Bristol City Centre
flood alleviation tunnel

by
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The city centre of Bristol is served by an existing combined sewer system. Inadequate capacity leads to highway flooding, property flooding and combined flow spills to the city's Floating Harbour. Modelling and optioneering concluded that there were two alternative solutions. First that 2000l/s of combined storm and foul flow needed to be transferred away from the area or secondly to supply storage capacity for 4500cu.m which would be re-introduced back into the system once the storm had abated.

Work in progress on the Bristol City Centre Flood Alleviation Tunnel *courtesy Wessex Engineering and Construction Services*

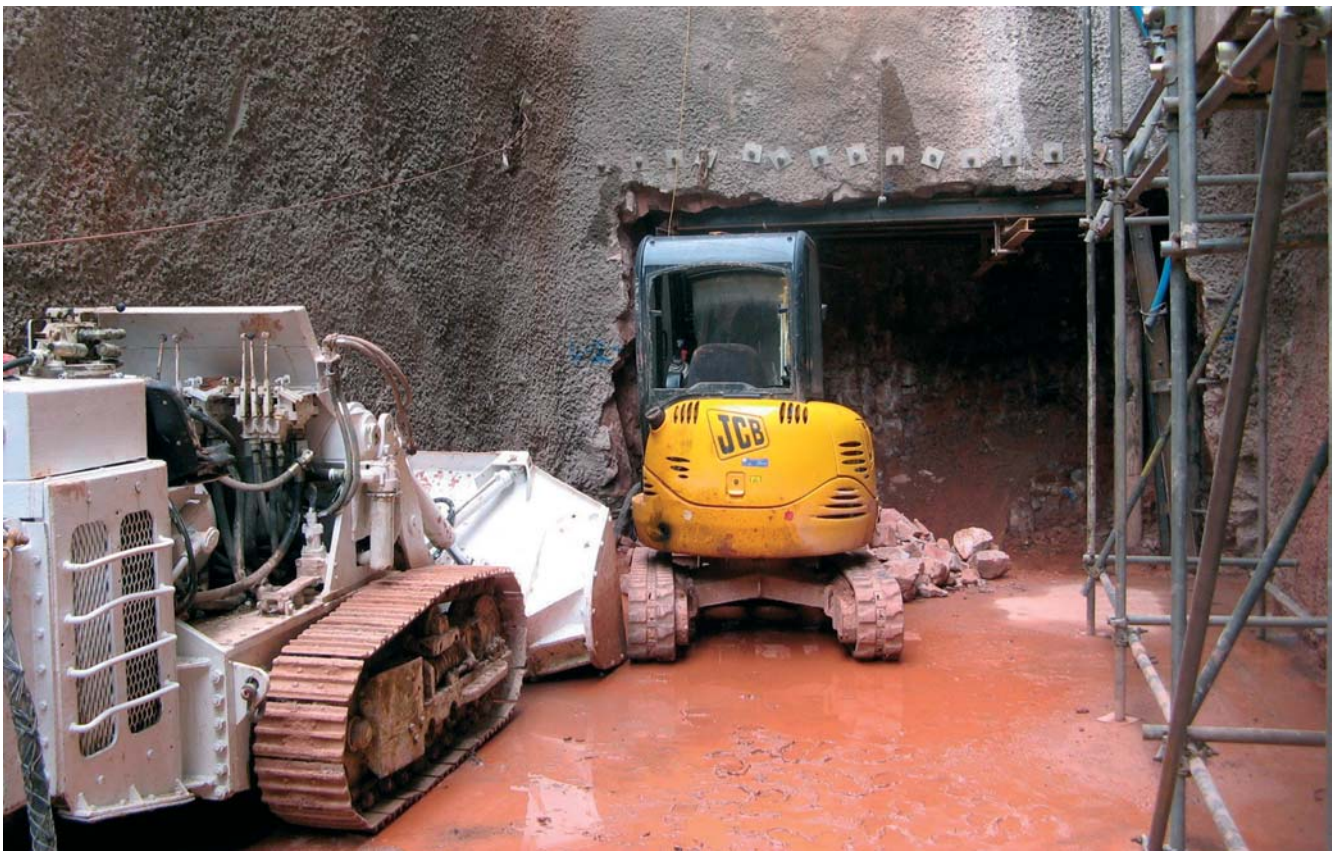
Wessex Engineering and Construction Services (WECS) was tasked with providing a scheme to improve the Bristol sewer system, remove 57 properties from the flooding register, reduce spills to the floating harbour and give the city centre area a 1:50 year storm protection.

These two solutions were further developed and options considered were to upsize the existing sewers to provide additional capacity of 2,000l/s, construct a large pumping station to transfer this flow out of the city centre catchment or a transfer tunnel and 400m of associated sewer connections. The storage solution required large storage tanks within the city centre area to accommodate 4500 cu.m.
Upsizing the existing sewer system or the construction of a large pumping station and rising mains within Bristol's city centre were rejected due to the forecast high cost and major disruption along main arterial roads into the city centre. The option to utilise storage tanks involved the construction of ten large diameter circular shafts throughout the city centre which were also rejected due to the potential disruption, cost and sustainability.

The scheme accepted by Wessex Water was a gravity combined sewer tunnel to connect the existing city centre system to the northern foul interceptor sewer built some 15 years ago and capable of taking the additional flow.

The scheme was further developed to the scheme currently being constructed on site, which is construction of a two metre diameter tunnel from a drive shaft located in a very small area between Bristol Ice Rink and a 12 storey multi storey car park on Frogmore Street. The reception shaft 800m away is to be the existing 3.66m diameter 75m deep shaft three on the Northern Foul Interceptor Sewer. The 400m of associated sewer connection was reduced to 90m by introduction of a flow control device to enable part of the exiting sewerage system to reverse flow, thereby saving the requirement to install 310m of 1200mm diameter sewer.

The scheme is being constructed by WECS acting as principal contractor, designer and CDM Coordinator. Donaldson Associates are the designer and tunnel excavation contractor is Specialist



Work in progress on Bristol Centre Flood Alleviation Tunnel ***courtesy Wessex Water Engineering & Construction Services***

Engineering Services utilising specialist contractors as required.

During the extensive ground investigation works carried out in 2005 and 2006, some 18 boreholes and 1200m of rock core was recovered and recorded. Following interpretation of this information over 200 changes in ground strata were identified and rock strengths in excess of 450 Mpa were recorded during laboratory testing. The cost of the ground investigation was in the region of £900,000.

After consideration of the ground investigation report, health and safety legislation and analysis of the techniques available to drive a tunnel in these conditions WECS decided to undertake the tunnel drive using traditional drill and blast methods. This system produces a bare rock tunnel supported by temporary supports from drive shaft to reception shaft which is then lined with in-situ concrete to produce a 2.0m diameter tunnel.

The size`of the plant within the tunnel required a drive shaft of 6m wide and 16m long. This drive shaft was located within 3m of the car park foundations in a horizon of mixed and weathered sandstone, with rock head at one end of the drive shaft being at ground level and 2m below the proposed base at the other. Due to the rock formation and the proximity of existing structure this shaft was supported with a system of 40 300mm diameter steel cantilever piles spaced at varying centres around the shaft perimeter linked by a concrete ring beam at surface and requiring a waling beam at the mid point of the shaft. The rock faces between the piles were supported with 75mm of steel fibre reinforced shotcrete applied as excavation progressed.

The initial 50 metres of tunnel drive is 4.5 metres wide by 3 metres high to allow the use of EIMCO shovel and conveyor belt muck removal along with the BOART twin boom drilling jumbo through the difficult phase alongside the twelve storey car park and eight storey ice rink.

The tunnel then takes a 30 metre radius bend at which point it reduces in size to 3.5 metres wide by three metres high on its final drive to Woodland Road. During this 750 metres drive the equipment utilised is the BOART twin boom drilling jumbo and scoop tram. Additional side cross cuts and slashes are required to allow storage, turning and passing of plant.

At the time of writing, the tunnel length is 275m with works progressing well.

Note: ***The Editor & Publishers wish to thank Mark Thomas, Site Manager with Wessex Engineering & Construction Services, for providing above article for publication.***■