National Rivers Authority
Anglian Region

Item No.	Report No.
Subject: Future Water Resources Strategy	

Meeting: RRAC

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Preliminary nature to be stressed wording related strategy

INTRODUCTION

This paper reviews the water resources of the Anglian Region, and the demands upon them, both for abstraction and for the environment. It identifies future deficiencies and the conflicts which may arise in meeting them. A Regional Water Resource Strategy is proposed.

'Local' issues, for example the needs of particular areas, will be dealt with in more detailed planning studies.

WATER RESOURCES

a) Quantity

Anglia has the lowest rainfall in the country, and high evaporation. Table 1 shows that it's effective rainfall* is only one third of that of the rest of England and Wales. In a one in fifty drought year (the kind of extreme event for which public water supply schemes are commonly designed) this can reduce to one eighth.

In the natural state all effective rainfall would find its way to rivers (and then to the sea) either directly, or indirectly after infiltrating underground and emerging as spring flow. Table 1 shows that the mean natural run off would be nearly 11,000 tcmd** in an average year, falling to less that 3,000 tcmd in a one in fifty year drought.

Evaporation is concentrated in the summer months, and the region experiences a 'drought' every summer in the sense that evaporation exceeds rainfall, soils dry up and river flows become very small. Virtually all summer water whether in the tap or in the river has to come from storage of winter water.

Figure 1 shows the major rivers and the chalk, limestone and sandstone aquifers, whose natural storage is the region's principal water resources asset. It also shows the surface storage reservoirs operated by the water undertakers, and the inter-river transfers and river support boreholes operated by NRA to redistribute and augment water resources.

b) Quality

The region's rivers are slow flat and eutrophic. In dry summers sewage and trade effluents form a substantial part of their flows and rigorous effluent treatment and control have to be practised. Despite these disadvantages, most surface waters can be economically treated for public supply and other uses. Groundwaters are generally higher quality, but are becoming increasingly contaminated with diffuse pollutants.

* Effective rainfall is rainfall minus evaporation.

** tcmd = thousands of cubic metres per day; 1 tcmd would provide the total water supply to about 4,000 people.

DEMAND FORECASTS

Current forecasts of future water demands in the Anglian Region are as follows:

	FORECAST DEMAND TCMD			
	1991	2001	2011	
PWS (i)	1854	2199	2440	
Direct Abstraction	476	569	618	(ii)
Rivers (iii)	400	400	400	
Totals	2730	3168	3458	

(i) Figures include all of Essex Water Company, whose future growth in demand is wholly dependent on Anglian resources; but exclude Lee Valley Water Company whose demands may be met from either Thames or Anglian resources, in variable amounts, and whose demands are counted as bulk exports.

(ii) Figures exclude demands for major power generation, which could conceivably add 200-300 tcmd.

(iii) Total of required residual flows to tide from major rivers.

The public supply element is approximately 8% higher than the previous (1988) forecasts, due largely to increased population estimates. It presumes that water undertakers will control leakage to the economic levels defined in Standing Committee Technical Report No. 26 on leakage. No account is taken of the effects of domestic metering; although recent trials showed reductions in demand, experience in other countries is that customers soon revert to previous water usage. However, demand levels 10% lower and 10% higher than these 'best estimates' are considered in order to indicate the effect of uncertanties in the demand forecasts.

A secure water supply requires a greater allocation of resources than the demand forecast, in order to cover:

a) Non-transferability of surpluses, especially with groundwater sources,

b) Peak demand years (order of 5%).

c) Potential loss of sourceworks, due for example to pollution,

d) Possibility of unpredicted demand increases, for example a large new factory.

Adding approximately 10% margin to the PWS figures, leads to the following total forecasts. The figure for 2031 is derived by extrapolation and is included solely as an indicator of the possible situation which could arivse two generations ahead. Major power generation demands are omitted.

	1991	2001	2011	2031
Best Estimate	2900	3400	3700	4300
Low Forecast		3000	3300	
High Forecast		3700	4100	

This growth rate is believed to be the fastest in the country. In addition it is necessary to take account of:

a) Private domestic wells, of which there are several thousand.

b) Massive 'fen demands' in dry summers, which sustain crop growth by sub-irrigation at the expense of river flows.

c) River flows necessary to sustain environmental interests. Apart from the flows to tide identified above, these are non-consumptive and do not add to the total demands. However, the flows needed for ecological purposes are inadequately understood. Research in progress may identify additional flow needs.

d) The need to sustain water levels in a wide variety of springs, fens, meres and other environmental wetlands, some of which are of national and international importance.

ALLOCATED WATER RESOURCES

The reliable yields of water resources currently allocated by licence are approximately as follows:

PWS 2100 tcmd
Direct Abstractions 500 tcmd

Where appropriate the PWS figure has been based upon OFWAT's reference level of service, which is that restrictions on water use should not exceed:

A hosepipe ban on average not more than once every 10 years

Need for voluntary savings of water on average not more that once in twenty years.

Risk of rota cuts or use of standpipes on average less than once in one hundred years.

It also assumes that the water undertakers will install any works necessary to utilise the hydrological yield of the water resources allocated to them by licence.

The target level of service for spray irrigation is that there should be a risk of shortages not more than once in 12 years. There is no stated target for other direct uses.

BULK TRANSFERS

The following bulk transfers are made by water undertakers across the region's boundaries:

IN:	Bunter Sandstone to AWS (Lincoln Area)	70 tcmd
	Thames Water to Essex Water Company (Chigwell)	91 tcmd
OUT:	AWS to Lee Valley Water Company (Ex-Grafham)	45 tcmd*
	AWS to STWS (ex-Rutland)	16 tcmd

* Provisional figure for 2011; could increase significantly.

This gives the region a net gain of the order of 100 tcmd via the PWS network.

GROWTH OF EFFLUENT

Increasing effluents 'automatically' increase the yield of reservoirs. A conservative estimate of the total extra yield which will be generated in this way by 2011 is 100 tcmd.

PREDICTED DEFICITS

Combining the above figures leads to the following best estimates of abstractive deficits. Figure 1 illustrates the comparison of demands with reliable outputs available to meet them, including the 'low' and 'high' demand forecasts.

	FORECAST DEFICIT - tcmd		
	1991	2001	2011
P.W.S.	0	170	400
Direct Abstraction	0	70	100
Total	0	240	500

In addition the following must be addressed.

1. The zero overall deficit for 1991 masks many local shortfalls which cannot economically be met by transferring surpluses from elsewhere. Local studies are in progress.

2. A study in 1984 proposed a desirable Level of Service that "water should be generally available with only minor limitations ... and with only minor quality problems". It showed that this standard applied in only 18% of the area.

3. Certain rivers and wetlands are unacceptably affected by licensed abstractions. River and wetland needs must be quantified and catered for.

4. Unsatisfied 'fen demands' are additional to the tabulated deficits. These cannot be quantified, but already there is conflict between the need to divert water into the fens and the need for minimum flows to the estuaries.

5. Additional major power generation demands cannot entirely be ruled out.

6. NRA is a national body. Neighbouring regions, particularly Thames, are in even more immediate difficulty.

MEETING THE DEFICITS

NRA's duty is to conserve, redistribute and augment water resources, and secure their proper use; to have "particular regard" to the needs of water undertakers, "regard" to the reasonable needs of other abstractors, and to further and promote the conservation of the natural environment. It therefore has a positive role in meeting all water resource deficits.

NRA, Anglian Region proposes to fulfil that role as follows:

1. To establish water resource allocation objectives as guidelines for its activities in this field. A draft for discussion is attached as Annex 1.

2. To produce a statement on water resource availability and licensing policy; this is in preparation.

3. To establish optimum water resource development plans in collaboration with others and

4. To implement those plans, or as appropriate to ensure that they are implemented by others.

The remainder of this paper is an overview of the options available to meet the deficits, and a proposed strategy for doing so.

AVAILABLE WATER RESOURCES

Long average water resources (rainfall minus evaporation) total some 11,000 tcmd, almost 3 times the highest predicted demand figure.

It is not possible to use the entire average resource, both for lack of storage to cover dry years and because small coastal catchments cannot be developed economically. On the other hand the discharge of effluents leads to substantial re-use, and the 3-fold theoretical margin is not totally unrealistic.

The margin is much 'tighter' in dry years, but in overall terms there is no intrinsic shortage of water - provided it can be made available at the right time, place and quality, with the right degree of reliability and with proper safeguards for existing rights. Achieving this is the purpose of water resource management. and the water environment

DEVELOPMENT OPTIONS

The most likely 'local' water resource development options are:

Northern Area

1. Chalk, Limestone and Sandstone aquifers, but there is little left to develop.

2. Trent Water for Humberside and Lincoln public supply, and distributed around Fen areas for direct demands.

3. Consider further use of Rutland Water in Lincoln, but probably reject on grounds of cost, plus need further south.

4. Gwash-Glen transfer will release Limestone water for abstraction.

Central Area

1. Chalk and Sandstone aquifers, which still have substantial potential (though subject to increasing environmental constraints).

2. AWS to increase Grafham yield by constructing Brownshill tunnel, for which they have the powers. An alternative would be to reduce the Offord residual flow. This would be cheaper but needs an Environmental Impact Assessment.

3. Widespread river support pumping.

Eastern Area

1. Chalk and Crag aquifers. The Chalk still has substantial potential (though subject to increasing environmental constraints).

2. Progressive enhancement of Ely Ouse - Essex System and Great Ouse Groundwater Scheme, perhaps by reduction in residual flows to tide and/or by Stour Augmentation Groundwater Scheme; however, the marginal yields of new developments are severely limited by transfer constraints and by lack of storage in the system.

3. Possible conjunctive use of local Chalk and crag sources with Alton, or augmentation of Alton via the Ely Ouse - Essex System.

4. Possible diversion of Chelmsford and Witham effluents to augment water resources.

5. Widespread river support pumping.

Regional Options

There are also large scale "strategic" options which require consideration in the context of national as well as regional planning. These are:-

1. Southward distribution of Trent Water.

2. Groundwater recharge (technically difficult and expensive).

3. A major reservoir site at Great Bradley on the upper Stour was investigated in the late 60's; it was found to be expensive but is well sited to command the south and east of the region and to alleviate current deficits in the London area.

MANAGEMENT OPTIONS

There are 'Management' Options largely available to abstractors as well as engineering options; for example leakage control, and minimising legitimate water use by promoting water saving techniques. NRA will continue to foster the proper use of water resources by all concerned, and to audit the water undertakers' forecasts of population and demands.

The use of price is an attractive way to control water demands. The water undertakers are actively investigating domestic metering and NRA supports this and the use of tariffs which signal the full economic value of water to the customer as a means of conserving water resources. NRA's scope for controlling demand by the use of its own Charges Scheme is limited by the legal constraints on that scheme and the relatively low charges which result. However, current research may suggest ways forward.

DISCUSSION AND ANALYSIS

is this so?

After allowing for demand control measures, there is a predicted need to develop some 500 tcmd of extra yield over the next 20 years. For comparison the yield of Graham Water is about 240 tcmd. The natural resources are there to achieve this, but the increasing emphasis on environmental needs will severely constrain the 'easy options' of continued piece-meal groundwater development.

There is fundamental conflict between the need to take more water out of the rivers, and the need to sustain flows in them. Minimum acceptable river flows will have to be established and maintained, and wetlands protected against the lowering of groundwater by abstraction. Anglian NRA already actively supports many of its rivers and this will be continued and extended. For the same reason abstraction from the lower ends of the rivers, and especially winter abstraction, will be favoured as opposed to excessive abstraction of groundwater which would reduce river flows.

An additional factor, on time scales of 20 years or more, is climatic change. The current 'best guesses' of the climatologists suggest a trend to hotter drier summers, but wetter winters. This would increase summer demands, but offers the prospect of more winter water - hence a strategic need for more large scale storage. In this context a reservoir on the upper Stour would be strategically placed to contribute to the needs of Thames Region, and to augment water resources throughout southern Anglia. In Lincolnshire the River Trent which is supported via public supply reservoirs further west can serve this purpose. The large groundwater reserves of Norfolk, properly utilised, should meet all local needs and could provide increased abstractions from the lower reaches of the Norfolk rivers for transfer elsewhere.

The proposed strategy is therefore one of utilising groundwater as far as possible, but sensitively; and at the same time starting immediately to look to larger, longer term surface water options - particularly the River Trent and Reservoir storage. If continued development of groundwater were to prove environmentally unacceptable, then major (and very expensive) surface water options such as these would be the only alternative to rigorous controls on population and water-use growth in this Region.

Although questions of charging policy have been touched upon, this strategy is deliberately confined to what should be done; it leaves for later discussion who should do what and who should pay.

Most of the figures on which this review is based require detailed review and updating. Water resource planning groups have been established to do this.

PROPOSED STRATEGY

NRA Anglian Region proposes the following strategy in response to predicted demand increases over the next 20 and more years.

1. To review water resource availability, and its detailed licensing policy. This is underway.

2. To review the needs for minimum river flows, and to set formal MAFs; to protect such flows against excessive abstractions and where appropriate to sustain them by river support pumping.

3. To secure the proper use of water by supporting leakage reduction, sound charging policies and good husbandry by water users.

4. To audit the water undertakers' demand forecasts and to require leakage reduction to economic levels as a pre-requisite to licensing increased abstractions.

5. To encourage augmentation works by users, for example the provision of winter storage reservoirs.

6. To license additional groundwater, but subject to sustainability and to the acceptability of the environmental consequences.

7. To continue to undertake multi-purpose redistribution and augmentation works, where appropriate and economic.

8. To look to the River Trent to meet longer term needs in the northern area.

9. To endorse AWS's intention to distribute their 'Ruthamford' water towards the south and east of their area; and to determine the best way of maximising Grafham yield, whether by Brownshill Tunnel or by reduction in Offord MRF.

10. To look to continued groundwater development in the Norwich area, or to the alternative of increased river abstractions backed by river support pumping.

11. To utilise the Great Ouse Groundwater Scheme to meet local demands in that area and, in conjunction with the Ely Ouse - Essex Transfers, to meet demands in Essex and parts of Suffolk.

12. To investigate the feasibility of using Chelmsford and Witham effluents to augment water resources.

13. To investigate options for enhancing the Ely Ouse - Essex system by additional storage, such as a reservoir at Great Bradley, to increase its potential to meet rising demands in the south and east of the region, particularly Ipswich, and possibly in the Thames Region.

SUMMARY OF STRATEGIC PROPOSALS

In broad summary the Region needs:

1. Positive measures to avoid waste or improper use of water.

2. In the south: immediate consideration to a new reservoir.

3. In the north: increasing use of Trent Water.

4. In the East: continuing, but sensitive, groundwater development.

5. In the Central area: use of some river flows currently 'lost' to tide.

David Evans
October 1990

Revaluation of existing situation and correction of sins of past.

TABLE 1

RAINFALL AND EVAPORATION

	Anglian Region			Rest of England and Wales		
	Average Year	Driest Year (i) in 10	Driest Year (i) in 50	Average Year	Driest Year (i) in 10	Driest Year (i) in 50
Rainfall - mm (ii)	595	505	463	940	835	770
Evaporation - mm (ii)	448	435	423	453	445	450
Effective Rainfall mm	147	70	40	487	390	320
Effective Rainfall tcmd	10,870	5,180	2,960	-	-	-

Notes:

(i) Defined as a year in which the effective rainfall has the stated chance of being so low. This could arise from alternative combinations of low rainfall and/or high evaporation and the Rainfall and Evaporation figures are indicative only.

(ii) Data are taken from Met. Office 'MORECS' and other statistics except that Effective Rainfall (and hence Actual Evaporation) for England and Wales is derived from "An estimate of annual run-off from England and Wales, 1728-1976" by Marsh and Littlewood (Hydrological Sciencies, 23rd Novembeer 1978). Details are given in "Calculation of Average and 1 in 10 year met. statistics" (AWA August 1979).

WATER RESOURCES - NORTHERN AREA	(1) Order of Additional Resources available for Abstrative Use - tcmd
1. N. Limestone	20
2. C. Limestone	20
3. S. Limestone (with Gwash-Glen transfer)	15
4. N. and S. Lincs Chalk	5
5. Spilsby Sandstone	10
6. Gravels and other minor aquifers	10 - 20
7. River Trent	
- to Humberside via Elsham - to Lincoln via new intake - to various Fen areas	)) 500+)
Note 1: These are potential maxima; local constraints may severely limit the extent to which they can actually be utilised	

Note that not priority ranked.

WATER RESOURCES - CENTRAL AREA	(1) Order of Additional Resources available for Abstrative Use - tcmd
1. Nar Chalk (including Babingley etc)	30
2. Wissey Chalk (possibly as d/s river intake?)	40
3. Little Ouse Chalk	60
4. Lark Chalk	30
5. Lodes/Granta Chalk	0
6. Cam/Rhee Chalk	0
7. Ivel Chalk	40?
8. Sandringham Sands	30
9. Bedford/Cambridge Greensand	0
10. Oolite	0
11. Gravels and other minor aquifers	small
12. Reduction of Offord MRF (to increase Grafham yield) or Brownshill Tunnel	up to 90
Note 1: These are potential maxima; local constraints may severely limit the extent to which they can actually be utilised	

WATER RESOURCES - EASTERN AREA	(1) Order of Additional Resources available for Abstrative Use - tcmd
1. Norfolk Chalk and Crag	200 - 300
2. Suffolk Chalk and Crag (including conjunctive use with Alton)	40
3. Essex Chalk	small
4. Enhancement of Ely Ouse - Essex System	)
- GOGW	)
- SAGS	)
- Reduced Denver MRF	) 50
- Hanningfield input capacity	)
5. Ely Ouse - Stour - Alton	
6. Chelmsford and Witham Effluents	40 - 50
7. Reservoir on upper Stour	200 ?
Note 1:	
These are potential maxima; local constraints may severely limit the extent to which they can actually be utilised	

ANNEX 1

DRAFT WATER RESOURCE ALLOCATION OBJECTIVES

1. To allocate water, where possible, in such a way as to meet all reasonable demands, including environmental demands, as far as possible, at minimum overall cost. ~~what~~ not prime NRA role under NRA as base

2. Where economic, to augment and/or re-distribute water resources to meet demands, including environmental demands, to appropriate standards of reliability.

3. Where availability is in doubt, to give prior (and equal) priority to existing protected rights and to established environmental needs. ?

4. To interpret "reasonable needs" as including agreed predicted increases in demand to a time horizon consistent with purpose of use; for example 15 years in the case of public supply, 10 years for most industrial and agricultural licences.

5. Never to allow licensed abstraction from an aquifer unit, plus groundwater allocated to river needs, to exceed long average recharge to that unit. X Yes but need more strategic debate

6. To encourage the storage of winter water.

7. To encourage efficient water use, and where possible re-use for purposes appropriate to the quality of the resource.

8. Where water is to be exported from a catchment, to encourage (and in appropriate cases to require) its abstraction from the downstream end of the river, rather than from groundwater or from the upper reaches.

9. Why. Where appropriate, to encourage groundwater abstraction in preference to summer surface water abstraction, other than at or near the tidal limit of the river.

10. Duty To avoid derogation, either to abstractive rights or to environmental interests, except:

    a) by agreement with the derogated party,
    b) where appropriate compensation works (e.g. river support) are provided, or
    c) where such derogation is minimal and/or leaves the reliability of the affected abstractor at or above that considered appropriate to the purpose of use.

11. To ensure that all licence conditions are simple, practical and enforceable; in particular that cessation conditions do not have to be invoked more often than say once in four or five years.

12. To seek to revoke unused licences, and to reduce under-used ones.

13. To set discharge consents appropriate to anticipated future flow regimes, rather than to commit current flow regimes wholly to effluent dilution.

7th December 1990