Fine-tuning TUNNELS

Extensive work to upgrade Wellington's Terrace Tunnel will extend its working life, and bring it up to 21st Century standards. Image courtesy of NZTA.

Road tunnels are handy ways to get through hilly terrain – so long as they function well. Two of those in the capital (in constant use by around 40,000 and 45,000 vehicles per day respectively) are being upgraded to today's standards.

Opened in 1978, Wellington's 460-metre-long Terrace Tunnel is a vital link in the city's transport network, on the cross-town route to the airport. Rob Whight, the former NZ Transport Agency (NZTA) State Highways Manager for Wellington, says the work will extend the tunnel's working life. The project involves upgrading its fire-fighting, lighting, ventilation and drainage systems, constructing new tunnel control buildings, and making earthquake safety improvements. It is scheduled to be completed before this year's Rugby World Cup.

The Wellington Tunnels Alliance (a consortium formed by NZTA, Leighton Contractors and global engineering firms AECOM and Sinclair Knight Merz), is managing the project. It will start similar improvements in the near future to the 80-year old, 623-metre-long Mount Victoria Tunnel; another vital transport link, it connects the city with the eastern suburbs and airport. The Mt Victoria Tunnel is also part of State Highway 1, although both local and through traffic use it.

The Alliance has created a good team environment according to AECOM's Daniel Wood, bringing together "a wealth of skill and intelligent people" so the project can proceed quickly. "The Alliance Board includes representatives from each of the Alliance partners to help in decision-making – which is a very good way to manage complex projects," he says. "We have also been working closely with the Wellington City Council, the Greater Wellington Regional Council and with the New Zealand Fire Service throughout the project. A community group, including residents and users, are contributing to the tunnel projects' communications plans, and have come up with some helpful suggestions."

Mechanical and electrical systems in the Terrace Tunnel are now over 30 years old and need to be replaced or updated. Longitudinal mechanical ventilation (jet fans) will manage vehicle emissions in the tunnel. Under normal operating conditions, they will run at the lowest speed practical for the traffic and wind flow, which will minimise fan usage, noise, and energy consumption while maintaining good air quality in the tunnel and at sensors outside the portals. The tunnel's short length and the air flows generated by vehicle piston effects mean that the fans will probably be used mainly during heavy traffic congestion.

The instrumentation required to measure and control the airflow includes an ultra-sonic airflow sensor, differential portal pressure sensors, and traffic flow and speed measurement sensors in each lane. Pollutant levels including carbon monoxide, particulates (opacity), and oxides of nitrogen will also be continuously monitored inside the tunnel.

An Australasian team of fire safety engineers is responsible for upgrading the tunnel's fire-fighting systems. The team, which includes Melbourne-based Jean Marc Berthier, who managed the French/Italian Mont Blanc Tunnel post-fire upgrade, has prepared a tunnel safety file for the NZTA. Fire safety engineers from Brisbane and peer reviewers from Switzerland will ensure the fire safety measures meet international best practice.

Initial fire safety work included removing the wall lining and false ceiling, and replacing the sprinklers with a deluge system. According to Paul Corbett, who is overseeing the entire project for the Alliance, the deluge system means larger volumes of water can be discharged in a controlled area, targeting the fire, rather than the smoke. To accommodate the volume of water the deluge system could release in a fire, the tunnel's water supply and drainage are being concurrently upgraded.

New jet fans to manage air quality are of a larger diameter so can shift greater volumes of air than those they are replacing. They will also be used in an emergency for managing smoke during the self-egress phase, and to facilitate firefighters' access. An emergency operating strategy has been developed to respond to the problem of smoke control in a bi-directional tunnel, so the fans will generate air flow in the direction considered safest for the specific fire. During evacuation, the ventilation strategy will be coordinated with directional exit signage mounted in the tunnel walls.

New fire detection systems, including video camera incident detection and a fire wire, are also being installed. The fire wire detects heat and can locate precisely where it is coming from. It will assist fire-fighting by relaying the information to the NZTA Traffic Operations Centre in Johnsonville. The fire hydrant system, which runs in pipes long the walls, is being protected with a guardrail.

A deluge system will be installed in the ceiling to pour water onto a fire at a very high rate of 6.5 millimetres per minute. This open-head, high-capacity sprinkler system is normally activated manually by the tunnel controller but can also be automatic in zones, with input from fire or incident detection systems. One way deluge systems differ from sprinkler systems is that zones can be shut off or reactivated as the situation requires.

Efficient lighting is another aspect of the project brief. Mr Corbett says the lighting being installed will be brighter, less expensive to run and have more transition zones than existing lighting. The new lights are sensitive to light outside, mimicking it during daylight hours, but as you travel through the tunnel the lighting is gradually lowered until the mid-point, then increased gradually towards the exit. Lighting will be enhanced by a light wall colour.

Variable message signs within and outside the tunnel will help daily operations by alerting motorists to essential information such as speed limits, delays and lane availability. Emergency communication methods have been included in the Alliance's brief, so motorists inside the tunnel can be contacted in a crisis. Re-broadcast systems, which can interrupt the 10 most used frequencies on vehicle radios, will provide travellers with information and updates are being set up.

Seismic safety improvements include bracing the cable ladders and componentry. They have been assessed for 50-, 1,000- and 2,500-year earthquake return periods as required by the codes. Parameters for acceptable seismic performance of tunnel structures have been proposed, and the likely damage levels inferred from section capacities. The predicted performance of the primary tunnel structures in the design earthquakes complies with the proposed acceptable performance requirements.

Given the tunnel's strategic importance to the city's transport network, finding the best time to close the tunnel to undertake the work presented the Alliance team with a problem. The team prepared a traffic management model of their proposed solution and discussed it with the Wellington City Council.

Mr Wood says they found that closing the tunnel between 8pm and 6am from Sunday to Thursday works best. While this is longer than closures for maintenance in the past, he says the 10-hour closure allows a full working shift, and thus minimises the duration of the work.

To date the extended closure hours have struck the right balance, with little traffic delay. The team took great pains to minimise noise from overnight work, since there are residential areas nearby. This involved modelling the noise, and agreeing a noise management plan with the Council.

Ultimately, upgrading the tunnels will improve users' safety and bring Wellington's transport network into line with current standards. Tunnels are major items of infrastructure which may remain in service for long periods. Wellington Tunnels Alliance vision is "smarter tunnels for the 22nd century", and the refurbishment will help Wellington's tunnels meet their users' needs over the next few decades, and maintain their utility into the future. WRITER **Juliet Palmer**

Work on the tunnel is undertaken at night; traffic is diverted so work can continue from the early evening until morning. Image courtesy of NZTA.