BATH FLOOD DEFENCE SCHEME

NRA

National Rivers Authority

South Western Region

BATH AND THE RIVER AVON

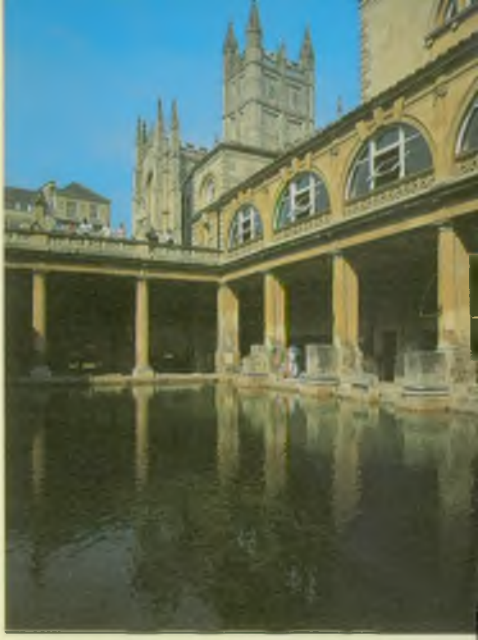
The city of Bath and its local water environment go hand-in-hand together.

Today the view of the River Avon at Pulteney Bridge is a magnet for tourists, and famous throughout the world.

But it was not always so. For in recent geological times the main tributaries of the Avon – the Somerset Frome and Midford Brook on the Mendips – were thought to be headwaters of the River Thames.

At that stage the River Avon on its journey to Avonmouth would have been a much smaller river with its source being the By Brook flowing through Castle Combe and Box.

A dramatic geological fault then completely changed the situation. The two 'Thames' headwaters were captured and switched to become sources of the Avon.



The Great Bath

The vastly increased flows in the Avon cut deep gorges through the limestone in Bath and the sandstone in Bristol.

This was the making of Bath, as deep springs were exposed by this natural erosion, including the hot springs which so attracted the Romans.

The town they built – known as Aquae Sulis – was established at the point where the road from the south-west to Lincoln crossed the River Avon.

By the end of the first century AD a remarkable bathing complex had been constructed enticing visitors from all over the Roman world. One contemporary writer, Solinus, described the hot springs as 'furnished luxuriously for human use'.

A temple watching over the springs was dedicated to Sulis Minerva – a hybrid deity thought to be a combination of the old Celtic god Sul, probably the pre-Roman guardian of the waters – and the Roman Minerva, goddess of healing.

In subsequent centuries, the power of the River Avon was used for milling and so played its part in the affluence of the westcountry during medieval times, when the wool trade was at its peak.

Weirs were constructed across the river to service the mills and these resulted in the 'ponding' of the river throughout its length. Pulteney weir has been the site of such mills since Roman times.

Between 1724 and 1727, one of Bath's most famous characters, Ralph Allen, instigated the construction of new cuts and locks to form a navigation on the River Avon between Bath and Bristol. This was to aid the worldwide transport of his famous stone.

The city continued to prosper and is famed for its Georgian architecture. Pulteney Bridge was built by Robert Adam in 1771 as part of an agreement with the Bathwick Estate to bring water to Bath from the springs at Sham Castle.

There was a darker side too, however. In Victorian times industry and public waste made the River Avon a convenient sewer, and at the bottom of Avon Street – known locally as suicide row – it was all too often used for taking away human life.

And then there were the floods . . .

Newbridge, 1960

A HISTORY OF FLOODS

A river will cut itself a channel within which its waters can be accommodated most of the time. But a river does not always flow within its banks. At times of flood the river flow is too much for the normal channel and the river overtops its banks and spreads over the floodplain.

Large areas of Bath, even in Victorian times, were built in the floodplain, right up to the bank of the low flow limit of the river.

As a result Bath has flooded on numerous occasions over the years. One of the earliest floods recorded was in 1725 and records of the highest flood levels include levels 12 feet above Pulteney Weir crest thirteen times since the beginning of the nineteenth century.

Visitors today can note the levels of many floods etched on the south abutment of Halfpenny Bridge, the footbridge over the Avon at the rear of Bath Spa railway station. And graphic accounts of Bath floods have frequently appeared in the local Evening Chronicle newspaper.

As long ago as 1824 the town's concern at the damage, and even loss of life, caused by floods led to the formation of the Flood Relief Committee.

This sought recommendations 'either from gentlemen conversant with hydrostatics, or Engineers by profession' for a flood defence scheme.

Green Park Road, 1968

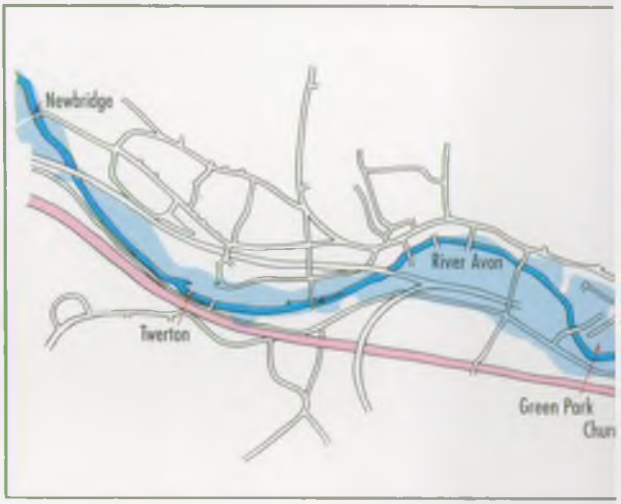
Scenes from the 1960 flood:
Top: Junction of Southgate and St James Parade
Left: Lower Bristol Road and Green Park Road
Middle: Southgate
Right: James Street West

Thomas Telford, a 'civil engineer of the first eminence' was chosen to select the most suitable project, but ended up preparing his own report.

He recommended a new bridge and some cuts and channel improvements at a cost of £50,000.

The high price and conflicts over land interests prevented acceptance and the committee was wound up.

It was to be the first of many attempts to tame the floods.



Flooded area, 1960

LOOKING AT THE OPTIONS

Over the years engineers have considered many other different options for reducing the risk of flooding in Bath.

In 1877 a cheaper scheme to leave the channel alone, but replace the solid weirs with others which could be lowered in floods to release the water faster, came to nothing.

The serious floods of 1882 produced a scheme combining both channel and weir improvements at a cost of over £100,000. This proved unacceptable too.

Another briefly considered proposal, made in 1896, was to cut an 8 kilometre long, 3.2 metre diameter bypass tunnel between Limpley Stoke and Twerton.

The Land Drainage Act was passed in 1930 and under it the River Avon Catchment Board was set up. It was this Authority that finally grasped the nettle and accepted the earliest idea of improving weirs and channels.

However, the war intervened and prices rose dramatically after it. It was only in 1953 when a new chief engineer, Frank Greenhalgh, took office that the project started to see the light of day.

He looked at four main options, rejecting three of them. These were:

1. Construction of a flood control dam upstream of Bath. Such a 'detention reservoir' requires a lot of land, and no suitable site was available in a location to aid Bath.
2. Construction of a flood bypass. An open channel bypass through Bath was impossible and a flood bypass tunnel of sufficient capacity would have been extremely expensive.
3. Construction of watertight embankments and walls above existing ground level to control flood flows. The permeable ground of Bath would have allowed seepage under these

Under construction – Pulteney Weir, 1972

Twerton sluices during construction, 1965

defences, and in some places buildings close to the river's edge would have allowed no room for these defences.

Small lengths of flood wall do exist along the boundary of the Bath Cricket Club below North Parade, and along a stretch of the lower Bristol Road below Churchill Bridge.

The fourth and chosen option was to increase the capacity of the in banks river channel, to allow flood flows through at a lower level. The close proximity to the river banks of buildings throughout Bath meant that improving the capacity of the channel through most reaches required a channel shape that was most efficient with land, i.e.rectangular.

DESIGN AND CONSTRUCTION

The River Board agreed to carry out improvements capable of handling the maximum flood for which any record existed. This was 370 cubic metres per second in 1882.

To test the potential of the scheme, following experimental work at Bristol University in 1956, the Board constructed a model of the river in a purpose-built building in Melksham.

The 60-metre long concrete model represented eight miles of the River Avon through Bath, at a scale of 1:240 horizontally, 1:60 vertically. The model was calibrated by passing known flood flows through it and measuring levels at known points. The model was varied to study the effects of various works, bridge removal and dredging.

After two years of tests the scheme was shown to be suitable. The only hesitation was, yet again, over the costs involved.

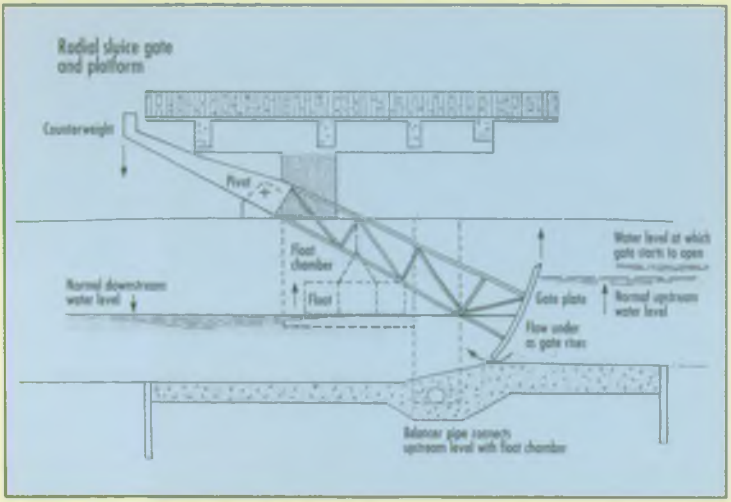
Then ironically the weather intervened once more to concentrate minds. Floods reached a peak on 4/5 December 1960, almost the worst ever recorded. By 13 December the scheme was finally given the green light.

The work was phased over a long period and completed in 1974 at a cost of £3 million (more than £12 million at today's prices).

The Old Bridge was the most marked obstruction to flood flow. Its' arches became almost totally blocked with trees

The hydraulic model showing Twerton, 1956

Underpinning of Newbridge, 1964



The radial gate opens automatically as levels rise upstream. A pipe connects to float chambers either side of the gate. As the levels rise, so large hollow metal boxes connected to the gate float up overcoming the counterweight. This raises the gate plate, allowing more water to flow through

and other debris during a flood, diverting flood flow over river banks and up Southgate Street. Built in 1734 the bridge was demolished in 1964 to make way for the single span Churchill Bridge and its accompanying footbridge which carried all the services over the river.

Meanwhile, in the same year work began on 'underpinning' Newbridge. The bed of the river under its arch was lowered by two metres, and its foundations shored up with concrete. Three other bridges received similar treatment, including Pulteney Bridge. Here excavations carried out in 1964 exposed oak-piled foundations, which were then covered in concrete to lower the bed by 1.5 metres.

Pulteney Bridge underpinned

River flows through Bath are maintained at a constant level by two 13-metre wide sluice gates built at Twerton. The gates – completed in January 1967 – replaced two old weirs which provided power to mills on Weston Island.

The construction of the modern weir at Pulteney, finished in 1972, was a particularly sensitive part of the scheme.

Its setting by the famous bridge had led to the Royal Fine Arts Commission suggesting that the best architectural and landscape advice be sought by the engineers.

This was agreed and a difficult task undertaken boldly with the majority of the costs involved with the diversion of a 1.15 metre diameter sewer pipe across the river.

The success of the weir was demonstrated with the accolade of a Civic Trust Award. Part of the citation read,

In one of the most beautiful, and thus vulnerable settings in Europe . . . here the designers have given Bath, already rich in wonders, a new wonder . . . [the weir] is a triumph both visually and accoustically. Its steps, three great crescents

cascading across the Avon, are rims of foam in sparkling contrast to the quiet water above them reflecting Pulteney Bridge.

Channel widening and deepening from Pulteney to Twerton took place from May 1971 until March 1974. River banks were sheet piled and anchored in the dry, then the channel was dredged in between.

Dredged material was used to raise Green Park, the area at Newbridge, now used for a park and ride scheme, and the area that has since been removed to form Newbridge Marina.

The Bristol Avon River Authority started construction of the scheme and their successor body Wessex Water took over and completed it. On its formation in 1989 the National Rivers Authority (NRA) inherited the powers for its maintenance.

THE FUTURE

Pulteney Weir, Bath

Without the flood defence scheme Bath would have flooded in December 1979, March 1982 and January 1995. Studies of the flows and levels of these events accurately identified the protection afforded to Bath. The City is safe from an event that would occur on average once in 150 years. Of course, that event, or worse could happen tomorrow.

The words of an anonymous commentator around 1880 are still true today.

"If the city hopes to escape them [floods] altogether, we believe that only disappointment will be the consequence, for that engineering skill will ever succeed in the work of total prevention is hardly to be hoped for".

Nevertheless, the NRA, through its radio links with gauging stations at Bathford and further upstream would be able to predict such an event, and via the police give those that would be affected at least a two hour warning before the water started flowing out into the streets.

The NRA also ensures that the level of protection is not jeopardised. Every five years the whole length of the scheme is surveyed to ensure the channel has not silted up. Since the scheme was completed the channel has proved virtually self-cleaning, and no redredging has been necessary.

Through the planning process the NRA also guards against the loss of flood storage area on natural floodplains upstream of Bath. Any reduction in storage would mean extra water having to flow through the city. At the NRA's insistence, the Department of Transport had to replace storage lost to the 1994 construction of the Batheaston bypass. This was achieved by their agreement to excavate wildlife ponds in the meadows.

Acknowledgements

The Bath flood defence scheme was the brainchild of the then Chief Engineer of the Bristol Avon River Authority, Frank Greenhalgh, who saw the work through to completion. He also assembled information on the scheme without which this leaflet would not have been possible.

The floodplain between Grosvenor and Bathford, 1982

THE NATIONAL RIVERS AUTHORITY

The National Rivers Authority is an independent public body established in 1989 as 'Guardian of the Water Environment'. The main functions of the NRA are flood defence, water quality regulation, pollution control, environmental monitoring, water resources planning and control, fisheries, recreation and conservation.

NRA SOUTH WESTERN REGION

HEADQUARTERS
National Rivers Authority
South Western Region
Manley House
Kestrel Way
Exeter EX2 7LQ
Tel: Exeter (01392) 444000
Fax: Exeter (01392) 444238

NORTH WESSEX AREA
OFFICE
Rivers House
East Quay
Bridgwater
TA6 4YS
Tel: Bridgwater (01278) 457333
Fax: Bridgwater (01278) 452985

Telephone the emergency hotline to report all environmental incidents, such as pollution, poaching and flooding, or any signs of damage or danger to our rivers, lakes and coastal waters. Your prompt action will help the NRA to protect water, wildlife, people and property.

NRA emergency hotline

0800 80 70 60

24 hour free emergency telephone line

SW-5/95-2k-D-ANOA

Awarded for excellence

Cover picture:
River Avon at Pulteney