# Management Of Water in a Domestic Context in England and Wales.

BY

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Abstract

# MANAGEMENT OF WATER IN THE UK.

By
Indigo T Cotton

1. To analyse the UK Water Supply and Demand, and to compare with other European nations. In particular to investigate the justification and adoption of hosepipe bans and other restrictive measures.

2. To look at the devices available for the recycling and more efficient use of water in the domestic context, and in particular how these relate to domestic gardening.

3. To propose a design for whole house water conservation and recycling, looking at the total costs, and the implications for the water industry, and the individual consumer.

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TM PROJECT 1996/1997.

## ACKNOWLEDGMENTS

The author wishes to thank Kate Almond, Mick and Loretta Cotton, for their support.

# INTRODUCTION

## Population.

*Is there enough water to go around ?*

In the past 300 hundred years the world population has swollen to enormous proportions (see fig 1). It has increased seven fold, but the consumption of water has increased 35 times. In the past 15 years the population on the planet has increased from about 5.5 billion to 6.2 billion in the year 2,000 (Understanding Global Issues, 1994/4).

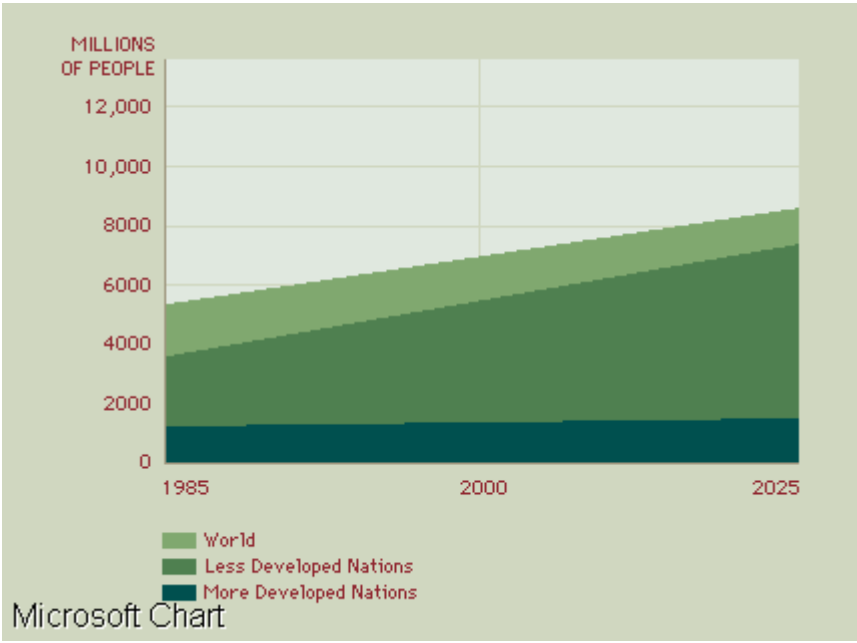



Figure 1 Graph showing the population increase in the world since 1985 to the year 2025, although the increase in the world population will start to drop by the year 2025.

The UN medium projections issued in 1990 show the world population increasing from 5.3 billion in 1990 to 6.2 billion in 2000, and 8.5 billion in 2025. "High" and "low" projections for 2025 are 9.1 billion and 7.9 billion respectively.

The average world birth rate is projected to decline from the 1990 level of 26 per 1000 to 22 per 1000 at the end of the century and to 17 per 1000 in 2025 (corresponding to a fall in TFR from 3.3 in 1990 to 2.3 in 2025). Because of the expanding share of the population at high-mortality ages, the average world death rate is expected to decline only slightly; from 9 (per 1000) in 1990 to 8 in 2025.

Average world life expectancy, however, is projected to rise from 65 years in 1990 to 73 years in 2025.

Wide variations in population growth will undoubtedly persist. In the developed world, population growth will continue to be very low and in some nations will even decline. Western Europe as a whole is projected to have a declining population after 2000. U.S. Census Bureau projections, assuming middle fertility and mortality levels and net immigration averaging 880,000 per year, show U.S. population increasing from 249 million in 1990 to 334 million in 2025 and 383 million in 2050. Thereafter, growth would be virtually zero.

The UN expects the less-developed countries to have steadily falling rates of population growth. For the less-developed world as a whole, the 1990 growth rate of 2.0 percent per year is projected to be cut in half by 2025.

**Climate in Europe.**

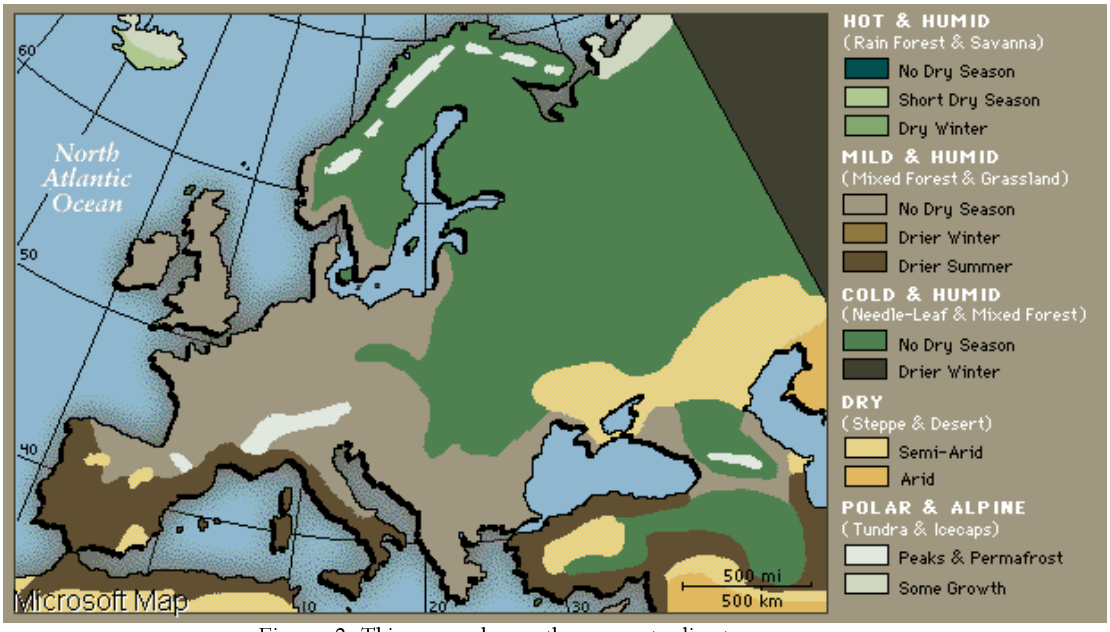



Figure 2 This map shows the current climate situation in Europe, this could all change according to the Department of the Environment.

The current situation in Europe is shown in the above map (fig 2) but according to a press release from the Department of the Environment the following effects could happen with the current trend in climate change, according to the Intergovernmental Panel on Climate Change (IPCC) "dry regions beset by water supply and quality problems" and they call for the reduction in the Greenhouse gases to try and combat this problem. In order to achieve this the UN Framework Convention on Climate Change (FCCC) was formed, and at the RIO Earth Summit in June 1992 the FCCC was adopted and has now been ratified by over 150 countries, the agreed goal being the reduction on greenhouse gasses to 1990 levels by the year 2000.

The Department of the Environment claim that the UK will, by the year 2000, have reduced the level of emission of greenhouse gasses below 4 to 8 per cent of 1990 levels by the year 2000. As a result of this UK is now calling for developing countries to reduce the greenhouse emissions by 5 to 10 per cent below 1990 levels by 2010. The climate of the UK could shift from about 20

degrees latitude to 40 degrees latitude, with weather similar to the south of France but the UK being more prone to drought and some areas ( with the sea rising) prone to saline flooding.

The net effect of these increases could be a world-wide rise in temperature, estimated at 2° to 6° C over the next 100 years. By the year 2050 scientists predict a temperature rise from 9 °C to around 10.6°C (DoE press release July 1996). According to the met office temperature data for the past 45 years 1990 to 1945 the UK average for this period is 10.0787 °C. See fig on average temp for England and Wales. So this average could become as high as 10.6787 °C. The data from the Met office only goes back 45 years and does mot take into account the 1990 to 1996 where there was high climatic change which could affect this mean average. There could be a sea level rise of 35 cm (DoE press release July 1996) and an increase in the frequency of storms. The total rain fall to the UK could increase by 10% there will be a divide, the Northwest becoming more prone to flooding and the Southeast becoming susceptible to droughts. The climate change will effect many area where water is depended on, they include:

- Water treatment and domestic drinking water supply.
- Supply for industry, irrigation and power production.
- Agricultural water use.
- Sewage, sewage treatment, effluent disposal and dilution.
- Land drainage and flood protection.
- Navigation.
- Fisheries, conservation and recreation.

*The effect on drinking water*

There is a risk that the ground water supply around coastal areas could become prone to becoming saline, where the fresh water is in effect polluted be saline water. This is caused by the increasing sea levels. A report by the World Meteorological Organisation posed the following questions in response to the effect on drinking water: If climate change implies longer periods with out rain fall, what problems will this pose in a particular region? If there is a gradual increase in the frequency of longer dry spells, where are the shortages first occur, how will they spread, and how quickly? What part of climate change are likely to cause the most problem? How big a problem is salinization to low-lying coastal areas? If a rise of 35cm is correct then many of the UK underground aquifers could become saline.

*Water world wide*

The global volume of water is estimates to be 1,384,1200,000 km $^3$ (Korzoun and Sokolov in McDonald and Kay 1988). The oceans make up 1,348,000,000 or 97.39% of this (see fig 3). This leaves only 36,020,000 km $^3$ or 2.61% fresh water on the planet, this is tide up in the polar caps, in ground water, lakes and rivers and in the atmosphere.

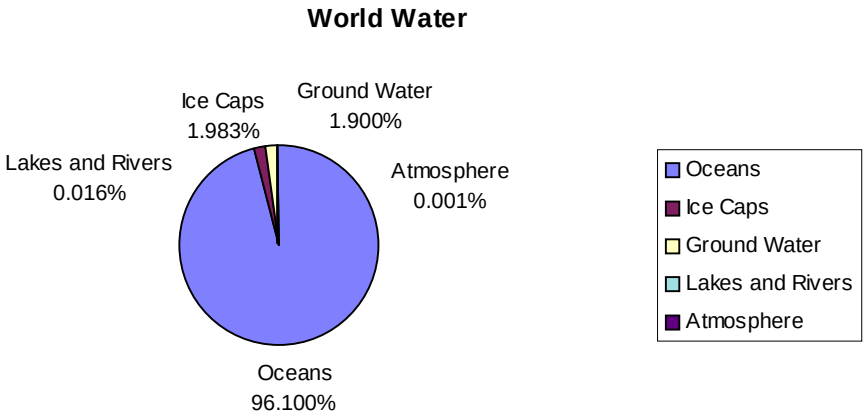



Figure 3 This chart shows the total volume of the earth's water in relation to each other. (data water resources and climate change, 1987)

The fresh water which is only a small amount 2.61% of the total amount available in the world. The chart below shows the break down of the fresh water, some of the water is readily available as its in the form of rain or flows in rivers, but other are a source of fresh water but harder to reclaim i.e. Icebergs.

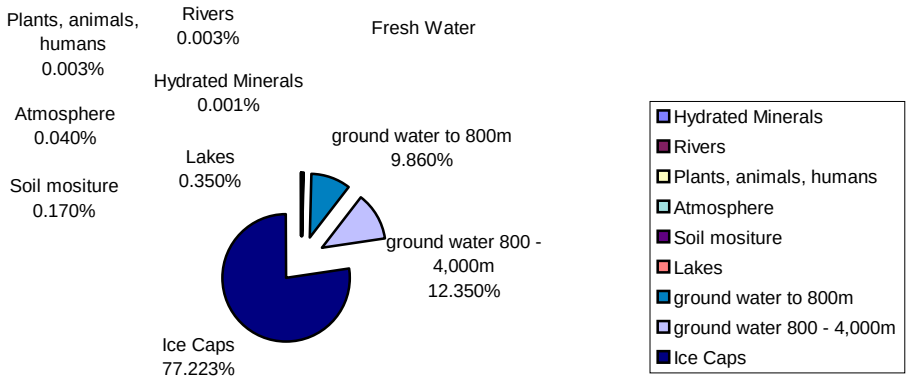



Figure 4 Chart to show the amount of Freshwater available and in what proportion. (Data from McDonald & Kay 1988)

From the above chart (fig 4) it can be seen that of all the available fresh water in the world, only about 23.0% is readily accessible in the form of groundwater, but ground water takes 1,400 years to return to its former level. The global balance of water is critical.

*Resumption Period.*

On a global scale the resumption period is not of much consequence, but on a local scale this can make the difference between floods and drought. The table below (Table 1) shows the recycling time for different locations.

| Type of Water | Period of Resumption |
|---|---|
| World Ocean | 2,500 years |
| Ground Water | 1,400 years |
| Soil Moisture | 1 year |
| Polar glaciers and permanent snow cover | 9,7000 years |
| Glaciers in mountain areas | 1,600 years |
| Underground permafrost zone | 10,000 years |
| Water storage in lakes | 17 years |
| Swamp water | 5 years |
| Water in Stream Channels | 16 days |
| Atmospheric moisture | 8 days |

Table 1 to show the global storage locations and the resumption periods. (Data from McDonald & Kay 1988)

The largest area of water consumption comes from lake water and River water, it can be see from the about table that the resumption period for underground water is 17 years. The Essex Water Company has 98% of the water abstracted is from rivers and the remaining 2% comes from boreholes, the supply from boreholes has a resumption period of about 1,700 years. Abstraction of water from rivers is a concern. See river flow graph (figure 21).

*Climate Change in the UK*

The Department of the Environments report found the following effects would happen to the UK over the next 30 years, see the above fig.

- Extreme climate events such as floods and droughts and more frequent storms.

- North West of the country could become much wetter, more flooding.
- South East could have less rain and become more prone to droughts.
- Over the next 30 years the British climate could be shifted as much as 200km northwards.

**Growth in population and consumption.**

*Increasing demand.*

It has been shown that the amount of fresh water available to each person has fallen dramatically over the past 100 years. In England and Wales there is a similar situation with a marked increase in the amount of water used by each person, although in England and Wales the main abstraction comes from Rivers in the winter and this water is stored in reservoirs. The water which is available to each person is dropping. According to Understanding Global Issues, The danger of water wars 1994, the UK has renewable fresh water resources of about 2,110 cubic meters per person and uses 507 cubic meters per person, this data is from 1990. Countries are 'water stressed' if the amount of water available per capita is below 2,000 cubic meters and 'water scarce' if the amount of renewable fresh water is below 1,000 cubic metres. The population of England and Wales demand for water has increased more than the underling trend in population growth. Nation wide the domestic consumption has grown by 13% over the last 10 years and continues to grow at 1% each year. This is not only due to an increasing population but the amount of water each person is using has also increased.

**The Situation In England and Wales Now**

The United Kingdoms density is now at about 225 inhabitants / km $^2$ 242,429 km $^2$(Source: Environment in Europe 1995) , giving a population of about (225 x 242,429) 54,546,525 this is the total for the UK. In relation to the other EU (EU15) countries the UK's density is ranked 3$^{rd}$

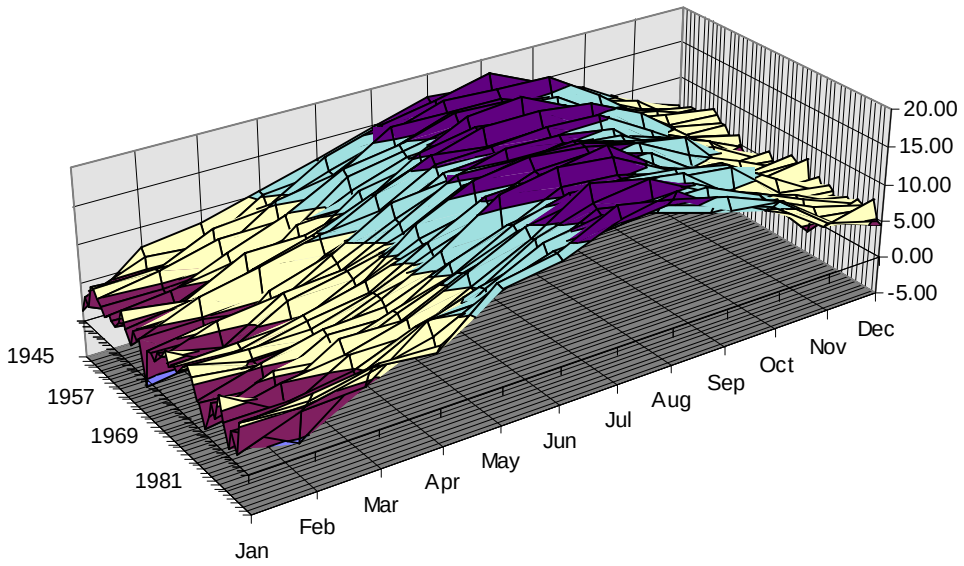



Figure 5 Average Temp in the UK over the past 45 years. (data from the Met office)

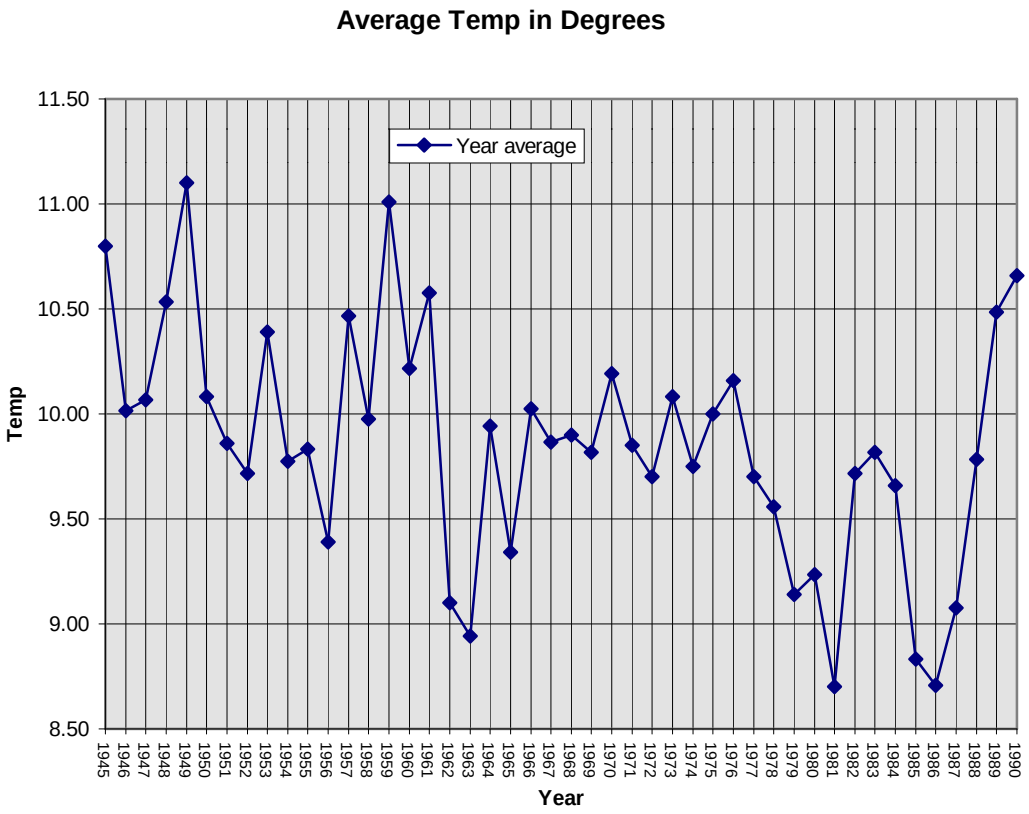



Figure 6 Chart showing the average temperature for the last 45 years. (Data from the Met Office)

The mean average temperature for the last 45 year has fluctuated in the UK, (see above fig 6). From the above data (fig 6) there is no real trend that would lead to the conclusion that the United Kingdom's climate is becoming warmer. According to NRA report on Saving Water '*The droughts of 1984, 1988-92 and 1995 have also been significant in raising awareness of the need to use water sensibly*'

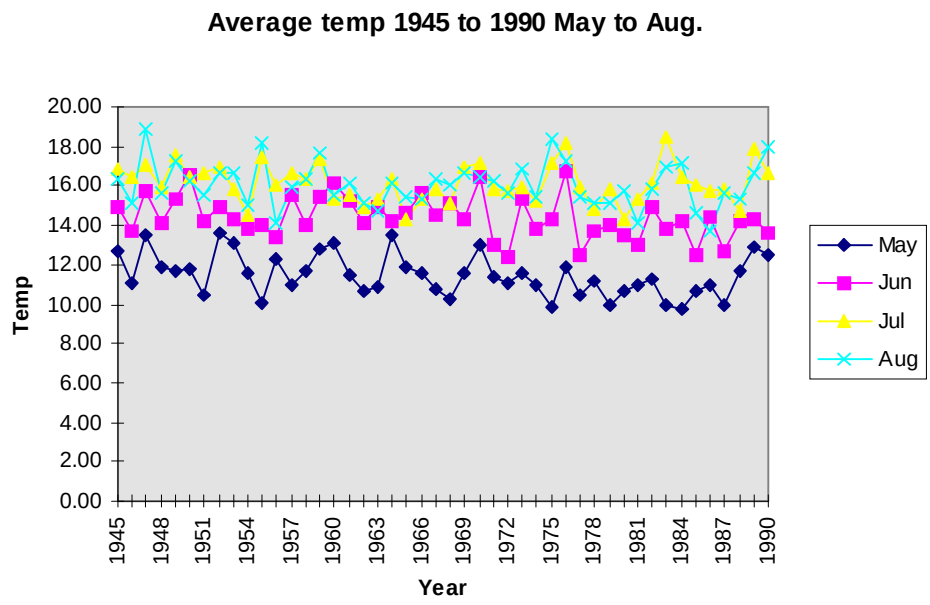



Figure 7 Graph Showing Average Temp in UK from 1945 to 1990 May to Aug showing and increase in 1975 and 1983 and 1989(Source: Met Office)

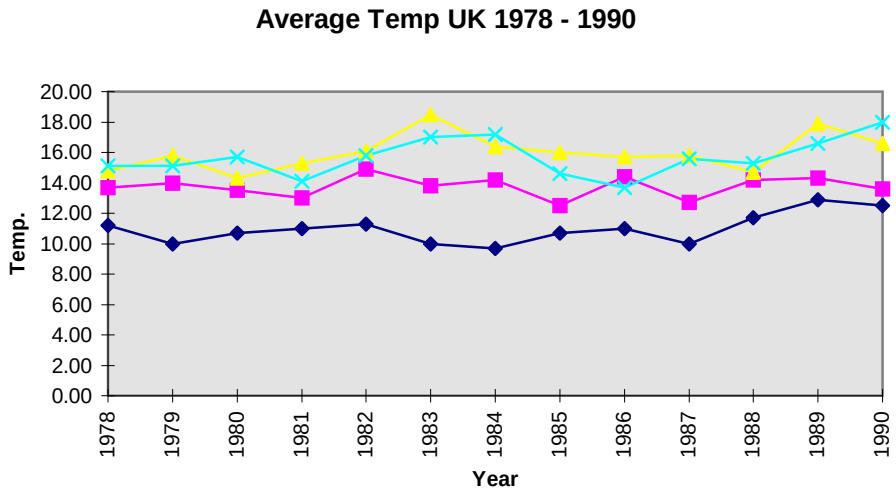



Figure 8 Graph showing Average temp from 1978 to 1990 showing the increase in temp in 1983 and 1989. Key see above(Source: Met Office)

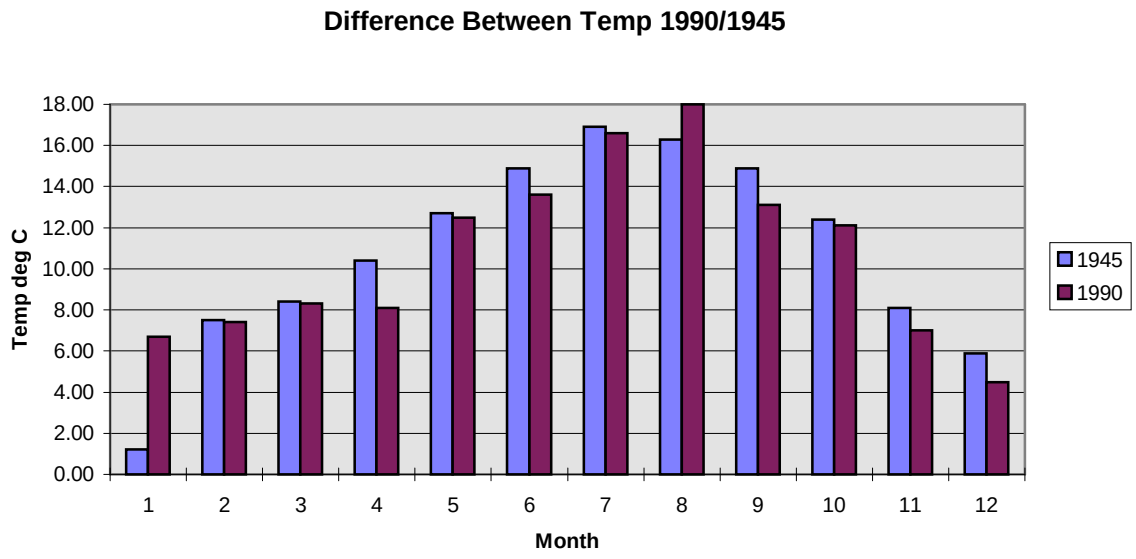



Figure 10 The difference in average temperatures from 1945 to 1990.(Met Office)

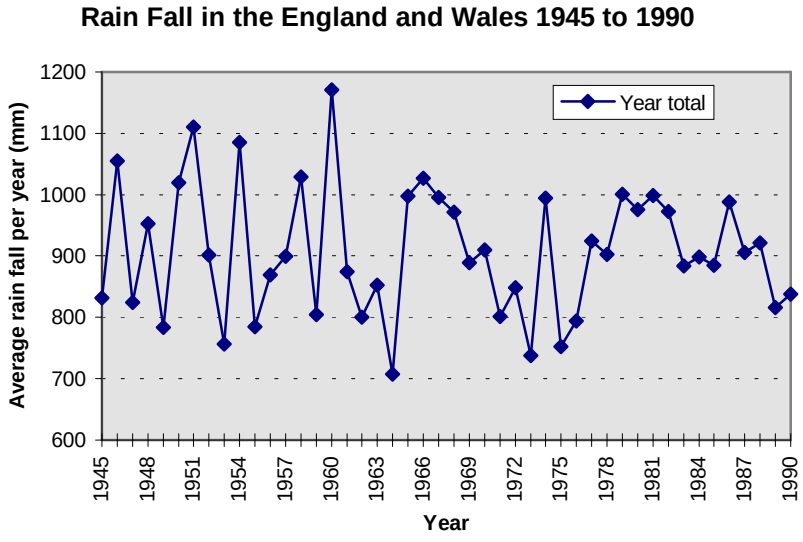



Figure 9 Rain fall in England and Wales from 1945 to 1990

It can be seen from the above graph (fig 10) of temperature differences that the year of 1945 was considerable colder during the summer months but there is a trend for the summers to be warmer with less rain and the winter to be warmer, also in figure 9, there is a tendency for the rain fall to have become more stable, but because there is a general increase in the average temp any decrease in rain fall will become more marked. Figure 11 shows the difference between the rain fall in 1945 and 1990. In 1990 there was an increase in rain fall in winter but a decrease in the rain fall for the summer months.

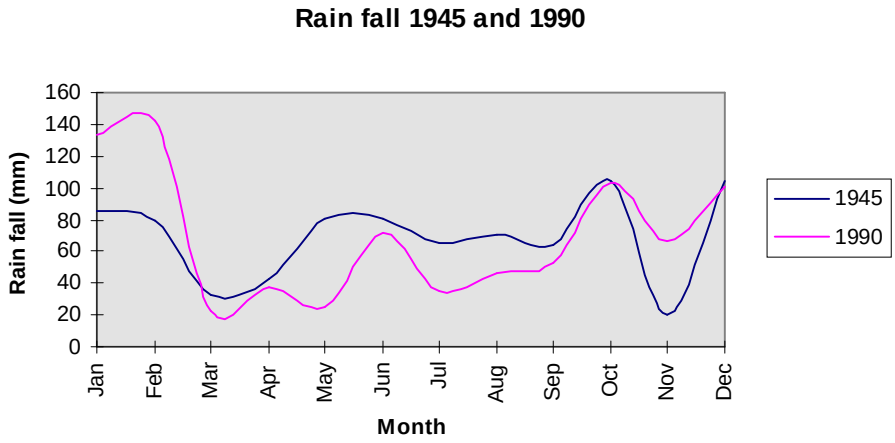



Figure 11 Rain Fall in England and Wales 1945 to 1990

## Water

The amount of fresh water available for each person has fall over the past 46 years, according to Understanding Global Issues the amount has fallen from 16,000 $m^3$ per person in the 1950 to about 7,800 $m^3$ per person.

## Demand Management in Europe and Overseas

| | Litres/head/day |
|---|---|
| Austria | 148 |
| Belgium | 110 |
| Denmark | 188 |
| Finland | 150 |
| France | 165 |
| Germany(west) | 148 |
| Hungary | 200 |
| Italy | 225 |
| Luxembourg | 175 |
| Netherlands | 168 |
| Spain | 125 |
| Sweden | 190 |
| Switzerland | 275 |
| United Kingdom | 140 |
| Average | 171.9 |
| | |

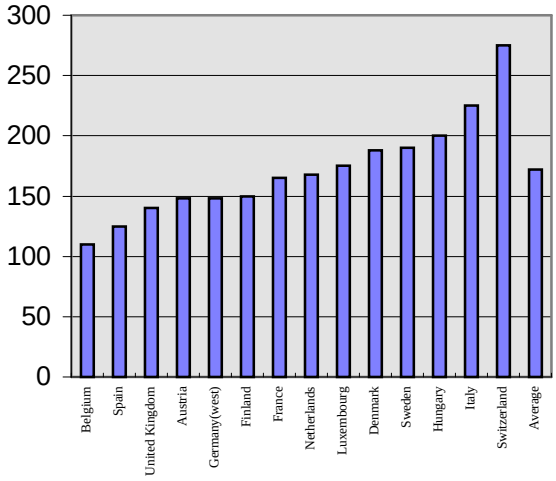



Figure 12 Graph and table showing the amount of water consumed in Europe (litres per person per day).

**Policy and Legislation Overseas**

A number of developed countries have policy statements which are dealing with and contributing to a change in attitude. Demand management is seen as a tool to modify future demand. In general these policies have grown from periods of drought of a growing realisation that future demand cannot be met by the current network and distribution systems.

For example in 1974 in the USA the Safe Drinking Water Act resulted in expensive treatment costs and coupled with environmental legislation made the construction of new dams difficult and so forced demand management issues to be consider. In Japan a Water Conservation policy was formed in the 1970`s to promote water saving measures and the importance of water saving equipment. Also in Japan the Ministry of Health and Welfare set the Water Bureaux a national target of 90% of Distribution input should be delivered to customers ( i.e. maximum of 10% leakage).

The Federal Water Policy of 1987 in Canada gave a new emphasis on water demand management as a major new direction for managing Canada's water resources. In the USA there is no general policy on water control, but there are several statutes which are central to the federal governments effort to control water resources. In New Zealand the management of water resources is governed by the Resource Management Act of 1991, the purpose being to "promote the sustainable management of natural and physical resources". Under this act the local councils are expected to control water allocation and usage permits. In France the Water Law of 1993 brought about compulsory Regional Water Plans which were designed to create a balance between various water users. In Canada, in 1990, a byelaw made it illegal to discharge to the sewer system cooling water which had been only used once.

In Singapore there is a water conservation tax on industry using more than a specified amount of water. New factories that require more than $500m^3$/month must get a City approval before they start operating. There is also government help available to incorporate conservation , recycling and use of low quality water.

The Water Pollution Acts in the 1970`s/1980`s in the USA, Japan and Germany stimulated an interest in reducing waste water discharge which indirectly contributed to a reduction in demand. By contrast, Spain's response to water shortages caused by uneven rainfall was to spend over $54 billion on more that 100 dams, with little or no thought on demand management measures.

**Metering and Charging Policy**

In most counties, unlike the UK, the majority of domestic households are metered and bills paid on the amount of water used. The only countries where the majority of households are not metered is in the UK and Norway. In the Netherlands 24% of properties are charged at a flat rate with the remaining

metered. In Sweden, where 1.5 million meters serving population of 8.8 million.

In France all properties must be equipped with a metering system to allow both operator and consumer the know the amount of water they are consuming.

Where meters have been installed in recent years some very significant reductions in both average and peak demands have recorded. Reductions in average household demand have fallen by 10-20% (Hamburg, Canada, Copenhagen) which agrees with the UK National Metering Trials although some greater reduction have occurred,

| | |
|---|---|
| Toowomba, Australia | (41%), |
| Manakau, New Zealand | (35%), |
| Philadelphia, USA | (45%), |
| Gothenburg, Sweden | (33%). |

**Leakage**

Leakage , as in the UK, is an area which has frequently been neglected. As stated by Herrington (1987) what constitutes an acceptable level of leakage is also variable.

| | |
|---|---|
| USA | 10-15 % |
| New Zealand | 12 % |
| France | 7 - 8 % |
| Germany | 3 % |

Only Japan has set a national target, to achieve a target of 10% which is likely to reduce to 5% in future.

In general, elsewhere a cost effective approach is adopted. If the cost of leakage detection and repair is less than the cost of water saved then leakage detection is practised. However, no environmental cost of leakage are included in this equation.

| Country | Year | Leakage % |
|---|---|---|
| France | 1992 | 40 |
| Norway | 1981 | 55 |
| Manila | 1983 | 50 |
| Boston | 1982 | 36 |
| Malaysia | 1987 | 43 |
| Portugal | 1987 | 30 |
| South Africa | 1987 | 29 |
| Sweden | 1987 | 21 |

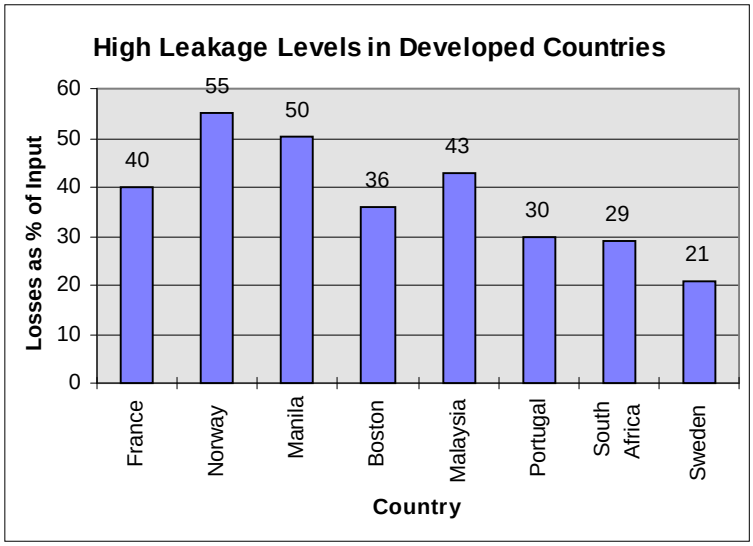



Figure 13 Graph to show the differences between leakage in different countries around Europe and the world.

It can be seen from the above graph (fig 13) that the country with the highest leakage per cent is Norway with approx. 55%, conversely the lowest are Portugal (30%) South Africa (29%) and Sweden (21%). If you compare these to the UK leakage at current rates of about 24% in England and Wales (for more detail see fig 17).

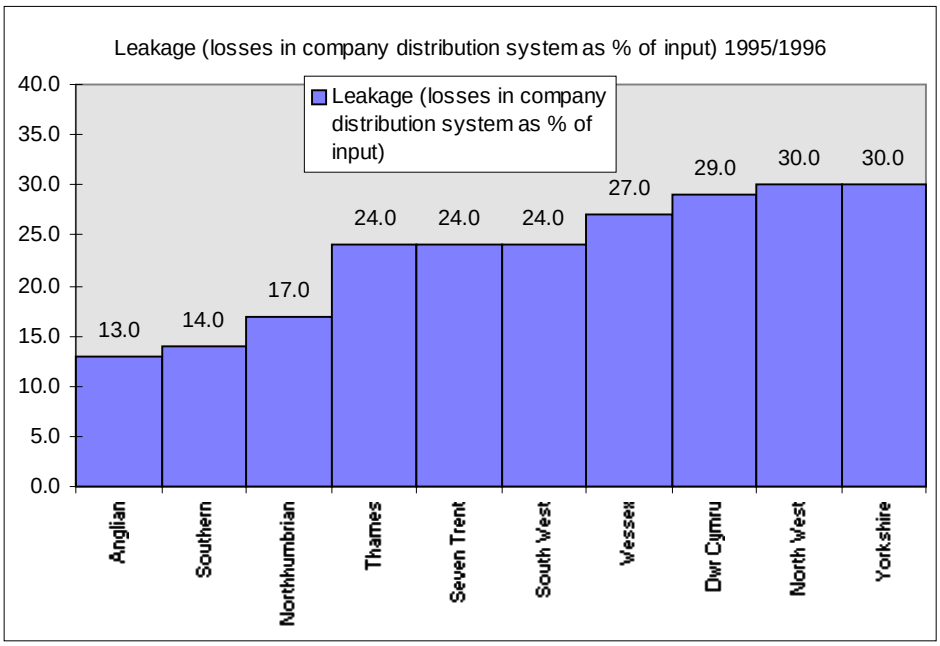



Figure 14 Graph showing leakage in the 10 water companies of England and Wales.

One of the main causes of leakage is the poor condition of the distribution system with some system being 50 - 100 years old and the rate of renewal of such pipes will be an important factor in the control of leakage. In Germany where the leakage rate is about 9% the current rate of mains renewal is approximately 2% per year compared to the United Kingdoms 1%.

The problem is also evident in developing countries where the distribution net work is newer but the maintenance of such networks is probably lower. The cities of Cairo, Jakarta, Lagos, Lima and Mexico all have had in excess of 50% leakage in recent years.

Another factor for Japan reaching the target of 90% of water delivered is the fact the network operates at a pressure of about 15 to 20 meters, but in the UK and the USA the average pressure is somewhere around 40 to 50 meters.

**Recycling, Re-use and Use of Non-Potable Water**

Around the world there are numerous example of dual supply systems in operation where lower quality non-portable water is used to meet a variety of needs.

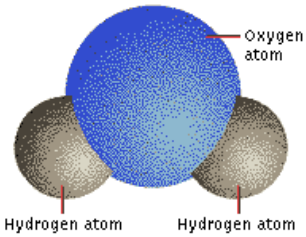
**Germany**: At Braunschweig 44.5 ML/day of wastewater is used for irrigation and this has been operation since 1954.

**Israel**: With a reclamation rate of 65% of its wastewater, Israel is the highest reclamer of waste water in the world. Re-use for irrigation has been in practised in Israel since the 1950s. There is now a study to see if reclaiming wastewater for urban use ( municipal flush toilets and fire hydrants, irrigation of parks and golf courses and small industry) with a view to reclaiming wastewater and supplying more that 16% of Israel total water needs.

**France**: On the Mediterranean island of Porquerolles, 60% of the trickle irrigation is met by treated wastewater.

**Hong Kong**: In 1976 one-sixth of demand for toilet flushing was met from sea water.

**Venice, Florida**: Reclaimed water has been used for urban irrigation (park and golf courses) since 1991. A survey showed that 73% of respondents would use reclaimed water.




# Overview of the water supply to UK homes and Companies.

## Privatisation and History of the Water Industry.

### *1945 - Water Act*

This act helped provide some legislation and provide a Waterworks Code. The act actively encouraged amalgamations between water companies, a survey carried out in 1915 identified some 2160 water undertakings and 786 local authorities. By 1963 the number has dropped to 100 water boards, 50 local authorities and 29 privately owned water companies, some of which had been in operation since the seventeenth century.

### *1973 Water Act.*

This act created the ten multi-purpose water companies of England and Wales that were later privatised. There role was "to plan and control all uses of water in each river catchment area".

### *1983 Water Act.*

This change the organisational structure of the water authorities. This saw a reduction in the rights of representation on the water authorities and meetings were closed to the public and press. This then lead to the Consumer Consultative Committees (CCC). Member of the CCC were appointed by the water authorities from organisations invited by the water authorities to put names forward and a representative of the water authority sat on each committee.

### *February 1986- Department of Environment White Paper.*

A discussion paper on the possible privatisation of the water industry. The paper proposed privatising the 10 water authorities to produce a competitive market, the white paper stated "*Privatisation itself will encourage the water service plc's to compete effectively in fields where they can do so. Where this is not practical the*

*Governments aim is to introduce a system of regulation which will stimulate a competitive approach. Profit is a more effective incentive than Government controls.*"

***July 1987 - Department of Environment Consultation Paper.***

In response to the white paper, many organisations has expressed concern about privatising the regulatory aspect of the water authorities. The Secretary of State then formed a separate non-departmental public body - the National Rivers Authority, this was to take the responsibility of water quality in rivers, lakes and bathing waters and the associated functions.

***1989 Water Act - Privatisation Regulation.***

The National Rivers Authority was set up to deal with water quality.

***1991 Water Industry Act***

The brought together the various sewerage legislation and consolidated the 1989 Act.

***1992 Competition and Services (Utilities) Act.***

The Act applied to the four regulatory bodies dealing with privatised utilities - gas, electricity, telecommunications and water. Its aim was to bring the powers of all the regulators up to those of the strongest. It gave the Director increased powers to determine disputes and to increase competition in the industry.

***1995 Environment Act***

The Act formed the Environment Agency (EA)

***1997 Byelaws:***

They are due for up review in 1997.

**Location of the water companies Regions in England Wales.**

At the present time in England and Wales there are 10 water companies, these companies were formed from the old regional water authorities which were privatised in 1989. They are North West, Northumbria, Yorkshire, Welsh, Seven-Trent, Anglian, Thames, South West Wessex and Southern.

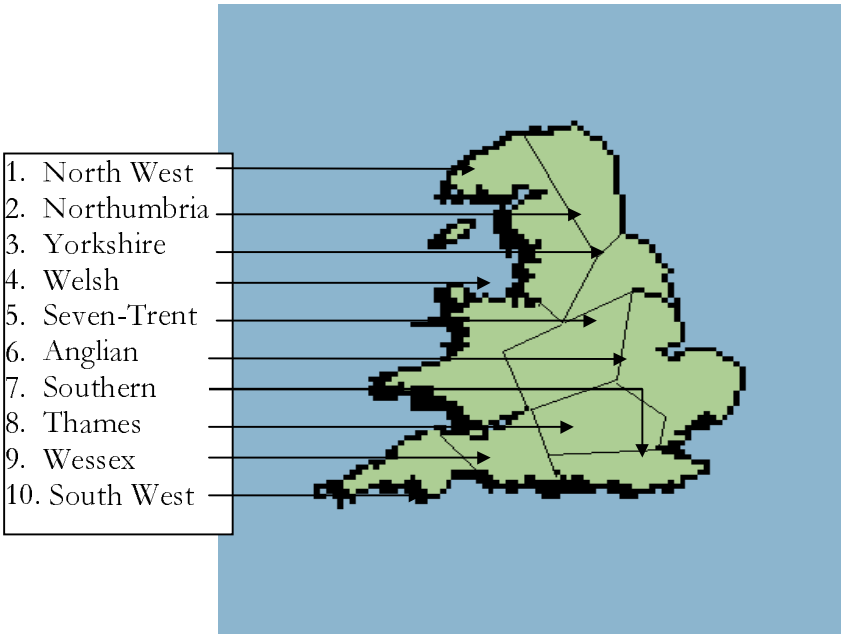



Figure 15 Map of England and Wales showing the 10 water companies

**The structure of the water Companies in England and Wales.**

About 50 Million people in England and Wales are supplied with 16,500 million litres of water daily which is about 99% of the population. A few facts about the water companies in England and Wales:

- There are about 1,600 treatment works in England and Wales.
- There are about 310,000 km of pipes.
- 5,000 service reservoir or water towers.

- Each companies network is divided into supply zones of 50,000 people.
- There are 2,600 zones in all.

The companies, these are the companies which supply the water to all the homes and business in England and Wales, it can be seen from the above fig that there are 10 main regions, but there are other smaller regions which exist within there areas, with 2,600 zones in England and Wales.

Each of the main water regions are broken down into smaller regional water areas, see the list below.

ANGLIAN REGION

- Anglian Water.
- Essex and Suffolk Water.
- Cambridge Water.
- Tending Hundred Water.

NORTH EAST REGION.

- Northumbria Water.
- Hartlepool's Water.
- Yorkshire Water.
- York Water.

NORTH WEST REGION.

- North West water.

MIDLANDS REGION.

- Severn Trent Water.
- South Staffordshire.

SOUTHERN REGION.

- Southern Water.
- Portsmouth Water.
- South East Water.
- Mid Kent Water.
- Folkestone and Dover Water.

SOUTH WEST REGION.

- South West Water.

- Wessex Water.
- Bournemouth and West Hampshire Water.
- Bristol Water.

THAMES REGION.

- Thames Water.
- Three Valleys Water.
- North Surrey.
- Sutton and East Surrey Water.
- Mid Southern Water.

WELSH REGION.

- Welsh Water (Dwr Cymru).
- Wrexham Water.

| Company | Population Connected(water) millions | Average Household Bill 1995/96 (water & sewerage)£ | Profit(after tax, before dividends) 1994/95 £m | Dividends paid 1994/94 £m | Investment in water and sewerage services 1994/95 £m | Leakage (losses in company distribution system as % of input) |
|---|---|---|---|---|---|---|
| Thames | 7.3 | 172.0 | 282.2 | 101.2 | 326.7 | 24.0 |
| Seven Trent | 7.2 | 189.0 | 238.0 | 105.0 | 374.7 | 24.0 |
| North West | 6.8 | 195.0 | 259.2 | 93.9 | 373.7 | 30.0 |
| Northumbrian | 1.2 | 199.0 | 79.1 | 19.4 | 79.0 | 17.0 |
| Yorkshire | 4.4 | 207.0 | 131.6 | 55.8 | 188.6 | 30.0 |
| Southern | 2.1 | 214.0 | 130.8 | 43.9 | 157.1 | 14.0 |
| Wessex | 1.1 | 234.0 | 100.8 | 34.6 | 91.0 | 27.0 |
| Dwr Cymru | 2.8 | 263.0 | 101.4 | 49.6 | 197.3 | 29.0 |
| Anglian | 4.0 | 275.0 | 196.8 | 77.3 | 300.6 | 13.0 |
| South West | 1.5 | 317.0 | 55.0 | 34.5 | 159.0 | 24.0 |

Table 2 The key facts about the ten water companies of England and Wales.

The companies, these are the companies which supply the water to all the homes and business in England and Wales, it can be seen from fig. 2 that there are 10, but there are other smaller regions which exist within there areas.

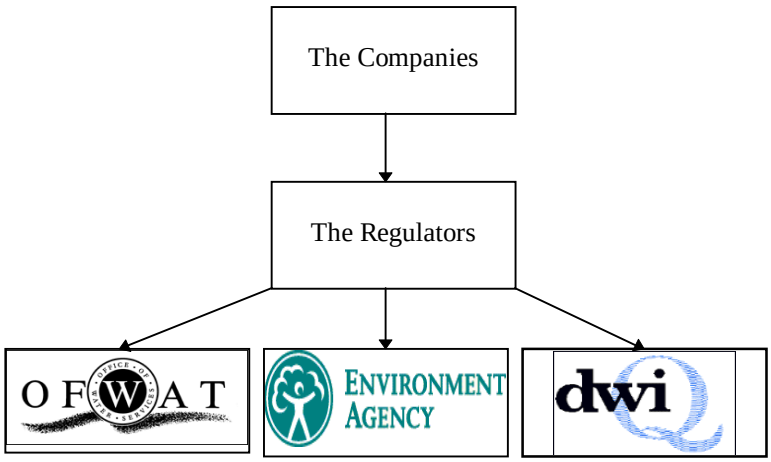



Figure 16 The structure of the water industry in England and Wales.

OFWAT - Office of Water Services.

EA - The Environment Agency.

DWI - Drinking Water Inspectorate

*The Water Companies*

These companies were formed from the old regional water authorities which were privatised in 1989, as with many companies the water companies are no exception and they have diversified into other areas i.e. The Power Companies. The water companies still have a main core business to provide and that is:

- to abstract water from rivers, reservoirs and underground sources.
- to treat it to a very high standard.
- to deliver drinking water to our homes and businesses.
- to collect our wastewater.
- to treat our wastewater to remove polluting potential.
- to return the water safely to the aquatic environment.

*The Regulators, OFWAT, DWI, EA.*

There are three main regulators of the water industry, they are OFWAT which is the economic regulator of the water companies, and is a non-ministerial government department.

The EA which protects water resources and river quality, and is a non-departmental public body established by the Environment Act 1995, and is managed on a regional basis. It has three goals:

1. To protect and improve the quality of rivers, estuaries and coastal waters, by effective pollution control.
2. To manage water resources. This will have to balance the needs of the consumer with that of the environment. this also relates with and long term plans.
3. To protect people and property from flooding - either from sea or rivers.

As from the 1 April 1996, the functions of the National Rivers Authority (NRA) were merged into the new Environment Agency EA. It also merged with the functions of Her Majesty's Inspectorate of Pollution (HMIP), and the waste responsibilities of the local authorities. The Environment Act also made a requirement to take into account the cost and benefits of any environmental improvements.

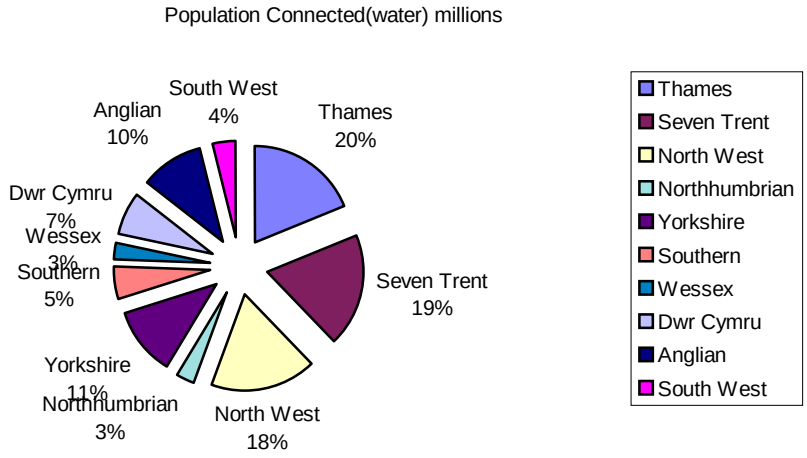



Figure 17 Pie Chart showing the population associated with each area.

The DWI, which regulates the drinking water quality, was set up in 1990. Its main task is to check that the water supplies by the water companies of England and Wales is wholesome drinking water with the requirements of the Water Supply (water quality) Regulations 1989.

The DWI carries out various inspection on companies to check the quality of water. The Government has 55 standards for drinking water. Most of these

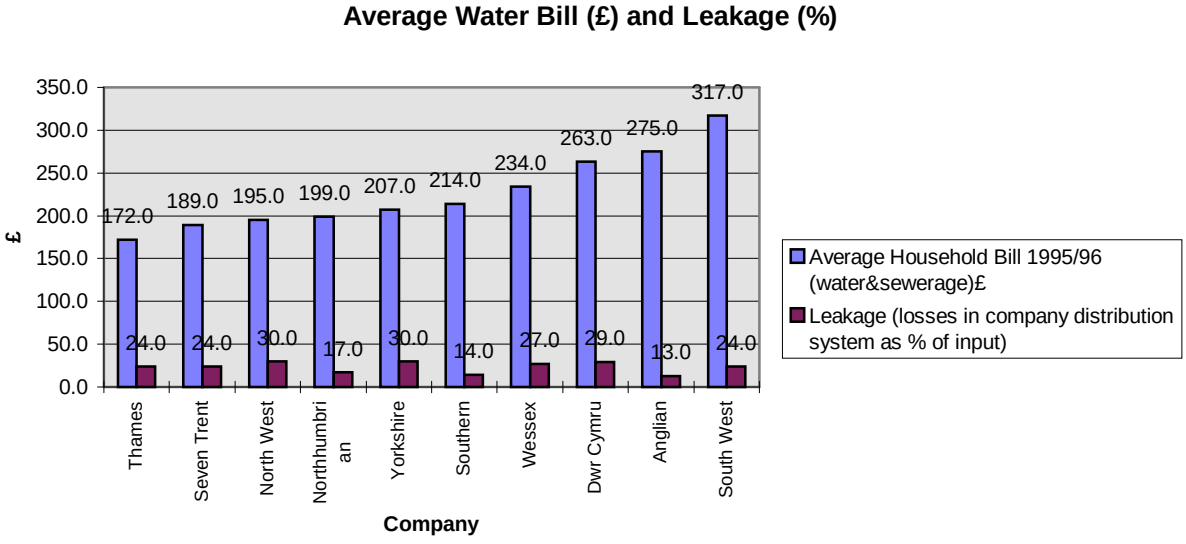



Figure 18 Showing the average house hold bill for each area and the according leakage.

come from the European Community Directive(ECD) but some UK standards are more strict and a few are based on the World Health Organisation (WHO) guidelines. Generally they test for

- Bacteria
- Chemicals, such as nitrate and pesticides
- The way the water looks and tastes.

The DWI test for impurities such as Bacteria, Pesticides, Lead, Taste and Odour and Nitrates, the statistics from 1994 to 1990 are shown below.

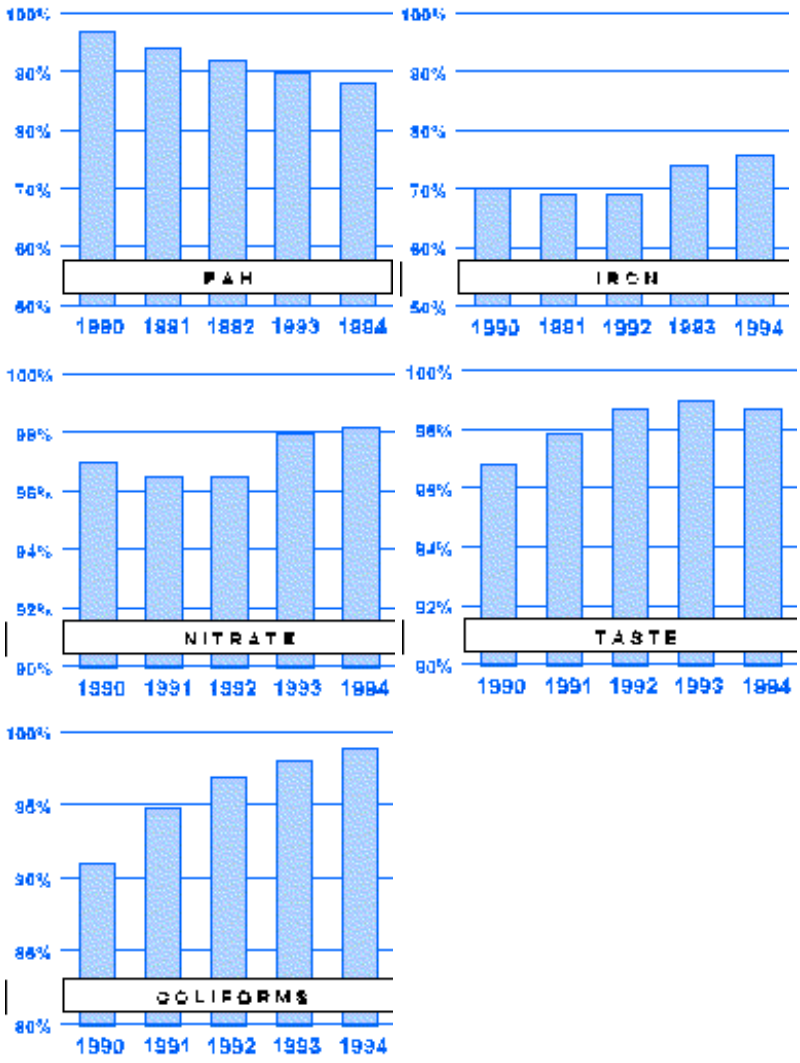



Figure 19 Graphs to show the different water tests the DWI performs.
(Source: DWI Internet site)

## CURRENT HOUSEHOLD WATER TREATMENTS

### Mechanical/Physical Drinking Water Refinement:

Physical water purifiers decrease the formation of lime deposits on pipes and equipment through electric or strong magnetic fields, thus changing the structure of the water so that the calcium carbonate does not seek a source outside of the water (e.g. pipes) to seed upon.

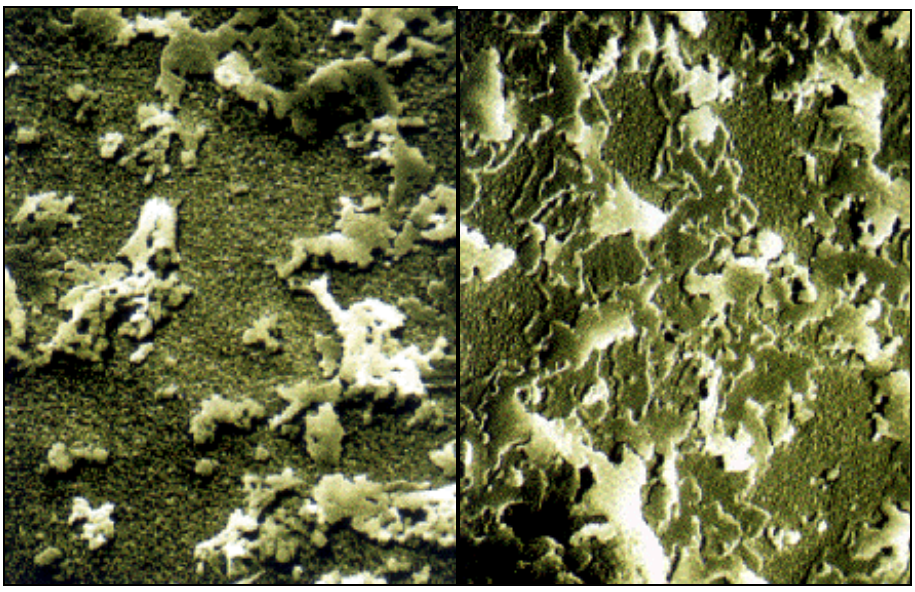


Figure 20 Pictures showing the difference between surfaces which have limescale deposits, left before, and the right after treatment.

**Active Carbon Filtering:**

This involves passing the water through a mechanical filter combined with active carbon granulate. The large surface area of the granules has a great absorbent quality and causes some particles to be deposited on their surface. The active carbon binds with substances like chlorine, pesticides, etc. Smaller substances like chromium, nitrates, phosphates, as well as some bacterias and viruses pass through the filter before the undesired substances leach through into the drinking water. Some such filters are a good culture for bacteria. Ion Exchangers: Ion exchangers help to eliminate water hardness by exchanging the cations calcium for chloride, hydroxide or sodium. This method does not remove lead, asbestos and chlorified carbohydrates, and leads to a high sodium content which then must be removed.

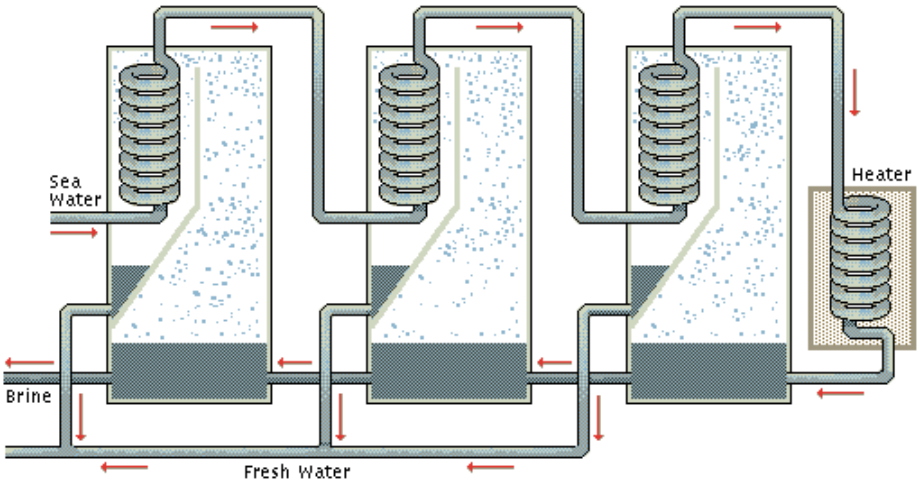
**Reverse Osmosis:**

This method cleans the water by passing the water under pressure through a semi-permeable membrane with microscopically small pores. Larger molecules

of harmful substances and minerals are held back by the membrane and then washed away. Reverse osmosis can filter out lead, cadmium, nitrates, sulphates, mercury, bacterias and viruses, and pyrogenes. It is a scientifically recognized method of filtration, resulting in pure water which does not produce the damages of calcium deposits. Because of its purity, it helps to draw impurities out of the body and assist metabolism. The process requires a minimum of 3 to 5 quarts of water (much more in poorer quality units) to produce 1 quart of pure water.

**Steam Distillation:**

This method of purification has been used for many years. It removes up to 99% of all impurities by heating the water and then condensing it again. The




Microsoft Illustration

Figure 21 Distillation, process of heating a liquid until its more volatile constituents pass into the vapour phase, and then cooling the vapour to recover such constituents in liquid form by condensation.

impurities separate out, leaving the water pure. People have claimed that drinking distilled water draws vital minerals out of the body. However, some research suggests that the minerals in question are already integrated within the

body, and that drinking distilled water will only draw out the sedimentary anorganic minerals, which is desirable. The main drawback to distilled water is that, although it is pure, it is energetically weak.

In 1993 the NRA created a National Centre for Demand Management (NCDM). The Demand management Centre provides a service to the NRA Head Office and Regions. The NCDM report on the following:

- demand forecasting.
- domestic and non-domestic metering.
- domestic consumption monitoring studies.
- leakage from customer and company pipes.
- industrial and agricultural demand.
- water restrictions.
- levels of service to water supply customers.
- tariffs and economic incentives.
- water saving technology.
- customer and water company education on efficient water use.

**River Flow Down**

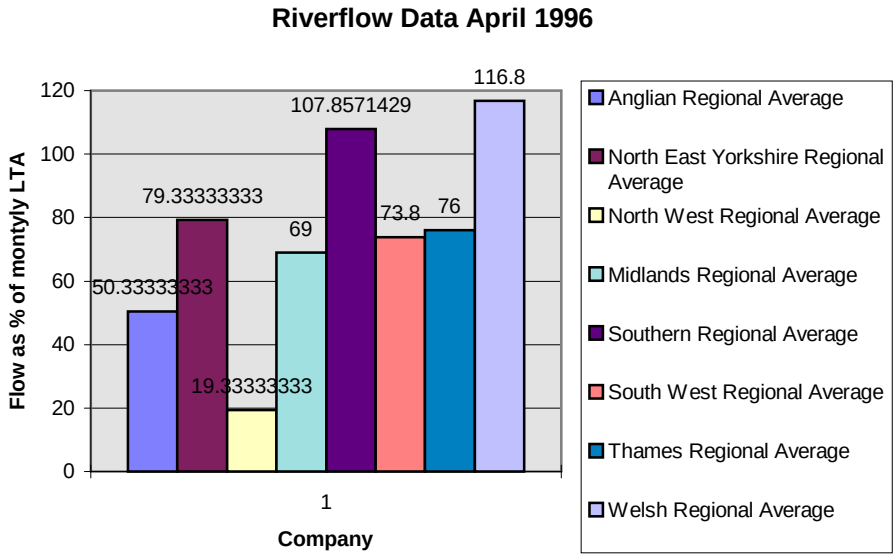



Figure 22 Graph showing the average river flow in the main river in England and Wales, April 1996 (source: EA plans to safeguard summer water supplies. May 1996)

It can be seen from the graph (fig 21) that the worst hit area is the North West Regional area with 19.33% of long term average, as the UK relies on river flow for most of its water supply, this highlights the critical balance of supply exceeding demand with all but two of the rivers below the expected flow rate for that month. Abstraction from these rivers must be done with care so not to reduce the flow any more.

## SECTION 2. TO WATER OR NOT TO WATER ?

Overview.

- Companies have reported an increase in the demands for water consumption (measured by distribution input) during the summer of

1995. "This peaking has be for a longer period than previous years." - OFWAT Report May 1996

- There is a increasing trend in watering gardens (linked to the prolonged hot summer). This can result in peak demands.
- An increase in winter consumption in some companies.
- There is little evidence to show an increase in non-household demand and the underlying growth of household usage. This suggests an increase in winter demand might be due to increased leakage.
- Metering can have a significant effect on reducing peak demands increased by watering.

*Company demand forecasts in Strategic Business Plans (SBPs)*

The table below shows the level of demand for water as submitted to OFWAT in their SBP in March 1994, each year the water companies of England and Wales have submit this data. The companies have to predict the amount of water they expect to use in the coming year. The Data comes from *Future levels of demand and supply for water* ,OFWAT (November 1994).

Table 3: Changes in components of demand forecast in Strategic Business Plans (SBPs).

| Component | Level forecast for 1994 -95 (Ml/d) | Change in Ml/d 1994 -95 to 2014-15 | % change 1994 -95 to 2014 -15 |
|---|---|---|---|
| Water Delivered to households | 8,120 | 1,010 | 12.4 |
| Water delivered to non-households | 4,168 | -192 | -4.6 |
| Distribution losses | 3,517 | -725 | -20.6 |
| Distribution input | 15,940 | 93 | 0.6 |

Source : Report on recent patterns of demand for water in England and Wales : OFWAT : May 1996.

The SBP gives a long term plan to guide for companies and in this case the SBP shows the assumed usage of water for 1994 - 1995. This data was based on previous historical information. The forecast expected a very small growth (0.6) in the distributed input i.e. the amount of water consumed. According to the figures from OFWAT water consumption patterns will change. They give an optimistic view of water usage, with an increase in house hold water usage to be increased by 1,010 Ml/d in the year 2014, from the present usage of 8,120 Ml/d. This gives an annual growth percent change at about 0.62. There will be a reduction in the amount of the forcasted distribution losses, -20.6 % change from 1995 to 2015, compare this to the actual amount of demand.

| Component (Ml/d) | Forecasts in SBP`s for 1994-95 | 1994-95 out turn | Factors accounting for difference |
|---|---|---|---|
| Water delivered to house holds | 8120 | 8305 | Consumption 141 Supply pipe leakage 44 |
| Water delivered to non-households | 4168 | 4290 | Measured consumption 69 Meter under registration 53 |
| Other uses | 136 | 181 | Water taken unbilled 45 Operational uses 0 |
| Distribution losses | 3517 | 3711 | 194 |
| Distribution input | 15940 | 16485 | 545 |

Table 4 To show the error in forecast from the SBP and the read data.

So the actual figures show an increase in the amount of water losses for the year 94/95. This could be due to the fact that the summer of 1995 recorded peak demands. Some water companies had to impose hosepipe bans so they were in a DG1 (population at risk of water shortages) and a DG4 (population subject to hosepipe bans).

The report concluded:

*"Where companies are experiencing a rise in peak demands accentuated by garden watering, there is evidence that metering of households properties ( particularly sprinkles use) can have a significant effect on reducing the peak demands. Companies and zones with a relatively high proportion of household meters generally did not experience such high peak demands during 1995 as similar areas with a lower proportion of household meters. As a result of the peak demands experienced in the summer of 1995, a number of companies now compulsorily meter sprinkles users" and "where companies have experiencing an increase in leakage or where levels are high then it is important that companies reduce leakage to economical levels."*

## Water Demand in England and Wales

Table 5 Average Household use of water in Europe (l/head/day).

| Number in household | Very High Usage | High Usage | Average Usage | Low Usage |
|---|---|---|---|---|
| 1 | 190 | 100 | 80 | 30 |
| 2 | 240 | 130 | 120 | 60 |
| 3 | 260 | 160 | 150 | 80 |
| 4 | 290 | 190 | 180 | 100 |
| 5 | 310 | 220 | 200 | 110 |
| 6 | 340 | 250 | 220 | 130 |

All figures shown in $m^3$

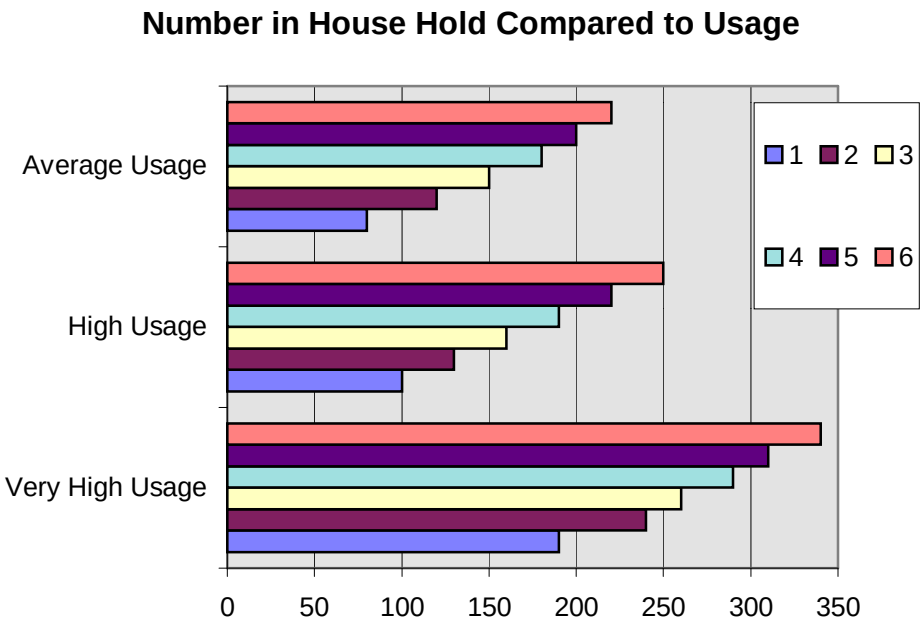



Figure 23 Fig to show the difference between water usage and number of persons in a house.

**Table of Water Use in the UK**

The according to information from Anglian Water the following graph was produced. It shows the losses in each region in England and Wales.

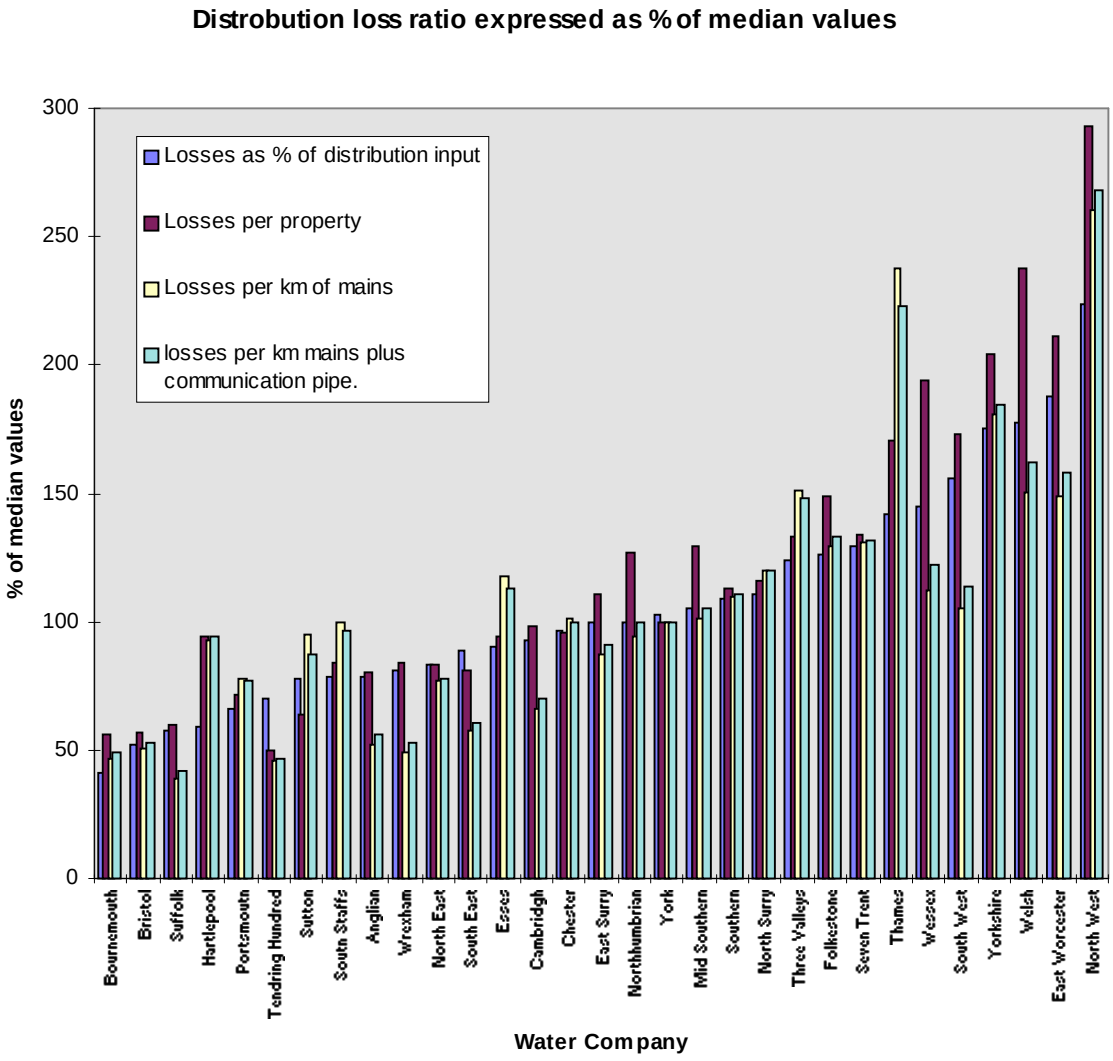



Figure 24 Typical water losses in England and Wales

*Bathroom on average uses :*

- A shower uses 48 litres in 8 minutes.
- A power shower uses 112 litres in 8 minutes.

- A bath uses 80 litres.
- Brushing your teeth uses 9 litres.
- A toilet uses 8 litres a flush.

*Kitchen uses:*

- A dripping tap uses 90 litres a day.
- A running tap uses 9 litres a minute.
- A dishwasher uses 35 litres a cycle.
- A waste disposal unit uses 30 litres a day.

*Garden uses:*

- A hose uses 1100 litres an hour. ( 18.3 litres a minute )
- A sprinkler uses 1100 an hour.
- Washing you car with a hosepipe uses 300 litres.
- A garden seep hose uses 100 litres an hour per 10 meter run.

*Demand Patterns in the UK.*

*Sprinkler and hosepipe sales.*

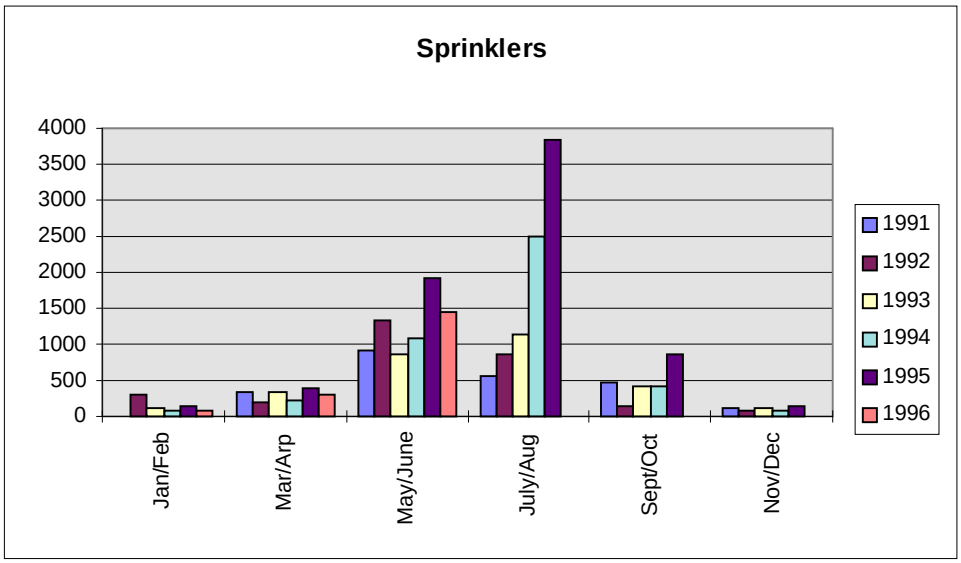



Figure 25 Graph Showing the number of sprinklers sold 1991 to 1996 ( Source: Hose Lock)

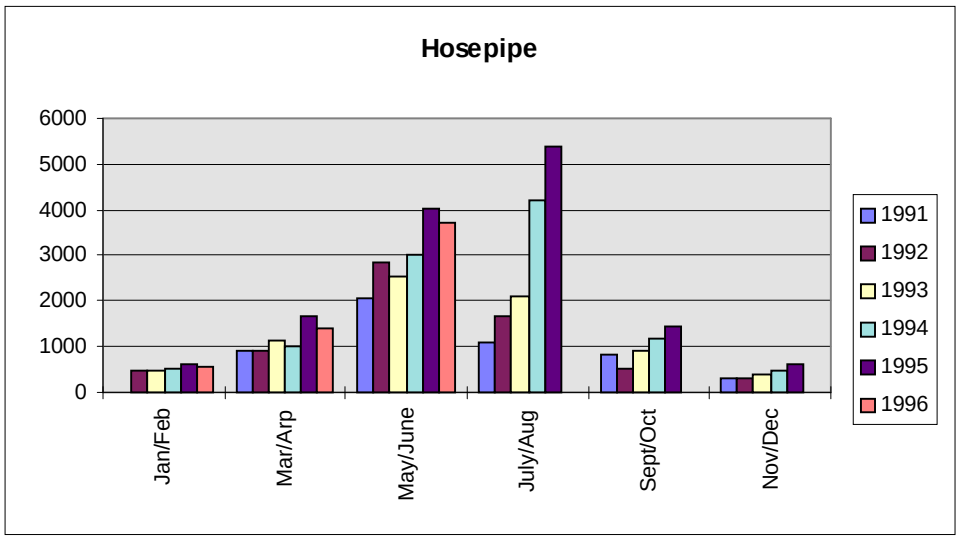



Figure 26 Graph showing the number of hosepipe's sold by Hozelock 1991 to 1996 (source: Hozelock)

The above graph (fig 25) shows the number of sales of hose pipes from 1991 to 1996. There is an increase in the number of hosepipes sold from the months Jan to May from years 1991 to 1995 (1995 being a DG4 period in some regions in England and Wales) but care must be taken as the data only shows the sales in hosepipes to distributors and not to the general public, so stockpiling is not taken into account. As a general picture of the number of hosepipes sold then this is a good indicator. If this is then linked to consumption of water for the same period, see graph below. There is a direct correlation with the number of sales of hosepipes and the amount of water used. This also corresponds to the temperature for the same time period. The higher the average the temperature for a given area the higher the consumption for that area. Also as a general picture the amount of irrigation equipment also increases. According to some of the water companies:

"*Hosepipe and sprinkler ownership has grown from 42% and 11% respectively in 1991 to 49% and 16% respectively in 1994.*" Thames

"*The rise from 14% in 1990 to 21% in 1994 in the ownership of outside taps was not anticipated.*" Hartlepool

But one water company has estimated that in the UK, garden watering probably does not account for more than 10% of the total consumption even on the hottest days. The ownership of hosepipes still lags behind France and

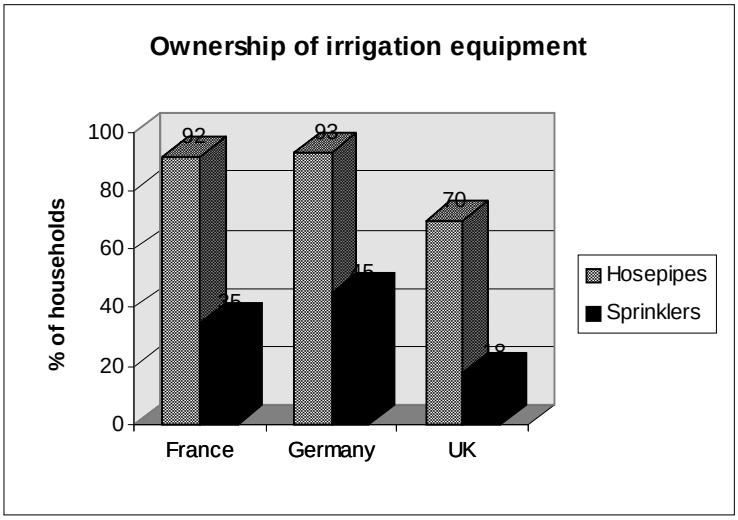



Figure 27 Ownership of irrigation equipment - International comparison

Germany, which my suggest that the current market still has room to grow.

*Peak demands*

During the dry, hot summer of 1995 there were peak demands for water. It is necessary to consider factors which will have an impact hot and day weather has on demand. The largest peak in this demand is due to household demand. To understand the changes it is necessary to find the difference between

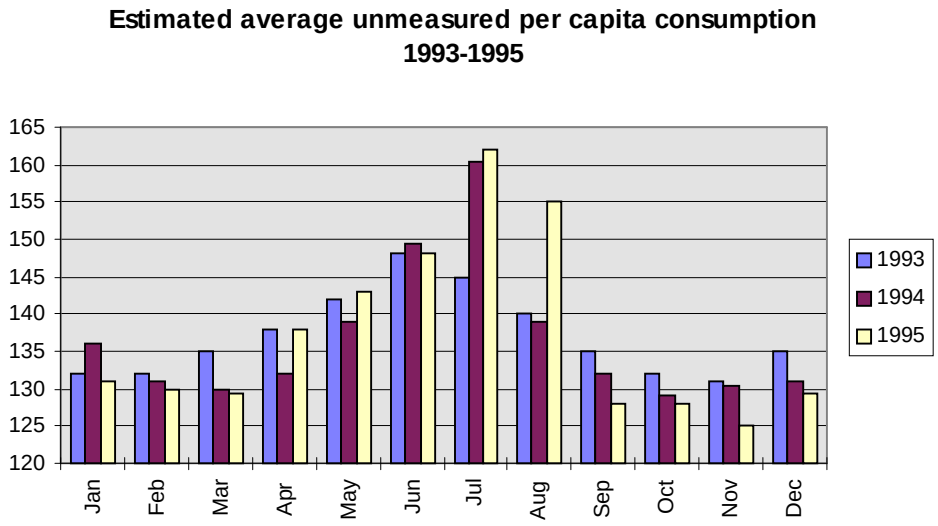



Figure 28 Graph showing the amount of water used in litres per head per day from 1993 to 1995 (source: OFWAT, Report on recent patterns of demand for water in England and Wales.)

domestic use and non-domestic use.

*Household use for non-domestic purposes (e.g. garden watering)*

According to OFWAT report of may 1996 'A number of companies have reported an increase in water used on the garden in recent years. Use of garden watering equipment is generally confined to the summer months (especially early summer) and is mainly consternated in the evening.' and ' Increase in ownership of such equipment can lead to greater average demand levels and more 'peaked' distribution, especially during hot, dry summers.' The sales of

irrigation (hosepipes and sprinklers) equipment confirms this with sales from Hozelock increasing during the so called drought years, sale falling in cold years and sales increasing in warmer year where there is less rain fall (see fig 24 and 25, sales data from Hozelock.)

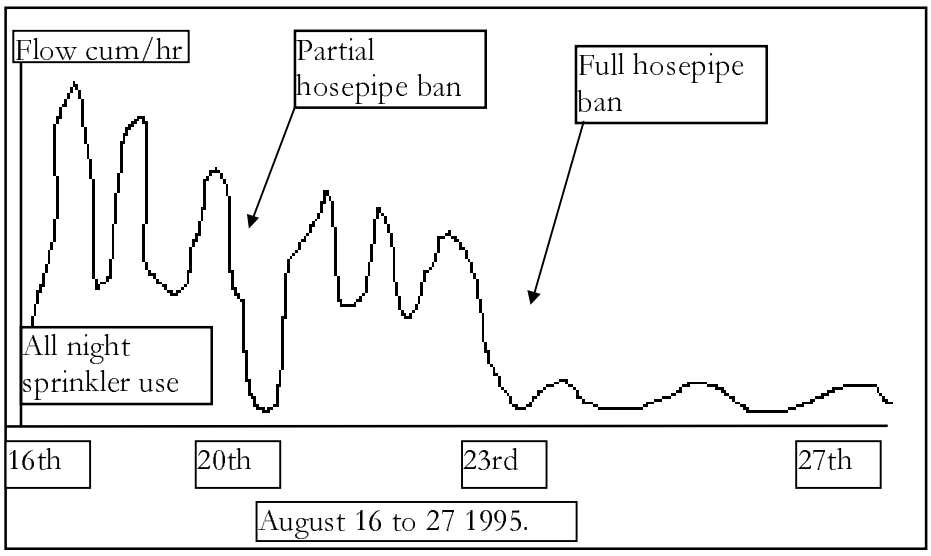
There has been very little research into consumption in household gardens, however evidence from the water companies and the trend in the garden watering market can be used as a guide.

The water companies have provided only anecdotal evidence on increasing watering over the summer of 1995:

"*There are...numerous anecdotal reports of sprinklers left running continuously for long periods.*" North Surrey.

"*Usually our peak hour demands occur between 7am and 9 am. However, when problems were notified during this summer (summer of 1995), it was between 6pm and 10pm. This leads us to assume that out major increase in demand could be largely attributed to garden watering.*" South East

"*The greatest load on the distribution system during peak periods trends to occur between 7 and 9pm, usually, but not always on a Sunday when demand can exceed 400% of average. There is little doubt that this is almost all due to garden watering especially sprinklers.*" Sutton.



It can be seen from the above graph ( amended from OFWAT May 1996) of the demands in a rural suburb of stonebridge in which all properties have large gardens, that at the initial demand, the 16th to about the 23rd (full hosepipe ban). From the 16th to the 20th there were significant levels of overnight sprinkler use. After the 23rd August 1995, when the hosepipe took effect (and temperature returned to near normal levels), demand returned to the expected levels for the area. So the hosepipe ban did have an impact on the demand level for that period.

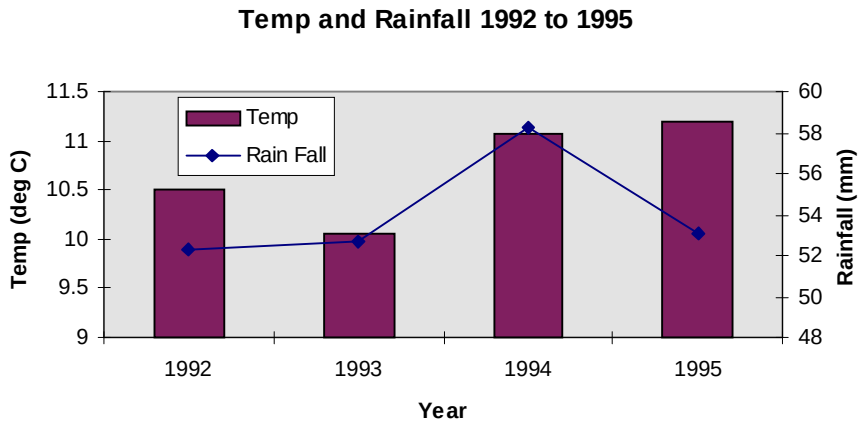



Figure 29 Rainfall and Temp data from Met Office Wisley Guilford weather station.

The above Rainfall and Temp graph (fig 31) shows higher that average temps for England and Wales (average temp in England and Wales is 10.0787°C from 1945 to 1990), so confirming the droughts of 1988-1992 and 1995

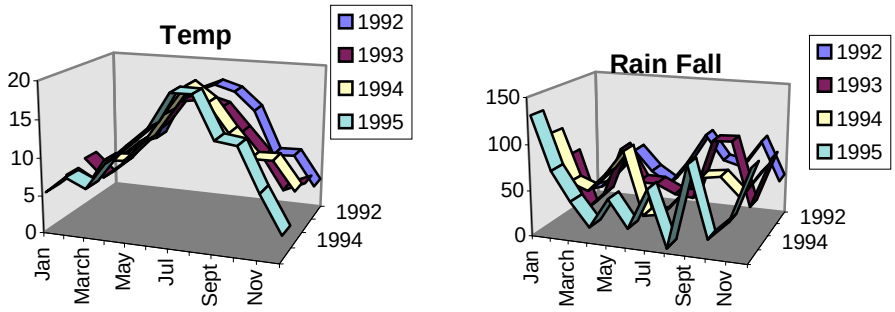



Figure 30 Rainfall and Temp from 1992 to 1995.

**New Technology against Drought-Large Scale.**

*Could rocks end drought ?*

As it has been shown the UK could soon be subject to a change in weather patterns, if the fact and figures about global warming are true.

*Controlling evaporation during storage.*

With limited rainfall and groundwater available to meet the increasing demand for water, 'water loss control' is becoming an important factor to consider. One way to limit the amount of evaporation. In World Water October 1996 p20 there is outlined a system for reducing evaporation by up to 50%.

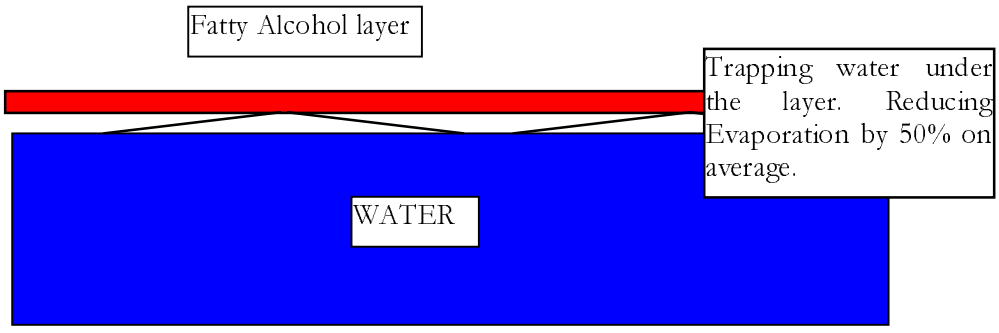



Figure 31 *Hydrotech is an emulsion of fatty alcohol's in water*

*'Hydrotech is an emulsion of fatty alcohol's in water. It has a creamy like consistency and can be easily diluted with water. When diluted emulsion is applied to the surface of the water it forms an invisible layer and is clamed to reduce evaporation by 50% on average'*

*A look at the devices available for the recycling and more efficient use of water in the domestic context, and in particular how these relate to domestic gardening.*

**What can Be done by the water companies to reduce demand.**

*Water Byelaws*

The Byelaws are to enable the water companies to enforce they to prevent waste, undue consumption, misuse or contamination of water supplies. This comes under section 17 of the Water Act 1945. In 1989 when the water companies became privatised, these powers were removed in the 1989 Water Act as it was thought the private sector should not have such powers. The replacement to this act was the new section 74 of the Water Industry Act 1991. Proposed amendments to the act are.

- requirements for all new houses to have a shower.
- prescribed maximum water use volumes for toilets, dishwashers and washing machines.
- maximum flow volume shower heads.
- better design of hot water systems. (no long pipe runs)
- compulsory metering of houses with swimming pools.
- whether hoses should be actuated by a spring loaded trigger mechanism.
- minimum urinal control systems to be made mandatory.

**Options Available and the Cost Incurred.**

Some of these figures are based upon the Saving Water Report 1995 by the NRA.

*1. Domestic Metering - Water Company.*

- Domestic properties metered over 20 period to achieve 95% of all properties metered.
- Actual cost of meter installation = £200.
- £12/prop/year for meter reading, billing enquiries and replacing meters. This figure includes £40 of the initial installation so the capital element is £160/prop.
- Where meters are install average demand is reduced by 10%
- Where meters are installs supply pipe leakage is reduced by 1.5 l/prop/hr.

*2. Leakage Detection and Repair. - Water Company.*

- Water companies with total losses (including supply losses) currently less than 6 l/prop/hr remain at this level
- Water companies with distribution losses currently greater that 6 l/prop/hr achieve.
- To achieve 6 l/prop/hr requires increasing annual marginal cost from 4.7p/$m^3$ (current) to 17.0p/$m^3$ (20 years) and maintaining this level for 40 years.

*3. WC Replacement/Conversion. - Domestic*

- Average volume per flush (England & Wales) = 9.5 litres.
- Average number of flushes per household per day 10.5 f/h/d ( source: Water Facts 1992)

- 10% of households have either dual flush or 7.5 litre flush WC's as follows

| | |
|---|---|
| Pre 1981 | 90% |
| dual flush (9/5 litres) | 7% |
| 7.5 litre flush | 3% |

Table 6 For pre 1981 WC's the volume / flush is 9.81 litres

- 20 % of house holds have 2 WC's
- 25% of non-household use is domestic, of which 43% is WC flushing, 5.052 million WC's.

Based on these results there are various option which enable the water companies to reduce the demand for flushing WC's.

Option 1.

Convert pre-1981 WC's with 7.5 litre flush. By drilling small hole in siphon. Cost £30/WC.

Option 2.

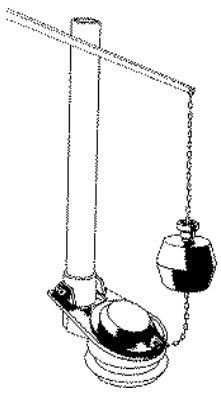
Replace pre-1981 WC's with 6 litre flush. Cost £300/WC.

Option 3.

Convert pre-1981 WC's with a 9 litre/5 litre dual flush, with average 6.15 litre/flush. Cost £30/WC.

Option 4.

Reduce the flush volume available by fitting a restraining device. Such as the devices below.



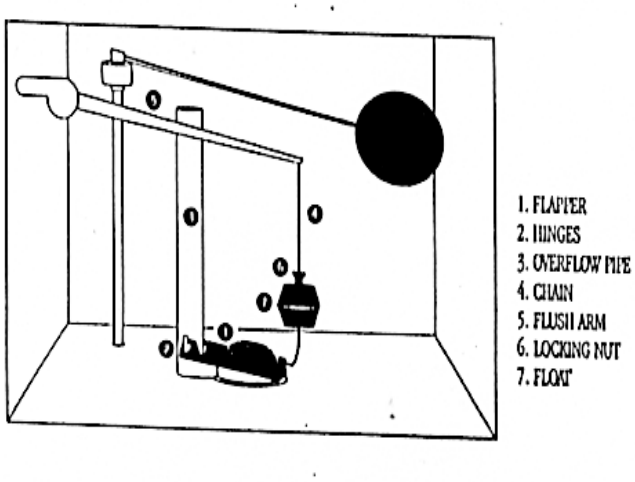



Figure 32 Fig 34 Devices for Reducing the Water flow in a WC.(Source: American Water and Energy Savers, Inc. Internet)

FLOAT-A-FLAPPER was designed to easily replace your existing flappers. Even though it reduces usage by 30%-50%-you get a clean efficient flush every time.

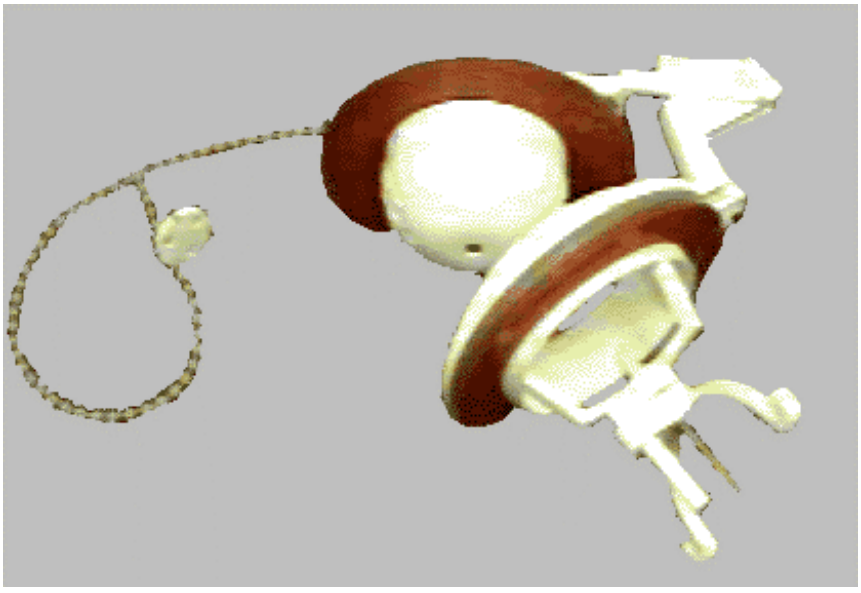


Figure 33 FLUSHMISER (Source : Internet Designed by Ivette Zuloaga)

*4. Use of Grey Water for WC flushing - Domestic*

Water used for WC flushing:

= Av. volume/flush (9.5 litres) X av. no. flushes/day (10.5 litres) X no. of households.

If any of the WC replacements/conversion options are implemented the potential saving is correspondingly reduced. Capital cost/household = £1000 (approximate cost of recycling system). Cost of annual maintenance = £15/prop/year.

*5. Shower Installation - Domestic*

- A bath uses 80 litres of water per use.
- A shower uses 35 litres of water per use.
- 95% of households have baths at 0.6 uses/day/household and 25% of households have showers at 0.55 uses/day/household.(source: Water facts 1992)
- 75% of households to have showers installed over a twenty year period.
- Showers would be used totally at the expense of baths and at the rate of 0.55/day/household.
- £200 per shower installed.

*6. Controllers on Urinals - Water Company/Domestic/Industrial*

- 20% of non-household use is used for urinal flushing. (Webster 1979)
- 20% of non-household have urinals.
- Of those, 75% do not have controllers and so flush at equal time intervals, day and night, and over the weekends.
- Controller reduces consumption by 79%
- Cost/controller = £200.

*7. Low volume shower heads - Domestic.*

- Applied to all households as part of installation programme or as retrofit programme.
- Volume/use of shower reduced by 10%
- Cost = £10/shower.

*8. Efficient washing machine - Domestic.*

- Washing machine use assumed to be 110 litres/cycle (source: Water facts 92)
- Water efficient washing machine now use 80 litres/cycle and it is stipulated in the water Byelaws that all new machines must not exceed 80 litres/cycle.
- Although ownership levels of 85%, total saving is calculated on the basis of every household having a washing machine. Households without washing machines will be using machines at a launderette.
- Uses/household/day at 0.75 and saving of 30 litres/cycle (110-80)
- The cost of this option (to the undertaker) is zero as water efficient washing machines would be introduced as householders replace their existing machines.

*9. Efficient Dishwashers - Domestic*

- From published figures a household with a dishwasher uses only 7.1 litres/day more than a household without one. At 25 litres/use so there is little scope for improvement. (source: Which Magazine)

*10. Car washing and external use - Domestic.*

- Currently comprising of some 3% per capita demand, it is expected this will reduce due to metering and through education.

*11. Resource development cost.*

Resource development costs including treatment and distribution varies from £0.75 m/Ml/day to £1.5m/ML/day and has been made up from the following:

Low resource costs (£0.75 m/Ml/day)

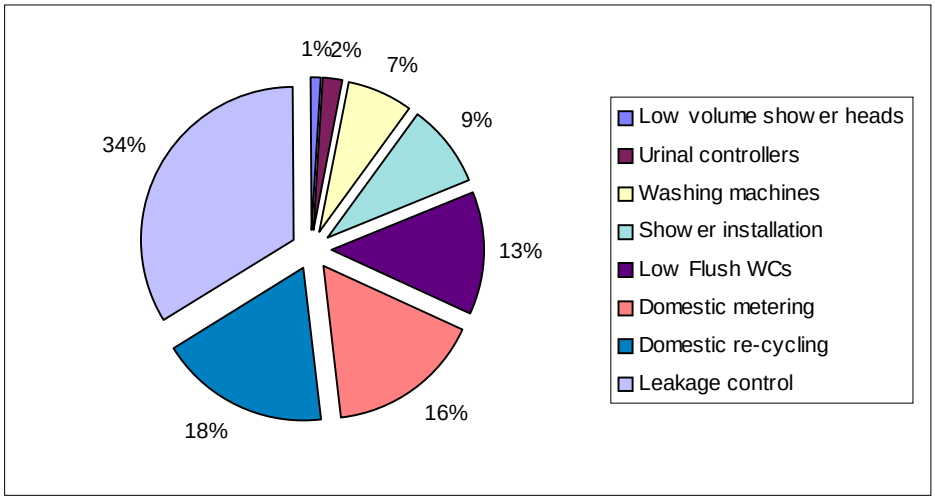
£500,000 per Ml/d of capacity, resources and treatment.

+£100,000 per Ml/d of bulk transfer costs

- 25% on cost to allow for leakage and operational use.

High resource cost (£1.5 m/Ml/day) are double this cost.

Figure 34 Potential water savings in a domestic context., based of the data from the NRA.




(Source: NRA/OFWAT)

## Potential water savings

### Saving Water in the home

*Results of Analysis*

Table 6 showing the potential saving S&E and N&W (England and Wales) Data from Saving Water NRA Report

| Demand Option | Saving South and | Saving North and | Total |
|---|---|---|---|

| | East | West | |
|---|---|---|---|
| Leakage Control | 900 | 1440 | 2340 |
| Domestic Re-cycling | 1260 | 710 | 1970 |
| Domestic metering | 650 | 410 | 1060 |
| Low flush WCs | 550 | 300 | 850 |
| Shower Installation | 390 | 220 | 610 |
| Efficient washing machine | 280 | 160 | 440 |
| Controllers on Urinals | 90 | 50 | 140 |
| Low volume shower heads | 25 | 15 | 40 |
| Total | 4145 | 3305 | 7450 |

all figures in Ml/d

The above graph (Fig 35) from the National River Authority Shows that the

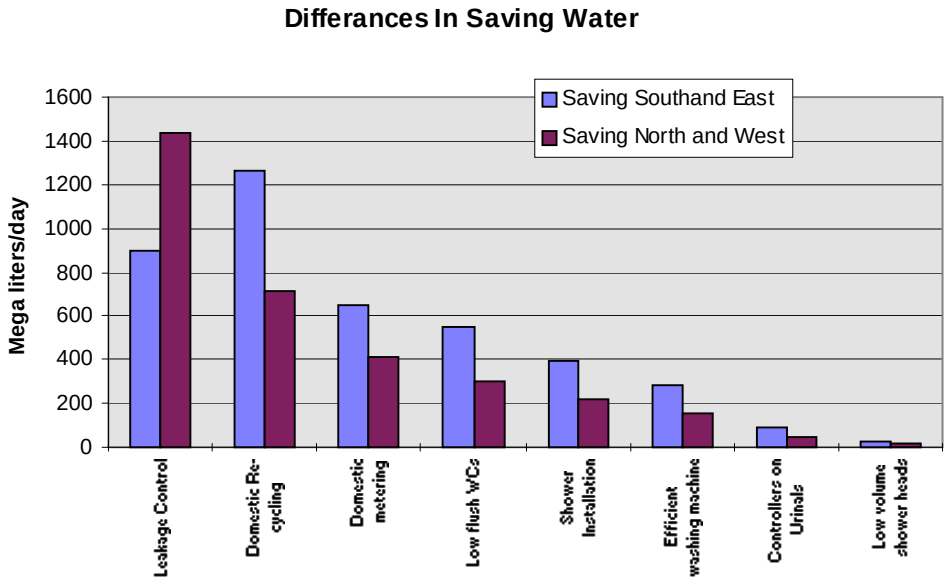



Figure 35 Graph showing the differences between Saving Water in South/East and North/West..(Source : Saving Water, NRA Report.)

main concern with drought areas is leakage control. Second to this is the Domestic Recycling in the South and East of England and Wales. This is the area of most interest and has the second highest potential for saving water, only to Leakage Control (see fig 36).

**Demand Management Priorities.**

The following priorities areas should be the water saving focus of a national Demand Management Strategy.

- Leakage Control.
- Selective domestic metering.
- Education.
- Water efficient appliances.
- Byelaws.

49 WAYS TO SAVE WATER (source : American Water and Energy Savers, Inc. Internet site)

SAVING WATER INDOORS

1. Never put water down the drain when there may be another use for it such as watering a plant or garden, or cleaning.
2. Verify that your home is leak-free, because many homes have hidden water leaks. Read your water meter before and after a two-hour period when no water is being used. If the meter does not read exactly the same, there is a leak.
3. Repair dripping faucets by replacing washers. If your faucet is dripping at the rate of one drop per second, you can expect to waste 2,700 gallons per year which will add to the cost of water and sewer utilities, or strain your septic system.
4. Check for toilet tank leaks by adding food colouring to the tank. If the toilet is leaking, colour will appear within 30 minutes. Check the toilet for worn out, corroded or bent parts. Most replacement parts are inexpensive, readily available and easily installed. (Flush as soon as test is done, since food colouring may stain tank.)

5. Avoid flushing the toilet unnecessarily. Dispose of tissues, insects and other such waste in the trash rather than the toilet.
6. Take shorter showers. Replace you shower head with an ultra-low-flow version. Some units are available that allow you to cut off the flow without adjusting the water temperature knobs.
7. Use the minimum amount of water needed for a bath by closing the drain first and filling the tub only 1/3 full. Stopper tub before turning water. The initial burst of cold water can be warmed by adding hot water later.
8. Don't let water run while shaving or washing your face. Brush your teeth first while waiting for water to get hot, then wash or shave after filling the basin.
9. Retrofit all wasteful household faucets by installing aerators with flow restrictors.
10. Operate automatic dishwashers and clothes washers only when they are fully loaded or properly set the water level for the size of load you are using.
11. When washing dishes by hand, fill one sink or basin with soapy water. Quickly rinse under a slow-moving stream from the faucet.
12. Store drinking water in the refrigerator rather than letting the tap run every time you want a cool glass of water.
13. Do not use running water to thaw meat or other frozen foods. Defrost food overnight in the refrigerator or by using the defrost setting on your microwave.
14. Kitchen sink disposals require lots of water to operate properly. Start a compost pile as an alternate method of disposing food waste instead of using a garbage disposal. Garbage disposals also can add 50% to the volume of solids in a septic tank which can lead to malfunctions and maintenance problems.

15. Consider installing an instant water heater on your kitchen sink so you don't have to let the water run while it heats up. This will reduce heating costs for your household.
16. Insulate your water pipes. You'll get hot water faster plus avoid wasting water while it heats up.
17. Never install a water-to-air heat pump or air-conditioning system. Never air-to-air models are just as efficient and do not waste water.
18. Install water softening systems only when necessary. Save water and salt by running the minimum amount of regenerations necessary to maintain water softness. Turn softeners off while on vacation.
19. Check your pump. If you have a well at your home, listen to see if the pump kicks on and off while the water is not in use. If it does, you have a leak.
20. When adjusting water temperatures, instead of turning water flow up, try turning it down. If the water is too hot or cold, turn the offender down rather than increasing water flow to balance the temperatures.
21. If the toilet flush handle frequently sticks in the flush position, letting water run constantly, replace or adjust it.

## SAVING WATER OUTDOORS

1. Don't over water your lawn. As a general rule, lawns only need watering every 5 to 7 days in the summer and every 10 to 14 days in the winter. A hearty rain eliminates the need for watering for as long as two weeks. Plant it smart, Xeriscape. Xeriscape landscaping is a great way to design, install and maintain both your plantings and irrigation system that will save you time, money and water. For your free copy of "Plant it Smart," an easy-to-use guide to Xeriscape landscaping, contact your Water Management District.

2. Water lawns during the early morning hours when temperatures and wind speed are the lowest. This reduces losses from evaporation.
3. Don't water your street, driveway or sidewalk. Position your sprinklers so that your water lands on the lawn and shrubs ... not the paved areas.
4. Install sprinklers that are the most water-efficient for each use. Micro and drip irrigation and soaker hoses are examples of water-efficient methods of irrigation.
5. Regularly check sprinkler systems and timing devices to be sure they are operating properly. It is now the law that "anyone who purchases and installs an automatic lawn sprinkler system MUST install a rain sensor device or switch which will override the irrigation cycle of the sprinkler system when adequate rainfall has occurred." To retrofit your existing system, contact an irrigation professional for more information.
6. Raise the lawn mower blade to at least three inches. A lawn cut higher encourages grass roots to grow deeper, shades the root system and holds soil moisture better than a closely-clipped lawn.
7. Avoid overfertilizing your lawn. The application of fertilizers increases the need for water. Apply fertilizers which contain slow-release, water-insoluble forms of nitrogen.
8. Mulch to retain moisture in the soil. Mulching also helps to control weeds that compete with pants for water.
9. Plant native and/or drought-tolerant grasses, ground covers, shrubs and trees. Once established, they do not need to be watered as frequently and they usually will survive a dry period without any watering. Group plans together based on similar water needs.
10. Do not hose down your driveway or sidewalk. Use a broom to clean leaves and other debris from these areas. Using a hose to clean a driveway can waste hundreds of gallons of water.

11. Outfit your hose with a shut-off nozzle which can be adjusted down to fine spray so that water flows only as needed. When finished, "Turn it Off" at the faucet instead of at the nozzle to avoid leaks.
12. Use hose washers between spigots and water hoses to eliminate leaks.
13. Do not leave sprinklers or hoses unattended. Your garden hoses can pour out 600 gallons or more in only a few hours, so don't leave the sprinkler running all day. Use a kitchen timer to remind yourself to turn it off.
14. Check all hoses, connectors and spigots regularly.
15. Consider using a commercial car wash that recycles water. If you wash your own car, park on the grass to do so.
16. Avoid the installation of ornamental water features (such as fountains) unless the water is recycled. Locate where there are mineral losses due to evaporation and wind drift.
17. If you have a swimming pool, consider a new water-saving pool filter. A single backflushing with a traditional filter uses from l80 to 250 gallons or more of water.

## GENERAL WATER SAVING TIPS

1. Create an awareness of the need for water conservation among your children. Avoid the purchase of recreational water toys which require a constant stream of water.
2. Be aware of and follow all water conservation and water shortage rules and restrictions which may be in effect in your area.
3. Encourage your employer to promote water conservation at the workplace. Suggest that water conservation be put in the employee orientation manual and training program.

4. Patronise businesses which practice and promote water conservation.
5. Report all significant water losses (broken pipes, open hydrants, errant sprinklers, abandoned free-flowing wells, etc.) to the property owner, local authorities or your Water Management District.
6. Encourage your school system and local government to help develop and promote a water conservation ethic among children and adults.
7. Support projects that will lead to an increased use of reclaimed waste water for irrigation and other uses.
8. Support efforts and programs to create a concern for water conservation among tourists and visitors to our state. Make sure your visitors understand the need for, and benefits of, water conservation.
9. Encourage your friends and neighbours to be part of a water conscious community. Promote water conservation in community newsletters, on bulletin boards and by example.
10. Conserve water because it is the right thing to do. Don't waste water just because someone else is footing the bill such as when you are staying at a hotel.

11.Try to do one thing each day that will result in a savings of water. Don't worry if the savings is minimal. Every drop counts. And every person can make a difference. So tell your friends, neighbours and co-workers to "Turn it Off" and "Keep it Off".

## Watering Systems for Garden

This section will take a closer look at irrigation equipment for the Garden, and the main problems people in England and Wales experience with their water. According to the NRA "The drought of 1984, 1988 - 92 and 1995 have risen the awareness of the need to use water sensibly." Care has to be taken to use recycled water or re-use water where ever possible.

*Sprinklers*

*Soaker Hoses*

*Drip Systems*

One technique that can result in water saving is the use of trickle or drip irrigation techniques rather than the more conventional spry irrigation methods. Drip irrigation can be up to 95% efficient whereas with spray irrigation this can be as low as 35% due to evaporation losses. Australia, Israel, Mexico, South Africa and the USA were all using methods of drip irrigation by the mid 1970s.

*Gravity Distribution Systems*

*Overhead Irrigation*

*Water Sorces other than the Mains*

*Pump Types*

**Common Water problems in the Garden**

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http://www.americanwater.com/ - American Water & Energy Savers

http://ag.arizona.edu/AZWATER/ - Arizona Water Resources Research Center

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http://darcy.uwaterloo.ca/ - Waterloo Centre for Groundwater Research

http://www.wvawater.com/ - West Virginia-American Water

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## LIST OF ORGANISATIONS CONSULTED

### INDUSTRY

Peek Measurement.

Balmoral Composites.

Munters Incentive Group-
Environmental
Components Division.

ELE International Limited.

Highland Tank.

Waterloo hydrogeologic.

Blue-White Industries.

Triogen.

Sensus Metering Limited.

### INSTITUTES

Oxford Brookes

- Mechanical Engineering Department.
- Civil Engineering Department.
- Geography Department.

Linacre College Oxford.

### REGULATORS

OFWAT.

Drinking Water Inspectorate.

Environment Agency

Seven Trent Water.

Thames Water Ltd.

Essex & Suffolk Water.

Met Office, London.

Anglian Water Services.

## GLOSSARY OF TERMS

**Active leakage control**: Water Company operating practices of detecting leakage from knowledge of night flows, pressure etc.

**Aquifer**: Underground porous rock formed from rocks, sand, gravel and capable of holding large amount of water.

**BABE**: Idea from the National Leakage Control Initiative, Bursts and Background Estimates.

**Background Leakage**: The background leakage is due to small leaks which would be uneconomical to fix.

**Byelaws**: The byelaws exist to prevent waste, undue consumption, misuse of contamination of water. They are due for up review in 1997.

**Consumption**: The sum of water supplies to the customer and plumbing losses.

**Consumptive use**: Use of water which is not returned to an aquifer or to a river via sewage works e.g. garden water.

**Drought:** A marked deficiency of rain compared to that usually occurring at the place or season under consideration.

**Drought Order** : A means where a water company and/or the NRA can apply to the Secretary of State for the imposition of water restrictions.

**DG1**: Population at risk of water shortages.

**DG2**: Properties at risk of low pressure.

**DG3:** Properties subject to unplanned supply interruptions of 12 hours of more.

**DG4**: Population is subject to hosepipe bans.

**DG5**: Properties at risk of sewer flooding.

**DG6**: Billing queries not responded to within 20 days

**DG7**: Written complaints not responded to within 20 days.

**Dual Flush WC**: A WC with two flush settings, 9 litres for long and 5 litres for short.

**Earth Summit:** The meeting of world leaders at Rio in 1992 to talk about the world environment.

**Economic level of Leakage**: The level of leakage where the marginal cost of find the leaks equals the marginal cost of the leaking water.

**Flush Controllers**: Devices that can be fitted to sestinas to control the amount of volume flow.

**K factor:** The amount over and about inflation which water companies can charge their customers.

**L/h/d:** Litres per head per day.

**L/km/sec:** Litres per km of main per second.

**L/prop/hr:** Litres per property per hour.

**$M^3$/km/day:** cubic meter per km of distribution network per day.

**Minimum night flow:** The min flow into a discrete distribution area during the night. Used by the water companies to determine the leakage level.

**Ml :** Mega litres or 1 million litres.

**Ml/day :** Mega litres per day ( approx. 220,000 gallons per day)