

**Preliminary Cost Effectiveness Analysis (pCEA) of Water
Resources Measures to meet WFD Environmental
Objectives.**

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Contents

Summary

1. Introduction
2. WFD Environmental Objectives and Basic Measures to manage abstraction
3. Abstraction Pressures on Flows and water levels in water bodies
4. Existing Measures to Manage Abstraction Pressures
5. Estimating the impact of Abstraction on WFD Objectives
6. Cost effectiveness of Measures to reduce Potential Flow Deficits
7. National Priorities for Additional Measures to Manage Abstraction Pressures
8. Phasing of a Programme of Water Resources Measures to meet WFD Objectives

Note on Statistics and Cost Information for Wales

References

Appendix 1: Details of the two Scenarios for WR Measures

Preliminary Cost Effectiveness Analysis (pCEA) of Water Resources Measures to meet WFD Environmental Objectives.

Summary

The WFD includes environmental objectives to prevent deterioration and improve the ecological status of surface waters. However, it gives no regulatory thresholds or targets to control the impact of water abstraction on river flows, freshwater flows into estuaries and lakes. It requires that groundwater abstraction should not exceed the available groundwater resource of a groundwater body. Each River Basin Management plan is to include measures to control abstraction of ground and surface waters together with promoting an efficient and sustainable use of water to meet environmental objectives.

Water is abstracted to meet a wide range of uses throughout England & Wales. The current rate of abstraction is over 50,000 MI/d for England and 8,000 MI/d for Wales (Environment Agency's Area in Wales). For England, the largest rates of abstraction from both non-tidal surface water and groundwater are for public water supply, while abstraction from tidal waters is dominated by abstraction for power generation. For Wales the largest rates of abstraction are for power generation for both tidal and non tidal waters, with agriculture abstracting the most from groundwater. Over the past 10 years there appear to be no significant trends in the amounts abstracted in England and Wales. These national abstraction patterns mask important regional differences in trends both in quantity and in use.

The long history of Water Resources legislation for England and Wales has resulted in a comprehensive system for managing abstraction licences. This includes management of abstraction licences to meet the flow objectives derived from the Catchment Abstraction Management strategies. However, a significant number of licences were issued over 40 years ago with little or no regard for the impact on the water environment. As a result the Environment Agency is already investigating those licences where the impact is perceived to be unsustainable within its Restoring Sustainable Abstraction (RSA) programme. This programme includes a review of those abstraction licences around *Natura 2000* sites and as required by the Habitats Directive. The majority of these are for public water supply licences.

In 2001 the EA published its strategy for Water Resources management over 25 years. This is used to guide and influence the patterns of abstraction and water use within the Water Company Water Resources Plans. In addition the Water Savings group has been set up to promote an efficient and sustainable water use for England. This group is lead by Defra and is reviewing and promoting a number of measures to limit water demands.

The costs of managing the water resources of England and Wales, including water abstraction, are paid for out of annual charges paid to the Environment Agency by abstraction licence holders. In addition, the costs of modifications to water company licences governing abstraction near Habitats Directive sites are likely to be included

within the periodic review of water price limits in England (PR09). Compensation to modify other types of abstraction licences will be paid for from annual abstraction charges. The total cost of the RSA programme is estimated to be £448m. Proposals by the Water Savings group to meter households in water scarce areas in England are currently out for consultation. The estimated cost of these is £1,000m.

Although the WFD gives no direct regulatory thresholds for controlling abstraction, the WFD UKTAG is developing a suite of conditional standards as a practical guide to managing water abstraction. The standards for lakes and rivers are complete while those for estuaries are still under development. The UKTAG conditional river flow standards for rivers together with those for CAMS can be compared with estimates of river flows to give a measure of the impact of surface and groundwater abstraction. This is termed the potential river flow deficits. The total potential flow deficits for England range from 1059 MI/d to 3388 MI/d and for Wales from 15 to 172 MI/d. The results indicate that 90% of the potential flow deficits for England and 95% for Wales are linked to water company abstraction licences.

The water bodies with potential flow deficits have yet to be matched to the results of the ecological classification as well as compared with the designation of heavily modified water bodies. In addition there are uncertainties attached to both the derivation and the application of the generic conditional flow standards on which the deficits are based. The exact causal links between flow and ecological status require further site specific investigations. Without these there is a risk that the costs of reducing abstraction pressures will not be balanced by the benefits of good ecological status.

The measures to reduce abstraction pressures include:

- relocation or replacement of the abstraction points
- reductions in the demand for water
- mitigation of the impact on the water body
- measures to promote the efficient use of water resource

Of these the relocation or replacement is seen to be the most direct and hence effective. However the costs of replacement sources can escalate in areas of limited resources. The effectiveness can also be limited by the time required to implement replacement sources. Measures to replace sources can take up to 20 years. By contrast measures to reduce water demands such as metering can be installed within five years. The most effective combinations of measures are often unique to the particular areas and supply networks. The Water Company Water Resource plans provide a useful framework for guiding and regulating the pattern of measures. The regional variation in the effectiveness of measures together with measures being applied in unique combinations to particular sites places limitations on national unit cost estimates of measures to reduce potential river flow deficits. For the purpose of this exercise it has been assumed that the national average unit cost of measures to reduce the potential flow deficits lies between £2m and £5m per MI/d for England & Wales.

The programme of additional measures to manage abstraction to support the WFD environmental objectives are grouped around the priorities of measures to:

- Prevent deterioration in status
- Protected area objectives completed by 2015

- Restoration to good status by 2015 unless delays or less stringent objectives can be justified.

The additional measures required to prevent deterioration include the revision of the existing Abstraction Licensing procedures together with measures to curb increases in abstraction and as identified by the Water Savings Group. The measures to meet the Protected Area objectives require secure funding for the revision of abstraction adversely impacting on Habitats Directive sites and as identified in the RSA programme. The effectiveness of measures to manage abstraction to support the restoration of water bodies to good status is hampered by the scientific uncertainties attached to the conditional flow standards and the calculation of potential river flow deficits highlighted in section 5. As such there are risks that measures to reduce potential river flow deficits will not be cost effective in supporting good ecological status.

Given this important caveat, the priorities and estimated costs of measures were used to determine the two scenarios for phasing the programme of measures.

Scenario 1: The estimated range of costs to meet all the WFD environmental objectives by 2015 irrespective of uncertainties in effectiveness and the risks to the continuity of supplies are:

- **England : £ 3,569 m to £17,409m**
- **Wales: £ 72m to £ 905m**

Scenario 2: The estimated range of costs to meet the WFD environmental objectives over three cycles and by 2027 are:

- **England £2,730m to £10,140m**
- **Wales £ 59m to £ 509m**

The bulk of these costs would fall on water company licences.

These estimates are limited by the uncertainties that exist in the causal link between conditional flow standards and attaining good ecological status. As such, the conditional flow standards and the derived potential flow deficits should be used to target a phased programme of site specific investigations as described for scenario 2. These investigations would establish the ecological benefits of reducing abstraction licences. The investigations would also establish how any limitations of flow on supporting ecological status are working in combination with any changes to water quality or channel morphology. Where the need and benefits of measures to reduce abstraction pressures are clearly identified, the cost of the best combination of measures to achieve them would be identified within Water Company Water Resources plans. The costs of measures to reduce other abstraction licences would be included within the Environment Agency's abstraction charges scheme.

1. Introduction

This chapter describes the costs and effectiveness of Water Resources measures to support the environmental objectives within the WFD. The measures include those to manage water abstraction from both ground and surface water together with those to secure a sustainable and efficient water use.

The WFD ecological objectives relate to water quantities in surface and groundwaters are described, as are the pressures from abstraction on the water environment and the measures in place to manage them. This is followed by a description of the information available on the impact of abstraction on the water environment and in particular river flows. The range, cost and effectiveness of measures to manage the pressures and impacts of water abstraction are identified. The priorities for managing the pressure and impacts are outlined, as well as the timing of the programmes of measures to deal with them.

2. WFD Environmental Objectives and Basic Measures to Manage Abstraction

Water abstraction can alter the flows and water levels of surface and groundwaters to such a degree that it may alter the ecological status of surface water bodies. The allowable degree of alteration is by reference to the WFD environmental objectives.

2.1 Environmental Objectives

The WFD environmental objectives relate to

- Surface waters
- Groundwater
- Protected Areas

Surface Waters

The WFD gives no regulatory thresholds or targets to control the impact of water abstraction on river flows, freshwater flows into estuaries and lakes. There are environmental objectives set to maintain and protect the ecological status of surface waters. Ecological status is defined by reference to five classes within an ecological classification. For the high status class, flows are to reflect near natural or undisturbed conditions. For the remaining classes, water quantity is recognised only as a supporting element to the ecological classification¹.

The WFD ecological classification will be completed by the end of 2007. However, to help guide the management of water abstraction, conditional standards have been derived by the UKTAG for river flows and lakes and are under development for freshwater flows into estuaries. These conditional standards provide the best available estimates for the flows required to support the WFD environmental objectives of good ecological status or no deterioration in ecological status. An outline of the available conditional flow standards is given in section 5.1.

The conditional flow standards may be adjusted for those water bodies where the form or flows have been heavily modified to accommodate a specified use such as reservoir impoundments or regulated river stretches. The designation of heavily modified water bodies will be completed by the end of 2007.

Groundwater

The WFD requires that groundwater abstraction should not exceed the available groundwater resource of a groundwater body. The available groundwater resource is defined as the long-term average recharge into the groundwater body minus the groundwater outflows required to maintain the ecological status of dependant rivers and wetlands. The definition of available resource also includes the maintenance of groundwater levels to prevent saline intrusion in coastal groundwater bodies. The practical definition of how to apply the definition to the management of groundwater abstraction is still under development by UKTAG.

Protected Areas

The environmental objectives for protected areas include completion of the Habitats Directive review of existing consents by 2015. This includes assessment of the impact of abstraction on the conservation objectives of *Natura 2000* sites and the modification or revocation of abstraction licences where required.

2.2 Priorities of Measures

The WFD gives priorities for meeting the different environmental objectives. The priorities and how they relate to the management of water abstraction and water quantity are as follows in priority order:

- *No deterioration* in status: Measures to be in place as soon as is practical. For surface water bodies, abstraction should not be allowed to reduce flows to the extent that there is a deterioration in the ecological status i.e. a reduction from one class to another. For groundwater bodies, abstraction must be limited to the available resource.
- *Protected Area objectives*: by 2015 the Habitats Directive objectives should be fully implemented. This requires that abstraction is not and will not adversely effect the conservation objectives of *Nature 2000* sites.
- *Good Status*: by 2015, all water bodies should be restored to good ecological status, unless delays or less stringent objectives can be justified. For surface water bodies abstraction should be reduced where flows are altered to such an extent as to prevent good ecological status. For groundwater bodies groundwater abstraction should be reduced to produce a positive balance in available groundwater resources. For both surface and groundwater, justification for delays in meeting good status or for meeting a less stringent objective would be made on the grounds of technical feasibility or disproportionate costs.

2.3 Basic Measures

The WFD also includes a list of basic measures that are a minimum requirement for the programme of measures and to be included in each River Basin Management plan. Those relevant to Water Resources are the basic measures to:

- implement the Habitats Directive (Art 11.3 a)
- promote an efficient and sustainable water use in order to avoid compromising the environmental objectives (Art 11.3 c)
- manage and control abstraction of surface and groundwater (Art. 11.3 e)

3. Abstraction Pressures on Flows and Water levels in water bodies

Water is abstracted from surface and groundwater sources throughout England and Wales either for use directly by the end user or for treatment by water companies and distribution to industrial and domestic customers. In many parts of England and Wales local sources are insufficient or provide inadequate supplies in dry spells. This has led to the development of a wide variety of supply systems. Most are based on conjunctive use of abstractions from different resources. Water from reservoirs, direct abstraction from rivers and groundwater can be used at different times to give greater reliability. A full description of the major elements of regional water resources are given in the Environment Agency's Water Resources Strategy 2001².

The total amount of water abstracted from, surface water, groundwater and tidal waters in 2004 was 50,496 million litres per day (Ml/day) in England and 8,389 Ml/day in Wales. The breakdown by use for both countries is given in table 1 a, below.

Table 1a 2004 actual abstraction by sector (Ml/d) – groundwater and all surface water

	England		Wales	
	Ml/d	%	Ml/d	%
Agriculture	440	1	223	3
Industry	5716	11	553	6
Public Water Supply	15,631	31	1,578	19
Other Potable Uses	106	<1	<1	<1
Amenity Environmental	3,649	7	419	5
Power Generation	24,953	50	5,615	67
Total	50,496	100	8,389	100

Source: Defra Abstraction Statistics

The largest amount abstracted is for power generation for both England and Wales. However for most sites this often has the least impact on flows with most of the water being discharged back into surface water very close to the point of abstraction. By contrast water abstracted for public water supply is distributed to households through complex supply networks. The discharge of waste water from households via sewer networks to sewage treatment works out falls is very often several kilometres downstream from the original abstraction point.

Tables 1b, 1c and 1d give the actual abstraction for non tidal, tidal surface waters and for groundwater.

Table 1b 2004 actual abstraction by sector (MI/d) – non-tidal surface water

	England		Wales	
	MI/d	%	MI/d	%
Agriculture	218	1	56	1
Industry	3,118	13	539	7
Public Water Supply	10,611	46	1,548	19
Other Potable Uses	40	<1	0	0
Amenity Environmental	3,286	14	419	5
Power Generation	5,981	26	5,580	69
Total	23,254	100	8,142	100

Source: Defra Abstraction Statistics

Table 1c 2004 actual abstraction by sector (MI/d) – tidal surface water

	England		Wales	
	MI/d	%	MI/d	%
Agriculture	1	<1	0	0
Industry	1,924	9	0	0
Public Water Supply	2	<1	0	0
Other Potable Uses	0	0	0	0
Amenity Environmental	0	0	0	0
Power Generation	18,957	91	33	100
Total	20,884	100	33	100

Source: Defra Abstraction Statistics

Table 1d 2004 actual abstraction by sector (MI/d) - groundwater

	England		Wales	
	MI/d	%	MI/d	%
Agriculture	220	3	168	78
Industry	674	11	14	6
Public Water Supply	5,019	79	31	14
Other Potable Uses	66	1	0	0
Amenity Environmental	363	6	0	0
Power Generation	15	<1	2	1
Total	6,357	100	214	100

Source: Defra Abstraction Statistics

Plots of the total water abstracted are given in figure 1 in England & figure 2 in Wales for the period 1994 to 2004. There appear to be no discernible trends in the amounts of water abstracted over this period in both countries. Groundwater forms a significant part of the amount abstracted in England with relatively little being abstracted in Wales.

Figure 1 Actual abstraction 1994-2004 for England

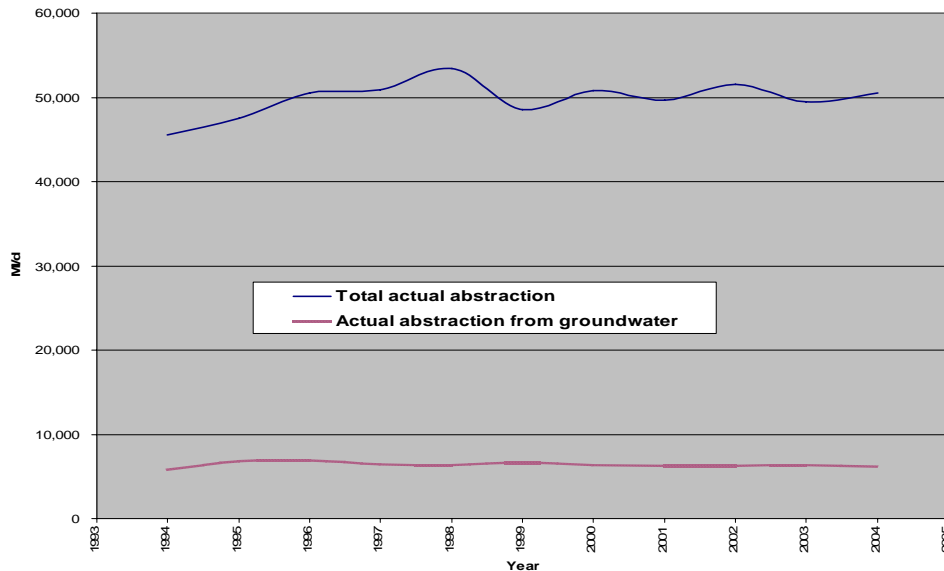
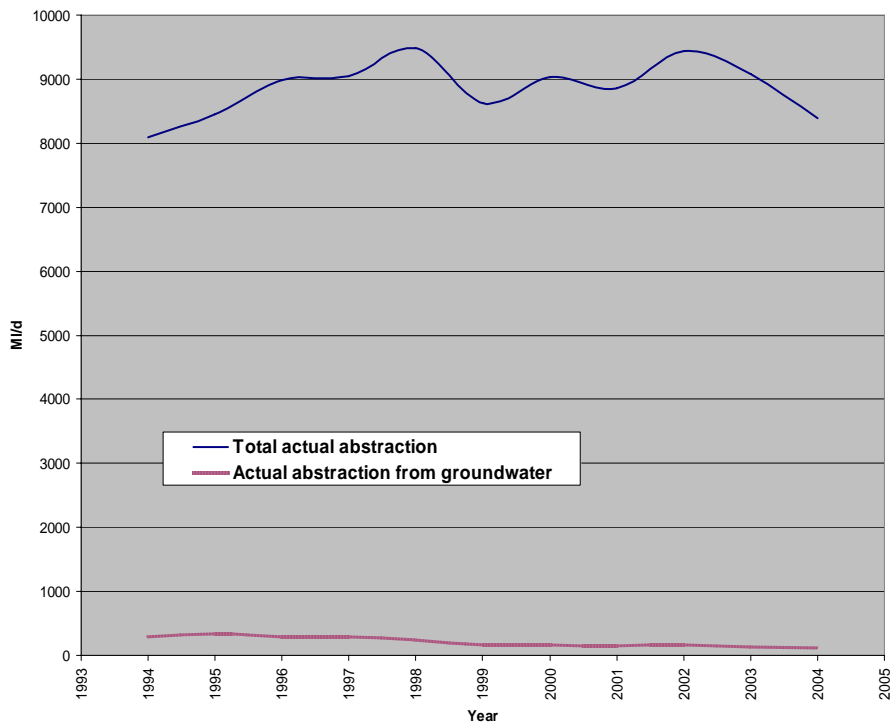


Figure 2 Actual abstraction 1994-2004 for Wales



There are significant variations in the patterns of use, trends and the groundwater component within the River Basin Districts of England & Wales. For instance, in some parts of SE England abstracted the groundwater component makes up nearly 70% largely for public water supply. More information on the regional patterns of abstraction are given in the Regional Water Resources Strategies (Environment Agency 2001)².

The above statistics do not include water abstracted for categories of use (such as trickle irrigation, dewatering excavations or water abstracted for drainage or navigation purposes) that are currently outside licence control. Also they do not include the abstractions from areas currently designated as exempt from control by the Water Resources Act 1991.

In summary, water is abstracted to meet a wide range of uses throughout England & Wales. The current rate of abstraction is over 50,000 MI/d for England and 8,000 MI/d for the Environment Agency's Area in Wales. For England, the largest rates of abstraction from both non-tidal surface water and groundwater are for public water supply, while abstraction from tidal waters is dominated by abstraction for power generation. For Wales the largest rates of abstraction are for power generation for both tidal and non-tidal waters with agriculture abstracting the most from groundwater. Over the past 10 years there appear to be no significant trends in the amounts abstracted in England and Wales. However the national patterns of use mask important regional differences in quantity and use.

4. Existing Measures to Manage Abstraction Pressures

The Environment Agency has sets of measures to actively manage abstraction pressures on surface and groundwater at the site, catchment, regional and national scales. These processes include:

- The Abstraction Licensing System
- The Restoring Sustainable Abstraction (RSA) programme
- Catchment Abstraction Management Strategies (CAMS),
- Water Resources Strategies and Water Company Plans
- Commitments to Demand Management and the Water Savings Group.

In addition many of the data needs to support these processes are provided by a well established hydrometric monitoring network, and the Environment Agency manages a number of schemes to help operationally manage abstraction pressures in the form of transfer and river support schemes.

4.1 Abstraction Licensing System³

There is a long history of legislative support for the control and regulation of abstraction from surface and groundwater bodies. The need to avoid or mitigate any adverse impact of pumping from surface or groundwater has been recognised within the legislation for England & Wales for over 40 years (Water Resources Acts 1963 & 1991). Initially abstraction controls focussed on protecting the rights of existing water users such as other abstractors, fisheries, navigation and riparian users. However increased environmental awareness combined with the droughts of the 1990's lead to public concerns as to the impact of abstraction on the water environment. Following extensive public consultation the government published "Taking Water Responsibly" in 1999 which identified several gaps in the regulation of abstraction and impoundments and recommended changes in the management of water abstraction for England & Wales⁴.

Many of these recommendations were accommodated within the Water Act 2003⁵. The principle changes within this Act include:

- Extension of the requirement for an abstraction licence to previously exempt groups of water users e.g. Canal transfers, trickle irrigation, dewatering of excavations
- Increased focus on efficient and sustainable water use
- Enhanced provisions to enable management of water resources impoundments.
- Requirement that all new abstraction licences should be time limited
- From 2012 on, that where an existing permanent abstraction licences is revoked because the abstraction is causing serious environmental damage then compensation is not payable.

Table 2 below shows the number of permanent and time limited abstraction licences that were administered by the Environment Agency in England and Wales, for 2004. The permanent abstraction licences were issued to remain in force or until revoked by the Environment Agency. The procedure for revoking abstraction licences is complex and in many cases requires compensation payments to the abstraction licence holder (see RSA programme below). All new abstraction licences are time-limited. Time-limited licences are usually issued for 12 or more years with renewal being dependant on the continued and justifiable use for the water and the strategy for dealing with time limited licences.

Table 2 Number of Permanent and time-limited licences in 2004

	England	Wales
Number of permanent licences	36,093	2,527
Licensed quantity of permanent licences (MI/d)	68,926	13,044
Number of time-limited licences	7,464	348
Licensed quantity of time-limited licences (MI/d)	10,319	1,743

During 2005, some 23,000 small, mainly agricultural, abstractions were removed from the abstraction licence system under the deregulation provisions of the Water Act 2003.

Annual charges are paid by abstractors to the Environment Agency to recover the cost of managing water resources. These are for the most part based on the quantity licensed although some spray irrigation licences are charged according to the amount used. There are regional components to the charges as well as adjustments for seasonal use and the amount returned to water courses. The charges scheme is currently under review. The last review⁶ considered:

- Recovery of compensation costs to revoke or modify environmentally damaging abstraction licences
- Charging incentives to improve the sustainability of abstraction

4.2 Restoring Sustainable Abstraction Programme (RSA)⁷

The long history of legislation means that the Environment Agency regulates a large number of abstraction licences issued over the last 40 years by the Environment Agency's predecessors. Many of these licences were issued on a 'grandfather rights' basis with no consideration of the environmental impact. As such the quantities of water abstracted at some sites are now perceived to be unsustainable. The RSA programme includes:

- Investigations to review the environmental impact of potentially unsustainable abstraction licences

- Appraisals of the options to deal with unsustainable licences and if necessary modify or revoke abstraction licences together with the identification of funding routes for replacement abstraction licences or compensation

The measures or options considered manage the impact of existing abstraction licences include relocation or replacement of the abstraction point, reductions in the demand for water, and measures to reduce or mitigate the site impact.

Table 3, gives the number of conservation sites included in the programme where the impact of surrounding abstraction licences will be investigated. This includes those designated *Natura 2000* sites where the surrounding abstraction licences are under investigation as required by the Habitats Directive review of existing consents; such sites fall within the Protected Areas environmental objectives of the WFD.

Table 3 RSA Programme: Sites under Investigation

	England	EA Wales
Habitats Directive	181	39
SSSIs	107	-
Others	170	11
Total	458	50

See Note at end of the chapter regarding "EA Wales"

4.3 Catchment Abstraction Management Strategies (CAMS)⁸

CAMS provide for a regular review of management of abstraction licences within catchments in order to:

- Evaluate the state of catchment water resources and water availability based on conditional flow targets
- Inform the public on water availability and reliability for new abstraction licence applications
- Provide a fair and consistent framework for the management of existing permanent and time limited abstraction licences
- Provide an open and sustainable approach to local water resources management

The first programme of CAMS started in 2001. It includes consideration of 116 catchments and is due to be completed in 2008. CAMS methods have recently been reviewed and modified in the light of Water Framework Directive requirements. The revised methods will be used in the second cycle of CAMS 2008 to 2015.

CAMS include assessments of water availability made against river flow objectives. The assessment identifies those catchments where existing rates of abstraction are having an unacceptable impact on river flows. It also identifies those catchments where, if existing abstraction licences were used to their full allocation, these would have the potential to cause unacceptable impacts on low flows.

CAMS also play a key role in the promotion of the trading of abstraction licences. This is seen as means of encouraging a more efficient allocation of water rights in areas of water scarcity⁷.

4.4 Water Resources Strategies and Water Company Plans

In 2001 the Environment Agency produced a Water Resources Strategy for England and Wales² based on regional strategies from the eight regional units. The strategy seeks to promote an efficient and sustainable water use that is focussed on a positive supply/demand balance and to protect the water environment. The strategy considers a likely range of water demand scenarios over the next 25 years and for all relevant economic sectors. The strategy identified options or measures to meet increases in abstraction pressures for England & Wales within the environmental objectives that existed prior to the Water Framework Directive. The Strategy included a range of both demand side and supply side measures to meet both the future needs of society and the water environment. The strategy is used to guide the water resources input into Regional Spatial strategies and other regional and national planning policies. It is also used to influence⁹ Water Company Water Resources plans that are now a statutory requirement under the provisions of the Water Act 2003.

The 2001 Water Resources Strategy is currently under review and a revision is likely to be published in 2008.

4.5 Demand Management & the Water Savings Group

The Water Savings group is lead by Defra and aims to co-ordinate measures to promote the efficient use of water in England. These include consideration of the role of metering in water-stressed areas and measures to promote water efficiency in new buildings and developments. The "Consultation on Water Metering in Areas of serious Water Stress"¹⁰ includes an indicative map of water stressed areas together with a partial regulatory impact assessment. The recently published "Code for Sustainable Homes" includes measures to encourage efficient use of water¹¹.

4.6 Hydrometric Monitoring Network

The hydrometric monitoring network gathers and stores data from river flows, rainfall, groundwater levels and evapotranspiration estimates. It includes several data sets that have been running for over 25 years. These data, particularly those from rivers flow gauging stations, are used regularly to inform individual abstraction licence management decisions and the assessment of water availability within CAMS.

4.7 Transfer and River Support schemes

The Environment Agency operates a number of schemes to transfer water between catchments or to seasonally augment river flows to meet the requirements of downstream abstractors and the needs of the water environment. These represent a valuable part of the Water Resources infrastructure of England & Wales.

4.8 Current Costs of Managing Abstraction

The costs of both managing and maintaining the operational support for abstraction are paid for from a national system of abstraction charges³. These raised £129m for 2006/07 which paid for all the costs of managing and regulating water abstraction detailed above together with the payment of charges on the capital costs of works and equipment at a fixed rate of return. Nearly 87% of the abstraction charges are paid by water companies.

The Water Act 2003 has yet to be full implemented. The additional costs to abstractors of implementing this were estimated to be between £2.05m and £41.4m in set up costs with an additional £83k/year in additional operating costs. The additional cost of administration and regulation from the Water Act 2003 will be paid for from the Environment Agency's abstraction charges.

We have no estimate of the costs incurred by Water Companies and the Environment Agency to investigate the impacts of existing abstraction licences on conservation sites as part of the RSA programme. The estimated costs for completing the programme are given in table 4 below. This is based on the costs of measures to reduce abstraction licence impacts by an estimated amount and in advance of site specific investigations.

The majority of the abstraction licences under review are held by water companies, and the costs for modifying or revoking those impacting Habitats Directive sites are expected to be included in the PR09 environment programme. It is anticipated that compensation for changes to other licences will be paid for by increases in abstraction charges.

Table 4 RSA Programme: Estimated Costs (£m)

	England	EA Wales
Habitats Directive	336	39.
SSSIs	32	-
Others	40	0.5
Total	408	39.5

See Note at end of the chapter regarding "EA Wales"

Finally, many water companies have additional programmes to both enhance the water environment and mitigate the impact of water abstraction on water resources. It has not been possible to estimate the cost of these for this report.

5. Estimating the Impact of Existing Abstraction on WFD Objectives

5.1 Conditional Flow Standards

As outlined in section 2.1, the WFD gives no regulatory threshold that must be reached for river flows, freshwater flows into estuaries and lakes. However in order to promote the sustainable use of water and to allow water users to operate without adversely affecting WFD objectives, conditional flow standards are in various stages of development¹³. These are under active development by the WFD UK Technical Advisory Group (UKTAG) under the direction of the UK Administrations (Defra, Scottish Executive, WAG, and the Northern Ireland Executive).

To date conditional flow standards have been derived for:

- Rivers
- Lakes

While the standards for:

- Estuaries
- Groundwater quantitative status

are still under development.

5.2 Derivation of Conditional River Flow Standards to Quantify Abstraction Pressures

The conditional flow standards for rivers have been developed to promote sustainable rates of abstraction without compromising WFD environmental objectives of good ecological status and deterioration in ecological status. They provide a useful and precautionary framework for managing new abstraction proposals.

Flow conditions in the form of "hands off" flows or levels have been used to manage abstraction licences for over 40 years in England & Wales. A more consistent approach to determining the flows available for abstraction was developed for CAMS.

The UKTAG flow standards have built on the experience gained in the CAMS 1st cycle (2001 to 2008) together with the best information available on the effects of flows on the biological quality elements identified within the WFD. The standards recognise 8 river types, with each type displaying different sensitivities of the ecology to changes in flow. The allocation of river water bodies to a particular type can be derived from either field data or mapped parameters. For each type, the amount of water available for abstraction at different frequencies of flow has been derived based on the best available scientific information and expert opinion.

The UKTAG flow standards have been used to improve the conditional river flow standards to be used in the 2nd cycle of CAMS (2008 to 2015). The conditional river

flow standards will be used to guide the management of the impact of water abstraction from 2008 onwards.

5.3 Estimating the Impact of Abstraction and Discharges on River flows

The long history of the surface and groundwater bodies of England and Wales for both abstraction and discharges means that many of the flows significantly depart from the natural regime. The degree of departure was mapped for all 7,800 river water bodies as part of the WFD River Basin Characterisation exercise of 2004¹⁴ and using estimates of natural flows estimated from the LowFlows2000 model¹⁵. The flow characterisation database has now been adapted to provide estimates of the net impact of abstracted quantities on natural flow frequencies estimated for each river water body. The accuracy and technical limitations of these estimates are given in ENTEC (2007)¹⁶ and work is in progress to improve the database.

The current database does not include:

- account for abstraction for canal transfers, trickle irrigation, dewatering.
- include areas previously exempt from licensing controls (e.g. parts of Wales)

In addition, it has not been possible to represent surface water abstractions from reservoirs nor the effects of reservoir releases on downstream water bodies. The calculations assume that groundwater abstraction is having a 100% impact on river flows. The calculations have also been applied to the outflows of lake water bodies as a measure of the net impact of abstraction.

5.4 Conditional Flow Standards and Potential River Flow deficits

The flow characterisation database described in 5.3 can be used to estimate the impact of abstraction on the natural flow regime. This can be compared with that allowed by the conditional river flow standards (based on the UKTAG flow standards). Where the net effect of abstraction and discharge rates is to take flows below the standard this is termed a potential flow deficit. The potential flow deficits for each of the river water bodies can be summed to give national estimates for England & Wales. Full details of the method and approach adopted to make these estimates are documented elsewhere (ENTEC 2007)¹⁶.

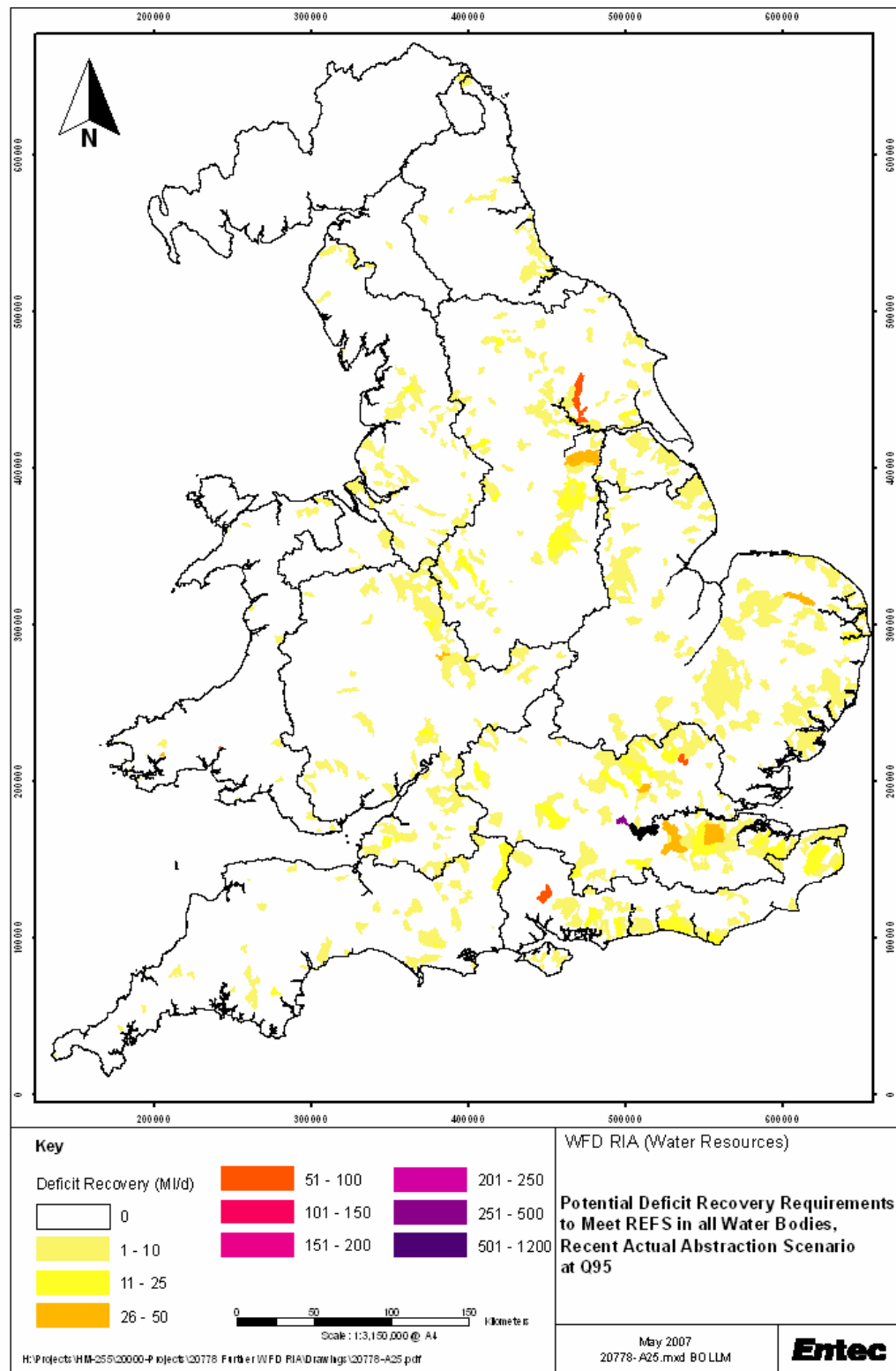
The results of this exercise are given in table 5 and show that the total potential flow deficits for river water bodies in England of 3,388 MI/day and in Wales of 172 MI/day.

Table 5 Potential River Flow Deficits Using Conditional river Flow Standards

ML/d	
England	3,388
Wales	172
Total	3,560

The distribution of river water bodies with potential flow deficits is given in Figure 3. This shows a widespread of water bodies with potential flow deficits of up to 25 MI/day through out England with patches across Wales. The map shows water bodies with potential flow deficits in excess of 250 MI/day to the west of London and high potential flow deficits of up to 100MI/day in the Humber and Thames River Basin Districts.

Figure 3 Map of River Bodies with Potential flow Deficits



Ranking the potential flow deficits gives a valuable clue as to how a programme of investigations of those water bodies with potential river flow deficits might be prioritised. A preliminary analysis suggests that the top ten water bodies have potential deficits of nearly 1300 MI/day, which is over a third of the total potential flow deficit. This gives an indication as to how the larger flow deficits are concentrated on a relatively small number of sites.

Table 6 gives the percentage distribution of potential flow deficits by sectors of use. This indicates that abstraction for public water supply produces the greatest potential river flow deficit for both England and Wales.

Table 6 Distribution of Potential River Flow Deficits (%) by Sector

Sector	England	Wales
Agriculture	3%	0%
Industry	4%	2%
Public Water Supply	90%	95%
Other Potable Uses	0%	2%
Amenity Environmental	2%	1%
Power Generation	1%	0%
Total	100%	100%

5.5 Potential Flow Deficits calculated from CAMS 1st Cycle

The first CAMS programme includes river flow objectives that have been derived in a similar way as the conditional river flow standards. However, the CAMS flow objectives are compared with natural and actual river flows at a much smaller number of assessment points. There are just over 1200 assessment points for CAMS compared to over 7,800 water body assessment points within the artificial influences database. Also CAMS assessment flows can be regarded as more accurate with the potential river flow deficits being derived for measured river flows with local assessments of the abstraction and discharge components.

CAMS assessment results are available for just under 90% of the catchments considered in the first CAMS cycle. Of these some 167 were assessed as being "over abstracted" or having current abstraction rates that deplete river flows below the CAMS flow standards. The extent of this deficit is 1,074 MI/day. This is made up of 1059 MI/day for England and 15 MI/day for Wales.

Table 7 Potential Flow Deficits from CAMS 1st cycle for Recent Actual Abstraction Rates

	Potential Flow Deficit (MI/day)
England	1,059
Wales	15
Total	1,074

In addition the available first cycle CAMS results have identified those catchment where, if existing licences were used to their full allocation, they would have the potential to have an unacceptable impact on river flows. The forecast impact of abstraction at full licensed quantities would create flow deficits of 1,927 MI/day for England and 70 MI/day for Wales.

5.6 Range of Potential Flow Deficit Estimates

This section has presented two sets of results that characterise the pressure of current abstraction rates on two sets of conditional flow standards. The CAMS first cycle figures are based on locally checked data but for a less extensive set of points. The potential flow deficits from the conditional flow standards based on a more extensive set of points but using data that has not been locally quality controlled. Given this comparison and for the purpose of this exercise we propose expressing and summarising the impact of abstraction pressures on river flows as ranging between the CAMS results and potential flow deficit results. That is between 1,059 and 3,388 MI/day for England and between 15 and 172 MI/day for Wales.

5.7 Habitats Directive Review of Consents: Impact of estimated Licence Reductions on Potential Flow Deficits

The Habitats Directive Review of Consents represents an important part of the RSA programme. As part of this estimates have been made of the likely abstraction licence reductions required to meet the Habitats Directive conservation targets and how this may reduce the potential flow deficit estimates. The estimated reductions in actual abstraction for those licences affecting Habitats Directive would reduce the downstream potential flow deficits by only 55 MI/d for England & Wales.

5.8 Use of conditional river flow standards in decision making

The generic conditional flow standards provide a useful, wide ranging and precautionary set of conditional limits and will be used to guide the management of abstraction at the catchment, regional and national scales. However much of this work is still under development and current estimates of potential river flow deficits have yet to be matched against the ecological classification and heavily modified designation of river water bodies.

The use of conditional river flow standards in decision making must be informed by the scientific uncertainties associated with their derivation and application. The exact

causal links between flow and ecological status are hard to define without further monitoring and investigation. Deriving an accurate relationship between flow and ecological status, is further complicated by other pressures such as contaminants or morphological changes. These together with the abstraction may interact to varying degrees and make the individual impact of abstraction on ecology difficult to unravel. Consequently, only detailed, site specific, investigations can adequately determine the environmental impact of water abstraction and these should be used to guide any large investment decisions. Only site specific investigations can adequately determine any ecological benefits and the value of reducing or modifying particular abstraction licences.

6. Cost Effectiveness of measures to reduce Potential flow Deficits

The measures to ameliorate abstraction impacts and to reduce potential flow deficits fall into four groups of measures:

- relocation or replacement of the abstraction points
- reductions in the demand for water
- mitigation of the impact on the water body
- measures to promote the efficient use of water resource

The cost effectiveness of these have been identified to varying degrees in the reports from the Water Industry, Agriculture, industry and navigation working groups.

6.1 Cost-Effectiveness of Measures identified in Working Group reports

Water Industry Group

The Water industry group report details the costs and effectiveness of a wide range of measures to reduce abstraction pressures. These included the extension of existing policies such as leakage reduction and increased domestic metering, as well as relocation or replacement of source works. However, the report did not identify measures to mitigate abstraction impacts or promote the efficient use of water resources.

Water Industry group report considered reduced mains pressure as leakage measures but this was ruled out by many water companies as it might lead to lower levels of service to customers. Source works replacement with desalination plants was seen as a last resort because of doubts over high energy costs and waste disposal issues. Nevertheless desalination had to be considered for water company areas where the availability of conventional water resources was limited.

The Water Industry group considered combination of measures to reduce abstraction by up to 1440 Ml/day and at points derived from the Characterisation maps of 2004. The bulk of the reductions (83%) were by source works replacement or relocation with demand reduction accounting for 6% and leakage reduction 11%.

The most expensive and least cost effective measures were considered to be demand management measures. Of the 18 water companies responding only 8 included demand management measures within their estimates. The next least cost effective measure was leakage reduction. 10 companies included this within their list of measures. Some companies considered that they are already operating below the economic level of leakage and they did not consider further reductions to be worthwhile. Source works replacement was seen as the most cost effective measures although the unit costs varied across the country and in line with the availability of replacement water sources.

The Water Industry report gives relocation of source works as the most cost-effective measure. This is particularly surprising as demand management measures in particular

are relatively quick to implement when compared to the construction of new source works which can take up to twenty years.

Agriculture Group

The report does not give any measures for dealing with reductions in abstraction licences. The most significant impact of abstraction for agriculture is for spray irrigation. Peak spray irrigation demands are usually in summer and coincide with other pressures on river flows. Measures to replace direct abstraction from surface waters with winter filled storage reservoirs together with water conservation measures are identified in Weatherhead et al.(1997)¹⁷.

Industry Group

The Industry Group report notes that for most of the PPC industries efficient water use has or will be achieved by the application of the site specific targets within application of the Best Available Technology and the promotion of efficient water use via Envirowise.

The report gives the costs and effectiveness of measures for dealing with abstraction to cool electricity generating stations and abstraction and impoundment for hydroelectric power stations. The net amount of water lost to evaporation at water cooled sites is thought to be restricted to 40 or 50% with the rest returned near to the point of abstraction. For Hydropower generation, the impact of reductions in abstraction or alterations to reservoir storage releases will result in lost energy production. As the impact of these will vary seasonally it has been difficult to give unit costs.

Navigation.

The navigation report did not identify the need for measures to control the impacts of abstraction for estuaries and coastal waters. For inland waters, abstraction takes place at some 200 British Waterways installations for the purpose of filling the canal network. Under the requirements of the Water Act 2003 British Waterways will need to apply for licences for these abstraction points. At the moment there is insufficient information on which to judge whether additional measures will be required to meet WFD environmental objectives.

6.2 Effectiveness and Unit Costs of Measures to Reduce Abstraction Pressures

Estimates of the effectiveness and unit costs of a wide range of measures to reduce abstraction pressures from public water supply, agriculture and industry are presented in Table 8. The list of measures within the relocation of source works relocation, demand management and supply efficiency categories have been derived from tables within the Water Resources for the future - a Strategy for England & Wales (Environment Agency 2001 Tables 6.1 & 6.2). These have been supplemented by any further information available from the Water Industry, Industry and Agriculture reports. The list of mitigation measures is derived from information within CAMS and RSA programme sustainability appraisals. Information on the measures to optimise resource use is taken from documents already referred to in sections 4.1 and 4.3.

Table 8 Unit Costs of Measures to reduce Abstraction Pressures

Relocation of source works	Time to implement (yr)	Effectiveness	Uncertainty	% sector split			Range of Costs £M/MI/d
				PWS	Industry	Agriculture	
New reservoir	15-20	H	M	95	5		2-5
Reservoir raising	5-10	H	M	100			2-5
Farm SI winter storage reservoirs (single farm)	2-3	H	M			100	2-5
Farm SI winter storage reservoirs (farm consortium: 10-15)	3-5	H	M			100	0.1-2
Surface water abstraction (unsupported for pws)	5-10	M	M	60	30	10	0.1-2
Groundwater abstraction	3-5	M	M	70	20	10	2-5
Desalination	2-5	L	H	100			2-5
Wastewater re-use (pws)	3-5	H	H	100			>5
Wastewater re-use (non-pws)	3-5	H	L		90	10	0.1-2
Aquifer artificial recharge and recovery	5-10	M	H	90	10		2-5
Pipeline raw water transfer	3-5	M	H	70	20	10	2-5
River transfer	5-10	M	M	70	20	10	0.1-2
Operational improvements	1-3	M	L	80	20		0.1-2
Demand Management and supply efficiency							
Household Rainwater use (new development, non-potable)	1-3	L	M	90	5	5	0.1-2
Household Greywater use (new development, non-potable)	1-3	L	H	90	5	5	0.1-2
Water audits on existing houses and buildings	1-3	M	L	80	20		0.1-2
Subsidies & rebates applied to household washing machines, etc.	1-3	L	H	100			0.1-2
Sustainable homes - retrofitting water efficient supplies	3-5	L	M	100			0.1-2

Extension to household metering	3-5	M	M	100			2-5
Tariffs for measured charges	1-3	M	M	80	15	5	0.1-2
Water efficient household goods - mandatory performance criteria	3-5	L	H	100			0.1-2
Irrigation efficiency protocols and sequencing	1-2	L	H			100	0.1-2
Improved network leakage control	2-5	M	M	100			2-5
Education & awareness campaign – Good practice guidelines	1-3	M	H	50	50		2-5
Certification of work and approved standards for overall building performance	1-3	M	H	100			2-5
Mitigation of impact							
Flow Augmentation	3-5	H	M	70	20	10	0.1-2
River bed lining (<20 m wide)	1-2	L	M	90	10		<£1.8M/km
Habitat restoration marginal vegetation	1-2	H	H	70	20	10	<£0.3M/km
Habitat replacement Freshwater stream	1-2	H	H	70	20	10	£0.06M/km
Habitat replacement Inundation vegetation	1-2	H	H	70	20	10	£430/ha
Flow control/management	3-5	H	H	70	20	10	0.1-2
Measures to Optimise water resource use							
Licence trading	1-2	L	H	70	20	10	0.1-2
Charging incentives	1-2	M	H	70	20	10	0.1-2
Water efficient operation as a condition of abstraction licences	1-2	M	H	70	20	10	0.1-2

The columns in the table provide a broad assessment of the applicability, effectiveness and costs of measures. Column 1 gives an estimate of the time to implement a measure. This is based on the estimated time to promote, gain permissions and construct or install measures. Column 2 & 3 gives an overall assessment of the effectiveness and uncertainties of a measure in reducing abstraction pressures and in terms of High (H), Medium (M) or Low (L). Columns 4,5,6 give an indication of the appropriateness of a measure to particular sectors in terms of a percentage split. The last column gives the range of costs to implement a measure. This is given as a unit costs in £ million/Ml/day and for three bands: 0.1 to 2, 2 to 5 and greater than £5 million/Ml/day. The cost information is largely based on operating and capital cost of schemes analysed for the Regional Water Resources Strategies 2001 and the Water Industry Group reports. The cost ranges include both capital and operating costs discounted over appropriate periods.

The unit costs in this table can be compared with those derived from the different sector groups. From the industry group, the unit cost of replacing abstraction mainly from estuaries, for water cooled electricity generating stations was estimated to be between £0.8m and £3.1m per Ml/day. This compares favourably with ranges in the table. By contrast the unit costs given in the water industry report appear to be higher. The annual cost for reducing abstraction for England & Wales is estimated as £539 million per year or £9,702m over 18 years or three river basin planning cycles. This gives an estimated unit cost of £6.7m per Ml/day over 18 years for all the measures described within the water industry report to reduce abstraction pressures by 1,439 Ml/day.

6.3 Technical Feasibility & Time to Implementation

The phasing of different WR measures is governed by the time to implement them in addition to consideration of their effectiveness and certainty of outcome. For instance it may not be technically feasible to relocate larger source works within one river basin planning cycle, and to do so could pose risks to the continuity and reliability of supplies. The time to relocate a source of supply is governed by the need to purchase land or gains access to new sources of supply, promotion of the scheme and gaining permissions, as well as the engineering considerations of design and construction of the source and supply network. By way of an example one of the last reservoirs built in England at Carsington, Derbyshire took three public enquiries and twenty three years from concept to construction.

By contrast many of the demand side measures can be implemented more quickly. However, their success is governed by other social and economic considerations. For instance, the effectiveness of meters to reduce demand must be considered in conjunction with the tariff of charges that go with them. In turn the pattern of charges requires important considerations of equity and affordability across all sectors of society. In general demand measures can be more effective as a basket of measures eg campaigns can underpin the success of other strategies reliant on adapting behaviour or can increase uptake etc.

6.4 Measures Considered to be Not Cost Effective

The Water Industry group ruled out all measures that would increase health and safety risks to their customers. The reduction of pressure within supply networks was ruled out as resulting in unacceptable drops in the service level to customers.

There remain large scale measures that are considered to have limited cost effectiveness. A large scale water transfers or a water grid to transfer water from the north to the south-east of England would cost between £9 billion and £15 billion. This would be between 4 and 10 times more expensive than further development and more efficient use of local supplies. Similarly the cost of transferring water from Wales to south-east England would be about 50% more expensive than developing local supplies¹⁸.

6.5 Unit Costs in Areas of Limited Resources

The pattern of the availability of resources and demand varies geographically across the country and identified in the 2001 Regional Water Resources Strategies. These pointed to increases in the unit cost of replacing or relocating sources in areas of limited resources. This was identified in the Water Industry report but there no link is given between higher costs of measures in river basin districts with limited water resources.

The increased costs of producing water in areas of limited resources, together with the high energy and treatment costs of replacing sources with new supplies point to a strategy of using measures that reduce demand or increase supply efficiency in advance of options for relocating sources. These measures include the adoption of universal metering in areas where water availability is limited together with the continued promotion of efficient water use whether for households, industry or agriculture.

6.6 Combinations of Measures: Water Company Water Resources Plans

The types and combination of measures that provide a most cost effective solution are largely unique to the site, pattern of use, supply network and other pressures of the site in question. It is for this reason that more detailed evaluation of the cost effectiveness of combinations of measures is best done on a site by site basis to either within the procedures agreed for Water Company plans or using the appraisal techniques used within CAMS and RSA sustainability appraisals.

6.7 National Range of Unit Cost of Measures

The regional variation in the effectiveness of measures together with measures being applied in unique combinations to particular sites places limitations on national unit cost estimates of measures to reduce potential river flow deficits. However for the purpose of this exercise we have assumed a national average unit cost of measures to reduce the deficits to lie between £2m and £5m per MI/d for England & Wales and based largely on Table 8. However these estimates are adopted with the proviso that

in River Basin Districts where resources are relatively scarce the units costs of in particular source works relocation will be much higher and as identified in the Water Industry report.

7. National Priorities for Additional Measures to manage Abstraction pressures

The priorities for establishing measures to meet the WFD environmental objectives in relation to abstraction management were outlined in section 2.2. These are in order of priority:

- *No deterioration* in status: Measures to be in place as soon as is practical. For surface water bodies, abstraction should not be allowed to reduce flows to the extent that there is a deterioration in the ecological status. For groundwater bodies, abstraction must be limited to the available resource.
- *Protected Area objectives*: by 2015 the Habitats Directive objectives should be fully implemented. This requires that abstraction is not and will not adversely effect the conservation objectives of *Nature 2000* sites.
- *Good Status*: by 2015, all water bodies should be restored to good ecological status, unless delays or less stringent objectives can be justified. For surface water bodies abstraction should be reduced where flows are so altered as to prevent good ecological status. For groundwater bodies groundwater abstraction should be reduced to produce a positive balance in available groundwater resources. For both surface and groundwater, justification for delays in meeting good status or for meeting a less stringent objective would be made on the grounds of technical feasibility or disproportionate costs.

The additional national measures required to meet these groups of environmental objective are outlined below.

7.1 No Deterioration: measures to protect surface water ecology and groundwater balances

i) Abstraction Licensing

Existing abstraction licence application and determination procedures will require adaptation to meet flow conditions and groundwater balances that support the WFD default objectives. The conditional standards for all surface water bodies and groundwater resource balances will be recognised within existing licensing procedures. This will require the further development of flow conditions for all river, lake and estuary water bodies and consideration of these within groundwater balances. It will also require recognition of high status water bodies where the opportunities for abstraction will be limited. Much of this work (developing procedures and standards) is in progress and will be completed by 2008 at an estimated cost of between £0.6m and £1.0m for England and Wales to be paid for from abstraction charges.

The default WFD objectives may result in more water being allocated to meet environmental needs and will reduce the availability of water resources to meet a growth in water demands. This will be particularly significant in River Basin Districts where resources are already considered to be limited. At the time of writing we have no forecast estimates available as to how this may impact on the viability and costs of future new abstraction proposals.

Article 4(7) of the WFD allows for consideration of new developments that may compromise the default WFD objectives. These procedures can be accommodated within the existing Water Resources and Environmental Impact legislation to deal with abstraction proposals that will result in derogation of WFD environmental objectives.

ii) Demand Management and Water Savings Group

The existing commitment to further development of measures to limit water demands was identified in section 4.5. In particular these form an important component in limiting abstraction pressures and preventing deterioration at existing water company abstraction points across SE England. The costs of converting houses to metered water use in water stressed areas is estimated to be in the order of £1,000m¹⁰.

7.2 Protected Areas : measures to meet Habitats Directive objectives

i) RSA Programme

The Restoring Sustainable Abstraction Programme includes both the investigations and measures required by the Habitats Directive. The estimated costs of completing this are given in Table 4. The majority of the licences that require modification within this programme are held by Water Companies and it is expected that the costs will be recognised in the PR09 settlement where they impact on *Natura 2000* sites (Table 9 below). For other water company licences and those licences not held by water companies, any compensation payments for revoking or modifying licences will be paid for out of increases in Abstraction charges to all licence holders.

Table 9 RSA Programme PWS and non PWS apportionment estimates.

	PWS (%)	Non PWS (%)
English Agency Regions	93	7
EA Wales	98	2

ii) Abstraction Licensing

The requirements to meet the Habitats Directive requirements when considering new abstraction licence proposals are already included within the Environment Agency's abstraction licence procedures.

7.3 Good Status: measures to support good ecological status and to meet good groundwater quantitative status

i) Restoring Sustainable Abstraction programme

The measures to achieve good status would be a new and additional driver to the established RSA programme. The RSA programme would have to be substantially expanded to accommodate the increased scale of investigation required to review the impact of existing abstraction licences.

Any assessment of the scale of the measures to manage abstraction to support the restoration to good status of water bodies is limited by the uncertainties that exist in:

- the ecological status of surface water bodies has yet to be determined as has the role of flows in supporting good ecological status.
- there are uncertainties in the derivation and application of conditional river flow standards to surface water bodies
- there are gaps in the setting of the standards for groundwater, estuaries and heavily modified water bodies

Nevertheless, the available information from the ranges of potential flow deficits to meet the conditional river flow standards identified in section 5 can be used to indicate the limits of the impact of current levels of abstraction. These can be combined with the range of unit costs of measures identified in section 6 to give an estimate of the range of costs to manage existing abstraction licences (Table 10)

Table 10. Estimated Range of Costs of Measures to meet Conditional flow Standards

	England		Wales	
Range of Unit Costs £m per MI/d	CAMS 1 1059 MI/d	Conditional Flow Standards 3388 MI/d	CAMS 1 15 MI/d	Conditional Flow Standards 172 MI/d
2.0	£2,118m	£6,776m	£30m	£344m
5.0	£5,295m	£16,940m	£75m	£860m

This table is used to develop estimates of the expenditure for the two scenarios to support WFD environmental objectives developed in section 8 below.

The apportionment of these costs can be determined from the distribution of those abstraction licences contributing to the potential flow deficits as given in table 6. This indicates that the bulk of the costs would be borne by the Water Industry (90% England and 95% Wales).

(ii) Improvements to Hydrometric and Transfer Schemes

Both these schemes are important to the management of water resources (see section 4.6). However, they both include structures or operational methods that may have a significant impact on the WFD environmental objectives of downstream surface water bodies. Although many of these sites are likely to fall within the heavily modified designation requiring less rigorous flow conditions, there will be sites that will require modifications to structures or mitigation of impacts. The costs of these are estimated to lie in the range of £60m to £100m for England and £3m to £6m for Wales and funded from abstraction charges.

8. Timing of a Programme of Water Resources Measures to meet WFD Environmental Objectives

The priorities and costs of a programme of measures to manage abstraction pressures to support WFD environmental objectives were described in section 6. This section examines the options for the timing of this programme and in the light of the uncertainties and technical limitations of measures to manage abstraction pressures.

8.1 Development of Scenarios

We have considered the options for programming these measures in terms of two scenarios:

- Scenario 1 No delay: Achieve all environmental objectives by 2015 and ensure no deterioration in ecological status. This would require no adjustment to the default WFD objectives.
- Scenario 2 Phasing: Achieve environmental objectives over three cycles of the WFD ending 2027 while achieving no deterioration in status. This would use the permitted range of WFD alternative objectives as justified by disproportionate costs or technical feasibility.

How these scenarios can be applied to the timing of additional water resources measures is given below. Details of how the cost estimates for each scenario are derived are given in appendix 1.

8.2 Scenario 1: No Delay

If it is assumed that the conditional flow standards accurately reflect the flows to support good ecological status then all potential river flow deficits will have to be reduced by 2015. This would require completion of all the WR measures by 2015 as detailed above in section 6.1 for Protected Areas and 6.2 for no deterioration together with the measures to reduce abstraction reviewed in section 6 and costs detailed in table 10. For this scenario the range of estimated range of costs would be:

England : £ 3,569 m to £18,409m
Wales: £ 72m to £ 905m

8.3 Scenario 2 : Phasing Measures over 3 cycles

In order to manage the scientific uncertainties and determine the technical feasibility of measures, we have considered the phasing of measures over three WFD cycles. This includes site specific investigations to evaluate the ecological benefits of reducing abstraction pressures together with technical feasibility of any measures. To this end we propose the following programme:

For each cycle:

- Continue to operate revised water abstraction licensing procedures to prevent deterioration in the WFD ecological status of water bodies resulting from increasing abstraction pressures
- Continue to promote the twin track approach to managing abstraction pressures as established in the Water Resources Strategy.

Then for the 1st cycle ending 2015:

- Protected Areas. Completion of the Habitats Directive Review of Consents and complete all measures to reduce any adverse impacts of water abstraction licences.
- Complete investigations for remaining sites in RSA programme.
- for those water bodies with largest flow deficits, completed site specific investigation that establish the ecological benefits of modifying or reducing abstraction licences and cost and appraise the options for completing them
- Revise the conditional river flow and other standards in the light of experience gained from investigations and monitoring.
- Finance and complete Water Savings group commitments to reducing water demands and supply efficiency.

England: estimate cost 1st cycle from £1,503m to £1,776m

Wales: estimate cost 1st cycle from £ 43m to £ 62m

For the 2nd cycle ending 2021

- Complete the measures for the remaining sites in the RSA programme
- Complete the measures to modify or reduce licences determined from investigations in the first cycle. We estimate that investigation will reduce the need to reduce abstraction pressures by up to 50%.
- Re evaluate the impact of all abstraction licences in the light of the revised standards
- for those remaining water bodies with flow deficits, completed site specific investigation that establish the ecological benefits of modifying or reducing abstraction licences and cost and appraise the options for completing them

England: Estimated costs 2nd cycle from £ 703m to £4,386m

Wales: Estimated costs 2nd cycle from £ 9.0m to £232m

For the 3rd cycle ending 2027

- Complete the measures to modify or reduce licences determined from investigation in the second cycle

England: Estimated costs of 3rd cycle from £ 525m to £3,975m

Wales: Estimated costs of 3rd cycle from £ 7.5m to £ 215m

Total Costs for all 3 cycles to 2027

England	£2,730m to £10,140m
Wales	£ 59m to £ 509m

8.4 Assessment of Scenarios

Uncertainties in the conditional flow standards do not provide sufficient evidence for them supporting good ecological status and the levels of investment detailed in scenario 1. There is no clear evidence that use of the adoption of the standards to justify the high level of investment in measures detailed in scenario 1, would result in benefits to the water environment.

Flow is considered to be a supporting element to the environmental objectives and we have yet to evaluate how existing flow standards relate to the ecological classification of river water bodies. In addition the designation of river water bodies as heavily modified is likely to alter flow standards to support good ecological potential rather than good ecological status. We have yet to consider the environmental objectives and freshwater flow standards for both estuaries and groundwater.

In many cases it will not be technically feasible to implement measures to reduce abstraction pressures on the water environment by 2015 as in scenario 1. Many of the measures to relocate abstraction points take long periods of time to implement. The bulk of the abstraction licences that produce river flow deficits are for public water supply (Table 6). Revoking or modifying these licences by 2015 without replacement source works would result in disruption to public water supplies, the economy and possible health problems in the communities served.

Scenario 2 will meet the priority environment objectives for Protected Areas and will prevent any deterioration in the status of water bodies in the first cycle. It provides for phased programme of investigations that will provide firm evidence for the need and cost-effectiveness of measures to manage the impact of abstraction rates on flows. Any measures to modify or revoke will be phased in within the limits of technical feasibility and minimising any disruption to the continuity of supply. Scenario 2, allows for the further development of the conditional standards guided by the ecological classification and the designation heavily modified water bodies. It also allows for the continued improvement in the accuracy of conditional standards, in the light of monitoring data and site assessments.

8.5 Conclusions and Recommendations

Completing all the measures to reduce abstraction and meet conditional flow standards in Scenario 1 would result in an unjustified and mistimed investment and may not result in tangible benefits to the water environment. In addition the required speed of change to supplies and networks will not be technically feasible and would put the continuity of many water supplies at risk.

By contrast Scenario 2 offers a phased and adaptive approach to supporting the WFD ecological objectives in the light of further information and experience. It provides for meeting the priority objectives for Protected Areas while managing abstraction to prevent no deterioration by the end of the first cycle. It also provides for measures to

manage existing abstraction pressures for those water bodies where site specific investigations confirm that costs can be matched by benefits to the water environment.

The conditional flow standards and the derived potential flow deficits should be used to target a phased programme of site specific investigations as described for scenario 2. These investigations would establish the ecological benefits of reducing abstraction licences. The investigations would also establish how any limitations of flow on supporting ecological status are working in combination with any changes to water quality or channel morphology. Where the need and benefits of measures to reduce abstraction pressures are clearly identified, the cost of the best combination of measures to achieve them would be identified within Water Company Water Resources plans. The costs of measures to reduce other abstraction licences would be included within the Environment Agency's abstraction charges scheme.

Note on Statistics and Cost information for Wales

The RSA programme statistics and cost information in this chapter are for "EA Wales". The boundary for EA Wales includes parts of the Dee and Wye catchments within England. It excludes part of the upper Severn catchment, which lies within the political boundary of Wales. All the other abstraction, potential flow deficit and cost estimate information refers to "Wales", the political boundary.

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Appendix 1. Details of Costs of the Two Scenarios for Phasing WR Measures.

The options for programming the measures to manage abstraction pressures are expressed in terms of two scenarios:

- Scenario 1 No delay: Achieve all environmental objectives by 2015 and ensure no deterioration in ecological status. This would require no derogation to the default WFD objectives.
- Scenario 2 Phasing : Achieve environmental objectives over three cycles of the WFD ending 2027 while achieving no deterioration in status. This would use the permitted range of WFD derogation as justified by disproportionate costs or technical feasibility.

Scenario 1 No Delay

This would require completion of all the WR measures by 2015

The estimated costs for England are:

Protected Areas. (Table 4)	£ 336m.
Revised Abstraction licensing procedures	£ 1m
Other sites in RSA programme (table 4)	£ 72m
Commitments to reducing water demand	£ 1,000m
Reducing the impact of abstraction licences (Table 9)	£ 2,100m to £16,900m
Mods to hydrometric & transfer schemes (see below)	£ 60m to £ 100m
England : Estimated Range of costs	£ 3,569 m to £18,409m

The estimated costs for Wales are:

Protected Areas. (table 4)	£39m
Revised Abstraction licensing procedures (inc. in above)	-
Commitments to reducing water demand	-
Reducing the impact of existing abstraction licences	£ 30m to £ 860m
Modifications to hydrometric & transfer schemes	£ 3m to £ 6m
Wales : Estimated Range of costs	£ 72m to £ 905m

Scenario 2 : Phasing Measures over 3 cycles:

For each cycle:

- Continued to operate revised water abstraction licensing procedures to prevent no deterioration in the WFD ecological status of water bodies resulting from increasing abstraction pressures
- Continue to promote the twin track approach to managing abstraction pressures as established in the Water Resources Strategy.

Then for the 1st cycle ending 2015:

- Protected Areas. Completion of the Habitats Directive Review of Consents and complete all measures to reduce any adverse impacts of water abstraction licences.
- Revision of Abstraction Procedures
- Complete investigations for remaining sites in RSA programme.
- For those water bodies with largest flow deficits, completed site specific investigation that establish the ecological benefits of modifying or reducing abstraction licences and cost and appraise the options for completing them
- Revise the conditional river flow and other standards in the light of experience gained from investigations and monitoring.
- Carry out the commitments to reducing water demands and abstraction pressures

For England

Protected Areas.	£ 336m.
Revision of Abstraction licensing procedures	£ 1m
Commitments to reducing water demand	£1,000m
Investigations 50% of the water bodies with flow deficits	£106m to £339m
Modifications to hydrometric & transfer schemes	£ 60m to £100m
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England: estimate cost 1 st cycle from	£1,503 m to £1,776m

For Wales

Protected Areas.	£ 39m.
Investigations 50% of the water bodies with flow deficits	£1.5 m to £ 17m
Modifications to hydrometric & transfer schemes	£ 3m to £ 6m
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Wales: estimate cost 1 st cycle from	£ 43m to £ 62m

For the 2nd cycle ending 2021

- Complete remaining sites on RSA programme
- Complete the measures to modify or reduce licences determined from investigations in the first cycle. We estimate that investigation will reduce the need to reduce abstraction pressures by up to 50%.
- Re evaluate the impact of all abstraction licences in the light of the revised standards
- for those remaining water bodies with flow deficits, completed site specific investigation that establish the ecological benefits of modifying or reducing abstraction licences and cost and appraise the options for completing them

For England

Remaining RSA sites	£72m
Measures required from 1 st cycle investigations	£ 525m to £3,975m
Investigations remaining water bodies with flow deficits	£ 106m to £ 339m
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England: Estimated costs 2 nd cycle from	£ 703m to £4,386m

For Wales

Measures required from 1 st cycle investigations	£ 7.5m to £ 215m
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Investigations remaining water bodies with flow deficits	£1.5 m to £ 17m
Wales: Estimated costs 2 nd cycle from	£ 9.0m to £232m

For the 3rd cycle ending 2027

- Complete the measures to modify or reduce licences determined from investigation in the second cycle

England	
Measures required from 2 nd cycle investigations	£ 525m to £3,975m

Wales	
Measures required from 2 nd cycle investigations	£ 7.5m to £ 215m

Total Costs for all 3 cycles to 2027

England	£2,730m to £10,140m
Wales	£ 59m to £ 509m