NRA

NRA - Anglian Region
Strategic Options Study

MEETING FUTURE WATER NEEDS IN ANGLIA

OPTIONS FOR TRANSFER OF WATER FROM THE RIVER TRENT AND RESERVOIR STORAGE AT GREAT BRADLEY

Technical Summary of the Feasibility Report

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This study is one of a series being undertaken to assess options to meet future water needs in Anglia

TECHNICAL SUMMARY OF THE FEASIBILITY REPORT

Background

Demands for water in Anglia are increasing steadily. In order to meet expected demands into the next century, the NRA is working towards a Water Resources Strategy for the region. The NRA aims to :

- secure the proper use of water;
- conserve, redistribute and augment water resources to meet the reasonable needs of industry, agriculture and public water supply;
- protect and where possible enhance the water environment

Technical studies are being undertaken by the NRA and others to establish :

- the future demand for water by the public, industry and agriculture;
- the water needed to sustain springs, wetlands, rivers and estuaries;
- the current capacity of existing sources and transfer systems to provide water reliably;
- the opportunities for reducing wastage and using water more efficiently;
- options for making more water available, including :
    - further use of river water
    - further use of groundwater
    - further use of effluent from waste water treatment
    - further bulk water transfers
    - further reservoir storage

A draft strategy will be published for public comment during 1993.

This report describes the results of a study by independent consulting engineers into the outline feasibility, cost and environmental implications of the bulk transfer of water from the River Trent and the construction of a reservoir at Great Bradley on the Suffolk/Cambridgeshire border.

At this stage it is emphasised that no decision has been made by the NRA or any other body on whether a new reservoir or bulk transfer system should be built. If it is decided that water transfer and/or a reservoir are to form part of the strategy then further detailed planning must be completed. Detailed planning would include :

- further studies including formal public consultation and environmental assessments

- obtaining powers for construction, possibly involving a Public Inquiry

The Current Study

Figure 1 shows the options studied in the report along with their possible components, while Figure 2 shows the possible location of a reservoir at Great Bradley.

It is likely that abstractions from the Trent would be restricted during times of low river flow. Storage of winter flows would then be necessary, in existing reservoirs or in a new reservoir on the transfer route, to provide a year round supply of water.

The Trent water transfer investigation comprised five components, three in the transfer system "upstream" of Great Bradley and two "downstream". These are components 1 to 3, 5 and 6 respectively. Component 4 is the Great Bradley reservoir.

The NRA currently operates two major raw water transfer schemes, the Trent-Witham-Ancholme Scheme and the Ely Ouse-Essex Scheme, which are also shown on Figure 1.

Water transfers would be by pipeline, tunnel or existing river, canal and drainage channels. Where there would be a need for channel enlargement it might be possible to mitigate adverse affects of channelisation or even to use the opportunity to make environmentally sensitive engineering improvements including the creation of low flow channels, meanders, pools and riffles.

Initial liaison with the following bodies has been undertaken to raise awareness of potential environmental issues:

- English Nature
- Countryside Commission
- County Councils
- Local naturalist/wildlife trusts
- Parish Councils in the Great Bradley area

Component 1 - Trent-Witham-Ancholme transfers

This component would increase the transfer capacity of the existing Trent-Witham-Ancholme Scheme and provide water for onward transfer from the lower River Witham. The existing scheme is licensed for the NRA to abstract 180 thousand cubic metres per day (tcmd) from the River Trent for many purposes, most notably to support Anglian Water's supply to South Humberside. Two transfer routes between the Trent and Witham have been studied for the possible additional transfer of up to 600 tcmd.

The routes, which are shown on Figure 3 are :

- By pipeline to the upper River Witham near Newark

- By short pipeline at Torksey then via the Fossdyke Navigation.

Alternative Trent-Witham transfer links at Newark have been costed and Route 1.3 identified as the best (See Figure 3). For transfers above 100 tcmd the River Witham channel would require minor improvements; these minor improvements extend downstream to Lincoln for higher transfers up to 600 tcmd. The estimated capital cost for transfers by this route for the maximum transfer volume would be £45 million.

The capacity of the Fossdyke Navigation for additional transfers above the current maximum transfer capacity of 220 tcmd may be limited to 100 tcmd if only relatively minor bank protection, lock and dredging works are considered. For additional flows up to 600 tcmd major bank protection and other improvement works to the canal would be required. These improvements would however be less costly and generally have less environmental impact than transfers near Newark and down the Witham to Lincoln. The estimated capital cost for transfers by pipeline at Torksey and the Fossdyke Navigation for maximum transfer volume is £21 million.

The transfer via the Torksey pipeline and the Fossdyke Navigation is therefore considered to be the more suitable alternative.

Increasing the existing Witham to Ancholme transfers by up to 150 tcmd was considered and it was determined that the existing system could be uprated by 50 tcmd; the main restriction being the pipeline capacity between Short Ferry and Toft Newton Reservoir. A second pumping station and pipeline would be required for higher flows. A short length of the River Ancholme channel would require major improvements for the higher additional transfers considered. Toft Newton Reservoir currently has about 4 days storage. Under the new system this would drop to about 2 days. Whilst this should be sufficient reserve to cover for power failures it is unlikely to be sufficient to cover for a major pollution incident on the Trent, particularly as this is a tidal river. We recommend, therefore, that storage be increased in line with increased transfer capacity. The estimated capital cost of uprating the existing transfer to the maximum transfer volume is £28 million including the provision of additional storage.

With respect to environmental and water quality issues:

- In general increased reliance on Trent supported water for transfer to the River Ancholme should not present problems for potable water supply. Occasional high levels of sulphate in the River Trent should be investigated.

- Fisheries in the Fossdyke, the Witham below Claypole Mill and the Ancholme could be affected by the transfer of large (especially intermittent) volumes, mainly due to physical disruption; Water quality considerations are not likely to be significant, with the exception of transfers from the Trent (NWC Class 2) to the upper River Witham (NWC Class 1a) which is not in any case being recommended.

- Opportunities for enhancement of the fisheries and ecological potential of the Ancholme (below Toft Newton) exist through the adoption of environmentally sound channel improvements. These have been included in the cost estimates.

- Transfer of further Trent water to the slower flowing reaches of the lower River Witham is not likely to result in problems with algal growth as the rivers have a similar trophic status and transfers would reduce the residence times in the Witham.

The impact of proposed abstraction on the River Trent has been investigated. The proposed maximum abstraction would be a significant percentage of flows in the Trent at times of low flow. The consequent reduction in low flows would have an impact on the estuarial regime particularly with respect to sediments, water depths and velocity. These concerns would apply even more in the case of abstractions at Newark because the reach between Newark and Torksey is potentially sensitive to alterations to the flow regime. Therefore although the assumption for the purposes of the study is that the quantities to be transferred from the Trent would be available, this is unlikely to be the case under very low flow conditions and strategic storage may therefore be required within the system.

Component 2 - Witham to Denver

Five main routes for the transfer of up to 400 tcmd from the lower River Witham upstream of Boston to the Ely Ouse at Denver have been investigated, with branch routes to Rutland and Grafham (see Figure 4). The routes would involve the use of pipelines, tunnels and watercourses including drainage channels and rivers.

The predominant use of pipelines and watercourses would be less costly than the use of tunnels. The estimated capital costs of the cheapest three routes for the maximum transfer volume are as follows :

- Witham to the Twenty Foot River by pipeline, through the Middle Levels drainage system with tunnel from Nordelph to Denver (Route 2.2) - £121 million.

- Witham to, and along the South Forty Foot Drain, and then pipeline directly to Denver (Route 2.3) - £122 million.

- Witham to Denver by direct pipeline (Route 2.1) - £134 million

However, abstractions by others and problems with operation control involving open channels for drainage purposes would make routes involving open channels less attractive compared with the direct pipeline from the Witham to Denver.

Water quality, particularly sulphate concentration, would be a problem for the route involving the Middle Level Drains. Treatment to reduce sulphates is not considered to be a realistic option. Sulphate levels would thus present a risk to transfers via the Middle Level Drains.

The capital cost of the route from the lower Witham to the Ouse at Offord via Wansford (Route 2.5) compares favourably with routes 2.1 to 2.3 for transfers of 100 to 200 tcmd, but would be more expensive at higher rates of transfer (£145 million for 400 tcmd). Route 2.5 would offer greater flexibility for transfers to Rutland Water and Grafham Water, and when these transfers are included would have the lowest capital cost for 100-200 tcmd transfers and be comparable for 400 tcmd transfers to Denver. Route 2.5 would have higher operating costs than Route 2.1 to 2.3 but this would be mitigated by the expected low load factors.

Salinity conditions in the lower River Witham and South Forty Foot drain are of concern but should improve with current works at the sea sluices and with higher flows occasioned by water transfer.

This component (except routing to Rutland and Grafham) has been studied in more detail and preferred routes developed to outline design stage as part of the separate Witham to Denver Transfer Study.

Component 3 - Denver to River Wensum

Component 3 could transfer up to 100 tcmd of Trent supported water from the Cut-Off Channel above Denver to the River Wensum for public water supply abstraction upstream of Norwich.

Four transfer routes have been investigated, all of which include the use of the Cut-Off Channel. Two of the routes involve a pipeline to the closest Wensum tributary (Wendling Beck) which would require substantial alteration, with a third longer route to the main Wensum channel at Swanton Morley. The fourth route would be a direct pipeline to Costessey Water Treatment Works (WTW) at Norwich (see Figure 5).

The direct pipeline to Costessey WTW (Route 3.4) would be the most costly option, with an estimated capital cost of £26 million for the maximum transfer volume. It would however be the simplest to operate, not be subject to losses during river transfers and would avoid impact on the River Wensum.

Of the others, the longer route to Swanton Morley (Route 3.3) would be the most expensive, with an estimated capital cost of £22 million for the maximum transfer volume. The routes discharging to Wendling Beck (Routes 3.1 and 3.2) are likely to be unacceptable given the potential effects in the river and adjacent Sites of Special Scientific Interest (SSSI).

Other environmental and water quality considerations for transfers to the Wensum are:

- The water quality in the River Wensum upstream of Norwich is generally high (class 1A) and therefore the quality of Trent supported water transfer is of prime importance. The quality of transferred water is dependent among other factors on the extent of mixing with other waters en route. Further detailed water quality data and more sophisticated analysis for the Trent-Wensum route would be required to model natural water quality improvements during transfers, particularly for BOD and ammonia levels. However, transfers of Trent water might result in downgrading of the Wensum which would be unacceptable.

- Periodic high levels of chlorides and sulphates in the Cut-Off Channel might be a problem, and consideration of their effect on spray irrigation of sensitive crops would require improved water quality data and analysis.

- The fisheries and overall ecological value of the Wensum are extremely important; transfer of Trent supported water could have significant implication for both, and the benefits of direct treatment for phosphates before discharge would need to be investigated. Preliminary indications are that the capital cost of phosphate treatment for the maximum transfer volume would be approximately £1 million. There might also be significant operating costs, depending on the frequency of transfers.

- Adverse effects on local residents are not thought to be significant; recreational impacts on fisheries could be significant and would be sensitive.

As a result of the additional cost of treatment, likelihood of losses and possibly unacceptable impact on the River Wensum of the first three route options, we recommend the direct route to Costessey WTW.

Component 4 - Great Bradley Reservoir

Ely Ouse water normally discharges to the tidal reaches of the river at Denver, south of Kings Lynn. However, at times of water need, Ely Ouse water can be transferred along the Cut-Off Channel and thence through tunnel, the Kennett pumping station and pipeline to discharge into the River Stour at Kirtling Green south of Newmarket.

This and the associated Wixoe - Great Sampford transfer enables Ely Ouse water to be fed into the Stour and Essex rivers and off-river reservoirs thus providing augmented water supplies to much of Essex. The Ely Ouse to Essex transfer system was commissioned in 1971 and is owned and operated by the NRA. This system has been used extensively in recent years.

The problem with the existing transfer system is that, during dry summers, there is insufficient spare water in the Ely Ouse. To augment supplies further, it would be necessary to obtain a reliable source elsewhere. The most likely source would appear to be the River Trent but there are now doubts as to whether this would provide a reliable source during dry periods.

The only alternative would be a storage reservoir. One possible site is at Great Bradley. It has the great strategic advantages of being on the route of the existing Ely Ouse - Essex transfer so that Ely Ouse water can be fed directly into it, and it would be in a position to regulate the Stour and Essex rivers and thus have the maximum flexibility to provide water wherever required from Ipswich to London.

The reservoir would require the construction of an embankment dam up to 30m high in the upper reaches of the River Stour at Great Bradley. A subsidiary embankment would be required to protect the upstream community of Weston Green for all but the smallest reservoir size. Work has been carried out to re-assess the technical proposals in a 1970 feasibility report in the light of modern geotechnical knowledge, to assess potential reservoir seepage losses, and to assess the environmental implications.

The principal geological problem is the variable thickness of impermeable boulder clay on the floor of the reservoir site overlying more permeable chalk. We have concluded that it would be feasible to construct a dam at this location and that the reservoir could be made sufficiently watertight by blanketing part of the reservoir floor with clay.

Of the two dam sites proposed in the 1970 report, the downstream alignment ("A") has the advantage of achieving a given storage volume at a significantly lower water level than the upstream location ("B"). This would mean fewer dwellings being affected, and a lower overall cost. We therefore recommend the downstream alignment.

Recent experience of the design and construction of clay embankments on clay foundations suggests that embankments with flat slopes containing a minimum of drainage features are satisfactory and cheaper than steeper drained alternatives. This conclusion has been confirmed for Great Bradley and would have the advantage of reducing the importation of granular fill to a minimum.

Diversion of the B1061 would be required to maintain the existing road network. Access for construction traffic would require the upgrading of the C231 from Brinkley to the A45 and the construction of a bypass west of Brinkley.

There would be an appreciable number of potential environmental implications and the site includes four SSSI's and ancient woodlands a proportion of which could be lost depending on the top water level. There are no Scheduled Ancient Monuments but there are several recognised archaeological sites within the possible reservoir area.

The largest impact would be on the local communities and population. Four reservoir top water levels have been considered. For the largest potential reservoir and based upon existing contour maps there are 53 residential properties within the highest water level contour of 105.5mAOD.

Landscaping for mitigation and enhancement of the reservoir and embankments would be proposed if the project is implemented. This would include planting new woodland, intermittent tree planting, shelter belt and hedgerow planting, regrading of the shoreline and embankments, provision of bunds to provide secure wetland habitats for birds, creation of artificial islands, open park land and provision of bridle ways, cycle tracks and footpaths.

All of the reservoir schemes built in Britain in the last two decades are now places which offer much in the way of amenities, recreation and conservation which would not have existed without them. Such features would be an integral part of any reservoir project at Great Bradley.

The existence of a large volume of storage at Great Bradley and pre-treatment for phosphates would greatly improve the quality of water transferred to the Essex rivers by significantly reducing nitrate and phosphate levels and improving other water quality parameters.

The largest strategic reservoir would have a top water level of 105.5mAOD, an area of 11.8 sqkms (2900 acres) and a storage volume of 106 million cubic metres (see figure 6). This compares closely with Rutland Water which has an area of 12.6sqkms (3 100 acres). The capital cost would be approximately £73 million.

The smallest reservoir considered would have a top water level at 94.6m AOD and a capacity of 24 million cubic metres. The estimated capital cost of the 'small' Great Bradley Reservoir would be £39 million.

Whatever size of reservoir were chosen it could not be operational before the year 2000. However before a final decision is made on the need for a reservoir, a study should be carried out to examine whether there are other suitable sites.

Component 5 - Great Sampford to Rivers Roding and Stort

This component would transfer up to 200 tcmd of Trent supported water from the existing Ely Ouse- Essex Scheme's discharge point at Great Sampford on the River Pant to the Rivers Roding and/or Stort (see Figure 7). These transfers could provide additional water resources, whether supported by the Trent and/or by a reservoir, for South Essex and East London.

Feasible routes for this component are linked to the 'upstream' Component 6 routes, and the likely choice of route in Component 6 means that only transfers starting from Great Dunmow or downstream on the Chelmer are considered.

Costs of the route from Great Dunmow on the Chelmer to Great Canfield on the Roding (Route 5.2) would be lower than those for the two routes which discharge at High Ongar (Routes 5.3 and 5.6). We therefore recommend Route 5.2. The estimated capital cost of Route 5.2 for the maximum transfer to the Roding of 100 tcmd is £11 million.

The upper reaches of the Roding above High Ongar already exhibit a high degree of channelisation and there is scope for environmental as well as hydraulic improvements to this river. However, more work would be required before the extent of channel works can be determined. If discharge at Great Canfield proves to be unacceptable or uneconomic, a direct pipeline from Great Dunmow to High Ongar (Route 5.6) would be the alternative option. The estimated capital costs of Route 5.6 for the maximum transfer volume is £15 million.

The most upstream transfer route to the Stort would have the greatest environmental impact and would involve extensive river improvement works. The southerly route alternatives are a longer more expensive route to the Stort at Sawbridgeworth, or a cheaper route to Pincey Brook with more river works and potential environmental impact. The cost difference between these routes is not significant and, bearing in mind environmental factors, discharge at Sawbridgeworth is recommended. The estimated capital cost of this route for the maximum transfer volume is £11 million.

In the absence of storage at Great Bradley Reservoir, fisheries and aquatic ecology of the rivers Roding and Stort may be affected by the transfer of water originally derived from the Ely Ouse and/or the Trent. There may also be occasional high chloride levels which could affect abstractions for spray irrigation, especially where chloride sensitive crops are grown. Further study would be required. The impact may not be significant based on the experience of neighbouring rivers receiving Ely Ouse water.

Component 6 - Great Sampford to the River Chelmer

This Component would transfer up to 400 tcmd from the existing Ely Ouse Essex Scheme's discharge point at Great Sampford on the River Pant to the River Chelmer (see Figure 7). 200 tcmd would be for discharge to the Chelmer, and 200 tcmd for onward transfer to the Rivers Roding and Stort (Component 5).

Three transfer routes have been investigated : a direct pipeline from Great Sampford to the uppermost reaches of the Chelmer (route 6.1); routing along the River Pant to an intake upstream of Bridge End and then by pipeline to discharge downstream of Great Dunmow (Route 6.2); and by direct pipeline from Great Sampford to Great Dunmow (Route 6.3).

The capital cost of the first and third routes would be similar, both substantially less than the second route. The third route would have the lowest operating cost and would involve less river works than the first, hence less environmental impact, and is therefore recommended. The estimated capital cost of Route 6.3 for the maximum transfer volume (400 tcmd) is £37 million.

In the absence of storage in Great Bradley Reservoir, fisheries and aquatic ecology of the River Chelmer may be affected by the transfer of water originally derived from the Ely Ouse and/or Trent. Similarly there may be occasional high chloride levels in the Chelmer which could affect abstractions for spray irrigation, especially where chloride sensitive crops are grown.

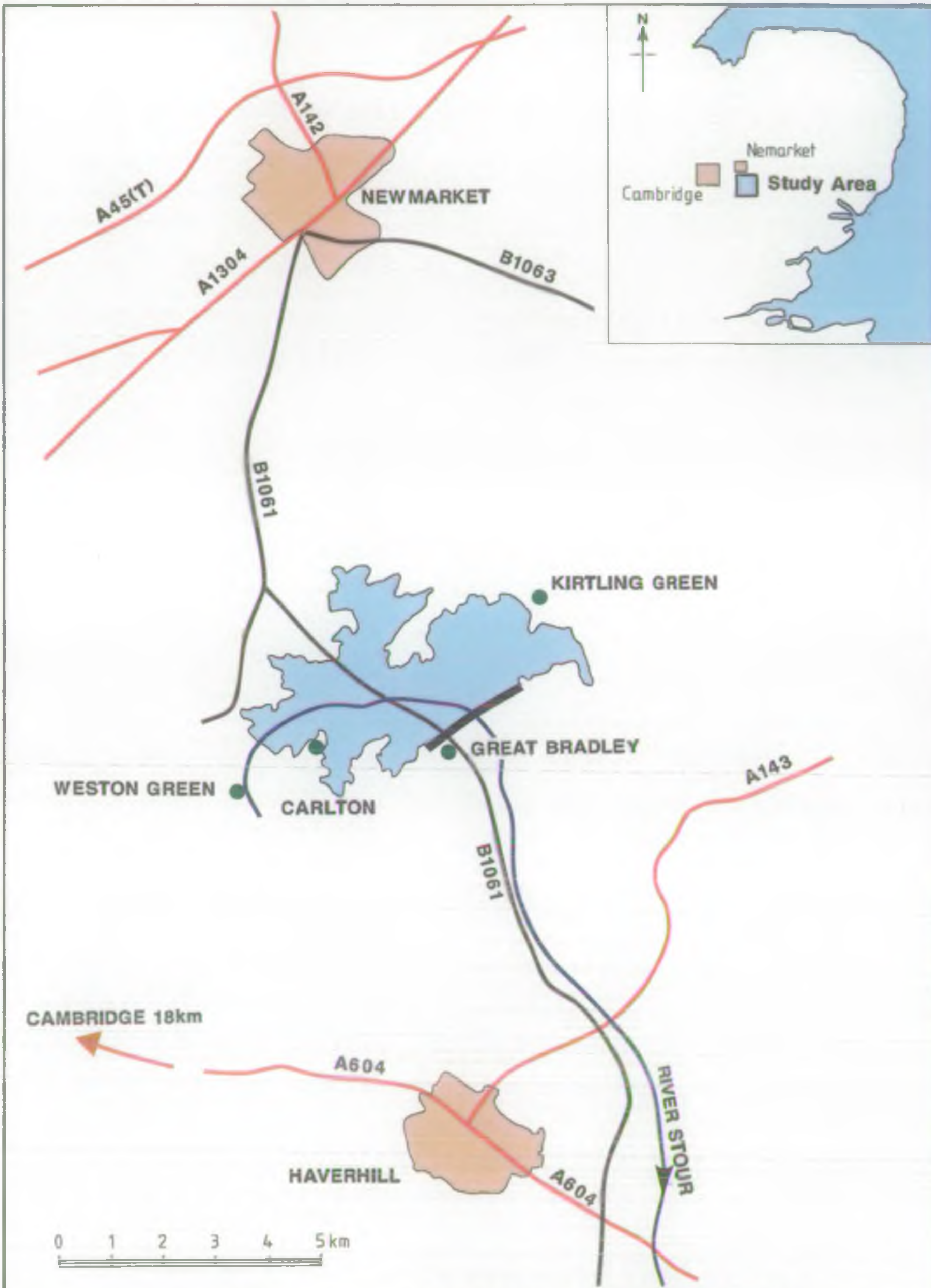
The Next Stages

Table 1 shows a summary of the preferred routes and costs of the various transfer options considered.

The results from this study of Trent bulk transfers and a reservoir at Great Bradley will be used along with the results of other studies in developing a water resources strategy for the region. The strategy will identify options to meet the reasonable water needs of the region well into the next century whilst protecting and where possible enhancing the water environment. A draft strategy will be published for public comment during 1993.

Should a bulk water transfer system and/or a new reservoir form part of the strategy then further studies, formal consultation and environmental assessment would be necessary.

WS Atkins	NRA NRA Anglian Region	STRATEGIC OPTIONS STUDY STRATEGIC TRANSFER LINKS - PROPOSED AND EXISTING	Figure 1



WS Atkins	NRA NRA Anglian Region	STRATEGIC OPTIONS STUDY GREAT BRADLEY RESERVOIR POSSIBLE LOCATION PLAN COMPONENT 4	Figure 2

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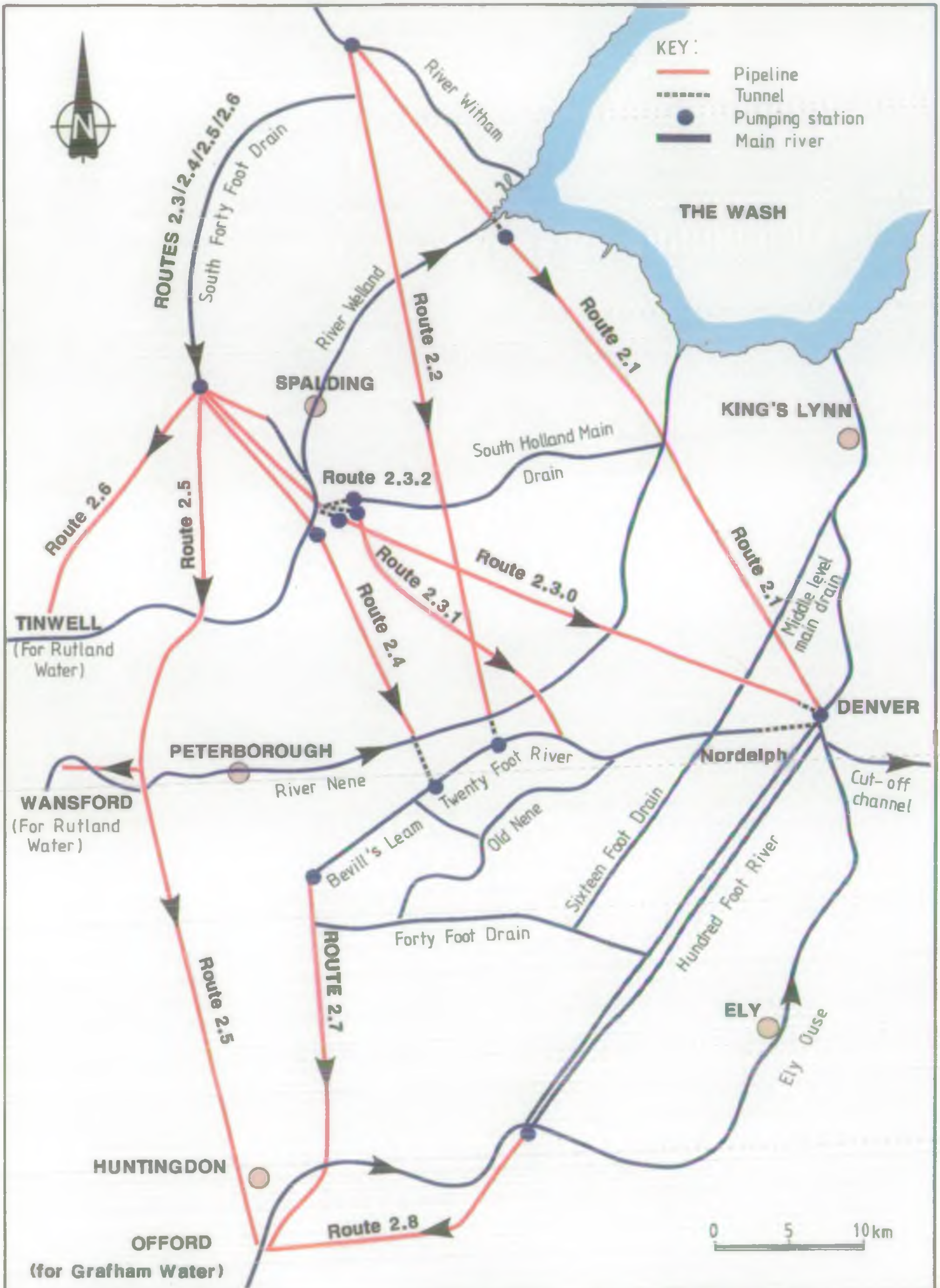
STRATEGIC OPTIONS STUDY

COMPONENT 1 - POSSIBLE TRANSFER ROUTES

Figure 3



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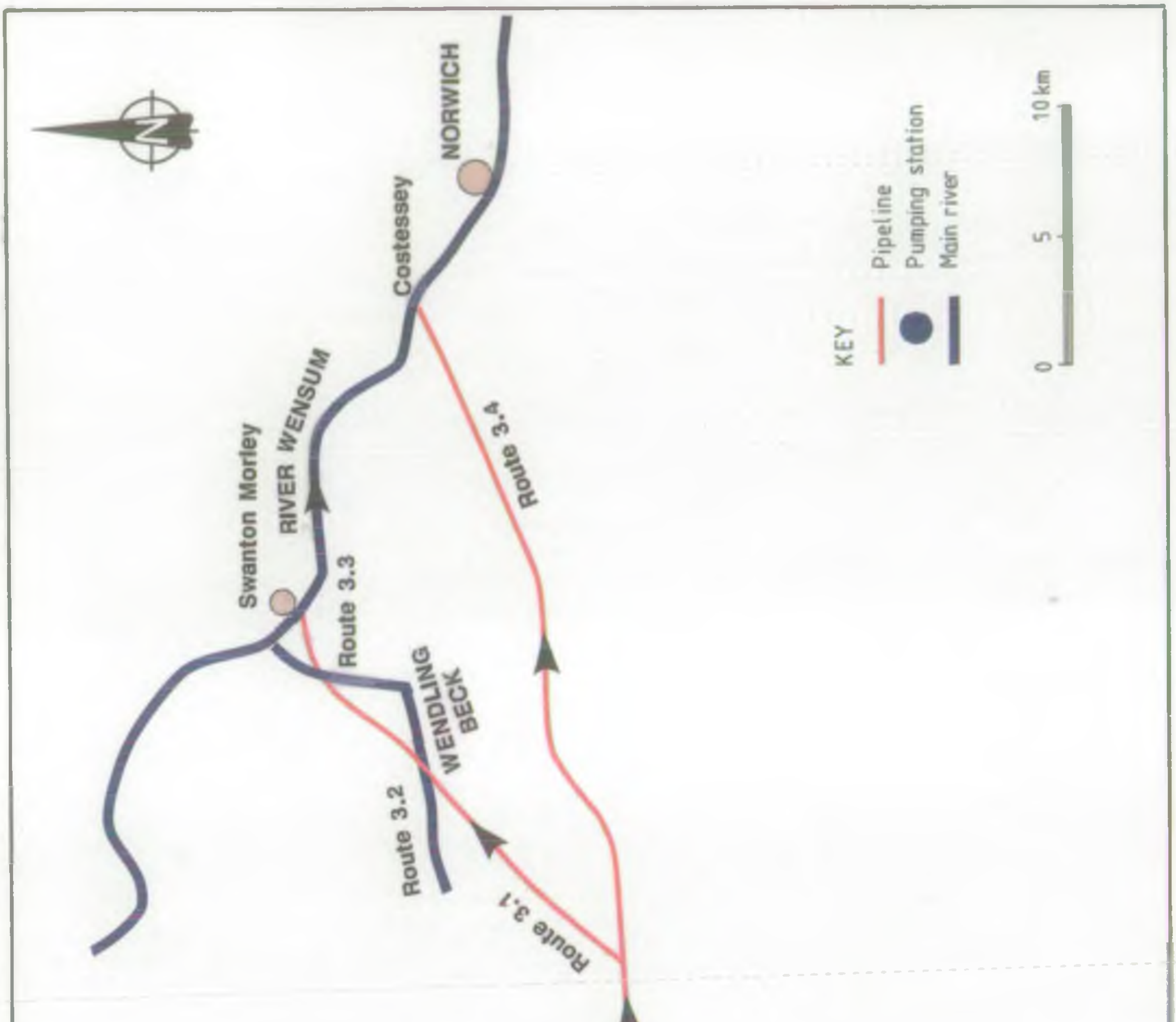
STRATEGIC OPTIONS STUDY

COMPONENT 2 - POSSIBLE TRANSFER ROUTES

Figure 4



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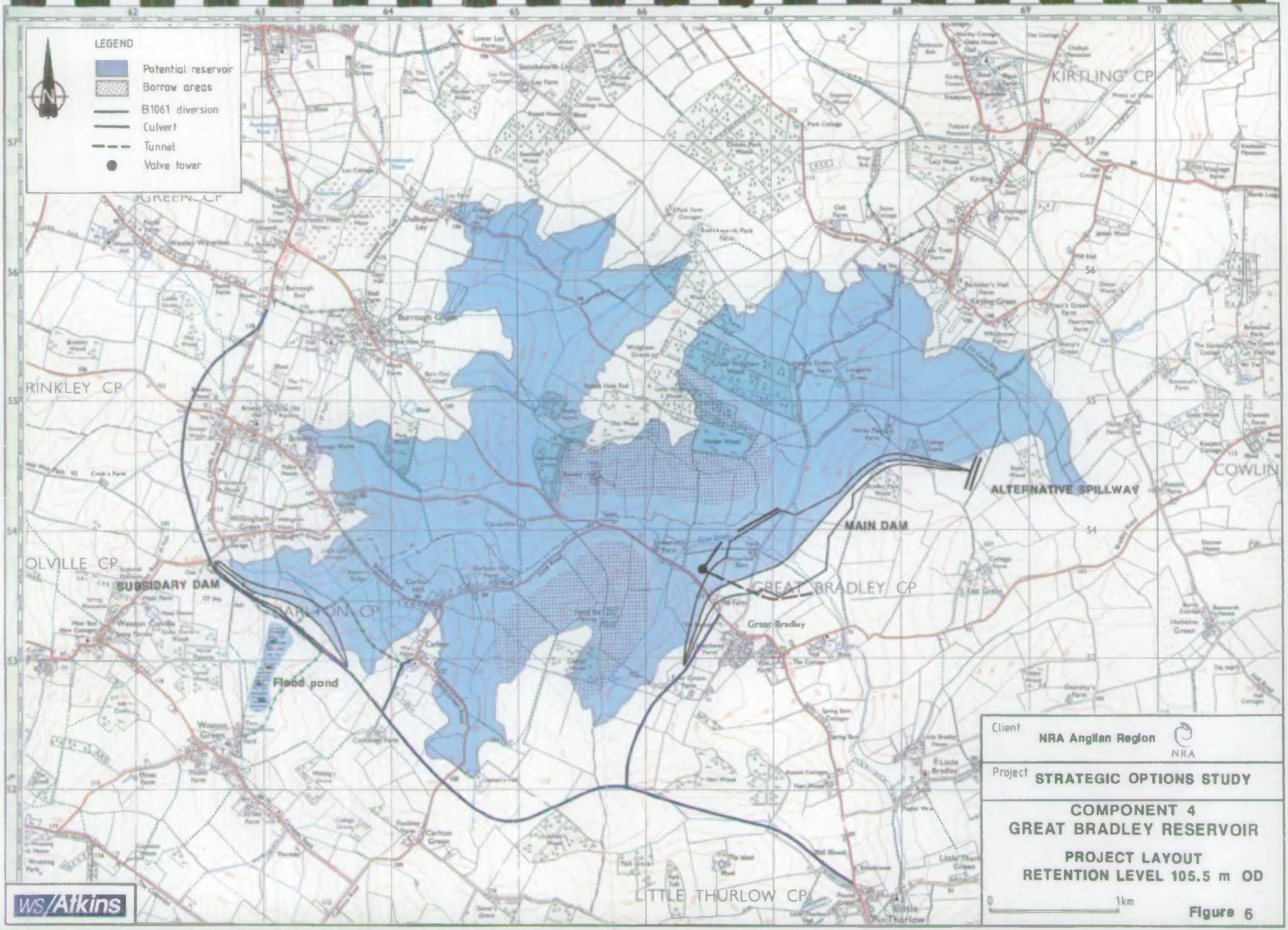
STRATEGIC OPTIONS STUDY

COMPONENT 3 –

POSSIBLE TRANSFER ROUTES

Figure 5


LEGEND
Potential reservoir
Borrow areas
B1061 diversion
Culvert
Tunnel
Valve tower
KIRTLING CP
GREAT BRADLEY CP
LITTLE THURLOW CP
COWLIN
SUBSIDARY DAM
MAIN DAM
ALTERNATIVE SPILLWAY
Flood pond
Great Bradley
Client
NRA Anglian Region
NRA
Project
STRATEGIC OPTIONS STUDY
COMPONENT 4
GREAT BRADLEY RESERVOIR
PROJECT LAYOUT
RETENTION LEVEL 105.5 m OD
0
1km
Figure 6
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STRATEGIC OPTIONS STUDY

COMPONENTS 5 AND 6 - POSSIBLE TRANSFER ROUTES

Figure 7

TABLE 1

STRATEGIC OPTIONS STUDY

TRENT TRANSFER OPTIONS - SUMMARY OF PREFERRED ROUTES AND COSTS

Component No and Description			Preferred Route	Transfer Capacity tcmd	Capital Cost £m	Comments
1	Trent-Witham-Ancholme		Fossdyke Navigation, River Witham	100 200 600	5 8 21	) No significant public water supply quality problems) Bank protection, lock and dredging works needed) Availability of Trent water at low flows to be reviewed
			Pipeline from Short Ferry (R Witham) to Toft Newton (R Ancholme)	150	28	Includes additional storage at Toft Newton needed for security against R Trent pollution Opportunities for Ancholme channel improvements for fisheries
2	R Witham to R Ely Ouse at Denver		Direct Pipeline (preferred at high rates)	400	134	Avoids control and environmental problems across Fens Would enable controlled feed to Middle and South Level
		or	R Witham, pipeline to Ouse at Offord via Nene at Wansford (option at lower flow rates)	100 200	51 74	) Enables transfers to Rutland and Grafham if required)
3	Denver to R Wensum at Costessey		Direct Pipeline	100	26	Ensures no environmental or quality problems in R Wensum
6	R Pant to R Chelmer		Direct Pipeline Gt Sampford to Gt Dunmow	400	37	Less impact and cheaper than routing along R Pant or discharging to upstream reaches
5	R Chelmer to R Roding		Gt Dunmow to Gt Canfield (R Roding)	100	11	Opportunities for environmental improvements to R Roding
	R Roding to R Stort		Gt Canfield to Sawbridgeworth (R Stort)	100	11	Less impact than Pincey Brook or direct pipeline alternatives

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