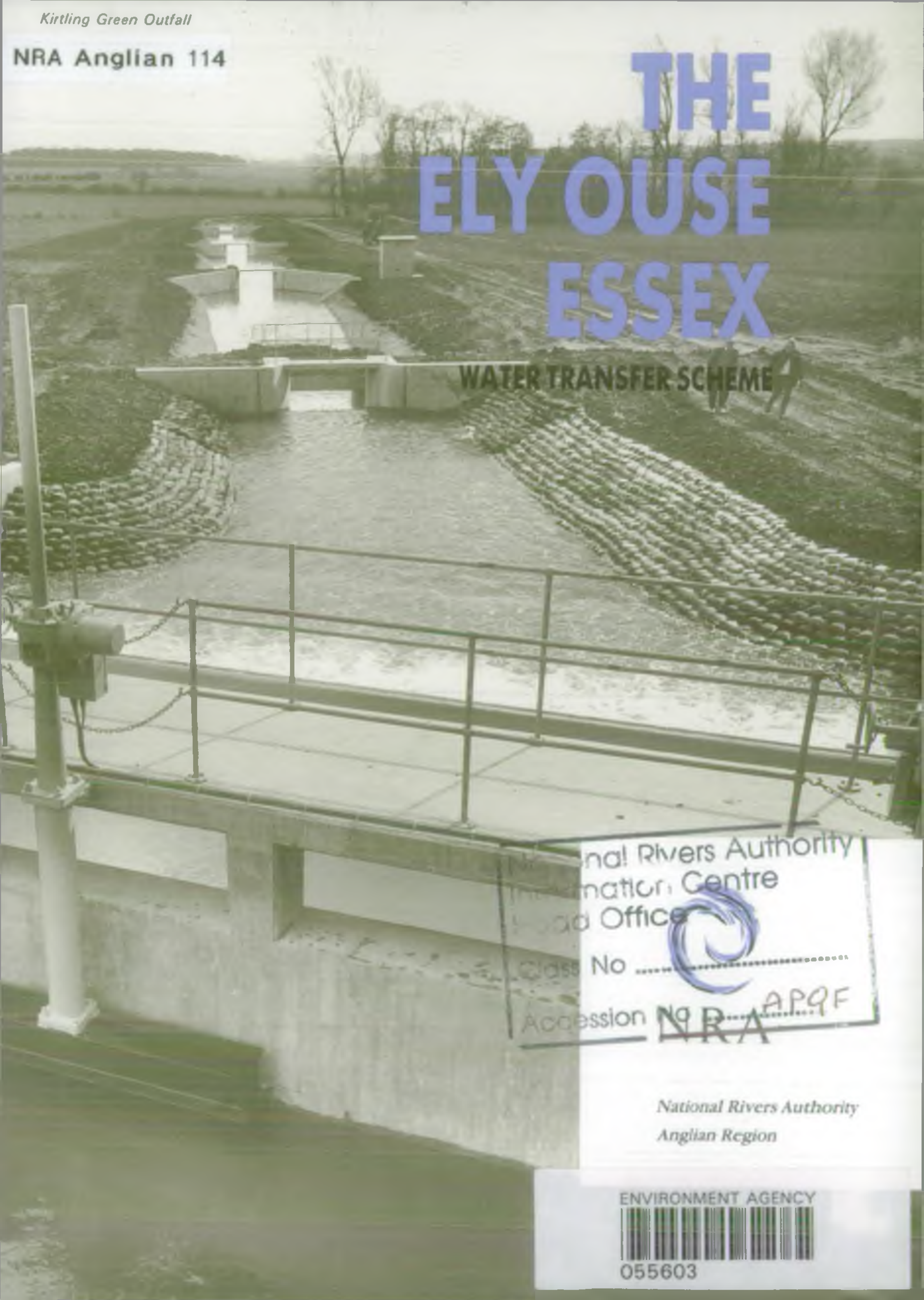


THE ELY OUSE ESSEX

WATER TRANSFER SCHEME

National Rivers Authority
Anglian Region

The Ely Ouse-Essex Scheme

In 1964 the Ministry of Housing and Local Government Study highlighted the fact that expansion and development and the general population increase anticipated in the South Essex area could result in problems over water supply in the 1970s. The former Great Ouse and Essex River Authorities investigated a scheme to transfer surplus water from the Ely Ouse to head waters of the Essex rivers to increase their flows and make available extra water to the existing reservoirs in Essex, and the Ely Ouse–Essex Water Act 1968 was promoted jointly by the two Authorities. One great merit of the scheme was that it utilised existing reservoir capacity thus avoiding the loss of agricultural land to create new reservoirs.

The Ely Ouse River drains a catchment of approximately 3640 km² (1410 sq. miles) upstream of Denver and is fed by four main tributaries, the Cam, Lark, Little Ouse and Wissey. All these rivers are retained at a similar level downstream of Bottisham, Isleham, Hockwold and Stoke Ferry respectively, by the sluice at Denver at which point surplus water discharges into the tidal channel and reaches the Wash near King's Lynn.

This leaflet also describes the flood protection scheme at Denver which includes the Cut Off Channel on the eastern limit of the Fens. Under the Ely Ouse–Essex scheme surplus water from the eastern part of the catchment, which would otherwise be lost to tidal waters and eventually to the Wash, is transferred to the flood protection scheme Cut Off Channel at Denver, and by raising the level in this channel by 0·6 m at the impounding sluice the water is sent in a reverse direction in the channel to Blackdyke, Hockwold some 25 km to the south east. At this point water is drawn off into a tunnel 20 km long which terminates at Kennett. Pumps lift the water from the tunnel and through a 14·3 km long pipeline over the watershed to the River Stour at Kirtling Green. Part of this discharge is drawn off at Wixoe about 13·7 km downstream and pumped 10·3 km over further watersheds to the River Pant, through a pressure relief or balancing tank at the highest point.

The total distances of transfer from Denver to Abberton and Hanningfield reservoirs through aqueducts and improved river channels are approximately 141 km and 148 km respectively. For about two-thirds of this length use is made of existing watercourses.

Great Sampford Outfall

TECHNICAL DESCRIPTION

Two sluices on the Ely Ouse at Denver, one downstream and one upstream of a dividing sluice, transfer water into the Cut Off Channel. The downstream sluice will discharge a flow to maintain the required level in the Relief Channel, and the upstream sluice diverts the surplus water into the Cut Off Channel.

The Dividing Sluice is designed to enable the water level in the channel to be raised approximately 0·6 m, and thereby produce a reversal of flow, water is then abstracted at Blackdyke. In high floods the gates are raised to permit the channel to be used for its original flood protection purpose.

Blackdyke Intake

At the intake water is drawn from the Cut Off Channel and passed through coarse screens and self-cleansing bandscreens and a short length of 1·68 m diameter pipe.

Tunnel

The tunnel of approx. 2·5 m diameter was driven in the gault clay by mechanised digging shields and lined with precast concrete segments.

Kennet Pumping Station

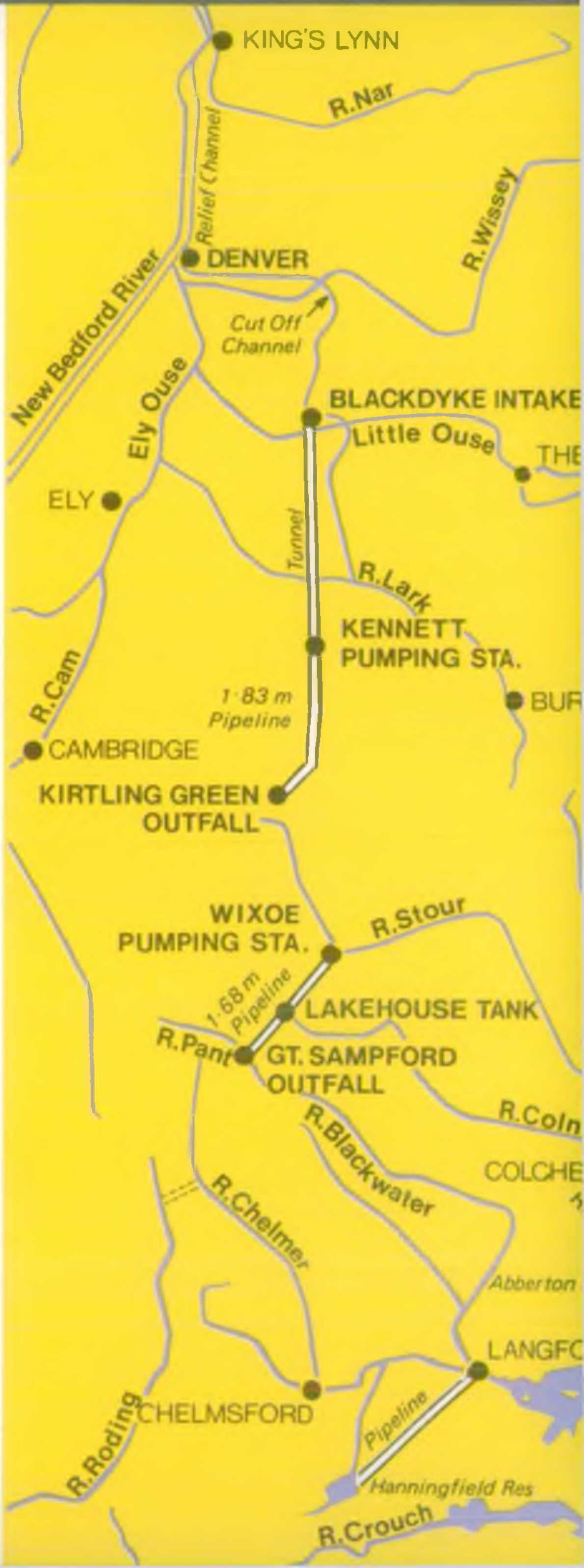
The main pumps are two vertical spindle 114 thousand cubic metres per day (tcmd) fixed speed borehole type pumps of 3500 hp each, set in the shaft cap and with groups of 2 and 3 impellers at depths of 51 m and 9 m from the surface respectively. Two submersible pumps of 23 tcmd fixed speed are provided for dewatering the tunnel and for supplementary flows. The pumps operate in an open well below ground level and are served by a 65-tonne Goliath crane.

Kennet–Kirtling Green Pipeline and Outfall

The 1·83 m dia welded steel main is 13 mm thick, bitumen lined and sheathed and cathodically protected. The pipeline is laid in trench with a minimum cover of 1 m or 1·2 m depending on the nature of the ground.

There are washouts at low points, and 'pigging' chambers at each end for swabbing devices. Anti-vacuum valves and air valves are provided for relief of negative pressures in surge conditions.

At Kirtling Green water discharges through a stilling basin structure before flowing in an open channel to the river.



The Transfer Scheme

The Flood Protection Scheme

Parts of the fenland are as much as 1·5 m below mean sea level; high flood level is 3·5 to 4 m above it.

Our problem is not fen drainage, it is the protection of the fens from flooding by the failure or overtopping of the river embankments.

This suggests that the remedy is to make the flood banks high enough and strong enough to contain the floods. Alas, the solution is not quite so straightforward; another kind of fenland soil comes into the picture – the "buttery clay". "Buttery clay" is an apt description of the soft, silty clay which overlies most of the fenland floor beneath the upper coating of peat or silt.

From surface level to the hard Kimmeridge clay, gault or chalk may be as much as 5 or 6 m; even more in a few places. The flood embankments rest, one is inclined to say they float, upon the peat and buttery clay layers. This affects them in three respects, liability to sinking, stability, and seepage underneath them.

The flood banks sink as the peat and the soft clay consolidate slowly under their weight. As they sink the safe margin above flood level (freeboard) diminishes and they have to be heightened. The weight of the clay added to them in the heightening starts off a new sinking process – and so on.

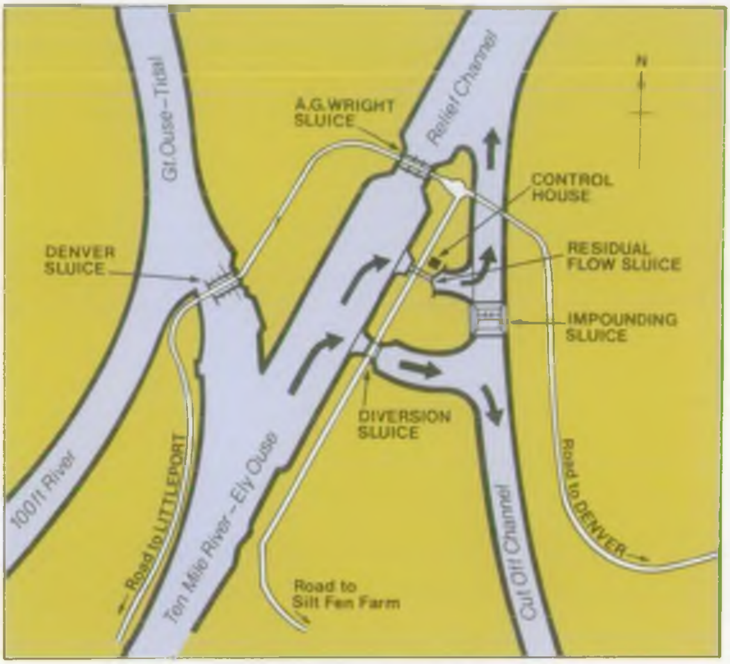
It is obvious that continually heightening the banks will not provide the solution to the problem, which has been the subject of arguments, counter arguments and disputes at intervals since the 17th century, although the real nature of the problem was not appreciated by the numerous writers on the subject. The main problem was that the flood waters were not "getting away", and it was not realised that Sir Cornelius Vermuyden had given the solution nearly 300 years earlier.

The obstacle to the discharge of the South Level waters through Denver Sluice is that in times of flood the water level from the old and new Bedford–Ouse outside the sluice was higher than the waters coming from the Ely–Ouse and its south level tributaries. However, the low water level at King's Lynn under high flood conditions is about 3·5 m lower than at Denver. Therefore, by bypassing the Denver Sluice and bringing the point of discharge to King's Lynn, advantage can be taken of this lower water level to enable the flood waters from the South Level rivers to get away. A relief channel was, therefore, cut from Denver with sluice gates at each end. To ease the flood level in the Ely–Ouse itself a cut off channel from the River Lark near Mildenhall crossing the River Little Ouse and the River Wissey takes flood waters from all three rivers and conveys them to the Relief Channel for discharge at King's Lynn.

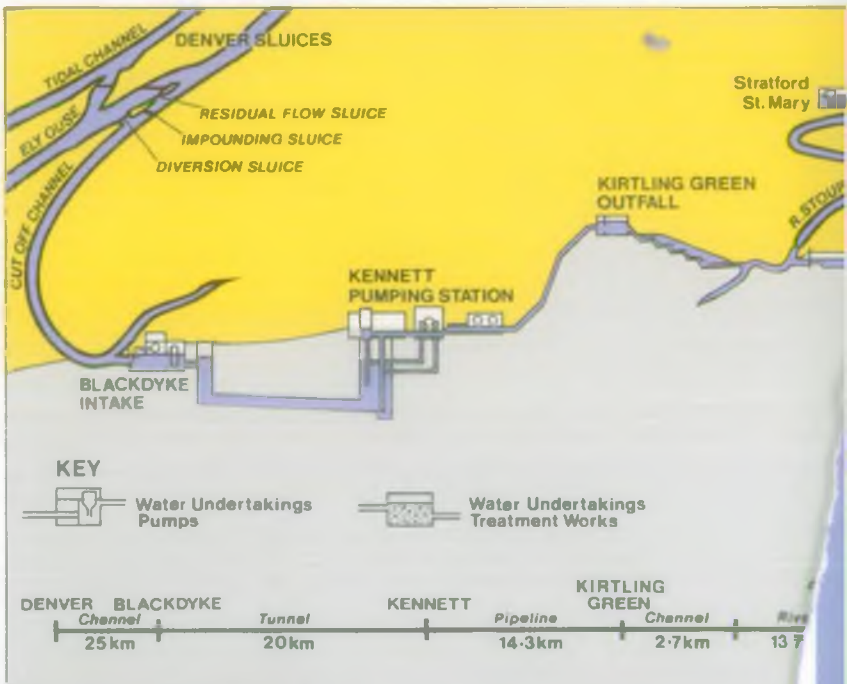
When the incoming tide rises the tail gate sluices at King's Lynn close and the outflow of the flood water ceases. The water is then contained in the Relief Channel and it rises inside the gates until the tide once again falls, the gates open and the discharge of the flood water is resumed.

In addition to the new channels, the Ely–Ouse River was widened to increase its capability. The basic principles of this scheme were in fact put forward by Vermuyden in 1638, and he produced a drawing of the scheme in 1642. It was, however, over 300 years before the same conclusions resulted in the scheme being carried out. With the completion of the scheme in 1964 the old problem of how to move excess water from the Fens into the sea has largely been overcome.

Denver Sluice

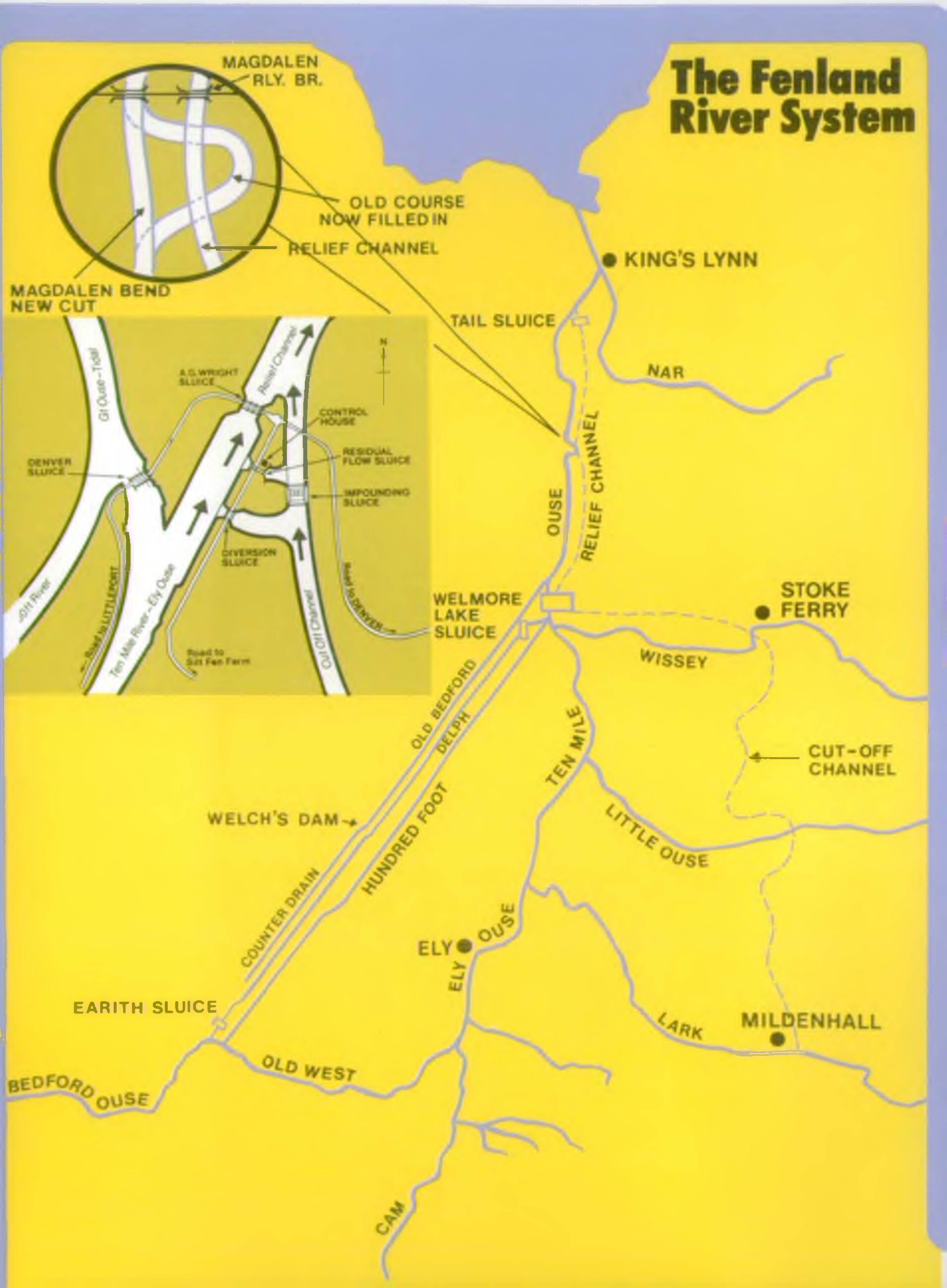


The Denver Sluice Complex



Diagrammatic Layout of the Scheme

The Fenland River System



Wixoe Pumping Station

Wixoe Pumping Station

Reasonably constant river levels are maintained by an automatic bottom hinged control gate.

Water is drawn from the River Stour via a settling pound and through self-cleaning bandscreens by two fixed speed 91 tcmd pumps and one variable speed 45 tcmd pump, all of which discharge into a 6·3 km long 1·68 m internal diameter pipeline to the balancing tank at Lakehouse Grove.

Great Sampford Outfall

Water flows by gravity from the balancing tank to the outfall on the River Pant through a 4 km long 1·68 m dia pipeline.

Surplus pressure energy of the water is dissipated through two 227 tcmd vertical sleeve valves with 760 mm outlets submerged in a stilling pool. The water then flows down a stepped channel to the river.

Improvement to River Channels

16·8 km of the River Stour below Kirtling Green and 16 km of the River Pant (Blackwater) below Great Sampford have been improved to accept the increased flows by widening and deepening certain stretches and enlarging waterways through some bridges and mills. Ten new automatic control gates were constructed on the River Stour and one on the River Pant.

Note: 4·55 tcmd = 1 million gallons per day (mgd).

NRA

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Ely–Ouse at the lower end of the Hundredfoot River. This excluded the tidal water from the South Level Rivers and turned it up the Hundredfoot – it was, in fact, the beginning of all year round control.

In 1713 disaster struck again when a combination of high tides and exceptional floods burst Denver Sluice. Once again the tides could flow unchecked into the South Level rivers, land was inundated, much of it became derelict, and incursions of the tide were frequent. In fact in 1715 a sturgeon measuring 7 ft 8 in long was captured in Thetford Mill Pool. It was obvious that Denver must be rebuilt, and in 1750 it was rebuilt by Labelye, a Swiss engineer.

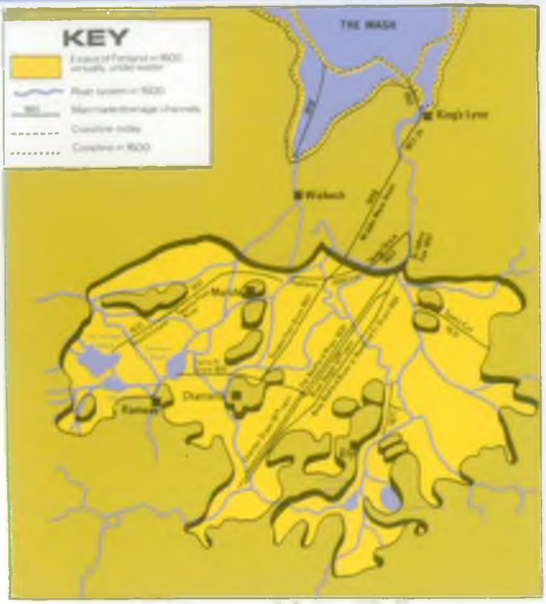
Labelye's work was to last well, in fact, the sluice which he had constructed was to remain in use until the last construction by Sir John Rennie in 1834. This was to give three main sluice-gates, which exist today in their original position, but at that time the upstream gates were not, as today, vertical lift gates, but were in fact, pointed wooden doors. In 1848 the Middle Level Main Drain was completed, much of it with a 50-foot bed width, and an outfall sluice at St Germains, into the tidal river.

During the 18th century work was continued. Mills were first used to drain the land effectively, only once again to cause a new problem when the Black Fen fields began to shrink away from the channels that drained them. Small mills delivered the water into small drains, and then further along a larger Mill would lift it into a canal, and finally the largest Mill of all would be used to lift it into the river.

The moisture content of waterlogged peat may be as much as 800% and when it is drained the immediate effect is a shrinkage of the top layer from which the water has been abstracted. This initial shrinkage may be more than a foot in the first year. This is followed by the oxidation of the dried surface, which results in further wastage. Loss from this cause, which continues so long as the peat is dry, may be one or two inches a year.

The Black Fens gradually became an upside-down world with rivers higher than the surrounding land, and thus began the separation of the fenland drainage network into two systems, a high level system carrying the upland rivers through the fens and low level systems carrying the drainage water to the mills or pumps.

During the 1930's and 1940's, due to modern diesel and electric pumping machinery, there was no technical difficulty in providing good fen drainage, and the problem has accordingly resolved itself into the protection from flooding of the Fenland from overtopping, or breaching, of the flood banks. To counteract the continuous sinking, the flood banks had to be continually raised to give an adequate degree of freeboard, nearly $1\frac{1}{2}$ million pounds being spent on this work between 1930 and 1954, without, however, really solving the problem. Major floods occurred in 1936, 1937 and 1939, after which the former Great Ouse Catchment Board called in Sir Murdoch MacDonald and Partners to prepare a report. The subsequent report proposed a Great Ouse Flood Protection Scheme designed to increase the freeboard of the flood banks in the South Level over maximum flood level, not by raising them, but by reducing the flood level itself. This scheme was, however, shelved because of the intervention of the second Great World War.



Historical Diagram of Fenland Drainage

In 1947 occurred the greatest flood of which there is any record, when 40,000 acres of Fenland were flooded. The 1947 flood discharge was twice as great as that of 1937 and as a result Sir Murdoch MacDonald and Partner's proposals were revised based on a flood about 5% greater than that of 1947 coinciding with a period of Spring tides. In 1949 the Great Ouse River Flood Protection Bill was passed by Parliament.

Fenland

In a massive arc around the Wash lies the great Fenland plain. Of the total area of England and Wales, only 5% is classified as first class agricultural land, and almost the whole of the Fenland falls into this category. Today, these are England's most prosperous agricultural areas, but their plenty has been hard won.

This is the Fen Country where land and water, down the ages, have been in such precarious balance that inches have measured the difference between fertility and flooding; where generation after generation has witnessed its livelihood engulfed by the wild waters of disaster. Only in the last two decades has the area finally been made secure by modern engineering and the application of millions of pounds of capital.

The post-glacial deposits in the shallow fenland basin are of three main types, the coastal silts of marine origin, the peats lying inland off the silt belt, and the fen clays deposited during a period of marine transgression.

To look back to the end of the 16th century when upland river and gale propelled tide alternated their push and pull across large areas, some were dry enough for summer pasture but submerged in winter, others squelching all the year round. Thus the scanty local population developed a special way of life. They were a people apart, among whom other Englishmen rarely ventured. Some were outlaws, most were laws unto themselves. They called themselves the "Breedlings".

The floors of their flimsy wattle and daub huts, thatched with sedge, were often awash, they slept on beds of reeds with Bullrush down stuffed into their pillows. For warmth they burned smokey squares of dried peat. They shook with ague, a mosquito-borne endemic malaria, in which fever and thirst alternated with severe pains in arms and legs. Their remedies were brandy and opium.

Militantly protective of their way of life, the Breedlings reacted with effective violence when the first overall plans for draining the entire fen area were announced in the 17th century. Battle they did, and for many decades sluice gates and other mechanisms installed according to the new designs required armed guards for protection, but even these were not always enough to save them from the Breedlings wrath.

In 1630, Francis, 4th Earl of Bedford, commenced the first major attempt to drain the Fens, and was joined by thirteen associates or "Adventurers". The work was not to be adjudged complete until 1652. Bedford engaged as engineer the just-knighted Sir Cornelius Vermuyden, a Dutchman, familiar with Dutch methods of keeping out the sea, who had already demonstrated his skill in drainage works at Hatfield Chase in Yorkshire.

Vermuyden was to design and supervise the work, which consisted principally of the making of two new straight cuts – the Old and New Bedford rivers, from Earith to Salters Lode on the tidal River Ouse, thus cutting off the loop of the river through Ely and shortening the distance to the sea by ten miles. A flood storage reservoir of 5600 acres was created between the two new rivers, and embankments built to contain flood water and tides.

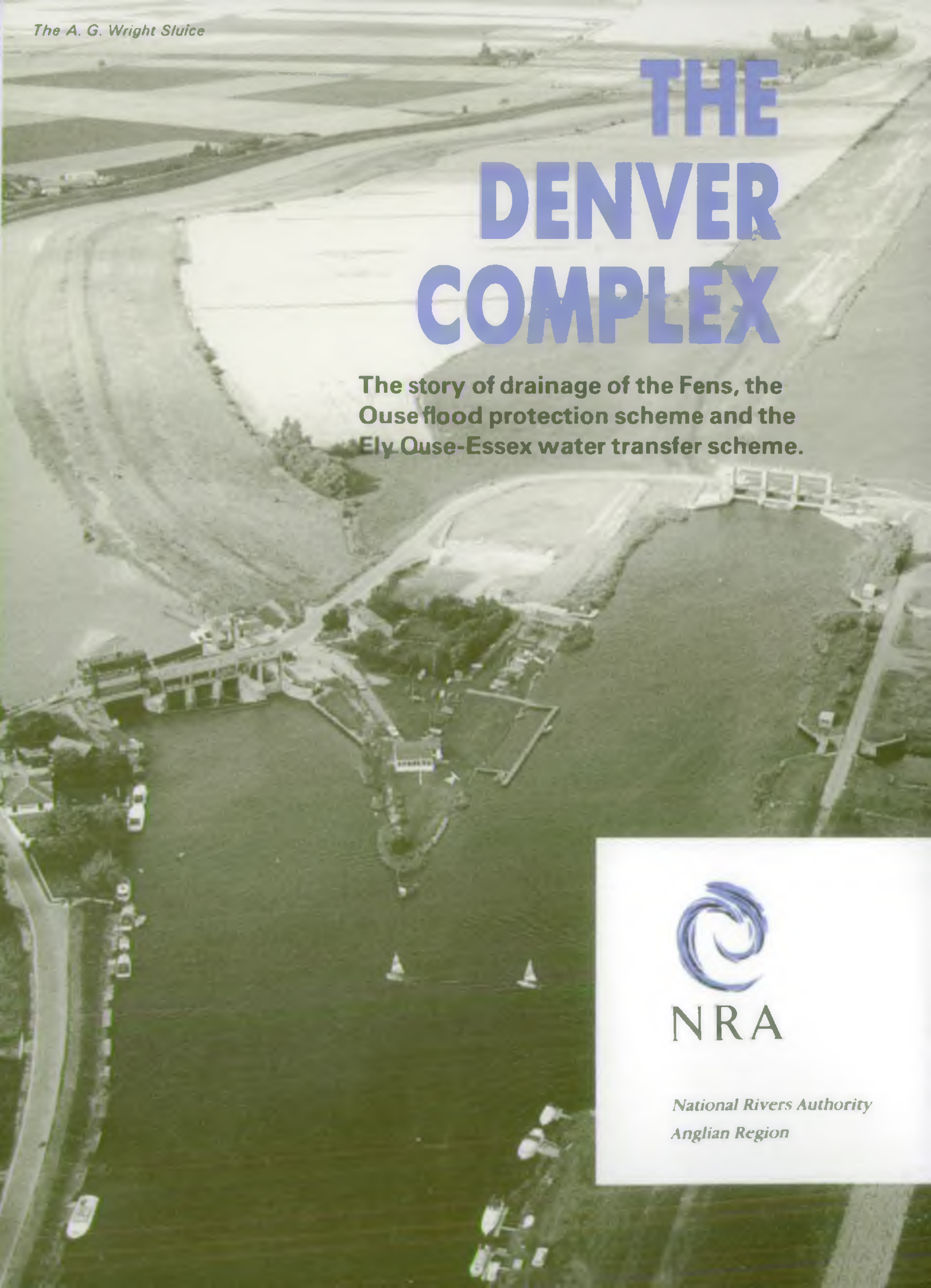
In 1631 the first of the great cuts, known as the Old Bedford River, was dug, seventy feet wide and twenty-one miles long, from Earith to Salters Lode on the tidal river. A sluice at its upper end regulated the amount of water diverted from the river's ordinary course, and a Tail sluice resisted inflow from the tidal water and the sea.

However, in the 1640's man-made destruction was an even more present danger than the waters. The western rim of the Fen country became an active theatre of the Civil War and in its confusion the Breedlings saw and took their opportunities.

When Cromwell took control of government after the end of the war, he promptly set William, the recently acceded 5th Earl of Bedford, and Vermuyden to work again. During the 1650's a vastly extended network of cuts and drains and sluices was completed. Parallel to the Old Bedford River a new river was cut, called the New Bedford River, or Hundredfoot, and in 1651 the first Denver Sluice was constructed across the

THE DENVER COMPLEX

The story of drainage of the Fens, the Ouse flood protection scheme and the Ely Ouse-Essex water transfer scheme.



The A. G. Wright Sluice

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