ANGLIAN
WATER RESOURCES

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Synopsis

This paper describes water resources in the Anglian Region and how they are currently used; predicts future demands of all kinds; and suggests how NRA should manage water resources in response to those demands.

CLIMATE

1. Anglia has the lowest rainfall in the country, and high evaporation. As a result it has much the lowest effective rainfall,ƒ and the least water resources. For example, Table 1 shows that Anglia's average effective rainfall is only 147 mm/year, compared with 487 mm/year for the rest of England and Wales.

2. On average, rainfall is spread fairly uniformly through the year. However, evaporation is concentrated in the summer. As a result it is normal for Anglia to experience a 'drought' every summer, in the sense that evaporation exceeds rainfall, soils dry up, river flows become very small, and storage of winter water is necessary to maintain supplies.

3. The close balance between rainfall and evaporation makes Anglia particularly vulnerable to periods of low rainfall. For example, Table 1 shows that 1 year in 10 effective rainfall in Anglia falls to some 70 mm, 48% of average. The equivalent for the rest of England and Wales is 390 mm, 80% of average.

4. In a 1 in 50 drought year (the kind of extreme event for which Public Water Supply schemes are commonly designed) the rest of England and Wales still enjoys 66% of normal resources, but Anglia has only 27%.

5. This paper does not address the possibility of climate change, as the potential effect on water resources remains far from clear.

NATURAL WATER RESOURCES

6. In the natural state all effective rainfall would find its way to rivers (and thence to the sea) either directly, or indirectly as springflow after infiltrating underground and passing through porous rocks (aquifers).

7. Table 1 shows that the mean natural run-off would be nearly 11,000 tcmd* in an average year, falling to under 3,000 tcmd in a 1 in 50 year drought. Most run-off occurs in winter; natural summer flows reduce to near zero in clay catchments, and to perhaps 1/4 of their winter rate in those rivers best supported by spring flows.

ƒ = effective rainfall is Rainfall minus Evaporation
*tcmd = thousands of cubic metres per day; 1 tcmd would provide the total water supply to a town of about 4,000 people.

8. Figure 1 shows the locations of all the major rivers, and of the Chalk, Limestone and Sandstone aquifers, whose natural storage is the Anglian Region's principal water resources asset.

DEVELOPED WATER RESOURCES

9. Because of Anglia's climate, large volumes of water storage have been developed over the years. As a result Public Water Supplies are in general not vulnerable to the short 'one-Summer' droughts which affect other parts of the country. In Anglia droughts of this kind are commonplace, and whereas a very dry Summer is harmful to agriculture (because soil water storage is limited) it takes at least a 'Summer-Winter-Summer' drought to create Public Water Supply difficulties.

10. About half of the developed storage is underground. Anglia's aquifers are approaching full exploitation, with the exception of parts of the Norfolk Chalk.

11. The rest of the developed storage is in reservoirs, notably those for Public Supply at Abberton, Hanningfield, Pitsford, Grafham, Covenham, Ardleigh, Alton and, largest of all, Rutland Water (Fig. 1). These are mostly filled by pumping from the Region's major rivers. More recently many farm storage reservoirs have been privately built to store winter water for summer irrigation.

12. Virtually all groundwater abstractions are at the expense of spring flows. Many rivers and wetlands have already been affected historically, largely by Licences of Right, and increasing abstraction exacerbates the situation. This applies particularly to streams draining the heavily exploited Lincolnshire Chalk and Limestone aquifers and to a lesser extent the Cambridgeshire and Suffolk Chalk.

13. However river flows are artificially augmented:

    a) by effluents from inland sewage treatment works and other discharges

    b) by river to river transfer schemes, notably the Ely Ouse-Essex and Trent-Witham-Ancholme Schemes; and

    c) by river support pumping from groundwater, which is being progressively developed to optimise the use of the Chalk resources in the Central and Eastern Areas.

WATER QUALITY

14. The Region's rivers are mostly slow, flat and eutrophic. In dry summers sewage and trade effluents form a substantial proportion 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. Ground waters are generally of higher quality and need less treatment.

15. Water quality issues which constrain the use of water resources are:

a) Iron, manganese and fluoride concentrations make some ground water unfit for public supply.

b) Connate saline water limits the development of some aquifers.

c) Saline intrusion from the sea affects both surface and groundwaters in some coastal areas.

d) The risk of pollution has caused the closure of some relatively shallow sourceworks.

e) Increasing concentrations in both surface and groundwaters of agri-chemicals, particularly nitrates and pesticides, due largely to intensive agriculture.

DEMANDS FOR WATER

Public Water Supply

16. Table 2 shows demands for Public Water Supply projected to 2011, (1988 forecasts). The growth rate is the fastest in the country, and in round figures Public Supplies, including export to neighbouring areas, may rise from 1,750 tcmd in 1986 to over 2,300 tcmd by 2011.

Direct Water Use

17. Table 2 also shows demands for raw water taken by private abstractors. In round figures these could rise from 500 tcmd in 1986 to over 1,000 tcmd by 2011, most of the potential increase being for power generation and for spray irrigation.

18. These figures exclude private domestic wells, of which there are several thousand. These are unlicensable, and may reduce in number, but they have protected rights which must be allowed for in any water resource development.

19. There are also very substantial summer demands to maintain drain levels in the Fen areas. As far as possible these have been allowed for in the assessments of water resources available for other purposes, but they are not fully understood and there is a need to investigate the size, impact and possible future control of Fen demands.

In-River Demands

20. In-river demands have led to the setting of 'minimum residual flows' (MRF's) at certain key points. Minimum flows to tide, listed in Table 3, total approximately 400 tcmd.

21. Other MRF's have been set further inland to protect environmental interests, but being non-consumptive these do not add to the total demands on the Region's resources.

BALANCE OF DEMANDS AND RESOURCES

22. The consumptive demands detailed above are summarised as follows:-

	1986	1991	2001		2011
PWS	1,750	1,821	2,067		2,324
Direct Water Use	500	555	680	up to	1,090
Minimum Flows to Tide	400	400	400		400
Total Consumptive Demand	2,650	2,776	3,147	up to	3,814

23. The total forecast demand at 2011 is less than 35% of Anglia's total average resources (paragraph 6), almost a three-fold margin.

24. 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.

25. Thus in overall terms there is no intrinsic shortage of water in the Anglian Region - provided it can be made available at the right time, place and quality, with the right degree of reliability and with proper safeguards against derogation of existing rights. Achieving this is the purpose of water resource management.

CURRENT LEVELS OF SERVICE AND SOURCEWORKS OUTPUTS

(a) Public Water Supply

26. Anglian Water's target level of service for P.W.S. 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 than once in 20 years.
Risk of rota cuts or use of standpipes on average less than once in 100 years.

27. Tables 4 and 5 show the current reliable outputs of PWS sourceworks, from surface and groundwaters respectively. In the case of the larger reservoirs these are the 'normal' outputs at which the frequency of restrictions will be as in paragraph 26. For the smaller surface waters the figures are for maximum sustainable output during the worst recorded drought, which is roughly equivalent. In the case of groundwaters, sourceworks reliable outputs are the borehole outputs which can be relied upon in drought conditions subject to all the constraints of licence, resource availability and installed capacity.

28. Current PWS reliable outputs (including those of water companies) total:-

Surface water	1,200 tcmd
Ground water	870 tcmd
Total	2,070 tcmd

(These are 1987 estimates, and subject to review)

29. These figures will increase in two ways:-

a) The yields of Grafham, Rutland and other surface resources are not yet fully realised because of limitations in treatment capacity. When this constraint is lifted the total reliable yield increases by over 100 tcmd.

b) Increasing effluents 'automatically' increase the yield of reservoirs, particularly Grafham and Rutland. A conservative estimate of the total extra yield which will be generated in this way by 2011 is 100 tcmd.

30. Thus the anticipated reliable output at 2011 of public supply sourceworks already developed will be over 2,200 tcmd.

(b) Direct Water Use

31. Anglian Water's 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.

32. It is not generally practicable to assess the reliability of existing licences, but it is believed that most existing licensed abstractions are reliable to the target level of service.

33. However, many licence applications have to be turned away, or toned down, for lack of reliably available water, (especially for summer water when demand is greatest) or for water quality reasons. This is becoming more widespread as more and more catchments approach full development. The water resources level of service therefore needs to be expressed not in terms of the reliability of existing licences, but by the availability of raw water. An exercise carried out in 1984 defined the five levels of service described in Table 6, and evaluated which level currently applied in each of the Region's 188 sub-catchments. Inevitably the exercise was partly subjective, but it was based on a rigorous examination of each catchment, by staff with the closest knowledge, in conjunction with the coordinator of the exercise in order to ensure regional consistency. This lead to a 'profile' of each sub-catchment describing

- problems experienced by existing licencees,
- the availability of summer surface water, winter surface water and/or groundwater,
- the existence or otherwise of A.W. support works,
- any known water quality problems, and,
- any other relevant information.

The profile was then translated to the Level of Service measure described in Table 6. Table 7, which summarises the results, shows:-

a) that only 18% of the Region was at or better than Level 2 (water available with only minor limitations or quality problems), and

b) that almost 40% was at or worse than Level 4 (significant shortfalls for existing customers, only winter water available for new customers, and/or significant quality problems).

34. The high incidence of Levels 3 and 4 is because summer surface water is almost totally committed, and ground water is largely so; Level 5 applies to coastal catchments where the water is largely saline and to some heavily developed inland catchments. Levels 1 and 2 mostly apply only where river augmentation works enhance the availability of water.

35. In only 16% of sub-catchments is the level of service decided by poor quality rather than by non-availability.

36. The 1984 exercise suggested that in principle Level 2 should be the target. However this would not always be economic to achieve and it was therefore proposed that the Target Level of Service for water resources should be "To make water available for all classes of water use with only minor limitations and/or works by the customer, and with only minor quality problems; <u>or</u> to such lower level as is economic in any particular area".

37. Current compliance with this target, and the cost of achieving full compliance, have not yet been assessed. This would require cost-benefit analysis of each sub-catchment (or at least of representative samples).

(c) <u>Rivers</u>

38. The residual flows to tide listed in Table 3, and others set at inland locations, protect low river flows against further artificial reduction. For those cessation flows that control the major PWS abstractions Anglian Water's target level of service is that they should be reduced as an emergency drought measure not more often than once in twenty years (co-incident with a voluntary savings campaign on treated water use).

39. However such cessation flows do not compensate for loss of natural flows due to pre-existing abstractions (especially Licences of Right). In some cases, notably the Witham, Ancholme, Stour, Blackwater and various rivers in the Great Ouse Groundwater Scheme area, river flows are artificially sustained. However most rivers are not augmented and there has been no systematic assessment of level of service in respect of river flows. Nor is there yet any objective way of determining whether a depleted river should be augmented, and if so to what minimum flow. The methodology for setting minimum residual flows or minimum maintained flows is seen as the highest priority if sensible water resource planning is to be done in the context of overall environmental management.

<u>PREDICTED DEFICIENCIES</u>

<u>Public Water Supply</u>

40 The developed sourceworks reliable outputs (paragraph 29) appear to show a healthy surplus over current demands (paragraph 22). However this surplus has 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.

41. The apparent surplus masks local problem areas (for which progressive developments are in hand), and there is a long term need to develop some 300-400 tcmd for public supply by 2011.

Direct Water Use

42. Paragraph 22 suggests a need to make available an additional 500-600 tcmd for direct use. Half of this would be for one large inland power station, which remains speculative; much of the rest would be for spray irrigation, though recent enquiries suggest some resurgence in demand for raw water for industry. Developments to meet these demands should ameliorate the poor level of service situation revealed in paragraph 33.

Rivers

43. River flow deficiencies have not yet been systematically identified, although action is already being taken, or considered, in respect of several rivers whose flows have been unacceptably depleted. The setting of minimum acceptable flows in accordance with the 1989 Water Act may well reveal further river flow deficiencies, and hence lead to greater allocation of water resources (and expenditure) to river flows.

Total Deficiencies

44. In total there may be need to make available additional raw water resources of up to 1,000 tcmd by 2011.

DEVELOPMENT OPTIONS

45. There are many options to increase sourceworks output (or to transfer surpluses). The main ones are:-

Northern Area	Trent - backed Public Water Supplies, either via Elsham or a new intake near Lincoln.
	Further dissemination of Trent water.
	Optimise use of local groundwaters (and, for PWS, Bunter Sandstone from ST Area).
	More widespread use of Rutland Water
Central Area	Widespread development of the Chalk aquifer.
	Reduction in some residual flows to tide (following effluent improvements) to release water for other purposes.
	Surface water (possibly from Grafham) for Cambridge Co.
	Transfer of Ouse and Nene waters into Fen areas.
Eastern Area	Progressive enhancements to Ely Ouse-Essex system.
	Developments of Chalk aquifer.
	Enhancement of Alton Water by conjunctive use with Chalk aquifer.
All Areas	Minor development of groundwaters for local uses.
General	Possible utilisation of PWS surpluses ('Ruthamford' System) for other more immediate needs.

46. Table 8 enlarges on this list, and suggests speculative gross figures totalling in excess of the predicted need. However many of the options would be either expensive (surface reservoirs inland or in the Wash) or otherwise controversial (reducing residual flows to tide); others (particularly groundwaters) are still subject to detailed investigations. Where available, groundwater is generally preferred on grounds of cost, quality and ability to phase development. However as aquifers become increasingly fully developed the effort needed to further exploit them increases disproportionately.

CHARGING IMPLICATIONS

47. Many of the necessary developments will be carried out by the user, for example single purpose reservoirs and boreholes, strategic trunk mains and the like. However, many of the options in paragraph 45 are multi-purpose raw water developments which are appropriate to the NRA. It will be necessary very soon to determine on what basis NRA will decide what water resource developments to undertake. It is also desirable to devise a Charges Scheme which both recovers the necessary costs and delivers the economic 'signals' to water abstractors necessary to ensure that NRA's expenditure is properly and economically directed.

SUMMARY AND PROPOSALS

48. The National Rivers Authority's duty in respect of water resources is to conserve, redistribute or otherwise augment them for the benefit of all customers including public supplies (to which "particular regard" must be paid), direct water use and in river needs. Comprehensive water resource planning is seen as the only responsible way in which this general duty can be discharged. The aim must be to implement a system which ensures that a complete plan is prepared and regularly kept up to date.

49. The analysis above has shown that:-

a) There is a near 3-fold margin of gross natural water resources over total predicted demands, though in dry years this reduces greatly.

b) In more practical terms, there is a realistic overall margin of sourceworks outputs over current PWS demands.

c) There are local problem areas for Public Supply for which developments (primarily groundwater) are under way.

d) The level of service in terms of raw water being available to potential direct abstractors at the right time, place and quality is poor in most areas.

e) The following deficits are predicted by 2011:-

PWS	300-400 tcmd
CEGB	Up to 300 tcmd
Other direct users	Up to 300 tcmd
Total	Up to 1,000 tcmd

f) There are sufficient natural resources to allow these predicted deficiencies to be met, provided sufficient expenditure is committed to the necessary investigations and developments, and to ameliorating the potential environmental effects.

g) For reasons of cost and quality, groundwater development is generally preferred, but is limited in quantity and as it approaches full development is strongly subject to the law of diminishing returns.

h) There is need to review policy with respect to the setting and subsequent maintenance of minimum river flows.

50. Thus although there is no intrinsic shortage of resources, substantial expenditure (both investigation and capital development) will be required if water is to be made reliably available to meet the predicted deficiencies.

51. Previous water resources legislation included specific duties to plan to meet future demands. The 1989 Bill carries only the general duty quoted at paragraph 48. Therefore there is need for guidance on NRA's role in water resource planning and augmentation and on the complementary issue of charging policy.

52. It is proposed that:-

(i) the water resource planning groups should review the balance of demands and resources, and establish in detail the investigations and development works needed to meet predicted water resource shortfalls. These groups, which have already been established, include representatives of NRA (Region and Areas) and of major water users particularly the water undertakers.

(ii) preliminary work be undertaken on the methodology of establishing water resource levels of service on either a national or a catchment basis having regard to the costs involved and economic considerations.

(iii) Licensing policy be rationalised across the Region as far as possible in accordance with target levels of service.

(iv) Policy guidelines be produced covering

a) the setting of minimum acceptable flows,

b) the extent to which NRA should undertake water resource augmentation works including the maintenance of minimum river flows; and

c) charging policy to pay for them.

(v) Operation of existing augmentation works should be based on similar criteria to those used to determine the need for new works.

(vi) An attempt be made to estimate the consumptive use of water in the Fens which may be crucial in maintaining minimum residual flows in drought periods.

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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 Sciences, 23rd November 1978). Details are given in "Calculation of Average and 1 in 10 year met. statistics" (AWA August 1979).

TABLE 2

DEMANDS FOR WATER (tcmd : average)

(Forecasts made 1988)

	1986		Forecast 1991	2001	2011
Public Water Supply (Treated Water)					
Anglian	1,155		1,194	1,371	1,552
Cambridge	74		81	97	112
East Anglian	70		84	93	102
Essex (i)	394		402	431	456
Tendring	29		32	36	41
Lee Valley (vi)	16		16	25	45
Severn-Trent (vii)	12		12	14	16
Total Treated Water	1,750		1,821	2,067	2,324
Direct Water Use (Raw Water)	Lic'd	Actual			
CEGB (v)	2	2	2	2	up to 290 (iv)
Other Industry	504	234	245	269	293
Spray Irrigation (iii)	312	249 (iii)	292	391	487
Other Agriculture (vii)	43	15	16	18	20
Total Raw Water (ii)	861	500	555	680	up to 1,090
Total Water Use		2,250	2,376	2,747	up to 3,414

Notes :

(i) Demands of Essex Water Company, though partly in Thames area, are included in full.

(ii) Excludes non-licensed uses such as domestic wells and transfers of river water to maintain summer levels in the Fens.

(iii) Figures are for average abstraction during a drought year. The peak summer abstractions are far higher.

(iv) Figure is for a single proposed major power station; depending on the type of station chosen, the water demand could be 50% higher.

(v) Subject to power generation proposals which may stem from electricity privatisation.

(vi) Lee Valley Water Company's use of Grafham Water.

(vii) Export to Severn-Trent PLC from Rutland.

(viii) Excludes fish farming, water-cress beds etc.

TABLE 3

RESIDUAL FLOWS TO TIDE

River	Location	Required Flow (i) tcmd	Purpose	Comments
Ancholme	Ferriby Sluice	say 25 (ii)	Largely to exclude salt water	Conditional - see Reference 7
Witham	Grand Sluice	40 (ii)	- ditto -	- ditto -
South Forty Foot	Black Sluice	10 (ii)	- ditto -	- ditto -
Louth Canal	Tetney	2.2	- ditto -	Reference 7
Gt.Eau	Cloves Bridge	2.2	- ditto -	Reference 7
Glen	Surfleet	4	- ditto -	Reference 8
Vernatts Drain	Surfleet	8	- ditto -	Reference 8
Nene	Dog-in-a-Doublet	20	Estuary quality & siltation	Provisional - see Reference 9
Bedford Ouse	Brownshill	21	Estuary quality & to exclude saline water	Suggested figure for proposed Brownshill intake
Ely Ouse	Denver	114 May-Aug (iii) 318 Sept-April (iii)	Estuary quality	Ely Ouse - Essex Act 1968. Under Review : Reference 10
Stour	Cattawade	2 (iii)	Fisheries	Essex River & South Essex Water Act 1969
Chelmer & Blackwater	Langford	2 (iii)	Eastuary quality	Hanningfield Water Order (1950). (Provided by treated effluent).
Wensum	Heigham	44.4		Licence condition
Waveney	Shipmeadow	23		Licence condition
Gipping	Sproughton	9		Statutory
Mill River	Bucklesham	2.5		

(i) These are flows which have been adopted for planning, operational and licencing purposes

(ii) Subject to review

(iii) Statutory

TABLE 4

CURRENT* P.W.S. SOURCEWORKS RELIABLE OUTPUTS - tcmd - SURFACE SOURCES

Sourceworks		Anglian Water	Other Companies
Covenham		64	
Elsham		59 (ii)	
Saltersford		20	
Rutland		227 (i) (290)	
Grafham		196 (i) (240)	
Pitsford		39	
Ravensthorpe, Hollowell etc		12	
Foxcote		7	
Clapham		22	
Stoke Ferry		9	
Nar (+ Loke Road)		11	
Ardleigh		13	13
Abberton	) with Ely Ouse -) Essex scheme		346
Hanningfield	)		
Heigham		44	
Bucklesham		(standby)	
Alton Water		30	
Broads Rivers			50
Export to Lee Valley Water Company		-45	
Import from Thames Water			91
TOTAL - surface water		708	500

(i) Limited by treatment capacity; figures in brackets are hydrological yields.

(ii) Non-potable industrial supply.

*1987 estimate

TABLE 5

CURRENT* P.W.S. SOURCEWORKS RELIABLE OUTPUTS - tcmd - GROUND WATER SOURCES

Resource	Anglian Water	Other Companies
North Lincs Chalk	122	
South Lincs Chalk	5	
North Lincs Limestone	16	
Central Lincs Limestone	22	
Southern Lincs Limestone	64	
Spilsby Sandstone and Minor Aquifers	24	
Bunter Sandstone (Severn Trent Area)	72	
Greensand	32	
Minor Aquifers (Cambridge)	5	
Chalk - Cambridge	137	83
Chalk - Colchester	74	29
Chalk - Norwich (incl. Crag)	132	34
Chalk - Thames W.A.		18
Total - Ground Water	705	164
Surface Sources c.f.	708	500
TOTAL	1,413	664

* 1987 estimate

TABLE 6

DEFINITIONS OF WATER RESOURCES LEVELS OF SERVICE

Level	Water Availability	Water Quality
1	Readily available to stated operational standards	No problems
2	Available with minor limitations and/or works by customers	Only minor problems
3	Available with significant limitations and/or works by customers	Some problems
4	Significant shortfalls for existing customers on stated operational standards; virtually only winter water available for new customers	Significant problems
5	Widespread shortfalls Little or no 'new' water available	Substantial problems

TABLE 7

% OF AREA AT STATED LEVEL OF SERVICE (IN 1984)

	Level 1	Level 2	Level 3	Level 4	Level 5
Northern Area	0	5	37	35	23
Central Area	2	30	47	18	4
Eastern Area	0	17	48	27	8
Region	1	17	43	27	12

TABLE 8

MAIN RESOURCE DEVELOPMENT OPTIONS

Resource	Means of Development	Possible Additional Yield (i) tcmd	Comment
Ground Water			
Lincs. Limestone	Conventional boreholes	40	
Lincs. Chalk	Redistribution of b/hs and/or conjunctive use with surface resources.	20	
Gt. Ouse Chalk	Conventional b/hs and/or river regulation b/hs	100 - 200	
Norfolk & Suffolk Chalk	"	200 - 300	
Essex Chalk	Conventional b/hs and/or further conjunctive use with surface resources	30	
Greensand & other minor aquifers	Conventional boreholes	100	
Surface Water			
Rivers Trent, Witham & Ancholme	Increase capacity of existing transfer system	200 or more	
River Gt. Eau	Provide storage	40)	) Unlikely to be chosen because of disadvantage with storage options
River Bain	Provide storage	up to 60)	)
Rivers Welland & Nene	Provide storage, additional to Rutland	140)	)
River Bedford Ouse	Storage additional to Grafham (inland or in the Wash, Stage I only)	up to 300)	Unlikely to be chosen because of disadvantage with storage options
River Bedford Ouse	Additional intake to Grafham, at Brownshill	up to 140	
River Great Ouse	Reduce residual flows to tide	) up to 100	
River Ely Ouse	Reduce residual flows to tide	)	
Essex Rivers	Additional storage	180)	Unlikely to be chosen because of disadvantage with storage options
	TOTAL	up to 1850	

(i) These are potential gross yeilds, for all purposes. Some of the figures are very speculative and would depend on investigation.

Anglian Water Authority

Location of Major Resources and Major Elements of Regional Transfer Network

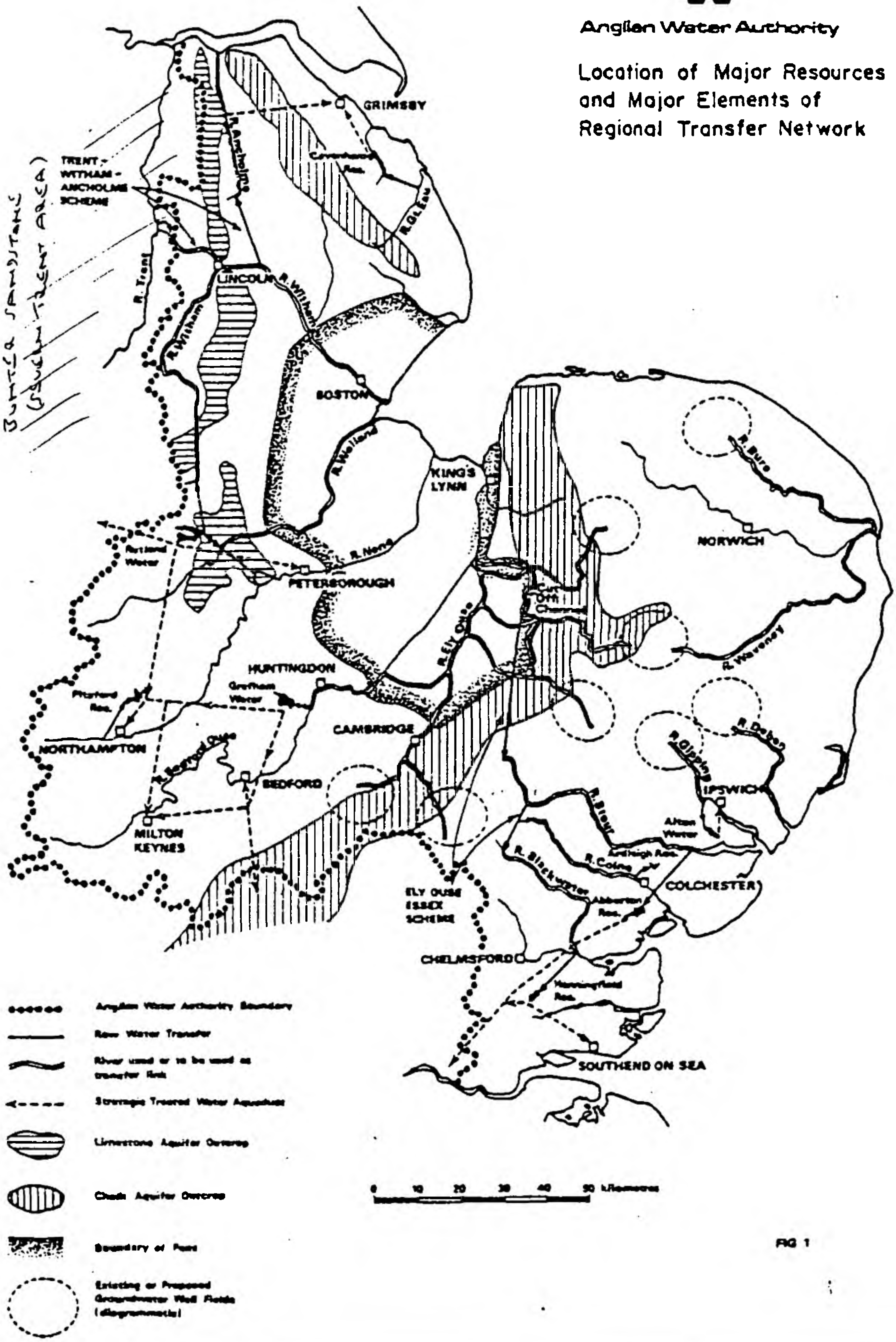

FIG 1