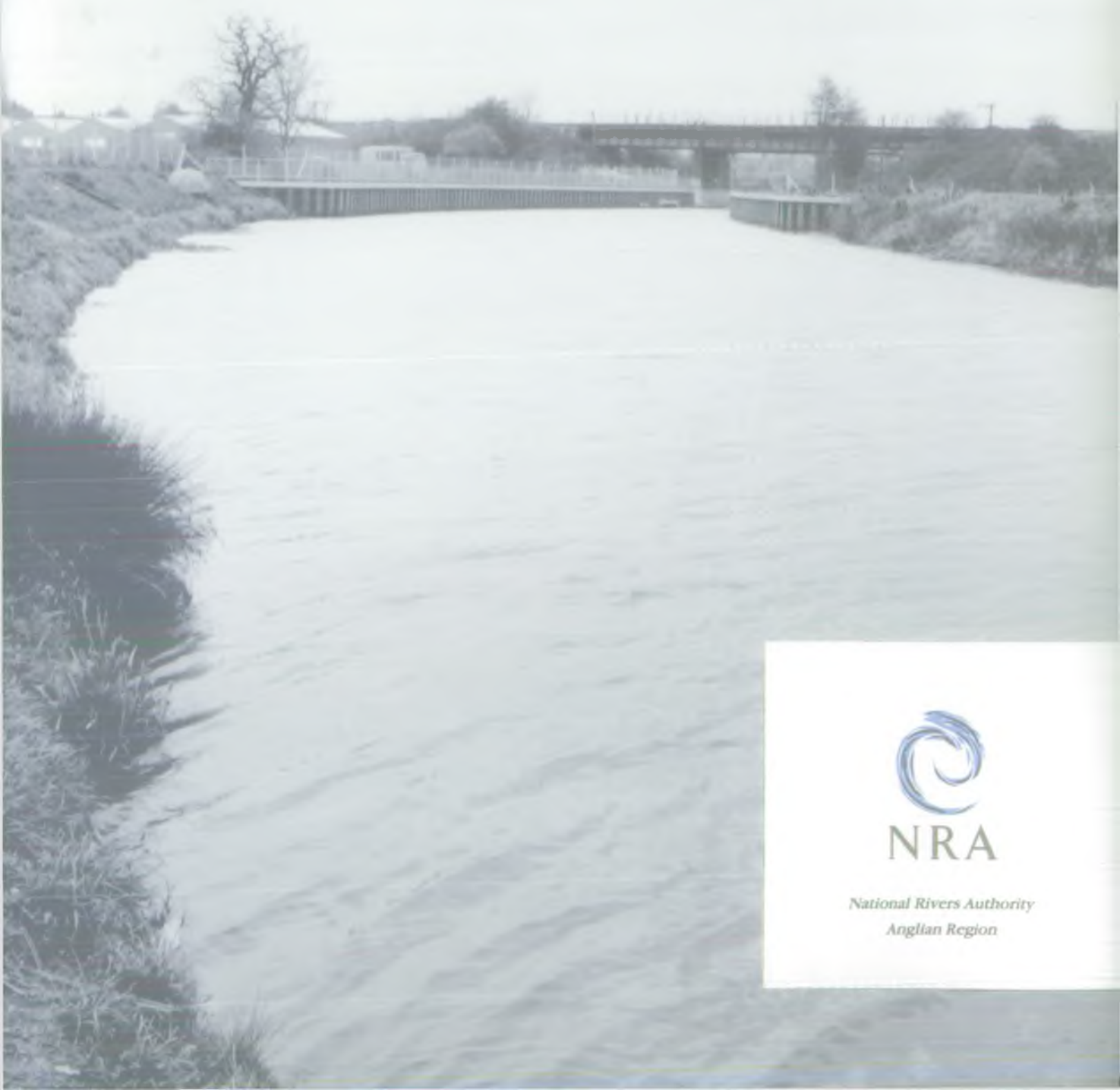


IPSWICH FLOOD DEFENCES



NRA

*National Rivers Authority
Anglian Region*

GEOLOGY

Chalk is present throughout the catchment, but in the area to the east of Ipswich it is concealed by London clay. Elsewhere it is overlain by sandy crag deposits and glacial sand and gravel. These permeable deposits outcrop only in the river valley, the major part of the catchment being covered by heavy boulder clay. This clay limits the infiltration of rainwater to the underlying chalk aquifer, so heavy rainfall quickly runs off into the river and causes a rapid increase in river flow.

Heavy demands are made on the water retained in the underground chalk stratum, both for public and industrial supply and for some spray irrigation. Only limited spray irrigation abstraction from the river is permitted because of the low summer flows. The Alton Water pumped storage scheme uses the greater volume of water available during the winter months.

EXTENT OF SCHEME

To provide protection to the urban area at risk from tidal and fluvial flooding along 4.2km of channel, extending upstream from Cliff Quay to the Norwich Railway Line Bridge.

DESIGN CRITERIA

The defences should be capable of withstanding a surge tide level of 4.20m AODN, similar to that recorded in Ipswich on 1 February 1953, with an assumed fluvial flow not in excess of 3 cumecs.

The improved channel should be capable of passing a fluvial flood of 110 cumecs against a tidal level no greater than 2.8m AODN, flows in excess of this being contained on the flood plain upstream of the Norwich Railway Line Bridge.

DEFENCE LEVELS

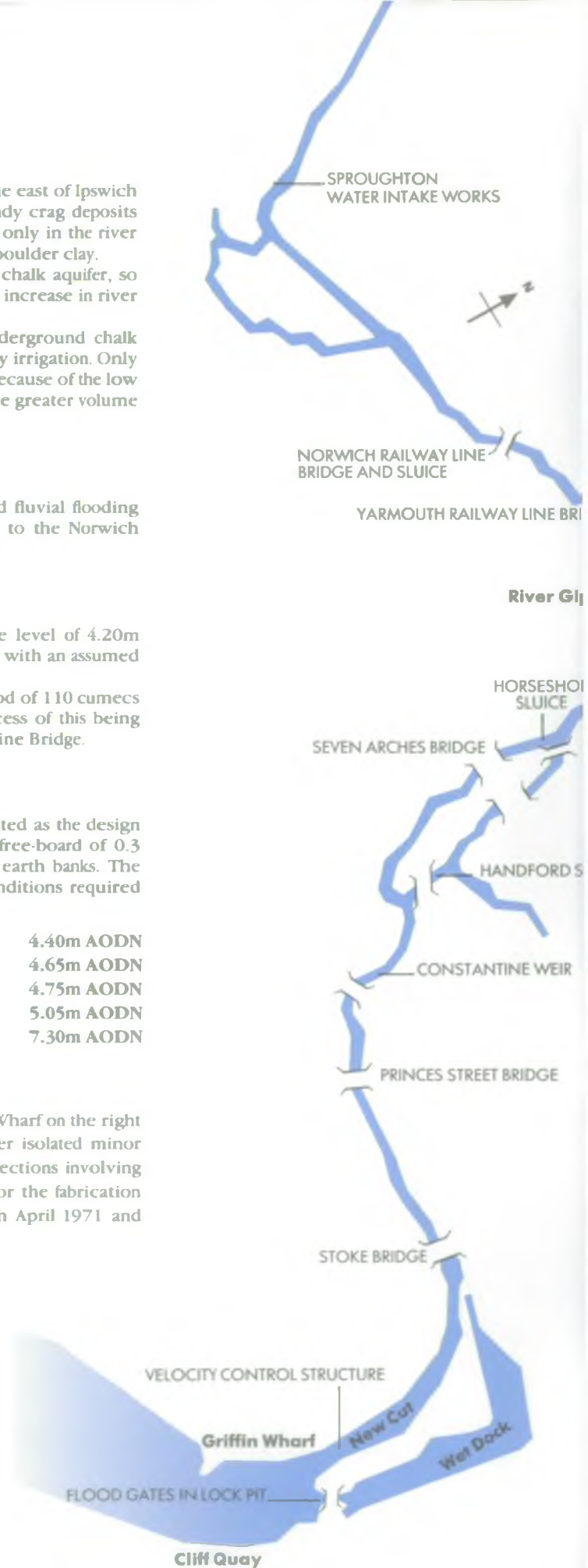
The observed 1953 surge tide level of 4.20m AODN was adopted as the design level at the Cliff Quay end (downstream) of the scheme. A free-board of 0.3 metres was adopted for the hard defences and 0.6 metres for earth banks. The levels were adjusted upstream, except where special site conditions required modification. The general design levels are:

<i>Cliff Quay to Stoke Bridge</i>	4.40m AODN
<i>Stoke Bridge to Horseshoe Sluice</i>	4.65m AODN
<i>Horseshoe Sluice to Yarmouth Railway Line Bridge</i>	4.75m AODN
<i>Yarmouth Railway Line Bridge to Norwich Railway Line Bridge</i>	5.05m AODN
<i>Upstream Norwich Railway Line Bridge</i>	7.30m AODN

WORKS

The works extend from Cliff Quay on the left bank and Griffin Wharf on the right bank upstream to the Norwich Railway Line Bridge with other isolated minor works upstream. The works were carried out in six phased sections involving separate contracts for civil engineering works and contracts for the fabrication and installation of the steel sluice gates. The works started in April 1971 and were completed in February 1983.

*Above Ordnance Datum Newlyn



FLOOD WALLS DOWNSTREAM OF STOKE BRIDGE

These walls are designed to exclude the North Sea Surge from the area adjacent to the New Cut. The work consists of the construction of mass concrete flood walls on the existing quay, the new walls having a top level of 4.40m AODN. These walls are up to 1.5m above quay level, the freeboard being restricted by the shallow founded quays onto which the flood walls are constructed. Access gates and steps over the wall are provided where necessary.

VELOCITY CONTROL STRUCTURE IN THE NEW CUT

A velocity control structure has been installed to regulate the flow of water passing down the New Cut at times of high fluvial flows coincident with the low tide level. Under this condition, if no velocity control structure had been installed, bed scour could have resulted with possible undermining of the quay walls along the New Cut and the foundations of a road bridge. The work consisted of the building of a bottom hinged tilting sluice gate, together with the necessary concrete foundations and steel sheet piled walls. The velocity control gate will normally lie flat on the river bed and cause no obstruction to river flow or navigation. The water levels would remain as they exist without any form of control. At times of high river flow particularly when this is coincident with low spring tides the gate will be raised, thus holding back the river and causing velocity of water flowing down the New Cut and through Stoke Bridge to be reduced to a safe level.

The gate itself is a single span electro-hydraulically operated, bottom hinged fish belly tilting gate of 32.0m effective width, operated from one end. When it is raised it has a crest level of 0.37m AODN and when lowered no part of the gate projects above the level of -3.0m ODN. The gate is operated by the National Rivers Authority, from a control house built on land adjacent to the structure.

The velocity control gate was fabricated in three sections in Sheffield and bolted together on site. The gate is installed in a concrete lined steel sheet piled flume, which halves the bed width at the site. As a result of the necessity to maintain navigation in the channel during construction the civil engineering works were constructed by means of a two stage cofferdam completing all of the works on the east bank prior to the commencement of works on the west bank.

FLOOD GATES IN LOCK PIT

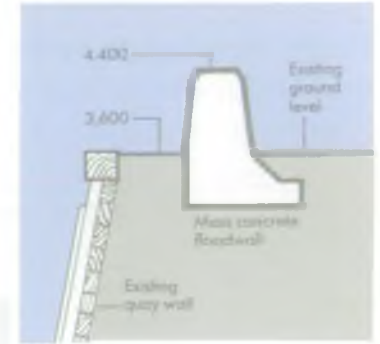
These gates are designed to exclude the North Sea Surge from the Ipswich Wet Dock. A pair of mitre gates were installed in an existing recess to the lock to the Ipswich Dock. The width of the lock is 14.24m, the sill level is -4.79m ODN and the top of the gates is 4.25m AODN. The gates are electro-hydraulically controlled with the main motors and pumps situated in cabins at either side of the lock. The controls to both gates are situated on the right hand side of the lock, and are operated by push button. The lock gates are closed by the Ipswich Port Authority Harbour Master when a surge tide approaches the danger level and then opened when the danger period has passed.

RIVER BANK AND BED PROTECTION

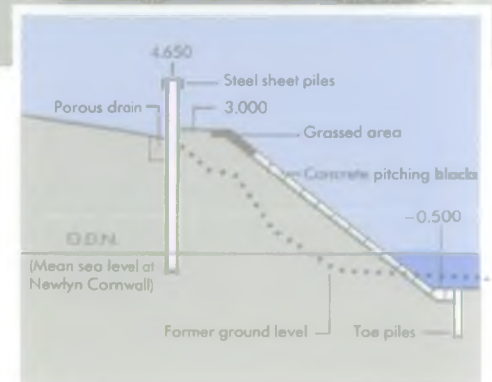
Two types of river bank protection have been used in the scheme. In the tidal length between Stoke Bridge and Constantine Weir the banks have been protected with pre-cast concrete pitching slabs, laid behind toe piles. In the non-tidal length stone filled wire baskets were laid on the banks in areas where the new river bank was formed in the old river channel, to minimise erosion.

Bed protection is provided where the flood flow would cause scour. This is downstream of the velocity control structure, downstream of Norwich Railway Line Sluice, downstream of Horseshoe Sluice, at Stoke Bridge, Princes Street Bridge, Yarmouth Railway Line Bridge and some other localised areas of high river velocity. The bed protection takes the form of fascine mattresses. To form a fascine mattress willow branches are bound together to form a square grid onto which is placed reeds and brushwood and topped with further willow branches. The whole mattress is in the order of 800mm thick and is held on the river bed by means of lump stones each 55kg in weight and placed at random. This method of protection has been used for centuries and found to be very effective.

Typical section of concrete floodwall



Riverbank approaching Stoke Bridge



Typical bank protection

Laying a fascine mattress



THE RIVER GIPPING

There has been a long history of flooding in Ipswich, and records show significant flooding on 14 occasions due to tidal surges and on four occasions due to river flooding. The flooding of 100 hectares of urban area in 1953 affected 700 residential and more than 580 commercial and industrial properties, whilst in 1939 the river flood affected about 3,000 residential properties.

The River Gipping flows about 20 kilometres from Stowmarket to Ipswich where it joins the River Orwell tidal estuary and is now the focal point of a thriving dockland area. Indeed, the river was once navigable as far as Stowmarket, but in years past this fell into disuse and it is the downstream section of the river which has been adapted to suit changing requirements.

The length of the river between the western borough boundary and a man-made channel known as The New Cut, alongside the Ipswich Wet Dock, forms the crux of the flood defences for Ipswich.

The flood defence scheme is based on two main criteria: firstly that the defences should be capable of withstanding a high tide similar to January 1953 and secondly, that the channel should be capable of dealing with flow approximately equal to the last two major floods of 1939 and 1947.

Construction work started in 1971 and took twelve years to complete.

RIVER GIPPING CATCHMENT



CATCHMENT STATISTICS

Catchment Area	–	315.3 square kilometres
Length of main river	–	29 kilometres
Average rainfall	–	625 mm
Effective rainfall	–	150 mm
Average River flow at Bramford Gauging Station	–	0.988 cumec (cubic metres per second)
Ratio of daily flow	–	1000:1

River improvements
above Horseshoe Sluice



Horseshoe
Sluice



Handford Sluice

SLUICE



The River Gipping velocity
control structure

NORWICH RAILWAY LINE SLUICE TO HORSESHOE SLUICE

Immediately downstream of the Norwich Railway Line Bridge a single vertical lifting gate was installed to allow control of high river flows in excess of 110 cumecs. The gate is a single electro-mechanically operated vertical lifting sluice, 12.2m wide, with a height of 4.6m. The purpose of the gate is to restrict the discharge into the built-up area of Ipswich to 110 cumecs, the peak flow being retained on the flood plain area upstream until the channel through Ipswich is capable of carrying the discharge. Between Norwich Railway Line Sluice and Yarmouth Railway Line Bridge it was necessary to carry out a major channel diversion. This diversion is formed in a trapezoidal earth channel with earth flood banks. At Yarmouth Railway Line Bridge the channel is formed in a length of flumed rectangular channel with steel sheet piled walls. Downstream of Yarmouth Railway Line Bridge the channel has been improved and earth flood banks formed.

HORSESHOE SLUICE

The existing Horseshoe Weir was replaced by a pair of electrically operated, vertical lifting gates each 6.1m wide and 3.75m high. The sill level is 0.9m AODN and the top of the gate is at a level of 4.65m AODN when fully lowered. The gates are controlled automatically from an upstream float well to give alternative upstream water levels which can be pre-set between 3.65m AODN and 4.30m AODN. They can also be operated from the adjacent control house. These gates will normally be closed and the summer flow of the River Gipping will be regulated over Handford Sluice.

HANDFORD SLUICE

The original vertical lifting Handford Sluice gate was replaced by a bottom hinged tilting gate on a fixed weir. The gate is 9.15m wide and 1.9m high, electro-mechanically operated by push buttons. The gate is set under normal conditions to maintain automatically a minimum water level of 3.2m AODN. At times of high tidal level the gate becomes buoyant to the tide and the electro-mechanical control overridden to stop the ingress of salt water. When the gate is fully raised under a tide lock condition the top of the tilting gate is at 4.65m AODN.

HORSESHOE SLUICE TO CONSTANTINE WEIR

This section of river improvement excludes the North Sea Surge from the surrounding land and also increases the capacity of the river to carry high fluvial discharges. As a result of high density land use between Horseshoe Sluice and Seven Arches Bridge, the channel has been formed from steel sheet piles driven on both banks. On the section downstream of Seven Arches Bridge the channel was designed in a way to maximise the available cross sectional area. As the improvements were in an area of stable ground conditions no protection of the river banks was necessary and flood defences above existing ground level have been constructed as earth banks.

CONSTANTINE WEIR TO STOKE BRIDGE

This length of channel improvement combines work to exclude the North Sea Surge from adjacent property and also provides an improved and protected channel for high fluvial flows. The river has been realigned and regraded in a manner to maximise the cross sectional area and improve the flow characteristics of the existing river channel. Steel sheet piles were driven at the top of the channel slope to provide the full height flood defence. Steel sheet piles were also driven at the toe of the new slopes, which have been reveted with concrete pitching blocks to prevent erosion. In some places where there was insufficient land to get an adequate trapezoidal channel, a rectangular channel was formed by using vertical steel sheet piling from bed level to the defence level.

CONTROL AND MONITORING SYSTEM

A central control house monitors water levels in the river throughout Ipswich by means of permanent water level gauges. In the event of a flood whilst the majority of the sluices operate automatically there is a facility in the master control house to operate the sluices manually. Incorporated into the system are various alarms should any faults arise.