Nottingham Left Bank Flood Alleviation Scheme

a £51m scheme providing increased flood protection to 16,000 homes and businesses along the River Trent's left bank

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A robust appraisal from the outset coupled with a flexible approach through design and execution, has been crucial to stand up to the complexities of delivering a six-year programme of flood defence works in Nottingham. The Nottingham Left Bank Flood Alleviation Scheme (FAS) will increase flood protection to more than 16,000 properties and provide additional security for key infrastructure at the heart of the city's community. The scheme encompasses work at six separate locations along a 27 kilometre stretch of the River Trent, from Sawley to Colwick. Engaged under the Environment Agency's National Engineering and Environmental Consultancy Agreement (NEECA) framework, the FAS is being delivered by framework partners Black & Veatch as principal consultant and Jackson Civil Engineering as main contractor.

Constructing defences for the left bank of the River Trent *Courtesy of the Environment Agency*

History

Nottingham has a history of flooding dating back to 1795. The current defences were constructed after serious flooding in 1947 affected 28 miles of road, 3,000 properties and 86 factories in the city centre.

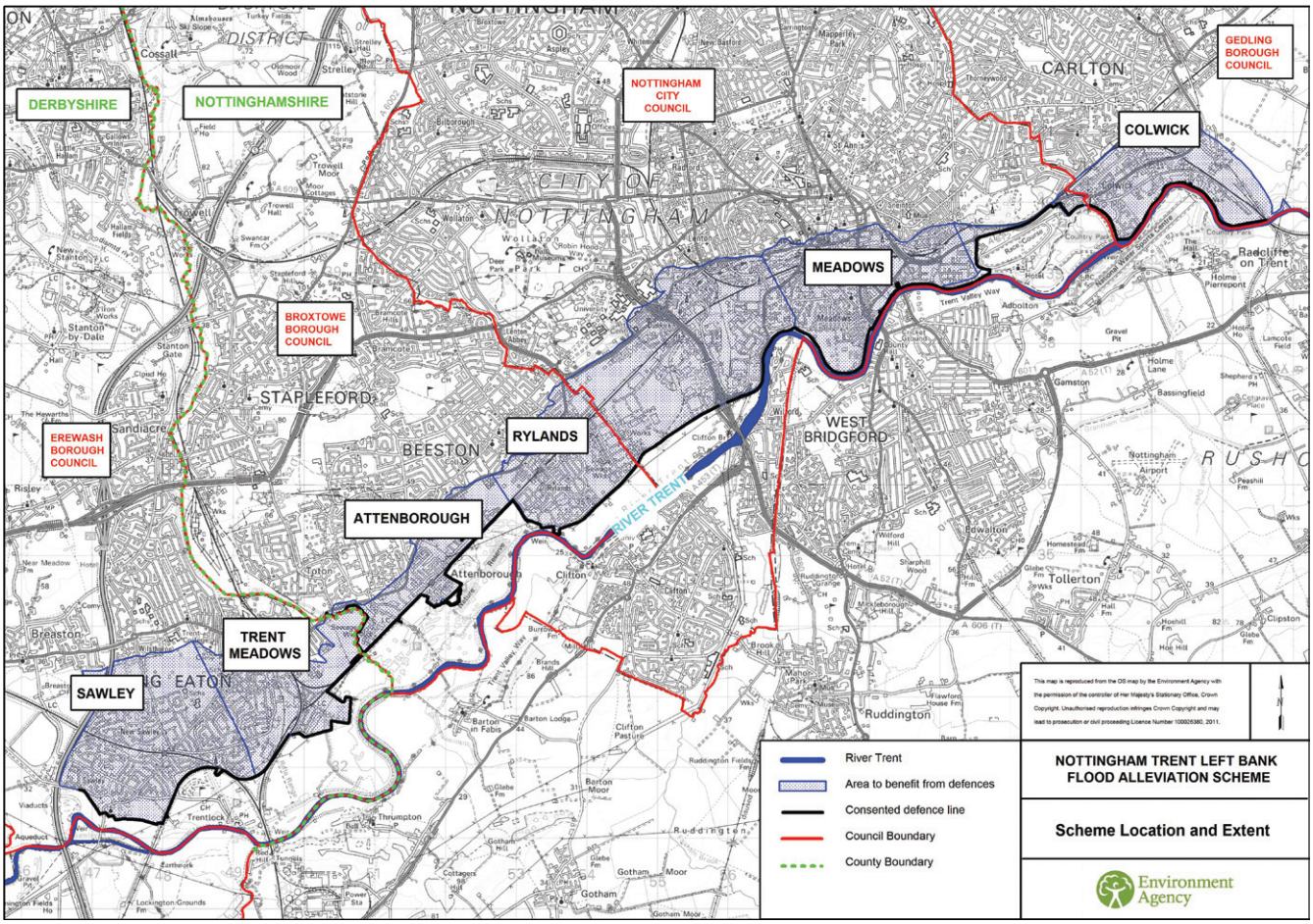
Following further significant flood events in 1998 and 2000, the Environment Agency embarked on a series of studies to investigate flood risk along a 200 kilometre length of the River Trent and its main tributaries. The results published in the Fluvial Trent Strategy 2005 indicated existing defences offered a reduced level of protection compared with latest best practice recommendations.

In response to these findings, the Environment Agency commissioned the Nottingham Trent Left Bank Flood Alleviation Scheme to appraise, and ultimately improve, flood protection along the River Trent's left bank.

Black & Veatch was appointed to conduct a full strategic flood risk assessment, including the inspection of existing defences, topographic surveys, ground investigations, computer modelling of the river, economic analysis and a review of the options. The work confirmed that some areas were only protected against a flood which had a 1-in-50 chance of occurring in any year and in some areas the defences were approaching the end of their useful life. Subsequently, £51 million of government funding was approved to improve flood defences through central and outlying areas of Nottingham.

Design

The FAS has been designed to protect 16,000 homes and businesses on the left bank of the River Trent against a flood with a 1% (1-in-100) annual probability of occurrence. The works has been split into six sections: Sawley; Trent Meadows; Attenborough; Rylands; Meadows; and Colwick.



Site Location Plan: Located between the M1 at Sawley and Colwick, a distance of 27km, the works has been split into six sections: Sawley; Trent Meadows; Attenborough; Rylands; Meadows; and Colwick - Courtesy of Black & Veatch

A multi-disciplinary team has been required to assist the design project including specialist inputs such as hydraulics, hydrology, river modelling, structures, geotechnics, economics and planning. At its peak, the design team encompassed around 50 professionals working out of Black & Veatch's Swansea, Treforest, Redhill and Chester-based UK offices, with support from the company's offshore design office in Mumbai.

The size of the scheme also necessitated preparation of an environmental statement to assess the environmental impact of the whole scheme and provide an opportunity for the public to comment.

Integral to B&V's design, options such as whether to maintain defences at their existing position or alter the alignment to provide more space for the river had to be considered. Additionally, the original model was revisited and the options reappraised since the availability of more sophisticated modelling techniques had produced different data to the results obtained at earlier appraisal. There has been considerable discussion of the options in order to ensure a buildable design with the greatest value to both the client and the community.

In most cases the improvement works involve raising and/or widening existing embankments and replacing or building new walls where required. Additionally the foundations have been designed to support future raising if necessary.

Challenges

Construction commenced in Sawley in June 2009 with a programme to complete all sections by 2012. Throughout the works considerable efforts have been made to keep local residents and both statutory and non-statutory consultees involved in the decision making process. In particular, programme management has needed to be flexible to accommodate the project's constraints whilst ensuring the three-year construction works remain on target. Working across high ground and railway embankments in a restricted working corridor, the challenges included dealing with a wide variety of land types which included grazing, commercial and residential property and local wildlife sites as well as affecting roads, railways and a canal.

The defence alignment through Attenborough was particularly challenging, not least because of its close proximity to a nature reserve designated a Site of Special Scientific Interest (SSSI). The Attenborough SSSI covers some 220 hectares and comprises a number of lakes that were created as a result of gravel extraction. It provides a valuable habitat for over-wintering waterfowl and sustains an important breeding bird community. Mitigation options acceptable to Natural England had to be developed as part of the planning process. Additionally, Attenborough village and the village green had significant local human, historic and nature conservation issues, which had to be considered.

The programme has also had to accommodate redesign of defences through the Meadows section of the works. The defences here needed to be sympathetic to the site's important features and monuments including the War Memorial and band stand, as well as meeting local ambitions to improve Victoria Embankment which is already a key recreational area for the city.

The original design included demountable defences, which were thought to provide the ideal option to maintain accessibility during the annual riverside festival. However, following the events of the 2007 flooding in Upton and the findings of the Pitt Report (Pitt et al., 2008) the use of demountable flood defences was discounted because the consequences of their failure would compromise the integrity of the scheme.

Consideration of the realignment options resulted in a period of extensive public consultation with a wide number of interested organisations and people. The consultation process has included local drop-in sessions, newsletters and public displays. In reaching a preferred alignment, the team worked hard to strike a good balance between meeting the needs of flood protection, the community, conservation and enhancing the area's visual appearance.

Environmental enhancement

Environmental considerations have been a very important part of the Nottingham FAS. As such, the team is in close collaboration with the local community, and organisations such as Nottinghamshire Wildlife Trust, Natural England and the local council and community groups as part of an ongoing consultation process.

To mitigate for taking 1.5 hectares of land within the Attenborough SSSI boundary, the scheme has committed to deliver 8.8 hectares of new habitat which is presently mostly open water. Working closely with Nottinghamshire Wildlife Trust and Natural England, the FAS team have established the best types of habitat to create, and the team will continue to support these organisations throughout the construction and after care phases of habitat creation.

Innovative solutions

The team was required to turn traditional thinking on its head to address the constraints of constructing a 2.5km length of flood wall parallel with the railway line at Attenborough Nature Reserve.

Because of the highly permeable ground conditions within this section of the works, measures were required to create a seepage cut off – an impermeable barrier below ground. The method chosen had to minimise the amount of land use, reduce environmental disturbance, and take account of working alongside high voltage electric cables and a major railway line to the satisfaction of Central Networks and Network Rail.

Trenchmix offered a new approach to conventional hammer driven sheet piles. The plant operated by Bachy Soletanche was chosen because it was possible to use it within a few metres of the live main railway. The Trenchmix machine mixes the existing ground insitu with cement and additives without the need to excavate and remove it. The resulting mix of soil and grout solidifies to form a continuous underground barrier, preventing high flood levels driving water through the ground beneath the flood wall, and protecting the areas behind the defences.

The Trenchmix machine offered significant benefits. It was faster than conventional sheet piling machines, and its lower noise and vibration levels reduced disturbance to wildlife, visitors and local residents. Because less land was needed to build the defence, any earth excavated could be recycled on site for landscaping work, which resulted in less traffic on local roads.

Sustainable construction

Eager to reduce waste and recycle at every opportunity, the team's integrated approach has ensured designs have been developed with this in mind. By suggesting the best construction solution at the earliest stage of the design process, the team has managed to reduce costs, waste and carbon emissions.

Recycled stone and crushed concrete material has been moved from contract to contract for use as haul routes until the material can no longer be used. Leftover good material is now part of the permanent road and path construction.

At the Attenborough site, bulk rockfill has been utilised at the lake edges for use as both temporary working platforms minimising the total volume of material needed to be brought to site, maximising reuse and ultimately providing an excellent sub-layer for the reedbed growing media.

The Trenchmix machine provided an innovative construction solution to prevent water seeping below flood defences in Attenborough
Courtesy of the Environment Agency

Careful phasing of the works has also helped enormously with waste reduction. By considering the Nottingham Left Bank project as a whole, the team has been able to maximise the uses for materials needed for temporary works, and reduce to almost zero, the amount of material with no use at all.

Conclusions

Stephen Bowden, B&V's Project Manager and an integral part of the project team for the past six years, reflected on what makes the Nottingham Left Bank Flood Alleviation Scheme stand out:

> *"A scheme of this size has been difficult to control. It has taken a long time to deliver, and in that period of time things have changed on many fronts. For Black & Veatch it changed on the modelling, and for the Environment Agency it changed in their aspirations for what they wanted in terms of demountable defences. We have faced these challenges and come through them because of the willingness of all parties involved to work collaboratively, and our preparedness to adopt a flexible approach."*

The Nottingham Left Bank FAS is one of the biggest and most complex flood alleviation schemes ever built in Britain. With much of scheme already substantially completed, work on the last element of the Attenborough section is expected to start in Autumn 2011 and the scheme is on target for completion in Summer 2012.

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