Banbury Flood Alleviation Scheme

the people of Banbury can appreciate rain without a flood of bad memories now that a storage reservoir & other flood defences protect them from catastrophe

by Emma Booth, Steven Lee, and Lise Taylor

Many people in Banbury recall the Easter of 1998 not as a time to celebrate new beginnings but as a time of severe devastation. The railway station and roads were closed and approximately 125 residential and 35 commercial properties were flooded, resulting in more than £12.5 million of damage. Another flood in the summer of 2007 reinforced the need to fully implement a flood alleviation scheme first conceived in 2001. More than 5 million people in England and Wales live and work in properties that are at risk of flooding from the river or sea. As the lead public body responsible for protecting and improving the environment in England and Wales, the Environment Agency is responsible for managing that flood risk. The geography and geology of the valley along the river that runs through Banbury made the community particularly susceptible to flooding during heavy rains.

River realigned (away from Oxford canal) to make room for the construction of the new flood embankment - Courtesy of Suave Aerial Photographers

The Environment Agency engaged Black & Veatch to provide study and design services for the Banbury Flood Alleviation Scheme, and the company delivered recommendations in 2001. Mid-stream funding changes and rescheduled public inquiries delayed implementation of the comprehensive flood alleviation scheme over the next decade, but construction began in 2011 based on flood modelling and design work updated after the 2007 flood. As designer and site supervisor, Black & Veatch has worked closely with the Agency and also with the main contractor, Galliford Try.

Implementation of a multifaceted scheme

The flood alleviation scheme consists of five major elements, designed to comprehensively and considerably lower Banbury's chances of flooding in the future.

Flood storage reservoir upstream of Banbury: A 2,850m long earth embankment dam has been constructed, creating a flood storage area. Largely located in the natural floodplain of the River Cherwell, the flood storage area collects rainwater otherwise likely to swell the river over its banks. The dam embankment has a maximum height of 4.5m and an average height of 2.5m.

Road raising: Raising 860m of the A361 road in the flood storage area, and installation of culverts will ensure improved drainage and balanced water levels on both sides of the road during flood events.

Localised storage defences downstream of the reservoir: Defences constructed in three specific locations in Banbury will provide additional flood relief during severe storm events. A 400m long earth embankment up to 2m high, combined with culverts, will protect the Wildmere Industrial Estate from flooding. Joined to this embankment is a flood wall constructed around the site of Prodrive, a motorsport and automotive technology businesses. Installation of a 210m long sheet pile wall with a concrete capping beam and

a 100m long, 2m high earth embankment dam will protect the Tramways Industrial Estate and Banbury United Football Club from flooding.

Pumping station at Moorfield Brook: The pumping station is a different type of localised defense downstream of the reservoir. Completed in 2004, the Moorfield Brook Pumping Station effectively protected more than 400 homes in the Grimsbury area of Banbury in 2007 by pumping rainwater into the river downstream of development.

Creation of Biodiversity Action Plan (BAP) habitat: The community will benefit not only through flood protection but also from post-construction reinstatement that includes improved footpath access and creation of a 12ha BAP habitat. Habitat development includes conversion of the borrow pit (which supplied earth for embankment construction) into a Cherwell District Council country park; three river realignments incorporating ponds; and various new and replacement plantings including trees and hedgerows.

Excavations for the scheme unearthed archaeological finds that had to be carefully collected and catalogued. These included prehistoric flint tools, historic farmsteads, medieval ridge and furrow agricultural field patterns, and battlefield artifacts.

Teamwork

The team continually worked together to identify ways to reduce costs for the client and overcome challenges. Availability of material was a significant project challenge. The local borrow pit provided the 100,000m^3 of earth needed for the reservoir embankment, but efficiently sourcing and removing clay of the right specification while eight archaeologists investigated unexpected Neolithic remains proved extremely difficult. However, working with the Black & Veatch supervisor and the earthworks subcontractor, the team were able to discuss and agree different options promptly, and finally agreed an amended specification for the clay. This allowed the team to use a different type of clay than originally anticipated, which mitigated some of the delay due to the archaeological excavations and increased production.

As designer and contractor, Black & Veatch and Galliford Try also effectively worked together to incorporate use of limestone blocks discovered in the borrow pit. The team used the limestone blocks in two ways:

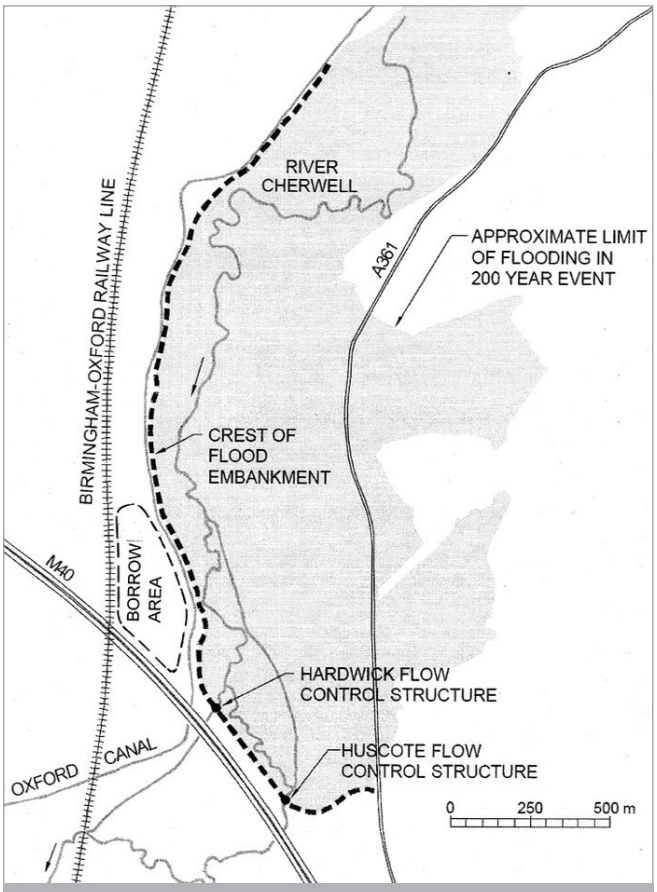
- As an alternative to stone-filled gabion baskets in the river.
- Crushed and screened as granular material for use in the embankment instead of imported material.

In addition to reducing costs for the Environment Agency, this substitution significantly reduced the environmental footprint of the scheme.

Passive flow control contributes to the proactive solution

The reservoir features two identical passive flow control structures set 400 meters apart on each branch of the river, and an auxiliary spillway. Flows are passed downriver though specially shaped fixed orifices that were innovatively designed to convey a constant amount of water as the reservoir fills with rainwater and the head (pressure) across the control structure increases. The double-baffle orifices and 30m long spillway incorporated into each flow-control structure automatically operate when the reservoir is full, precluding the need for a power supply, control system, or operator.

Although similar double-baffled orifice devices have been used for flow control in irrigation schemes for many years, their selection and development for the Banbury scheme was a unique approach; presentation of the concept at a conference in June 2004 led to more rapidly implemented application in other schemes, benefitting flood control efforts both in and outside Banbury.



Main features of Banbury flood storage reservoir showing the new embankment (dashed line) and approximate limit of flooding in a 200-year event (light grey shaded area) - Courtesy of Black & Veatch

Installation of Beaney kerbs on the A361 as part of the construction work to raise the road level where it passes through the flood storage area Courtesy of Black & Veatch

Flooding of Banbury Railway Station during the April 1998 floods Courtesy of Black & Veatch

New sheet-piled flood wall with concrete capping provides flood protection to football pitch at Banbury Utd - Courtesy of Black & Veatch

Black & Veatch and the Environment Agency designed the passive flow control structures within the reservoir embankment to meet sustainability objectives. Specifically, the design enables the Agency to avoid the use of gates, reliance on power supplies, and automation or on-site staffing during floods. The structures have no moving parts and will therefore ensure a high degree of resilience for the whole life of the scheme while minimising the operational maintenance costs.

Flood relief at last

Peter Collins, Environment Agency Team Leader for West Thames Area Flood Risk Management commented:

> *"The Environment Agency is delighted with the new Banbury Flood Storage Reservoir and other flood risk management structures. On completion, the flood alleviation scheme will provide flood protection to more than 400 residential properties and 73 commercial properties in Banbury."*

With construction of the Banbury Flood Alleviation Scheme nearing completion, the scheme is already providing the town with flood protection from a 1 in 60 year flood. When construction is completed in July 2012 the scheme will begin operating at full capacity, and the community will find the odds against future flooding even more in its favour. With only a 1 in 200 chance of flooding in any single year, Banbury residents can breathe a collective sigh of relief and look forward to a great new beginning.

The Editor & Publishers thank the following for preparing the above article for publication: Emma Booth, Project Manager with Black & Veatch; Steven Lee, Project Manager with the Environment Agency; and Lise Taylor, Environment Agency National Framework Manager for Black & Veatch.

One of the twin flow control structures within the flood embankment, looking upstream towards the baffle orifice; limestone blocks and gabions provide erosion protection to banks - Courtesy of Black & Veatch

Inspiration & Innovation

We're building a world of difference. Together.
Where business solutions begin with a conversation. Fresh insight and endless expertise result in constant innovation. And the complex is always made manageable.

That's the Black & Veatch difference.

Redhill +44(0)1737 774155

BLACK & VEATCH
Building a world of difference.®

Consulting • Engineering • Construction • Operation | www.bv.com