				
Supply side actions	Utilise inter-company water transfers	Optimise groundwater sources (i.e. replacing pumps, deepen pump intake)	Additional output where applicable	Negotiate additional bulk imports form neighbouring companies	Plan for fast tracking engineering work, pressure control schemes and re-commissioning of dormant licensed sources
	Increase frequency of monitoring for the top of the list permit sites	Start preparing for Drought Permit applications	Increase frequency of monitoring for the rest of the permit sites	Apply for the permits at the top of the list	Apply for the remainder permits of the list

Drought Zone Level 4					
Demand side actions	Commercial restrictions Drought Order in place	Monitor effectiveness of commercial restrictions		Application for an extension if necessary	
	Enhance leakage reduction				
Supply side actions	Potential Drought Orders for increase of peak licences. This option will be formed following Drought Zone2 and 3 assessment of options where there is identified deficit	Implementation of infrastructure improvements	Implementation of pressure control schemes	Re-commissioning of dormant licensed sources	Negotiate additional bulk imports form neighbouring companies
	Drought Permits in place	Intensive environmental monitoring in place for all the permitting sites (potentially other sites as well)		Application for an extension if necessary	

3.1 Risk Assessment to Maintain Security of Supply

In order to highlight the areas that are likely to be at risk of supply failure due to loss of resource throughout the drought, a water balance methodology is used that splits the company area into hydraulic demand zones (HDZ) and estimates the water balance forecast within them and at company level using our zonal mass balance model. The equation that describes the above calculations in a HDZ is:

Risk of supply failure = Source availability + Internal/External transfers – Demand

The outcome of the assessment means we are able to assess the risk of a supply deficit at both zonal and company level and thereby to identify the scale and timing of mitigation and investment measures necessary to maintain security of supply. An example of the water availability / demand forecast monitoring tool is shown in Figure 3.1.

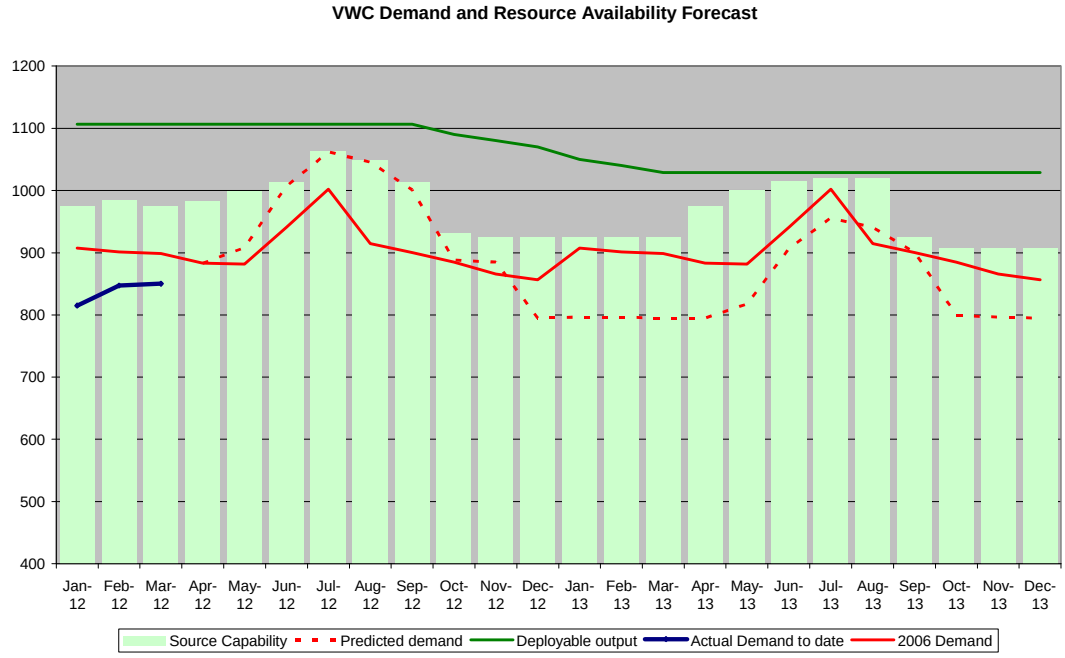


Figure 3.1 Demand and Resource Availability Forecast

3.1.1 Zonal Risk Assessment

As our groundwater and surface water sources are managed conjunctively to meet demand, during a drought demand can be transferred between adjacent resource zones. This happens under normal operating conditions but is critically reviewed during a drought.

In order to do this, a water balance model has been built based on the forecasted supply availability and demand e.g. over a third dry winter year (long term drought), for each HDZ. Source availability is verified by examining the actual drought conditions compared to our baseline Source Reliable Output (SRO) assessment used for our Water Resources Management Plan (WRMP). Demand is also based initially on the normal and dry year average and peak demand scenario's from our WRMP but reviewed and adjusted to reflect specific year forecasts e.g. in the current Olympic year peak demand is expected to continue for an extended period from mid July though August. The demand in each zone will be met by the source availability in that zone plus the internal or external transfers. In order to assess any potential supply deficit in a zone transfers are based initially on the capacity data from our suite of Hydraulic Models. For each zone the security of supply in each zone is then verified firstly with a simple simulation with every source taken out of supply at each step. A more complex scenario of two or more sources out of supply at the same time is then tested to identify any potential deficit and thus requirement to replace lost output either by increasing local capacity, transferring from adjacent zones or by reducing demand or any combination of these measures by considering options from our supply/demand options database (ref. Table 3.5).

3.1.2 Severe Drought : Unprecedented Low Groundwater Conditions: Third Dry Winter Risk Assessment Case Study 2012

Demand forecasts for a third dry winter year have been estimated based on the average of the peak demand periods experienced in the past 10 years in order to be as representative as it can be at this stage. The source availability forecast for a severe drought is estimated based on historic data for our groundwater sources, pumping test data and predicted yield under lower than ever observed groundwater levels. This assessment categorises the groundwater sources using the traffic light system into 3 categories: Red, Amber and Green. The red sources are the most sensitive in changes in water levels and are expected to go out of supply. For the amber sources a 25% reduction in output has been estimated, while the green ones are expected to yield their Deployable Output (DO). The results of this assessment indicate that there will be a reduction of up to 100Ml/d scattered throughout the supply area. This figure represents the worst case scenario assuming that water levels will decline everywhere at the same rate without any recharge taking place.

Our mass balance model has been used to evaluate potential zones at risk of supply deficit. Once preliminary investment requirements are identified more detailed design assessments are carried out using more sophisticated hydraulic models that exist for all hydraulic demand zones. The categorisation of the HDZs using the traffic light systeml helps to identify the critical HDZs with the higher deficit and subsequently the critical sources within that zone.

In addition to this, underperforming sources have been categorised using the traffic light system based on any pump issues experienced historically, using the our operational Production team's knowledge. Water quality issues and constraints are also included in the above assessment to verify the capability of each individual source under low groundwater conditions in order to produce a list with the viable options. The next step is to run multiple scenarios to determine first and second contingency and investment plans. The risk assessment results in a series of operational and investment recommendations to maintain security of supply in unprecedented drought and these are put forward for approval and subsequent implementation by the Drought Management Team

3.2 Demand Reductions in Drought

Experience of the drought in 2006 indicated a reduction of up to 7% on monthly demand in our area and 15% at peak week resulting from the comprehensive and co-ordinated communications campaign BeatTheDrought.Com. The impact of demand side measures was also assessed in 2006 by the UKWIR Drought and Demand Project. This report assessed the range of impact of various combinations of restrictions and communications programmes with the result shown in Table 3.2.

Table 3.2: Estimated Impact of Restrictions on Demand (*Source: UKWIR*)

Restriction	Summer demand effect	Estimated summer savings (Ml/d)	Winter demand effect	Estimated winter savings (Ml/d)
Unattended hosepipe ban	5%	63	3%	33
Full hosepipe ban	5% - 10%	63-126	No effect – 7%	0-77
Non-essential use ban	20%	255	n/a	-
Full hosepipe ban – effect on neighbouring company	2% - 4%	25-50	n/a	-

Accordingly, using experiences gained from previous droughts and demand management activities we have estimated likely resources or demand reductions for options to balance supply with demand. The outcome of these measures will depend upon the scenario, level of activity and the extent of the drought. For example the scale of a public relations campaign would be dependent on drought severity and location and could be escalated to include water efficiency information or a call for restraint. Actions that may be used in a drought scenario are summarised in Appendix 4.1 and Appendix 4.2 and include both demand and resource options. The range of assumed cumulative benefits is shown in Table 3.2 and Figures 3.1 and 3.2.

Appendix 4.1 and Appendix 4.2 list the different actions and consider the risks associated with each, along with when they would be implemented and whose approval is required. The savings from demand side measures and the possible extra resources which can be released will be dependent on the specific drought characteristics. The experience of the 2006 UKWIR project to assess the impact of demand side measures on demand demonstrated that a wide range of outcomes may be seen dependant on the spatial variation of drought and thus the area and water companies affected. Actions taken in concert with other companies for example as a result of the BeatTheDrought.com initiative were collectively significantly more effective than when carried out in isolation. To this end Table 3.2 has been compiled to demonstrate our estimates of the range of impacts of drought measures. In addition two graphs have been created, Figures 3.1 and 3.2 showing our estimates of the cumulative impact from one drought Zone to the next of the implementation of drought options, with three scenarios for minimum, average and maximum likely savings. For example the implementation of temporary usage ban restrictions may not independently result in a major reduction in demand. This would be generated from a combination of the increased publicity and water efficiency awareness leading up to and after the point that the restrictions are necessary.

3.2.1 Demand Side Management Actions

A summary of each chosen demand-side drought management action is presented in the table in Appendix 4.1. This table demonstrates:

- How the company has outlined the priority, order, timing and combination of demand side actions it will take in a drought

- An overview of the key demand measures undertaken within each Zone when the triggers have been activated.

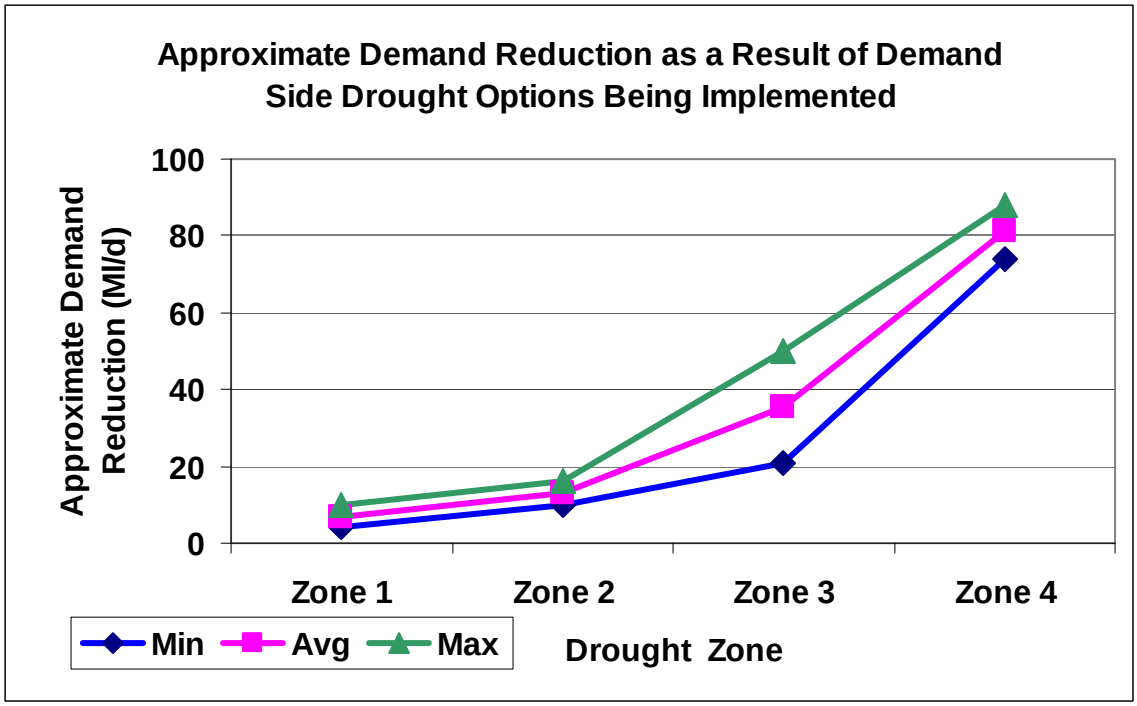


Figure 3.2 : Cumulative Demand Reductions from Drought Options

3.2.2 Zone 1 - Normal Operation

Water Efficiency measures have been and continue to be promoted by Affinity Water, in recognition of the essential role played by demand management in maintaining the supply/demand balance.

3.2.2.1 Metering

In recognition of high consumption, all customers who operate a garden sprinkler are required to pay by metered charges as well as those with integrated swimming pools. We also encourage customers to 'opt' for measured charges. Our change of ownership metering policy has been suspended, as this was not supported and funded by OFWAT in the recent price review. Our current policy is to increase the proportion of customers who are metered by metering all new properties and offering free meters to customers who request them. We were also constrained by the recent price review to defer our compulsory metering plans for 5 years, however we are proposing to continue our policy on compulsory metering from 2015 as we operate in a region that is designated as under serious water stress. We are planning to achieve 90% metering penetration by 2030, whilst current meter penetration is approximately 38%. Metered customers are generally more receptive to efficiency programs as there is a greater financial incentive for them to reduce their water usage. In the context of a drought however it is likely that unmeasured customers would also become more receptive to the (increased) promotion of water efficiency information.

3.2.2.2 Tariffs

In order to understand the best way of introducing new ways of charging for water, pilot trials are being carried out. These will evaluate the cost-effectiveness and influence on consumption of new tariffs. A water efficiency (WE) programme is also being devised to

supplement the effect of metering and tariffs on demand. This programme will be based on the latest evidence of cost-effectiveness of WE measures and Ofwat benchmarks in order to improve the reliability of outcomes. We will also be investigating the use of new devices for reading meters automatically (AMR30) in a tariff trial so that we can draw conclusions on the cost effectiveness of AMR and of tariffs in drawing up programmes of accelerated street by street metering should the need arise in the future.

3.2.2.3 Current Water Efficiency Strategy

Our ongoing baseline media and communications plan provides customers with information on water efficiency measures. This is achieved through newsletters and sales to all domestic customers, updating our website, operate a very active water saving squad, working with local authorities, direct contact with commercial customers, talks to local groups and national lobbying via Water UK and associated networks and the work done by the Educational and Environmental Centre, especially with student groups. The company also has a strong record of distributing water saving devices.

We contribute to and support industry and academic R&D groups in order to understand the issues involved in promoting water efficiency nationally. The Company continues to participate in groups such as the WE Network, Anglian Regional Water Efficiency Group, National Water Conservation Group, and the Water UK/Ofwat/Defra/Environment Agency Quadripartite.

We already take a pro-active approach to promoting water efficiency through a wide range of initiatives including:

- Customer consumption self audit packs.
- Increasing meter penetration and commensurate water efficiency promotion (literature sent out, direct customer contact etc.).
- Reducing consumption among industrial and commercial customers, via water regulations, inspections and key customer contacts.
- Increased education and awareness among customers and the general public.
- Development of communications patterns to best suit the customer base (web site, media, billing run, other opportunities) and in response to prevailing environmental conditions.
- Water Regulations training provisions for local plumbers.

Our ongoing water efficiency campaign is coupled with the enhancement of existing and additional activities under different drought scenarios, as outlined in the Communications Plan (see Section 4). For example if, from the control curves (Section 2.1 and Appendices 2 & 3), it appeared likely that the coming summer would be dry then a water efficiency message would be released to coincide with the planting season for gardeners.

3.2.2.4 Future Water Efficiency Strategy

Our WRMP sets out future plans for water efficiency in eight distinct strands. Objectives for each strand are demonstrated in Table 3.3 below:

Table 3.3 AW Future Plans for Water Efficiency

Activity	Objectives
Promotion	• To discharge the Company's statutory duty to promote water efficiency to our customers and the duty to conserve • To satisfy customer expectations regarding water efficiency advice • To offer added value services for customers to highlight potential water savings (e.g. sale of water butts)

	• To support enhanced activity during drought conditions • To seek external partnerships to discharge the duty to conserve
Influence Behaviour	• To maintain our commitment to our Education programme and develop the service provided to education establishments • To carry out consumer research and engage with our customers in order to understand the motivations and water efficiency behaviours. • To engage with our regulators to influence approach/concept of water efficiency. • To form strategic partnerships with influencers and policy advisors so that they begin to promote credible and appropriate water efficiency messages.
Measurement	• To carry out projects and tasks in accordance with best practice • To identify opportunities for joint working partnerships to deliver more for less • To provide an accurate and robust measurement and sustainability of the impact of water efficiency measures • To ensure appropriate business decisions can be taken on the cost-effectiveness of future plans and subsequent implementation
Supply/ Demand Balance	• To demonstrate to our Regulators (EA, Ofwat & Defra) that water efficiency measures are assessed appropriately within an economically optimal supply/demand investment programme • To support the company's supply/demand balance to reduce domestic PCC.
Target Setting	• To set measurable annual targets representative of all strands of water efficiency activity carried out by the company. • To establish baseline position and monitor our performance against the targets. • To consistently measure our performance against other water companies in the South East of England using audited and published data. • To actively seek to challenge and better previously set targets on an annual basis to continuously improve when compared to previous years.
Operational use of Water	• To ensure we are able to demonstrate a responsible attitude with its use of water • To put in place a culture of efficient use of water in our own operations • To satisfy our 'Duty to Conserve' by reducing wasted volumes • To enable realistic targets to be set and achieved to demonstrate efficient use of water in its own operations • To provide robust audit trails of operational and waste volume.
Industry	To work with others in partnership: • To maintain a leading position in the industry • To exchange measurement data to improve the robustness of the effects and sustainability of water efficient measures. • To continue the development of new initiatives that enable wider distribution and understanding of WE devices and techniques.
Company R & D	• Develop expertise in achieving and delivering water efficiency • To continue to identify and consider innovative WE opportunities

3.2.3 Zone 2 – Raised Awareness

- Public Relations Campaign – Customer awareness focussing on drought implications.
- Leakage – Maintain former levels of leakage reduction as the target is met and set target of 24 hour response to visible leaks.

3.2.4 Zones 3 and 4

From the 1st October 2010 Section 36 of the Flood and Water Act 2010 allows water companies a wider range of temporary water use restrictions that they can implement during a drought without requiring a drought order. This updates the legislation on temporary water use restrictions, substitutes the previous section 76 of the Water Industry Act 1991 and therefore supersedes the previous hosepipe ban powers.

The Water Use (Temporary Bans) Order 2010 provides detailed definitions of uses, exemptions and conditions in relation to these new powers. The Drought Direction 2011 sets out those uses that still require an ordinary drought order to restrict in a drought. These three pieces of legislation supplement each other and together they set out the categories of water use that can be restricted by a company and additionally with a Drought Order.

The background to the Order arises from the 2004-2006 drought experienced in the South East. The limited scope of hosepipe bans which applied only to the watering of private gardens and the washing of cars gave rise to public criticism. The focus of the powers was seen as unfair in preventing garden watering whilst filling private swimming pools could continue.

Climate change scenarios and historic information suggests a multi-year drought could occur once in every 20 years. Such prolonged shortages of rain will require the implementation of restrictions on water use to conserve water supplies and protect the environment.

The changes introduced to the legislation have made the powers clearer and have enabled more effective and equitable restrictions during times of drought. It is hoped that through introducing these new powers it will lead to better conservation of water earlier on in a drought and ensure supplies are protected for essential domestic use.

3.2.4.1 Representations and actions prior to implementation of restrictions

Before any restriction is implemented under these new provisions, we will provide the opportunity for representations to be made.

Publicity Requirements

Section 76B of the WIA 1991 has enhanced previous publicity requirements with regard to imposing restrictions. Before any prohibitions can be applied, we will:

- Publish notice on the website at the same time as we publish notice in two newspapers circulating in the affected areas.
- Provide details in the notice of how to make representations about proposed prohibition and exceptions.
- Give notice each time the scope of any prohibition imposed under section 76 of the WIA 1991 is altered in any way; and
- Give notice in relation to the lifting of any prohibitions on the website and in two newspapers circulating in the affected areas.

An estimate of one week for preparation for the notices and the publicity should be allowed for. Whilst there will be a lead in time for the implementation of restrictions to allow for representations, there is no such lead in time necessary for the revocation of restrictions; the lifting of a ban will take effect as soon as notice is given by one of the required means.

Making Representations

Before a restriction is implemented under these new provisions, we will provide the opportunity for representations to be made. The time allowed for representations will depend on the scale of the proposed restrictions. For the Temporary Ban measures we will allow for 2 weeks for representations to be made in the first instance and one week for any subsequent notices or changes in the restrictions or the exceptions. Our proposed timescales are outlined in Appendix 4.1. Those seeking to make a representation will be able to do so by completing and returning a representation form (Appendix 4.3). The following forms of media will be available:

- Website
  - E-copy of the form will be available to be completed and returned directly online
  - Paper copy will be available for downloaded to be printed off, then returned to head office
- E-mail
  - Email representation to a dedicated email address
- Telephone
  - A contact service advisor will be able to post a copy of the form to a customer address
  - A contact service advisor will be able to complete an e-copy of the form by taking customer details on the phone

Handling Representations

Representations received into the business will be collected and reviewed on a weekly basis. A panel of three members from the Drought Management Group will convene to discuss the outcome of representations with responses proposed for approval by the DMG. A final decision will be made by all three representatives on any action to be taken as a result of the representation within 3 weeks. Representations will be considered on an individual basis and as a whole. Exceptions from restrictions will not be granted on a case by case basis unless provision is made in the public notice. There will be no appeal process if the application for a concession or exception is denied.

Large non-household customers

Large non-household customers are mostly not directly affected under our proposed policy for implementation of the Water Use (Temporary Bans) Order 2010. However, we feel it is appropriate to keep them informed of our intentions relating to any Temporary Ban and the potential of escalation of the restriction through Drought Orders.

We intend to write to large non-household customers informing them of the restrictions indicating how they can contact us if they required further support. To ensure the message is spread as far and wide as possible we also intend to write to representative groups providing them with relevant information including timescales for proposed Drought Order applications where appropriate. These groups will be encouraged to circulate key information to their members.

In addition to written communication, we intend to hold a series of forums to allow our customers to share their concerns and to offer support in addressing the issues they face. Individual forums will be organised by industry sector providing companies with an opportunity to collaborate on issues and gain an understanding on how the Temporary Ban might impact their particular field of business. We ran the first of these sessions during the 2012 drought experience with organisations within the sports and leisure sector. This sector was selected as it is the most directly affected by the restrictions. Forums were then run bi-weekly across the remaining industry segments up until and beyond the date that the restrictions were removed.

3.2.4.2 Implementation of Restrictions

Our proposed policy for implementation of the Water Use Order 2010 (WUO 2010) and Drought Direction 2011 (DD11) measures is summarised in table 3.4 below. Appendix 4.4 and Appendix 4.5 comprise a series of figures of each of these activities summarising key information associated with each restriction. These appendixes have been adapted from the figures listed in the UKWIR Model Code of Practice.

Table 3.4: Summary of Implementation Policy for WUO and DD11

Zone 3 – All 11 Temporary Ban measures (WUO 2010) introduced in single phase	Zone 4 – All 10 Drought Order (DD11) measures introduced in single phase
• Watering a garden using a hosepipe • Cleaning a private-motor-vehicle using a hosepipe • Watering plants on domestic or other non-commercial premises using a hosepipe • Cleaning a private leisure boat using a hosepipe • Filling or maintaining a domestic swimming or paddling pool • Drawing water, using a hosepipe, for domestic recreational use • Filling or maintaining a domestic pond using a hosepipe; and • Filling or maintaining an ornamental fountain • Cleaning walls, or windows, of domestic premises using a hosepipe • Cleaning paths or patios using a hosepipe • Cleaning other artificial outdoor surfaces using a hosepipe	• Watering outdoor plants on commercial premises • Filling or maintaining a non-domestic swimming or paddling pool • Filling or maintaining a pond • Cleaning non-domestic premises • Cleaning a window of a non-domestic building • Operating a mechanical vehicle-washer • Cleaning any vehicle, boat, aircraft or railway rolling stock • Cleaning industrial plant • Suppressing dust • Operating cisterns

A single phase in which all eleven activities are simultaneously banned at the start of the Temporary Ban is felt to be the clearest implementation policy. We are aware that the complexity of the new restrictions has the potential to be confusing and we will endeavour to minimise confusion by informing our customers on what the restrictions are, what they mean and how we have responded to representations on our website.

As earlier outlined in section 2.4.2 levels of decline in groundwater are dominated by natural discharge from the aquifer, and will far outweigh any differences on a yearly basis made from demand management savings. Our priority is to ensure we have sufficient groundwater supplies to meet demand, whilst minimising the impact of these abstractions on the environment. By imposing the full use of powers immediately we maximise the benefit of the restrictions and ensure resources remain within our ability to supply the customer base. This also sends out a strong and clear message to our customer base that the situation is deteriorating. Additionally, as observed in Figure 3.1, customers would not normally experience an abrupt start to restrictions. Water savings are made gradually throughout Zones 1 and 2 following an initial media and Communications campaign raising the awareness of the situation.

Where the groundwater level was tracking the drought curve, but not likely to cross deeply into the Zone for some time, we may delay the imposition of restrictions to an appropriate time. For example, if the Zone 3 trigger level was not crossed until the Autumn and then tracked the trigger level, either slightly above or below, we would not aim to impose restrictions until the spring of the following year, when the pattern and amount of recharge was understood. We would review the situation in January, when the first half of the recharge season was completed and the DMG would, in consultation with the Environment Agency and neighbouring water companies, and then again in April.

We would not be introducing the measures given in the Drought Direction 2011 legislation if the water situation was not becoming demonstrably very serious. We consider that a straightforward total ban without exemptions not only sends a clear message underlining the severity but also maximises water savings and is easier to communicate and administer. In the unlikely event of the need to apply for an Emergency Drought Order, such an approach would stand the company in good stead for an application.

3.2.4.3 Exceptions

Our DMP only includes formal statutory exceptions outlined in the Water Use Temporary Bans Order 2010. In order to conserve water and ensure a safe and secure supply during a drought, no other exceptions will be normally granted by us. Where other exceptions are proposed, we will state this in our public notice. Please refer to each figure within Appendix 4.4 and Appendix 4.5 for a more detailed outline of the activities covered by each restriction and whether a statutory exemption is associated with each. A summary of the statutory exemptions is listed below

1) On the grounds of health and safety:

- *to clean the surfaces of a private leisure boat to prevent it from transferring invasive species to new waters.*
- *to clean the walls or windows of domestic premises.*
- *to clean paths or patios or other artificial outdoor surfaces*
- *to fill or maintain a domestic pond or ornamental fountain in which fish or other aquatic animals are being reared or kept in captivity.*

2) To fill or maintain a domestic swimming or paddling pool:

- *where necessary in the course of its construction.*
- *that is designed, constructed or adapted for use in the course of a programme of medical treatment.*
- *used for the purpose of decontaminating animals from infections or disease.*
- *used in the course of a programme of veterinary treatment.*
- *in which fish or other aquatic animals are being reared or kept in captivity.*

3.2.4.4 Compensation

The company will not consider any applications for compensation in the event that temporary bans on water usage are introduced except as required by legislation. The company has to plan on the basis that it may have to impose restrictions during long periods of very dry weather or drought. If you require further clarification on this please refer to the following link available through the Ofwat website – http://www.ofwat.gov.uk/sustainability/waterresources/restrictions/.

We do not anticipate any impact on private abstractors resulting from the suggested Drought Permit options described in Section 4 of this document and no provisions for compensation are made under these circumstances. Where any claim for compensation is received into the business, this will be assessed by our insurance team. Where necessary, a loss adjuster will be appointed to negotiate and settle the claim with the complainant.

3.2.4.5 2012 Drought and Working with Neighbouring Water Companies

We outlined above our intentions on how we will normally apply the restrictions and our approach to potential exceptions. However, in a drought scenario that affects wider areas of the country it is very important that the water companies liaise with the purpose of communicating a consistent message. At the time of this document's publication temporary restrictions are in place across the majority of the water companies in the South East of England. For the purposes of consistency and avoidance of customers' confusion, it was jointly agreed that we implement restrictions in the same way as the other water companies. Therefore, in an initial phase small businesses and drip irrigation systems are allowed an exception from the restrictions. The use of hosepipe by the frail and disabled is also an exception. Whilst this document details our baseline policy on exceptions where restrictions are being applied by other water companies at the same time and under similar conditions we will apply our exceptions in a consistent manner. Where differences in timing or exceptions continue to apply we will inform our customers (and make information available on our website) the reason why differences are necessary.

The practice of applying consistent restrictions on water use has been applied at the inception of the Temporary Water Use Ban in 2012. The public notice referring to the restrictions in 2012 and the changes to our suggested approach on consistency grounds can be found below. The exceptions related to small business and drip irrigation systems are lifted three months after the ban in place. This allows our customers time to adapt their business model whilst recognising the specific conditions of the current drought. Our forecast of drought conditions means we will be applying for drought permits and drought orders through the summer of 2012 in anticipation of groundwater levels falling to unprecedented levels be the autumn of 2012. Therefore exceptions to the Temporary Use Ban would be inconsistent with the need to implement further drought permit or drought order measures.

NOTICE OF TEMPORARY BAN ON WATER USE
WATER INDUSTRY ACT 1991
WATER USE (TEMPORARY BANS) ORDER 2010

VEOLIA WATER CENTRAL LIMITED and **VEOLIA WATER SOUTHEAST LIMITED** (the "Companies") hereby give notice under Section 76B of the Water Industry Act 1991 that from 00:01 hours on 5 April 2012 until further notice, water supplied by them (whether or not by meter) to the whole of their respective water supply areas **must not be used** for the following purposes: (the **"Prohibitions"**):

1. watering a "garden" using a hosepipe;
2. cleaning a private motor-vehicle using a hosepipe;
3. watering plants on domestic or other non-commercial premises using a hosepipe
4. cleaning a private leisure boat using a hosepipe;
5. filling or maintaining a domestic swimming or paddling pool;
6. drawing water, using a hosepipe, for domestic recreational use;
7. filling or maintaining a domestic pond using a hosepipe;
8. filling or maintaining an ornamental fountain;
9. cleaning walls, or windows, of domestic premises using a hosepipe;
10. cleaning paths or patios using a hosepipe; and
11. cleaning other artificial outdoor surfaces using a hosepipe.

A **"garden"** includes all of the following: a park; gardens open to the public; a lawn; a grass verge; an area of grass used for sport or recreation; an allotment garden as defined in Section 22 of the Allotments Act 1922; any area of an allotment used for non-commercial purposes; and any other green space. The definitions of words and phrases used in the Water Industry Act 1991 and the Water Use (Temporary Bans) Order 2010 apply to the Prohibitions and the Exceptions below.

Exceptions
The following exceptions apply to the Prohibitions:

(a) a hosepipe may be used to water an area of grass or artificial outdoor surfaces used for sport or recreation, where this is required in connection with a national or international sporting event;

(b) a hosepipe (connected to a metered water supply unless hand held at all times) may be used to water plants or gardens at domestic premises and allotment gardens:

(i) by persons holding a valid Blue Badge issued by a local authority; or

(ii) by persons who are frail or have a disability preventing them from using a water can and who do not meet the requirements of (i) above, if they register with the relevant Company.

(c) until 23:59 hours on 4 July 2012:

(i) plants may be watered on domestic or other non-commercial premises using a fixed drip or trickle irrigation watering system, connected to a metered water supply, which is fitted with a pressure reducing valve and a timer and which places water drip by drip directly onto the soil surface or beneath the soil surface, without any surface run off or dispersion of water through the air using a jet or mist; or

(ii) any person whose business was in existence before 15 March 2012 and whose income is solely dependent on cleaning:

- private motor-vehicles;
- walls or windows at domestic premises;
- paths or patios; or
- other artificial outdoor surfaces

may use a hosepipe for these purposes;

(d) the exceptions set out in the Water Use (Temporary Bans) Order 2010.

Information
(1) The effect of this Notice is to extend and vary the exceptions to the Prohibitions announced in a noticed published on 15 March 2012 in the Daily Mail and the Sun newspapers (and on the Companies' websites), in light of representations made. Further information about each of the exceptions is published on the relevant Company's website.

(2) Persons undertaking the activities excepted in paragraph (c) above are encouraged to contact the relevant Company as soon as possible for information on how to switch to using rainwater or recycled water for these activities.

(3) It is an offence to contravene any of the Prohibitions. The maximum penalty for each offence on conviction is £1,000.

(4) Representations about the temporary use ban may be made by email to: droughtrepresentations@veoliawater.co.uk before 08:00 hours on Wednesday 4 April 2012. If, as a result of such representations, Veolia Water Central Limited and/or Veolia Water Southeast Limited decide to vary any of the Prohibitions, a further notice will be published.

Veolia Water Central Limited
Tamblin Way, Hatfield, Hertfordshire, AL10 9EZ
www.veoliawater.co.uk/drought

Veolia Water Southeast Limited
The Cherry Garden, Cherry Garden Lane, Folkestone, Kent, CT19 4QB
www.veoliawater.co.uk/thedrought

29 March 2012

3.3 Supply Side Options Appraisal

A summary of each chosen resource side drought management action is presented in the table in Appendix 4.2. This table demonstrates how the company has outlined the priority, order, timing and combination of supply side actions it will take in a drought. The actions outlined in this section will be investigated and assessment during Drought Zones 2 and 3 to be ready for implementation in Drought Zone 4.

3.3.1 Supply side options

An overview of the measures reviewed, investigated and used in severe drought to replace lost resources is highlighted below and the benefits shown on Figure 3.2: Supply options are included in our WRMP database and are listed in table 3.5.

- **Operational performance optimisation** – All operational sites are reviewed to ensure they are operating optimally in face of drought conditions. Maintenance of plant is carried out with a view to minimising 'downtime or 'outage'. A review is undertaken of all previous drought measures to ensure they remain in place or plans are replaces to restore drought settings. Instrumentation is checked to ensure reliable data is reported eg. Borehole level transducers. All plant 'outage' is managed through our Control Room to maximise availability through the drought and any capital works requiring outage is rescheduled to minimise loss during critical periods. Plans for outage are held by the Control Room. Liaison with neighbouring water companies takes place to ensure a clear understanding of the effect of drought on imports and exports and any loss of capacity is used in our mass balance assessment to verify security of supply (section 3.1).
- **Utilisation of groundwater sources** – Source assessment has been undertaken for all groundwater sources to identify those that are underperforming compared to their expected/licensed capacity. Water level investigation at these sources identifies possible ways to optimise the performance of the source either by changing the operational pattern or by replacing the pumpset and placing the pump deeper in the borehole. Taking into account local hydrogeological characteristics and the constraints imposed on the yield of a borehole, an optimum pattern is identified in order to maximise output under peak demand conditions and establish sustainable constant rate output under average demand periods. As such, under every scenario run for the different HDZs we can ensure that source availability has been maximised before alternative options are sought. The above assessment aims to identify contingency plans for every source that might go out of supply due to low water levels or reduced output.
- **Additional Output** – Review sources to determine the feasibility of increasing abstraction by increasing pumping capacity or drilling satellite well. In sites where blending options are currently in place, this may trigger water quality issues, as a different blending option would need to be sought or installation of different treatment plant should be considered. Therefore, this option is also restricted from the current infrastructure in case further blending options are to be investigated. Risk assessments are undertaken to identify possible risks of water quality failures. Moreover, moving water with different chemical characteristics within the pipes might possibly deteriorate the water quality, as more "aggressive" water is able to erode the chalk lining in the pipes and increase turbidity. During this process it is very likely that leakage will be increased as the chalk lining is being removed from the pipes. All the risks are assessed to identify possible options especially in sources currently affected by water quality issues.

- **Re-commissioning of sources** – Re-instate dormant sources taking account of group licence considerations. Abandoned and/or disconnected sources are another option to be considered. In many cases, the local aquifer characteristics might restrict the output of a source and give a low yield at a high operational cost. However, in cases where the location of the source is critical to supply a local area, this could be a very important contingency plan. The abandoned sources were often out of supply due to water quality issues, which may be overcome by the installation of the appropriate treatment plant subject to discussion and approval of DWI. Borehole sites de-commissioned for water quality reasons may also be re-commissioned for grey water use by key customers.
- **Intra Company Transfers** – Utilise flexibility of our infrastructure. This is an option that is considered based on the water balance for each Hydraulic Demand Zone (HDZ). In cases where we have surplus in a HDZ, there is the potential of the extra water to be transferred to adjacent zones based on the current infrastructure. Hydraulic modelling is undertaken to identify potential transfers and the capability of the existing network configuration. Restrictions on the flow direction and the current setting of the mains have been taken into account in order to define available options. The possibility to transfer water from one zone to a neighbouring zone is already identified in most cases, (Control Room response plans and Hydraulic Modelling contingency plans) and used in our mass balance model to define the need for additional network reinforcements to meet forecast zonal drought deficits.
- **Bulk Imports/exports** – A review of imports and exports with neighbouring water companies and key private borehole owners may identify short term bulk imports where neighbouring drought conditions allow. This option is to be considered especially in zones where the current network is operating at full capacity. In this case, imports from neighbouring water companies will be sought based on the capability of the infrastructure and the company's ability to move water to the area that is needed. Current options are reviewed and compared with outputs from scenario testing.
- **Engineering work** – Consideration is given to fast tracking infrastructure improvements. In places where it is very critical to move water from one zone to another. Our Asset Delivery Teams have the expertise necessary to accelerate network reinforcements.
- **Pressure Control Schemes** – Assess the implementation of additional schemes where possible. Changes in network pressure can be an option especially in the areas that are near the edges of the network. However risk assessments should be undertaken prior to this and hydraulic modelling should be able to simulate changes in pressure that will determine whether the scheme is viable or not.
- **Drought Permits/Orders** – Only under very severe drought scenario (Drought Zone 4, unprecedented groundwater levels).
    - ***Lifting of abstraction constraints*** – Suspension of existing Low Flow Licence conditions. In environmentally sensitive areas that the impact of groundwater abstraction has been identified and quantified, there is the possibility of lifting the current restrictions to allow for increased abstraction schemes. In cases where river augmentation scheme is currently in operation, this could be lifted and increased output achieved from currently underperforming sources based on the licence rate. In any of the above cases, Drought Permits would be required from the Environment Agency to enable these to be realised and environmental assessments for target locations are included in Section 4.6 and Appendix 6.
    - ***Increase peak output where possible for sources above licensed volumes***. Drought Orders will be required to enable these to be realised. Potential sources

have been identified but this scheme will be implemented once the potential transfer capability has been ensured. In many cases water is available in areas with lower demand and as such the transfer potential from the individual source to the zone where the demand is, needs to be investigated. Moreover, this scheme must also ensure that the current pump setting can cope with higher abstraction rates, therefore a pump test at increased output will be required. In cases where the current setting includes a fixed speed pump this may not be achievable under low water levels and a replacement pump need to be considered. There is a revolving pump testing programme that identifies pumps that already run at or near their maximum head and any further lowering of the water levels might reduce the efficiency of the pumps. This programme highlights the pumps that need to be reconfigured or replaced in order to be efficient at much lower water levels and overtake the extra pressure caused by pumping at a greater depth.

- ***Install pumps and treatment at currently unlicensed boreholes*** (ours and third party) where possible. Drought Orders would be required to enable these to be realised. Potential sources are not identified at this time, but the ongoing investigation under the NEP projects has indicated areas with certain hydrogeological characteristics capable of sustaining a relatively high yield. This is to be confirmed once the appropriate boreholes have been selected and a pumping test will need to be undertaken. Moreover, the connection of the third party boreholes to our network is an issue to be considered as the location would determine the likelihood of such option. This option will be considered in areas where the forecast local demand could be met by a small source as in places where large volumes are needed the most appropriate option is to drill a new borehole.

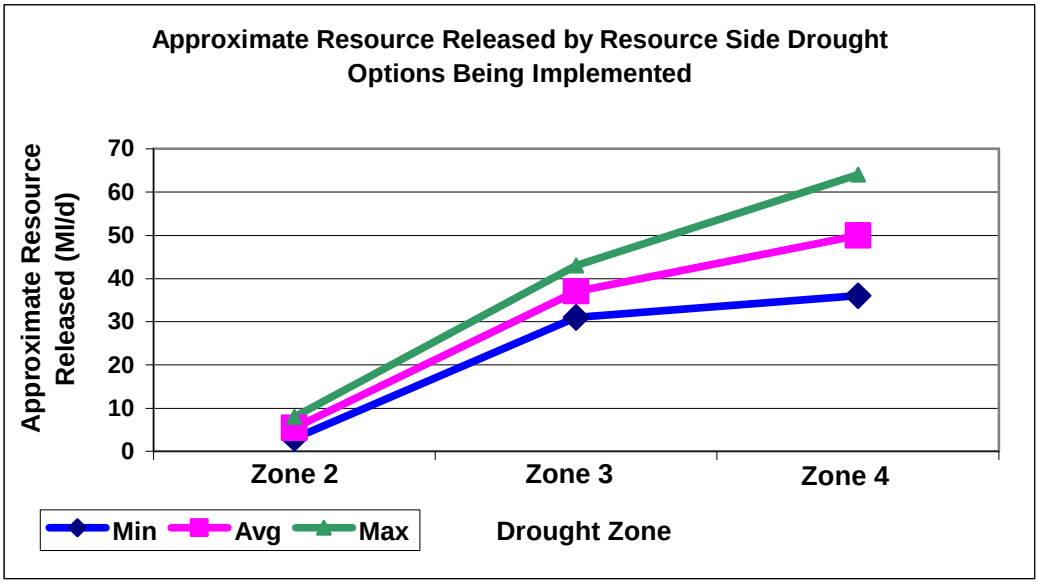


Figure 3.3: Cumulative Volume Benefits from Resource Side Measures

A first list of options has been identified and is presented below in Table 3.5 although this is not exhaustive and is constantly refined in order to reflect any changes in water balances and the critical HDZs. According to this, a gain of 53Ml/d is possible on average demand taking into account only the confirmed numbers and possibly 605Ml/d on peak if every scheme is implemented however this figure must be treated with caution. From the implementation of source optimisation and development of new sources 187Ml/d are considered likely to be gained on peak and 46Ml/d on average, with an extra 413Ml/d being the gain from transfers either internal or external on peak.

Table 3.5 List of Drought Management Options

Drought Management Options	Potential Gain [ML/D] AVG	Potential Gain [ML/D] PEAK	Category
AW-RES-CEN-0040: Treated Water Storage (Central)	0.00	9.14	Link/Transfer
AW-EGW-CEN-0100: WHEA Peak Licence Scheme	0.00	2.00	Source optimisation/new source
Boxted to Harpenden Link	TBC	30.00	Link/Transfer
Bovington to Heronsgate Booster	TBC	140.00	Link/Transfer
HUGH Source Optimisation	TBC	TBC	Source optimisation/new source
LANE to BATC	TBC	40.00	Link/Transfer
AW-EGW-CEN-0051: HILF Dual Pump Option	0.00	28.00	Source optimisation/new source
AW-EGW-CEN-0220: NORT treatment scheme	0.00	3.41	Source optimisation/new source
AW-NGW-CEN-0160: Denham/Uxbridge - new source	5.00	5.00	Source optimisation/new source
AW-WTW-CEN-0062: ICKE Treatment Recommissioning - New Licence Option	0.00	11.00	Source optimisation/new source
AW-NSW-CEN-0240: Slough Arm - British Waterways	3.00	3.00	Emergency
AW-NSW-CEN-0320: Grand Union canal	2.00	2.00	Emergency
AW-EGW-CEN-0080: SHAK Optimisation	0.00	2.63	Source optimisation/new source
REDB Source Optimisation	TBC	TBC	Source optimisation/new source
AW-WTW-CEN-0120: Treatment scheme, POOR	0.00	11.37	Source optimisation/new source
Maximise Group Licence at HUNT	4.50	4.50	Source optimisation/new source
GERR Source optimisation	TBC	TBC	Source optimisation/new source
LITT Source Optimisation	TBC	TBC	Source optimisation/new source
AW-EGW-CEN-0380: CHES source optimisation	0.00	1.09	Source optimisation/ new source

STON Source Optimisation	TBC	TBC	Source optimisation/new source
Bulls Green / Preston Pump	TBC	TBC	Link/Transfer
AW-EGW-CEN-0400: SCHO (relocation)	0.91	0.91	Source optimisation/new source
AW-EGW-CEN-0250: CHOR	0.00	3.00	Source optimisation/new source
AW-EGW-CEN-0390: HART borehole replacement for PORT [Instead of McMullens Brewery]	TBC	TBC	Source optimisation/new source
AW-EGW-NOR-0350: TEMP peak optimisation	0.06	1.19	Source optimisation/new source
Optimise SUND to ARKR Link	TBC	44.00	Link/Transfer
AW-NGW-NOR-0200: VAUX Groundwater	4.00	4.00	Source optimisation/new source
AW-NGW-NOR-0290: HADH - new borehole	3.35	2.55	Source optimisation/new source
AW-NGW-NOR-0310: LUTG	2.00	2.00	Source optimisation/new source
AW-EGW-NOR-0260: RUNG - peak licence	0.00	1.95	Source optimisation/new source
AW-EGW-NOR-0330RUNC optimisation [POTENTIAL]	2.55	1.95	Source optimisation/new source
AW-WTW-NOR-0270: RUNC - treatment	2.55	1.95	Source optimisation/new source
WEND - Not on the list of options	1.90	3.09	Source optimisation/new source
AW-EGW-NOR-0230: SPRF - maximise average group licence	1.90	3.09	Source optimisation/new source
AW-EGW-NOR-0280: NEWP & WEND maximisation	TBC	TBC	Source optimisation/new source
AW-RTR-NOR-0210: Lowerfield bulk import increase from Cambridge	2.00	4.00	Source optimisation/new source
AW-EGW-NOR-0370: LOND peak licence	1.13	1.13	Source optimisation/new source
AW-EGW-NOR-0150: ROYD number 4 borehole	4.60	6.91	Source optimisation/new source
AW-ASR-NOR-0190: ROYD Artificial recharge	2.00	5.00	Link/Transfer

AW-RTR-NOR-0410: Cambridge to North - existing emergency supply	TBC	TBC	Link/Transfer
Coppersmill / New River Connection	TBC	40.00	Link/Transfer
Cambridge Connection	TBC	15.00	Link/Transfer
AW-EGW-NOR-0340: HEMP source optimisation	0.00	0.00	Source optimisation/new source
ARMI & THAX Source Optimisation	TBC	TBC	Source optimisation/new source
AW-NGW-NOR-0300: STAN - licence	TBC	TBC	Source optimisation/new source
HIGH Booster	TBC	30.00	Link/Transfer
Standon North Mains	TBC	10.00	Link/Transfer
WHIT Re-use	TBC	30.00	Source optimisation/new source
AW-NSW-CEN-0030: SGSK	10.00	10.00	Source optimisation/new source
FORT Mains	TBC	50.00	Link/Transfer
AW-EGW-SOU-0360: HORS source re-commissioning	TBC	TBC	Source optimisation/new source
North Surrey North	TBC	40.00	Source optimisation/new source
Total Gain (Ml/d)	**53.45**	**604.86**	

3.4 Drought Orders & Permits to remove existing low flow constraints

We currently have 12 sources where there are provisions in the licence for abstraction to be controlled by environmental constraints. These sources are considered below as potential Drought Permitting sites under Drought Zone 4. No other Drought Permitting sites will be considered. The sources are as follows:

Table 3.6 Potential Drought Permitting Sites

Source	Additional Annual Volume	Additional Daily Volume	Waterbody/ Catchment	Comments
SLIP	Up to 5.46Ml/d	Up to 6.82Ml/d	Ashwell Springs Augementation	New Operating Agreement in Place 2011, site will not be considered for Drought Permit
WELL	Up to 0.3Ml/d	Up to 0.3Ml/d	Charlton Mill Pond Augmentation, River Hiz	
UTTL/SPRF	Up to 6Ml/d	Up to 6Ml/d	River Cam Augmentation	Augmentation could be from UTTL or SPRF
THUN	Up to 2.73Ml/d	Up to 2.73Ml/d	River Rib	Abstraction reduction, no augmentation
FULL	Up to 2.23Ml/d	Up to 2.23Ml/d	River Mimram	Abstraction reduction, no augmentation
OFFS/ OUGH	Up to 1Ml/d	Up to 1Ml/d	River Hiz Augmentation	
HUNT	Up to 2.91Ml/d	Up to 2.91Ml/d	River Gade	Abstraction reduction, no augmentation. Site cannot produce additional water
Total	**15.17Ml/d**	**15.17Ml/d**		**SLIP is excluded from the total**

In addition we operate a number of sources whose abstraction is controlled under Low Flow Alleviation Schemes. These agreements include provision for suspension under drought or emergency conditions. The sources affected are shown in Table 3.7.

Table 3.7 Low Flow Alleviation Schemes

Source	Additional Annual Volume	Additional Daily Volume	Waterbody/ Catchment	Comments
FRIA, BOWB	Up to 4.61Ml/d (1.61 from FRIA and 3 from BOWB)	Up to 3 Ml/d (0 from FRIA and 3 from BOWB)	River Ver	River Ver Operating Agreement- abstraction reduction
AMER, GREM, CHAL	Up to 8Ml/d	0Ml/d	River Misbourne	River Misbourne Operating Agreement- abstraction reduction
Total	**Up to 12.61Ml/d**	**3Ml/d**		

Any drought orders and permits submitted would be supported by a full environmental assessment as described in Section 4 Environmental Monitoring Plan. The drought permits

will be submitted in a priority order according to the magnitude of their potential environmental impact, starting with those with the least potential impact. The sequence is outlined in Section 4 and further explained through the Environmental Impact Assessments in Appendix A5.

4 ENVIRONMENTAL MONITORING PLAN

We carry out routine collection of hydrometric and water quality data, irrespective of drought throughout our operating area. Following a revision to the Water Industry Act s39B(4)(c), as amended by s63 of the Water Act 2003, we are also required to monitor the effects of drought and the measures taken by us to mitigate a drought. Discussions between the Environment Agency and ourselves have resulted in 10 sites being identified which have the potential for lifting of environmental licence conditions, see Section 3.4. This chapter details the environmental monitoring which we would enact prior to, and in the event of, an application for a drought permit/drought order, as described in Section 3.

These sites have been prioritised according to the magnitude of the potential environmental impact compared to the benefits in supply. Of these 10 sites we anticipate significant environmental impact on only one designated wildlife site, this is on the SSSI at Ashwell Springs. Hence the SLIP site has been removed from the list as we have no intention of applying for a drought permit on this site It needs to be noted that the priority might need to be shifted should shortages of water into supply occur in areas supplied by sites further down in the list. All decision will be made after mutual agreement with the Environment Agency.

Table 4.1 Priority List of Sites with Environmental Constraints

Priority Order	Permit sites	Incremental volumes (Annual)	Comments
1	FRIA, BOWB	4.61	Ver Operating Agreement, no permit required
1	THUN	7.34	Permit required
1	UTTL/SPRF	13.34	Permit required
2	AMER, GREM,CHAL	21.34	Misbourne Operating Agreement, no permit required
3	FULL	23.57	Permit required
3	OFFS/OUGH	24.57	Permit required
4	WELL	24.87	Permit required
5	HUNT	27.78	Permit required, no adequate plant in place

The following sections describe activities for routine baseline monitoring and drought monitoring by ourselves and the EA.

4.1 Baseline Hydrological Monitoring

4.1.1 Monthly Hydrological Monitoring Reports

A list of monthly, hydrological monitoring is given in Appendix 5. The Asset Sustainability Team is responsible for updating and reviewing these different hydrological factors. These cover the whole of our supply area and the outcomes include analysis of key river flow and groundwater levels hydrographs, using routine monitoring data provided by the Environment Agency. MORECS data on precipitation, effective precipitation and soil moisture deficit, as measured and calculated by the Met Office (Table A5.1 in Appendix 5) are also utilised. This information and analysis assists in the identification of long term

weather patterns and the likelihood of aquifer recharge during the autumn and winter months. It is also used for water situation forecasts.

The Asset Sustainability Manager is responsible for notifying the Asset Management Director should the monthly hydrological monitoring indicate that the Zone 1 drought trigger is likely to be breached, Figure 2.3.

During a period of drought, this information is also used to inform our Drought Management Group (DMG). For drought monitoring all these parameters from the monthly report are duly considered and recorded, however given our reliance on groundwater (60%) and that no drought constraints placed on the River Thames intakes or our import of Anglian Water based on operating agreements, we have identified groundwater levels as being the main parameter for the monitoring of drought conditions.

Monitoring points selected for drought assessment are the Environment Agency observation boreholes located at Chalfont Centre, Lilley Bottom and Elsenham Nurseries. This provides data covering the Western, Central and Eastern regions of our operating area. The selected sites are unaffected by abstractions and give a good indication of the groundwater level conditions across our supply area. Many other groundwater observation points are used to verify the situation outlined by theses three locations. The flow in the River Thames, at Kingston Lock, is also monitored to complete the company wide picture. The report makes reference to specific river flow licence triggers to monitor the requirement for reduced abstraction under existing licence conditions.

We also review the EA's monthly hydrological summaries produced by the relevant Area and Regional EA teams for additional information on the current hydrological situation.

4.1.2 Groundwater Level Monitoring at Operational Sites

We routinely monitor daily groundwater levels in all of our production boreholes/wells as part of our routine operation and water resource planning. This information is used to aid the determination of the development and severity of a drought and identify any early impacts of such a drought on our resources and local environment.

4.1.3 Quarterly River Photos

Our Asset Sustainability Team take digital river photographs quarterly at 120 defined locations on 17 rivers considered to be environmentally sensitive within our supply area. This has allowed the Team to compile a photographic record from 1998 of key locations on these sensitive rivers for reference purposes, (Appendix 5). This also ensures that each river is visited at least once every three months through different hydrological conditions and allows the early identification of any potential low flow concerns. This record has also proved useful in our liaison and discussions with the Environment Agency and the public over key low flow licence triggers or environmental schemes.

4.1.4 Environment Agency Baseline Monitoring – Thames Region

4.1.4.1 Hydrological Monitoring

The Environment Agency undertakes routine hydrological monitoring of river flows and groundwater levels across most of our supply area. A fundamental assumption of our DMP is that the monitoring carried out by the EA will continue and derived data will be made available. We are in regular communication with the EA to ensure that the information we hold is up to date.

Good data sets exist for the Rivers Ver, Misbourne, Rib and Mimram, (Appendix 6) which can be fully utilised in the baseline assessment for a drought application in these catchments. In addition, the River Colne has been identified as an area for improvement under the NEP programme and additional data is collected. In previous drought situations where hydrological data records have been considered to be limited, additional data have been collected. The proposed schedule for each permit site is detailed in the Environmental Impact Assessments, Appendix 6. These schedules are subject to joint revision by us and the EA depending on the severity of the drought.

4.1.4.2 Ecological Monitoring

The Environment Agency holds baseline information on macroinvertebrate populations for the Ver, Misbourne, Mimram and Rib (Appendix 5), collected as part of their Water Resources Survey (RSA) plan. Under the WFD classification they have also undertaken a number of ecological surveys, which have confirmed that a number of ecological populations are suffering from low flows in rivers. The NEP projects have identified areas for improvement. Additional ecological data will be collected according to the monitoring schedules in the Environmental Impact Assessments, Appendix 5. This data will be utilised in the application for any drought permit or order.

4.1.5 Environment Agency Baseline Monitoring - Anglian Region

4.1.5.1 Hydrological Monitoring

The EA routinely monitor river flows and groundwater levels, with good data sets existing for the Hiz, Rhee, Cam and Upper Cam catchments (Appendix 6). The EA conduct routine 'check gauging' programme at their flow gauging stations to measure flows 2 times a year. In addition, some limited historic spot gauging data exists for these rivers and can be utilised as part of the baseline assessment.

In previous drought situations where hydrological data records have been considered to be limited, additional data has been collected. This process will most likely be repeated in potential future drought scenarios.

4.1.5.2 Ecological Monitoring

The EA hold baseline data on macroinvertebrates in the Hiz, Rhee and Cam. The River Cam at Great Chesterford is a key site in the EA's drought plan and therefore monitored every other month during a drought. Good baseline data also exists for three other sites on the Cam (Appendix 6).

Baseline macroinvertebrate data for the River Rhee at Ashwell is collected by the Environment Agency. This site is located just downstream of the spring head within the SSSI with data from 1990 onwards. There is also baseline macroinvertebrate survey data for the Hiz and Oughton. A good dataset exists for the Hiz upstream of Hitchin Sewage Treatment Works with data available from 1995. The site is on a three year rolling programme and will next be monitored in 2012. Some limited data also exists for the Oughton at the Flour Mill from 1999 until 2008 (this site is no longer monitored).

4.1.6 Existing Studies of Potentially Affected Sites

Following on from and in conjunction with the AMP3, AMP4 and AMP5 National Environment Programmes, and the earlier Alleviation of Low Flow (ALF) Schemes, we routinely undertake project specific environmental monitoring. This monitoring involves groundwater level monitoring and spot gauging of river flows, as well as some baseline ecology surveys (River Corridor and River Habitat Surveys) on various sites including those potentially affected under drought. This monitoring is also carried out on sites where

we hold Time-limited Licences to gain valuable information on the impact of our daily activities. This information may also be utilised for baseline monitoring and to enhance understanding under drought conditions. A summary of studies taken on the various rivers that cross our supply area is shown on Table 4.2.

Table 4.2: Examples of Existing Studies of Potentially Affected Sites

River/Site	Studies	Comment
Misbourne	Alleviation of Low Flow Study and AMP5 NEP Options Appraisal	AMP5 monitoring and preferred options
Ver	Alleviation of Low Flow Study and AMP5 Investigation and Options Appraisal	AMP5 continued investigation and monitoring
Colne and Mid Colne Lakes	Alleviation of Low Flow Study (lakes) and AMP5 Investigation and Options Appraisal	AMP5 continued investigation and monitoring
Rib	AMP4 NEP Investigation on lower reaches and AMP5 NEP Investigation and Options Appraisal on upper/mid reaches	AMP5 continued investigation and monitoring in upper/middle reaches
Gade	AMP3 Upper Gade Sustainability Study and AMP4 Options Appraisal	Various reports and data
Mimram	AMP3 Mimram Sustainability Study and AMP4 Investigation	AMP4 investigation and monitoring
Beane	AMP3 Beane Sustainability Study and AMP4 Investigation	AMP4 investigation and monitoring
Cam	River Cam Environmental Report (1998)	Various reports and data
Rhee	Investigations at Ashwell Springs	Various reports and data
Pant	AMP3 Investigation	Various reports and data
Hiz	Alleviation of Low Flow Study and subsequent reviews/monitoring	Various reports and data

A number of investigations and subsequent options appraisal is included in our AMP5 National Environmental Programme (NEP). As part of this programme a number of new monitoring locations have been identified, including river spot gauging, river water level and groundwater level monitoring locations. These sites are either being monitored on a regular basis or their monitoring is attached to a specific signal test. The detailed monitoring programme is outlined in Appendix 6. This information may also be utilised for baseline monitoring and to enhance understanding.

4.2 Drought Environmental Monitoring

Following discussions with the EA additional environmental monitoring would be instigated in preparation of applying for a drought order or permit following one dry winter. Experience of drought conditions in the our area has shown that our operation is robust to one year's drought conditions and that drought permits or orders are not likely to be required until we have seen two or even three dry winters. Therefore we anticipate at least one season of actual drought conditions to update our preliminary environmental impact assessments (Appendix 6). This additional monitoring would continue throughout the period of the implementation of the application and until flows/levels have returned to LTA conditions. Our area straddles two EA Regions and these are discussed separately below.

4.2.1 South East Region

Hydrological

The EA routinely monitors flows on all rivers in our supply area at a number of permanent gauging stations. Data from these gauging stations are sent to us on a monthly basis. Spot flow gauging is also carried out by the EA on the rivers Ver and Misbourne at various locations along the river course on a monthly basis. Additional monthly spot gauging during the summer is being undertaken within our NEP projects on the Mid Rib, Ver, Upper Colne, Mid Colne and the Mid Colne Lakes as part of the AMP5 Environment Programme investigations on these catchments.

Observation boreholes along three river valleys (Ver, Mimram and Misbourne) are dipped monthly by the EA. Should the company apply for a drought permit we would require replication of their hydrological monitoring on the relevant river catchment. This would need to occur monthly in conjunction with the EA's own monitoring but offset by two weeks.

The lower reaches of the River Gade are hydrologically very complicated due to its interaction with the Grand Union Canal and therefore no additional monitoring is proposed. Historically, hydrological data for the River Rib have been very limited, therefore the EA have identified a requirement for us to collect additional baseline data. This was carried out in 2006, as discussed in Section 4.1.4 in conjunction with the AMP4 study on a fortnightly basis. Further data are collected as part of our AMP5 NEP studies.

Macroinvertebrates & Fisheries

In the event that we anticipate the need for a drought application, the suggested for additional ecological monitoring outlined in the Environmental Impact Assessments in Appendix 6 will be implemented. This would involve mostly macroinvertebrate surveys as described in Appendix 6, unless the circumstances indicate otherwise and a revised scheduled is agreed with the EA. Monitoring of fish populations will be undertaken by observation on scheduled walk-over surveys, when we are in Drought Zone 2. These will bring up matters of immediate concern and potential mitigation measures, i.e. fish rescues, where required. Discussions are ongoing with the Agency over the resourcing requirements for these ecological surveys. A decision on these resources will be taken when needed.

4.2.2 Anglian Region

Hydrological

The EA routinely monitor flows on the Hiz, Rhee and Cam. Data from these gauging stations are recorded on a daily basis. In addition to this observation boreholes in these catchments are dipped on at least a 3 monthly basis.

A further 5 boreholes around Ashwell have data loggers installed and are downloaded by the EA on a 3 monthly basis. A new Operating Agreement on the abstraction at SLIP and the augmentation of the Ashwell Springs was signed between us and the EA in 2011. we could apply for a drought permit for the lifting of the augmentation condition under Drought Zone 4 conditions, however we have decided that we are not going to use this option, because of the sensitivity of the Aswell Spring SSSI. Therefore, no preliminary environmental impact assessment has been prepared for this site.

As there were limited data on flow accretion in the River Cam, we collected additional baseline spot gauging data in summer 2006 (during the 2005-2007 drought). River support from UTTL was not provided in 2006 and therefore provides good information on unsupported low flows. In the event that we anticipate the need to apply for a Drought Permit or Order, spot gauging on the Cam at three locations would be undertaken to

provide additional data, as outlined in Appendix 6. This would continue through the period of the drought application and its implementation.

The EA monitor water levels at the Oughton Head spring, and at Charlton Mill Pond, where we currently automatically record water levels in the pond. This pond has been relined and is supported by us as part of a Licence condition when levels decline below a trigger level. Additional monitoring would be undertaken should we anticipate the need to apply for a Drought Permit or Order to reduce or cease the environmental support from OUGH/OFFS, or WELL.

Macroinvertebrates

Macroinvertebrates are routinely monitored by the EA under the Local Conservation Monitoring programme at Ashwell Springs (TL 2700 3980). This data is collected annually downstream of the designated spring head for local conservation purposes. Surveys are carried out on the river Hiz in Hitchin. It is anticipated that these sites in the Hiz could be used for additional drought monitoring as agreed with the EA at the time of a drought application.

4.3 Supporting Monitoring Data

Appendix 5 contains supporting data, schedules and location charts for hydrological monitoring as follows:

A5.1 AW Monthly Hydrological Data Specification

Table A5.1 Data Collected and Reviewed for the AW Monthly Hydrological Report

A5.2 Location River Monitoring Photographs

A5.3 Notes and Key to Environmental Monitoring Charts

Figure A5.5.1 River Ver Drought Monitoring Locations

Figure A5.5.2 River Misbourne Drought Monitoring

Figure A5.5.3 River Mimram Drought Monitoring Locations

Figure A5.5.4 River Rib Drought Monitoring Locations

Figure A5.5.5 River Hiz/Oughton Drought Monitoring Locations

Figure A5.5.6 River Cam Drought Monitoring Locations

More detailed monitoring schedules that are associated with the drought permits can be found in the individual catchment Environmental Impact Statements in Appendix 6.

4.4 Environmental Assessments for potential Drought Permits and environmental condition lifting

Table 4.3 highlights some of the potential environmental impacts that have been identified which may occur following the implementation of a drought action. These impacts will be monitored as described in Section 4.2 and Appendix 6.

Table 4.3: Potential Environmental Impacts from Drought Action

Action	Examples of Potential Impact
Increased Groundwater Abstraction	Associated reduction in river flow, resulting in potential for: • decrease in dissolved oxygen content • higher water temperatures • variations in compositions of macroinvertebrates and plants • increased concentration of pollutants, • increased turbidity/sedimentation • algal blooms • fish to become stranded in affected reach • reduction in aesthetic appeal
	Prolonged period of no flow, resulting in potential for: • loss of aquatic macrophytes and invasion of terrestrial plants • drying of river bed and loss of habitat for aquatic fauna e.g. macroinvertebrates • fish kills
	Associated reduction in local groundwater levels, resulting in potential: • derogation of third party abstractions
Cessation of River +Support	Associated reduction in river flow, resulting in potential for: • decrease in dissolved oxygen content • higher water temperatures • variations in compositions of macroinvertebrates and plants • increased concentration of pollutants, • increased turbidity/sedimentation • algal blooms • fish to become stranded in affected reach • reduction in aesthetic appeal
	Prolonged period of no flow, resulting in potential for: • loss of aquatic macrophytes and invasion of terrestrial plants • drying of river bed and loss of habitat for aquatic fauna e.g. macroinvertebrates • fish kills

4.5 Impact on Fisheries

Should a fish rescue be required as a direct result of any of the above actions the following procedure has been agreed with the EA:

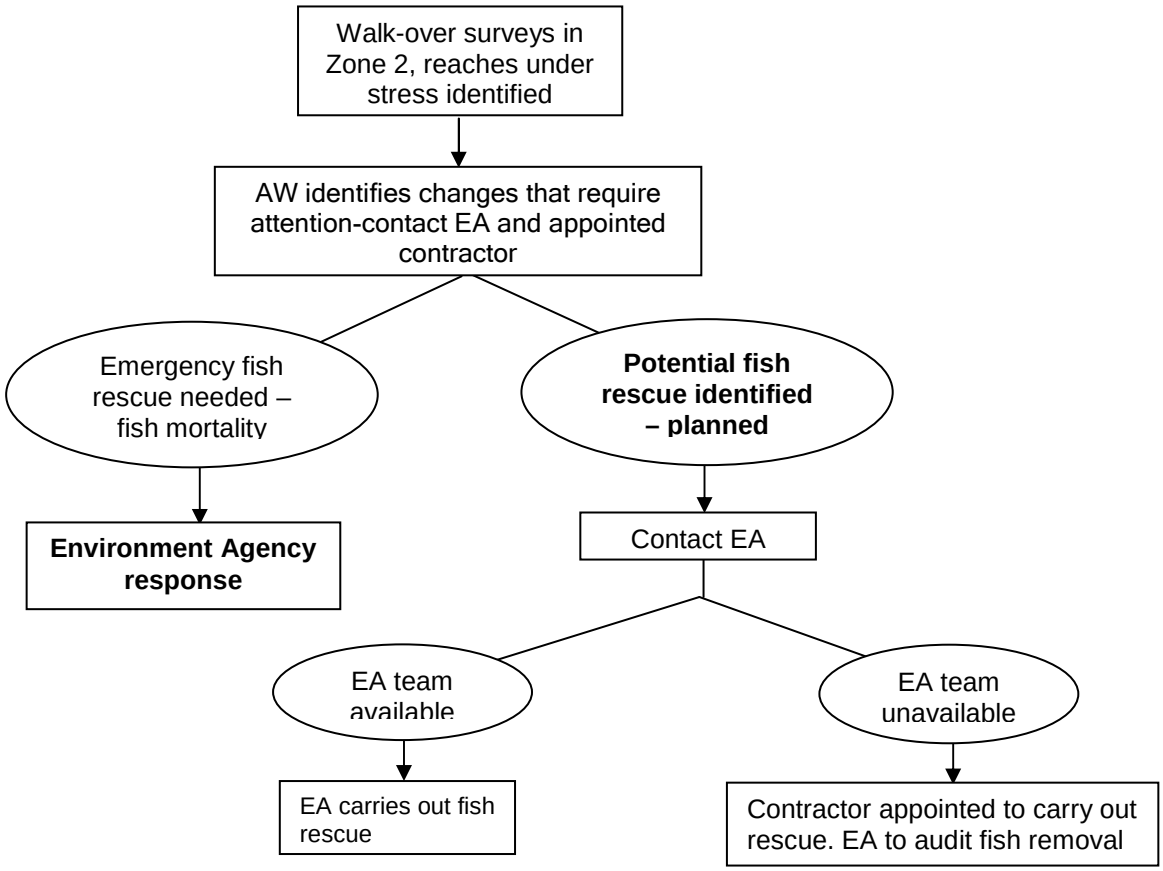


Figure 4.1: Procedure for dealing with fish stress resulting from drought

4.6 Outline Environmental Impacts of Drought in Target Catchments

The catchments that are considered possible candidates for drought management measures in terms of temporary variations in licence conditions under either Drought Permit or Drought Order are discussed in the following sections. Each will provide an outline of the potential impacts on the catchment however an EIA would explore in further detail the magnitude of the problem. We also identify potential environmental impacts of such variations and where we will be carrying out studies where we need to improve our understanding of those impacts.

4.6.1 Environmental Impact Statements

During previous droughts, additional environmental monitoring was undertaken at a number of key locations. The data was collected and reviewed in conjunction with the EA, with an assessment of the likely environmental impact of potential drought actions carried out. This was compared against a model impact assessment that allowed the identification of data gaps. The data gaps identified will be taken forward in our environmental monitoring programme and will be reviewed on an annual basis.

The findings from the initial impact assessments are included in sections 4.6.2 to 4.6.10 above. The statements relate to the Ver, Misbourne, Rib and Cam catchments and give more detail on the potential drought application and consider known hydrological and ecological interests that could be impacted by implementing one of these applications. The catchment assessments will be reviewed annually and updated when appropriate to take account of data collected since the last review. In this way the preliminary statements will reflect changing conditions over time and be maintained in a state of readiness pending future drought conditions. Preliminary environmental assessments have also been conducted for the Gade, Mimram and Hiz based on existing information from previous studies. Gaps have been identified and will be covered by the proposed drought monitoring programme.

Every drought is different and therefore it is essential that environmental assessments for potential Drought Permits or Low Flow Alleviation sites reflect specific local conditions. Enhanced drought monitoring will be implemented in Zone 2 Trigger. Drought Permits and lifting of environmental conditions are not expected to be required until following a second dry winter and therefore the preliminary Environment Impact Assessments will be updated to reflect the specific hydrological and spatial conditions experienced in the meantime.

4.6.2 Ver Catchment

The operation of FRIA at the peak rate of 15.9Ml/d during a drought is thought will not to have an immediate impact on the adjacent River Ver as this upper part of the River is likely to be dry at the time when abstraction at peak is most probable. The operation of the site may however potentially reduce flows further downstream and delay the return of river flows. BOWB has been brought back into supply following a pollution incident in 2005. Appropriate water quality tests have been conducted to ensure drinking water compliance. According to the Ver Operating Agreement, river augmentation from BOWB should occur during low flow periods. However, due to background contamination concerns, the EA has expressed their opposition to augmentation. We have since ensured that abstraction from BOWB is reduced to approximately half, when the river flow is reduced. An increased abstraction from BOWB during the drought will cause delays in recharge, therefore it is recommended that abstraction is reduced towards the end of the drought to ensure that recharge will not be disrupted.

As part of the NEP project, the Ver is currently under options appraisal work trying to identify mitigating actions for low flows.

4.6.3 Misbourne Catchment

The implementation of the Misbourne Operating Agreement and subsequent reduction in abstraction at GREM, AMER and CHAL is thought to have improved flows during ‘average’ conditions. We monitor conditions in the Colne Valley on a continuous basis and share our findings with the EA annually. Under drought conditions it is likely that the Misbourne will be dry throughout much of its length, as seen in summer 2005, and therefore the impact of increased abstraction may be difficult to determine. It is possible that it may delay the recovery of flows for a short period.

As part of the NEP project, the river Misbourne is currently under options appraisal work trying to identify mitigating actions for low flows.

4.6.4 Mimram Catchment

The operation of FULL at the summer peak licence (11.36 Ml/d) has the potential to decrease flows in the adjacent Mimram. It is likely that during a period of drought the flow in this section of the Mimram will be very low or dry and therefore the impact of the

additional abstraction on the river may be difficult to detect. A significant reduction in abstraction from FULL in 1997 is not thought to have had any noticeable benefit on river flows through Welwyn.

We have been notified by the EA that they will impose sustainable abstractions declines on the FULL licence. No timeline has yet been set on this. We are in the process of negotiations with the EA to agree on alternative sources to compensate for the volume to be lost.

4.6.5 Rib Catchment

It is unclear what impact the operation of THUN at the higher rate of 11.82 Ml/d would be on river flows when these are below the licence trigger at the Wadesmill Gauging Station. The lower Rib dried during the 1997-8 drought when THUN was operating at a lower abstraction rate and therefore the impact of an increase in abstraction may be difficult to detect. Work completed on the AMP4 National Environment Programme concluded that Lower Rib low flows were due to hydrogeological reasons, with groundwater flows from the Rib to Lee, by passing lower Rib reaches. These investigations have helped to further understand this relationship and information would be available to support a drought application.

4.6.6 Gade Catchment

The River Gade is hydrologically complicated as it runs parallel to and in and out of the Grand Union Canal. Flows in much of the River are therefore impacted by the use and operation of the Canal and its lock gates. Continued abstraction at HUNT when flows are below the trigger is unlikely to have a significant local impact on the Gade due to the connection with the Canal being more influential on river flows. However, increased abstractions from HUNT have operational implications, as the plant to operate on higher rates is not in place. Therefore, if a drought permit is granted for HUNT, engineering work needs to take place before the permit is used. The option is included in the supply side options list (Table 3.5).

4.6.7 River Cam Catchment

The cessation of support flows to the River Cam at UTTL has the potential to significantly reduce flows in the River, with potential aesthetic issues through the Audley End Estate. There are various weir structures through this artificially landscaped reach of the Cam which further impact low flows even with river support. This reach of the Cam is also understood to be stocked with trout by the Audley End Fly Fishing Club.

Protected rights

The UTTL and SPRF Licence (Serial No. 06/33/27/82) lists a number of protected rights covering third party abstractions in the vicinity of SPRF and UTTL sources. It is believed that work undertaken by us in 1998 to improve the yield and supply from these boreholes near Springwell Farm has resolved most of these issues. However, the Springwell Nurseries borehole is considered to be impacted by the operation of SPRF and they are therefore notified before any operation of this source, in order to monitor water levels in their borehole. There are no known issues on third party abstractions relating to the operation of UTTL.

Mitigation

As mitigation for cessation of support from UTTL, we could support the Cam from our boreholes at SPRF. This is thought to maintain flows above the Great Chesterford trigger but does not benefit as much of the River Cam, including the reach through the Audley End Estate as it is located downstream of UTTL. The Asset Sustainability Manager will

therefore liaise with the Environment Agency and seek to inform the Audley End Estate of the cessation of river support.

It would be our intention to provide support to the river when it is operationally possible to do so to minimise period of no support.

4.6.8 River Beane Catchment

The WHIH license will be reduced as part of the EA sustainability reduction drive. No timeline has been set on this yet. We are in the process of negotiations with the EA to agree on alternative sources. This site does not have the potential for a drought permit.

4.6.9 River Colne Catchment

As part of the NEP project, the Colne is currently under investigations options appraisal work trying to identify mitigating actions for low flows.

4.6.10 River Hiz/Oughton Catchment

The cessation of support to Charlton Mill Pond (Upper Hiz) and/or the River Oughton at OUGH has the potential to cause the upper sections of these rivers to dry. There is public access to footpaths adjacent to these areas and therefore the cessation of support has the potential to have an aesthetic impact on this amenity. Stocked non-native fish species are known to be present in an isolated part of the Upper Hiz and provision for moving these fish in the event of cessation of support would be discussed with the owner. The occupier of the mill in the upper Hiz has recently carried out extensive renovation and lining of the mill pond and operational experience to date indicate that a low input of water is sufficient to maintain lake levels. Additional support to the Hiz below the Mill Pond is possible by the EA through their own river support borehole and this will supplement that from our own source.

If we were to cease support at OUGH, the spring would dry and recovery of flows would be likely to be delayed. We are currently working with the EA to define an operating protocol at both these sites that will cover droughts as well as other periods of low flows.

It would be our intention to provide support to the river when it was operationally possible to do so to minimise periods of no support.

4.7 Post Drought Monitoring

Following the expiry of a drought application, we will continue the enhanced drought monitoring until flows/levels have returned to the long-term average conditions. Data collected during the recovery phase will be valuable in reviewing the DMP and the Environmental Monitoring Plan ready for the next drought sequence.

4.8 Environment Agency Liaison

We liaise with the EA on a regular basis on a variety of water resources, environmental impact and water quality issues. The Asset Sustainability Manager will be the primary point of contact with Environment Agency staff including their Drought Co-ordinators. The manager will be supported by the Physical Assets Department including the Water Resources Specialist.

We also intend to involve Natural England in our discussions through the pre-application process. None of our proposed permitting sites or sites with potentially lifting

environmental conditions has the potential of an impact on a designated site. However, we believe that the expertise of the Natural England employees could assist with building more comprehensive environmental statements during the pre-application process as well as during the time the drought permits will be in place.

5 COMMUNICATIONS PLAN

5.1 Communications Strategy

A multi faceted strategy will be employed to provide opportunities for the largest number of people to receive and understand the need for their assistance in our plans to meet the challenges of a drought by modifying their existing water usage patterns. The Communications Plan has two major strands:

- Ongoing communication of activities focused on encouraging water conservation and awareness of limitations of water resources in the South East.
- Targeted communications activities to manage communications around drought scenarios.

The two strands maintain a springboard from which to launch enhanced drought communications activities that will create a climate of discussion amongst our audiences and maximise opportunities to encourage our customers and stakeholders to educate themselves through credible endorsements.

We now have in place a continuous programme of communications throughout the year urging and educating people to be more efficient in their use of water. We will:

1. Continue to use every opportunity to encourage our different audiences to enter the dialogue and further the cause of saving water.
2. Build on existing relationships and communications channels with stakeholders.
3. Build on existing relationships with media to ensure a regular flow of information to brief and update on the situation and avoid inaccurate information gaining credence.

5.2 Objectives

The overall purpose of the Communications Plan is to establish a comprehensive strategy that provides communications support to the DMG in managing customer supply/ demand, enabling us to:-

- manage efficiently the communications process with customers, other stakeholders, other water companies, our regulators and internally;
- identify all target audiences and appropriate communications channels to
  - provide suitable levels of information;
  - ensure a regular dialogue and close working relationship;
  - ensure our stakeholders receive accurate information directly from us;
- ensure co-ordinated and consistent messages are disseminated to all stakeholders and affected/ interested parties;
- raise awareness of water issues and the need for ongoing water conservation, and increase understanding of peak demand or drought scenarios;
- communicate the positive steps taken by Affinity Water to enable it to manage any peak demand/ drought scenario.

5.3 Target Audiences

The following main groups would be specifically targeted as part of the communication exercise, as shown in Table 5.1.

Table 5.1 : Target Stakeholder Communication

Group	Objective	Prospective Channels
Domestic Customers recognising the wide variations among different groups in terms of age, demography, metered etc	Educate Provide real practical advice on using less water	Billing booklet Broadcast media Contact centre staff External messaging Web site
Customers (commercial)	Improve water efficiency, reduce unnecessary water usage	Face : face contact Written communications
Stakeholders (MPs, LA's, Parish Councils)	Educate - endorsements Broadcast drought messages to a wider audience	Seminars Written communications Local Authority newsletters etc Lobbying
Influencers (advice groups, children, media)	Encourage change of behaviour and greater awareness of needs to conserve water	Citizens Advice Bureaux, libraries, schools & our education teams
Staff	Provide up to date information for staff that interact with customers Low cost reinforcement of messages among friends & family	Regularly updated internal briefing notes
Local Interest Groups	Communicate monitoring programme and mitigation actions, receive valuable local environmental information	Parish Council meetings Interest group meetings Written communications
Other Initiatives	To provide a series of water conservation messages across a broad series of channels	• Joint B&Q promotion with other south east water companies • University student campaigns • Continue dialogues with EA & other water companies • Gifts & giveaways at local events • Joint appeals for restraint with EA and other water companies, regional basis.

5.3.1 Key Stakeholders

We already have good relations with many of the relevant stakeholders however we consider the following parties to be the key contacts to keep up to date in managing any drought:

Environment Agency	Defra
Secretary of State for the Environment	Ofwat
Greater London Assembly	Local Authorities
Consumer Council for Water (CCW)	Water Wise
Neighbouring Water Companies	Natural England

Within Drought Zones 1&2 information would be communicated through standard press releases, which will be coordinated as far as possible with the EA and other water companies. If the resource levels trip into Drought Zones 3 & 4 we would communicate via monthly updates to each organisation on the drought situation.

5.4 Key Messages

The key messages that would be circulated by us in the circumstances that a Trigger condition (excluding Zone 1) has been breached include:

- Actions taken by ourselves to help manage supply and demand
- Continuous monitoring of data to try to predict likelihood of drought
- DMG and OASIS team actions[3]
- Focus on reducing leakage

General messages that would be circulated include:

- How to be more water efficient in the home and the garden
- Key facts and figures on water, resources, availability, dryness of the South East
- Amount by which demand increases at peak times (summer)

Experience has shown that the general public do not respond well to didactic communication styles, particularly where they may feel that access to clean water is a basic human right. Regularly changing the message and its style of delivery also helps to sustain people's interest and keep them engaged and co-operating.

For this reason a number of different approaches will be taken to ensure that water conservation messages are communicated in a variety of forms that will broadcast a serious message that appeals to different age and socio economic groups.

5.5 Targeted Communication Channels for Drought Conditions

Table 5.2 below summarises the channels that will be employed to communicate targeted drought messages.

Table 5.2 Target Communication Channels for Drought Communications

Communication Channel	Audience / Mechanism	Objectives & Metrics	Comment
Annual billing booklet.	All domestic customers. Booklet posted with bills	1.2m households 25% of customers to read new drought section in booklet	To include customer water audit 60% despatch Feb – March.
Stakeholder Engagement	MPs, Local councillors. Personalised letters & newssheets. Newsletter	40 MPs, 41 local authorities. Active support from 50% of above	Opportunity to influence discretionary water use among local councils
Local Authorities: websites, residents newsletters	Council tax payers. Articles written by us and printed in local authority newsletters etc.	22 local authorities co-operated in 2005, target 30 in 2006, 35 in 2007. Target 200 Parish councils	Potential to extend to 41 local extra authorities, plus parish councils
Affinity Water Web site	All domestic customers. Web site available to all web users	Target 500 hits / week	1) water audits on line 2) further source of drought information for customers 3) opportunity for people to report anyone wasting water

[3] DMG – Drought Management Group, ref. section 2.7
OASIS – Summer operations group which meets to discuss the availability of water to put into supply.

Communication Channel	Audience / Mechanism	Objectives & Metrics	Comment
			4) Downloadable posters & information materials for use by customers
Education Centre	Children interacting with Clay lane Education Centre.	18,000 children taught per year. Continuation of water conservation as key topic in key stage 3 teaching	Interaction takes place at our education centre as well as in local schools
Local Press	Local domestic residents. Pieces written and submitted to local media	At least 2 advertorials or our own drought press releases / week	Useful for targeting campaigns in specific areas
Local Events / roadshows	Local residents. Manned AW display stands to promote messages. Water Saving Squad	Target minimum of 6 high benefit events / year	Opportunity for face : face discussion on local issues
Speaker Platforms	Local residents & business forums	Audiences of 30+, attend 2 events per month	Opportunity for face : face discussion on local issues
Broadcast Media	Local residents. Press releases and appearance on local radio programmes such as JACK FM	Various	Phone in discussions could be high interest during time of drought
External Poster advertising	Local residents & businesses	Add-shells & poster sites. Use to be assessed once severity of draught is understood	Needs large scale campaign to achieve necessary saturation
Social Media	Facebook Twitter	Over 1000 followers on Twitter have selected to receive updates and news from Affinity Water	Used on a generic basis - i.e. cant be used to segment customers by geography, etc

5.6 Programme for Distributing Information on Water Efficiency and Conservation

5.6.1 Baseline Communications

Ongoing Communication Activities include the promotion of water efficiency and water conservation. Details of our baseline communications campaign are shown in Table 5.3.

Table 5.3 Baseline Communications Programme for Water Efficiency

Communication Channel	Target Audience	Timing	Responsibility
Regular dialogue with EA	Regulator	Ongoing	Asset Management
Regular dialogue with local environmental groups	Stakeholders	Ongoing	Public Relations/ Env. Manager/ Asset Mangmnt.
Media campaign to provide a steady information stream on need for water conservation, spotting leaks using dedicated leakspotters line, protecting water pipes etc Heightened campaign in summer months – eg additional news releases, leakspotter competitions, gardening tips on radio Flexible campaign that can be heightened should any drought scenario be expected	Customers and stakeholders via the media	Ongoing	Public Relations
Develop relationships with journalists in key media to provide background briefings on water supply/ demand In a drought scenario maximise relationship and seek supportive editorial	Customers via the media	Ongoing	Public Relations
Billing booklet and other Company brochures to carry water efficiency messages Produce specific leaflets on water efficiency – at home, in the garden	Customers (both domestic and commercial)	Ongoing	Marketing/ Education & Environment Centre
Our website explains the need for water efficiency and has separate sections focused on tips for home and business	Customers (both domestic and commercial)	Ongoing	Public Relations
Participation at a range of community events, promoting water efficiency through displays, leaflets and water efficient planters, and offering free Hippos	Customers (both domestic and commercial)	Mainly spring/ summer	Public Relations/ Education & Environment Centre
Speaker platforms to community groups eg Rotary Clubs, Chambers of Commerce, special interest	Customers (both domestic and commercial)	Ongoing	Across business
Education programme focused on encouraging water efficiency, including water audits to help schools be more water efficient, and interactive activities for children to carry out with their parents	Customers (and customers of tomorrow)	Ongoing	Education & Environment Centre
Re-launch successful conservation schemes – Garden Care, Green Care, Tips on Taps	Customer (Domestic)	Ongoing	Public Relations
Publicize all activities above to underline key message of water efficiency	Customers/ stakeholders	Ongoing	Public Relations
Promote water saving devices (water butts, hose guns etc) through website, leaflets and	Customers (both domestic and	Ongoing	Public Relations/ Marketing

Communication Channel	Target Audience	Timing	Responsibility
billing leaflet	commercial)		
Promote self water audit packs through websites, billing booklet, leaflets	Customers (both domestic and commercial)	Ongoing	Public Relations/ Marketing

5.6.2 Drought Communications

A targeted communications campaign will be implemented in accordance with severity of the drought and corresponding Drought Zones as detailed in Table 5.4 below. A number of different activities are initiated in every Zone. As a new level is reach, activities become accelerated. Please note that the information used was valid on the production date of this document.

Drought Zone 2

A dedicated drought webpage is created for Affinity Water. The number of visits is monitored to assess its effectiveness. The url has been used on all communications to the public.

We will contact all AW local authorities with a request to create a link from their websites to our drought page.

When the temporary use ban will be launched we will issue a press release to all AW print and broadcast media and repeat the exercise during the week the ban comes into place. The generated media enquires from national, local and broadcast media will be recorded and monitored as an effectiveness measure.

Weather sponsorship will be in place on local radio stations. The local radio station we work with runs weather slots hourly after the news between 6am and 11pm Monday to Friday (23 mentions per day x 5) and at the weekends from 7am until 11pm (22 mentions per day x 2). The plan for our sponsorship is to last for around 10 seconds. The local radio station has around 70,000 weekly listeners covering a large percentage of Hertfordshire, a website which receives thousands of hits per day, 1800 followers on Twitter and an e-newsletter that 11,500 people have signed up to receive.

A billing insert will be distributed with bills to just under 800,000 customers. The print and production of this will cost around 0.008p per customer. The flyer will contain information about the restrictions and will advertise free water saving devices.

A communication will be issued to 1500 councillors and MPs at not cost. This is expected to result in a regular dialog on the issue with some stakeholders.

Advertising of the restrictions will be placed in local newspapers at a cost of £20,000 for 3 weeks in 10 newspaper groups. This is expected to generate additional requests for water devices, the number of which will be monitored. The value of this promotion might only incrementally increase device uptake but it will provide the opportunity to raise awareness of the drought with an estimate of 550,500 customers who will have the opportunity to see the ad in one week. Local newspaper audiences tend to be repeat purchasers and so the message could be seen on three occasions with a total of 1,651,500 opportunities to see.

At this stage, an involved communication plan with other water companies and Water UK is established. Regular meetings with the other water companies will be in place,

potentially orchestrated by the Environment Agency. Focused discussions with the Water UK water resources liaison panel are organised and regular reporting of the water resources situation in each water company's supply area is out in place.

Drought Zone 3
All Drought Zone 2 activities will continue and will be supplemented with:

An additional communication to stakeholders will be issued at no cost.

Newspaper advertising will be taking place for 3 months in all local newspapers. This is an awareness generating campaign and is expected to lead to an increased number of hits to the website. This campaign will reach an audience of 800,000 customers over ten weeks, providing 9.6million opportunities to see.

Radio advertising will take place from the date we will get into Zone 3. This provides 766,305 opportunities to hear, over a 12 week period and in total provides 9,195,660 opportunities to hear. The campaign will raise awareness of the drought, increase device uptake and generate hits to the website for information about the restrictions.

Additional broadcast media interviews on local radio stations will be in place, at no cost.

Drought Zone 4
All Drought Zone 2 and 3 activities will continue and will be supplemented with:

More focused messaging towards our commercial customers will be in place. Environmental interest groups and organisations will receive regular updates as well. Advertising will continue. The costs that will be occurred are in the order of the costs for the other Zones with supplementary advertising.

Table 5.4 Targeted Communications Activities Related to Zone Breaches

Action and Purpose	Responsibility
Normal conditions	
Routine water efficiency and water resources situation communications with stakeholders and customers	Communications Manager

Action and Purpose	Responsibility
Zone 1 Trigger	
Inform EA that Zone 1 has been breached	Asset Sustainability
Prepare bulletins and briefings internally to - Board/ EMT (Executive Management Team) - VW UK/ VW Paris	Public Relations
Increase media campaign on water conservation, and to encourage leak spotting	Public Relations
Preparatory briefing in community newsletter (MPs/ local authorities)	Public Relations
Prepare copy for leaflets in billing book	Public Relations

Action and Purpose	Responsibility
Zone 2 Trigger	

Action and Purpose	Responsibility
Zone 2 Trigger	
Increase monitoring to evaluate possibility of drought occurring (fortnightly monitoring)	Asset Sustainability
Convene Drought Management Group	Asset Management Director
Inform EA	Asset Management Director
Internal briefing and regular updates to - Board/ EMC - VW UK/ VW Paris - Employees (through Briefings, Bulletins, Team Brief, Intranet, notice boards) - Ensure any employees who will have to deal direct with customers receive full and consistent briefings - Brief manager of Safeguard register and Water Care	Public Relations
Briefing to environmental groups	Public Relations/ Asset Management/ Environment Manager
Alert and regular briefings for opinion formers & regulators - EA - DEFRA - Ofwat - Water UK - CCW - DWI	 Asset Management MD MD Asset Management Director Customer Service Dir Head of Water Quality Services
Alert and regular liaison with environmental/ public health authorities	Scientific Services
Alert and regular liaison with other water companies	Head of Supply
Alert and regular liaison with environmental groups and local pressure groups	Asset Management/ Environmental Manager/ Asset Sustainability
Alert and regular liaison with MPs and local authorities, include information on website	Public Relations
Brief local consumer associations and community groups (eg Help the Aged)	Commercial Development/ Marketing
Brief business customers – particularly agriculture, large water users, leisure water industry and fire services	Commercial Development
Liaison with schools, hospitals and care homes	Education & Environment Centre/ Public Relations/ Commercial Development
Volunteer to participate in appropriate broadcasts	Public Relations
Include information on water conservation relating to drought in resident newsletters and billing book	Public Relations
Review current Water Efficiency schemes and possibly launch new projects	External Relations/ Customer Services/ Stakeholder Services
Produce creative materials in readiness for drought campaign. Identify preferred poster locations.	Public Relations

Action and Purpose	Responsibility
Zone 3 Trigger	
Inform EA regarding escalation	Asset Management Director
Internal briefing and regular updates regarding escalation to - Board/ EMC - VW UK/ VW Paris - Employees (through Briefings, Bulletins, Team Brief, Intranet, notice boards) - Ensure any employees who will have to deal direct with customers receive full and consistent briefings - Brief manager of Safeguard register and Water Care	Public Relations
Set up Environmental/ Public Health liaison	Scientific Services Manager
Briefing to environmental groups regarding escalation	Public Relations/ Asset Management/ Environment Manager
Alert and regular briefings for opinion formers & regulators regarding escalation - EA - DEFRA - Ofwat - Water UK - CCW - DWI	 Asset Management MD MD Asset Management Director Customer Service Dir Head of Water Quality Services
Customer Communications - Direct mailer, especially to vulnerable/ special needs customers - Establish drought helpline - Briefing for call centre and Q&As - Call centre message	Public Relations/ Customer Service
Website updated regularly to include latest information - Further source of drought information for customers - Opportunity for people to report anyone wasting water - Downloadable posters and information for customer use	Public Relations
High level media campaign for press and broadcast media - Editorial - Advertising - Billboards - Posters at local amenities - Ensure key local trade press and special interest magazines/ journals are covered - Public notices - Local authority residents magazines/ parish magazines	Public Relations
Mobilize relationships with key journalists in press and broadcast media to keep updated and on side	Public Relations
Consider road-shows	Public Relations

Action and Purpose	Responsibility
Zone 3 Trigger	
Use speaker platforms to community associations to communicate key messages	Across business
Communicate supply restrictions – temporary water usage restrictions - Prepare and place media ads - Contact trade associations of key activities to explore implications of restrictions on non-essential use - Consult key customers on non-essential use - Issue supporting news release - Prepare statement and Q&As for media/ customer enquiries - Update website - Prepare details for enquiries on compensation - Briefing and Q&As to call centre - Update drought helpline	Public Relations
Advertise application for drought permits/orders Prepare statement and Q&As to respond to any media/ customer enquiries	Public Relations Public Relations
Prepare guidelines for discussion with private well owners and programme of visits	Asset Management
Review and revise communications plan depending on effectiveness to date	Public Relations
Update briefing to key journalists	Public Relations

Action and Purpose	Responsibility
Zone 4 Trigger	
Inform EA regarding escalation	Asset Management Director
Internal briefing and regular updates regarding escalation to - Board/ EMC - VW UK/ VW Paris - Employees (through Briefings, Bulletins, Team Brief, Intranet, notice boards) - Ensure any employees who will have to deal direct with customers receive full and consistent briefings - Brief manager of Safeguard register and Water Care	Public Relations
Briefing to environmental groups regarding escalation	Public Relations/ Environment Manager
Alert and regular briefings for opinion formers & regulators regarding escalation - EA - DEFRA - Ofwat - Water UK - CCW - DWI	 Asset Management MD MD Asset Management Director Customer Service Dir Head of Water Quality Services

Communicate supply restrictions – DD11 drought restrictions	
- prepare ad campaign to inform commercial customers	Public Relations
- prepare and deliver journalist briefing, media statement	Public Relations
- prepare Q&As for customers/ media	Public Relations
- update website	Public Relations
- update drought helpline	PR/ Customer Service
- briefing to customer call centre	PR/ Customer Service

6 POST DROUGHT ACTIONS

6.1 Identifying end of drought

The end of a drought can be defined as when the risk of impact from drought is no greater than during a normal year, and where normal conditions have continued for a period of time. The hydrological conditions as a drought recedes can be complex and identifying the end of a drought can be difficult to determine. We will confirm first and foremost with the Environment Agency that the water resource situation has returned to normal before taking any action. The following stakeholders would also be notified before any actions are taken: DEFRA, OFWAT, Water UK, Consumer Council for Water, DWI, Environmental Groups.

The end of a drought will be determined using the company's triggers, with all restrictions able to be removed when GW levels have moved sustainably out of Zone 3. The lifting of the ban will first require notice in relation to the lifting of prohibitions to be published on the company website and in two newspapers circulating in the affected areas. Unlike the imposition of restrictions however, there is no such lead in time necessary; restrictions will be revoked instantly after the notice is given.

Figure 2.10 demonstrates that it can take up to 2 years of consecutive above LTA rainfall in order to recover from a long term drought scenario. It would require restrictions to be in place throughout this period until groundwater levels have fully recovered. A media campaign would be regularly reinforced outlining clear messages and educating customers that restrictions would remain in place despite heavy rainfall.

6.2 Post-drought actions

Directly after a drought event, it will be the responsibility of the Director of Asset Management to produce a "lessons identified" report that will enable future processes to be improved. This report will be produced within 3-6 months of a drought ending and will be followed up within a year with evidence that recommendations were acted upon. The report will include:

- A review of the environmental impact of the drought by analysing baseline, in-drought and post-drought data.
- Determining if the appropriate environmental monitoring of baseline, during and after a drought was carried out to measure the impact of any drought permits or drought orders.
- A review of the effectiveness of any mitigation measures implemented.
- A review of the success of any drought permit and drought order applications
- An assessment of how well individual sources delivered additional water and determine where any re-assessments of yields may be needed or invested to maintain yields of sources.
- An assessment of the estimates of demand reduction from the implementation of demand side drought management actions.
- An investigation into whether or not the company would need to make any changes to its demand forecast or longer term demand forecast

Additionally a drought workshop would be held to assess the efficacy of the management process and review whether any improvements or changes to the drought plan were required.

APPENDICES

Appendices

APPENDIX 1 LONG TERM CONTROL CURVES

A1.1 Long term control curves: Chalfont Centre, Lilley Bottom and Elsenham Nursery

This Appendix shows long-term measured water levels at the three observation boreholes used by us to evaluate the groundwater level conditions across our supply area. Their Locations are shown on Figure 2.1. Onto the long-term measured water levels, four drought triggers have been super-imposed, which are based upon historical information relating to when publicity campaigns and hosepipe bans were used in the past. Whilst ensuring that drought zone 2 is a 1-in-5 year event and drought zone 3 is a 1-in-10 year event. Drought zone 4 was set just below lowest recorded levels as we managed to maintain supply without having to resort to drought permits, drought orders nor standpipes and rota-cuts.

Figure A1.1.1 Drought Trigger Monitoring at Chalfont Centre DT1

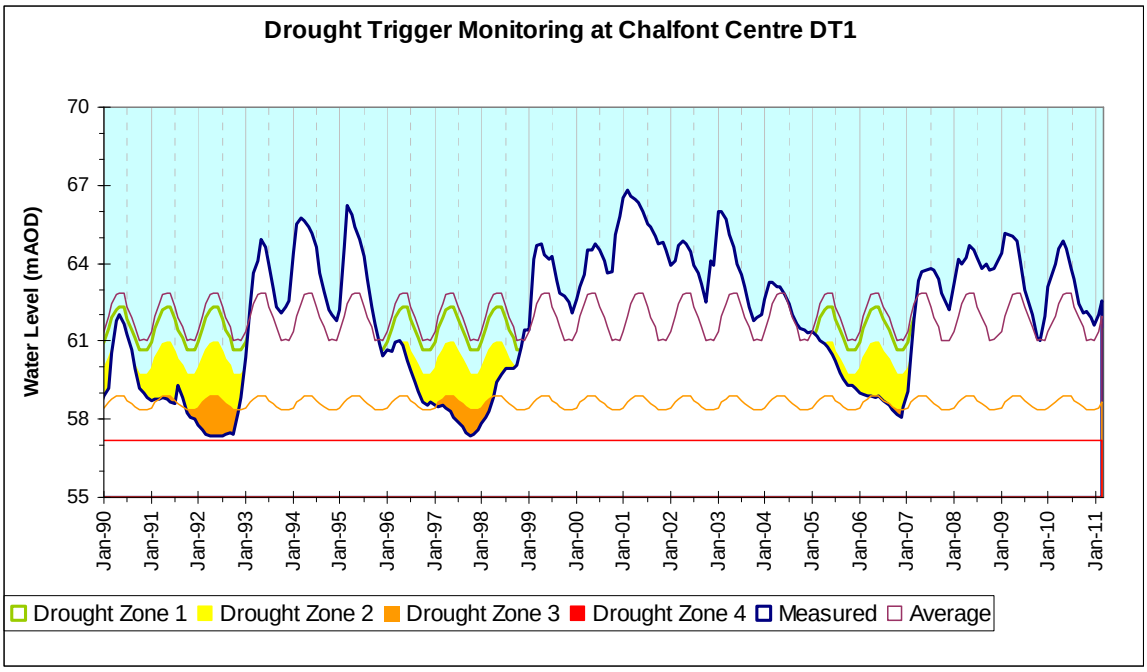


Figure A1.1.2 Drought Trigger Monitoring at Chalfont Centre DT2

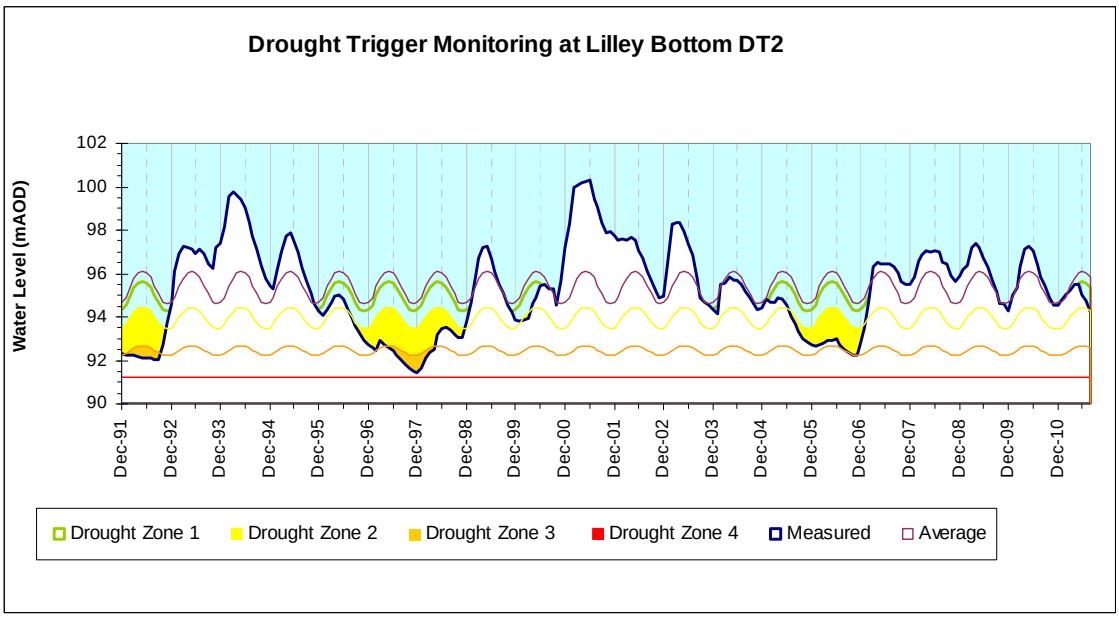
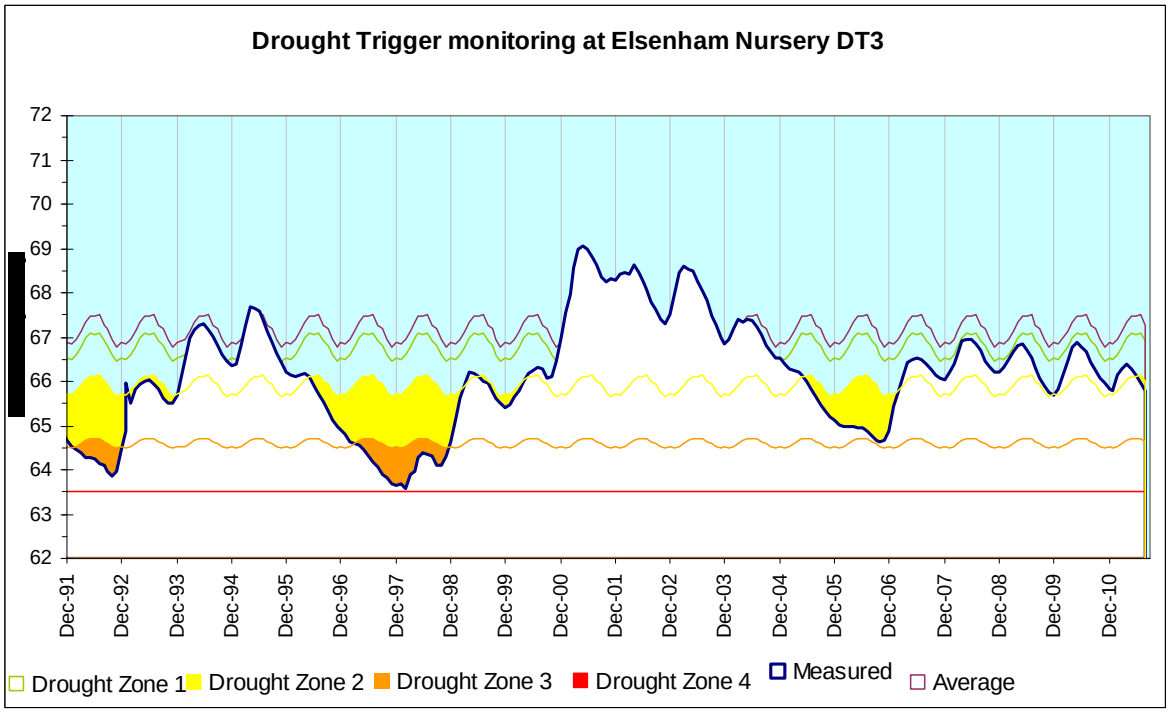


Figure A1.1.3 Drought Trigger Monitoring at Chalfont Centre DT1



APPENDIX 2 SHORT TERM CONTROL CURVES

A2.1 Short term control curves: Chalfont Centre, Lilley Bottom and Elsenham Nursery

This Appendix contains graphs showing the same information as contained within Appendix 1 however over a shorter timescale of two years as opposed to 20 years. The long-term control curves are used to produce the drought triggers based on historical information those triggers are then transferred from a 20 year timescale to a 2 year one to enable us to monitor drought on a month by month basis.

Figure A2.1.1 Drought Triggers at Chalfont Centre DT1

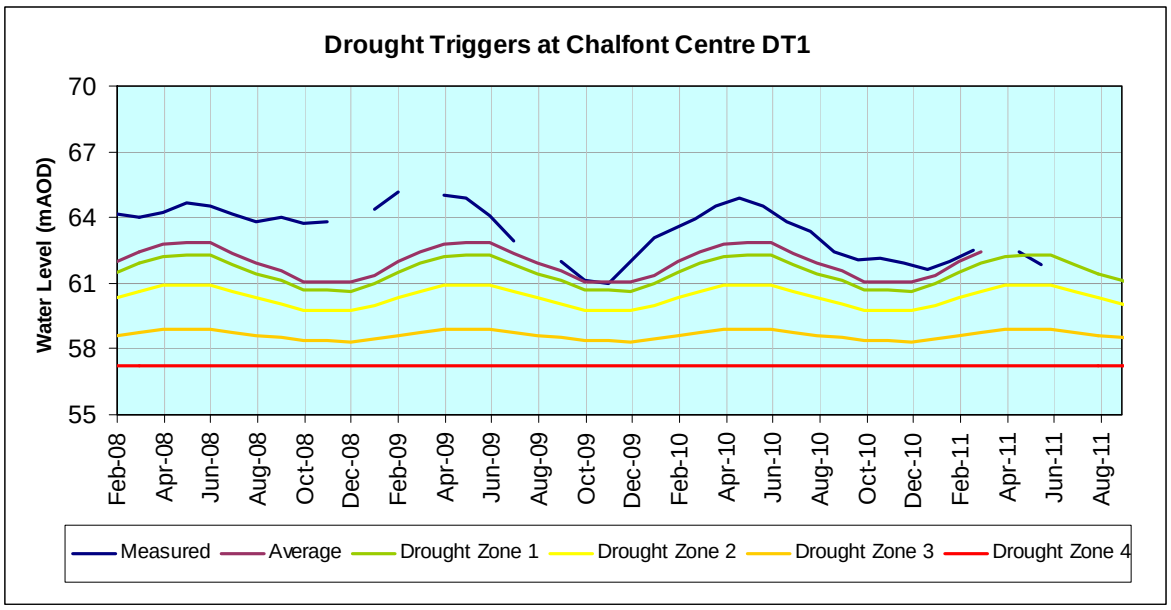


Figure A2.1.2 Drought Triggers at Lilley Bottom DT2

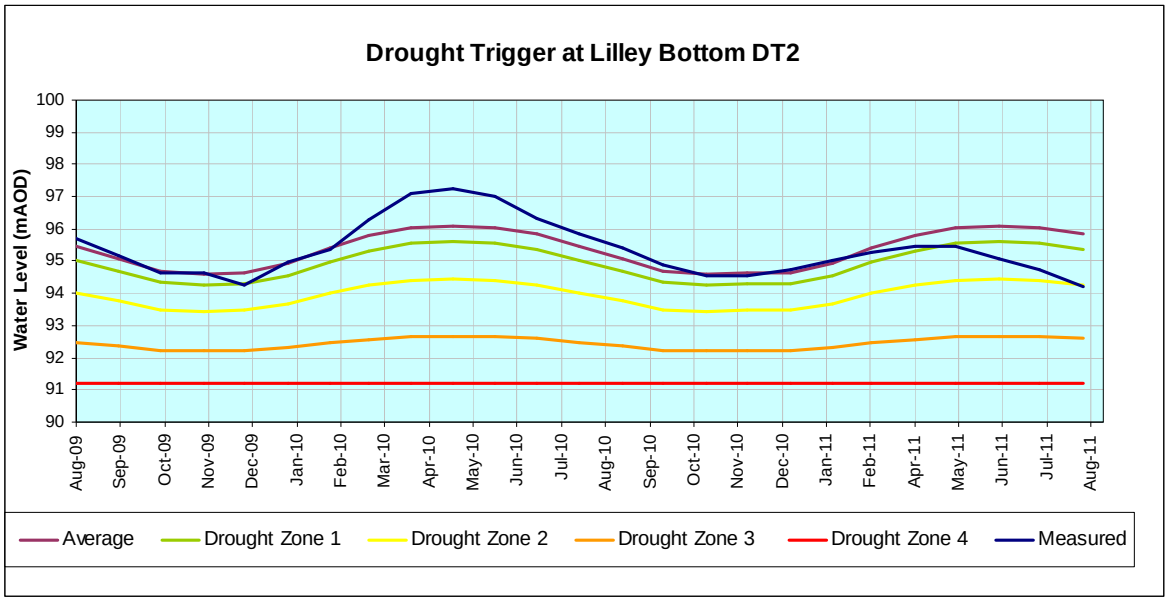
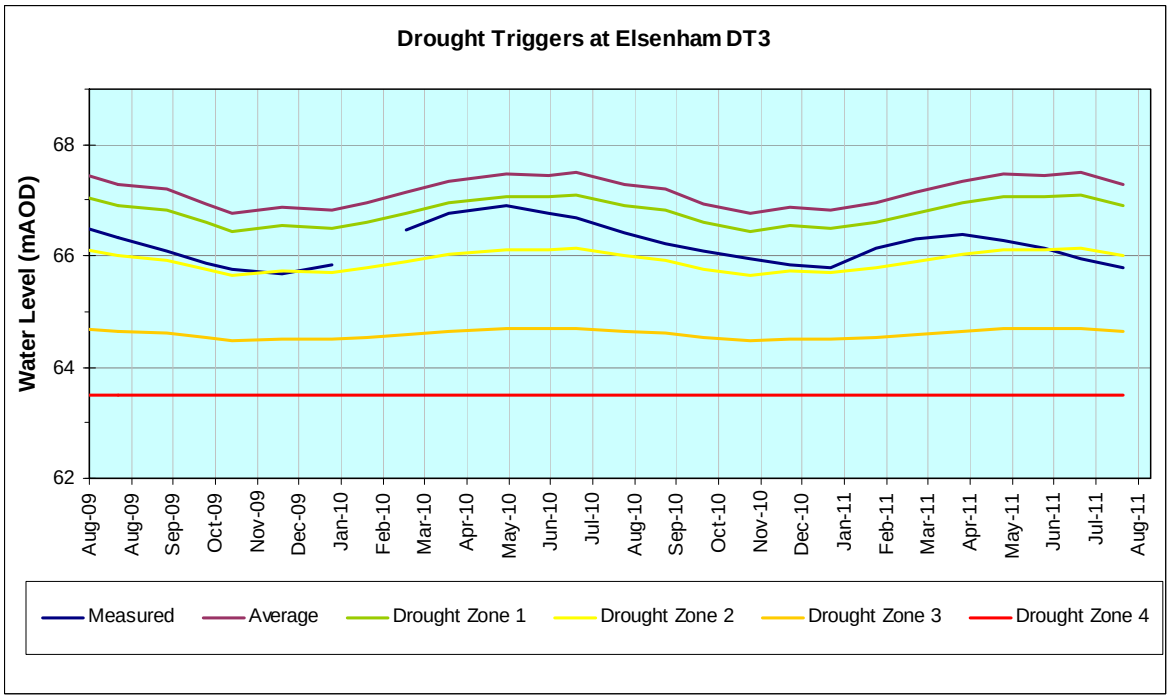


Figure A2.1.3 Drought Triggers at Elsenham DT3



APPENDIX 3 FORECASTINGS AND SCENARIOS

A3.1 Hydrograph analysis rise in groundwater levels

The two sets of data used to conduct the hydrograph analysis work are:

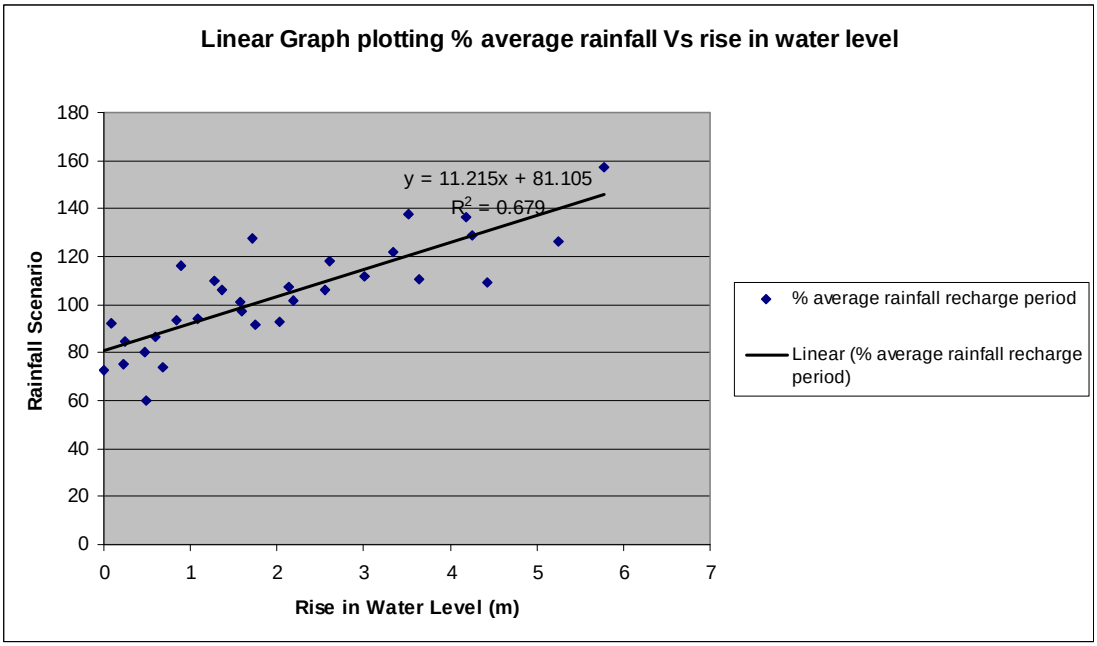
- Rainfall return periods. These have been obtained from the Oxford Rainfall Data set
- Actual recorded groundwater levels at Lilley Bottom Observation Borehole

The Oxford rainfall set was used as it has rainfall records from 1853. These were compared with MORECS rainfall (squares 151 & 152) and a good fit (82%) was determined for the recharge period and thus have been used to determine the return period for the recharge season in our recharge area.

The absence of long term records of operational borehole performance prevents comparison with droughts before 1976. Whilst there are long term observation borehole groundwater level sequences, it is not possible to correlate these with fluctuations in levels in operational boreholes without pumping data from historic drought events. As a result we have selected data from between 1980 and 2010 to be analysed.

For each year, the total rise in groundwater levels was recorded. A monthly breakdown of actual water levels was noted during this period of total rise and then a calculation of the rise per month was undertaken. The average rainfall return period was then plotted against the relevant year. This enabled us to plot a linear graph (Figure A3.1) demonstrating the correlation between % of rainfall and rise in water level. This relationship supports the methodology underpinning the hydrograph analysis that volumes of rainfall are proportionate to levels of recharge.

Figure A3.1.1 Linear Graph plotting % average rainfall Vs rise in water level



For the available water level record, years were selected to represent the water level changes associated with the different return periods. The four rainfall scenarios that were selected for the hydrograph analysis work are outlined in table A3.1. The analysis work to generate the water level readings is outlined in Table A3.2.

Table A3.1.1 Four rainfall scenarios selected for analysis

Rainfall Scenario (%)	Recharge Year
130	1992/1993
120	2002/2003
80	1990/1991
60	1991/1992

Table A3.1.2 Analysis of rises in groundwater levels during four selected years

Rainfall Scenario		80%	60%	130%	120%
Year		1991	1992	1993	2003
RECORDED WATER LEVEL (M)					
September				92.02	
October				92.72	
November				93.75	
December				94.62	94.98
January		92.94		96.08	96.54
February	96.25	93.01	92.24	96.92	98.3
March	96.57	93.07	92.24	97.27	98.32
April	96.83	93.34			98.32
May	97.09	93.42			
June					
July					
total rise	0.84	0.48	0	5.25	3.34

Ave Month rise	0.28	0.16	0	0.875	0.835
CHANGE IN WATER LEVEL (M)					
September					
October				0.7	
November				1.03	
December				0.87	
January				1.46	1.56
February		0.07		0.84	1.76
March	0.32	0.06	0	0.35	0.02
April	0.26	0.27			0
May	0.26	0.08			
June					
July					

We have transposed the actual level of water rise per month and when the rise occurred for the 80% and 60% scenario onto a hypothetical starting water level situation to forecast two different scenarios. During the months there is no water level rise we have assumed that groundwater levels are declining using an average monthly figure as described in A3.2. This allowed an artificial hydrograph to be constructed to cover the different return periods. These hypothetical water sequences have been superimposed on the drought curves and indicates when and for how long we will be in any of the drought zones. The rainfall scenarios have been applied over a single, multi and long term periods.

A3.2 Hydrograph analysis fall in groundwater levels

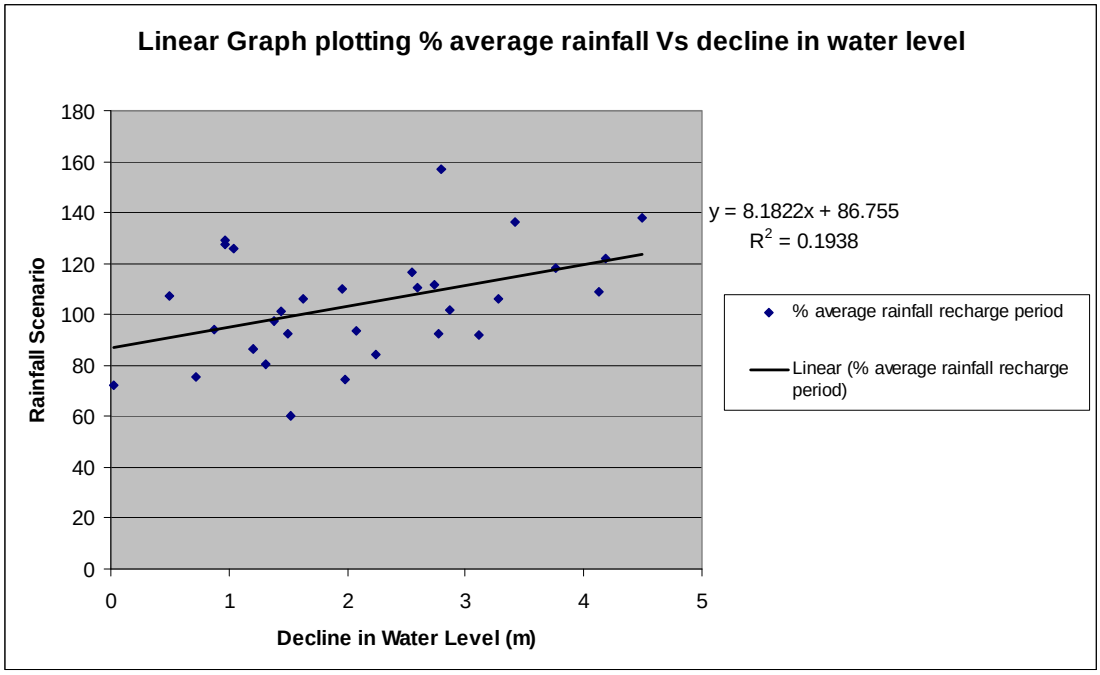
The two sets of data used to conduct the hydrograph analysis work are:

- Rainfall return periods. These have been obtained from the Oxford Rainfall Data set
- Actual recorded groundwater levels at Lilley Bottom Observation Borehole

The absence of long term records of operational borehole performance prevents comparison with droughts before 1976. Whilst there are long term observation borehole groundwater level sequences, it is not possible to correlate these with fluctuations in levels in operational boreholes without pumping data from historic drought events. As a result we have selected data from between 1980 and 2010 to be analysed.

For each year, the total decline in groundwater levels was recorded. A monthly breakdown of actual water levels was noted during this period of total decline and then a calculation of the decline per month was undertaken. The average rainfall return period was then plotted against the relevant year. A linear graph was plotted (Figure A3.2) demonstrating that there is no clear relationship between % of rainfall and drop in water metre level.

Figure A3.2.1 Linear Graph plotting % average rainfall Vs decline in water level



A line graph was then plotted comparing groundwater level declines over different years (Figure A3.3). The pattern highlights that the rate of decline remains consistent regardless of summer rainfall and starting water level. Average monthly decline figures were then calculated over the past twenty years (only using the months where there has been a decline). These monthly average decline figures have then been applied to each rainfall scenario, fitting around months in which groundwater levels rise, which is related to the amount of rainfall. A more detailed breakdown of these figures is highlighted in Table A3.3.

Figure A3.2.2 Example of similarity in rates of groundwater decline over different years

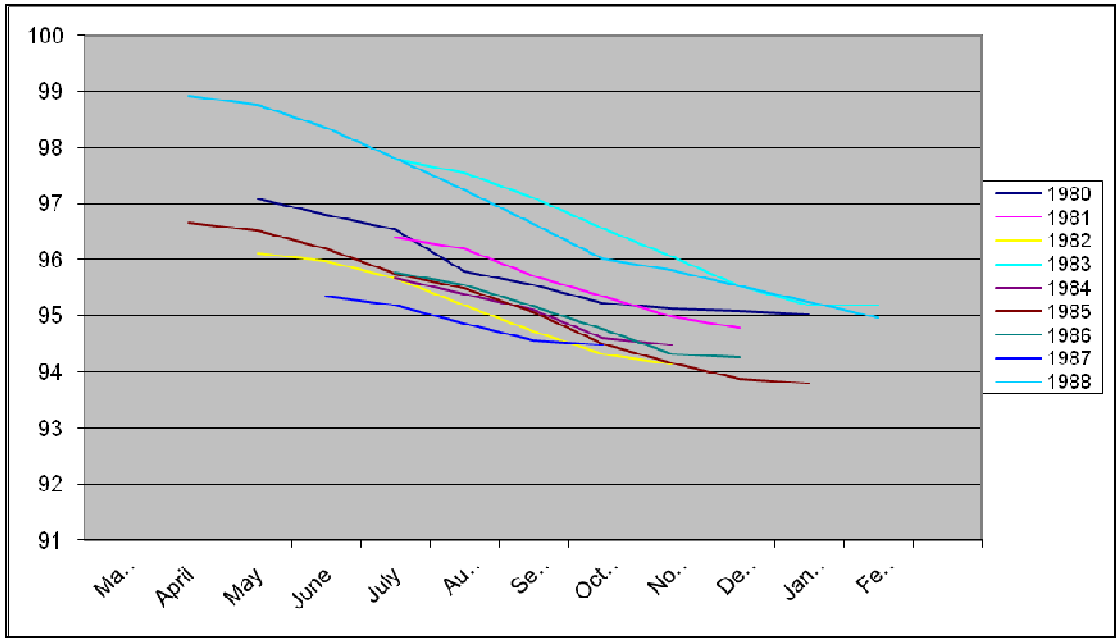


Table A3.2.1 Average monthly rate of groundwater decline between 1980-2011

Month	Average Decline
April	0.14
May	0.125
June	0.3
July	0.48
August	0.29
September	0.39
October	0.3
November	0.2
December	0.15
January	0.05
February	0.01
March	0.085

A3.3 Relevance to Strategic Environmental Assessment Directive and Habitats Regulation Assessment

There follows below a short discussion on the interpretation of the legislation relating to the Strategic Environmental Assessment Directive (SEAD) 2001/42/EC. Which is enabled in the UK via the Statutory Instrument 2004 No 1633 - Environmental Assessment of Plans, Programmes Regulations 2004. There is also EU Directive 85/833 on the assessment of the affects of certain public projects on the environment as amended by Council Directive 97/11/EC. There are no Habitats Directive sites within our supply area that would be impacted by our DMP and thus this directive (92/43/EEC) is not relevant to our activities.

The SEA legislation deals with future developments and construction activities. Our Drought Plan is not a development plan. It highlights short term operational actions that we would take in order to manage and where possible, improve our water resource position to make water available to customers whilst minimising that impact on the environment. Thus, this plan is in reality an emergency plan, parts of which may or may not be required during any given drought event. Our plan highlights potential short-term environmental impacts of its implementation and we will undertake monitoring as detailed herein to assess and mitigate these temporary impacts where possible.

Having considered the requirements of Articles 3.2, 3.3 and 3.5 in the SEAD, and the guidance offered by the Office of the Deputy Prime Minister in 2005, we do not consider that any Strategic Environmental Assessment is required to support this Drought Management Plan.

Under **The Conservation (Natural Habitats, & c.) Regulations 1994,** Regulation 60 imposes a condition on all permitted development which:

a) is likely to have a significant effect on a European Site (either alone or in combination with other plans or projects), and

b) is not directly connected with or necessary to the management of the site for nature conservation.

The condition imposed by Regulation 60 applies to ALL forms of permitted development. There are no exceptions. Regulation 60 applies only to European sites as defined by the Habitats Regulations. As a matter of policy though it should also be applied to pSPA and Ramsar sites. VWE Drought Management Plan is not a development plan. In addition, there are no European sites or pSPA or Ramsar sites within our supply area that would be impacted by our Plan and, therefore, a Habitats Regulation Assessment is not applicable.

APPENDIX 4 DROUGHT MANAGEMENT ACTIONS

A4.1 Demand options during drought

	Option Implementation Assessment (Demand Side)				Environmental Assessment			
Option Name	Trigger	Implementation Timetable	Permissions Required & Constraints	Risks Associated with Option	Risk to the Environment	Summary of Possible Environmental Impacts	Monitoring Requirements	Impact on Other Activities
Increased Intensity of PR Campaign	Zone 2	1 week preparation time, any time of year, duration of drought	DMG	Communication through the media are often problematic due to poor coverage of television and radio	None			
Water Efficiency Campaign	Zone 2	1 week preparation time, any time of year	DMG	See Communications Plan	None		Measure change in HDZ, preliminary indication 2-3%	
Increased Targeting of Meters	Zone 2	1 week preparation time, any time of year	DMG	Water conservation through metering is more significant in long term	None		Measured readings. Number of installations	
Leakage Minimisation Effort Acceleration	Zone 2	1 week preparation time, any time of year	Board & Local Council to dig up roads	Reducing repair times to lower leakage is more complex	Minimal	Additional disruption to Highways & Byways	New leakage monitoring report. June return	
Pressure Management	Zone 3/4	1 week preparation time, any time of year	Board & DMG	Low pressure and no water to some customers	None		Zonal pressure	
Temporary Usage Bans Restrictions	Zone 2/3	1 week preparation, 2 week representations. Notification process beigns in band 2	Board & DMG	Reduction in level of service as agreed with OFWAT	None	Reduction in peak demand possible beneficial impact to environment	Water use study/ UKWIR/ EA. Attempt to measure impact of restrictions	Impact upon domestic customers
Drought Direction 2011 Measures	Zone 4	8 weeks preparation, 2 weeks representation. Application begins to SoS immediately after zone 4 is breached	Board & DMG	Low customer sensitivity to restrictions. Adverse economical impact on commercial customers	None	Reduction in average demand possible beneficial impact to environment	Company/ HDZ demand monitor	Impact upon public, industry, commerce & possibly local authorities

A4.2 Resource options during drought

	Option Implementation Assessment (Resource Side)				Environmental Assessment		
Option Name	Trigger	Implementation Timetable	Permissions Required & Constraints	Risks Associated with Option	Risk to the Environment	Summary of Possible Environmental Impacts	Details of Studies
Full assessment of Source Performance, internal transfers and network model scenario runs	Zone 2	8 weeks preparation time	DMG and Production	Conditions of sources and network unknown, future plans risks	None	Abstraction kept within licence limits therefore no increased risk to the environment	
Transfer from Surplus Area via existing networks	Zone 2	1 week preparation time	DMG and Production	Reduced security of supply transfer and network risks	None	Abstraction kept within licence limits therefore no increased risk to the environment	
Supply balancing	Zone 2/3	Immediate	DMG and Production	Possible network issues with change in quality of water	None	Abstraction kept within licence limits therefore no increased risk to the environment	
Additional outputs	Zone 3	Dependent on assessment od output capacity at the time	DMG, Production and Water Quality	Servicibility of plant and avaiability of suitably sized pumps	None	Low as abstractions will remain within Licensed limits	
Bring forward engineering works to enhance existing network capability	Zone 3/4	Dependent on status of project and permissions to install pipework	DMG, Network and Asset Management	delays in commissioning, may not delever benefits until in zone 3 or 4. Not new water only improving utilisation of existing resources	Minor linked with construction works	Abstraction kept within licence limits therefore no increased risk to the environment	
Pressure Control Schemes	Zone 3/4	Dependent on assessment of pressure distribution and management at the time	DMG, Network and Asset Management	delays in commissioning, may not delever benefits until in zone 3 or 4. Not new water only improving utilisation of existing resources	none	Abstraction kept within licence limits therefore no increased risk to the environment	
Re-commision dormant sources	Zone 3/4	Escalate from current WRP	Need EA and DMG approval	Water quality problems could impact delivery	Possible due to increase in abstraction	Reduction in local water levels and river flows. Delay onset of recovery of water levels	Test water quality and network/connectivity studies
Intercompany Transfers/ Bulk imports above those already available	Zone 4	Subject to availability	Formal agreement with neighbouring Company	Neighbouring Company will not have water to spare due to own customer demands	None, using existing transfer links	Low as abstractions will remain within Licensed limits	
Increase peak abstraction for same average license	Zone 4	Escalate from current WRP	Need EA and DMG approval	Environmental risk of increased abstraction. Only available for peak week	Possible due to increase in abstraction	Reduction in local water levels and river flows. Delay onset of recovery of water levels	Increased environmental monitoring as stated in DMP
Relax low flow Licence conditions	Zone 4	Application when in Zone 4, 2 weeks for decision making and 4 weeks for potential hearing	Need Board and EA approval	Environmental risk of inceased abstraction and delay in recovery of groundwater levels	Possible due to increase in abstraction	Reduction in local water levels and river flows. Delay onset of recovery of water levels	Increased environmental monitoring as stated in DMP
Unlicensed sources	Zone 4	Escalate from current WRP	Need EA and DMG approval	Water quality problems	Possible due to increase in abstraction	Reduction in local water levels and river flows. Delay onset of recovery of water levels	Thorough monitoring
Drought permits/orders	Zone 4	Apply for in zone 3 to use in zone 4	Need EA, DEFRA and DMG approval	Environmental risk of inceased abstraction and delay in recovery of groundwater levels	See EMP	See EMP	See EMP

A4.3 Temporary Use Restrictions Representation Form

Customer Representation Form

Name ……..

Address ……..

……..

Date ……..

1. Is the representation on the grounds of Health and Safety? (please circle)
   YES **NO**
2. If not what is the representation on the grounds of?
3. ……..
4. Which restriction is the representation referring to?
5. ……..
6. Please provide details on the reason for the representation

……..

……..

……..

FOR OFFICE USE ONLY

Representation Approved **YES** **NO**

Comments ……..

Date ……..

Approved by ……..

……..

A4.4 Activities covered by temporary bans under the Flood and Water Management Act 2010

The table below lists the restriction categories that may be used to manage a drought if temporary bans on water usage are imposed.

Table A4.4.1 Categories of Temporary Use Ban Restrictions

Figure	Activity/Title
A4.4.1	Watering a garden using a hosepipe
A4.4.2	Cleaning a private-motor-vehicle using a hosepipe
A4.4.3	Watering plants on domestic or other non-commercial premises using a hosepipe
A4.4.4	Cleaning a private **leisure** boat using a hosepipe
A4.4.5	Filling or maintaining a domestic swimming or paddling pool
A4.4.6	Drawing water, using a hosepipe, for domestic recreational use
A4.4.7	Filling or maintaining a domestic pond using a hosepipe
A4.4.8	Filling or maintaining an ornamental fountain
A4.4.9	Cleaning walls, or windows, of domestic premises using a hosepipe
A4.4.10	Cleaning non-domestic premises
A4.4.11	Cleaning paths or patios using a hosepipe

The following information applies to each activity:

Legislation:

All eleven activities are covered by the Water Industry Act 1991 section 76 as amended by the FWMA 2010 (i.e. temporary water use bans).

Programme:

Constrained by advertising in at least two newspapers relevant to the location and the water company's website. 2-3 weeks.

"Using a hosepipe"

The Water Use (Temporary Bans) Order 2010 provides the definition of "using a hosepipe" in relation to the WIA 1991 as including:

a) Drawing relevant water through a hosepipe from a container and applying it for the purpose; and

b) Filling or partly filling a container with relevant water by means of a hosepipe and applying it for the purpose.

A reference to a hosepipe includes anything designed, adapted or used for the same purpose as a hosepipe.

"Relevant water" refers to mains water i.e. supplied by the water undertaker; it does not include water supplied before the water use restriction was implemented.

The following tables provide details of our baseline application of Temporary Use Ban Restrictions.

A4.4.1 – Watering a garden using a hosepipe

DEFINITIONS

The category of activity under the temporary water use ban powers is **"watering a garden using a hosepipe".** It does **not** include using a hosepipe to water a garden for **health or safety** reasons.

Gardens

The Water Use (Temporary Bans) Order 2010 provides the definition of "a garden" as **including**:

a) a park;

b) gardens open to the public;

c) a lawn;

d) a grass verge;

e) an area of grass used for sport or recreation;

f) an allotment garden;

g) any area of an allotment used for non-commercial purposes;

h) any other green space.

"A garden" does **not include** the following:

a) agricultural land;

b) other land used in the course of a business for the purposes of growing, for sale or commercial use, any crops, fruit, vegetables or other plants;

c) land used for the purposes of a National Plant Collection;

d) a temporary garden or flower display;

e) plants (including plant organs, seeds, crops and trees) which are in an outdoor pot or in the ground, under cover.

"Allotment gardens" are defined in section 22(1) of the Allotments Act 1922.

"Agricultural land" is as defined in section 109(1) of the Agriculture Act 1947.

"National Plant Collection" means a plant collection which is part of the National Council for the Conservation of Plants and Gardens' National Plant Collection scheme.

"Outdoor pot" means a pot or other container that is outdoors or under cover.

"Under cover" means in a greenhouse or outbuilding or under a permanent canopy.

"Temporary garden or flower display" means those at a show or exhibition; and on public display for a period not exceeding 7 days.

"Grow" includes cultivate or propagate.

MESSAGES

Customers may water their gardens:

- By hand, using a bucket or watering can.
- With greywater through a hosepipe.
- Using rainwater from a water butt by hand or through a hosepipe.

The Turf Growers Association advises that established turf (>28 days old) does not require watering.

Public Sector

Under the Water Act 2003, public authorities have a water conservation duty and arguably should not wait until restrictions come into force before taking water conservation measures.

Storage tanks

Water drawn from the mains supply into tanks (other than hand held receptacles) for subsequent use for watering private gardens, lawns and landscaped areas via a hosepipe is not permitted.[1]

Methods for recycling water or finding water from alternative sources should be encouraged for those concerned about the financial implications of not being able to use mains water[2].

Sports Pitches

Watering areas of grass used for sport or recreation using a hosepipe are covered under this activity. This includes all sports pitches or similar such as cricket and football pitches, bowling greens, horseracing tracks and golf courses. It applies to both publically and privately owned facilities; both can be large users of water but some may have private water supplies for watering sports pitches. Watering for health or safety reasons is exempt from the legislation. Sports pitches can still be watered using other sources of water and innovative recycling methods can be encouraged.

EXEMPTIONS & CONCESSIONS

A statutory exemption exists in The Water Use (Temporary Bans) Order 2010 for the watering of gardens in respect of **health or safety** (see Section 5.7 of this report for further detail). This includes:

a) removing or minimising any risk to human or animal health or safety; and

b) preventing or controlling the spread of causative agents of disease.

A4.4.2 – Cleaning a private motor-vehicle using a hosepipe

DEFINITIONS

The category of activity under the temporary water use ban powers is **"cleaning a private motor-vehicle using a hosepipe".**

The Water Use (Temporary Bans) Order 2010 defines "**a private motor-vehicle**" as:

a) a mechanically propelled vehicle designed, constructed or adapted for use

[1] Summary of responses to the consultation, between 23 March and 15 June 2007, on proposed changes to powers to restrict non-essential uses of water, Defra, 2007
[2] Summary of responses to the consultation, between 23 March and 15 June 2007, on proposed changes to powers to restrict non-essential uses of water, Defra, 2007

on roads; or

b) a trailer designed, constructed or adapted for attachment to a vehicle falling under (a).

The definition **does not include**:

i) a public service vehicle, as defined in section 1 of the Public Passenger Vehicles Act 1981; and

ii) a goods vehicle, as defined in section 192 of the Road Traffic Act 1988.

Interpretation

Taxis and minicabs are not public service vehicles and so are subject to bans[3].

MESSAGES

Important positive messages:

- Customers can still wash their cars (including lights and windows) by hand using water from a bucket.
- Customers can use commercial carwashes (that don't use a hosepipe or similar apparatus), for example at garages.
- Customers can wash their cars with a hosepipe connected to a rainwater or greywater source (e.g. bathwater diverted to a receptacle for subsequent use).

Storage tanks

Water drawn from the mains supply into tanks (other than hand held receptacles) for subsequent use for vehicle washing via a hosepipe is not permitted[4].

Restrictions apply to water drawn from the mains supply after the statutory notice has been given. So water drawn into a container prior to that date may be used for washing cars, regardless of whether that use involves a hosepipe[5].

EXEMPTIONS & CONCESSIONS

None

[3] Consultation on proposed changes to powers to restrict non-essential uses of water, Defra, 2007
[4] Summary of responses to the consultation, between 23 March and 15 June 2007, on proposed changes to powers to restrict non-essential uses of water, Defra, 2007
[5] Summary of responses to the consultation, between 23 March and 15 June 2007, on proposed changes to powers to restrict non-essential uses of water, Defra, 2007

A4.4.3 – Watering plants on domestic or other non-commercial premises using a hosepipe

DEFINITIONS

The category of activity under the temporary water use ban powers is **"watering plants on domestic or other non-commercial premises using a hosepipe".**

The definition applies only to the watering of plants which are in an **outdoor pot or in the ground, under cover**.

It **does not include** watering plants:

i) grown or kept for sale or commercial use, or

ii) that are part of a National Collection or temporary garden or flower display (see Figure 5.1 for definitions).

"Domestic or other non-commercial premises" means

a) any land, building or other structure used or enjoyed in connection with the use of any of the following which is used principally as a dwelling:

i) a building or part of a building;

ii) a caravan;

iii) a boat; or

b) any land or premises which is not used principally for the purposes of a business.

"Plants" includes plant organs, seeds, crops and trees.

"Grow" includes cultivate or propagate.

MESSAGES

Customers may water their gardens:

- By hand, using a bucket or watering can.
- With greywater through a hosepipe.
- Using rainwater from a water butt by hand or through a hosepipe.

Storage tanks

Water drawn from the mains supply into tanks (other than hand held receptacles) for subsequent use for watering private gardens, lawns and landscaped areas via a hosepipe is not permitted.[6]

Methods for recycling water or finding water from alternative sources should be encourage for those concerned about the financial implications of not being able to use mains water[7].

Public Sector

Under the Water Act 2003, public authorities have a water conservation duty and arguably should not wait until restrictions come into force before taking water conservation measures.

EXEMPTIONS & CONCESSIONS

None

A4.4.4 – Cleaning a private leisure boat using a hosepipe

DEFINITIONS

The category of activity under the temporary water use ban powers is **"cleaning a private leisure boat using a hosepipe".**

"Private leisure boat" means a vessel or other thing, other than a seaplane, which is designed, constructed or adapted to move through, in, on or over water.

The definition does **not** refer to such vessels:

a) used in the course of a business; or

b) made available or accessible to the public.

The definition of the activity **does not include:**

a) cleaning of any area of a private leisure boat which, except for doors or windows, is enclosed by a roof and walls; and

b) using a hosepipe to clean a private leisure boat for **health or safety** reasons.

[6] Summary of responses to the consultation, between 23 March and 15 June 2007, on proposed changes to powers to restrict non-essential uses of water, Defra, 2007
[7] Summary of responses to the consultation, between 23 March and 15 June 2007, on proposed changes to powers to restrict non-essential uses of water, Defra, 2007

Interpretation:

Boats in private ownership only are included, whether trailer launched or not[8]. The definition extends to small watercraft such as canoes, kayaks, jet skis etc. In naval terms, a boat is small enough to be carried on another vessel (a ship). It is interpreted that ships and other large vessels such as cruise liners are normally used for commercial purposes so are not expected to come under this definition.

MESSAGES

Customers may wash such boats and vessels by hand, using a bucket.

The use of recycled water or rainwater is encouraged[9].

EXEMPTIONS & CONCESSIONS

A statutory exemption exists in The Water Use (Temporary Bans) Order 2010 for the cleaning of private leisure boats in respect of **health or safety** (see Section 5.7 of this report for further detail). This includes:

a) removing or minimising any risk to human or animal health or safety; and

b) preventing or controlling the spread of causative agents of disease.

Biosecurity concerns associated with the reduced washing of boat hulls, such as the introduction of non-native species to the UK, are therefore covered under this exemption.

A4.4.5 – Filling or maintaining a domestic swimming or paddling pool

DEFINITIONS

The category of activity under the temporary water use ban powers is **"filling or maintaining a domestic swimming or paddling pool".**

The Water Use (Temporary Bans) Order 2010 defines **domestic swimming or paddling pool** as a swimming or paddling pool, other than a pool that is being used for the purposes of a business, which is**:**

a) in a building or part of a building used principally as a dwelling; or

[8] Summary of responses to the consultation, between 23 March and 15 June 2007, on proposed changes to powers to restrict non-essential uses of water, Defra, 2007
[9] Summary of responses to the consultation, between 23 March and 15 June 2007, on proposed changes to powers to restrict non-essential uses of water, Defra, 2007

b) on any land or in any building that is used or enjoyed in connection with (a).

The definition **excludes** filling or maintaining a pool:

a) where necessary in the course of its construction;

b) using a hand-held container filled with water drawn directly from a tap;

c) that is designed, constructed or adapted for use in the course of a programme of medical treatment;

d) used for the purpose of decontaminating animals from infections or disease;

e) used in the course of a programme of veterinary treatment;

f) in which fish or other aquatic animals are being reared or kept in captivity.

Interpretation:

No formal definition of a swimming or paddling pool is provided but the intention appears to capture all pools that have a primary use that is not personal washing. No minimum size is specified. The restriction includes permanent and temporary facilities and whole or partial filling.

MESSAGES

Customers may fill swimming and paddling pools by hand, using a bucket.

Customers may choose to use a public swimming pool as an alternative to a private pool. Public pools are not covered by this restriction.

Use of alternative water sources, including rainwater, is permitted.

Backwashing of swimming pool filters is not covered by these powers; it is the topping up of the pool to replace lost water that is covered.

EXEMPTIONS & CONCESSIONS

A number of statutory exemptions are defined for this activity (see definitions above).

A4.4.6 – Drawing water, using a hosepipe, for domestic recreational use

DEFINITIONS

The Water Use (Temporary Bans) Order 2010 states that this activity refers to **"drawing water, using a hosepipe, to operate water slides or other**

recreational equipment".

"Domestic recreational use" means:

a) recreational use in connection with a domestic swimming or paddling pool (see full definition in Figure 5.6); or

b) recreational use on land that is used or enjoyed in connection with a building, or part of a building, used principally as a dwelling, other than for the purposes of a business.

Interpretation:

This is interpreted to mean both slides designed to be used with water and any temporary or "ad-hoc" water slides or sprinklers. It is taken to refer to recreational use for both children and adults.

MESSAGES

Customers may use a bucket to fill similar recreational equipment, for example to enable children to play. Filling of recreational toys directly from a tap is not included.

Many Local Authorities have recreational facilities for children in particular as part of their parks.

EXEMPTIONS & CONCESSIONS

None

A4.4.7 – Filling or maintaining a domestic pond using a hosepipe

DEFINITIONS

"Domestic ponds" are defined by the Water Use (Temporary Bans) Order 2010 as a pond, including a swimming pond, on land that is used in connection with a building, or part of a building, used principally as a dwelling; and is not being used for the purposes of a business.

The activity **does not include** filling or maintaining a pond in which fish or other aquatic animals are being reared or kept in captivity.

Interpretation:

The definition of both domestic and non-domestic ponds is interpreted to include both manmade and natural ponds of any size.

It is assumed that the definition of both domestic and non-domestic ponds refer to both outdoor and indoor ponds including ornamental ponds.

The activity covers both the filling and the topping up of these ponds.

MESSAGES

All ponds can be filled by the use of buckets.

The use of rainwater or other alternative (non-potable) sources is permitted.

EXEMPTIONS & CONCESSIONS

Ponds in which fish and other aquatic animals are kept are exempt from this activity (see above for definition).

A4.4.8 – Filling or maintaining an ornamental fountain

DEFINITIONS

The category of activity under the temporary water use ban powers is **"filling or maintaining an ornamental fountain".**

The Water Use (Temporary Bans) Order 2010 defines an **"ornamental fountain"** as including a cascade or any other display of moving water.

This does **not include** filling or maintaining an ornamental fountain which is in or near a fish pond and whose purpose is to supply sufficient oxygen to the water in the pond in order to keep the fish healthy.

Interpretation:

This includes filling by any means including permanent plumbing, and is not limited to use of a hosepipe.

The definition includes any water fountain or artificial cascade that serves a purpose that is primarily decorative. This is interpreted to include sculptures that have a water component.

This applies to fountains and cascades that are privately owned and those that are publicly owned. It also applies equally to features that recycle water and those that don't.

MESSAGES

The prohibition or restriction of this activity is less about saving water than it is about reinforcing the message of the seriousness of drought.

Companies may wish to encourage owners to display signs explaining that the fountain/cascade has been turned off because of the drought.

EXEMPTIONS & CONCESSIONS

Fountains in which fish and other aquatic animals are kept are exempt from this activity (see above for definition).

A4.4.9 – Cleaning walls, or windows, of domestic premises using a hosepipe

DEFINITIONS

The category of activity under the temporary water use ban powers is **"cleaning walls, or windows, of domestic premises using a hosepipe".**

The Water Use (Temporary Bans) Order 2010 defines this category as applying only to the cleaning of the **external walls or windows of domestic premises**.

The definition **excludes** cleaning activities for **health or safety** reasons.

"Domestic premises" under this activity means:

a) a building used principally as a dwelling or dwellings;

b) a garage, shed, outbuilding or other building or structure used or enjoyed in connection with a building used principally as a dwelling; or

c) a wall or other means of enclosure within the curtilage of a building used principally as a dwelling.

Interpretation:

This is interpreted to relate to all domestic building structures, whether they are permanent or temporary. Roofs are not interpreted as being covered, other than with respect to sky-light or similar windows. Domestic roofs are specifically covered under the Water Use (Temporary Bans) Order 2010 activity of 'cleaning other artificial outdoor surfaces using a hosepipe' (see Figure 5.15).

MESSAGES

Customers may clean building walls and windows by hand, using a bucket.[10]

If a building can be cleaned by permanent plumbing then it is still a permitted activity.

Storage tanks

Restrictions apply to water drawn from the mains supply after the statutory notice has been given. So water drawn into a container prior to that date may be used for cleaning the exterior of buildings[11].

Greywater and rainwater may be used to clean walls or windows.

Water fed poles are frequently used by window cleaners and are considered within the definition of 'anything designed, adapted or used to serve the same purpose as a hosepipe'. These systems use de-ionised water. Where mains water is the source used to create this de-ionised water, this activity is restricted.

EXEMPTIONS & CONCESSIONS

A statutory exemption exists in The Water Use (Temporary Bans) Order 2010 for the cleaning of domestic walls or windows in respect of **health or safety** (see Section 5.7 of this report for further detail). This includes:

a) removing or minimising any risk to human or animal health or safety; and

b) preventing or controlling the spread of causative agents of disease.

The grounds for an exemption for these purposes are considered to be rare – perhaps linked to accidents and incidents. Washing windows at height by hand should be minimised in order to reduce the risk of falls from height (Work at Height Regulations 2005).

A4.4.10 – Cleaning paths or patios using a hosepipe

DEFINITIONS

The category of activity under the temporary water use ban powers is **"cleaning paths or patios using a hosepipe".**

[10] Consultation on proposed changes to powers to restrict non-essential uses of water, Defra, 2007
[11] Summary of responses to the consultation, between 23 March and 15 June 2007, on proposed changes to powers to restrict non-essential uses of water, Defra, 2007

The definition **excludes** cleaning paths or patios using a hosepipe for **health or safety** reasons.

Interpretation:

It is interpreted to include the cleaning by hosepipe of all paths or patios regardless of who is undertaking the cleaning and whether they are domestic or commercial[12]. It is interpreted that this would include paths and patios made of any material such as concrete, paving slabs, stones, permeable paving etc.

MESSAGES

Customers can sweep paths or patios and they may wash them by hand using a bucket.

EXEMPTIONS & CONCESSIONS

A statutory exemption exists in The Water Use (Temporary Bans) Order 2010 for the cleaning of paths and patios in respect of **health or safety** (see Section 5.7 of this report for further detail). This includes:

a) removing or minimising any risk to human or animal health or safety; and

b) preventing or controlling the spread of causative agents of disease.

A4.4.11 – Cleaning other artificial outdoor surfaces using a hosepipe

DEFINITIONS

The category of activity under the temporary water use ban powers is **"cleaning other artificial outdoor surfaces using a hosepipe"**.

The definition **excludes** cleaning an outdoor surface using a hosepipe for **health or safety** reasons.

"Artificial outdoor surface" means any of the following:

a) any area outdoors which is paved or laid with hard or artificial material;

b) timber decking;

c) a quay;

d) a trailer designed, constructed or adapted to launch boats or other vessels

[12] Summary of responses to the consultation, between 23 March and 15 June 2007, on proposed changes to powers to restrict non-essential uses of water, Defra, 2007

or craft into water, other than a private motor-vehicle (see Figure 5.2);

e) the roof of any domestic premises.

"Quay" includes jetty, pontoon, wharf and slipway.

Interpretation:

It is interpreted to include the cleaning by hosepipe of all exterior surfaces, regardless of who is undertaking the cleaning and whether they are domestic or commercial[13].

This includes driveways (both domestic and non-domestic); and marine infrastructure such as pontoons and slipways, whether fixed permanently in position or floating[14].

MESSAGES

Customers can sweep outdoor surfaces and they may wash them by hand using a bucket.

EXEMPTIONS & CONCESSIONS

A statutory exemption exists in The Water Use (Temporary Bans) Order 2010 for the cleaning of artificial outdoor surfaces using a hosepipe in respect of **health or safety** (see Section 5.7 of this report for further detail). This includes:

a) removing or minimising any risk to human or animal health or safety; and

b) preventing or controlling the spread of causative agents of disease.

A4.5 Activities covered by ordinary drought orders under the Water Resources Act 1991 and defined in the Drought Direction 2011

The table below lists the restriction categories that may be used to manage a drought if drought orders **under the Water Resources Act 1991 and defined in the Drought Direction 2011** are imposed.

A4.5.1 Watering outdoor plants on commercial premises

A4.5.2 Filling or maintaining a non-domestic swimming or paddling

[13] Summary of responses to the consultation, between 23 March and 15 June 2007, on proposed changes to powers to restrict non-essential uses of water, Defra, 2007
[14] Summary of responses to the consultation, between 23 March and 15 June 2007, on proposed changes to powers to restrict non-essential uses of water, Defra, 2007

	pool
A4.5.3	Filing or maintaining a pond
A4.5.4	Cleaning non-domestic premises
A4.5.5	Cleaning a window of a non-domestic building
A4.5.6	Operating a mechanical vehicle-washer
A4.5.7	Cleaning any vehicle, boat, aircraft or railway rolling stock
A4.5.8	Cleaning industrial plant
A4.5.9	Suppressing dust
A4.5.10	Operating cisterns

The following information applies to each activity:

Legislation:

All ten drought orders are covered under the Water Resources Act 1991, as defined in the Drought Direction 2011.

Programme:

Constrained by application to Secretary of State and notice period. Approx. 8-12 weeks.

"Using a hosepipe"

The Water Use (Temporary Bans) Order 2010 provides the definition of "using a hosepipe" in relation to the WIA 1991 as including:

a) Drawing relevant water through a hosepipe from a container and applying it for the purpose; and

b) Filling or partly filling a container with relevant water by means of a hosepipe and applying it for the purpose.

A reference to a hosepipe includes anything designed, adapted or used for the same purpose as a hosepipe.

"Relevant water" refers to mains water i.e. supplied by the water undertaker; it does not include water supplied before the water use restriction was implemented.

A4.5.1 – Watering outdoor plants on commercial premises

DEFINITIONS

The activity coming under ordinary drought order powers is defined in the Drought Direction 2011 as **"watering outdoor plants on commercial premises using a hosepipe"** which covers the following:

i) plants which are in a pot or other container that is outdoors or under cover;

ii) plants which are in the ground under cover.

The activity **does not include** watering plants that are:

i) grown or kept for sale or commercial use; or

ii) part of a National Collection or temporary garden or flower display (see Figure 5.1 for definitions).

"Commercial premises" means any land, building, other structure or premises not being domestic or other non-commercial premises within the meaning of the temporary use ban

"Grown" includes cultivated or propagated.

"Plants" includes plant organs, seeds, crops and trees.

"Under cover" means in a greenhouse or outbuilding or under permanent canopy.

MESSAGES

Customers may water their gardens:

- By hand, using a bucket or watering can.
- With greywater through a hosepipe.
- Using rainwater from a water butt by hand or through a hosepipe.

Storage tanks

Water drawn from the mains supply into tanks (other than hand held receptacles) for subsequent use for watering private gardens, lawns and landscaped areas via a hosepipe is not permitted.[15]

Methods for recycling water or finding water from alternative sources should

[15] Summary of responses to the consultation, between 23 March and 15 June 2007, on proposed changes to powers to restrict non-essential uses of water, Defra, 2007

be encourage for those concerned about the financial implications of not being able to use mains water[16].

Public Sector

Under the Water Act 2003, public authorities have a water conservation duty and arguably should not wait until restrictions come into force before taking water conservation measures. Public sector actions such as not watering plants in public places will convey a clear message to public about the need to conserve supplies[17].

EXEMPTIONS & CONCESSIONS

None

Figure A4.5.2 – Filling or maintaining a non-domestic swimming or paddling pool

DEFINITIONS

The water use purpose coming under ordinary drought order powers is **"filling or maintaining a non-domestic swimming or paddling pool".**

The Drought Direction 2011 defines **non-domestic swimming or paddling pool** as a swimming or paddling pool, other than a domestic swimming or paddling pool as defined and covered by the WIA section 76(2)(e) (see Figure 5.6). The intention is that domestic pools should already have been restricted under temporary water use ban powers before a company seeks a drought order.

The purpose **excludes** filling or maintaining pool:

a) that is open to the public;

b) where necessary in the course of its construction;

b) using a hand-held container which is filled with water drawn directly from a tap;

c) that is designed, constructed or adapted for use in the course of a programme of medical treatment;

[16] Summary of responses to the consultation, between 23 March and 15 June 2007, on proposed changes to powers to restrict non-essential uses of water, Defra, 2007
[17] Consultation on proposed changes to powers to restrict non-essential uses of water, Defra, 2007

d) that is used for the purpose of decontaminating animals from infections or disease;

e) used in the course of a programme of veterinary treatment;

f) in which fish or other aquatic animals are being reared or kept in captivity;

g) that is for use by pupils of a school for school swimming lessons.

"Open to the public"

For the purposes of the exemption (a) above, a pool is **not** open to the public if it may only be used if the user is a paying member of an affiliated club or organisation; i.e. these pools are covered by this restriction.

Interpretation:

No formal definition of a swimming or paddling pool is provided but the intention appears to capture all pools that have a primary use that is not personal washing. No minimum size is specified. The restriction includes permanent and temporary facilities and whole or partial filling.

MESSAGES

Customers may fill swimming and paddling pools by hand, using a bucket.

Public pools are not covered by the restrictions.

Use of alternative water sources, including rainwater, is permitted.

Backwashing of swimming pool filters is not subject to these powers.

EXEMPTIONS & CONCESSIONS

A number of statutory exemptions are defined for this activity (see definitions above).

A4.5.3 – Filling or maintaining a pond

DEFINITIONS

Definitions:

"Domestic ponds" are defined by the Water Use (Temporary Bans) Order 2010 as a pond, including a swimming pond, on land that is used in connection with a building, or part of a building, used principally as a dwelling; and is not being used for the purposes of a business.

The activity under both types of restriction **does not include** filling or

maintaining a pond in which fish or other aquatic animals are being reared or kept in captivity.

Additionally, the Drought Direction 2011 excludes filling or maintaining a pond using a hand-held container which is filled with water drawn directly from a tap.

The Drought Direction 2011 activity of 'filling or maintaining a pond' **excludes** filling or maintaining a domestic pond using a hosepipe. The intention is that since this latter activity is already covered specifically by the temporary use ban, it should have been implemented before a drought order is sought.

Interpretation:

The definition of both domestic and non-domestic ponds is interpreted to include both manmade and natural ponds of any size.

It is assumed that the definition of both domestic and non-domestic ponds refer to both outdoor and indoor ponds including ornamental ponds.

The activity covers both the filling and the topping up of these ponds.

MESSAGES

All ponds can be filled by the use of buckets.

The use of rainwater or other alternative (non-potable) sources is permitted.

EXEMPTIONS & CONCESSIONS

Ponds in which fish and other aquatic animals are kept are exempt from this activity (see above for definition).

Figure A4.5.4 – Cleaning non-domestic premises

DEFINITIONS

The water use purpose coming under ordinary drought order powers is **"cleaning non-domestic premises".**

The Drought Direction 2011 provides the definition of this activity as the cleaning of any of the following **using a hosepipe**:

a) any exterior part of a non-domestic building other than a window;

b) a non-domestic wall.

It does **not** include the cleaning of any exterior part of a non-domestic building

or a non-domestic wall for **health or safety** reasons.

"Non-domestic building" is defined in the Drought Direction 2011 as any of the following not being domestic premises:

a) a building that is not used principally as a dwelling or dwellings;

b) any other structure.

This definition does **not** include any domestic premises as defined and covered by the Water Use (Temporary Bans) Order 2010 (see Figure 5.11).

"Non-domestic wall" means a wall or any other enclosing structure or partition which:

i) does not form part of a non-domestic building; and

ii) is not within the curtilage of a domestic building.

Interpretation:

Interpreted to relate to both permanent and temporary buildings and structures.

Interpreted to include building roofs.

MESSAGES

Building cleaning may proceed by hand using water from a bucket.

Greywater and rainwater may be used.

Storage tanks

Restrictions apply to water drawn from the mains supply after the statutory notice has been given, so water drawn into a container prior to that date may be used for cleaning the exterior of buildings[18].

EXEMPTIONS & CONCESSIONS

The Drought Direction 2011 provides a statutory exemption for **health or safety reasons (**see Section 5.7 of this report for further detail). The definition of this includes:

a) removing or minimising any risk to human or animal health or safety; and

b) preventing or controlling the spread of causative agents of disease.

The grounds for an exemption for these purposes are considered to be rare –

[18] Summary of responses to the consultation, between 23 March and 15 June 2007, on proposed changes to powers to restrict non-essential uses of water, Defra, 2007

perhaps linked to accidents and incidents.

A4.5.5 – Cleaning a window of a non-domestic building

DEFINITIONS

Definitions:

The activity coming under ordinary drought order powers is defined by the Drought Direction 2011 as **"cleaning a window of a non-domestic building using a hosepipe other than for health or safety reasons".**

"Non-domestic building" is defined in the Drought Direction 2011 as any of the following not being domestic premises:

a) a building that is not used principally as a dwelling or dwellings;

b) any other structure.

This definition does **not** include any domestic premises as defined and covered by the Water Use (Temporary Bans) Order 2010 (see Figure 5.11).

Interpretation:

Water-fed poles are frequently used by window cleaners and it is interpreted that they are included under the definition of hosepipes. These systems use de-ionised water. Where mains water is the source used to create this de-ionised water, this activity is restricted. The Inspector at the Mid Kent Water and Southern Water (Eastern area) ordinary drought order Hearings in 2006 indicated that window cleaners could argue that they are using water in a process (de-ionising) and so not covered by this restriction[19]. This has not been tested.

MESSAGES

Customers may clean windows by hand, using a bucket.[20]

The use of rainwater is permitted.

EXEMPTIONS & CONCESSIONS

The Drought Direction 2011 provides a statutory exemption for **health or safety reasons (**see Section 5.7 of this report for further detail). The definition of this includes:

[19] Report to the Secretary of State for Environment, Food and Rural Affairs, Applications by Mid Kent Water Limited and Southern Water Services Limited for ordinary drought orders restrictions on the non-essential use of water
[20] Consultation on proposed changes to powers to restrict non-essential uses of water, Defra, 2007

a) removing or minimising any risk to human or animal health or safety; and

b) preventing or controlling the spread of causative agents of disease.

The grounds for an exemption for these purposes are considered to be rare – perhaps linked to accidents and incidents. Washing windows at height by hand should be minimised in order to reduce the risk of falls from height (Work at Height Regulations 2005).

A4.5.6 – Operating a mechanical vehicle-washer

DEFINITIONS

The activity falls under ordinary drought order powers and is defined by the Drought Direction 2011 as **"operating a mechanical vehicle-washer, whether automatic or not".**

Interpretation:

Both Sutton and East Surrey Water and Thames Water appeared to consider that this restriction relates to mechanical car washers.

At the 2006 Hearing for the drought order applications for Mid Kent Water and Southern Water, Esso submitted an objection on the grounds that reducing margins on fuel sales meant that the contribution of car washers to profitability was important to the continuing viability of these businesses. The Inspector did not find that this argument was convincing[21].

MESSAGES

Cars and other vehicles can still be washed using buckets or using other sources of water.

EXEMPTIONS & CONCESSIONS

Exemptions on bio security grounds may be warranted.

A4.5.7 – Cleaning any vehicle, boat, aircraft or railway rolling stock

DEFINITIONS

The activity falls under ordinary drought order powers and is defined by the

[21] Report to the Secretary of State for Environment, Rood and Rural Affairs, Applications by Mid Kent Water Limited and Southern Water Services Limited for ordinary drought orders restrictions on the non-essential use of water

Drought Direction 2011 as **"cleaning any vehicle, boat, aircraft or railway rolling stock using a hosepipe".**

It does **not** include such cleaning for **health or safety reasons.**

"Boat" is defined by The Drought Direction 2011 as meaning a vessel or other thing which:

a) is designed, constructed or adapted to move through, in, on or over water; and

b) is not a private leisure boat within the meaning applied under the Temporary Use Ban.

"Vehicle" is defined as any of the following which is not a private motor-vehicle within the meaning applied under the Temporary Use Ban:

a) a vehicle designed, constructed or adapted for use on roads; or

b) a trailer or other thing designed, constructed or adapted for attachment to a vehicle falling within (a) above.

Interpretation:

The restriction is not specifically limited to the cleaning of external surfaces so would include the use of a hosepipe to wash down an interior area.

Interpreted to include all road **vehicles** including taxis and private hire vehicles, commercially owned trucks and utilities and public transport vehicles[22].

It is assumed that **'boats'** includes small watercraft such as canoes, kayaks, jet skis etc. In naval terms, a boat is small enough to be carried on another vessel (a ship). It is interpreted that ships and other large vessels such as frigates and cruise liners would also be included in the ban.

Railway rolling stock is interpreted to include passenger train cars, freight train cars, locomotives and tube trains.

Aircraft are interpreted to include privately and commercially owned airplanes, helicopters, gliders and hot air balloons.

MESSAGES

Methods for recycling water or finding water from alternative sources should

[22] Summary of responses to the consultation, between 23 March and 15 June 2007, on proposed changes to powers to restrict non-essential uses of water, Defra, 2007

be used for those concerned about the financial implications of not being able to use mains water[23].

Greywater and rainwater may be used.

Storage tanks

Restrictions apply to water drawn from the mains supply after the statutory notice has been given, so water drawn into a container prior to that date may be used for cleaning[24].

EXEMPTIONS & CONCESSIONS

The Drought Direction 2011 provides a statutory exemption for **health or safety reasons (**see Section 5.7 of this report for further detail). The definition of this includes:

a) removing or minimising any risk to human or animal health or safety; and

b) preventing or controlling the spread of causative agents of disease.

Biosecurity concerns associated with the reduced washing of boat hulls, such as the introduction of non-native species to the UK, are therefore covered under this exemption.

A4.5.8 – Cleaning industrial plant

DEFINITION

The activity coming under ordinary drought order powers is defined by the Drought Direction 2011 as **"cleaning industrial plant using a hosepipe other than for health or safety reasons".**

Interpretation:

Companies may identify industrial customers separately to other commercial customers. Local planning designations may also identify industrial locations.

Plant is interpreted to mean:

"The equipment, including machinery, tools, instruments and fixtures necessary for an industrial operation[25]".

[23] Summary of responses to the consultation, between 23 March and 15 June 2007, on proposed changes to powers to restrict non-essential uses of water, Defra, 2007
[24] Summary of responses to the consultation, between 23 March and 15 June 2007, on proposed changes to powers to restrict non-essential uses of water, Defra, 2007
[25] Adapted from http://www.thefreedictionary.com/Plant

This restriction is not interpreted to apply to normal industrial and manufacturing processes and necessary housekeeping, as the impacts of such a wide definition would be significant. Water companies may wish to seek guidance from a legal advisor to clarify this interpretation.

MESSAGES

Customers may clean such industrial plant by hand using a bucket.

The use of **greywater and rainwater** is permitted.

The use of water drawn into containers prior to the commencement of the restriction is allowed.

EXEMPTIONS & CONCESSIONS

The Drought Direction 2011 provides a statutory exemption for **health or safety reasons (**see Section 5.7 of this report for further detail). The definition of this includes:

a) removing or minimising any risk to human or animal health or safety; and

b) preventing or controlling the spread of causative agents of disease.

Figure A4.5.9 – Suppressing dust

DEFINITIONS

The activity coming under ordinary drought order powers is defined by the Drought Direction 2011 as **"suppressing dust using a hosepipe other than for health or safety reasons"**.

Interpretation:

This covers both domestic and non-domestic areas and all surfaces.

MESSAGES

Customers should use alternative, non-potable sources of water for dust suppression, such as recycled, greywater or rainwater. This is particularly the case where dust suppression is a necessary part of a business process.

Customers may use a bucket for the purposes of dust suppression, although it should be noted that the practicality of this may be limited to small scale operations.

EXEMPTIONS & CONCESSIONS

The Drought Direction 2011 provides a statutory exemption for **health or safety reasons (**see Section 5.7 of this report for further detail). The definition of this includes:

a) removing or minimising any risk to human or animal health or safety; and

b) preventing or controlling the spread of causative agents of disease.

Figure A4.5.10 – Operating cisterns

DEFINITIONS

MESSAGES

There are existing water efficient devices that customers can install to comply with this restriction, for example by installing controls to only flush after use or at certain times of day.

Waterless urinals, greywater or rainwater systems can also be fitted.

Customers will benefit from cost savings in the short and long term due to reduced water consumption.

EXEMPTIONS & CONCESSIONS

None

APPENDIX 5 ENVIRONMENTAL MONITORING

This Appendix contains information relating to Section 4, Environmental Monitoring, including tables detailing what information is collected and reviewed as part of the AW monthly monitoring process, locations of where river photographs are taken and the EA monitoring locations.

A5.1 AW Monthly Hydrological Data Specification

A5.2 Location River Monitoring Photographs

A5.3 Notes and Key to Environmental Monitoring Charts

A5.1 AW Monthly Hydrological Data Specification

Table A5.1.1 Data Collected and Reviewed for the AW Monthly Hydrological Report

Data	Description	Frequency	Date Source
Rainfall Effective Precipitation Soil Moisture Deficit	MORECS Data for Square 151 152 161	Weekly	Met Office
River Flows	River Red at Redbourn River Mimram at Fulling Mill River Ver at Redbourn River Gade at Croxley Green River Beane at Hartham River Rib at Wadesmill River Rhee at Ashwell River Cam at Great Chesterford River Stort at Roydon River Misbourne at Little Missenden River Mimram at Panshanger River Thames Kingston	Daily	EA
Groundwater Levels	Elsenham Nursery Lilley Bottom Therfield Rectory Chalfont Centre Champneys Gorhambury C Wayside Missenden Road	Monthly	EA

A5.2 Location River Monitoring Photographs

Environmental impact monitoring photographs have been taken consistently from a number of key locations since 1997.

Table A5.2.1 Location of Environmental Impact Monitoring Photographs

River	Photo No	Description
Ash	Ash01	Upstream, near the source of the B1038 road bridge Brent
Ash	Ash02	Downstream, Next to sewage works, Furneux Pelham
Ash	Ash03	Downstream, From Parsonage Lane Bridge, Albury
Ash	Ash04	Downstream, Hadham Ford, Little Hadham
Ash	Ash05	Downstream, From Winding Hill Bridge, Much Hadham
Ash	Ash06	Downstream, From the End of Pegs Lane Widford
Ash	Ash07	Downstream, From B1004 road bridge, Near Wareside
Ash	Ash08	Downstream, From Hollycross Road Bridge, Near Ware
Ashwell Springs	Ashwell01	Down steps at Ashwell Springs SSSI
Beane	Beane01	Upstream from footbridge over river next to the road, near Roe Green
Beane	Beane02	Downstream from road bridge over river
Beane	Beane03	Downstream from road looking under road bridge, Cromer
Beane	Beane04	Downstream from road bridge, next to Walkern Mill
Beane	Beane05	Downstream from Road, Aston
Beane	Beane06	Downstream from ford next to WHIT 1
Beane	Beane07	Downstream from road bridge looking towards Watton-at-Stone
Beane	Beane08	Downstream from Church Lane bridge, Stapleton
Beane	Beane09	Downstream from Vicarage Road Bridge, Waterford
Beane	Beane10	Upstream from bridge over river to car Park, Hartham (Hertford)

Bulbourne	Bulbourne 01	Upstream from Boswick Lane bridge, Dudswell
Bulbourne	Bulbourne 02	Upstream from New Road (B4506) Bridge, Berkhamsted
Bulbourne	Bulbourne 03	Downstream from Bank Mill Lane, Berkhamsted
Bulbourne	Bulbourne 04	Downstream from Little Heath Lane, near Bourne End
Bulbourne	Bulbourne 05	Downstream from Two Waters Road, Hemel Hempstead (near confluence with Gade)

River	Photo No	Description
Cam	Cam01	Upstream, from North Hall Road Bridge, near Henham
Cam	Cam02	Downstream, from Crabtree Hill Bridge, near Widdington
Cam	Cam03	Downstream, from road bridge to Widdington
Cam	Cam04	Upstream, from Sparrowsend Hill bridge, Wendens Ambos
Cam	Cam05	Downstream, From Walden Road bridge, Wendens Ambos
Cam	Cam06	Downstream, from Walden Road Bridge, Littlebury
Cam	Cam07	Downstream, from road bridge (off the B1383) in Little Chesterford
Chess	Chess01	The source, river runs along Missenden Road and disappears by a house outside Chesham
Chess	Chess02	Bury Pond, This also feeds the upper reaches of The Chess
Chess	Chess03	Waterside, From a Bridge which crosses the river by a weir
Chess	Chess04	Latimer Road and Stoney Lane cross roads, bridge where the river joins the lake in Latimer Park.
Chess	Chess05	River from public footpath which both run next to CHOR
Chess	Chess06	Rickmansworth, of A 412 Next to playing field by bridge where Chess Flows under A412

Colne	Colne01	Mimmshall Brook, North Mymms Park
Colne	Colne02	Upstream from B556 Courses Road bridge Colney Heath
Colne	Colne03	Upstream Watery Lane Bridge Broad Colney
Colne	Colne04	Upstream Near Drop Lane Bricket Wood confluence with Ver
Colne	Colne05	Downstream from Bushey Mill Lane bridge Watford
Gade	Gade01	Upstream from road bridge at Hudnall Corner
Gade	Gade02	Downstream from road bridge, Great Gaddesdon
Gade	Gade03	Upstream from bridge near Red Lion pub, Water End
Gade	Gade04	Downstream from A4147 bridge, Hemel Hempstead
Gade	Gade05	Downstream from road bridge, confluence with Grand Union Canal

River	Photo No	Description
Hiz	Hiz01	Ash Brook from Arch Road, Little Wymondley, Looking downstream
Hiz	Hiz02	Ippollitts Brook from Waterdell Lane, St. Ippollitts, Looking downstream
Hiz	Hiz03	River Hiz from Charlton Road with junction of Maydencroft Lane, Charlton, Looking downstream
Hiz	Hiz04	River Purwell from Chaucer Way bridge (off Purwell Lane), Hitchin, Looking downstream
Hiz	Hiz05	River Hiz from Cadwell Lane, downstream, next to sewage works
Hiz	Hiz06	River Oughton (Oughton Head) from Oughtonhead Lane (Footpath) off Hitchin Road. Looking downstream.
Hiz	Hiz07	River Hiz from Arlesey Road bridge, Cadwell. Looking downstream
Hiz	Hiz08	River Hiz from Mill Lane, Arlesey. Looking downstream
Hiz	Hiz09	River Hiz from the A6001 Langford. Looking downstream
Ivel	Ivel01	River Ivel Navigation, Near Clifton, up & downstream

Ivel	Ivel02	River Ivel, from B658 road bridge south of Biggleswade
Lee	Lee01	The source from Sundon Park Road Luton
Lee	Lee02	Downstream from Kingsdown Avenue bridge Luton
Lee	Lee03	Downstream from Osbourne Road bridge Luton
Lee	Lee04	Downstream from Cooters End Lane East Hyde
Lee	Lee05	Downstream from B652 Station Road Batford
Lee	Lee06	Downstream from B651 Station Road bridge Wheathampstead

River	Photo No	Description
Mimram	Mimram01	The source, through hedge from Lilley Bottom Road, Near Whitwell
Mimram	Mimram02	Downstream from road next to Nine Wells Watercress Farm, Whitwell
Mimram	Mimram03	Downstream from The Valley bridge, Whitwell
Mimram	Mimram04	Upstream looking into the garden of Rose Cottage, Whitwell
Mimram	Mimram05	Upstream from road, view of old mill pond, Hoo Farm
Mimram	Mimram06	Downstream from road at Kimpton Mill
Mimram	Mimram07	Downstream, view across St. Albans Road Ford (Pulmer Water)
Mimram	Mimram08	Upstream from High Street bridge, Welwyn
Mimram	Mimram09	Upstream from A1000 road bridge, near Digswell
Mimram	Mimram10	Downstream from Digswell Park Road bridge, near Digswell
Misbourne	Misbourne01	Upstream near the source from Link Road bridge, Great Missenden
Misbourne	Misbourne02	Upstream & Downstream from Deep Mill Lane bridge, off A413
Misbourne	Misbourne03	Downstream from road bridge in Little Missenden

Misbourne	Misbourne 04	Downstream from Mill Lane bridge, Amersham Old Town
Misbourne	Misbourne 05	Downstream from Bottom House Farm Lane, Off A413
Misbourne	Misbourne 06	Upstream from Pheasant Hill bridge next to The Pheasant Inn, Chalfont St. Giles
Misbourne	Misbourne 07	Upstream from 'Over the Misbourne' off A413, Gerrards Cross
Misbourne	Misbourne 08	Downstream from Old Mill Road bridge, Denham (near confluence with the Colne)
Quin	Quin01	Upstream from Bull Lane, Buckland
Quin	Quin02	Upstream from Bull Lane, Buckland (different to No 1)
Quin	Quin03	Upstream near Howlet's Farm, Barkway
Quin	Quin04	Upstream at Cross road to west of Nuthampstead
Quin	Quin05	Downstream from road off Briggin Hill near Anstey
Quin	Quin06	Downstream from Worsted Lane, Hare Street
Quin	Quin07	Downstream from Station road, Braughing

River	Photo No	Description
Rib	Rib01	Upstream from road in reed end, near source
Rib	Rib02	Downstream from bridge over river to entrance to Hodenhoe Manor
Rib	Rib03	Upstream from Vicarage Road bridge, Buntingford
Rib	Rib04	Downstream, road bridge near Westmill Bury, Westmill
Rib	Rib05	Upstream from A120 road bridge, Standon
Rib	Rib06	Downstream, Barwick Ford
Rib	Rib07	Upstream from A10 footbridge over river, Wadesmill
Rib	Rib08	Downstream from access road bridge to Paynes Hall, (off A602) Westmill.

Rib	Rib09	Downstream from Ware Park Road bridge, Bengeo, near confluence with River Lea.
Stort	Stort01	The source, Duddenhoe Grange, Langley
Stort	Stort02	Downstream from road bridge at Stickling Green
Stort	Stort03	Downstream from Poor Bridge, south of Clavering
Stort	Stort04	Downstream from The Street bridge, Manuden
Stort	Stort05	Downstream from road bridge next to Bentfield Mill House near Stansted Mountfitchet
Stort	Stort06	Downstream from Rye Street car park bridge, Bishop's Stortford
Stort	Stort07	Downstream from Pig Lane road bridge, south Bishop's Stortford
Stort	Stort09a	River Stort, Downstream from Burntmill Lane, Harlow
Stort	Stort09b	Stort Navigation, downstream from Burntmill Lane, Harlow
Stort	Stort10	Downstream from High Street bridge, Roydon
Ver	Ver01	The source, Kensworth Lynch
Ver	Ver02	Upstream, from Church End bridge, Markyate
Ver	Ver02a	Downstream from London Road Markyate
Ver	Ver03	Downstream, from River Hill bridge, Flamstead
Ver	Ver03a	Upstream from Watling Street Flamstead
Ver	Ver04a	Downstream from Luton Lane Harpendenbury
Ver	Ver04	Downstream, from bridge at Redbournbury
Ver	Ver05	Downstream, from St. Michael's Street bridge
Ver	Ver06	Weir in Westminster Lodge Park
Ver	Ver07	Downstream, Burydell Lane, Park Street
Ver	Ver08	Upstream, confluence with Colne, near Drop Lane

A5.3 Notes and Key to Environmental Monitoring Charts

Hydrometric monitoring:

- spot flow gauging
- drawings of recorded cross-sections
- calculation of flow through each spot-gauged cross-section
- comparison of depths and velocities under different flow conditions

Macroinvertebrate monitoring:

- Kick-sampling with variations as appropriate to sample the range of habitats at sites identified by EA
- preparation of data tables for macroinvertebrates, arranged by site and by date
- counts of taxa per sample
- LIFE scores for taxa, where available (Extance *et al*, 1999)
- analysis of samples for trends
- assessment of sensitivity of macroinvertebrates to flow

Fisheries monitoring:

Baseline walk-over surveys will be conducted in the Ver, Misbourne, Mimram, Rib, Hiz and Cam in Drought Zone 2, in order to identify reaches that are under stress. Stretches of the river with the potential to become isolated, if the drought situation deteriorates, are identified and flagged. Reaches of the river where rescued fish could be relocated are also identified. During the spot gauging visits and the river photos rounds any changes in the situation of the river will be reported and discussed with the EA Fisheries experts. An appointed fisheries expert consultant will be on stand-by, and when an action for fish rescuing is identified, we will liaise with the EA and the consultant for a consensus on actions.

Figure A5.3.1 River Ver Drought Monitoring Locations

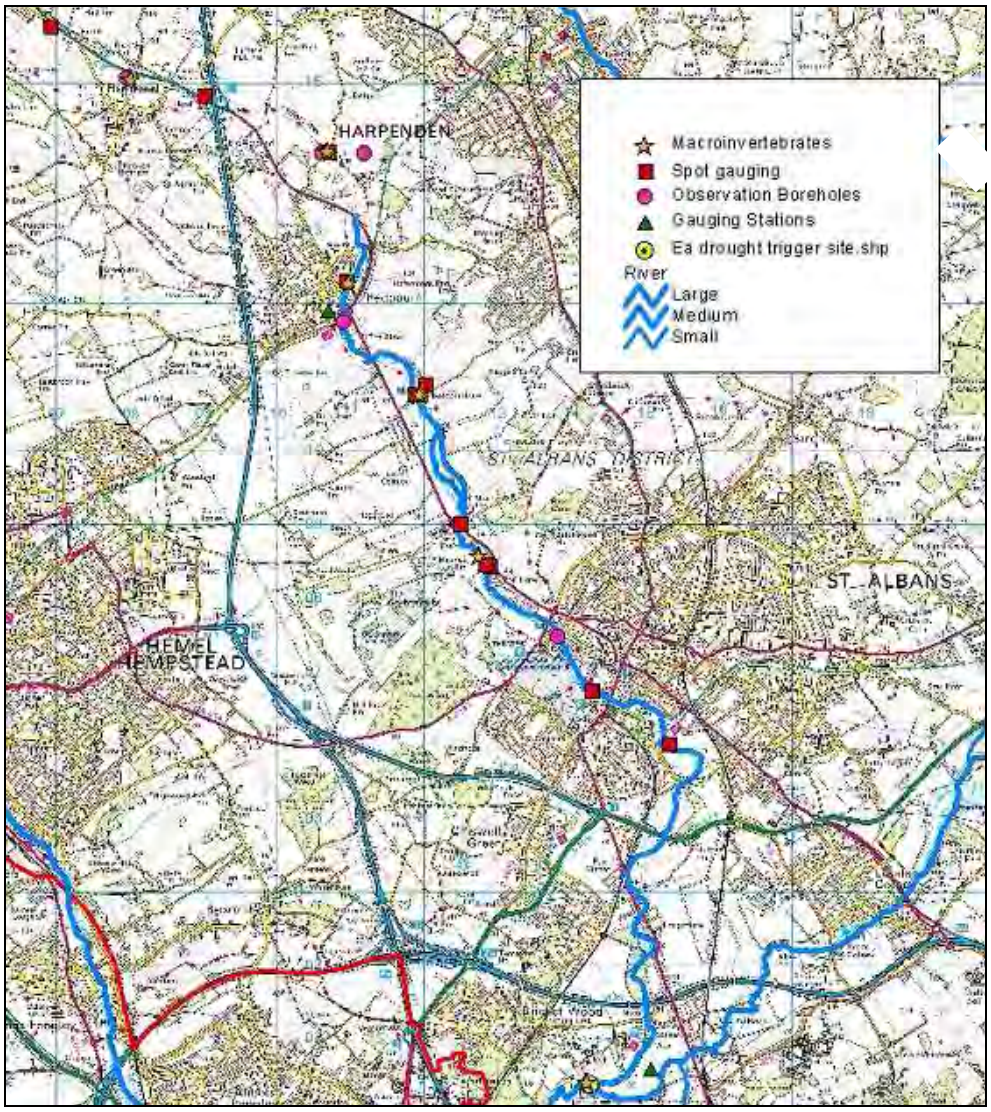


Figure A5.3.2 River Misbourne Drought Monitoring

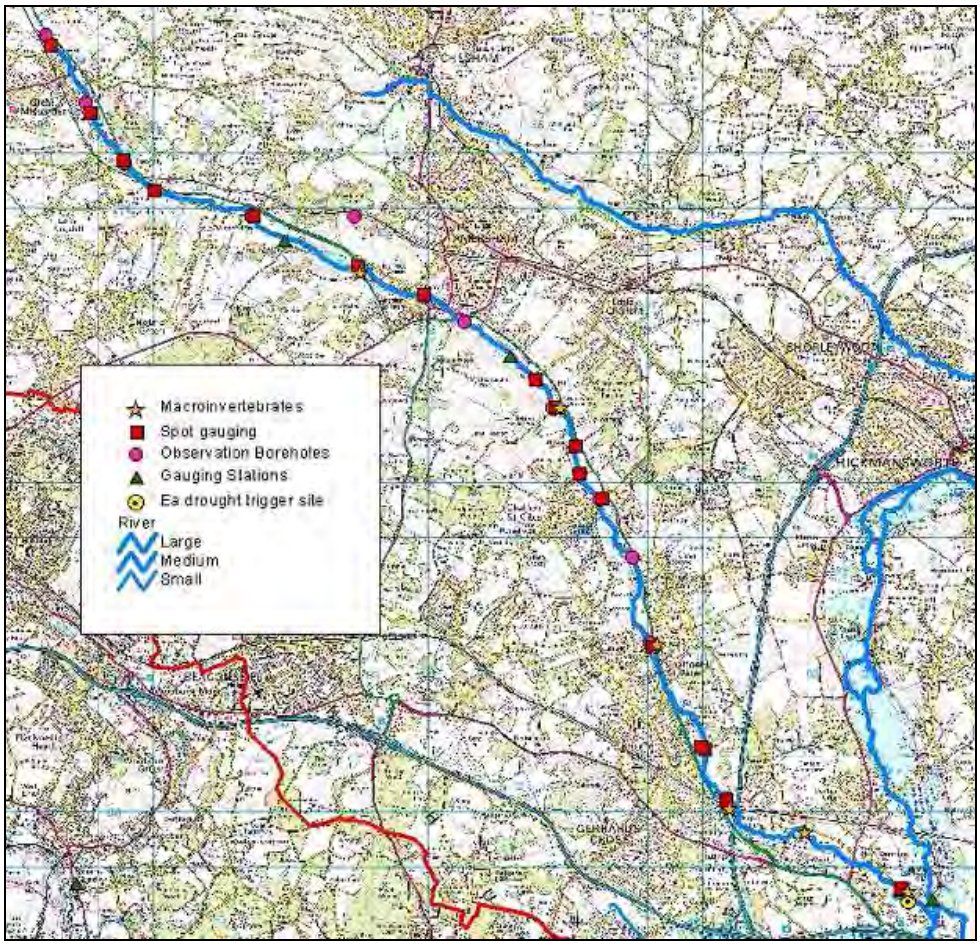


Figure A5.3.3 River Mimram Drought Monitoring Locations

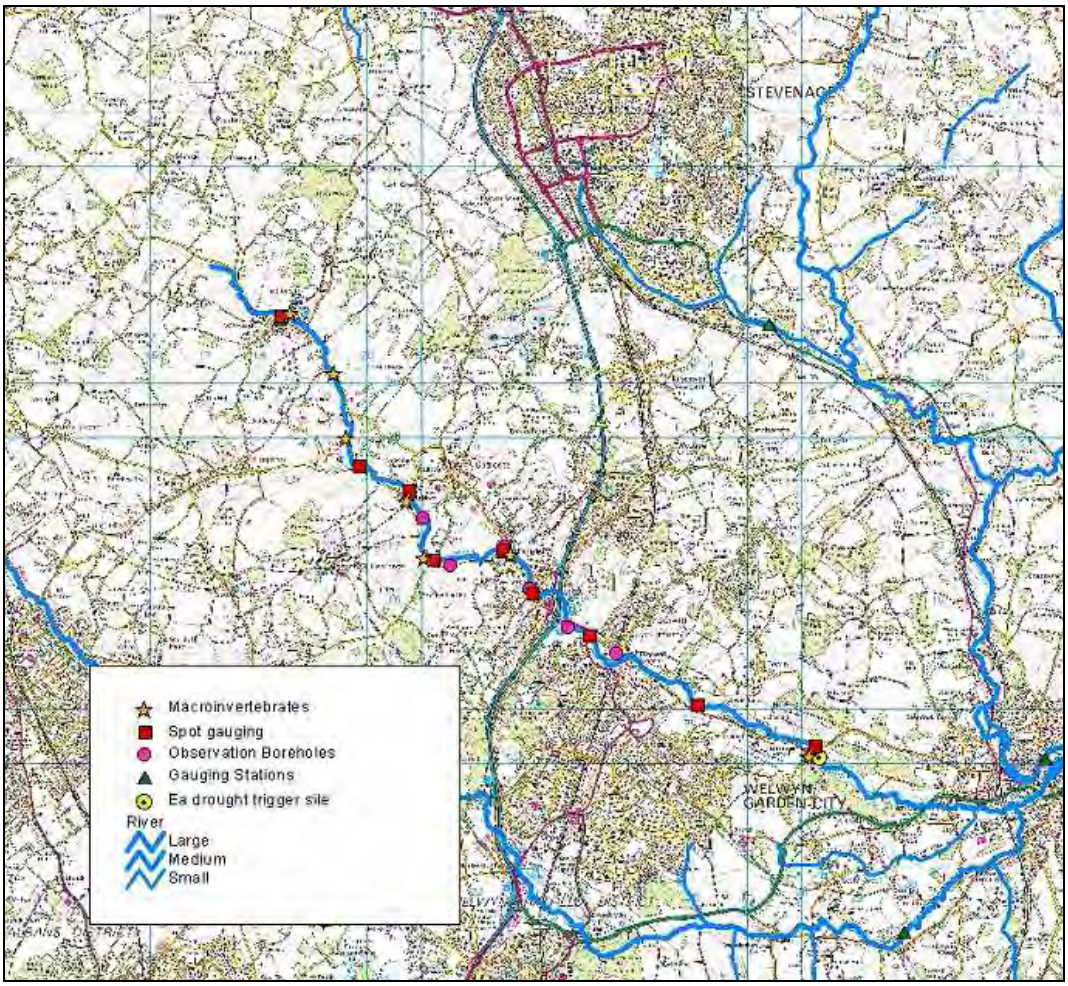


Figure A5.3.4 River Rib Drought Monitoring Locations

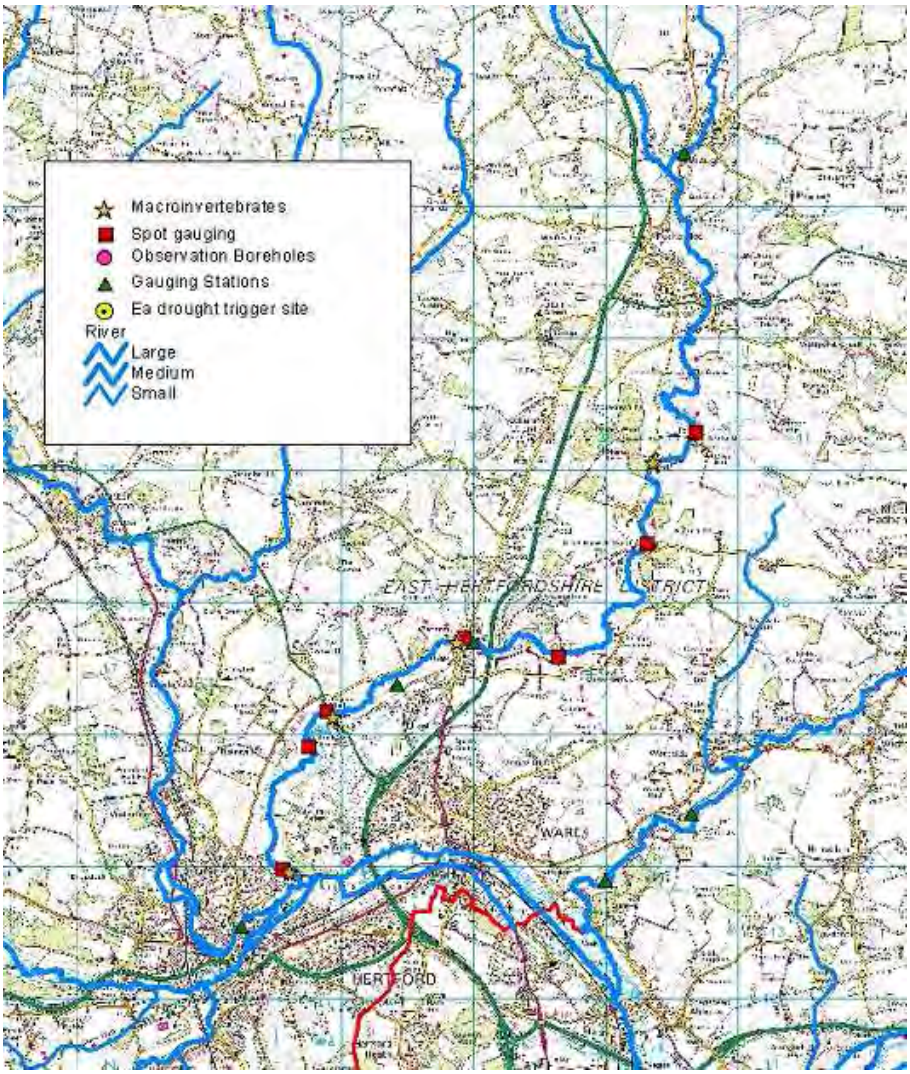


Figure A5.3.5 River Hiz/Oughton Drought Monitoring Locations

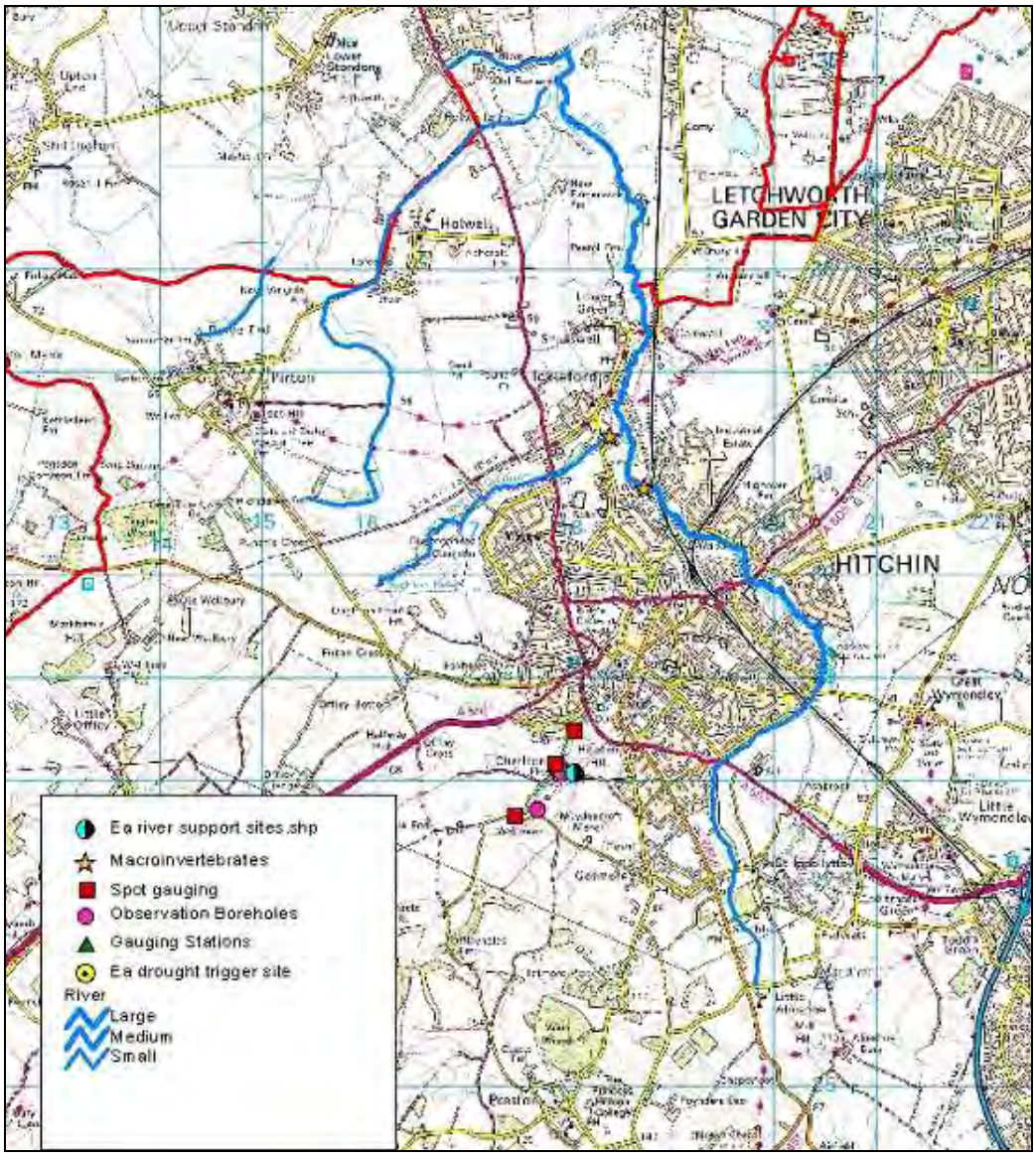
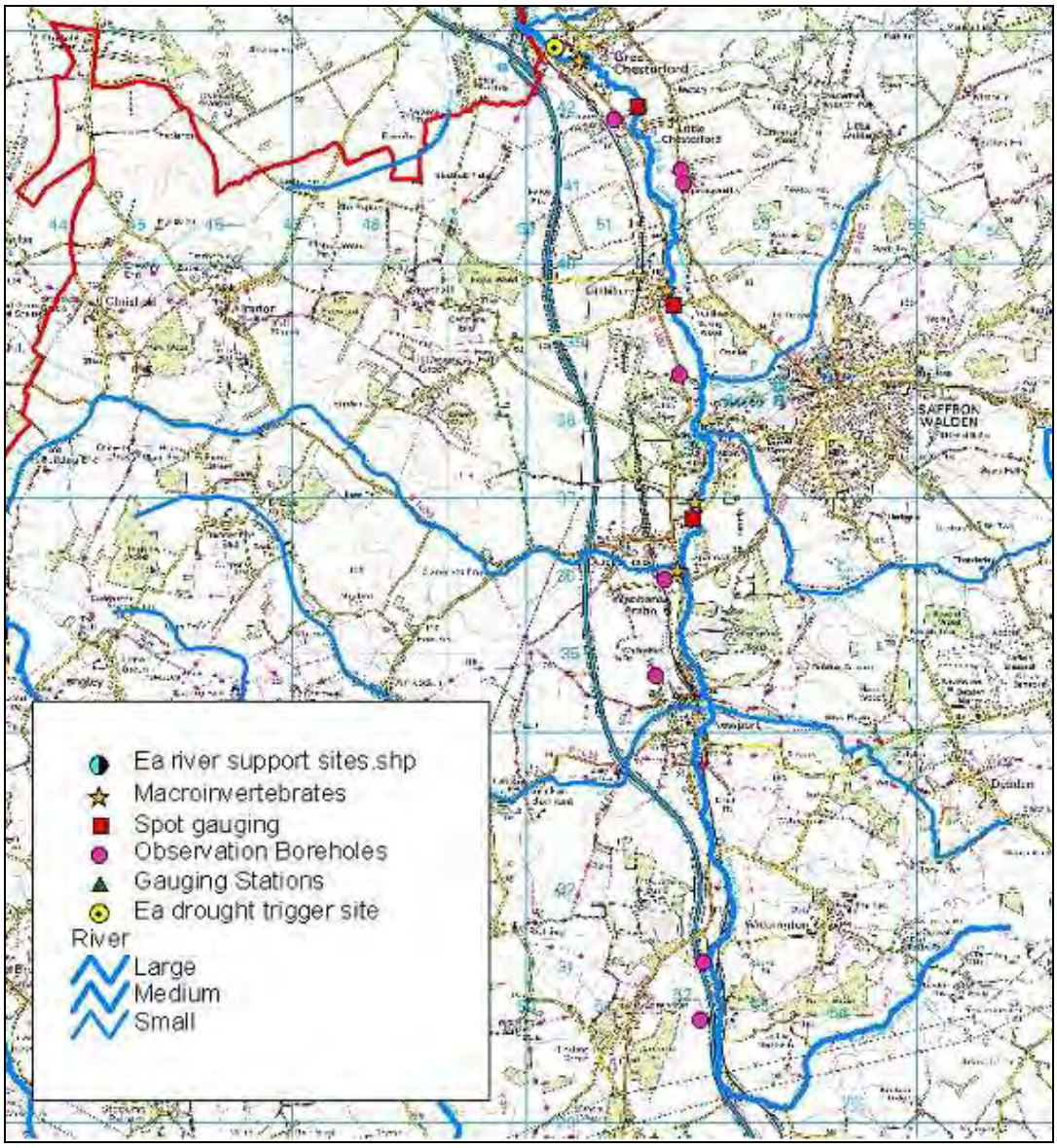


Figure A5.3.6 River Cam Drought Monitoring Locations



APPENDIX 6 PROVISIONAL ENVIRONMENTAL IMPACT STATEMENTS

A6.1 Additional Abstraction from the River Ver

A6.2 Additional Abstraction from the River Misbourne

A6.3 Additional Abstraction from the River Rib

A6.4 Additional Abstraction from the River Cam

A6.5 Additional Abstraction from the River Mimram

A6.6 Additional Abstraction from the River Hiz

A6.7 Additional Abstraction from the River Gade

This Appendix includes provisional environmental impact statements for sites that may be subject to a drought permit or drought order application at some future date. These will remain provisional and will be updated on an annual basis to reflect new data collected such that the documents will be at an advanced stage should they ever be required in earnest.

A6.1 Additional Abstraction from the River Ver

Potential Environmental Impact of an emergency suspension of the River Ver Operating Agreement at FRIA and the Luton Water Order at BOWB on the Flow and Ecology of the River Ver

Drought Permit/Order Source(s): Not required

Potential Additional Water Available: up to 4.61Ml/d (1.61Ml/d from FRIA and 3Ml/d from BOWB)

Statutory Designated Sites: None

A6.1.1 Background

The River Ver was included in the NRA list of the 'top 40' low flow rivers in England and Wales and has been subject to a series of investigations. These investigations concluded that the company's abstraction from FRIA was adversely impacting flows in the Upper River Ver. A licence variation and operating agreement were signed and the FRIA source effectively closed. FRIA still operates at a reduced rate to ensure that the site remains operational should it be needed in an 'emergency'. This water was replaced with water from supply from Anglian Water, the cost of which was funded by the Environment Agency. This licence includes an emergency clause to permit abstraction at the original Licence of Right volumes.

The Management Rules under Schedule 4 (2)iv of the Ver Operating Agreement makes reference to drought:

> *… the Undertaker shall seek not to use FRIA source unless the other sources supplying the System are unable to meet demand for water as a result of the occurrence of any of the following circumstances:*
>
> *iv Deficiencies in water resources arising from drought of the low level of water in underground strata.*

This licence also includes a provision which encompasses the original Luton Water Order (1961) for BOWB with the requirement for river support when flow in the River Ver between St Michael's Bridge and the Abbey Mills falls below 4.55Ml/d. A maximum discharge of 1.02Ml/d is required from Bow Bridge to the Ver at St Michael's Bridge to maintain flows above the trigger. However, this provision is no longer viable due to the potential background PFOs contamination of raw water in BOWB. Therefore, the EA have expressed their opposition to river augmentation from this site. In order to still comply with the Agreement, we voluntarily reduce the output from BOWB. This results in a net reduction in water available for public supply which under normal conditions is met by imports from other parts of the network.

Section 8 part 3a of the Luton Water Order makes reference to drought.

Any interruption of such a supply (supply to a protected source as described) *owing to frost, unusual drought, mechanical breakdown or other unavoidable cause shall not be a breach of any obligation.*

The emergency condition on the licence has been used on a number of occasions in recent years. This has included the temporary loss of output at other sites due to pollution incidents e.g. CRES Pumping Station (BP petrol spill) and BOWB Pumping Station (Buncefield fire).

However, the EA have indicated that they would still require monitoring and Environmental Impact Assessment for this site should the Company wish to lift the Agreement's conditions during a period of drought.

Increased abstraction from FRIA and/or BOWB would be the outcome of lifting the provisions of the Agreement. It would be our intention to minimise periods of increased abstraction from FRIA and to provide support from BOWB when operationally possible.

A6.1.2 Ecology

The River Ver is a groundwater fed Chalk-stream located within the Upper Colne catchment in Hertfordshire. As a chalk-stream it contributes significantly to the biodiversity of the region and has a high conservation value, as well as providing water for agriculture, recreational facilities and a record of the cultural history of the landscape (Clayton, 2005).

Following the Licence variation in 1993, public perception is that this reduction in abstraction has resulted in a benefit to flows in the River. However, recent studies (Stead, 2005 and Clayton, 2006) suggest that not all this water has had a direct benefit on flows in the River Ver with limited net gain measurable at the Gauging Stations (Redbourn and Hansteads, Colney Street).

There are no wetland SSSI's or Habitats Directive Sites along the course of the Upper River Ver (upstream of St Albans) but there are a number of sites of importance to Hertfordshire (County Wildlife Sites) associated with the River. These include Northfield Spring, Redbourn Watercress Beds, Ver Valley by Chequer Lane, Redbournbury Meads, Willow Plantation by Prae Mill Cottage and Prae Hotel.

Habitat availability has found to be an important factor in the distribution of macroinvertebrate species in the Ver. The winterbourne reaches of the River following the 1997 drought were found in 1999 to be recolonising slowly. Research by Leeming was undertaken on the Ver identifying the colonising abilities of different species. With the return of flows increases in mean taxon richness occurred in successive years in site in the upper reaches of the river. Previously dry sites above St Albans and within the urbanised reach recovered most strongly during 1993-5. A sharp fall in species richness in the upstream winterbourne sections occurred during

1995-6 reflecting the low flows and progressive drying of this section (Edmonds-Brown & Powers, 1999).

The Ver is home to characteristic chalk river flora. Surveys carried out in the late 1990s suggest that the recovery of in-channel flora following periods of low/no flow is rapid and that most species are fairly resilient. With regard to fauna, recovery may take a longer period for certain species depending on severity of water loss and period of drying (Edmonds-Brown & Powers, 1999).

Under the WFD classification, the River Ver is classified as 'poor (high)' overall status. In terms of invertebrates, it is classified as 'poor (high)' and in terms of fish as 'moderate (high)'

A6.1.3 Impact of Increased Abstraction

It is thought that river support from BOWB only benefits a short reach of the Ver immediately downstream of St Michaels Bridge (the discharge location) due to the channel modifications through Verulanium Park and other groundwater abstractions.

It is likely that increased abstraction from FRIA would increase the period of no/low flows in the upper reaches. However as the primary cause of the low flows is likely to be the natural onset conditions of drought it will be difficult to detect this, in conjunction with the fact that the benefit of the FRIA 'closure' has not resulted in an equivalent increase in flow in the Ver.

Low flows diminish the habitat suitable for certain chalk stream species. A reduction in flow volume and velocity lessens the ability of a river to wash sediment from the gravel. The resulting siltation can lead to invasion by non-aquatic species, and smothering of gravel spawning grounds for salmonids (Jacobs, 2006). Increased temperatures are also associated with low flows particularly during summer months. This has been shown to reduce dissolved oxygen levels for fish and invertebrate species and weaken the endurance of fish. Such factors, collectively, fundamentally change the Chalk stream characteristics (Jacobs, 2006).

Reduced flows within a chalk stream typically result in a reduction in the dilution of pollutants, which in turn alters this unique chemistry. The impact of low flows on both water quality and ecology are closely linked.

From a WFD perspective, it is likely that the River Ver's classification for fish might be affected temporarily. Under severe drought conditions is it expected, because of low flows, that the fish will be distressed, which might have an impact on the classification. Thus, walk-over surveys and fish rescues are suggested, as outlined in the later sections.

A6.1.4 Baseline Monitoring

The River Ver is regularly monitored by the EA and AW. All the current and historic information will be used as baseline for the environmental impact assessment

process, including all the ecological information collected during the various surveys outlined in the Ecology section.

Flow is measured at two permanent gauging stations on the River Ver at Redbourn in the upper reaches and Hansteads (Colney Street) near the confluence with the River Colne. A third gauging station is located on the River Red, a headwater tributary of the Ver, at Redbourn. Records for the Ver and Red at Redbourn began in 1993, with a longer flow record existing for the Ver at Hansteads with data back to 1956. Periods of no flow were observed in the Ver at Redbourn during the drought periods of 1996, 1997, 1998, 2005 and 2006.

Figure A6.1.1 Flow in the River Ver at Redbourn

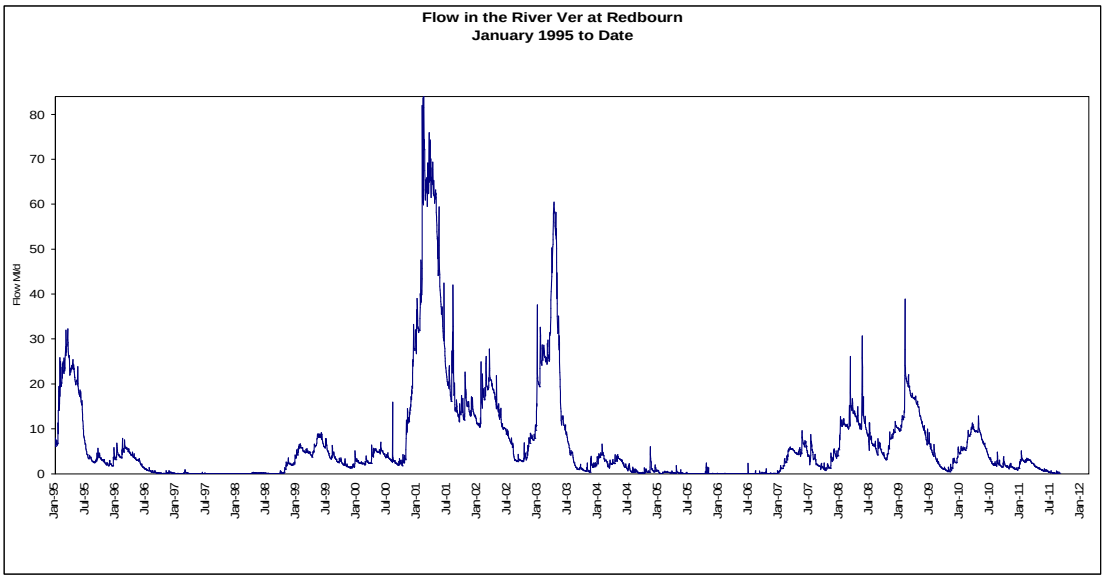


Figure A6.1.2 Flow in the River Red at Redbourn

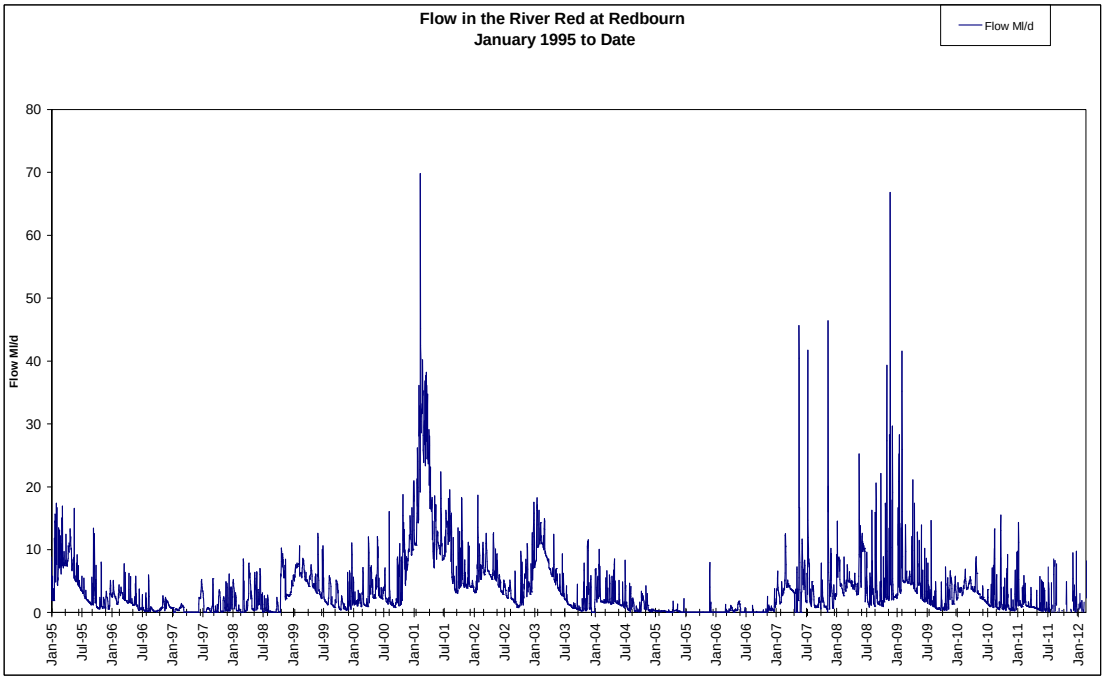
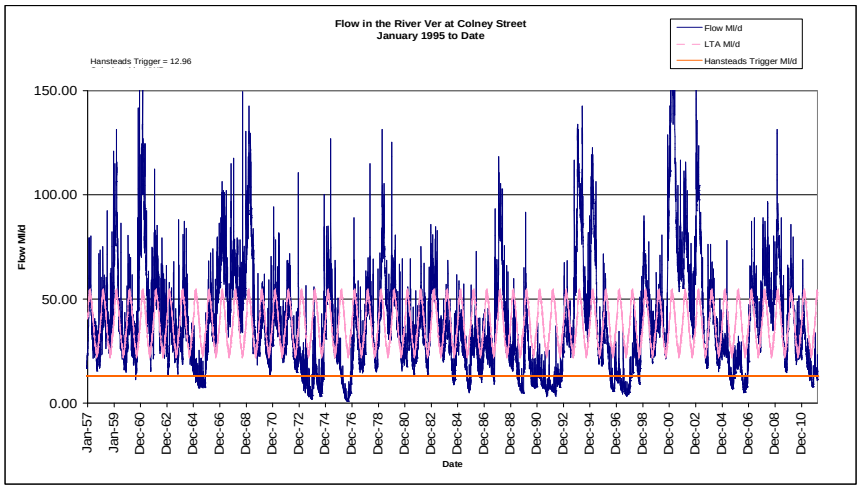


Figure A6.1.3 Flow in the River Ver at Colney Street



We undertake monthly spot gauging at 14 locations on the river as part of our AMP5 NEP programme. Signal tests at most of our pumping stations have been undertaken also as part of the NEP programme, which provided with useful information of the water balance in the catchment. All data collated and analysed for the NEP purposes will be used as baseline information for the pre-application process. We also take quarterly photos of the state of the river at 11 locations since 1997.

Groundwater levels are also monitored in the Ver catchment. The EA monitor groundwater levels in 6 boreholes on a monthly basis. We have installed level loggers at 5 boreholes in the catchment and we have another 2 boreholes drilled, where there was lack of data, which we dip on a monthly basis.

The Environment Agency have carried out fish surveys in seven locations on the River Ver. Only one survey has been carried out at each of these seven locations, the results of which are given in the Technical Information section.

River Habitat Surveys (RHS)[26] were carried out on the Ver between 1994 and 2007 by the Environment Agency. The data collected can be used to calculate a Habitat Modification Score (HMS) so that a Habitat Modification Class (HMC) can be assigned as shown in the table below (map in Technical Information section).

[26] River Habitat Survey (RHS) is a standardised methodology to characterise and assess the physical structure of freshwater rivers and streams. Each survey is carried out over a 500 m stretch and records the physical attributes of the banks and channel (such as material present, modification, flow types) and also information about the riparian habitat.

Table A6.1.1 Habitat Modification Class

HMC	HMC Description	HMS
1	Pristine/semi-natural	0-16
2	Predominantly unmodified	17-199
3	Obviously modified	200-499
4	Significantly modified	500-1399
5	Severely modified	1400+

The data can also be used to calculate a Habitat Quality Score (HQA) to compare rivers of similar types. Higher scores indicate a more varied habitat with a greater variety of natural physical features. Data provided by the Environment Agency shows there has been sixteen or seventeen RHS surveys on the River Ver (one survey has a grid reference that does not plot on the Ver although the river name in the data is given as the Ver). The details are given in Table 1 below (map in the Technical Information section). The results for five of the reaches show that the river has been severely modified. Six of the reaches show that the river is obviously modified; three show that it is predominantly unmodified and one shows it is pristine.

Table A6.1.2 River Habitat Surveys locations, dates and results

Survey_Id	NGR_Site	SurveyDate	HM_Class	HM_Score	HQA_Score
7041	TL0770015200	16/05/1996	5	1450	20
32823	TL0879014962	26/06/2007	3	460	17
38248	TL1073314004	15/07/2009	No score available		
7042	TL1130011200	06/06/1996	5	3370	56
20147	TL1190010900	08/11/1996	3	400	26
20146	TL1200010500	08/11/1996	3	370	13
10491	TL1230010300	15/08/1995	2	180	35
36014	TL1224910155	11/06/2008	5	1490	33
20145	TL1210010100	08/11/1996	2	20	20
20144	TL1220009600	08/11/1996	2	20	21
4084	TL1240009500	21/06/1995	5	3200	31
20143	TL1250009300	08/11/1996	3	450	22
32848	TL1261008701	27/06/2007	1	0	25
32851	TL1374807604	27/06/2007	5	1525	29
1084	TL1540005000	15/06/1994	3	340	26
10495	TL1430001300	15/08/1995	3	325	42
38249	TL1993203906	15/07/2009	No scores provided and grid reference does not plot on the Ver although the raw data gives the river name as the Ver		

Note: Point farthest upstream is shown first

A6.1.5 Additional Monitoring

Monitoring for the Ver will start in Drought Zone 3 as it is one of the top priority sites with environmental provisions to be lifted. The monitoring schedule will comprise of monthly spot gauging during Zone 2, fortnightly spot gauging during Zone 3 and weekly spot gauging during drought provision duration. If a drought provision is in place, the post drought spot gauging frequency will be weekly reducing to fortnightly and then monthly, following mutual agreement with the EA. If the drought provision is not used the post drought spot gauging frequency will be monthly. Monthly spot gauging is already in place by the VWC, which will increase in frequency accordingly. The spot gauging rounds include in-situ water quality monitoring (pH, dissolved oxygen, conductivity).

In addition, macroinvertebrate surveys will be undertaken in spring, summer and autumn at 12 locations. The spring and autumn rounds are scheduled by the EA for 10 sites, therefore the summer round at 10 sites will be undertaken by VWC.

Walk-over surveys are necessary for the characterisation of the state of the river during Drought Zone 2. The walk-over survey will be preferably undertaken by both EA and VWC, subject to mutual agreement. The objective of the surveys will be the identification of reaches under stress, so that a more detailed Environmental Impact Assessment can be completed at the time and immediate mitigation measurements can be implemented, such as fish rescues and debris/obstruction removal. The ideal period for the walk-by surveys is spring, subject to the timing of drought (Zone 2 to coincide with spring) and weather conditions.

Fisheries surveys are not planned to be undertaken specifically as part of the drought provision process. However, walk-over surveys will assist in assessment of the impact of drought on fish populations and the location of potential fish rescue sites.

Groundwater levels are monitored by the EA at 6 locations on a monthly basis. AW monitor monthly groundwater levels at 2 locations and have level loggers installed in 5 locations. Additional monitoring will be subject to agreement, with the options of logging boreholes in close proximity to the FRIA and BOWB sites

A6.1.6 Mitigation Measures

Our mitigation plans include actions before, during and after the drought. The major mitigation measures before the drought involve river restoration options, the measures during the drought ecological, hydrological and water quality monitoring and after the drought actions to enhance habitat recovery.

Following the walk-over surveys the critical sites identified will be looked at into detail in order to apply the mitigation measures required for the purpose of fish easement. Following the 2012 Drought experience, suggestions will be put forward for river restoration option at the critical sites, such as weir structure surveys and removals. In the cases that fish easement cannot be achieved, fish rescues of the populations under stress will be conducted. The ideal relocation places would be in the same river body further downstream at suitable locations identified during the walk-over surveys. In the event that downstream locations are not accessible or are deemed inappropriate due to low flows or adverse conditions, the fish will be relocated to different water bodies with similar quality characteristics. In this case, health checks of the relocated fish are necessary in order to ensure good health of the fish. After the end of the drought, the water body will be restocked. The restocking will be

required to be completed with a range of species and sizes, in order to ensure that the angling activity is not impacted and a balanced fish population is maintained.

After the event of the drought, additional walk-over surveys will take place in order to identify macrophyte species that suffered in the upstream reaches but are in a good status in the downstream reaches. Following the identification of these species, replanting of populations from the downstream reaches to the upstream reaches will be considered in order to ensure species recovery along the length of the river.

Following the end of the drought and the cessation of need for additional abstraction, the options of abstraction for augmentation or partial/full cessation of abstraction from the catchment reaches that have been more affected will be considered. This will aid the recovery of the natural flows into the river, which will ultimately reduce the time of the river remaining dry.

In the event that the emergency condition of the Ver Operating Agreement is utilised for 100 consequent days of additional abstraction of 4.61Ml/d, the additional volume of water that would be removed from the aquifer will add up to 461Ml/d. In order to compensate and aid in the recovery of the flows, we suggest that we will cease abstraction from BOWB and FRIA for 60 days or until flows return to normal, whichever is the shortest, should the demand levels allow for it.

Table A6.1.3 Summary of Drought Monitoring for all rivers

Data	Description	Normal Frequency	Drought Zone 3 Frequency	Drought Zone 4 Frequency/ additional abstraction	Post Drought Frequency
Groundwater Level	TL01/176 River Hill TL11/161 Luton Lane TL11/35 Bridge Nurseries TL11/162 Chequer Lane TL10/113 Bow Bridge TL10/50 Express Dairy	Monthly (EA)	Monthly (EA)	Monthly (EA) NB additional monitoring by AW subject to agreement	Monthly (EA)
Gauged River Flows	River Ver at Redbourn River Red at Redbourn River Ver at Colney Street	Daily (EA)	Daily (EA)	Daily (EA)	Daily (EA)
Spot Gauging	Markyate DS of Markyate Hollybush Lane Friars Wash Redbourn Golf Course u/s Redbourn Redbournbury Shafford Farm Pre Mill House St Michaels/West St Albans Mud Lane Opsec/Holywell Hill Cotton Mill Bridge	Monthly (AW)	Fortnightly (AW)	Weekly (AW)	Weekly, reducing to fortnightly, reducing to monthly (AW)

	Sopwell Main Channel				
Macro-invertebrates	River Hill, Flamstead	Biannual (EA)	3 times/year (EA, AW)	3 times/year (EA, AW)	3 times/year (EA, AW)
	Luton Lane, Redbourn	Biannual (EA)	3 times/year (EA, AW)	3 times/year (EA, AW)	3 times/year (EA, AW)
	Chequers Lane	Biannual (EA)	3 times/year (EA, AW)	3 times/year (EA, AW)	3 times/year (EA, AW)
	Below Redbournbury Farm Ford	3 times/year (EA)	3 times/year (EA)	3 times/year (EA)	3 times/year (EA)
	Above Pre Mill House	Biannual (EA)	3 times/year (EA, AW)	3 times/year (EA,AW)	3 times/year (EA, AW)
	Below Redbourne Road	Biannual (EA)	3 times/year (EA, AW)	3 times/year (EA, AW)	3 times/year (EA, AW)
	Below Kingsbury Mill	Biannual (EA)	3 times/year (EA, AW)	3 times/year (EA. AW)	3 times/year (EA, AW)
	Cottonmill Lane	Biannual(EA)	3 times/year (EA, AW)	3 times/year (EA, AW)	3 times/year (EA, AW)
	Sopwell	Biannual(EA)	3 times/year (EA, AW)	3 times/year (EA, AW)	3 times/year (EA, AW)
	Burydell Lane, Park Street	Biannual(EA)	3 times/year (EA, AW)	3 times/year (EA, AW)	3 times/year (EA, AW)
	Above Colne	3 times/year (EA)	3 times/year (EA)	3 times/year (EA)	3 times/year (EA)
	At Redbourn	Biannual (EA)	3 times/year (EA, AW)	3 times/year (EA, AW)	3 times/year (EA, AW)
Fisheries	Upper Ver Shafford Mill Verulam Golf Club	1 off in 2013 EA (for WFD classification)	Walk-over Surveys	Walk-over Surveys	Walk-over Surveys

A6.1.7 Conclusion

It is likely that if drought conditions were severe enough to require us to apply for a drought permit the Misbourne would already be dry over a significant length. Increasing abstraction from the catchment would therefore not have any immediate impact on river flows but would delay the recovery of flows following the drought by ~1-2months. The velocity of the river flow might also be affected. Potential mitigation measurements could include aeration, fish rescues, cessation of abstraction for up to 2 months to aid recovery, replanting of chalk stream vegetation, post-drought restocking and channel narrowing.

Table A6.1.4 Summary of Environmental Impact of Drought Permit on River Ver

Option Implementation Assessment	Option Name	Ver Operating Agreement Provisions lifting because of Drought
	Trigger	Zone 4 Drought Trigger and drought permits with lower environmental impact
	Deployable Output of action	4.61Ml/d
	Location	River Ver (FRIA, BOWB)
	Implementation timetable	Drought monitoring to start when Zone 3 trigger is breached. Discussion for lifting provisions to commence when Zone 4 trigger is breached and the applications for the permits higher on the list have been submitted
	Permissions required and constraints	Agreement of the Environment Agency is required. Relevant discussions will be frequently held with the Environment Agency. Discussions will also be held with the local interest groups.
	Risks associated with option	The associated risks are environmental and detailed below.
Environmental Assessment	Risk to the environment	Medium/Low
	Summary of likely environmental impacts	Delay of recovery of the dried out reaches after the drought by 1-2 months, potential extension of the dried out reaches, reduced flow velocity at dry reaches
	Baseline information used	Quarterly river photos at 11 locations, macroinvertebrates monitoring 10 biannual and 2 three times per year, fisheries surveys at 3 locations, monthly spot gauging at 12 locations, 3 gauging stations flow records, 5 level loggers (AW), 2 AW and 6 EA monthly groundwater level monitoring locations
	Summary of additional baseline monitoring requirements	Walk-by survey to identify affected locations, summer macroinvertebrates survey at 10 locations some of which might be dry, spot gauging fortnightly at 14 locations
	Mitigation measures	Fish rescues, create maroinvertenrates banks for re-stocking, potential river augmentation from the additional abstracted volumes, artificial narrowing of the channel to improve velocity, replanting of chalk stream vegetation. Stop BOWB and FRIA abstraction at the end of the drought to avoid recharge delays.
	Impact on other activities	No other activities are expected to be impacted on.

A6.1.7 Technical Information

Table A6.1.8 EA Fisheries Surveys Summary

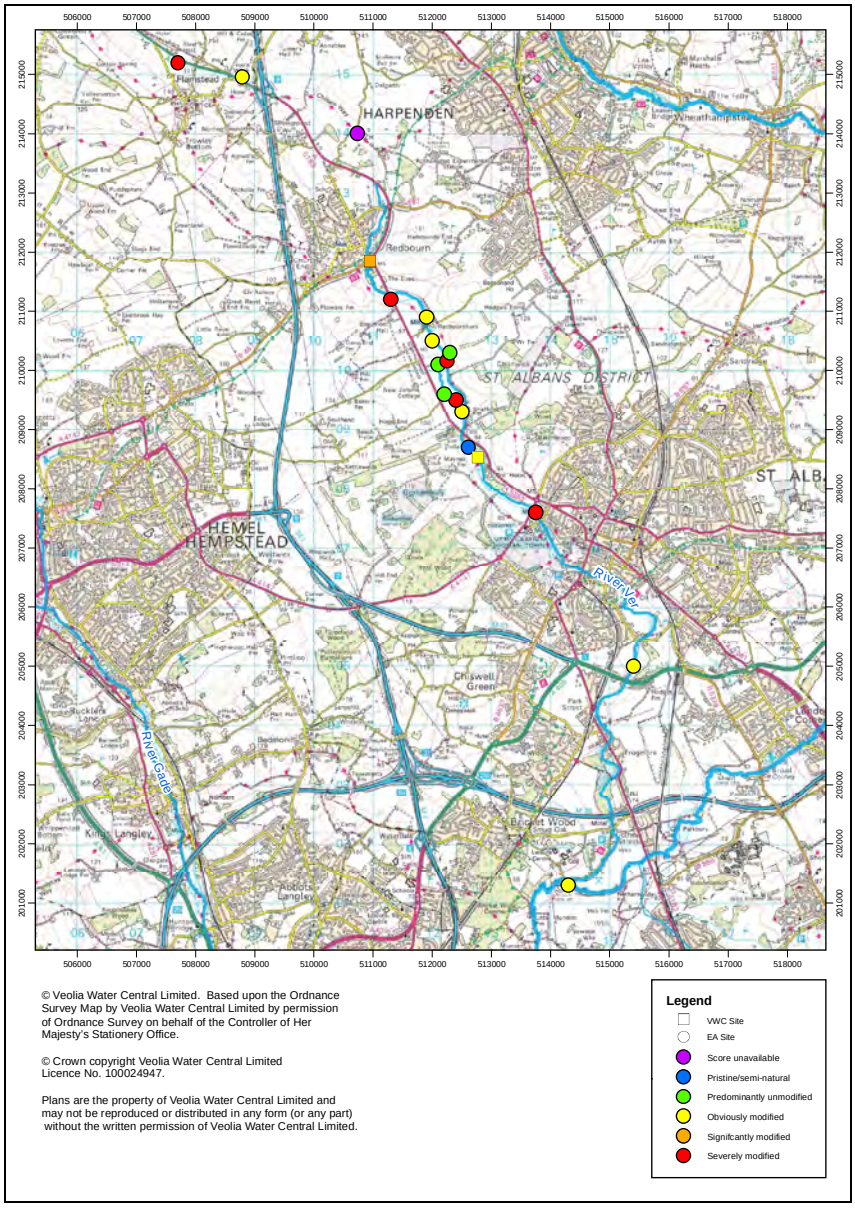
Site Name	Survey (Ranked) NGR	Date	Number of surveys
D/S Luton Lane	TL1080013500	19-May-04	1
Redbournbury fishery	TL1171511216	09-Jun-06	1
Shafford mill u/s	TL1223110205	08-Jun-06	1
Verulam Golf Course	TL1250009200	20-May-04	1
Shafford Mill	TL1255409160	06-May-04	1
Moor Mill	TL1497703065	20-Oct-09	1
Drop lane (Ver)	TL1502701903	07-Jun-06	1

Note: Point farthest upstream is listed first

Table A6.1.9 Fish Densities (number of fish per 100m^2) at all Sample Locations

	U/S → D/S						
	D/S Luton Lane 19/5/04	Redbournbury fishery 09/06/2006	Shafford mill u/s 08/06/2006	Verulam Golf Course 20/05/2004	Shafford Mill 06/05/2004	Moor Mill 20/10/2009	Drop lane (Ver) 07/06/2006
Brown / sea trout [*Salmo trutta*]		1.525	0.35	0.333	4.745	0.222	1.275
Chub [*Leuciscus cephalus*]				0.667	0.182		0.1
Dace [*Leuciscus leuciscus*]							0.15
Gudgeon [*Gobio gobio*]							0.1
Perch [*Perca fluviatilis*]						9.111	0.05
Bullhead [*Cottus gobio*]		25	12.5	13.333	4.562		0.1
Roach [*Rutilus rutilus*]						2.222	
Barbel [*Barbus barbus*]					0.182		
Rainbow trout [*Oncorhynchus mykiss*]				0.333			
Stone loach [*Barbatula barbatula*]		12.5	12.5				
Minnow [*Phoxinus phoxinus*]		25	25	35.333	1.825		5
3-spined stickleback [*Gasterosteus aculeatus*]	2	25	12.5	2.667	1.095		12.5
10-spined stickleback [*Pungitius pungitius*]	1.333						
NUMBER OF SPECIES	2	5	5	6	6	3	8

Figure A6.1.4 River Habitat Survey Locations and Results



A6.1.8 References

Clayton H. 2005. An evaluation of the impact of measures to restore flows in the River Ver. September 2005

Edmonds-Brown, V. and Powers, E. (1999) River Ver Report, June 1999. Prepared for Affinity Water and the Ver Society.

Jacobs. 2006. Restoring Sustainable Abstraction Programme Bow Bridge to Verulanium Park RSA-THEN-28/16. August 2006

Stead T. 2005. The Interaction between Groundwater and Surface Water along the River Ver. August 2005

A6.2 Additional Abstraction from the River Misbourne

Potential Environmental Impact of lifting environmental conditions of the Misbourne Operating Agreement on the Flow and Ecology of the River Misbourne

Drought Permit/Order Source(s): AMER, GREM, CHAL

Potential Additional Water Available: 8Ml/d

Potential Reduction in River Support: 0Ml/d

Statutory Designated Sites: None

A6.2.1 Background

In 1989 the National Rivers Authority (NRA) developed a national programme known as the Alleviation of Low Flows (ALF). This programme identified the top 20 low flow rivers in the country. The River Misbourne was identified as priority for action. As a result a two phase programme was proposed for implementation. Phase 1 was indicating reduction in abstraction in the upper Misbourne catchment by approximately 11Ml/d, which would give the groundwater levels the opportunity to recover and support the river flows, migrating the perennial head upstream towards Mobwell. Phase 2 indicated another 4Ml/d reduction in abstraction, bed lining of selected river reaches and river augmentation from bankside boreholes. However, these options were only suggestions and have not been formally assessed or agreed. They will, therefore, require individual technical assessments

In 1997/98 Phase 1 came into effect resulting in a reduction in licensed abstraction in the catchment by 8Ml/d. However, the Misbourne continued to suffer from low flows and remained on the EA Restoring Sustainable Abstraction Programme (RSAp) catalogue. Thus, an AMP5 Options Appraisal to identify and cost an appropriate scheme to improve the flow regime of the Misbourne, with benefits to chalk stream habitats, flora and fauna is underway.

Table A6.2.1 River Misbourne Drought Abstractions

	GREM	AMER	CHAL		BULS	GERR	Group Total
1967 Licence	28/39/28/334						
Daily Peak (Ml/d)	5.68	18.18	4.55		3.41	6.82	38.64
Annual Average (Ml/d)							29.63
				Group Total			
2003 Licence	28/39/28/334				28/39/28/559		
Daily Peak (Ml/d)	5.68	18.18	4.55	28.41	3.41	6.82	10.23
Monthly (Ml/d)		13.00					
Annual Average (Ml/d)	1.00	7.00	4.00	12.00			9.63
Change in Annual Average Licence (Ml/d)						29.63 - 21.63 =	**8.00**

A drought permit will not be required to lift the Phase 1 Misbourne Operating Agreement conditions under severe drought conditions. However, when we are in Drought Zone 4 and facing unprecedented water levels we will discuss with the EA lifting of the conditions. A permit application will not be required, however additional monitoring and environmental impact assessments will be in place.

A6.2.2 Ecology

The River Misbourne is a chalk stream and therefore an important habitat and potentially home to a number of biodiversity action plan species.

The Misbourne is currently classified as 'poor (very certain)' in terms of fish under the WFD objectives. Details from the main report which discusses fish surveys is 'Misbourne Alleviation of Low Flow study - Fisheries Monitoring 1997 to 2004' (Tomlinson and Perrow (2006)) can be found in the Technical Information section of this report. The only other fish data available was provided by the EA for a survey carried out in 2008. This is for a single survey (28/04/2008) at 'Isle of Wight Farm' (see Technical Information).

The Misbourne is currently classified as 'poor (uncertain)' in terms of invertebrates under the WFD objectives. The EA provided data for 25 sites on the River Misbourne and AW sampled 5 sites in Autumn 2010. A summary of the data available is provided in the Technical Information section.

The Environment Agency has carried out two macrophyte surveys on the River Misbourne and the results indicated that the macrophyte community is moderately changed from benchmark conditions at Little Missenden and slightly changed downstream of Gerrards Cross STW. There are also 17 River Habitat Surveys for the Misbourne, carried out between 1995 and 2008. Twelve of these surveys identified that the river is significantly or severely modified. The ecology in reaches that have been subject to physical modifications (notably re-sectioning, i.e. at London Road depot and the old mill leats, and poaching, i.e. at Lower Bottom House Farm Lane) is found to be less resilient to low flows. A lack of suitable habitat to provide refugia for flow sensitive ecology in modified reaches is also a significant limiting factor.

A6.2.3 Impact of Increased Abstraction

Previous conceptualisation of the catchment suggested that the river can be divided into three separate reaches: the upper and the lower Chalk reaches and an intermediate perched ephemeral flow section. Generally the river tends to lose water to the underground during low groundwater level conditions. The reaches that are more likely to be affected by increased abstraction from the Catchment are the middle ephemeral reach and the upper reaches. It is expected that these reaches would be naturally dry under Drought Zone 4. Therefore, it is believed that increased groundwater abstraction from the catchment would prolong the post-drought recovery period of flows and hence ecology at these reaches. It is anticipated that this prolonged period would not exceed 2 months. This is an assumption based on observations and general knowledge on the river, however, there is no hard evidence to support it. Therefore, the in drought and post drought monitoring is very critical in order for the appropriate evidence to be collected and used for future droughts It might also be the case that the length of the river is affected by additional abstraction from the catchment is increased. It is not expected that additional abstraction will have any long or short term impact on the WFD classification of the River Misbourne.

A reduction in river flow because of increased abstraction could increase siltation rates, increase temperature and reduce dissolved oxygen. It is also likely that fish populations will be isolated with the partial drying out of the river. A temporary loss of aquatic macrophytes is anticipated which would be expected to re-colonise post-drought.

A report was produced in 2000 (Ardeola Environmental Services), which discusses the consequence of the 1995-1997 drought and the subsequent recovery and concluded that even though the drought reached extreme levels all but a few taxa (e.g. white clawed crayfish which appear to be extinct on the river) re-colonised and population levels approached or exceeded those of pre-drought conditions. The report also states that the Misboume “has few features of particular conservation value, but this is mainly as a result of modification of the channel and floodplain, long before the drought event.”

The study also suggested that overall the river has adapted to have an extended winterbourne reach and that it has otherwise recovered to a ‘natural’ state following the drought. In addition it also suggests that droughts are no more than extreme examples of normal climatic variation and therefore, to take action such as channel remodelling, could be potentially as damaging as the droughts.

A full River Corridor Survey (RCS) was carried out in 1994/1995. RCS was then carried out in 1997 and 1998 (EA) and in 2003 (Tranter, 2003). These surveys covered 6 sections. The 2003 survey found that there had been improvements for five of the reaches following the implementation of the ALF particularly in terms of

channel morphology. Two of the sections were considered to be similar to the 1997/1998 surveys. These were the sections farthest downstream, which had been the least effected by the drought.

Using as baseline the 2009 WFD classification for fish and invertebrates, it is not expected that additional abstraction will have any effect on the classification. However, the more recent classifications demonstrate a better status in terms of invertebrates, which has the potential to temporarily deteriorate under drought conditions. This deterioration will probably last longer, if there is additional abstraction from the catchment. In drought and post drought monitoring is therefore very significant in order to assess the extent of the deterioration and use the knowledge in future droughts.

Other potential impact that might be detected under increased abstraction and drought conditions are reduction in aesthetic appeal and variations in compositions of inverts and plants. The walk-over surveys will be used for monitoring the level of these impacts.

A6.2.4 Baseline Monitoring

The River Misbourne is regularly monitored by the EA, the Chilterns Society, the River Misbourne Action and AW. All the current and historic information will be used as baseline for the pre-application process, including all the ecological information collected during the various surveys outlined in the Ecology section.

There are two EA flow gauging stations on the Misbourne, at Little Missenden and at Denham Lodge, which record daily river flows (Figures 1 and 2).

Figure A6.2.1 Flow in the River Misbourne at Little Missenden

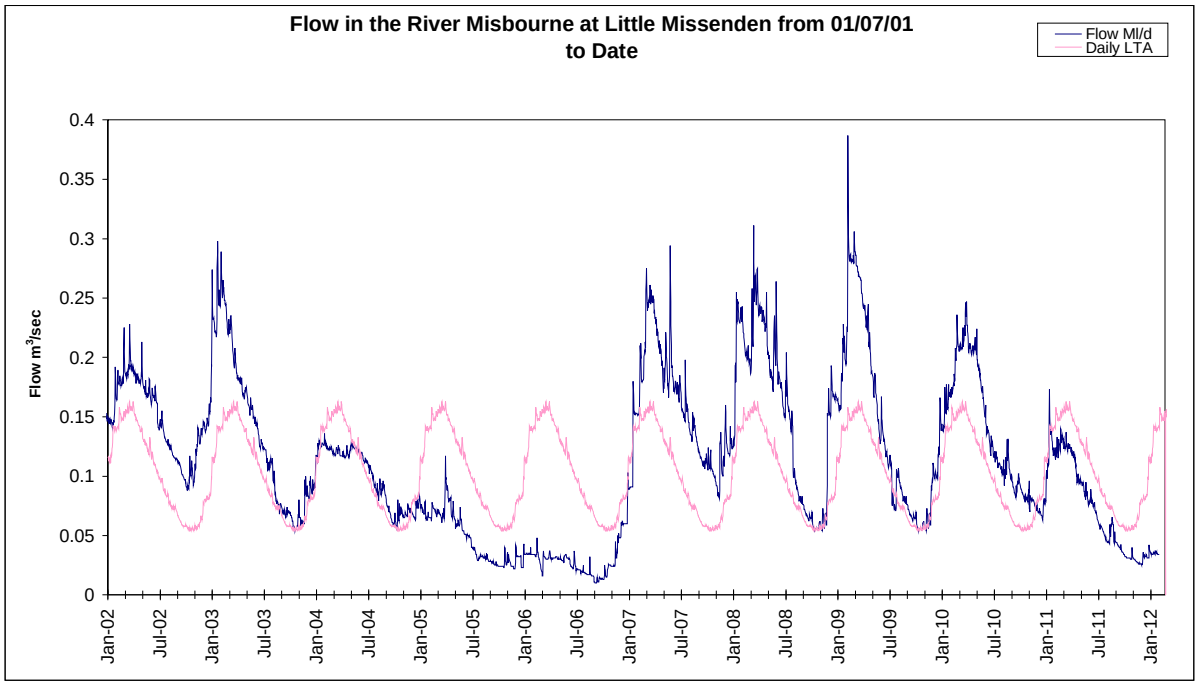
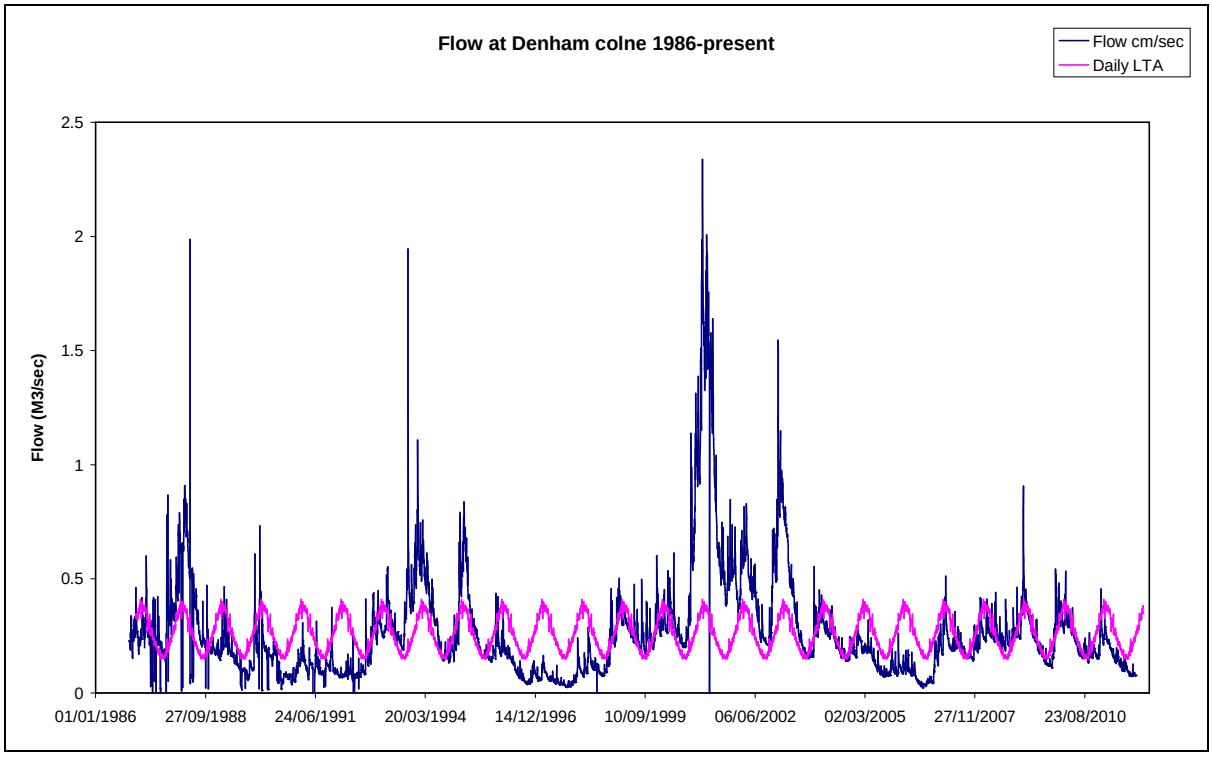


Figure A6.2.2 Flow in the River Misbourne at Denham



The Chilterns Society and the River Misbourne Action undertake monthly spot gauging at 21 locations on the river. The spot gauging was taken over by us during autumn 2011, as part of the signal testing programme and the augmentation trial from AMER as part of the National Environmental Programme. All data collated and analysed for the NEP purposes will be used as baseline information for the pre-application process.

Groundwater levels are also monitored in the Misbourne catchment. There are 11 boreholes in the catchment, where the EA and the Chilterns Society records monthly dips resulting in fortnightly data sets.

The results of fisheries surveys completed in between 1997 and 2004 are detailed in the Technical Information section. The EA completed another fisheries survey in the Misbourne in 2011 for the purposes of WFD classification. The results of this survey include brown trout *Salmo trutta* in the Isle of Whight Farm monitoring site and brown trout, stickleback, bullhead and rudd from the site downstream of Shardaloes lake. The full results of the survey will be taken into account for the baseline monitoring of the Environmental Impact Assessment.

Seventeen River Habitat Surveys (RHS) have been carried out within the Misbourne study area by the EA. The data collected can be used to calculate a Habitat Modification Score (HMS) so that a Habitat Modification Class (HMC) can be assigned as shown in the table below (map in Technical Information section).

Table A6.2.1 Habitat Modification Class

HMC	HMC Description	HMS
1	Pristine/semi-natural	0-16
2	Predominantly unmodified	17-199
3	Obviously modified	200-499
4	Significantly modified	500-1399
5	Severely modified	1400+

The data can also be used to calculate a Habitat Quality Score (HQA) to compare rivers of similar types. Higher scores indicate a more varied habitat with a greater variety of natural physical features.

The results of the RHS's carried out by the Environment Agency are given in the table below. Seventeen surveys have been carried out although only one has been carried out between Amersham and Chalfont St Giles. Twelve surveys show that the river is significantly or severely modified. The survey carried out between Amersham and Chalfont St Giles show the river to be 'significantly modified' on this reach.

Table A6.2.2 River Habitat Surveys

	Survey_Id	NGR_Site	SurveyDate	HM_Class	HM_Score	HQA_Score
d/s	30227	TQ0509486243	28/08/2003	5	1930	55
↑	35271	TQ0307387400	19/06/2008	2	100	38
	30226	TQ0277087711	28/08/2003	4	1020	41
	30225	TQ0134288346	28/08/2003	Score not available		
	10502	TQ0100089200	10/08/1995	3	300	33
	32874	TQ0025290473	03/08/2007	4	1280	23
	30224	SU9995391214	28/08/2003	4	1280	46
	30223	SU9983992202	29/08/2003	2	110	42
	31166	SU9973392697	21/10/2004	3	240	29
	32871	SU9859294967	03/08/2007	4	500	20
	32870	SU9494397856	03/08/2007	4	1220	29
	30222	SU9467597913	16/09/2003	5	1865	50
	31165	SU9450298387	21/10/2004	5	3660	59
	32868	SU9283698804	03/08/2007	5	1625	36
	31648	SU9181099105	08/08/2005	4	1010	43
	30221	SU9183199137	16/09/2003	5	2750	36
u/s	36008	SP9015300200	08/07/2008	5	2805	23

A6.2.5 Additional Monitoring

Monitoring for the Misbourne will start in Drought Zone 3 as it is one of the top priority sites with environmental provisions to be lifted. The monitoring schedule will comprise of monthly spot gauging during Zone 2, fortnightly spot gauging during Zone 3 and weekly spot gauging during drought permit duration. If a drought permit is granted, the post drought spot gauging frequency will be weekly reducing to fortnightly and monthly, following mutual agreement with the EA. The additional monitoring rounds and locations will be AW's responsibility. If additional abstraction following lifting of the operating agreement is not put in place the post drought spot gauging frequency will be monthly. Monthly spot gauging is already in place by the EA, therefore the additional spot gauging will be undertaken by AW. The spot gauging rounds include in-situ water quality monitoring (pH, dissolved oxygen, conductivity).

In addition, macroinvertebrate surveys will be undertaken in spring, summer and autumn at 7 locations. The spring and autumn rounds are scheduled by the EA, therefore the summer round will be undertaken by AW.

Walk-over surveys are necessary for the characterisation of the state of the river during Drought Zone 2. The walk-over survey will be preferably undertaken by both EA and AW, subject to mutual agreement. The objective of the surveys will be the identification of reaches under stress, so that a more detailed Environmental Impact Assessment can be completed at the time and immediate mitigation measurements can be implemented, such as fish rescues and debris/obstruction removal. The ideal period for the walk-by surveys is spring, subject to the timing of drought (Zone 2 to coincide with spring) and weather conditions. Alterations in aesthetic appeal and variations in compositions of inverts and plants will also be monitored during the walk-over surveys.

Fisheries surveys are not planned to be undertaken specifically as part of the permit pre-application process. However, walk-by surveys will assist in assessment of the impact of drought on fish populations.

Groundwater levels are monitored by the EA at 11 locations on a monthly basis. Additional monitoring will be subject to agreement, with the options of logging boreholes by AW in close proximity to the permit sites.

Table A6.2.3 River Misbourne Drought Monitoring

Data	Description	Normal Frequency	Drought Zone 3 Frequency	Drought Zone 4 Frequency/ additional abstraction	Post Drought Frequency
Groundwater Level	SP80/62 Black Horse SP80/63 Missenden Abbey SU99/59 London Road SU99/60 Mill House SU99/61 Old Road SU99/71 Amersham Church SU99/62 Amersham By-pass SU99/63 Bottom House Farm SU99/64 Chalfont St Giles SU99/65 Cherry Acre TQ09/128 Chalfont St Peter	Monthly (EA)	Monthly (EA)	Monthly (EA) NB additional monitoring by AW subject to agreement	Monthly (EA)
Gauged	River Misbourne at	Daily (EA)	Daily (EA)	Daily (EA)	Daily (EA)

River Flows	Little Missenden River Misbourne at Denham Lodge				
Spot Gauging	Mobwell D/S Abbey Lake/ U/S Abbey Pk D/S Abbey Pk Suffolk Bridge D/S Mile End Mill, Little Missenden Little Missenden G.Stn Shardloes Lake Outfall at Road Bridge Amersham Mill Amersham Church Amersham Garage Quarrendon Mill London Rd Depot Lower Bottom House Misbourne Farm Chalfont St Giles Water Hall Chalfont St Peter D/S Chalfont Park Lake L/C D/S Chalfont Park Lake R/C Isle of Wight Fm L/C Isle of Wight Fm R/C	Monthly (EA, Chilterns Society)	Fortnightly (AW, EA, Chilterns Society)	Weekly (AW, EA, Chilterns Society)	Weekly, reducing to fortnightly, reducing to monthly (AW, EA, Chilterns Society)
Macro-invertebrates	Little Missenden	Biannual (EA)	3 times/year (EA, AW)	3 times/year (EA, AW)	3 times/year (EA, AW)
	Above Old Amersham	Biannual	3 times/year (EA, AW)	3 times/year (EA, AW)	3 times/year (EA, AW)
	Bottom House Farm Lane	Biannual	3 times/year (EA, AW)	3 times/year (EA, AW)	3 times/year (EA, AW)
	Community Centre, Chalfont St Peter	Biannual	3 times/year (EA, AW)	3 times/year (EA, AW)	3 times/year (EA, AW)
	Above Gerrards Cross		3 times/year	3 times/year (EA)	3 times/year (EA)

	STW Below Gerrards Cross STW Denham Country Park	3 times/year Biannual 3 times/year	(EA) 3 times/year (EA, AW) 3 times/year (EA)	3 times/year (EA, AW) 3 times/year (EA)	3 times/year (EA, AW) 3 times/year (EA)
Fisheries	DS Shardeloes Lake Isle of Wight Farm Denham Country Club	1 off in 2011 (EA for WFD classification)	Walk-over Surveys	Walk-over Surveys	Walk-over Surveys

A6.2.6 Mitigation Measures

Our mitigation plans include actions before, during and after the drought. The major mitigation measures before the drought involve river restoration options, the measures during the drought ecological, hydrological and water quality monitoring and after the drought actions to enhance habitat recovery.

Following the walk-over surveys the critical sites identified will be looked at into detail in order to apply the mitigation measures required for the purpose of fish easement. Following the 2012 Drought experience, suggestions will be put forward for river restoration option at the critical sites, such as weir structure surveys and removals. In the cases that fish easement cannot be achieved, fish rescues of the populations under stress will be conducted. The ideal relocation places would be in the same river body further downstream at suitable locations identified during the walk-over surveys. In the event that downstream locations are not accessible or are deemed inappropriate due to low flows or adverse conditions, the fish will be relocated to different water bodies with similar quality characteristics. In this case, health checks of the relocated fish are necessary in order to ensure good health of the fish. After the end of the drought, the water body will be restocked. The restocking will be required to be completed with a range of species and sizes, in order to ensure that the angling activity is not impacted and a balanced fish population is maintained.

After the event of the drought, additional walk-over surveys will take place in order to identify macrophyte species that suffered in the upstream reaches but are in a good status in the downstream reaches. Following the identification of these species, replanting of populations from the downstream reaches to the upstream reaches will be considered in order to ensure species recovery along the length of the river.

Following the end of the drought and the cessation of need for additional abstraction, the options of abstraction for augmentation or partial/full cessation of abstraction from the catchment reaches that have been more affected will be considered. This will aid the recovery of the natural flows into the river, which will ultimately reduce the time of the river remaining dry.

In the event that the emergency condition of the Misbourne Operating Agreement is utilised for 100 consequent days of additional abstraction of 8Ml/d, the additional volume of water that would be removed from the aquifer will add up to 800Ml/d. In order to compensate and aid in the recovery of the flows, we suggest that we will reduce abstraction from the catchment by 4Ml/d for 200 days or until flows return to normal, whichever is the shortest, should the demand levels allow for it.

A6.2.7 Conclusion

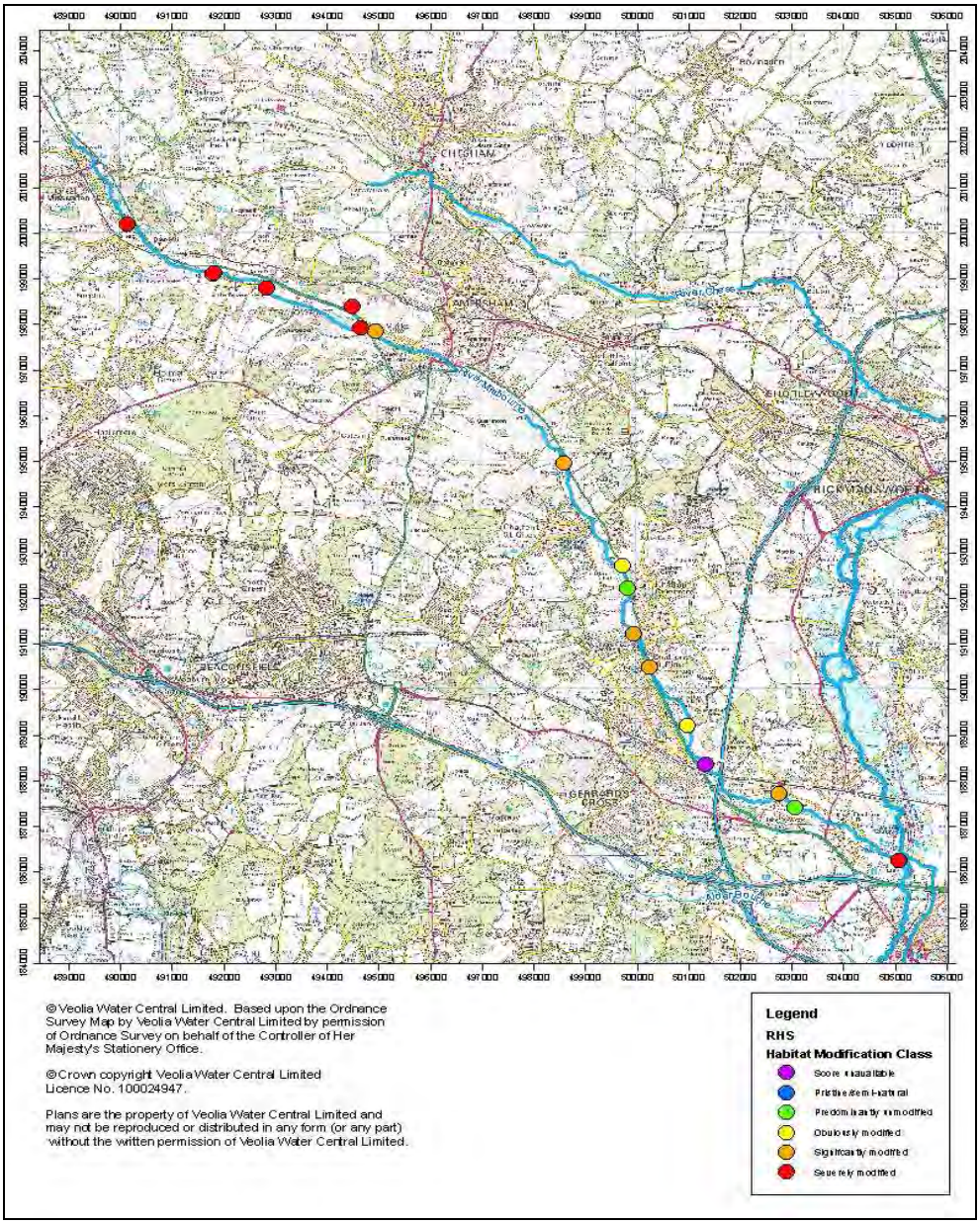
It is likely that if drought conditions were severe enough to require us to apply for a drought permit the Misbourne would already be dry over a significant length. Increasing abstraction from the catchment would therefore not have any immediate impact on river flows but would delay the recovery of flows following the drought by ~1-2months. The velocity of the river flow might also be affected. Potential mitigation measurements could include aeration, fish rescues, reduction of abstraction in order to aid recovery, replanting of chalk stream vegetation, post-drought restocking and channel narrowing.

Table A6.2.4 Summary of Environmental Impact of Drought Permit on River Misbourne

Option Implementation Assessment	Option Name	Misbourne Operating Agreement Condition lifting
	Trigger	Zone 4 Drought Trigger and drought permits with lower environmental impact
	Deployable Output of action	8Ml/d
	Location	River Misbourne
	Implementation timetable	Pre-application monitoring to start when Zone 3 trigger is breached. Application to be submitted after Zone 4 trigger is breached and the applications for the permits higher on the list have been submitted
	Permissions required and constraints	Permission from the Environment Agency is required. Pre-application discussions will be frequently held with the Environment Agency. Discussions will also be held with Chilterns Chalk Streams Project, Chilterns Society, Misbourne River Action and Local and Parish Councils.
	Risks associated with option	The associated risks are environmental and detailed below.
Environmental Assessment	Risk to the environment	Medium/Low
	Summary of likely environmental impacts	Delay of recovery of the dried out reaches after the drought by 1-2 months, potential extension of the dried out reaches, reduced flow velocity at dry reaches
	Baseline information used	Quarterly river photos at 8 locations, macroinvertebrates monitoring 4 biannual and 1 three times per year, fisheries surveys at 3 locations, monthly spot gauging at 21 locations, 2 gauging stations flow records, 1 level logger and 11 groundwater level monitoring locations
	Summary of additional baseline monitoring requirements	Walk-by survey to identify affected locations, summer macroinvertebrates survey at 4 locations, spot gauging fortnightly at 21 locations (in alternation with the EA and local interest groups)
	Mitigation measures	Fish rescues, create macroinvertebrates banks for re-stocking, reduction of abstraction in aid of recovery, artificial narrowing of the channel to improve velocity, replanting of chalk stream vegetation
	Impact on other activities	No other activities are expected to be impacted on

A6.2.7 Technical Information

Figure A6.2.3 River Habitat Survey (RHS) Results



Fisheries Monitoring 1997-2004

MIS001: There was re-colonisation by three spined sticklebacks but a desirable fish community (including brown trout and bullhead) is limited by the impounded and heavily engineered nature of the reach. Increased volumes of water have resulted in deeper water but not increased flow and the site is heavily silted. Restoration of the original channel is suggested as the best way to achieve an improved fish community.

MIS002: Re-colonisation following drought was quick and probably from relic populations in Shardloes lake. Bullhead re-colonised but remained in low numbers

and brown trout were recorded but it is not know whether this was from illegal stocking. Brown trout were utilising exposed gravels.

MIS003: Despite the length of time this site was dry sticklebacks re-colonised rapidly and the site was also colonised by minnows however, this colonisation was set back because the section dried up again in 2003.

MIS004: The improved flow regime created greater channel complexity and allowed for the colonisation of trout and bullhead. The origin of the trout is unknown but the report states that it can be considered that a desirable fish community has been achieved at this site.

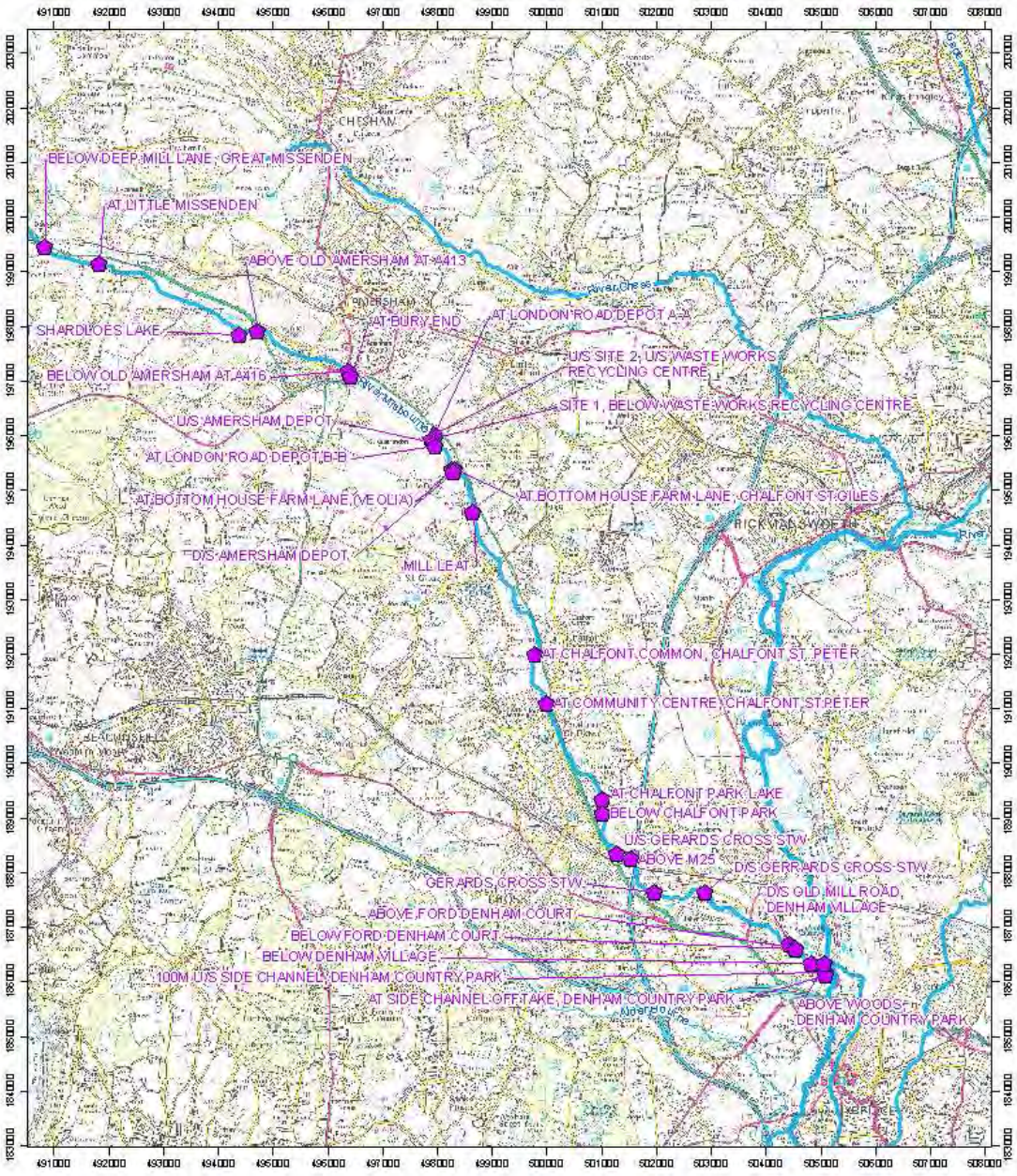
MIS005: This site was considered to have undergone a shift to a desirable community dominated by bullhead considered to be due to a reduction in silt as a result of increased flows and the loss of submerged and emergent macrophytes. However, 2004 saw a shift to a community dominated by stone loach but the reasons are unclear. Trout were not recorded at the site although suitable habitat was present and trout were present upstream.

MIS006: This site had continuous flow throughout the study period and is close to the River Colne and has the most diverse fish community. The improvements in the flow regime and channel form were considered to have stabilised the seasonally fluctuating minnow community and resulted in a positive response by the bullhead community. The expected colonisation of dace and roach did not occur.

Table A6.2.5 Fish Survey Results Isle of Wight Farm

Common Name	Scientific Name	Number
3 spined stickleback	*Gasterosteus aculeatus*	100-999
Bullhead	*Cottus gobio*	100-999
Stone loach	*Barbatula barbatula*	100-999

Figure A6.2.4 EA and AW Macroinvertebrate Sample Locations



TableA6.2.6AWAutumn 2010 invertebrate results

	Bottomhouse Farm Lane Sample No: 33653	London Road Depot A-A (New Point)	London Road Depot B-B (New Point)	Mill Leat (New Point)
Site/Station ID	**7777771**	**7777772**	**7777773**	**7777774**
Sample Date	**05/10/2010**	**05/10/2010**	**05/10/2010**	**05/10/2010**
Mollusca				
Physidae: *Physa fontinalis*	1		1	
Sphaeridae: *Pisidium* sp.		11	325	
Oligochaeta				
Oligochaeta		2	24	18
Hirudinaea				
Erpobdellidae: *Erpobdella octoculata*	3			
Crustacea				
Gammaridae: *Gammarus pulex*		13		
Gammaridae: *Crangonyx pseudogracilis*		30	19	38
Asellidae: *Asellus aquaticus*	6	8	23	
Ephemeroptera				
Instar I specimens			2	
Ephemeridae: *Ephemera danica*		16	8	47
Hepageniidae: *Hepagenia sulphurea*			1	
Instar II Hepageniiidae				2
Instar I Baetis				27
Baetidae: damaged specimens	18	12		
Baetidae: *Baetis fuscatus*			98	11
Odonata				
Agriidae: *Calopteryx splendens*		16		
Corixidae: *Sigara dorsalis*	3			

	Bottomhouse Farm Lane Sample No: 33653	London Road Depot A-A (New Point)	London Road Depot B-B (New Point)	Mill Leat (New Point)
Site/Station ID	**7777771**	**7777772**	**7777773**	**7777774**
Sample Date	**05/10/2010**	**05/10/2010**	**05/10/2010**	**05/10/2010**
Trichoptera				
Rhyacophilidae: *Rhyacophila dorsalis*		5	3	10
Rhyacophilidae: *Rhyacophila dorsalis (pupae)*				3
Hydropsychidae: *Hydropsyche pellicidula*		12	16	8
Hydropsychidae: *Hydropsyche angustipennis*		6		119
Glossosomatidae (pupae)			1	
Leptoceridae: *Mystacides nigra*	454			
Instar II caddis sp.		12		
Coleoptera				
Dytiscidae: *Colymbetes* sp. (larvae)	4			
Elminthidae: *Limnius volckmari* (adults)				1
Elminthidae: *Elmis aenea* (adults)			26	
Elminthidae: *Elmis aenea* (larvae)	1			
Diptera				
Psychodidae				
Chironomidae	317	113	13	9
Simuliidae: *Simulium* sp.	3	79	6	4
Culicidae	2	2		
Tabanidae	1			
BMWP	45	54	74	55

	Bottomhouse Farm Lane Sample No: 33653	London Road Depot A-A (New Point)	London Road Depot B-B (New Point)	Mill Leat (New Point)
Site/Station ID	**7777771**	**7777772**	**7777773**	**7777774**
Sample Date	**05/10/2010**	**05/10/2010**	**05/10/2010**	**05/10/2010**
ASPT	4.5	4.91	5.29	5.5
No of scoring taxa	10	11	14	10
FAMILY LIFE	6.22	7.7	7.64	9.14
SPECIES LIFE	6.3	7.17	7.42	8.33

A6.2.8 References

Angel, G. 2010. Misbourne RAS: Misbourne Flow Enhancement Investigation. Environment Agency, 2010.

Ardeola Environmental Services (2000). *Ecological monitoring of the River Misboume*.Unpublished report to Environment Agency, Thames Region, February 2000.

Entec. 2009. Misbourne RSAP Phase II: Final Report. Environment Agency, July 2009.

Misbourne Operating Agreement, Environment Agency, 2004.

6.3 Additional Abstraction from the River Rib

Potential Environmental Impact of a Drought Permit at THUN on the Flow and Ecology of the River Rib

Drought Permit/Order Source(s): THUN

Potential Additional Abstraction: 2.73Ml/d

Potential Reduction in River Support: N/A

Statutory Designated Sites: None

A6.3.1 Background

Licence 29/38/4/35 permits the abstraction of water from THUN Pumping Station by Affinity Water. This licence allows 11.82Ml/d peak and 11.13Ml/d average to be abstracted from THUN with an aggregated annual total of 13.64Ml/d combined with Hadham Mill (located in the Ash catchment).

Under this licence, the Company is required to reduce abstraction to the Licence of Right volumes of 9.09Ml/d when flows at the Wadesmill Gauging Station, as monitored by the EA, fall below 17.3Ml/d for 5 consecutive days. This results in reduction in the total volume of water available for public water supply. This is considered to mitigate the impact of our abstraction on river flows under below average conditions.

Under normal conditions the reduction in output is met by imports from other parts of the network, which displaces the abstraction elsewhere. A drought permit application would be required for this source to suspend the flow constraint and increase the allowance for abstraction at the higher rate of 11.82Ml/d. It would be our intention to only abstract the additional water when required to meet the demand and revert to the lower abstraction rate during times of lower demand.

A6.3.2 Ecology

A River Corridor Survey (RCS) was carried out by Ecological Survey Consultants in 1998 (Leatham and Ryding, 1998) for the Rib catchment. The survey describes the catchment in three distinct types;

- The upper reaches of the River Quin, mostly minor tributaries and the upper most reaches of the Rib which have the appearance of uniform field ditches with channels colonised by terrestrial plants.

- The middle and lower reaches of the River Rib and the lower reaches of the River Quin which have a semi-natural appearance with meanders and geomorphological features and the presence of aquatic flora and fauna.

- Several bournes in the west of the catchment (e.g. Aspenden Brook, Wadesmill Bourne), which are deep and naturally eroding and often wooded.

The land use in the catchment is described as predominantly arable implying that the river is susceptible to high levels of chemical pollution (e.g. from fertilisers and pesticides).

The bank vegetation is generally described as tall rank vegetation of low diversity with the banks being frequently hedged and bankside trees being frequent. The channel vegetation is described as being impoverished in many parts of the catchment, particularly where flows are low.

Various fauna is mentioned in the RCS report for the Rib catchment. Of particular interest is that water voles were recorded on sections of the Rib and that both the rivers Rib and Quin are described as providing sufficient nest sites and fish stocks to maintain a kingfisher population. However, the 2007 survey found no Water Voles or White-clawed Crayfish, and only limited signs of Otters with an established site at Joe's Island at the confluence with the River.

The Rib is classified as a salmonid river by the Environment Agency (Scarlett et al, 2005) and is known for its diverse macroinvertebrate population. It is also home to a number of Biodiversity Action Plan (BAP) and red data book species for flora and fauna, including the Brook Lamprey and Bullhead.

Surveys have recorded between 21 and 38 species of macroinvertebrates at Bengeo Hall between 1986 and 2004. LIFE scores have been calculated by the EA for the Bengeo Hall from 1995 onward and these suggest a possible increasing trend in scores over this period from a low in November 1997 of 5.85 to a score of 7.00 in September 2005. The trend over recent years follows a different pattern to the BMWP scores for the site which show a decline in biological quality since 2000. The cause of this is unknown at present.

In-channel habitat availability is thought to be limited by the influence of land use, primarily the deposition of silt, which is most notable in the middle reaches. The presence of in-channel structures is also thought significant during periods of low flows (Powers, 2006).

Brown Trout have been recorded in the lower Rib in the EA's 2003 survey. Observed differences in distribution of fish species, are likely to be a reflection of habitat type and availability.

BMWP[27] is ranked 'good' to 'very good' (>100) for the period 1964 – 2006 but showed a downward trend following a high in 1999. In contrast, LIFE scores generally increase from 1994 through 2006. The macroinvertebrate data showed that the Rib has a high diversity of species, and whilst there was fluctuations in the BMWP and

LIFE scores over the 2007 monitoring period, no significant long term decline in water quality or flow dependence was observed.

Under the WFD, the River Rib from the Quin confluence to its confluence with the River Lee is classified as 'poor' with high confidence in the overall classification. In terms of invertebrates it is classified as 'good (medium)' and in terms of fish it is classified as 'poor (high)'.

A6.3.3 Impact of Increased Abstraction

Current information indicates that the Lower River Rib loses water downstream of Barwick to the confluence with the Lee. During the AMP4 National Environment Programme an investigation on the contribution of abstraction at THUN on the reduced flows was completed. The Investigation concluded that whilst abstraction

[27] Biological Monitoring Working Party System: It was set up by Department of the Environment in 1976 to recommend a biological classification system for use in national river pollution surveys

can not be ruled out as impacting flows in this losing reach, variations in the geology and the influence of gravel extraction around Ware are the major reasons for the loss in flows downstream of Barwick.

The work has established that short-term fluctuations in abstraction from both WADE and THUN do not appear to have an immediate impact on flows in the River Rib. Much of the river in the area is a naturally losing reach of the river all the way to Westmill Farm, where water is lost directly to the River Lee and down gradient abstractions. Only after this location, for the lowest reach of the river Rib do river flows increase under all but very low flow conditions with flow derived from the River Beane catchment. Reduction in abstraction is unlikely to result in a corresponding increase in river flows, and whilst there may be a small increase, the majority would result in an increase in groundwater discharges to the river Lee.

With respect to the ecological status of the Lower Rib, macroinvertebrate data has showed a high diversity of species and no significant long term decline in water quality or flow dependence. Whilst some locations do indicate a decrease in species during droughts, these recover rapidly once normal rainfall conditions occur.

Groundwater contours produced on all available data show that there is a groundwater gradient to the south, with discharges to the River Lee or to pumping depressions caused by abstractions. There is a natural gradient from the River Rib to the Lee, and thus the middle section of the river naturally looses water. The hydraulic gradient below Wadesmill runs across as opposed to along the River Rib, where the groundwater appears to receive eastward flow from the river Beane, and this appears to contribute to increases in the flow in the lower part of the Rib.

The work has confirmed observations by the Environment Agency that flows in the Lower Rib decrease in times of low rainfall, respond quickly to rainfall events and are dependent on rainfall to maintain flows. The speculation that river flows may remain higher after rainfall events when THUN abstractions are lower is not supported by river and rainfall data for 2006, 2007 or 2008. For the most part, once rainfall events pass, flows revert back to the rate prior to the rainfall regardless of abstraction rates. This is with the exception of winter months when there is generally a rising limb in the river flow profile, due to recharge impacts and interflow. The relationship of rainfall to increases in flow is diminished in the summer and autumn months due to the higher soil moisture deficits and evaporation rates.

The accretion profiles show a general decline in flows along the whole length of the river studied from Latchford to Bengeo Hall, irrespective of the overall magnitude of flow, although the magnitude of the losses vary and are lower in times of low flows. Between Westmill Farm and Bengeo Hall, particularly in times of normal flows, there is generally an increase in flow, helping reduce the difference in overall losses. Two types of flow profile have been established, one with no preceding rainfall and one with rainfall within 3 days of the measurements. Where there has been little rainfall preceding the measurements, losses of between 4.2 and 15.3 Ml/d have been measured. Where rainfall did occur before the gauging, much lower losses were measured, and in some cases was positive, but in almost all cases, there are losses in the middle section of the river. Even assuming all abstraction is at the expense of river flows, then the river would still be losing water over this reach.

The additional abstraction that is proposed with the drought permit is not expected to have any effect on the overall status of the river under the WFD classification. Temporarily, the additional abstraction might cause deterioration of the Invertebrate classification around THUN, which is, however, expected to return to its original classification following recovery from the drought. An additional sampling location

upstream of THUN has been added to the monitoring schedule, in order to monitor this possibility.

A6.3.4 Baseline Monitoring

The River Rib is regularly monitored by the EA and AW. All the current and historic information will be used as baseline for the environmental impact assessment process, including all the ecological information collected during the various surveys outlined in the Ecology section.

Flow is measured at one permanent gauging station on the River Rib at Wadesmill. Records for the Rib at Wadesmill began in 1979.

We undertake monthly spot gauging at 8 locations on the upper/middle reaches of the river as part of our AMP5 NEP programme. All data collated and analysed for the NEP purposes will be used as baseline information for the pre-application process. We also take quarterly photos of the state of the river at 9 locations since 1997. The spot gauging data collected and analysed during the AMP4 investigation in the Lower reaches will also be used as baseline monitoring, as well as the data collected during the previous drought (2005/06).

Groundwater levels are also monitored in the Upper/Middle Rib catchment. The EA monitor groundwater levels in 7 boreholes on a monthly basis. We have installed level loggers at 4 boreholes in the catchment.

A number of River Habitat Surveys (RHS) were carried out on the Upper/Middle River Rib in the Study Area between 1994 and 2007 by the EA. The data collected can be used to calculate a Habitat Modification Score (HMS) so that a Habitat Modification Class (HMC) can be assigned as shown in Table 6.3.1.

Table A6.3.1 Habitat Modification Classes

HMC	HMC Description	HMS
1	Pristine/semi-natural	0-16
2	Predominantly unmodified	17-199
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4	Significantly modified	500-1399
5	Severely modified	1400+

A macrophyte survey was undertaken by consultants Mott MacDonald at 4 locations along the Mid River Rib in August 2011, in order to assess the trophic status and impact of low flow conditions along specific 100m stretches of the river. Sites were selected to correspond with sites where spot flow measurements and macroinvertebrates are also being surveyed. Mean Trophic Rank (MTR) and Macrophyte Flow Ranking (MFR) were calculated for all sites (Table 6.3.2).

Table A6.3.2 Mean Trophic Ran (MTR) and Macrophyte Fow Ranking (MFR)

River Site	National Grid Reference	Trophic Status as calculated from MTR scores	Flow Related Stress as calculated from MFR scores	Confidence Level
At Westmill	NGR Start: TL 370410 27516 NGR Finish: TL 36940 27523	Close to expected levels of eutrophication	No evidence of flow related stress	Moderate
Above River Quin	NGR Start: TL 38649 24757 NGR Finish: TL 38723 24691	Unlikely to be eutrophic	No evidence of flow related stress	Low
Above Standon	NGR Start: TL 39117 23905 NGR Finish: TL 39080 24006	Close to expected levels of eutrophication, but may be at risk	Evidence of slight flow related stress	Moderate
Standon Lordship	NGR Start: TL 39338 21455 NGR Finish: TL 39262 21524	Close to expected levels of eutrophication	Evidence of slight flow related stress	Moderate

The Mean Trophic Rank scores for Westmill and Standon Lordship had results that were close to the expected levels of eutrophication in River Community Type III areas – rivers flowing in catchments dominated by soft limestone such as chalk and oolite. The site above Standon was also close to expected levels of eutrophication but with a lower MTR score it may be more at risk of eutrophication. In contrast, the site above River Quin produced a score which deduced it unlikely to be eutrophic.

The two lower survey locations 'Above Standon' and 'Standon Lordship' both were identified as having evidence of slight flow stress, with a moderate confidence rating. The macrophyte survey identified the presence of two invasive non-native species. *Impatiens glandulifera* (Himalayan balsam) and *Heracleum mantegazzianum* (Giant Hogweed), which have the potential to outcompete native species of macrophyte, reducing diversity and habitat availability. Macroinvertebrate samples have been taken at 4 locations by the EA and Mott MacDonald on behalf of AW.

A6.3.5 Additional Monitoring

All available information for the Upper/Middle and Lower reaches of the River Rib will be used for the Drought Permit application process, where it is deemed relevant. The upper/middle reaches monitoring will continue as usual, however additional monitoring will be in place for the lower reaches. The additional monitoring section refers only to the lower reaches.

Monitoring for the Rib will start in Drought Zone 3 as it is one of the top priority sites with environmental provisions to be lifted. The monitoring schedule will comprise of monthly spot gauging during Zone 2, fortnightly spot gauging during Zone 3 and weekly spot gauging during drought provision duration. If a drought provision is in place, the post drought spot gauging frequency will be weekly reducing to fortnightly

and then monthly, following mutual agreement with the EA. If the drought provision is not used the post drought spot gauging frequency will be monthly. Monthly spot gauging is already in place by the AW, which will increase in frequency accordingly. The spot gauging rounds include in-situ water quality monitoring (pH, dissolved oxygen, conductivity).

In addition, macroinvertebrate surveys will be undertaken in spring, summer and autumn at 2 locations. The spring and autumn rounds are scheduled by the EA for 2 sites, therefore the summer round at 2 sites will be undertaken by AW. There will also be an additional location upstream of THUN monitored by AW 3 times a year.

Walk-over surveys are necessary for the characterisation of the state of the river during Drought Zone 2. The walk-over survey will be preferably undertaken by both EA and AW, subject to mutual agreement. The objective of the surveys will be the identification of reaches under stress, so that a more detailed Environmental Impact

Assessment can be completed at the time and immediate mitigation measurements can be implemented, such as fish rescues and debris/obstruction removal. The ideal period for the walk-by surveys is spring, subject to the timing of drought (Zone 2 to coincide with spring) and weather conditions.

Fisheries surveys are not planned to be undertaken specifically as part of the drought provision process. However, walk-over surveys will assist in assessment of the impact of drought on fish populations.

Groundwater levels are monitored by the EA at 7 locations on a monthly basis, 4 of which are in the Lower reaches. AW monitor monthly groundwater levels at 20 locations and have level loggers installed in 4 locations in the upper/middle reaches. Additional monitoring will be subject to agreement, with the options of logging boreholes in close proximity to the THUN sites.

The monitoring associated with the drought permit site is summarised in the table below:

Table A6.3.3 River Rib Drought Monitoring

Data	Description	Normal Frequency	Drought Zone 3 Frequency	Drought Zone 4 Frequency	Post Drought Frequency
Groundwater Levels	TL 31/13 Moles Farm TL 31/05 Marshalls Farm TL 31/133C Westmill No 4 TL 32/06 St Edmunds	Monthly (EA)	Monthly (EA)	Monthly (EA)	Monthly (EA)
Gauged River Flows	Rib at Wadesmill	Daily (EA)	Daily (EA)	Daily (EA)	Daily (EA)
Spot Gauging	Latchford Farm Barwick Ford Fabdens	No spot gauging in normal	Fortnightly (AW)	Weekly (AW)	Weekly, reducing to fortnightly,

	Wadesmill Paynes Hall Westmill Farm Lakes Bengeo Hall	years, monthly during drought zone 2 by AW			reducing to monthly (AW)
Macroinvertebrates	Location u/s THUN Barwick Hall Wadesmill Above Chapmore End STW Bengeo Hall	- 3 times/year (EA) Biannual (EA) Biannual (EA) Biannual (EA)	3 times/year (AW) 3 times/year (EA) 3 times/year (EA, AW) 3 times/year (EA, AW) Biannual (EA)	3 times/year (AW) 3 times/year (EA) 3 times/year (EA, AW) 3 times/year (EA, AW) Biannual (EA)	3 times/year (AW) 3 times/year (EA) 3 times/year (EA, AW) 3 times/year (EA, AW) Biannual (EA)
Fisheries	Barwick Ford 8 Acre Plantation Bengeo Hall	Annually (EA)	Walk-over Surveys	Walk-over Surveys	Walk-over Surveys

A6.3.6 Mitigation Measures

Our mitigation plans include actions before, during and after the drought. The major mitigation measures before the drought involve river restoration options, the measures during the drought ecological, hydrological and water quality monitoring and after the drought actions to enhance habitat recovery.

Following the walk-over surveys the critical sites identified will be looked at into detail in order to apply the mitigation measures required for the purpose of fish easement. Following the 2012 Drought experience, suggestions will be put forward for river restoration option at the critical sites, such as weir structure surveys and removals. In the cases that fish easement cannot be achieved, fish rescues of the populations under stress will be conducted. The ideal relocation places would be in the same river body further downstream at suitable locations identified during the walk-over surveys. In the event that downstream locations are not accessible or are deemed inappropriate due to low flows or adverse conditions, the fish will be relocated to different water bodies with similar quality characteristics. In this case, health checks of the relocated fish are necessary in order to ensure good health of the fish. After the end of the drought, the water body will be restocked. The restocking will be required to be completed with a range of species and sizes, in order to ensure that the angling activity is not impacted and a balanced fish population is maintained.

After the event of the drought, additional walk-over surveys will take place in order to identify macrophyte species that suffered in the upstream reaches but are in a good status in the downstream reaches. Following the identification of these species, replanting of populations from the downstream reaches to the upstream reaches will be considered in order to ensure species recovery along the length of the river.

Following the end of the drought and the cessation of need for additional abstraction, the options of abstraction for augmentation or partial/full cessation of abstraction from the catchment reaches that have been more affected will be considered. This will aid the recovery of the natural flows into the river, which will ultimately reduce the time of the river remaining dry.

In the event that River Rib Drought Permit is utilised for 100 consequent days of additional abstraction of 2.73Ml/d, the additional volume of water that would be removed from the aquifer will add up to 273Ml/d. In order to compensate and aid in the recovery of the flows, we suggest that we will reduce abstraction from the catchment by 3Ml/d on the low flow condition licence (abstraction of 6.09Ml/d) for 91 days or until flows return to normal, whichever is the shortest, should the demand levels allow for it.

A6.3.7 Conclusion

It is unlikely that additional abstraction from THUN will have any irreversible effects on the River Rib flow and hence the ecology. It is expected that the river flow in the vicinity of THUN will be reduced, if a drought permit is in place and used, therefore additional ecological monitoring upstream of the abstraction site is suggested.

Table A6.3.4 Summary of Environmental Impact of Drought Permit on River Rib

Option Implementation Assessment	Option Name	Rib Drought Permit
	Trigger	Zone 4 Drought Trigger and drought permits with lower environmental impact
	Deployable Output of action	2.73Ml/d on average, 2.73Ml/d on peak
	Location	River Rib (THUN)
	Implementation timetable	Drought monitoring to start when Zone 3 trigger is breached. Discussion for lifting provisions to commence when Zone 4 trigger is breached and the applications for the permits higher on the list have been submitted
	Permissions required and constraints	Agreement of the Environment Agency is required. Relevant discussions will be frequently held with the Environment Agency. Discussions will also be held with the local interest groups.
	Risks associated with option	The associated risks are environmental and detailed below.

Environmental Assessment	Risk to the environment	Medium/Low
	Summary of likely environmental impacts	Delay of recovery of the dried out reaches after the drought by 1-2 months, potential extension of the dried out reaches, reduced flow velocity at dry reaches
	Baseline information used	Quarterly river photos at 9 locations, macroinvertebrates monitoring 3 three times per year, fisheries surveys at 3 locations, 1 gauging station flow records, 4 EA monthly groundwater level monitoring locations
	Summary of additional baseline monitoring requirements	Walk-over survey to identify affected locations, summer macroinvertebrates survey at 3 locations, spot gauging fortnightly at 7 locations, increasing to weekly in Zone 4.
	Mitigation measures	Fish rescues, create maroinvertenrates banks for re-stocking, reduction of abstraction in aid of recovery, artificial narrowing of the channel to improve velocity, replanting of chalk stream vegetation.
	Impact on other activities	No other activities are expected to be impacted on.

A6.3.7 Technical Information

Table A6.3.5 Mean Trophic Rank (MTR) Score by Site

Location	MTR Score	'Bold' species count	Scoring species count	Non-scoring species count	Total Count
At Westmill	52.9	4	6	8	14
Above Quin	70.0	4	2	10	12
Above Standon	37.6	4	9	10	19
Standon Lordship	45.2	4	6	10	16

Table A6.3.6 Macrophyte Flow Ranking (MFR) Score by Site

Location	MFR Score	River Community Type	Macrophyte RAM Current Ecological Rating	Level of Confidence	RAM Rating Description
At Westmill	2.8	III	0	Moderate	Flow sensitivity of ecological indicators matches that under benchmark conditions
Above Quin	3.5	III	0	Low	Flow sensitivity of ecological indicators matches that under benchmark conditions
Above Standon	2.2	III	1	Moderate	Flow sensitivity of ecological indicators is only slightly changed from that under benchmark conditions
Standon Lordship	2.2	III	1	Moderate	Flow sensitivity of ecological indicators is only slightly changed from that under benchmark conditions

Type III - Chalk rivers and other base-rich rivers with stable flows

Table A6.3.7 Location of Non-Native Macrophytes

Location	EA Ref	Species	Comment
At Westmill	34344	*Impatiens glandulifera*	Present in low abundance
Above River Quin	34345	*Impatiens glandulifera*	Covers approx 2½ - 5% of channel
Above Standon	34273	*Impatiens glandulifera* *Heracleum mantegazzianum*	Very frequent on both banks 2 large plants on right bank
Standon Lordship	5555551	*Heracleum mantegazzianum*	3 plants cut on unstable island in channel, 2 further plants cut upstream from footbridge.

Figure A6.3.1 Location of Macroinvertebrate Surveys

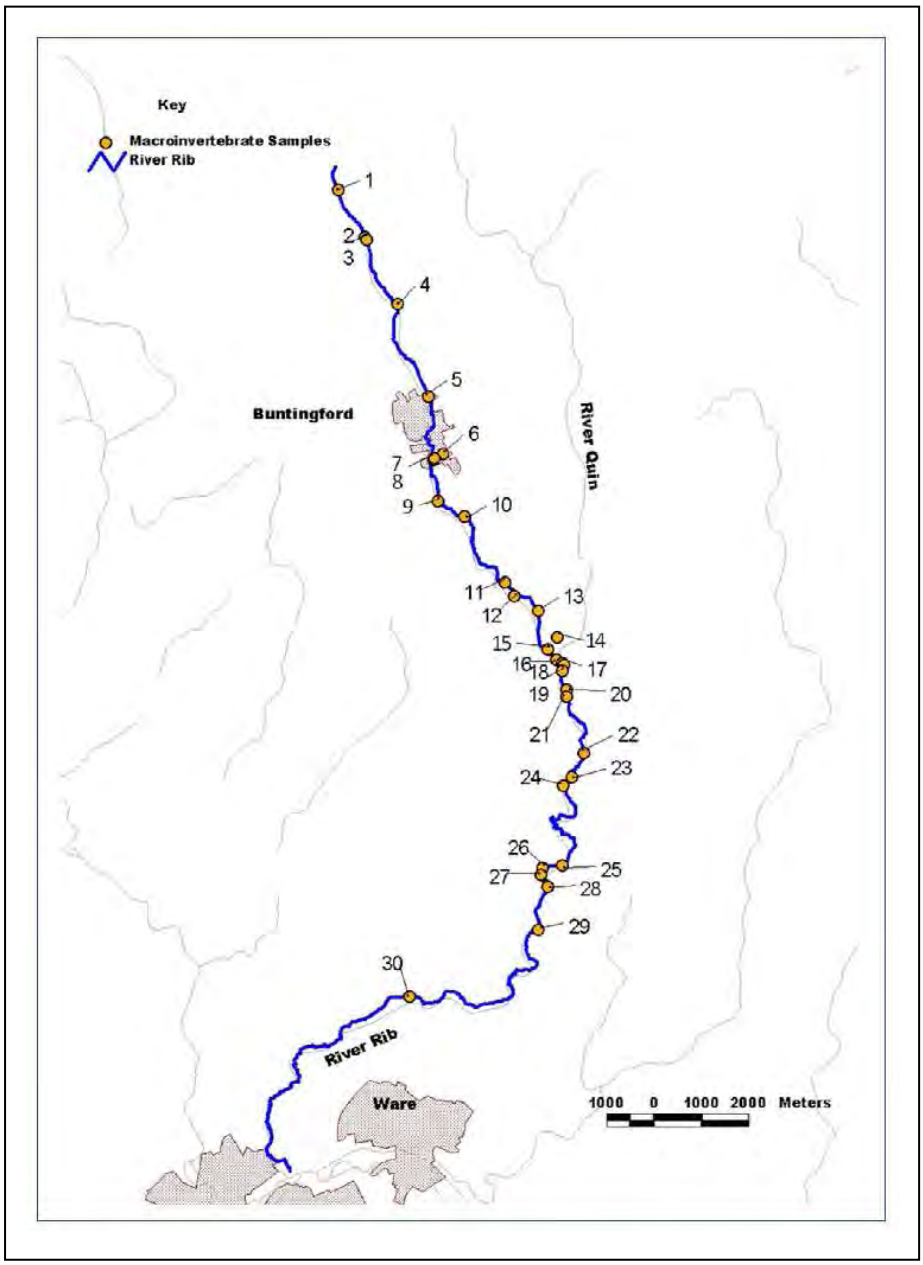


Table A6.3.8 Location and Frequency of 2011 Macroinvertebrate Surveys

Location	EA Ref	Grid Reference	Sampled By	Survey Date
Mid Rib				
Westmill	34344	TL 37060 27490	AW	12/05/11 07/10/11
Above Quin	34345	TL 38800 24700	AW	12/05/11 07/10/11
Above Standon	34273	TL 39134 23841	AW & EA	07/03/11 12/05/11 07/10/11
Standon Lordship	157123	TL 39301 21484	AW	12/05/11 07/10/11
Lower Rib				
At Barwick Ford	34346	TL 38700 20100	EA	07/03/11 01/08/11
At Wadesmill	34347	TL 3585 817450	EA	07/03/11
Above Chapmore End STW	33648	TL 3379 416344	EA	07/03/11
At Bengeo Hall, Hertford	34213	TL 3315 413930	EA	07/03/11

Table A6.3.9 Summary of Mid Rib Macroinvertebrate Survey 2011

EA Sample Point Number	34344		34345		34273			157123	
EA Sample Point Name	At Westmill		Above River Quin		Above Standon			Standon Lordship	
Sample Date	12/05/2011	07/10/2011	12/05/2011	07/10/2011	07/03/2011	12/05/2011	07/10/2011	12/05/2011	07/10/2011
Sampled By	AW	AW	AW	AW	EA	AW	AW	AW	AW
BMWP	88	58	116	92	97	112	105	105	116
Number Taxa	19	14	23	20	18	20	22	18	22
ASPT	4.63	4.14	5.04	4.6	5.39	5.6	4.77	5.83	5.27
LIFE (Family)	7.19	6.67	7.05	6.11	7.25	6.94	6.4	7.53	7
LIFE (Species)	7.57	6.43	6.45	6.18	7.67	7.38	6.54	7.92	7.25

Table 6.3.10 Summary of Lower Rib Macroinvertebrate Survey 2011

EA Sample Point Number	34346		34347	33648	34213
EA Sample Point Name	At Barwick Ford		At Wadesmill	Above Chapmore End STW	At Bengeo Hall Hertford
Sample Date	07/03/2011	01/08/2011	07/03/2011	07/03/2011	07/03/2011
Sampled By	EA	EA	EA	EA	EA
BMWP	73	87	122	99	121
Number Taxa	13	18	20	17	21
ASPT	5.62	4.83	6.1	5.82	5.76
LIFE (Family)	7.91	7.19	7.65	7.35	7
LIFE (Species)	8.33	7.27	8.41	8	7.2

A6.3.8 References

Leatham, R. and Ryding, I., 1998. *Strategic Corridor Survey of the Rib Catchment. A report for the Environment Agency.* Ecological Survey Consultants

Powers, E., 2006. *Lower Rib Interim Report* Jan06 v.2

Scarlett, P. M., Henville, P., O'Hare, M., Hutchinson, K., Duschlbauer, A., Maffeis, L., 2005 *Strategic River Habitat Surveys of the River Rib*, Thames Region Centre for Ecology and Hydrology report to Environment Agency Thames Region.

A6.4 Additional Abstraction from the River Cam

Potential Environmental Impact of a Drought Permit at UTTL on the Hydrology, Hydrogeology and Ecology of the River Cam

Drought Permit/Order Source(s): UTTL/SPRF

Potential Additional Abstraction: 0Ml/d

Potential Reduction in River Support: up to 6 Ml/d

Statutory Designated Sites: None

A6.4.1 Background

Licence 06/33/27/82 permits the abstraction of water from UTTL and SPRF Pumping Stations by Affinity Water. This licence allows 13.64Ml/d to be abstracted from UTTL and 13.64Ml/d to be abstracted from SPRF with an aggregated daily total of 18.18Ml/d and an annual aggregate equivalent to 15.95Ml/d.

Under this licence, the Company is required to provide a support flow to the River Cam when flows at the Great Chesterford Gauging Station fall below 147l/s (12.7Ml/d) as monitored by the Environment Agency. This support can be up to half of that being taken into supply, with the intention of maintaining a flow of 12.7Ml/d at the gauging station. Currently, this support flow is to be composed of the first 2.16 Ml/d from UTTL, the next 2.16 Ml/d from SPRF, with the remaining flow, if required, to be agreed in advance with the Environment Agency. This results in a net reduction in the total volume of water available for public water supply. Supply is maintained to customers by imports from other parts of the network, which displaces the abstraction elsewhere.

Currently, SPRF is not equipped to take water into supply but can be pumped to support flows in the Cam. Thus, the abstraction against this Licence can be 13.64Ml/d. Assuming full river support as defined under the Licence is required, then the maximum amount of water available to be taken into supply is half of this value i.e. 6.82Ml/d. Current set-up at the site restricts this to 6Ml/d, which is the drought deployable output of the source.

A6.4.2 Ecology

The ecology of the Upper Cam has been considered for its valued ecological resource and legally protected sites, as it is considered not to be practical to consider all species and habitats that could be impacted by a drought application.

The River Cam is a groundwater fed chalk stream characterised by a much flashier flow response than the chalk streams of the Chilterns, owing to a significant presence of Boulder Clay within the catchment. As a chalk stream it contributes significantly to the biodiversity of the region, as well as providing water for agriculture, recreation and cultural heritage within the landscaped grounds of the Audley End Estate.

The EA have monitored macroinvertebrates from 1990 onwards at Wendons Ambo and Great Chesterford and also at Littlebury Bridge from 1995. The Great Chesterford site (TL 5030 4270) is one of the EA's drought monitoring sites. LIFE scores for this site correspond well with flow as recorded at the Great Chesterford Gauging Station. Notable lows in LIFE score have been recorded in periods where flows has fallen below approximately 10Ml/d, as occurred in 1991-92 and again in 2006. During periods of higher flows in between the droughts, LIFE scores are seen to improve, suggesting that the macroinvertebrate population is able to sustain periods of lower flows.

LIFE scores for the EA GQA site at Littlebury Bridge (TL 5180 3960) also correspond well to periods of low flow. A decline in LIFE score is observed through the low flow period 1996-1998 followed by

a subsequent recovery to pre-drought LIFE scores by November 2000. The frequency of sampling has since been reduced from twice a year to bi-annual at three yearly intervals making trend analysis more difficult. A lower LIFE score was recorded in 2006 which can be attributed to the 2005-06 drought. Historic recovery from the late 1990s drought would suggest that a similar recovery in macroinvertebrate community will occur as flow at this site returns.

The lowest LIFE score for the period 1995-2006 was observed in May 2006 may be reflective of the lower flows observed during this period due to problems with the Great Chesterford Gauging Station over recording flows and the support from UTTL not being requested. BMWP scores for the same period also follow a similar pattern suggesting there may have been a decline in water quality which could have been associated with reduced dilution of effluents, or dissolved oxygen.

The upper Cam sustains a breeding wild brown trout population but the fishery is also stocked with farmed trout. The reach of the River around Littlebury is fished exclusively by The Audley Fly Fishing Club. Siltation of spawning grounds was raised as a concern by the Club in 1998.

The EA fish surveys identified poor recruitment of brown trout, dace and chub during the early 1990s drought. This was attributed to low flows resulting in a degradation of riffles habitats which are an important spawning habitat for trout; whereas poor recruitment was attributed as the cause for reductions in the dace and chub community. As this is a natural phenomenon and given consistent recruitment of previous years was not thought to have a serious long-term effect on the fish population.

There is one SSSI in the Upper Cam near Newport. Debden Water SSSI is located on a tributary stream of the River Cam to the East of Newport and some 2km upstream of UTTL. It is therefore considered to be outside the area of influence of a drought application to suspend or vary river support from UTTL.

There are no riparian County Wildlife Sites along the Upper Cam between UTTL and Great Chesterford.

The River Cam flows through the Audley End Estate where is has been significantly modified as part of the historic landscaping for the house. Channel modifications are known to influence stream ecology, with a notable reduction in refugia for invertebrates associated with channel resectioning and poaching by livestock. The Audley End Estate is managed by English Heritage and receives a significant number of visitors to the house and gardens. It is likely that a reduction or cessation in river support from UTTL will impact flows through these grounds. The presence of a large number of wildfowl on this ponded section of the River Cam has the potential to further exacerbate water quality problems in times of low flows.

Under the WFD classification of 2009, the River Cam is classified overall as ‘poor (very certain)’. In terms of fish the Cam is classified as ‘poor (very certain’ and in terms of invertebrates as ‘good’.

A6.4.3 Impact of cessation/reduction in river support

The cessation or reduction in river support to the River Cam will reduce river flow (discharge) and velocity of the reach of river downstream of the discharge point. A reduction in the river flow and depth of water in the Cam has the potential to lead to stranding of fish behind structures or in isolated reaches within the river. It could also lead to short term increased predation and the potential for a long term decrease in prey abundance. Exposure of marginal vegetation with potential dieback following prolonged exposure, exposure of fish spawning grounds and aerated habitats for macroinvertebrates are also potential impacts of a reduction in river flow, as well as the potential for invasion of terrestrial macrophytes. Increased abstraction could also lead to a reduction in erosion and increase in sediment disposition with the potential to result in the smothering of spawning grounds and benthic habitats.

Potential decreases in water quality due to decrease in the dilution of effluent could lead to an increase in fish and macroinvertebrate mortality, increased algal blooms and growth of sewage

fungi and aquatic macrophytes. A consequence of increased growth of aquatic macrophytes could be a restriction of fish passage and dominance of a limited number of macrophytes species and the maintenance of water depth and velocity in areas of reduced open water. Algal growth and the associated change in Biological Oxygen Demand and pH has the potential for the smothering of vegetation and sediments, increased mortality of molluscs and crustaceans due to increased pH and reduced Dissolved Oxygen with algal dieback and associated fauna mortality. There is also the potential for increased fish and macroinvertebrate mortality as a consequence of increased water temperatures and the associated decreased Dissolved Oxygen. It is also expected that there is going to be temporary deterioration in the invertebrate WFD classification.

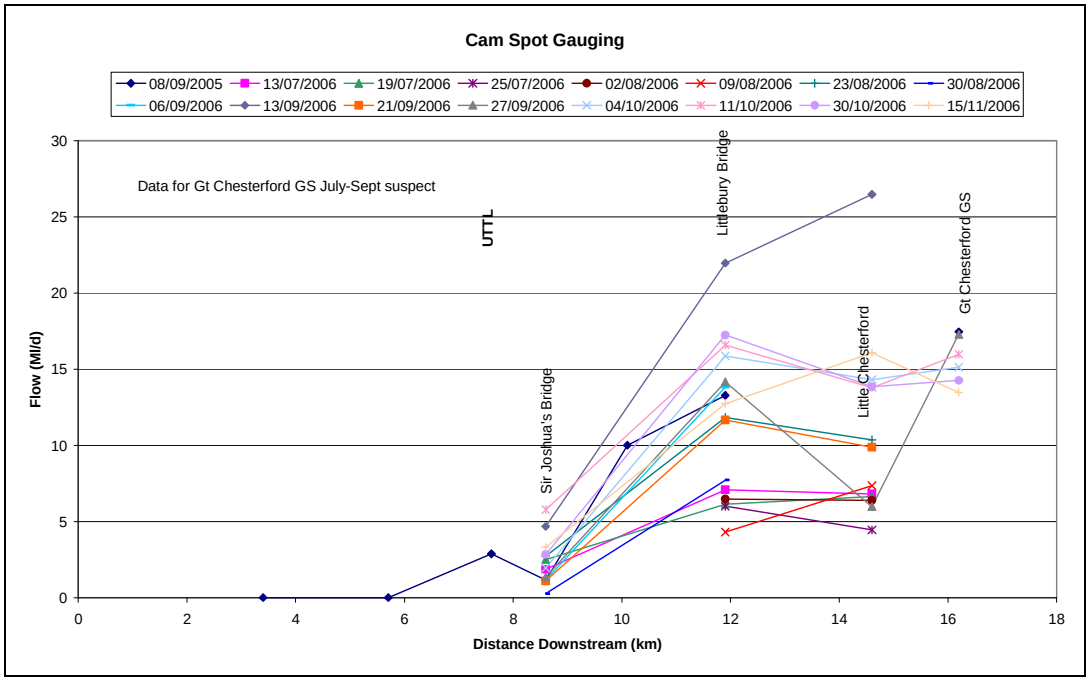
Current information indicates that the Cam has little flow in it above UTTL during Droughts. Downstream of Sir Joshua's Bridge there is a strongly accreting section of the river, where even during drought periods, increases of flow in the order of 5Ml/d have been observed. Flows then appear to remain the same, or decrease slightly between Littlebury Bridge and Little Chesterford, and then increase again to the gauging station at Great Chesterford. Thus, downstream of Sir Joshua's Bridge, the impact of augmentation just increases the natural flows. However, between Uttlesford Bridge and Sir Joshua's Bridge, augmentation may make the difference between some flow and no flow. In this reach, the River Cam flows through the grounds of Audley End which is of special historic interest and is open to the public. The river here has been modified with water held back by weirs to produce a wide, slow flowing lake feature in front of the House which is home to a large population of wildfowl. Whilst this section of the river is not a typical chalk stream habitat, it is of local importance. Augmentation from UTTL helps support flows in this section of the river, whilst flow from SPRF enters the river downstream of this section.

Support flows were provided to the Cam during the droughts of 1997 and 2005 and helped maintain flows above the trigger level. In the summer of 2006, flows at Great Chesterford were not recorded as having fallen below the trigger despite the drought situation in South East England. Further investigation by the Environment Agency identified an inaccuracy in the stage measurement at the gauging weir and consequently an over estimation of flow. The trigger would therefore have been breached and river support would have been required. Spot gauging undertaken at three locations upstream of the gauging weir suggests that flow was probably below the trigger for July and August 2006. During this period of low flows, the Environment Agency did not receive any calls from members of the public over concern over the lack of water in the river nor were they required to carry out any fish rescues (Reid pers comm.). This raises the question as to how and why the trigger level was set at 12.7Ml/d.

A6.4.4 Baseline monitoring

Affinity Water monitored the flow of River Cam at three locations during the 2005/06 drought period: Sir Joshua's Bridge, Littlebury Bridge and Little Chesterford. The flow between Sir Joshua's Bridge and Littlebury seems to be increased, most likely because of the Saffron Walden Sewage Treatment Works, which discharge to the River Cam approximately 3.7 Ml/d (Mott MacDonald, River Cam Environmental Report, 1998), and the two springs located 0.5km south of Audley End. Further downstream, the flow is seen to either slightly decreased or increased. The most probable reason for that is the surface water abstraction for irrigation of the farms in the surrounding area (see Figure A6.4.1).

Figure A6.4.1 River Cam spot gauging 2005/06



As noted above, flows in the summer of 2006 did in fact drop below the trigger level, but no support was given due to errors on the flow gauge at that time. This has provided useful information on what the natural flow regime would be without any support (see Figure A 6.4.2).

Figure A6.4.2 Flow in the River Cam at Great Chesterford

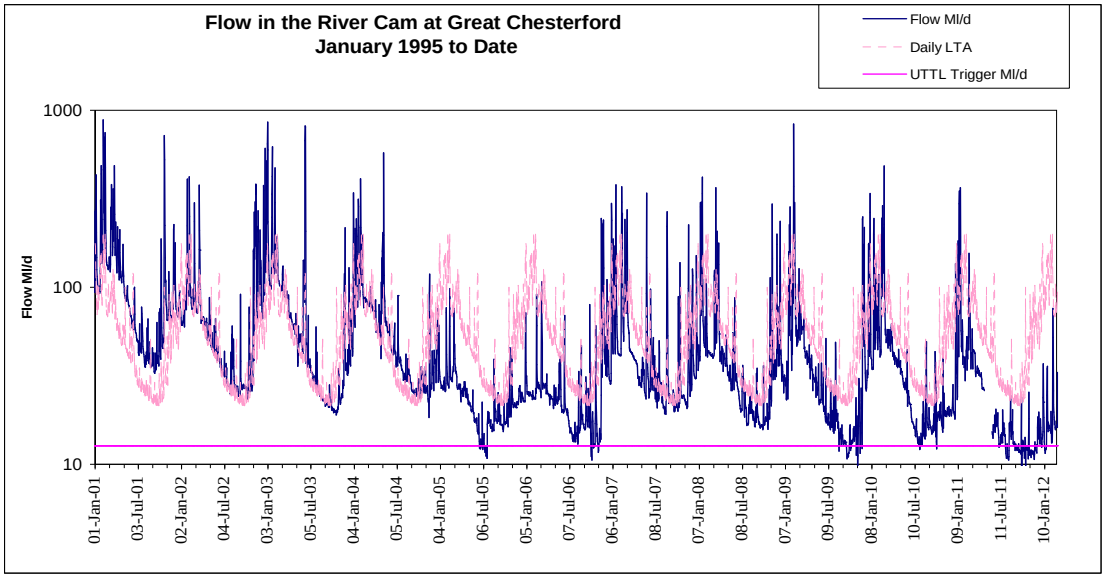


Figure A6.4.3 River Cam Flow, Abstraction and Augmentation 1997

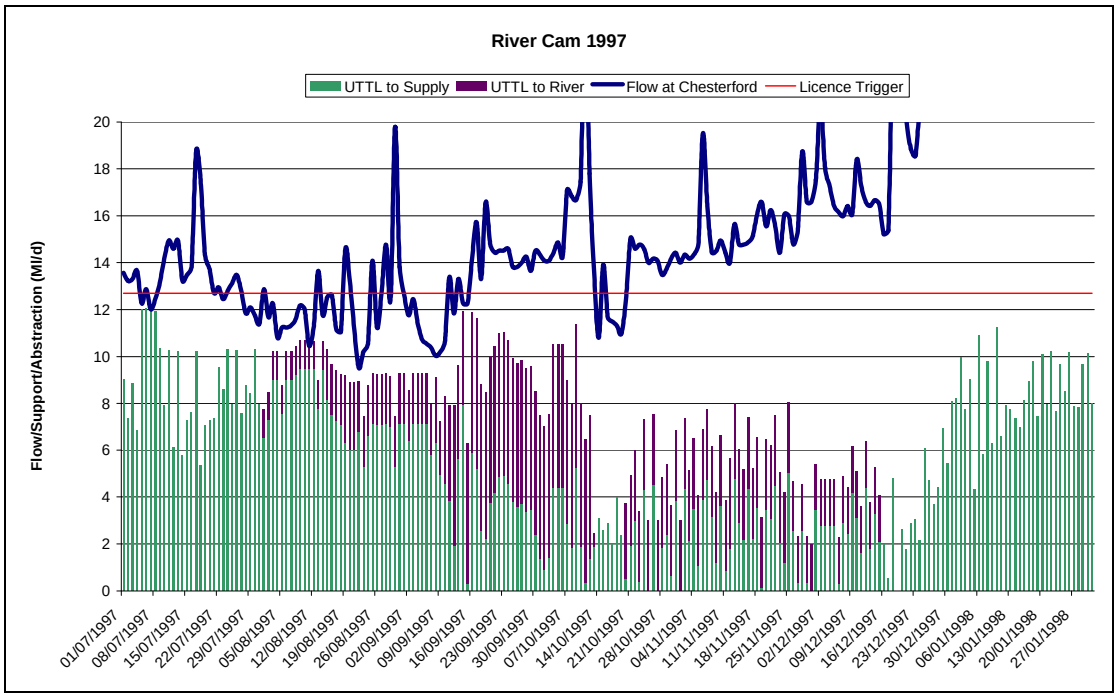
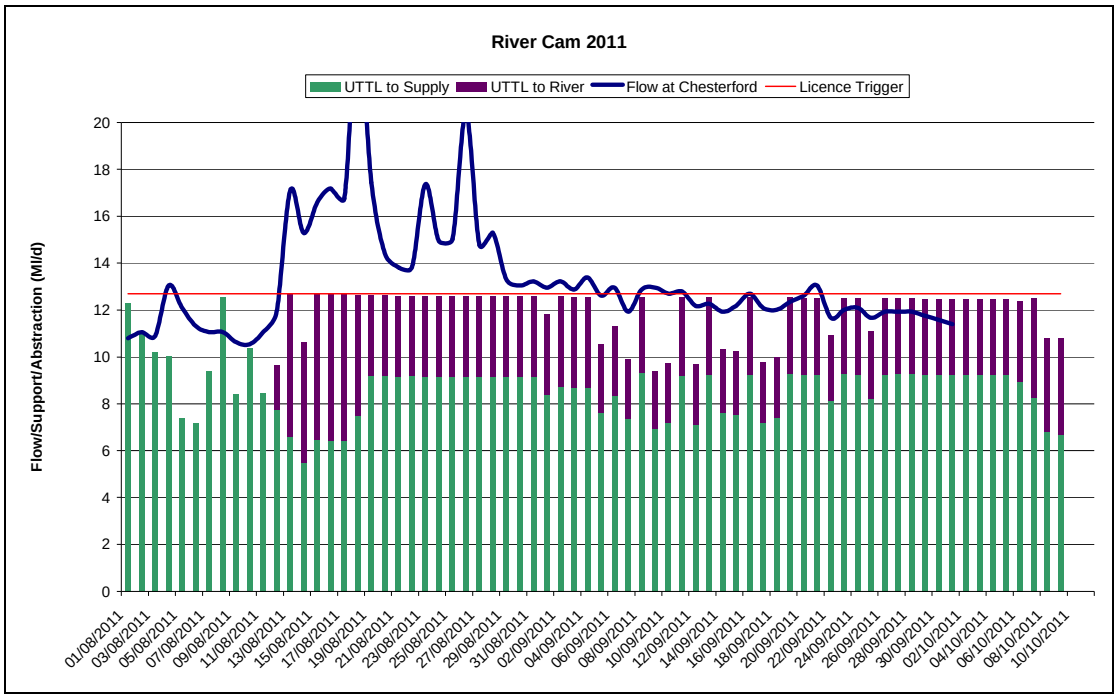


Figure A6.4.3 River Cam Flow, Abstraction and Augmentation 2011



A6.4.5 Additional monitoring

The provision of river support is predicted will mitigate the impact of our abstraction during low flow periods. Whilst this will be removed during the period of the operation of the Drought Permit, we will continue to provide support as and when operationally possible as this will help mitigate some of the impacts associated with the drought application.

We will undertake additional monitoring to better understand what impacts occur during the period of the Drought Permit, which will inform subsequent permits and possibly allow other mitigation measures to be developed. Such information will also confirm or refute the potential impacts as outlined above.

Table A6.4.1 River Cam Drought Monitoring

Data	Description	Normal Frequency	Drought Zone 3 Frequency	Drought Zone 4 Frequency	Post Drought Frequency
Groundwater Level	TL53/021 Oaks Plantation	Monthly (EA)	Monthly (EA)	Monthly (EA)	Monthly (EA)
	TL54/018 Bordeaux Farm	Monthly (EA)	Monthly (EA)	Monthly (EA)	Monthly (EA)
	TL53/002 Crossways	Monthly (EA)	Monthly (EA)	Monthly (EA)	Monthly (EA)
	TL53/004 Holmwood	Hourly (AW)	Hourly (AW)	Hourly (AW)	Hourly (AW)
	Springwell Farm (private well)	Hourly (AW)	Hourly (AW)	Hourly (AW)	Hourly (AW)
	Springwell Place	Hourly (AW)	Hourly (AW)	Hourly (AW)	Hourly (AW)
Gauged River Flows	Cam at Great Chesterford	Daily (EA)	Daily (EA)	Daily (EA)	Daily (EA)
Spot Gauging	Sir Joshua's Bridge Littlebury Little Chesterford	No spot gauging in normal year, monthly in drought zone 2 by AW	Monthly (AW)	Fortnightly (AW)	Monthly (AW)
Macro-invertebrates	Wendon Brook, Uttlesford	GQA (EA)	Walk-over Surveys, summer sampling (EA, AW)	Walk-over Surveys, summer sampling (EA, AW)	Walk-over Surveys, summer sampling (EA, AW)
	Wendon's Ambo	GQA (EA)			
	Littlebury	GQA (EA)			
	Great Chesterford	GQA (EA)			

A6.4.6 Mitigation Measures

Our mitigation plans include actions before, during and after the drought. The major mitigation measures before the drought involve river restoration options, the measures during the drought ecological, hydrological and water quality monitoring and after the drought actions to enhance habitat recovery.

Following the walk-over surveys the critical sites identified will be looked at into detail in order to apply the mitigation measures required for the purpose of fish easement. Following the 2012 Drought experience, suggestions will be put forward for river restoration option at the critical sites, such as weir structure surveys and removals. In the cases that fish easement cannot be achieved, fish rescues of the populations under stress will be conducted. The ideal relocation places would be in the same river body further downstream at suitable locations identified during the walk-over surveys. In the event that downstream locations are not accessible or are deemed inappropriate due to low flows or adverse conditions, the fish will be relocated to different water bodies with similar quality characteristics. In this case, health checks of the relocated fish are necessary in order to ensure good health of the fish. After the end of the drought, the water body will be restocked. The restocking will be required to be completed with a range of species and sizes, in order to ensure that the angling activity is not impacted and a balanced fish population is maintained.

After the event of the drought, additional walk-over surveys will take place in order to identify macrophyte species that suffered in the upstream reaches but are in a good status in the downstream reaches. Following the identification of these species, replanting of populations from the downstream reaches to the upstream reaches will be considered in order to ensure species recovery along the length of the river.

Following the end of the drought and the cessation of need for additional abstraction, the options of abstraction for augmentation or partial/full cessation of abstraction from the catchment reaches that have been more affected will be considered. This will aid the recovery of the natural flows into the river, which will ultimately reduce the time of the river remaining dry.

In the event that the River Cam Drought Permit is utilised through cessation of augmentation of up to 6Ml/d, the full volume of augmentation will be turned back on at the end of the period that the Permit is required. This will aid the flows in the River Cam and will assist in habitat and ecology recovery.

A6.4.7 Conclusion

To date the Company has not made a drought application for these sources, thus the impacts of removing this river support are unknown.

A drought application for this site would be made to reduce or cease river support from these sources thereby increasing the volume of water available for public supply, thus freeing up water to other parts of the network.

There would be no net increase in abstraction from these sites, but there would be a reduction in the environmental compensation flow to the River Cam, allowing flows to reduce further below the trigger level at Great Chesterford and further upstream. It would be our intention to manage these sites so that if demand could be met by other sources a support flow to the river would be made. The Company has and will continue to work closely with the EA on monitoring flows in the Cam as per licence conditions during historic operational difficulties.

Table A6.4.2 Summary of Environmental Impact of Drought Permit on the River Cam

Option Implementation Assessment	Option Name	Cam Drought Permit
	Trigger	Zone 4 Drought Trigger and drought permits with lower environmental impact
	Deployable Output of action	Up to 6Ml/d on average, 6Ml/d on peak
	Location	River Cam, UUTL/SPRF
	Implementation timetable	Pre-application monitoring to start when Zone 3 trigger is breached. Application to be submitted after Zone 4 trigger is breached and the applications for the permits higher on the list have been submitted
	Permissions required and constraints	Permission from the Environment Agency is required. Pre-application discussions will be frequently held with the Environment Agency. Discussions will also be held with Local and Parish Councils, the Audley End Estate and other local interest groups. A public hearing might be required, should objections be received.
	Risks associated with option	The associated risks are environmental and detailed below.
Environmental Assessment	Risk to the environment	Medium/Low
	Summary of likely environmental impacts	Reduction of river flows, potentially trapped fish, increase of sediment disposition, potential increased fish and invertebrate mortality, aesthetics in historic location.
	Baseline information used	Quarterly river photos at 7 locations, macro invertebrates monitoring 4 locations biannually on a three year rolling programme, 1 gauging station flow records, 3 groundwater level monitoring locations by EA and 2 by AW
	Summary of additional baseline monitoring requirements	Walk-over surveys to identify affected locations, summer macro invertebrates survey at 4 locations, spot gauging monthly at 3 locations
	Mitigation measures	Fish rescues, river augmentation whenever possible, artificial narrowing of the channel to improve velocity, replanting of chalk stream vegetation
	Impact on other activities	Poor water quality at Audley End landscaped water features, protected rights on private abstractions.

A6.5 Additional Abstraction from the River Mimram

Potential Environmental Impact of a Drought Permit at Fulling Mill on the Flow and Ecology of the River Mimram

Drought Permit/Order Source(s): FULL

Potential Additional Water Available: 2.23Ml/d

Potential Reduction in River Support: 0Ml/d

Statutory Designated Sites: None

A6.5.1 Background

The River Mimram is considered to be a chalk river supporting a good diversity of habitats and species. In 1981 the clause of the variation acting to limit the effect of the increased abstraction at Fulling Mill on the flow of the River Mimram was strengthened by introducing a river flow constraint. According to the constraint, from April to September inclusive when the rate of flow in the River Mimram at Fulling Mill gauging station is 0.085 m^3/sec (7.34Ml/d) or greater the FULL abstraction cannot exceed 11.365 Ml/d. from October to March inclusive and the rest of the summer days the daily abstraction at FULL is restricted to 9.09 Ml/d.

There is a number of adjacent wetland sites in the vicinity of the River Mimram designated as County Wildlife Sites. No evidence of degradation of these sites resulting from Affinity Water's abstraction has been identified in previous studies carried out. The potential for impact of the increase in abstraction permitted under the variation on the ecology of the catchment has also been investigated.

A drought permit will be required to lift the Mimram river flow constraint under severe drought conditions, when we are in Drought Zone 4 and facing unprecedented water levels.

A6.5.2 Ecology

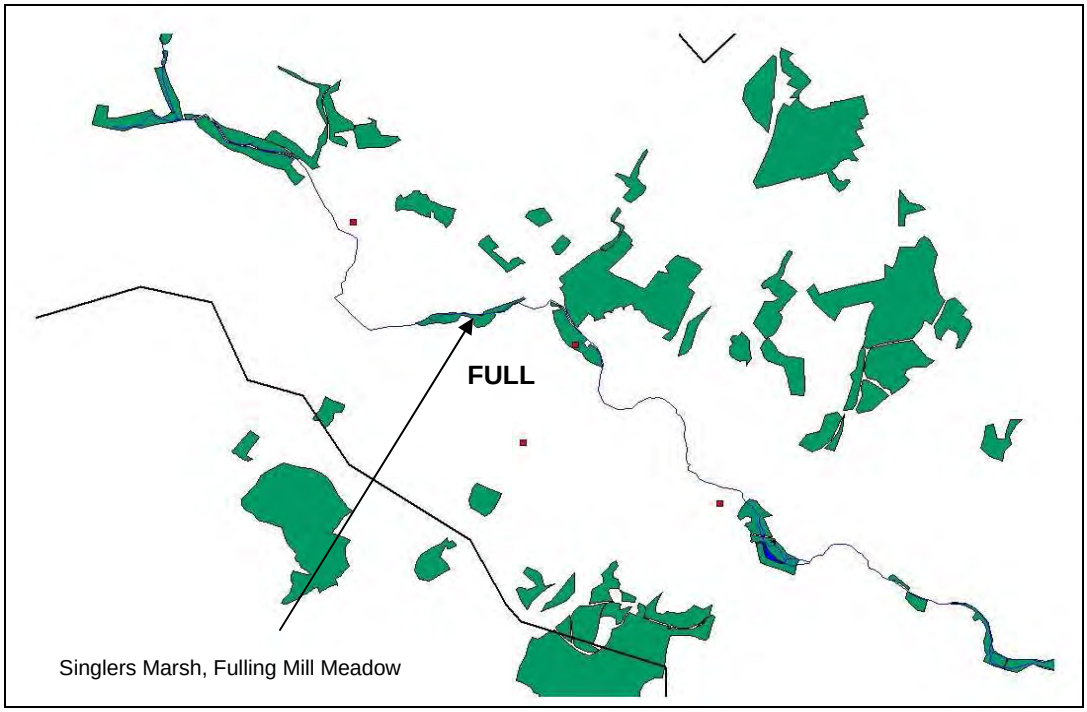
In September 1993, a River Corridor Survey (RCS) was carried out. However, the surveying took place just after heavy rainfall and the channel contained above normal flow for that time of year and overall the river flowed almost continuously during 1993 and supported vegetation typical of a chalk stream. In October 1997 a further survey was carried out over the upper reaches of the river, following a severe drought. This survey showed in comparison to the 1993 RCS that the presence of water was intermittent along almost every surveyed stretch. In the upper reaches there was a marked decline in aquatic vegetation compared with that of 1993 (Powers, 1998).

County Wildlife Sites (CWS) have been identified from the Hertfordshire Phase I Habitat Survey Reports compiled by the Biological Records Centre and Hertfordshire and Middlesex Wildlife Trust (1998). A number of key sites close to FULL have then been identified (see Figure1), although none have been noted as being affected by the abstraction historically.

Singlers Marsh, Fulling Mill Meadow (TL 229 165) surrounds the two pump houses at FULL. The site is registered on the Grassland Inventory and as a CWS. The land is a former grazing pasture with a diverse habitat including *Persicaria bistorta* (a species rare to Hertfordshire). In recent years degradation of this land has been attributed to poor river management, dredging and a poor grazing regime (HBRC).

The Mimram Valley Marsh, Hollards Farm (TL 221 168) CWS is located close to FULL consisting of a habitat of fen, sedge and reedbeds, marshy grassland and mixed woodland. This site is of local importance to birds and the Water Vole. Dredging of the adjacent river has resulted in the over-steepening of the banks (HBRC) and thus affected the marginal vegetation.

Figure A6.5.1 Country Wildlife Sites in the Vicinity of FULL



The Mimram is well documented for its diversity of macro invertebrates including mayfly and caddis fly larvae. There has been extensive monitoring, by the EA and their predecessors, of the macro invertebrates along the river since the mid-1970s. In general the river has supported a good diversity of species throughout the 1990s.

The Mimram is designated as a salmonid river (the water quality is suitable for trout and grayling). Brown Trout is the most abundant species present although a sustainable Grayling population has been reintroduced (NRA, 1994). Other species identified in the 1993/4 survey include; Bullhead, Pike, Roach, Rainbow Trout, Stoneloach and 3 spined Stickleback.

The lower Mimram has maintained flow at all times (Panshanger Gauging Station records), which would appear to be reflected in the greater diversity of the fish population, compared with the upper river. Over-dredging is thought to have prevented the migration of coarse fish from the Lee. (NRA, 1993/4). The upper reaches are noted to have been adversely affected by low flows.

Hertfordshire's Otter population currently centres on the River Lea and River Stort but could potentially expand into new territories. Potential Otter sites have been identified at 6 locations along the middle and lower Mimram. A survey noted that Otters had visited Tewinbury during July and December 1999, however, the survey did not establish whether this was a regular occurrence, (Pearce et al, 2000).

There are a number of known Water Vole habitats along the River Mimram. In 1999 Water Voles were found at seventeen sites along the River. Codicote Bottom and Digswell Meadow were considered to be strongholds for the Water Voles.

Low Water Vole populations at a number of locations on the River have been attributed to degradation of the riparian habitat including over shading, urban development, bank reinforcements, poaching of banks over widening and over deepening of the channel (Pearce et al, 2000).

Habitats favourable to this native crayfish were, in 1999, only found at small and isolated sections of the Mimram's channel. Dredging combined with low flows and poor management of in stream vegetation resulting in silt deposition along most of the River. Nutrient enrichment from arable fields adjacent to the river in the upper reaches and invasion by stinging nettles along side competition from the alien Signal Crayfish are thought to be contributing to their decline.

Riparian vegetation was found to be good at most sites along the river in 1999. In stream and emergent vegetation was identified as being present at most sites although overgrown in places choking the channel (Pearce et al, 2000). There is a number of plant species rare or uncommon to Hertfordshire found along the Mimram. These include the Southern Marsh Orchid (*Dactylorhiza praetermissa*) and Bistort (*Persicaria bistorta*). No evidence of these species being adversely affected by abstraction has been identified.

Macro invertebrate surveys have identified a good diversity of species along the river's length throughout the 1990's, maintaining high BMWP scores. The Mimram is also home to Otters, Water Voles and White-clawed Crayfish. Variations in the populations of these species have not been directly linked to Affinity Water's abstraction. River management (including flood defence work and dredging) has been identified as a significant factor in affecting these populations.

Under the WFD classification the River Mimram is classified as 'poor (very certain). From source at St Pauls Walden to the confluence with the Lee with fish classified as 'poor (very centrain)' for the length of the river. In terms of invertebrates, the Mimram is classified as 'high' from source to Welwyn and as ''moderate (uncertain)' from Welwyn to the confluence with the Lee.

A6.5.3 Impact of Increased Abstraction

As part of the drought monitoring programme, spot gauging was undertaken during the previous drought in 2006 and 2007 at eleven sites. The results from the spot gauging are shown in Figures A6.5.2 and A6.5.3 respectively.

Figure A6.5.2 River Mimram Spot Gauging 2006

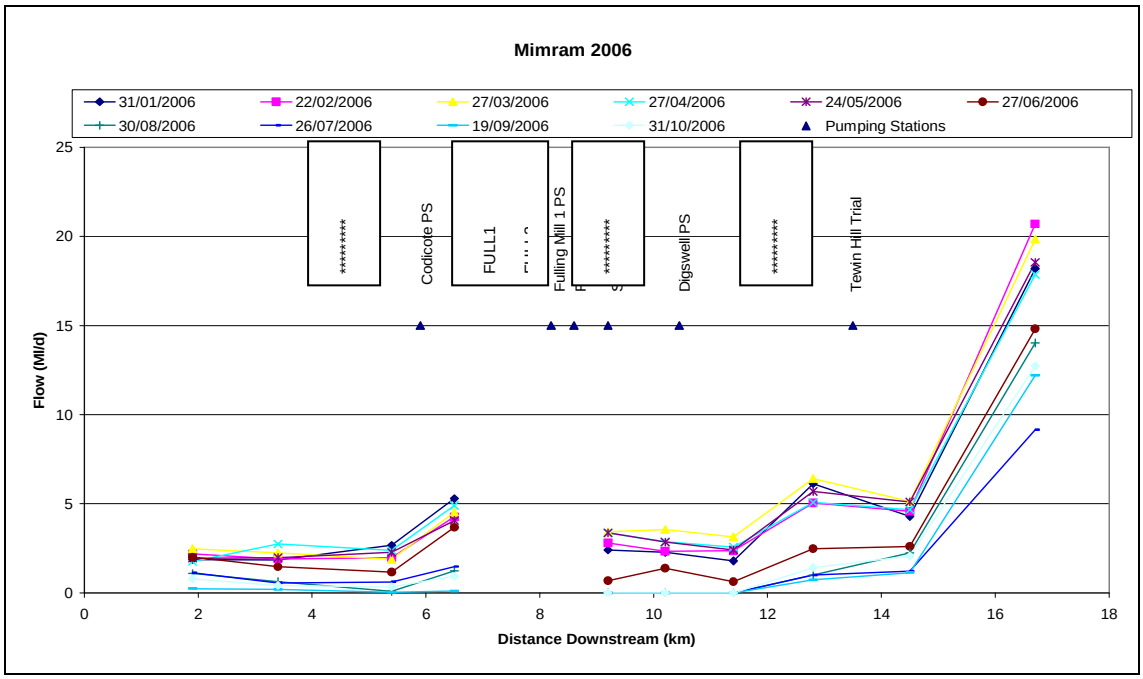
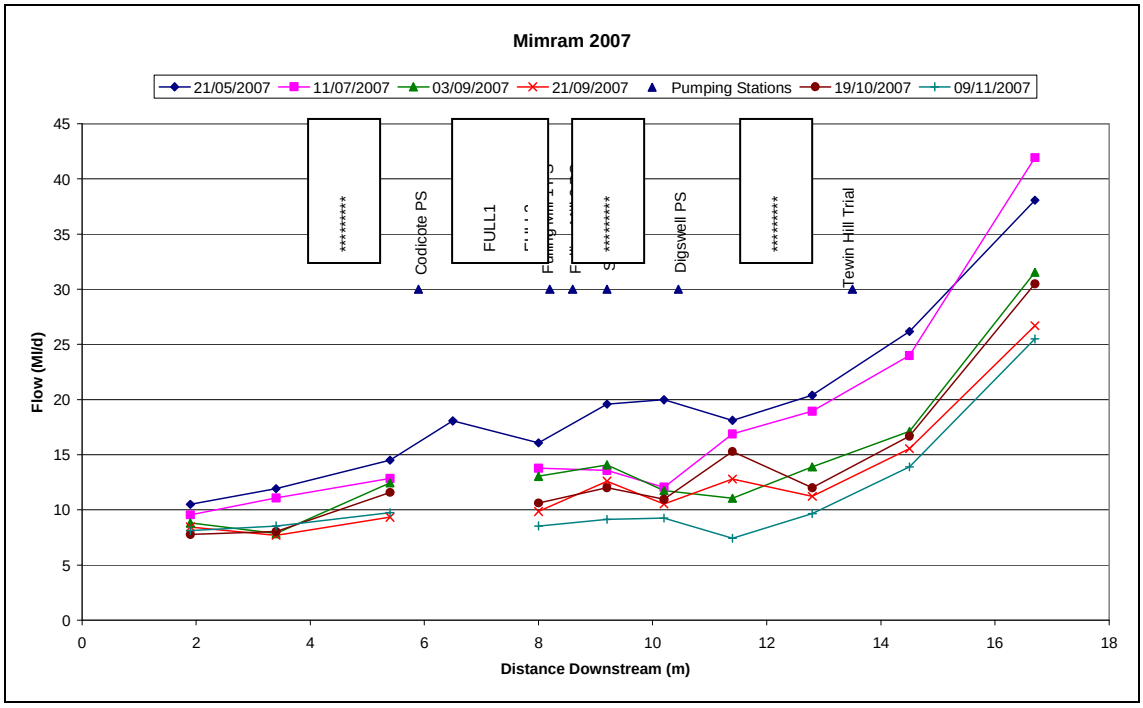


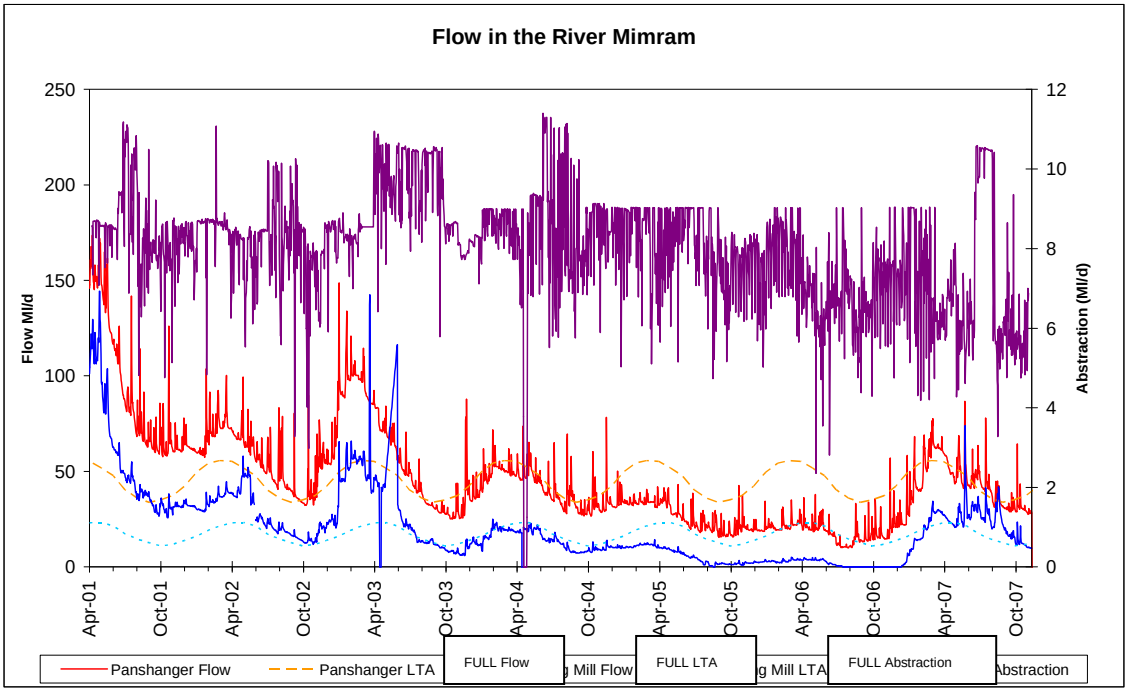
Figure A6.5.3 River Mimram Spot Gauging 2007



The flow of the river follows similar patterns in both 2006 and 2007 despite the difference in overall flows, with an increase between Tewin Lodge and Panshanger, which is believed to be a result of the springs around Tewin Fish Farm. The flow is slightly reduced around FULL by approximately 3Ml/d under most flow conditions, which is thought to be partly an impact of the abstraction. The biggest difference between two flow periods is the accretion between Tewin Lodge and Panshanger.

In Figure A6.5.4, the river flow has been plotted as measured at the Fulling Mill and Panshanger Gauging Stations, together with the FULL output. The river follows the same seasonal fluctuations at both gauging stations but there is a significant volume difference between the two stations which varies between 25 and 35 Ml/d. This difference derives from the existence of springs at Digswell and Tewinbury. This proves that this reach of the river has robust flows and is one reason that a potential replacement site for FULL in AMP4 was considered in this area, but eventually determined to be unfeasible.

Figure A6.5.4 Flow in the River Mimram and FULL Output, 2001-2007



The monitoring programme, which has been ongoing since 2001 and includes groundwater, river flow and surface water levels monitoring, has shown that the abstraction at FULL has a small impact (~3Ml/d) on river flows, and at very low flows can increase the length of dry river bed, hence the investigations to identify an alternative abstraction location in AMP4 which later proved unfeasible.

As the invertebrates are classified as in high status upstream of Welwyn, it is expected that temporary deterioration in the classification will occur under drought conditions, because of the reduced flow in the river. However, quick recovery is expected, as it was experienced in the previous drought. If a drought permit is granted for FULL and the licence condition is lifted, it is expected that the deterioration will be prolonged by probably 1-2 months. However, this has not been proven, as we have not applied for a drought permit on FULL in the past. Therefore, a robust monitoring schedule during droughts and drought permit periods will assist in collecting the adequate information, which can also be used in future droughts.

Between Fulling Mill and Digswell the presence of saturated valley drift forms a relatively impermeable body; therefore the river is perched between FULL and the spring at Digswell Lake. Nevertheless, groundwater abstractions have produced a conical depression of the piezometric surface which modified the relationship between river and groundwater. It is currently thought that FULL at times induces some river bed leakage. However the Boulder Clay still provides some protection to the riverbed limiting the effects of pumping to a reduction in spring flow in the vicinity of Digswell Lake.

A reduction in river flow because of increased abstraction could increase siltation rates, increase temperature and reduce dissolved oxygen. It is also likely that fish populations will be isolated with the partial drying out of the river. A temporary loss of aquatic macrophytes is anticipated which would be expected to re-colonise post-drought.

A6.5.4 Baseline Monitoring

River Mimram flow has been monitored since the 1950s by the Environment Agency at three Gauging Stations, Whitwell; Fulling Mill and Panshanger. The Base Flow Index (BFI) values, according to the Agency's surface water register, are 0.97 at Whitwell, 0.96 at Fulling Mill and 0.94 at Panshanger. Values close to 1.00 indicate a greater reliance on groundwater. The Mimram values indicate only a marginal decrease in groundwater influence downstream.

The two EA flow gauging stations on the Mimram in proximity to FULL, at Fulling Mill and at Panshanger, which record daily river flows, are represented in Figures 5 and 6.

Figure A6.5.5 Flow in the River Mimram at Panshanger (1953 - date)

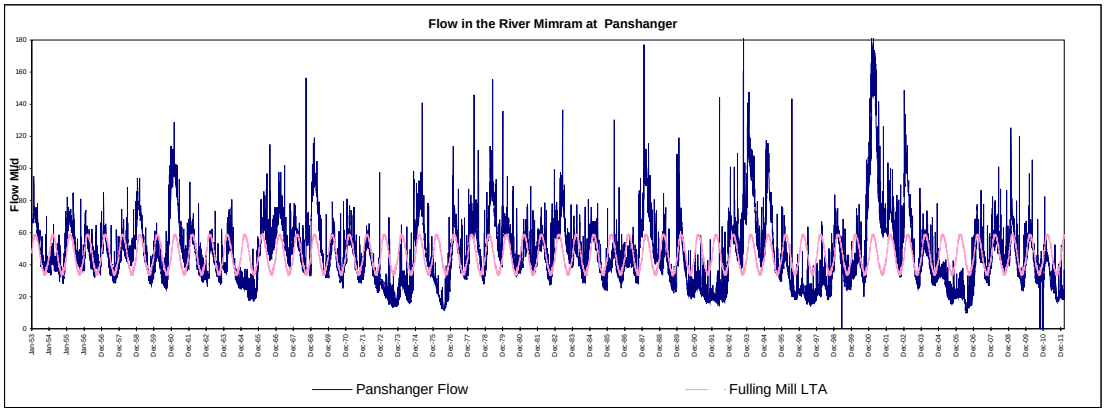
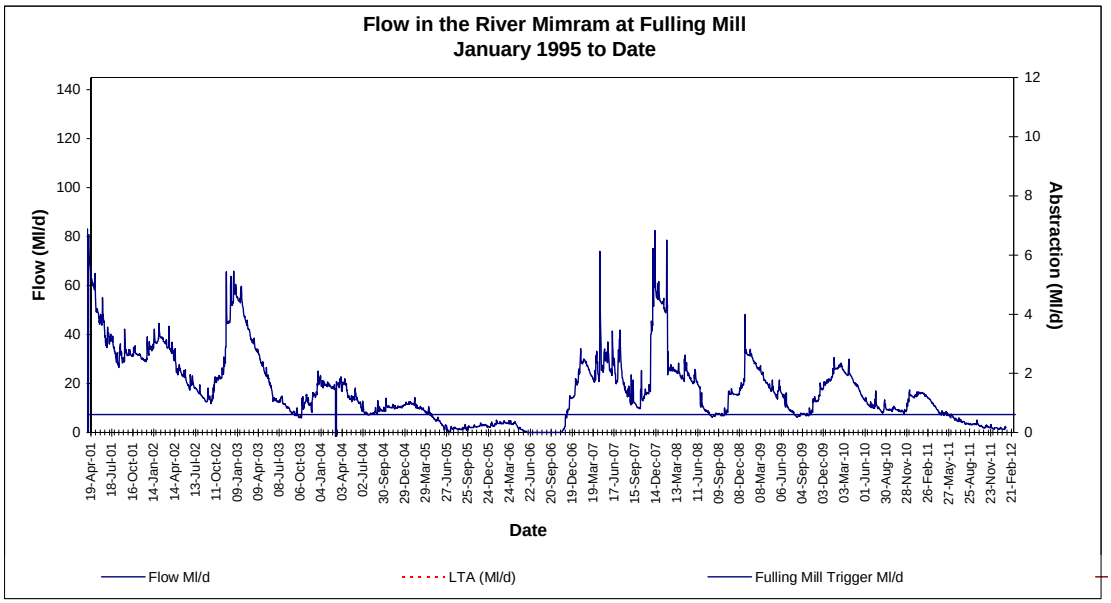
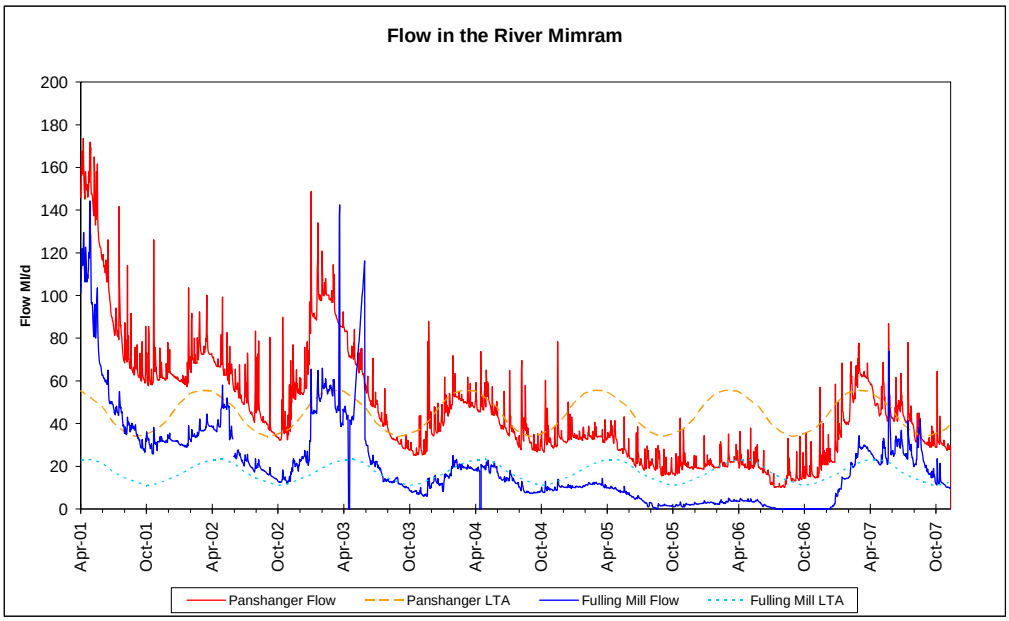


Figure A6.5.6 Flow in the River Mimram at Panshanger (1995 – date)



From the measured flow data it is possible to determine climatic variations comparing the flow with the Long Term Average (LTA). The period between April 2001 and July 2003 the flow exceeded the LTA. A period of normal flow between August 2003 and November 2004 was followed by a two year drought period. Since February 2007 the flow returned to a normal pattern (Figure 7).

Figure A6.5.7 Flow in the River Mimram at Fulling Mill and Panshanger



Groundwater levels are also monitored in the Mimram catchment. There are 11 boreholes in the catchment, where the EA and the Chilterns Society records monthly dips resulting in fortnightly data sets.

A6.5.5 Additional monitoring

Monitoring for the Mimram will start in Drought Zone 3. The monitoring schedule will comprise of monthly spot gauging during Zone 3, fortnightly spot gauging during Zone 4 and weekly spot gauging during drought permit duration. If a drought permit is granted, the post drought spot gauging frequency will be weekly reducing to fortnightly and monthly, following mutual agreement with the EA. All monitoring rounds and locations will be AW's responsibility. If additional abstraction following lifting of the operating agreement is not put in place the post drought spot gauging frequency will be monthly. The spot gauging rounds include in-situ water quality monitoring (pH, dissolved oxygen, conductivity).

The Environment Agency (EA) require three season invertebrate monitoring at three of the Water Resources invertebrate monitoring sites on the Mimram for the FULL drought permit. Two of these sites are currently surveyed twice a year and are likely to be dry – walkover surveys to assess whether the river is dry in these locations. One of the sites is a distance downstream from FULL and the EA currently survey it three times a year.

As the downstream site is a long way downstream of FULL the EA will require two additional (new) sites downstream of the abstraction to be monitored three times a year. The EA will require Affinity Water to carry out summer invertebrate monitoring pre and post drought permit at two sites - walk over surveys to identify if the river is flowing. Three seasons invertebrate monitoring is needed at two sites below the pumping station.

Walk-over surveys are necessary for the characterisation of the state of the river during Drought Zone 2. The walk-over survey will be preferably undertaken by both EA and AW, subject to mutual agreement. The objective of the surveys will be the identification of reaches under stress, so that a more detailed Environmental Impact Assessment can be completed at the time and immediate mitigation measurements can be implemented, such as fish rescues and debris/obstruction removal. The ideal period for the walk-over surveys is spring, subject to the timing of drought (Zone

2 to coincide with spring) and weather conditions. Alterations in aesthetic appeal and variations in compositions of inverts and plants will also be monitored during the walk-over surveys.

Fisheries surveys are not planned to be undertaken specifically as part of the permit pre-application process. However, walk-over surveys will assist in assessment of the impact of drought on fish populations.

Groundwater levels are monitored by the EA at 6 locations on a monthly basis. Additional monitoring will be subject to agreement, with the options of logging boreholes by AW in close proximity to the permit site.

Table A6.5.1 River Mimram Drought Monitoring

Data	Description	Normal Frequency	Drought Zone 3 Frequency	Drought Zone 4/Drought Permit Frequency	Post Drought Frequency
Groundwater Level	TL21/105 Mimram 9 (Digswell Park)* TL21/106 Mimram 8 (Hertford Rd)* TL21/108 Mimram 7 (Wellington PH) TL21/109 Mimram 6 (Fulling Mill La) TL21/110 Mimram 5 (Kimpton Rd) TL 21/107 Mimram 4 (Codicote PS)	Monthly (EA)	Monthly (EA)	Monthly (EA)	Monthly (EA)
Gauged River Flows	Mimram at Whitwell Mimram at Fulling Mill Mimram at Panshanger	Daily (EA)	Daily (EA)	Daily (EA)	Daily (EA)
Spot Gauging	Whitwell GS Chapmans Nursery Kimpton Mill (footbridge) Codicote Bottom Pulmer Water Fulling Mill GS Welwyn High Street Digswell Park US Near A1000 West Lodge Digswell Tewin Lodge	No spot gauging in normal year, monthly during drought zone 2 by AW	Monthly (AW)	Fortnightly/Weekly (AW)	Weekly, reducing to fortnightly, reducing to monthly (AW)

	Panshanger GS				
Macro-invertebrates	Whitwell Below Whitwell, Hoo End Codicote Bottom Below Codicote Bottom Rye End Farm Above Welwyn Town Panshanger	Biannual (EA) Biannual (EA) 3 times/year (EA) Biannual (EA) Biannual (EA) Biannual (EA) 3 times/year (EA)	3 times/year (EA, AW) 3 times/year (EA, AW) 3 times/year (EA) 3 times/year (AW) 3 times/year (AW) Biannual (EA) 3 times/year (EA)	3 times/year (EA, AW) 3 times/year (EA, AW) 3 times/year (EA) 3 times/year (AW) 3 times/year (AW) Biannual (EA) 3 times/year (EA)	3 times/year (EA, AW) 3 times/year (EA, AW) 3 times/year (EA) 3 times/year (AW) 3 times/year (AW) Biannual (EA) 3 times/year (EA)
Fisheries	Tewin Flyfishers Panshnger Quarry Codicote Duck Trap Wood Fulling Mill Lane	Annually (EA) Annually (EA) 1 off in 2012 (EA) 1 off in 2012 (EA) 1 off in 2012 (EA)	Walk-over Surveys (AW, EA)	Walk-over Surveys (AW, EA)	Walk-over Surveys (AW, EA)

* AW also holds some hourly logger data for these boreholes

A6.5.6 Mitigation Measures

Our mitigation plans include actions before, during and after the drought. The major mitigation measures before the drought involve river restoration options, the measures during the drought ecological, hydrological and water quality monitoring and after the drought actions to enhance habitat recovery.

Following the walk-over surveys the critical sites identified will be looked at into detail in order to apply the mitigation measures required for the purpose of fish easement. Following the 2012 Drought experience, suggestions will be put forward for river restoration option at the critical sites, such as weir structure surveys and removals. In the cases that fish easement cannot be achieved, fish rescues of the populations under stress will be conducted. The ideal relocation places would be in the same river body further downstream at suitable locations identified during the walk-over surveys. In the event that downstream locations are not accessible or are deemed inappropriate due to low flows or adverse conditions, the fish will be relocated to different water bodies with similar quality characteristics. In this case, health checks of the relocated fish are necessary in order to ensure good health of the fish. After the end of the drought, the water body will be restocked. The restocking will be required to be completed with a range of species and sizes, in order to ensure that the angling activity is not impacted and a balanced fish population is maintained.

After the event of the drought, additional walk-over surveys will take place in order to identify macrophyte species that suffered in the upstream reaches but are in a good status in the downstream reaches. Following the identification of these species, replanting of populations from the downstream reaches to the upstream reaches will be considered in order to ensure species recovery along the length of the river.

Following the end of the drought and the cessation of need for additional abstraction, the options of abstraction for augmentation or partial/full cessation of abstraction from the catchment reaches that have been more affected will be considered. This will aid the recovery of the natural flows into the river, which will ultimately reduce the time of the river remaining dry.

In the event that the River Mimram Drought Permit is utilised for 100 consequent days of additional abstraction of 2.73Ml/d, the additional volume of water that would be removed from the aquifer will add up to 273Ml/d. In order to compensate and aid in the recovery of the flows, we suggest that we will stop abstraction from FULL for 25 days or until flows return to normal, whichever is the shortest, should the demand levels allow for it. However, it needs to be noted that due to the forthcoming revocation of the FULL abstraction licence, the likelihood of ever using this Drought Permit is extremely low.

A6.5.7Conclusion

It is likely that if drought conditions were severe enough to require us to apply for a drought permit the Mimram would already be dry over a significant length. Increasing abstraction from the catchment would therefore not have any immediate impact on river flows but would delay the recovery of flows following the drought by ~1 month. Temporary deterioration of ecological status of the river is anticipated. The velocity of the river flow might also be affected. Potential mitigation measurements could include aeration, fish rescues, augmentation of the river flows from the additional abstracted volumes, replanting of chalk stream vegetation, post-drought restocking and channel narrowing.

Table A6.5.2 Summary of Environmental Impact of Drought Permit on the River Mimram

Option Implementation Assessment	Option Name	Mimram Drought Permit
	Trigger	Zone 4 Drought Trigger and drought permits with lower environmental impact
	Deployable Output of action	2.23Ml/d
	Location	River Mimram
	Implementation timetable	Pre-application monitoring to start when Zone 3 trigger is breached. Application to be submitted after Zone 4 trigger is breached and the applications for the permits higher on the list have been submitted
	Permissions required and constraints	Permission from the Environment Agency is required. Pre-application discussions will be frequently held with the Environment Agency. Discussions will also be held with Friends of the Mimram and local Parish Councils. A public hearing might be required, should objections be received.

	Risks associated with option	The associated risks are environmental and detailed below.
Environmental Assessment	Risk to the environment	Medium/High
	Summary of likely environmental impacts	Delay of recovery of the dried out reaches after the drought by 1-2 months, potential extension of the dried out reaches, reduced flow velocity at dry reaches, deterioration of macroinvertebrates status
	Baseline information used	Quarterly river photos at 10 locations, macro invertebrates monitoring 5 biannual and 2 three times per year, fisheries surveys at 3 locations, 3 gauging stations flow records, 6 groundwater level monitoring locations
	Summary of additional baseline monitoring requirements	Walk-over survey to identify affected locations, summer macro invertebrates survey at 4 locations, spot gauging monthly/fortnightly at 11 locations
	Mitigation measures	Fish rescues, create macro invertebrates banks for re-stocking, cessation of abstraction in aid of recovery, artificial narrowing of the channel to improve velocity, replanting of chalk stream vegetation
	Impact on other activities	No other activities are expected to be impacted on

A6.5.7 References

Vivendi Water Partnership. 2001. Application for the Renewal of the Abstraction Licence Variation at Digswell and Fulling Mill (29/38/2/73), Environmental Statement.

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A6.6 Additional Abstraction from the River Hiz

Potential Environmental Impact of ceasing river support from WELL to the Hiz and OUGH/OFFS to the Oughton on the Flow and Ecology of the Rivers Hiz and Oughton

Drought Permit/Order Source(s): WELL, OUGH/OFFS

Potential Additional Water Available: up to 0.3Ml/d from WELL and up to 1Ml/d from OUGH/OFFS

Statutory Designated Sites: None

A6.6.1 Background

The Rivers Hiz and Oughton were included in the NRA list of the 'top 40' low flow rivers in England and Wales in 1992 and have been subject to a series of investigations. These investigations concluded that our abstractions from WELL, OUGH and OFFS were adversely impacting flows in the Upper River Hiz and Oughton. A mitigation scheme was implemented in 1996 to provide augmentation of flows from our groundwater sources, to mitigate the impact of our abstraction on the flow, ecology and amenity value of these rivers.

Under a Heads of Terms agreement between AW and the EA, river support of up to 0.3Ml/d is required from WELL to Charlton Mill Pond when levels in the Pond are at or below 69.94 mAOD. The Pond forms the head of the River Hiz and in turn water from the Pond overflows into the River Hiz, thereby supporting flows downstream.

River support is also required from either OUGH or OFFS to the spring head of the River Oughton when the water level at Oughton Head is at or below 57.54mAOD. The volume of support shall not exceed the sum of 0.45Ml/d from OUGH and 0.55Ml/d from OFFS.

A Drought Permit is required to suspend the requirement for the river and the pondsupport. It would be our intention to provide support when operationally possible.

A6.6.2 Ecology

The Rivers Hiz and Oughton are groundwater fed chalk streams located within the Ouse catchment on the northern edge of Hertfordshire. As a chalk stream it contributes significantly to the biodiversity of the region and has a high conservation and amenity value.

There are no wetland SSSI's or Habitats Directive Sites along the course of the Upper Hiz and Oughton but there are a number of sites of local importance (County Wildlife Sites) associated with the River. These include Well Head, Charlton Mill Pond, Priory Park, Dog Kennel Farm Meadows and Oughton Head Common.

Habitat availability has found to be an important factor in the distribution of macroinvertebrate species chalk streams. Reaches of channel modification (resectioning and poaching) are thought to be significant in the presence of macroinvertebrates. Under the WFD classification the River Hiz is classified as heavily modified in 'moderate' status. In terms of fish, the Hiz is classified as 'poor (very certain' and in terms of invertebrates as 'Bad (very certain)'The mitigation measures in place include channel maintenance strategies, minimising disturbance to channel bed and margins, developing and devising sediment management strategies, channel alterations for retention of marginal aquatic and riparian habitats, invasive species management and appropriate techniques and timing of vegetation control.

A6.6.3 Impact of Cessation of River Support

Low flows diminish the habitat suitable for certain chalk stream species. A reduction in flow volume and velocity lessens the ability of a river to wash sediment from the gravel. The resulting siltation can lead to invasion by non-aquatic species, and smothering of gravel spawning grounds for salmonids (Jacobs, 2006). Increased temperatures are also associated with low flows particularly during summer months. This has been shown to reduce dissolved oxygen levels for fish and invertebrate species and weaken the endurance of fish. Such factors, collectively, fundamentally change the Chalk stream characteristics.

Reduced flows within a chalk stream typically result in a reduction in the dilution of pollutants, which in turn alters this unique chemistry. The impact of low flows on both water quality and ecology are closely linked.

A6.6.4 Baseline Monitoring

Flow is measured on the Hiz at Hitchin (TL185 290) by the EA, Figure 1. Water levels in Charlton Mill Pond are monitored by AW daily using a water level logger and the gauge board is read by the EA monthly. Water levels at Oughton Head are also monitored by the EA monthly along with groundwater levels in a number of observation boreholes in the area.

Figure A6.6.1 Flow in the Hiz at Hitchin 1980-2012

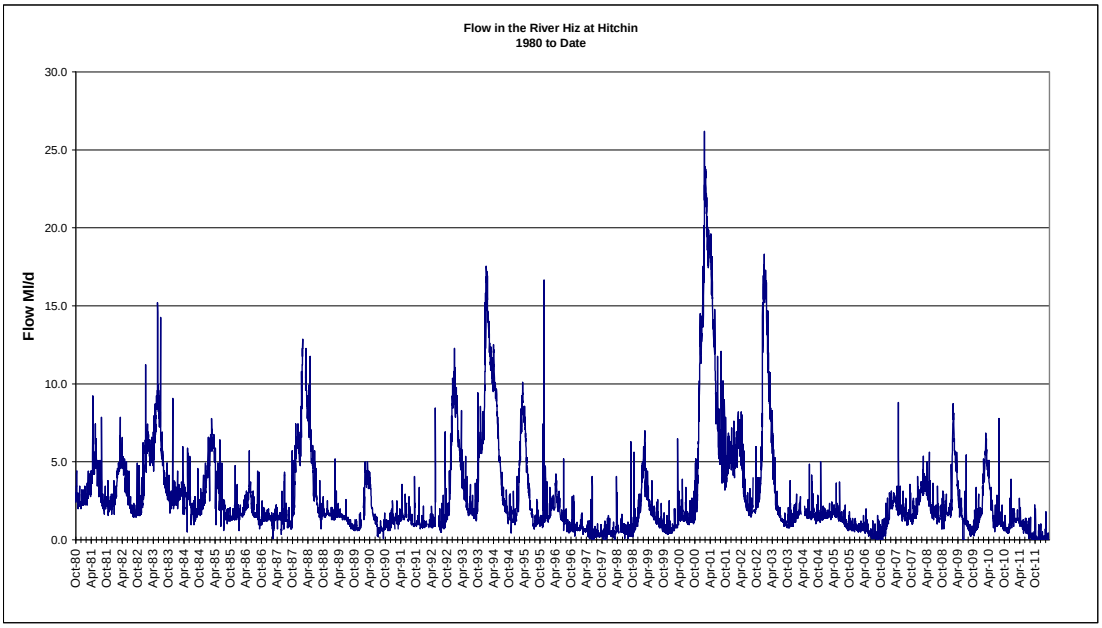


Figure A6.6.2 Water levels in Charlton Mill Pond

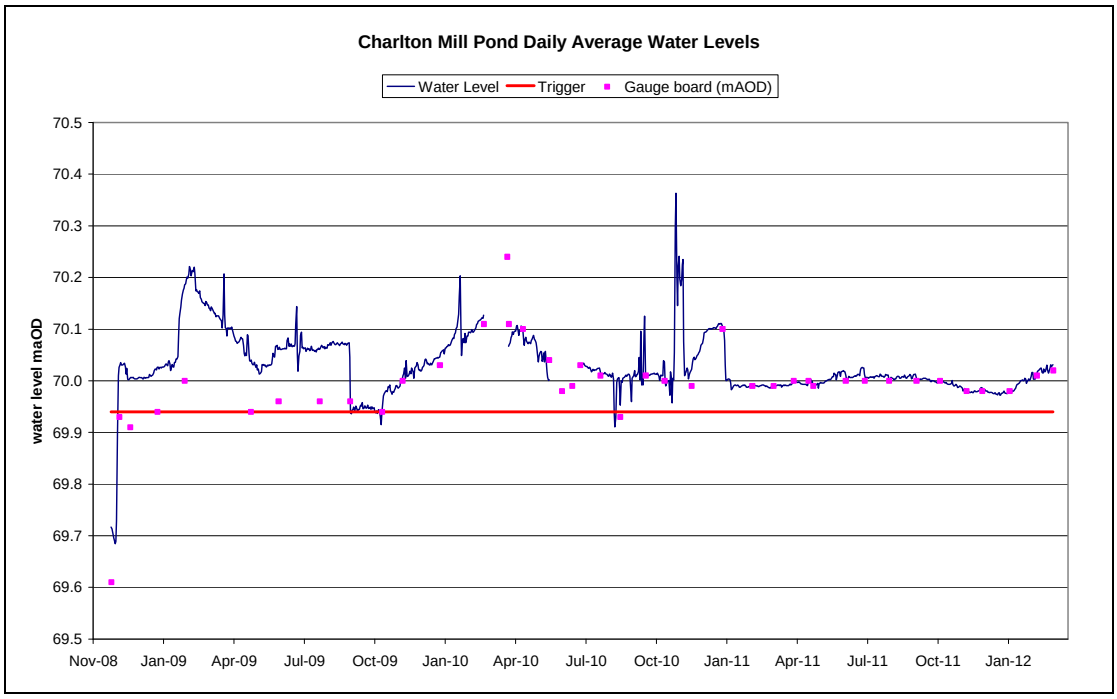
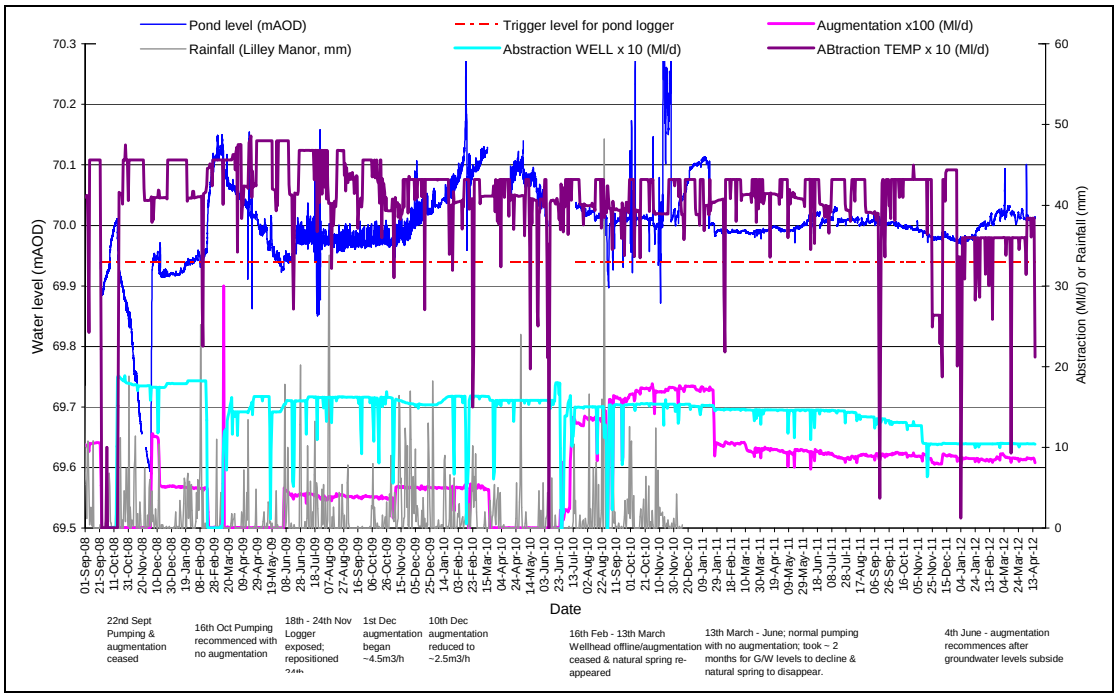


Figure A6.6.3 Abstraction and augmentation levels from WELL



The trigger levels are heavily monitored for augmentation reasons. Table 1 outlines the level of river support provided by the three abstraction point to the Hiz and the Oughton from 1997 until 2011.

Table A6.6.1 Annual river support volumes (Ml/y)

Year	WELL to Pond	OFFS to River	OUGH to River
1997	98.07	136.79	0.00
1998	26.75	137.10	0.00
1999	46.21	33.49	5.69
2000	66.43	0.00	3.34
2001	8.76	0.00	0.00
2002	24.56	0.00	0.00
2003	28.45	0.00	0.00
2004	80.33	0.00	0.00
2005	118.01	3.82	0.00
2006	28.85	11.63	0.00
2007	37.79	0.00	0.48
2008	29.79	0.00	0.73
2009	11.70	0.00	0.00
2010	30.89	0.00	0.00
2011	32.61	0.00	0.00

A6.6.5 Additional Monitoring

Monitoring for the Hiz will start in Drought Zone 3. The monitoring schedule will comprise of monthly spot gauging during Zone 3, fortnightly spot gauging during drought permit duration. If a drought provision is in place, the post drought spot gauging frequency will be fortnightly reducing to monthly, following mutual agreement with the EA. If the drought provision is not used the post drought spot gauging frequency will be monthly.

In addition, macroinvertebrate surveys will be undertaken in spring, summer and autumn at locations and frequency that will be arranged with the Environment Agency.

Walk-over surveys are necessary for the characterisation of the state of the river during Drought Zone 2. The walk-over survey will be preferably undertaken by both EA and AW, subject to mutual agreement. The objective of the surveys will be the identification of reaches under stress, so that a more detailed Environmental Impact Assessment can be completed at the time and immediate mitigation measurements can be implemented, such as fish rescues and debris/obstruction removal. The ideal period for the walk-by surveys is spring, subject to the timing of drought (Zone 2 to coincide with spring) and weather conditions.

Fisheries surveys are not planned to be undertaken specifically as part of the drought provision process. However, walk-over surveys will assist in assessment of the impact of drought on fish populations and the location of potential fish rescue sites.

Groundwater levels are monitored by the EA at 4 locations on a monthly basis. EA monitor monthly surface water levels at Charlton Mill Pond and AW have a level logger installed in the pond.

Table A6.6.2 River Hiz Drought Monitoring

Data	Description	Normal Frequency	Drought Zone 3 Frequency	Drought Zone 4/Drought Permit Frequency	Post Drought Frequency
Groundwater Level	TL12/128A BGS CH1 Well Head TL12/133 Bath Springs New TL12/135 Bath Springs New TL12/089 Bath Springs New	Monthly (EA)	Monthly (EA)	Monthly (EA)	Monthly (EA)
Gauged River Flows	Hiz at Hitchin Hiz at Arlesey	Daily (EA)	Daily (EA)	Daily (EA)	Daily (EA)
Spot Gauging	Hiz at Well Head Hiz at Charlton Hiz at Priory Park	Ad hoc (EA)	Monthly (AW, subject to agreement)	Fortnightly/weekly (AW, subject to agreement)	Monthly (AW, subject to agreement)
Surface Water Level	Charlton Mill Pond Windmill Pub Pond Charlton Oughtonhead	Monthly (EA), 2-hourly (AW) Monthly (EA) Monthly (EA)	Monthly (EA) 2-hourly (AW) Monthly (EA) Monthly (EA)	Monthly (EA) 2-hourly (AW) Monthly (EA) Monthly (EA)	Monthly (EA) 2-hourly (AW) Monthly (EA) Monthly (EA)
Macro-invertebrates	tbc	tbc	Walk-over Surveys	Walk-over Surveys	Walk-over Surveys

A6.6.6 Mitigation Measures

Our mitigation plans include actions before, during and after the drought. The major mitigation measures before the drought involve river restoration options, the measures during the drought ecological, hydrological and water quality monitoring and after the drought actions to enhance habitat recovery.

Following the walk-over surveys the critical sites identified will be looked at into detail in order to apply the mitigation measures required for the purpose of fish easement. Following the 2012 Drought experience, suggestions will be put forward for river restoration option at the critical sites, such as weir structure surveys and removals. In the cases that fish easement cannot be achieved, fish rescues of the populations under stress will be conducted. The ideal relocation places would be in the same river body further downstream at suitable locations identified during the walk-over surveys. In the event that downstream locations are not accessible or are deemed inappropriate due to low flows or adverse conditions, the fish will be relocated to different water bodies with

similar quality characteristics. In this case, health checks of the relocated fish are necessary in order to ensure good health of the fish. After the end of the drought, the water body will be restocked. The restocking will be required to be completed with a range of species and sizes, in order to ensure that the angling activity is not impacted and a balanced fish population is maintained.

After the event of the drought, additional walk-over surveys will take place in order to identify macrophyte species that suffered in the upstream reaches but are in a good status in the downstream reaches. Following the identification of these species, replanting of populations from the downstream reaches to the upstream reaches will be considered in order to ensure species recovery along the length of the river.

Following the end of the drought and the cessation of need for additional abstraction, the options of abstraction for augmentation or partial/full cessation of abstraction from the catchment reaches that have been more affected will be considered. This will aid the recovery of the natural flows into the river, which will ultimately reduce the time of the river remaining dry.

In the event that the River Hiz Drought Permit are utilised through cessation of augmentation of up to 1.3Ml/d, the full volume of augmentation will be turned back on at the end of the period that the Permit is required. This will aid the flows in the River Hiz and will assist in habitat and ecology recovery.

A6.6.7 Conclusion

Physical diversity of substrate type, a range of flow types and macroinvertebrate types are key factors in providing habitat for invertebrate (and hence fish and birds). It is likely that a reduction in river flow will increase siltation rates, increase temperature, reduce dissolved oxygen. The status of the river is expected to deteriorate temporarily with cessation of the augmentation.

Table A6.6.3 Summary of Environmental Impact of Drought Permit on the River Hiz

Option Implementation Assessment	Option Name	Hiz/Oughton Drought Permit
	Trigger	Zone 4 Drought Trigger and drought permits with lower environmental impact
	Deployable Output of action	Up to 1.3Ml/d
	Location	River Hiz/Oughton (WELL, OUGH/OFFL)
	Implementation timetable	Drought monitoring to start when Zone 3 trigger is breached. Discussion for lifting provisions to commence when Zone 4 trigger is breached and the applications for the permits higher on the list have been submitted
	Permissions required and constraints	Agreement of the Environment Agency is required. Relevant discussions will be frequently held with the Environment Agency. Discussions will also be held with the local interest groups, tenants of Charlton Mill Pond and local parish councils.
	Risks associated with option	The associated risks are environmental and detailed below.
Environmental Assessment	Risk to the environment	Medium
	Summary of likely environmental impacts	Delay of recovery of the dried out reaches after the drought by 1-2 months, potential extension of the dried out reaches, reduced flow velocity at dry reaches.
	Baseline information used	Quarterly river photos at 9 locations, 2 gauging stations flow records, 1 surface level loggers (AW), 4 EA monthly groundwater level monitoring locations and 3 EA surface water level monitoring locations.
	Summary of additional baseline monitoring requirements	Walk-by survey to identify affected locations, summer macroinvertebrates survey (tba), spot gauging monthly at 3 locations.
	Mitigation measures	Fish rescues, create maroinvertenrates banks for re-stocking, potential river augmentation, artificial narrowing of the channel to improve velocity, replanting of chalk stream vegetation.
	Impact on other activities	No other activities are expected to be impacted on.

A6.7 Additional Abstraction from the River Gade

Potential Environmental Impact of a Drought Permit at HUNT on the Flow and Ecology of the River Gade

Drought Permit/Order Source(s): HUNT

Potential Additional Water Available: 2.91Ml/d

Potential Reduction in River Support: 0Ml/d

Statutory Designated Sites: None

A6.7.1 Background

The River Gade is a groundwater fed chalk stream and a tributary of the Hertfordshire River Colne. Low flows occur during periods of low groundwater levels in the upper reach of the River and these have been investigated through the National Environment Programme. The middle and lower reaches of the Gade are hydrologicallly complex running in parallel and interconnected with the Grand Union Canal. These historic channel modifications have altered the natural course of the River Gade and significantly influence flow accretion in the HUNT reach of the river. The main focus of low flow concerns in the Gade have to date been limited to the upper reaches, upstream of the Bulbourne confluence and Grand Union Canal.

The Upper Gade was identified in the Environment Agency's Restoring Sustainable Abstraction Programme (RSAP) as a catchment impacted by licensed public water supply abstraction. Work was undertaken in AMP3 and AMP4 by AW and the EA to quantify the impact of our abstraction on river flows and identify options to improve the River's resilience to low flows. The primary objective of this study was to assess the size, location and operation of 30 weirs in the Upper Gade and to take spring and autumn macroinvertebrate samples at two sites upstream of Hemel Hempstead town centre. The removal of a number of weirs would allow a more natural watercourse to develop. This, along with channel narrowing would facilitate faster flowing water and allow the gravel bed typical of chalk streams to develop. In order to improve flows in the river under drought conditions a number of options were identified. including weir modification and channel re-profiling works, in order to achieve an improved hydrological regime at times of low flow.

A drought permit will be required to lift Schedule I of the GADD Group Licence under severe drought conditions, when we are in Drought Zone 4 and facing unprecedented water levels.

Schedule I requires that

> *When flow in the River Gade as measure at Croxley Green is less than 32,000m3 per day (32Ml/d) for five consecutive days, the quantities of water abstracted from HUNT shall not exceed 9,092m3/day (9.09Ml/d).*

HUNT is not currently capable of supplying its full licensed volume (12Ml/d) therefore if this is required during drought conditions additional engineering work would need to be put in place.

A6.7.2 Ecology

The River Gade is a chalk stream and therefore an important habitat and potentially home to a number of biodiversity action plan species. As a chalk stream it contributes significantly to the biodiversity of the region and has a high conservation value, as well as providing amenity value. The macroinvertebrates are a good indicator of the health of a river in as much as the presence of certain species such as caddis-flies and stoneflies indicate good quality and flow conditions prevail. The Environment Agency's Lotic-Invertebrate Index for Flow Evaluation (LIFE) score system has been developed as an indicator of optimum flow conditions whereby each species (or family) is designated a flow class and the abundance found in the species along with the flow class are used to calculate the LIFE score the inference being that the higher the score the better the flow conditions.

As part of the Upper Gade investigations and options appraisal two sets of macroinvertebrates samples, one in spring and one in autumn, were taken at two locations in Gadebridge Park, Hemel. These samples were then identified to species level and the LIFE scores calculated.

Figure A6.7.1 Upper Gade Life Scores

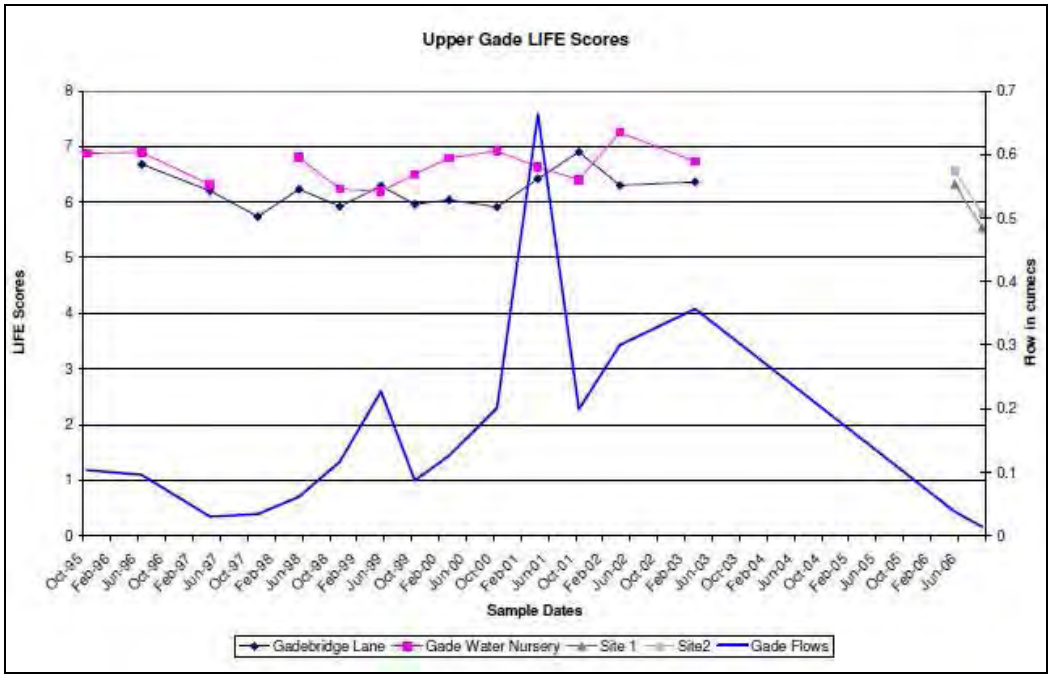


Table A6.7.1 Macroinvertebrate LIFE Scores

Date	Gadebridge Lane	Gade Water Nursery	Gade Flow (m^3/sec)
18/10/1996	-	6.88	0.103
21/06/1996	6.68	6.89	0.096
14/04/1997	6.2	6.31	0.03
27/11/1997	5.74	-	0.034
29/05/1998	6.23	6.8	0.061
04/11/1998	5.92	6.24	0.116
12/05/1999	6.29	6.19	0.227
27/10/1999	5.9	6.5	0.087
13/03/2000	6.04	6.79	0.126
10/10/2000	5.91	6.92	0.201
18/04/2001	6.42	6.63	0.663
10/10/2001	6.9	6.4	0.199
08/04/2002	6.3	7.25	0.3
26/03/2003	6.36	6.73	0.357
	Site 1	Site 2	
05/05/2006	6.32	6.56	0.038
25/09/2006	5.53	5.8	0.014

The River Gade is split into 6 different 'Reaches', each reach containing a number of weirs in a geographical area, following on from the previous one in a down-stream order. In this way restoration suggestions can cover several weir structures at once and encompass a holistic approach for river stretches of a similar general nature, rather than dealing with each structure independently of others nearby.

Table A6.7.2 Designated 'reaches' of the River Gade

Reach No	NGR (Top to Bottom)	Description
1	TL 02901160 to 03251093	Great Gaddesden area (Weirs 1 to 6)
2	TL 03251093 to 04101012	Water End area (Weirs 7 to 11)
3	TL 04101012 to 05400778	Piccotts End and Gadebridge Park (Weirs 13 to 20)
4	TL 05400778 to 05400723	College Grounds (Weirs 21 to 25)
5	TL 05400723 to 05450656	Water Gardens (Weirs 26 to29)
6	TL 0545-656 to 05450602	Moor End Road to Grand Union Canal

In terms of habitat improvements, it would be difficult to remove these fisheries impoundments without significant loss to the angling clubs and without causing major localised ecological changes.

However, there are a number of river reaches in between and areas in the lower reaches where some less significant weirs could be removed and more natural stream flows and habitats could be reinstated.

Under the 2009 WFD classification, the River Gade from the confluence with the Bulbourne to the confluence with the Chess is classified as artificial water body in 'bad' status. In terms of fish it is classified as 'good' status and in terms of invertebrates as 'bad (very certain)'.

A6.7.3 Impact of Increased Abstraction

The River Gade is an ephemeral chalk stream, rising from springs near Hudnall Corner (TL012139) and flowing through Hemel Hempstead before its natural course is intercepted by the Grand Union Canal. The River Gade's upper reaches above Great Gaddesden are dry throughout the summer months and flow only during periods of high groundwater levels.

AMP3 and 4 investigations show the perennial head of the river to be at Nettleden Road, with flows increasing towards the village of Piccotts End. There is then a decline in flows to Bury Mill, and in low flows, the river dries below the diversion weir through the Water Gardens in Hemel Hempstead town centre. Water enters the flood alleviation culvert via the diversion weir, even in low flows, to the detriment of the downstream river. HEC-RAS modelling has shown that the Bury Mill diversion weir can be raised by 0.15m without causing major flooding whilst keeping flow within the main channel at other times, which will extend the volume of flow through the Water Gardens and further downstream. As a drought mitigation measure we will ensure that the diversion at Bury Mill is clear and operating properly to maintain this extra flow in the main river. Recommendations were made for other weir structures along the river.

It is expected that under Drought Zone 4 the upper reaches of the Gade would be naturally dry due to the river's winterbourne nature. Therefore, it is believed that increased groundwater abstraction from HUNT would not impact flows in the sensitive upper reaches as they are approximately 6km north of the site. There is very little of the original course of the River Gade present in the HUNT part of the catchment due to the interconnection with the Grand Union Canal (GUC). There is an old mill stream running through the site flows in which are regulated by a weir off the GUC. Impacts on flows in the River in the vicinity are thought to be minimal.

A reduction in river flow because of increased abstraction at HUNT could increase siltation rates, increase temperature and reduce dissolved oxygen in the Mill Stream and downstream reaches of the Gade. It is also possible that fish populations may become isolated particularly if river levels fall below the crest of the various weirs and sluices located on the interconnections between the Gade and GUC. It is therefore possible that the fish classification in the Gade will temporarily deteriorate.

A6.7.4 Baseline Monitoring

The River Gade is regularly monitored by the Environment Agency. The EA monitor several boreholes and wells in the River Gade catchment on a monthly basis and have done so since 1974, the data is presented in the graphs below. Additional monitoring has been undertaken on the Upper Gade for the AMP3 and AMP4, including spot gauging at 9 locations and spring and autumn macroinvertebrate samples. Further spot gauging is undertaken four times a year on the Mill Stream at HUNT as part of routine operational monitoring at the site.

All the current and historic information will be used as baseline for the pre-application process, including all the ecological information collected during the various surveys outlined in the Ecology section.

There are two permanent EA flow gauging stations on the Gade, at Bury Mill and at Croxley Green, which record daily river flows (Figures A6.7.2 and A6.7.2).

Figure A6.7.2 River Gade at Bury Mill

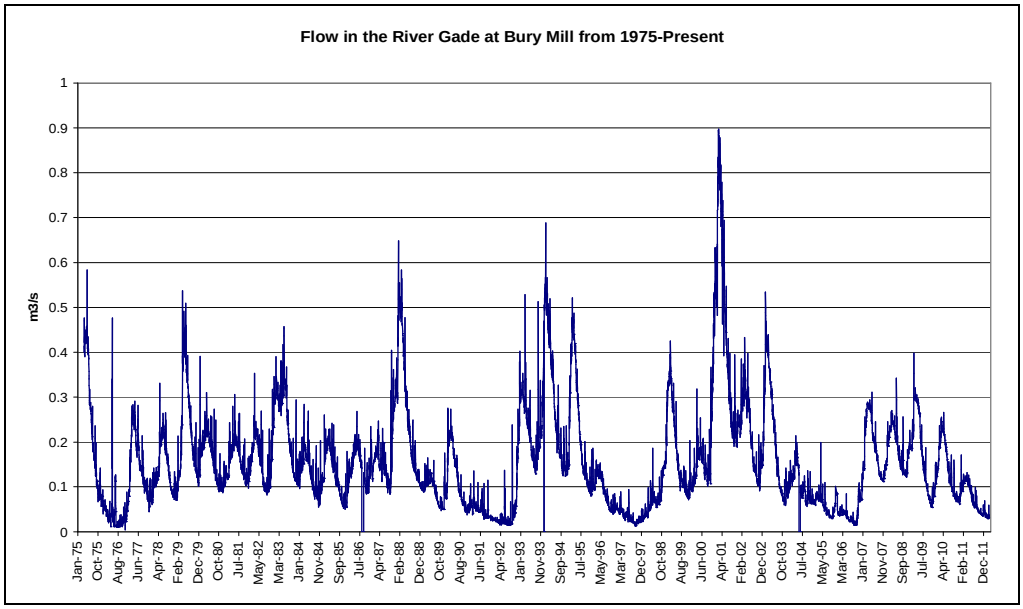
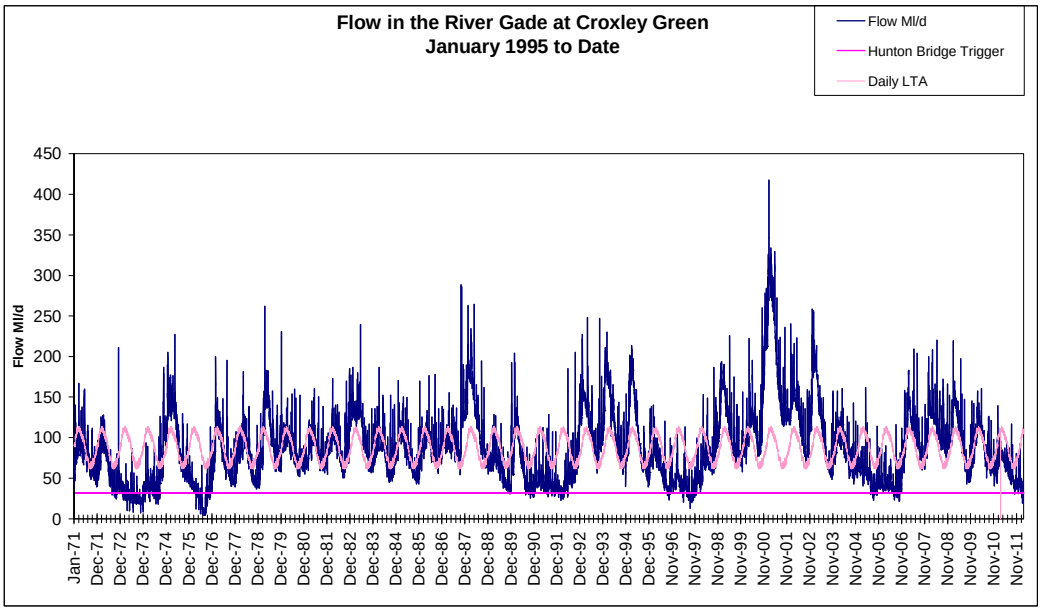


Figure A6.7.2 River Gade at Coxley Green



The cyclic pattern of high flows in the spring period and recession through the summer and autumn can clearly be seen, demonstrating the importance of autumn/winter recharge and thus groundwater base flows throughout this period. Flows in the Gade at Croxley Green have fallen below the HUNT licence trigger during all of the major drought periods but have recovered quickly at the end of the drought.

Due to the complex hydrology of the middle and lower Gade owing to the significant historic channel modifications associated with the GUC, any impact on flows associated with an increase in abstraction from HUNT would be difficult to detect. There is a significant volume of water present within the various channels and Canal in the lower catchment and it is therefore unlikely the river

would dry out in this area. However, flows may be reduced for a longer period 1-2 months as a result of the increased abstraction.

A6.7.5 Additional Monitoring

Monitoring for the Gade will start late in Drought Zone 3 as it is not one of the top priority sites with environmental provisions to be lifted. The monitoring schedule will be discussed and arranged with the Environment Agency and British Waterways. It is possible to monitor the flows at the Mill Stream and downstream of Cassionbury Park. However, it is expected that the flows will be heavily regulated by the sluices and the connections with the Grand Union Canal.

Walk-by surveys are necessary for the characterisation of the state of the river during Drought Zone 2. The walk-by survey will be preferably undertaken by both EA and AW, subject to mutual agreement. The objective of the surveys will be the identification of reaches under stress, so that a more detailed Environmental Impact Assessment can be completed at the time and immediate mitigation measurements can be implemented, such as fish rescues and debris/obstruction removal. The ideal period for the walk-by surveys is spring, subject to the timing of drought (Zone 2 to coincide with spring) and weather conditions.

Fisheries surveys are not planned to be undertaken specifically as part of the permit pre-application process. However, walk-by surveys will assist in assessment of the impact of drought on fish populations.

A6.7.6 Mitigation Measures

Our mitigation plans include actions before, during and after the drought. The major mitigation measures before the drought involve river restoration options, the measures during the drought ecological, hydrological and water quality monitoring and after the drought actions to enhance habitat recovery.

Following the walk-over surveys the critical sites identified will be looked at into detail in order to apply the mitigation measures required for the purpose of fish easement. Following the 2012 Drought experience, suggestions will be put forward for river restoration option at the critical sites, such as weir structure surveys and removals. In the cases that fish easement cannot be achieved, fish rescues of the populations under stress will be conducted. The ideal relocation places would be in the same river body further downstream at suitable locations identified during the walk-over surveys. In the event that downstream locations are not accessible or are deemed inappropriate due to low flows or adverse conditions, the fish will be relocated to different water bodies with similar quality characteristics. In this case, health checks of the relocated fish are necessary in order to ensure good health of the fish. After the end of the drought, the water body will be restocked. The restocking will be required to be completed with a range of species and sizes, in order to ensure that the angling activity is not impacted and a balanced fish population is maintained.

After the event of the drought, additional walk-over surveys will take place in order to identify macrophyte species that suffered in the upstream reaches but are in a good status in the downstream reaches. Following the identification of these species, replanting of populations from the downstream reaches to the upstream reaches will be considered in order to ensure species recovery along the length of the river.

Following the end of the drought and the cessation of need for additional abstraction, the options of abstraction for augmentation or partial/full cessation of abstraction from the catchment reaches that have been more affected will be considered. This will aid the recovery of the natural flows into the river, which will ultimately reduce the time of the river remaining dry.

It needs to be noted that there is not treatment capability on the HUNT site to utilise the additional volumes that the Drought Permit would make available. Therefore, additional investment will be

required before the Drought Permit application. This makes the Permit of low priority and highly unlikely to be used, unless the drought situation turns critical to the point of emergency.

A6.7.7 Conclusion

It is likely that if drought conditions were severe enough to require us to apply for a drought permit the Upper Gade would already be dry over a significant length. Increasing abstraction from the catchment would therefore not have any immediate impact on river flows but would delay the recovery of flows following the drought by ~1-2months. The velocity of the river flow might also be affected. Potential mitigation measurements could include aeration, fish rescues, augmentation of the river flows from the additional abstracted volumes, replanting of chalk stream vegetation, post-drought restocking and channel narrowing.

Table A6.7.3 Summary of Environmental Impact of Drought Permit on the River Gade

Option Implementation Assessment	Option Name	Gade Operating Agreement Drought Permit
	Trigger	Zone 4 Drought Trigger and drought permits with lower environmental impact
	Deployable Output of action	2.91Ml/d
	Location	River Gade
	Implementation timetable	Pre-application monitoring to start when Zone 3 trigger is breached. Application to be submitted after Zone 4 trigger is breached and the applications for the permits higher on the list have been submitted
	Permissions required and constraints	Permission from the Environment Agency is required. Pre-application discussions will be frequently held with the Environment Agency. Discussions will also be held with and Local and Parish Councils and British Waterways. A public hearing might be required, should objections are received.
	Risks associated with option	The associated risks are environmental and detailed below.
Environmental Assessment	Risk to the environment	Medium/Low
	Summary of likely environmental impacts	Reduced flow and velocity in the river and possibly in the Canal. Temporary deterioration in fish status
	Baseline information used	Quarterly river photos at 5 locations, 2 gauging stations flow records, one spot gauging location quarterly.
	Summary of additional baseline monitoring requirements	Walk-over surveys, potential additional spot gauging (frequency and locations)
	Mitigation measures	Weir removal/lowering, coordinated operation of sluices as required, potential river augmentation from the additional abstracted volumes, artificial narrowing of the channel to improve velocity, replanting of chalk stream vegetation
	Impact on other activities	No other activities are expected to be impacted on

APPENDIX 7 GLOSSARY OF TERMS

Abstraction	The removal of water from any source, either permanently or temporarily.
Abstraction Licence	The authorisation granted by the Environment Agency to allow the removal of water from a source
ACORN	A classification of Residential Neighbourhoods (ACORN) is a socio-demographic classification of neighbourhoods published by CACI Ltd. The system is based on the assumption that people who live in similar neighbourhoods are likely to have similar behavioural and consumption habits.
ALF	Alleviation of Low Flow. Predecessor to the Restoring Sustainable Abstraction (RSA) Programme looking at the impact of public water supply abstraction on low river flows.
Allowable Outage	The outage (calculated from legitimate unplanned and planned events) which affects the water available for use. An outage allowance may be made for such outages.
AMP	Asset Management Plan which identifies a company's future 5 year investment strategy.
AMP2	Asset Management Plan for period 1995-2000.
AMP3	Asset Management Plan for period 2000-2005.
AMP4	Asset Management Plan for period 2005-20010.
Annual average	The total demand in a year, divided by the number of days in the year**.**
Annual billing run	Sending out yearly bills for the measured and unmeasured consumption.
Aquifer	A water bearing rock used for water supply via wells, boreholes and springs.

Available headroom	The difference (in ML/d or %) between water available for use (WAFU), including imported water, and demand at any given point in time.
Average day demand in peak week (ADPW)	One seventh of total demand in the peak week in any 12 month demand period.
Average incremental cost (AIC)	A method of calculating the net present value of additional water delivered or reduced demand.
Average incremental social costs (AISC)	A method of calculating unit benefit of new supply or demand options including social and environmental costs. This is net present value of additional water delivered or reduced demand.
Baseline Forecast	A demand forecast which reflects a company's current demand management policy but which should assume the swiftest possible achievement of the current agreed target for leakage during the forecast duration, as well as implementation of the company water efficiency plan.
CAMS	Catchment Abstraction Management Strategy. Environment Agency strategy which sets out the new licensing policy for catchments throughout England and Wales.
Capital investment	Spending by firms on capital equipment. This includes spending on machinery, equipment and buildings.
Catchment	An area from which a source takes raw water.
Catchment Protection	Policies and actions to minimise pollution within the catchment.
Carbon Footprint	The amount of carbon dioxide (tonnes) emitted as a result of actions and processes undertaken by the company.
Change of Ownership Metering	Compulsive metering of consumption following a change of occupier providing there isn't already a meter at the property.
Communication Pipe	The part of a service pipe which is vested in the water supplier.
Consumption Monitor	A sample of properties whose consumption is Monitored in order to provide information on the consumption and behaviour of properties served by a company. Applied to household and non-household customers.
COPI	Construction Outputs Price Index. The rate of inflation that applies to a basket of construction prices over a period of time.
Critical Period	The period of time during which the customer experiences the greatest risk of loss of supply.

Crystal ball ®	Commercially available software which undertakes complex statistical analysis such as Monte Carlo analysis.
Demand Management	A sample of properties whose consumption is monitored in the implementation of policies or measures which serve to control or influence the consumption or waste of water (this definition can be applied at any point along the chain of supply).
Deployable Output	The output of a commissioned source or group of sources or of a bulk supply as constrained by(if applicable): • Environment • Licence, if applicable • Pumping plant and/or well/aquifer properties • Raw water mains and/or aquifers • Transfer and/or output main • Treatment • Water Quality
Distribution Input (DI)	The amount of treated water entering the distribution system at the point of production.
Distribution losses	Total leakage on the distribution system minus supply pipe leakage and is made up of losses on trunk mains, service reservoirs, distribution mains and communication pipes.
Distribution System (DSOU) Operation use	Water knowingly used by a company to meet its statutory obligations particularly those relating to water quality Examples include mains flushing and air scouring.
Drought	Period of low rainfall which particularly impacts levels of ground water recharge in the winter period and river flows and demand patterns in the summer months.
Drought management Plan	Statutory plans to manage supplies during a drought period.
Drought order	An authorisation granted by the Secretary of State under drought conditions, which imposes restrictions upon the use of water and/or allows for abstraction/impoundment outside the schedule of existing licences on a temporary basis.
Drought permit	An authorisation granted by the Environment Agency under drought conditions, which allows for abstraction/impoundment outside the schedule of existing licences on a temporary basis.
Drought threshold levels	A ground water level or river flow which is used to restrict raw water available from sources.
Drought Zone	4 zones based on groundwater level for the severity of the Drought 1 being lowest and 4 being the most severe drought since records began.
Dry year	A year of rainfall below long term average and is characterised with high summer temperatures and high demand.
Dry year Annual Average Unrestricted daily Demand	The average amount of water supplied in a dry year made up of the level of demand, which is just equal to the maximum annual average, which can be met at anytime during the year without introduction of demand restrictions. This should be based on a continuation of

	current demand management policies.
Economic Level of Leakage	The level of leakage where the cost associated with reducing leakage further is higher than the cost of putting more water into supply. This can be calculated both on a short and long term basis and is calculated in Ml/d.
Environment Agency	The government agency's main statutory body with responsibility for licensing abstraction, consenting discharge in addition to advising on environmental and flood risk management policy, and setting and enforcing environmental standards in England and Wales.
Environmental Impact Assessment	Requirement under Directive 85/377 EEC (as amended by Directive 97/11/EC) to carry out an assessment of the likely significant effects of a proposed development on the environment before consent is granted. EIA must be carried out in accordance with the Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999.
Environmental Statement	This explains the environmental issues identified as being important to a particular project under consideration as well as what the environment is like now, and how it might change as a result of the project. Consideration must be given to the alternatives that have been looked at and the ways in which the significant affects the project is likely to have may be avoided, reduced or addressed.
Feasibility Studies	An investigation into the viability of a plan to meet a particular need.
Final planning demand forecast	A demand forecast, which reflects a company's preferred policy for managing demand and leakage through the planning period, after taking account of all options through full economic analysis.
Final planning scenario	A companies preferred scenario for water available for use taking into account demand and headroom. It constitutes the best estimate for planning purposes, consistent with information provided to Ofwat for the periodic review to secure water supply.
Forecasts/Plan Horizon	The end date of demand forecast or water resources plan (for example, 2035).
Groundwater	An important part of the natural water cycle present underground, within strata known as aquifers.
Group Licence	Restrictions placed on a number of licenses to constrain the total output from the group.
Habitats Directives	A collective term for Birds Directive 79/409/EEC on the conservation of wild birds and Habitats Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora.
Habitats Directives Schemes	Programmes to assess and implement works in order to mitigate the impacts of abstraction on designated sites under the Habitats Directive.
Headroom	Minimum buffer that a prudent water company should allow to cater for uncertainties in specified components of the supply-demand balance forecast.

Hydraulic Demand Zone (HDZ)	Hydraulic area made up of district metered areas (DMAs) and unmetered areas or passive zones used for operational and planning purposes same as Water Demand Zone.
Hydrographs	Plots of water levels against time
Leakage Control	Control of the sum of distribution losses (on trunk mains, service reservoirs, distribution mains and communication pipes) and underground supply pipe losses (between the point of delivery at a property and the point of consumption).
Local Plan	Development plan prepared by district and other local planning authorities.
Local Planning Authority	Authority with responsibility for planning regulation and development control.
Maximum likelihood estimation (MLE)	A statistical technique where a reconciliation item is distributed to the largest and least certain components of an estimate of the magnitude of a variable. The technique can be applied to a reconciliation of a water balance.
Mega litres Per Day	(Ml/d) One mega litre equals one million litres (1,000 cubic metres) per day.
Meter Optants	Properties where a meter is voluntarily installed at the request of its occupants.
Micro –component analysis	The process of a deriving estimates of future consumption based on expected changes in the individual components of customer use.
Mitigation	The alteration of proposals to address specific concerns in order to achieve environmental, social or economic improvement
Monte Carlo Analysis	A statistical evaluation technique which obtains a probabilistic approximation to the solution of a problem by using statistical sampling techniques.
Net Present Value	The difference between the discounted sum of all of the benefits arising from a project and the discounted sum of all the costs arising from the project. Put simply it is the economic value of a project, at today's prices, calculated by netting off its discounted cash flow from revenues and costs over its full life.
Non-households	Properties receiving potable supplies that are not occupied as domestic premises, for example, factories, offices and commercial premises.
Normalisation Factor	A factor applied to bring the sum of all individual probabilities of an occurrence for an event to equal one.
Normal Year	An average year of rainfall and demand patterns.
Normal year annual average daily demand	The total demand in the year with normal or average weather patterns, divided by the number of days in the year.
Operating Costs	Routine operating expenses comprising day to day (both planned and unplanned) costs, such as wages, power, materials and transport.
Outage	A temporary loss (less than 3 months) of deployable output. Outage can be as a result of power loss, pollution events and others.

PCC	(Per Capita Consumption) Amount of water consumed per person, it can be unmeasured (uPCC) or measured.
Point of abstraction	The top of a borehole for ground water abstraction; the river intake for surface water abstraction to direct supply or bank side storage; the draw – off tower for a direct supply reservoir.
Point of Consumption	The point where the supply pipe rises above ground level within the property, usually inside the stopcock or an internal meter.
Point of delivery	The point at which water is transferred from mains or pipes, which are vested in the water supplier into, pipes which are the responsibility of the customer. In practice this is usually the outside stopcock, boundary box or external meter.
Point of Production	The point where treated water enters the distribution system.
Potable Water Produced	Raw water abstracted less treatment works operational use and treatment losses.
Potable Water Exported	Potable water exports from within a defined geographical area to an area outside that defined geographical area.
Potable Water Imported	Imports of potable water from outside a defined geographical area to a defined geographical area.
"Pull" System	A system of control on pump operation based on reservoir levels.
Potential Yield (PY)	Maximum output from a source or group of sources constrained only by well and/or aquifer properties for specified conditions.
Raw Water	Water taken from rivers, ground water or reservoirs prior to treatment.
Raw water abstracted	Raw water abstracted at the point where abstraction charges are levied. It is made up of raw water retained and raw water exported.
Raw water collected	Raw water retained plus raw water imported.
Raw Water exported	Raw water exported from a specific geographical
Raw Water Imported	Raw water imported from outside of a specified geographical area.
Raw Water Losses	The net loss of water to the resource system comprised of mains/aqueduct (pressure system) losses, open channel/very low pressure system losses, and losses from break-pressure tanks and small reservoirs.
Raw water operational use	Regular washing-out of mains due to sediment build-up and poor quality of source water.
Resultant Deployable Output (RDO)	The final deployable output allowing for constraints and share of group licenses which might be different to the volume on the license.
Reconciliation item	The difference between the estimates of the magnitude of a variable and the sum of the estimates of the individual components of that variable.

Regional Planning Authority	Prepares, monitors and reviews the regional planning guidance for its region. In every English region this now the regional assembly.
Regional Spatial Strategy	Statutory regional spatial strategies will replace non-statutory regional planning guidance notes produced for each English region. Regional spatial strategies will be part of the development plan. As a consequence, they are likely to be more detailed and will carry much more weight in relation to determining planning applications. In London, the spatial development strategy prepared by the mayor forms the regional spatial strategy.
Resource Zone	The largest possible zone in which all resources, including external transfers, can be shared and hence the zones in which all customers experience the same risk of supply failure from a resource shortfall.
Rest Water Levels	Non pumping level of water in a borehole or well.
RSA Programme	Restoring Sustainable Abstraction Programme – Environment Agency led programme of investigations looking at the impact of public water supply abstraction on river flows.
Return Events	An event or occurrence with the tendency to reoccur.
Return Period	The assessed frequency of occurrence of a specified return event.
Risk	A measure of the probability and magnitude of an event and the consequences of its occurrences.
Retail Price Index (RPI)	A measure of the increase in price of a specified basket of goods each year related to a base year.
SAC	Special Area of Conservation – An area designated under Article 3 of the Habitats Directive for its high quality conservation status, making a contribution to the conservation of habitats and species listed in Annex I and II (amended).
Screening Tool	A sequence of decision-making techniques that incorporate different criteria on which to base a decision, rather than techniques based solely on, for example, financial analysis. Its main role is to deal with large amounts of complex information in a consistent way, which can otherwise create difficulties.
Soil Moisture Deficit	The volume of rain in mm required to fully saturate the soil.
Source	A named input to a resource zone. A multiple well/spring source is a named place where water is abstracted from more than one operational well/spring.
Source Scale	Factors influencing individual source works.
Source works	Combination of boreholes, wells and springs providing water to a single treatment works.

Source Reliable Output	The outcome of a source yield assessment measured as Mega litres/day and usually linked to all peak values for specified constraints (same as those for deployable output)
Source Yield Assessment	The process of understanding the volume of water that any water source can provide during a critical period. This forms the basis of deployable output.
SPA	Special Protection Area – An area classified under Article 4 of the Birds Directive
SSSI	Site of Special Scientific Interest – An area designated under the Wildlife and Countryside Act for special interest by reason of any of its flora, fauna, or geological or physiographical features.
Strategic Environmental Assessment	A process designed to ensure that significant environmental effects arising from proposed plans and programmes and reasonable alternatives are identified, assessed, subjected to public participation, taken into account by decision makers, and monitored. SEA sets the framework for future assessment of development projects some of which require Environmental Impact Assessment (EIA).
Structural Water loss	Water lost from structures such as water towers, reservoirs.
Supply-demand balance	The deficit or surplus of supply against demand taking into account risk.
Supply pipe	The service pipe which is not vested in the water supplier and is normally the length of pipe between the property boundary where the water main is laid, and any terminal fitting directly connected to it and under mains pressure e.g. taps.
Supply pipe losses	The sum of underground supply pipe losses and above ground supply pipe losses.
Sustainability	Sustainability is essentially about protecting and enhancing the environment, and careful use of natural resources whilst considering

	today's needs and those of future generations.
Sustainability Appraisal	A process which provides for the systematic identification and evaluation of the economic, social and environmental impacts of a proposal.
Sustainability criteria	A range of attributes against which to measure performance and which indicate the level of Sustainability against a project or programme proposal.
Sustainability reduction	Reductions in deployable output required by the Environment Agency to meet statutory and/or environmental requirements.
Target headroom	The threshold of minimum acceptable headroom, which would trigger the need for water management options to increase water available for use or decrease demand.
Total leakage pipe losses	The sum of distribution losses from trunk main, reservoir and underground supply pipe losses.
Treatment work losses	Includes treatment work operational use, structural water losses and any overflow water lost from structure overflows from reservoirs and drains.
Treatment work water operational use	Water used as part of the treatment process which is not taken into supply.
Underground supply pipe losses	Losses between the water supplier's pipe work and the customers tap.
UKCIP02	The Climate Impact Programme 2002 release.
UKWIR	UK Water Industry Research Ltd
Unrestricted demand	The demand for water when there are no restrictions in place for example hose pipe bans.

Void property	A property connected to the distribution network but not charged because it has no occupants.
WRMP tables	Tables used for presenting key quantitative data associated with Water Resources Management.
WAFU	**Water Available For Use.** The value calculated by deducting allowable outages and planning allowances from deployable output in a resource zone.
WATCOM	Water Consumption Monitor – a study of water consumption of unmetered consumers to evaluate how unmeasured customers utilise water.
Water Balance	A calculation of the difference between the sum of the components of water consumption and the measured Deployable Output.
Water delivered	Water delivered to the point of delivery such as the customer's tap. This includes supply pipe losses.
Water delivered billed	Water delivered less water taken unbilled. It can be split into unmeasured household, measured household, unmeasured non-household and measured non-households water delivered.
Water Demand Zone	Discrete area fed by a number of sources and reservoirs same as a Hydraulic Demand Zone.
Water Framework Directive	European Legislation promoting the efficient use of water and protecting the environment from over abstraction by restoring it to a good ecological status.
Water taken	Distribution Input minus distribution losses.
Water Resource	The volume (Ml/d) of water that the company can use to meet customer demand. It can be considered on both regional and local scales.

Water Resource Zone	The largest possible zone in which all resources, including external transfers, can be shared and hence the zones in which all customers experience the same risk of supply failure from a resource shortfall.
Water Resource Management Plan (WRMP)	Water Companies' plans for supplying water to meet demand over a 25 year period.
Water treatment works	Plant where raw potable water is treated to a standard suitable for drinking. Note this is not dealing with sewerage.
White goods and Appliances	Household appliances that utilise water such as fridges, freezers, dishwashers, washing machines.
WRc	Water Research Centre

APPENDIX 8 ORGANISATIONS AND BODIES CONSULTED

Organisation	Location
Hurley Parish Council	Hurley
Tilsworth Parish Council	Tilsworth
Northaw & Cuffley Parish Council	Northaw
Croxley Green Parish Council	Croxley Green
Watton-At-Stone Parish Council	Watton-at-Stone
Ellesborough Parish Council	Ellesborough
Great and Little Kimble Parish Council	Great and Little Kimble
Kings Walden Parish Council	Kings Walden
Gamlingay Parish Council	Gamlingay
Sawston Parish Council	Sawston
Bar Hill Parish Council	Bar Hill
Harpenden Town Council	Harpenden
Little Dunmow Parish Council	Little Dunmow
Navestock Parish Council	Navestock
Strethall Parish Council	Strethall
Roydon Parish Council	Roydon
Reed Parish Council	Reed
Little Marlow Parish Council	Little Marlow
Sundon-Parish-Council	Sundon
Abbess, Beauchamp and Berners Roding Parish Council	Abbess Roding
Blackmore, Hook End and Wyatts Green Parish Council	Wyatts Green
Manuden Parish Council	Manuden
Ayot St Peter Parish Meeting	Ayot St Peter
Seer Green Parish Council	Seer Green
Thaxted Parish Council	Thaxted
Leaden Roding Parish Council	Leaden
Marlow Town Parish Council	Marlow
Shepreth Parish Council	Shepreth
Markyate Parish Council	Markyate
Anstey Parish Council	Anstey
Doddinghurst Parish Council	Doddinghurst
Nazeing Parish Council	Nazeing
Nettleden with Potten End Parish Council	Nettleden
Aythorpe Roding Parish Council	Aythorpe Roding

Willingale Parish Council	Willingale
Little Wilbraham & Six Mile Bottom Parish Council	Little Wilbraham
Stapleford Abbotts Parish Council	Stapleford Abbotts
Great Marlow Parish Council	Great Marlow
Walkern Parish Council	Walkern
Bayford Parish Council	Bayford
Sandon Parish Council	Sandon
Longstowe Parish Council	Longstowe
Great and Little Chishill Parish Council	Great Chishill
Bartlow Parish Council	Bartlow
Wicken Bonhunt Parish Council	Wicken Bonhunt
Great Shelford Parish Council	Great Shelford
Shalford Parish Council	Shalford
Croydon Parish Council	Croydon
Foxton Parish Council	Foxton
Waltham St Lawrence Parish Council	Waltham St Lawrence
Totternhoe Parish Council	Totternhoe
Ware Town Council	Ware
Albury Parish Council	Albury
Toft Parish Council	Toft
Chigwell Parish Council	Chigwell
Stokenchurch Parish Council	Stokenchurch
Chobham Parish Council	Chobham
Elstree and Borehamwood Town Council	Elstree and Borehamwood
Shere Parish Council	Shere
High Wycombe Charter Trustees	High Wycombe
Bygrave Parish Council	Bygrave
Broxted Parish Council	Broxted
Chartridge Parish Council	Chartridge
Cholesbury-Cum-St Leonards Parish Council	Cholesbury-Cum-St Leonards
Normandy Parish Council	Normandy
Margaret Roding Parish Council	Margaret Roding
Stansted Mountfitchet Parish Council	Stansted Mountfitchet
Harpenden Rural Parish Council	Harpenden
St Michael Parish Council	St Michael
Claygate Parish Council	Claygate
Eton Town Parish Council	Eton

Arkesden Parish Council	Arkesden
West Clandon Parish Council	West Clandon
Theydon Garnon Parish Council	Theydon
Littlebury Parish Council	Littlebury
Balsham Parish Council	Balsham
Sewards End Parish Council	Sewards End
Wimbish Parish Council	Wimbish
Willingham Parish Council	Willingham
Heath Reach Parish Council	Heath Reach
Newton Parish Council	Newton
Great and Little Hampden Parish Council	Great and Little Hampden
Wigginton Parish Council	Wigginton
Debden Parish Council	Debden
Great Chesterford Parish Council	Great Chesterford
Eversdens Parish Council	Eversdens
Little Abington Parish Council	Little Abington
Meldreth Parish Council	Meldreth
Orwell Parish Council	Orwell
Milton Parish Council	Milton
Thorley Parish Council	Thorley
Puttenham Parish Council	Puttenham
Sarratt Parish Council	Sarratt
Barton Parish Council	Barton
Chipperfield Parish Council	Chipperfield
Colney Heath Parish Council	Colney Heath
East Horsley Parish Council	East Horsley
North Weald Bassett Parish Council	North Weald Bassett
Shudy Camps Parish Council	Shudy Camps
Hempstead Parish Council	Hempstead
Hauxton Parish Council	Hauxton
Aldbury Parish Council	Aldbury
Great Missenden Parish Council	Great Missenden
Lane End Parish Council	Lane End
Kings Langley Parish Council	Kings Langley
Thriplow Parish Council	Thriplow
Winkfield Parish Council	Winkfield
Wexham Court Parish Council	Wexham Court

Codicote Parish Council	Codicote
Little Hadham Parish Council	Little Hadham
Houghton Regis Parish Council	Houghton Regis
Toddington Parish Council	Toddington
Aldenham Parish Council	Aldenham
Epping Upland Parish Council	Epping
Bledlow Cum Saunderton Parish Council	Bledlow Cum Saunderton
Aston Parish Council	Aston
Kensworth Parish Council	Kensworth
Whipsnade Parish Council	Whipsnade
Hatfield Heath Parish Council	Hatfield Heath
Matching Parish Council	Matching
Welwyn Parish Council	Welwyn
Wymondley Parish Council	Wymondley
Bisley Parish Council	Bisley
Fowlmere Parish Council	Fowlmere
Ickleton Parish Council	Ickleton
Takeley Parish Council	Takeley
Chalton Parish Council	Chalton
Barton le Clay Parish Council	Barton le Clay
Ridge Parish Council	Ridge
Artington Parish Council	Artington
Flamstead Parish Council	Flamstead
Little Bardfield Parish Council	Little Bardfield
Ingatestone and Fryerning Parish Council	Ingatestone and Fryerning
Furneux Pelham Parish Council	Furneux Pelham
Great Wilbraham Parish Council	Great Wilbraham
Widdington Parish Council	Widdington
Rampton Parish Council	Rampton
Kelshall Parish Meeting	Kelshall
Bengeo Rural Parish Council	Benge
Heydon Parish Council	Heydon
Graveley Parish Council	Graveley
Barrington Parish Council	Barrington
Chesham Bois Parish Council	Chesham Bois
Knebworth Parish Council	Knebworth
Pirbright Parish Council	Pirbright

Wheathampstead Parish Council	Wheathampstead
Ashdon Parish Council	Ashdon
Penn Parish Council	Penn
Newport Parish Council	Newport
Hockliffe Parish Council	Hockliffe
Lacey Green Parish Council	Lacey Green
Longwick cum Ilmer Parish Council	Longwick cum Ilmet
Princes Risborough Town Council	Princes Risborough
Cottenham Parish Council	Cottenham
Rushden and Wallington Parish Council	Rushden and Wallington
Downley Parish Council	Downley
Brent Pelham and Meesden Parish Council	Brent Pelham and Meesden
Ibstone Parish Council	Instone
Radnage Parish Council	Radnage
Bradenham Parish Council	Bradenham
Warfield Parish Council	Warfield
Great Abington Parish Council	Great Abington
Hildersham Parish Council	Hildersha,
Sheering Parish Council	Sheering
Bracknell Town Council	Bracknell
Benington Parish Council	Benington
White Roding Parish Council	White Roding
Stanford Rivers Parish Council	Stanford
Ongar Parish Council	Ongar
Longstanton Parish Council	Longstanton
Eaton Bray Parish Council	Eaton Bray
Stapleford Tawney Parish Council	Staplefor Tawney
Wyddial Parish Meeting	Wyddial
Cox Green Parish Council	Cox Green
Kimpton Parish Council	Kimpton
Haslingfield Parish Council	Haslingfield
Wanborough Parish Council	Wanborough
Ickleford Parish Council	Ickleford
Hambleden Parish Council	Hambleden
Piddington and Wheeler End Parish Council	Piddington and Wheeler End
West Wycombe Parish Council	West Wycombe
Fyfield Parish Council	Fyfield

Colnbrook & Poyle Parish Council	Colnbrook and Poyle
Widford Parish Council	Widford
Clothall Parish Meeting	Clothall
Papworth St Agnes Parish Meeting	Papworth St Agnes
Fawley Parish Meeting	Fawley
Lolworth Parish Meeting	Lolworth
Great Amwell Parish Council	Great Amwell
Caldecote Parish Council	Caldecote
Bishops Stortford Town Council	Bishops Stortford
Brickendon Liberty Parish Council	Brickendon Liberty
Great Munden Parish Council	Great Munden
Much Hadham Parish Council	Much Hadham
Standon Parish Council	Standon
Thundridge Parish Council	Thundridge
Braughing Parish Council	Braughing
Chrishall Parish Council	Chrishall
Hertingfordbury Parish Council	Hertingfordbury
Little Berkhamsted Parish Council	Little Brekhamsted
Barnston Parish Council	Barnston
Bramfield Parish Council	Bramfield
Hadstock Parish Council	Hadstock
Quendon & Rickling Parish Council	Quendon and Rickling
Waltham Abbey Town Council	Waltham Abbey
Farnham Parish Council	Farnham
Harston Parish Council	Harston
Knapwell Parish Meeting	Knapwell
Billington Parish Council	Billington
Tring Town Council	Tring
West End Parish Council	West End
Ripley Parish Council	Ripley
Chepping Wycombe Parish Council	Chepping Wycombe
Aspenden Parish Council	Aspenden
Buckland and Chipping Parish Council	Buckland and Chipping
Buntingford Town Council	Buntingford
Radwinter Parish Council	Radwinter
Hazlemere Parish Council	Hazlemere
Northchurch Parish Council	Northchurch

Therfield Parish Council	Therfield
St Martha Parish Council	St Martha
Bovingdon Parish Council	Bovingdon
Hormead Parish Council	Hormead
Hatley Parish Council	Hartley
Weston Colville Parish Council	Weston Colville
Leighton Linslade Town Council	Leighton Linslade
Amersham Town Council	Amersham
Stanstead St Margarets Parish Council	Stanstead St Margarets
Eastwick and Gilston Parish Council	Eastwick and Gilston
Oakington & Westwick Parish Council	Oaklington and Westwick
Chenies Parish Council	Chenies
Datchet Parish Council	Datchet
Old Windsor Parish Council	Old Windsor
Henham Parish Council	Henham
Grantchester Parish Council	Grantchester
Whaddon Parish Council	Whaddon
Hatfield Town Council	Hatfield
Latimer Parish Council	Latimer
Compton Parish Council	Compton
Flaunden Parish Council	Flauden
Stocking Pelham Parish Council	Stocking Pelham
Sunninghill & Ascot Parish Council	Sunninghill and Ascot
Chalfont St Giles Parish Council	Chalfont St Giles
Hinxton Parish Council	Hinxton
Shenley Parish Council	Shenley
Horton Parish Council	Horton
Wraysbury Parish Council	Wraysbury
High Wych Parish Council	High Wych
Sunningdale Parish Council	Sunninghdale
Wendens Lofts Parish Council	Wendens Lofts
Elmdon Parish Council	Elmdon
Hyde Parish Council	Hyde
Theydon Bois Parish Council	Theydon Bois
Tewin Parish Council	Tewin
Tongham Parish Council	Tongham
Little Gaddesden Parish Council	Little Gaddesden

Melbourn Parish Council	Melbourn
East Clandon Parish Council	East Clandon
Chorleywood Parish Council	Chorleywood
High Ongar Parish Council	High Ongar
Stondon Massey Parish Council	Stondon Massey
Great Easton & Tilty Parish Council	Great Easton and Tilty
Swavesey Parish Council	Swavesey
Chalfont St Peter Parish Council	Chalfont St Peter
Hertford Heath Parish Council	Hertford Heath
Effingham Parish Council	Effingham
Kelvedon Hatch Parish Council	Kelvedon Hatch
Barkway Parish Council	Barkway
Berden Parish Council	Berden
Seale & Sands Parish Council	Seale and Sands
Letchworth Garden City Council	Letchworth Garden City
Fulbourn Parish Council	Fulbourn
Ash Parish Council	Ash
Herongate and Ingrave Parish Council	Herongate and Ingrave
Carlton cum Willingham Parish Council	Carlton cum Willingham
Little Missenden Parish Council	Little Missenden
Duxford Parish Council	Duxford
Great Sampford Parish Council	Great Sampford
Little Sampford Parish Council	Little Sampford
Tadlow (Parish Meeting) Parish Council	Tadlow
Linton Parish Council	Linton
Westmill Parish Council	Westmill
Stapleford Parish Council	Stapleford
London Colney Parish Council	London Colney
Offley Parish Council	Offley
St Paul's Walden Parish Council	St Paul's Walden
Birchanger Parish Council	Birchanger
Woolmer Green Parish Council	Woolmer Green
Horningsea Parish Council	Horningsea
Abbots Langley Parish Council	Abbots Langley
St Stephen Parish Council	St Stepehn
Ockham Parish Council	Ockham
Mountnessing Parish Council	Mountnessing

Ashwell Parish Council	Ashwell
Over Parish Council	Over
St Ippolyts Parish Council	St Ippolyts
Shackleford Parish Council	Shackleford
Windlesham Parish Council	Windlesham
Datchworth Parish Council	Datchworth
Hatfield Broad Oak Parish Council	Hatfield Broad Oak
Little Chesterford Parish Council	Little Chesterford
Marlow Bottom Parish Council	Marlow Bottom
Medmenham Parish Council	Medmenham
Teversham Parish Council	Teversham
Harlton Parish Council	Harlton
Studham-Parish-Council	Studham
Chesham Town Council	Chesham
West Wickham Parish Council	West Wickham
West Wratting Parish Council	West Wratting
Wendens Ambo Parish Council	Wendens Ambo
Hunsdon Parish Council	Hunsdon
The Lee Parish Council	The Lee
Fen Drayton Parish Council	Fen Drayton
Hexton Parish Meeting	Hexton
West Horndon Parish Council	West Horndon
Chickney Parish Council	Chickney
Wareside Town Council	Wareside
North Mymms Parish Council	North Mymms
Abington Pigotts Parish Council	Abington Pigotts
Fen Ditton Parish Council	Fen Ditton
Little Canfield Parish Council	Little Cranfield
Hedsor Parish Council	Hedsor
Lilley Parish Council	Lilley
Stanbridge Parish Council	Stanbridge
Ugley Parish Council	Ugley
Elsworth Parish Council	Elsworth
Papworth Everard Parish Council	Papworth Everard
West Horsley Parish Council	West Horsley
Whittlesford Parish Council	Whittlesford
Binfield Parish Council	Binfield

Tring Rural Parish Council	Tring
Pirton Parish Council	Pirton
Waterbeach Parish Council	Waterbeach
Sandhurst Town Council	Snadhurst
Chalgrave Parish Council	Chalgrave
Coleshill Parish Council	Coleshill
Lambourne Parish Council	Lambourne
Send Parish Council	Send
Essendon Parish Council	Essendon
Ashley Green Parish Council	Ashley Green
Wimpole Parish Council	Wimpole
Streatley-Parish-Council	Streatley
Bourn Parish Council	Bourn
Caxton Parish Council	Caxton
Comberton Parish Council	Comberton
Croxton Parish Council	Croxton
Eltisley Parish Council	Eltisley
Guilden Morden Parish Council	Guilden Morden
Hardwick Parish Council	Hardwick
Madingley Parish Council	Madingley
Kingston Parish Council	Kingston
Girton Parish Council	Girton
White Waltham Parish Council	White Waltham
Buckhurst Hill Parish Council	Buckhurst Hill
Little Gransden Parish Council	Little Gransden
Nash Mills Parish Council	Nash Mills
Crowthorne Parish Council	Crowthrone
Landbeach Parish Council	Landbeach
Ardeley Parish Council	Ardeley
Cottered Parish Council	Cottered
Little Shelford Parish Council	Little Shelford
Sawbridgeworth Town Council	Sawbridgeworth
Weston Parish Council	Weston
Britwell Parish Council	Britwell
Moreton, Bobbingworth & The Lavers Parish Council	Moreton, Bobbingworth and The Lavers
Royston Town Council	Royston
Great Hallingbury Parish Council	Great Hallingbury

Little Hallingbury Parish Council	Little Hallingbury
Stanstead Abbotts Parish Council	Stanstead Abbotts
Preston Parish Council	Preston
Hughenden Parish Council	Hughenden
Cambourne Parish Council	Cambourne
Hertford Town Council	Hertford
Dry Drayton Parish Council	Dry Drayton
Watford Rural Parish Council	Watford
Newham and Caldecote Parish Council	Newham and Cadecote
Bassingbourn-cum-Kneesworth Parish Council	Bassingbourn cum Kneesworth
Litlington Parish Council	Litlington
Steeple Morden Parish Council	Steeple Morden
Loughton Town Council	Loughton
Great Canfield Parish Council	Great Canfield
Bisham Parish Council	Bisham
Holwell Parish Council	Holwell
Shottesbrooke Parish Council	Shottesbrooke
Felsted Parish Council	Felsted
High Easter Parish Council	High Easter
Stow-cum-Quy Parish Council	Stow cum Quy
Slip End Parish Council	Slip End
Eggington Parish Council	Eggington
Berkhamsted Town Council	Berkhamsted
Cookham Parish Council	Cookham
Redbourn Parish Council	Redbourn
Worplesdon Parish Council	Worplesdon
High Roding Parish Council	High Roding
Stebbing Parish Council	Stebbing
Saffron Walden Parish Council	Saffron Walden
Caddington Parish Council	Caddington
Epping Town Council	Epping
Turville Parish Council	Turville
Clavering Parish Council	Clavering
Elsenham Parish Council	Elsenham
Nuthampstead Parish Meeting	Nuthampstead
Radwell Parish Meeting	Radwell
Coton Parish Council	Coton

Great Dunmow Parish Council	Great Dunmow
Sandridge Parish Council	Snadridge
Wooburn & Bourne End Parish Council	Wooburn and Bourne End
Bray Parish Council	Bray
Barley Parish Council	Barley
Castle Camps Parish Council	Castle Camps
Horseheath Parish Council	Horseheath
Langley Parish Council	Langley
Histon Parish Council	Histon
Impington Parish Council	Impington
Great Gaddesden Parish Council	Great Gaddesden
Pampisford Parish Council	Pampisford
Slough Borough Council	Slough
Ealing Borough Council	Ealing
Bracknell Forest Council	Bracknell Forest
Hertsmere Borough Council	Hertsmere
The Royal Borough of Windsor and Maidenhead	Windsor and Maidenhead
South Bucks District Council	Denham
Wycombe District Council	Wycombe
London Borough Barnet	Barnet
St. Albans City Council	St Albans
Welwyn Hatfield Borough Council	Welwyn and Hatfield
Surrey Heath Borough Council	Camberley
Hertfordshire County Council	Hertford
East Hertfordshire District Council	Bishops Stortford
Central Bedfordshire Council	Bedford
Brent Borough Council	Wembley
Harlow District Council	Harlow
Uttlesford District Council	Saffron Walden
Woking Borough Council	Woking
Haringey Council	Wood Green
Spelthorne Borough Council	Knowle Green
South Cambridgeshire District Council	Cambourne
Essex County Council	Chelmsford
Brentwood Borough Council	Brentwood
North Hertfordshire District Council	Letchworth Garden City
Elmbridge Borough Council	Esher

Surrey County Council	Kingston
London Borough of Hillingdon	Uxbridge
Runnymede Borough Council	Addlestone
Guildford Borough Council	Milmead
Chiltern District Council	Amersham
London Borough of Hounslow	Hounslow
Three Rivers District Council	Rickmansworth
Luton Borough Council	Luton
Harrow Council	Harrow
London Borough of Enfield	Enfield
Stevenage Borough Council	Stevenage
Buckinghamshire County Council	Aylesbury
Watford Borough Council	Watford
Epping Forest District Council	Epping
Dacorum Borough Council	Hemel Hempstead
Chiltern District Council	Amersham
Guildford Borough Council	Guildford
Afriyie MP	Windsor
Baker MP	Wycombe
Beresford MP	Mole Valley
Blackman MP	Harrow East
Bray MP	Ealing Central and Acton
Burrowes MP	Enfield, Southgate
Clappison MP	Hertsmere
de Bois MP	Enfield North
Dorries MP	Mid Bedfordshire
Freer MP	Finchley and Golders Green
Gardiner MP	Brent North
Gauke MP	South West Hertfordshire
Gillan MP	Chesham and Amersham
Gove MP	Surrey Heath
Grieve MP	Beaconsfield
Halfon MP	Harlow
Hammond MP	Runnymede and Weybridge
Harrington MP	Watford
Haselhurst MP	Saffron Walden
Heald MP	North East Hertfordshire

Hopkins MP	Luton North
Hurd MP	Ruislip, Northwood and Pinner
Jenkin MP	Harwich and North Essex
Kwarteng MP	Spelthorne
Laing MP	Epping Forest
Lammy MP	Tottenham
Lilley MP	Hitchin and Harpenden
Lord MP	Woking
Mactaggart MP	Slough
Main MP	St Albans
McDonnell MP	Hayes and Harlington
McPartland MP	Stevenage
Milton MP	Guildford
Offord MP	Hendon
Penning MP	Hemel Hempstead
Pickles MP	Brentwood and Ongar
Pound MP	Ealing North
Prisk MP	Hertford and Stortford
Raab MP	Esher and Walton
Randall MP	Uxbridge and South Ruislip
Selous MP	South West Bedfordshire
Shapps MP	Welwyn Hatfield
Sharma MP	Ealing, Southall
Shuker MP	Luton South
Teather MP	Brent Central
Thomas MP	Harrow West
Villiers MP	Chipping Barnet
Walker MP	Broxbourne
Friends of the Mimram	Hatfield
Ver Valley Society	St Albans
Dacorum Environmental Forum	Hemel Hempstead
River Chess Group	Chesham
Colne Valley Angling Society	Hemel Hempstead
River Beane Group	
Chiltern Chalk Streams, Chiltern Conservation Board	Chinnor
RSPB Central England Office	Banbury
Herts & Middlesex Wildlife Trust	St Albans

National Association for AONB	Northleach
Friends of Stockers Lake	Chorleywood
Beds Wildlife Trust	Bedford
London Wildlife Trust	London
National Farmers Union	Petersfield
Countryside Management Service	Hertford
White Hill Centre	Chesham
Butterfly Conservation Association	Ware
RSPB	Brighton
Groundwork Herts	Hatfield
Groundwork Thames Valley	Denham
Herts & Middlesex Bat Group	Hertford
Hertfordshire County Council	Hertford
Rickmansworth Waterways Trust	Rickmansworth
Watling Chase Community Forest	Hertford
Bedfordshire Wildlife Trust	Bedford
British Disabled Waterski Association	Wraysbury
East of England Regional Assembly	Bury St Edmunds
Inland Waterways	Chesham
British Water Ways	Watford
English Heritage - London Region	London
English Heritage - East of England Region	Cambridge
English Heritage - South East Region	Guildford
Chiltern Society	Chesham
River Chess Association	Northwood
Dacorum Environmental Forum Water Group	Boxmoor
World Wildlife Fund	Godalming
London Colney Village Concern	London Colney
Defra	London
Consumer Council for Water	London
Environment Agency	Bristol
Natural England	London
OFWAT	Birmingham
Cambridge Water Ltd	Cambridge
Anglian Water Group	Huntingdon
Thames Water Utilities Ltd	Reading
Essex and Suffolk Water	East Hanningfield

South East Water Ltd	Kent
Arsenal Football	London Colney
Wembley National Stadium Ltd	Wembley
World Wildlife Fund	Weyside Park
Chiltern Chalk Streams, Chiltern Conservation Board	Chinnor
Age UK	London
Herts Chamber of Commerce	HERTS
Ascott Race Course	Ascot
The Association of Professional Landscapers	Theale
Horticultural Trades Association	Theale
Federation for Window Cleaners	Reddish
Wentworth Golf Club	Surrey
Aviva PLC	Stevenage
BAA Stansted	Bassingbourn Road
C2C: Carver Barracks	Essex
Cancer Research UK	South Mimms
EADS Astrium Ltd	Hertfordshire
East & North Herts NHS Lister	Stevenage
East & North Herts NHS QEII	Welwyn Garden City
GSK Harlow	Harlow
GSK Stevenage	Stevenage
GSK Ware	Ware
Johnson Apparelmaster UK	Letchworth
Johnson Matthey	Royston
O-I Manufacturing UK Ltd	Harlow
OCS Ltd	Gunnels Wood Road
Princess Alexandra	Harlow
Sunblest Bakeries	Stevenage
Synthomer Ltd	Harlow
University of Hertfordshire	Hatfield
Alpha Flight Services	Harmondsworth
BAA Heathrow	Harlington
Bakkover Pizza	Christchurch Avenue
Barnet General Hospital	Wellhouse Lane
Bio Products Laboratory	Elstree
Brunel University	Middlesex
C2C: R A F Northolt	Middlesex

C2C: RAF Uxbridge	Uxbridge
Harrow School	Middlesex
Health Protection Agency	London
Hertfordshire NHS Harperbury	Radlett
Holiday Inn London Heathrow	West Drayton
Katsouris: Abbeydale	Middlesex
Katsouris: Elveden	London
Kodak Ltd	Harrow
Kolak Snack Foods Ltd	London
London Renaissance	Hounslow
Marriott Hotels Ltd- Heathrow	Hayes
Medical Research Council Technology	London
Metropolitan Police Hendon	London
National Institute for Medical Research	Mill Hill
Nestle UK Ltd	Hayes
Northwick Park Hospital	Harrow
Park Inn Heathrow	West Drayton
Royal National Orthopaedic Hospital	Middlesex
Sheraton Skyline	Harlington
The Hillingdon Hospital	Uxbridge
Thistle London Heathrow Hotel	Longford
Wembley National Stadium Ltd	Wembley
West Coast Traincare	Brent
Ashford Hospital	Ashford
Coldingley Prison	Surrey
Crown Estate Commissoners (Windsor Great Park)	Berkshire
Ealing Hospital	Southall
Gate Gourmet Catering	Hounslow
H.M.Y.O.I Feltham	Middlesex
Le Pain Croustillant	Southall
London Linen	Southall
McLaren Group Ltd	Chertsey Road
Noon Products Ltd	Southall
Noon Products: Dean Way	Southall
Pirbright Camp	Woking
Pool & Sports Centre	Woking
Royal Holloway College	Egham

Shepperton Studios	Shepperton
St Bernards Hospital	Southall
St Peters Hospital	Chertsey
Thorpe Park	Surrey
Veterinary Laboratories Agency	Addlestone
Wentworth Golf Club	Surrey
Bucks Golf Co. Ltd	Denham
C2C: R A F High Wycombe	High Wycombe
H M S Warrior- Northwood HQ	Northwood
HMP The Mount	Bovingdon
IBC Vehicles	Luton
Luton and Dunstable Hospital	Luton
Luton Hoo / Elite Hotels	Bedfordshire
Mount Vernon Hospital	Northwood
Synergy Heathcare PLC	Dunstable
The Grove Hotel	Rickmansworth
VW Projects- Luton Airport	Bedfordshire
Watford General Hospital	Watford