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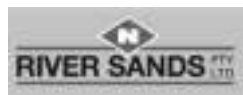
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**Cover photo:**

Legacy Way conveyor tunnel and TBM – courtesy of TransCity

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# Chairmans Foreword

Dear Members welcome to another Journal full of news on our industry. I'm sure you will find much of interest.

The ATS continues to work on your behalf, we have just decided on the dates for our next Tunnelling Short Course to be held in Melbourne, you'll find details later in the Journal. The state groups continue to arrange excellent technical sessions which are not only of great interest but can contribute towards your professional development.

All the talk at present seems to be about the North West rail link in Sydney with its 15kms of tunnels between Bella Vista and Epping, the longest rail tunnel ever constructed in Sydney. This is seeing a lot of our members moving their focus from Brisbane down to Sydney, let's hope everything runs smoothly and we are kept busy in the near future.

Notwithstanding the current list of projects on the drawing board there is still real concern about having enough ongoing work to keep our skill base here in Australia. We have already lost some good people to the high levels of sustained tunnelling activity in places like Hong Kong and Singapore and it will become increasingly difficult to tempt them back on a project by project basis.

This year's World Tunnel Congress is being held quite close to home in Bangkok. Due to its proximity I hope to see a strong contingent of ATS members. We need to keep in touch with the world scene not only to learn from them but to tell them what we are up to. The recent Tunnelling awards in Hong Kong featured a number of Australian projects so we do have something to share. I would also encourage ATS members to get involved with the International Tunnelling and Underground Space Assoc. (ITA) working groups as a way of keeping abreast of the latest developments and thinking.

**Simon Knight – Chairman**

## EDITOR'S NOTE

A recent poll to seek out members views of the current Journal format seemed to indicate general approval although many of you expressed that you would like to see more technical articles. Well this is all in your control, I am always keen to publish members articles on their current work so please start sending them through so that we can up the technical content of our Journal. I will of course continue to publish any news items you send me as well.

**David Lees**  
**ATS Journal**  
**Editor**



# THE DAVID SUGDEN YOUNG ENGINEERS WRITING AWARD 2012

**SPONSORED BY ATS**

**Win a chance to attend the 2013 ITA World Tunnel Congress in  
Geneva, Switzerland with accommodation**

- The competition is open to all ATS Members and University Students under 35 years of age (as at 30 June, 2012)
- The task is to write a technical paper on any subject related to tunnelling and underground construction — not less than 2,000 words and not more than 5,000 words.
- Best paper to be judged by the ATS Executive Committee.
- Closing date 30th June 2012
- Winner announced by 31 August, 2012
- The prize includes complimentary conference registration fees and \$2,000 towards personal travel and accommodation costs at the ITA World Tunnel Congress to be held in Geneva, Switzerland from 10–17 May 2013.

The winner may also have the opportunity to join the ATS Executive Committee as the Young Engineers Representative.

---

**For more information contact Sheryl Harrington at the ATS Secretariat  
Phone 1300 653 113 — Email: [sharrington@engineersaustralia.org.au](mailto:sharrington@engineersaustralia.org.au)**



# Legacy Way Tunnel

## Project background

**L**egacy Way is one of Australia's largest infrastructure projects, comprising of twin 4.6 kilometre two-lane tunnels which will run between tunnel portals located in Toowong and Kelvin Grove, Brisbane. The \$1.5 billion Legacy Way project is a key part of Brisbane City Council's TransApex plan, designed to reduce traffic congestion on Brisbane's arterial roads and improve cross city connectivity

Transcity has been selected as the consortium to design, construct and operate Brisbane's newest road tunnel. Transcity is an integrated team comprising of Spanish tunnelling and civil infrastructure company Acciona, together with Italian tunnelling company Ghella and Australian company BMD Constructions.

Acciona, one of Spain's largest corporations, is a global leader in infrastructure, renewable energy and water resource management and operates in more than 30 countries. Globally recognised for expertise in tunnelling, Acciona has over 30,000 employees across five continents. In Australia, Acciona Energy has built two major wind farms and is actively working to deliver major solar power projects. Acciona Agua is part of a consortium selected to design, build and operate South Australia's first major desalination plant at Port Stanvas, near Adelaide.

As a privately owned Italian company, Ghella demonstrates expertise in tunnelling work around the world. With more than 4000 employees operating in 14 countries, Ghella brings vast tunnelling and construction experience to the Transcity project team. With over 70km of tunnels excavated globally over the past five years, Ghella's work portfolio is extensive. Recent projects include Puerto Cabello – La Encrucijada railroad and subway lines in Valencia, Spain and Caracas, Venezuela; the Maldonado water tunnel for the city of Buenos Aires, Argentina, and; the San Ruffillo high-speed railroad project for the underground crossing of Bologna, Italy.

Brisbane-based construction company, BMD Constructions, is a privately owned company that has been operating for more than 31 years. BMD Constructions has over 1000 employees and operates in all states and territories of Australia. Recent and current projects include the \$824m SAFELink Alliance in Brisbane, the \$270m Sunbury Rail Electrification Alliance in Melbourne, and the \$100m Dalrymple Bay Coal Terminal 7 X Expansion near Mackay, North Queensland.

Entering the second year of construction on Legacy Way, Transcity Project Director Fernando Vara said the team was on schedule to commence tunnelling in 2012.

"Transcity is progressing well with worksites at each tunnel portal currently preparing for the start of tunnelling in mid-2012," Mr Vara said.

Transcity will use two Herrenknecht Double Shield Tunnel Boring Machines (TBM) to excavate the 4.6 kilometre-long tunnels from the Western Freeway at Toowong to the Inner City Bypass at Kelvin Grove. These machines are well suited for the excavation of long tunnels in hard rock, which is the predominant ground condition along the Legacy Way tunnel alignment.

"Due to the geological conditions under Brisbane's inner west, we anticipate our tunnelling journey will last approximately 12 months," said Mr Vara.

Originally used for tunnelling Brisbane's Clem7, these machines have been recycled and refurbished in Australia allowing both significant cost and time saving. While the outer structural shell, support gantries and cutter heads have remained in Australia, Herrenknecht has manufactured new hydraulic and electrical systems and a new main drive for use on Legacy Way's TBMs.

Mr Vara said recycling the machines would provide a time saving of six months and a significant cost saving across the project.

"In addition to the cost savings in recycling the Clem7 machines, there has also been a significant time benefit in allowing Transcity to commence tunnelling earlier than if we had procured new TBMs," Mr Vara said.

"Recycling allows the TBMs to be commissioned locally in Australia instead of Germany before disassembly and delivery to our western worksite at Toowong. These TBMs have a proven performance in local Brisbane conditions," he said.

During construction of Legacy Way, approximately one million cubic metres of solid material will be excavated from the twin tunnels. Traditionally, spoil is transported via haulage trucks to off-site storage locations, however, Transcity has refined the original design of an above ground conveyor system to create a tunnel conveyor system, minimising noise and dust impacts on the local Brisbane community.

This innovative solution will minimise the traditional impacts of truck movements through local streets, where the spoil from the tunnel excavation will instead be transported underground to the Mount Coot-tha Quarry, adjacent to the western worksite at Toowong. The spoil conveyor will be approximately 870m in length, of which



approximately 530m will be underground. This is less than half the length of the proposed overground conveyor, and will vary in depth between 15m and 35m.

The refined design of the conveyor provides some significant benefits:

- The spoil will be fully enclosed while travelling on the conveyor, decreasing dust impacts to the surrounding community
- Less vegetation clearing is required than with the overground conveyor
- Decreased noise impacts during operation as the conveyor will be underground
- Material will be transferred in one movement on the conveyor from the tunnel to its ultimate destination in the quarry
- A lower drop-off point in the quarry compared to the original design, further decreasing dust impacts as spoil is placed within the quarry

In November 2011, Transcity began construction of the spoil conveyor tunnel from the Mt Coot-tha Quarry. Once constructed, it will operate 24 hours a day, seven days a week in line with TBM operations.



### Legacy Way Visitors' Centre

The Legacy Way Visitors' Centre provides the community with a 'behind the scenes' look at the Legacy Way tunnel.

The state-of-the-art centre represents a new standard in education and learning and provides up-to-date project information and activities catering for both young and old.

Visitors can learn about the whole process of tunnel construction, from planning to completion via digital touch screens, construction animations, environmental management information and interviews with key project leaders. Information about the construction methodology Transcity is using to deliver the project is also available.

With free admission and free on-site parking, the Legacy Way Visitor's Centre is open from 10am to 6pm Monday to Friday, and 10am to 1pm on Saturdays.

### Why Legacy Way?

Legacy Way has been named in honour of Legacy, a not-for-profit organisation which supports Australian Defence Force servicemen and women and their families.

Once Legacy Way opens, Brisbane City Council will donate one cent from each toll to Legacy, which is expected to raise \$600,000 in the first five years of operation.

### Legacy Way Fast Facts

- TBM names
  - TBM 1: Annabell (named in honour of Annabell, daughter of fallen digger Lance Corporal Jared MacKinney)
  - TBM 2: Joyce (named in honour of WW2 Prisoner of War, Joyce Tweddell)
- Length = 110 metres (almost equal to the length of a football field)
- Weight (each TBM)= 2,800 tonnes
- Diameter = 12.4 metres (approximately the same size as a four-story building)
- Number of crew for operation = 22
- Progress per day = approximately 15 metres along the tunnel alignment
- Amount of spoil excavated from the two tunnels = over 1 million cubic metres
- Cost saving for recycling TBMs used on Clem7 = \$300 million
- Spoil and conveyor belt at the western end of the project will allow for 96,000 less truck movements, reducing the impacts of construction on the local environment and community



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## Legacy Way Conveyor Tunnel

**F**rom early October 2011 work began to construct a conveyor tunnel to transport excavated spoil material from Legacy Way's two tunnels to Mount Coot-tha Quarry. The spoil will be placed in an unused section of the quarry.

### Conveyor tunnel alignment

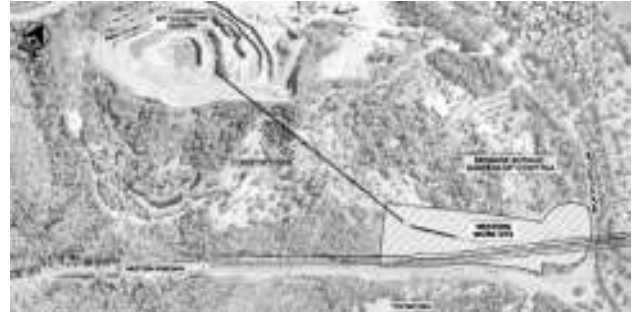
The conveyor tunnel design will minimise the impact on the surrounding residents and the environment. No additional bushland clearing is required to build the conveyor tunnel – saving two hectares of trees. The alignment provides the straightest and shortest route for the spoil material conveyor from Legacy Way's mainline tunnel to Mount Coot-tha Quarry.

The conveyor route has been shortened from 1,750m to 870m, of which approximately 560m will be underground. This will significantly reduce noise and dust levels.

This route provides significant environmental and community benefits through reduced tree clearing, truck haulage, noise, dust when compared to the previous overland conveyor proposal.

### Construction

The spoil conveyor tunnel will be constructed using traditional tunnelling methods involving excavation works followed by underground drilling and controlled blasting.



The tunnel will be constructed between 11.5 and 52 metres below ground between the western worksite and the Mount Coot-tha Quarry.

Construction of the new spoil conveyor tunnel will take approximately six months to complete. Barriers will be placed at the tunnel entrance to mitigate noise and dust from the underground drilling and blasting.

Blast curtains will be used during blasting activities at both the western worksite and the quarry to reduce noise. Vibration levels occurring from construction activities will be continuously monitored and recorded.

### Operation

Once constructed, the spoil conveyor tunnel will operate 24 hours a day, seven days a week in line with tunnel boring machine operations.

Spreading and compacting of the tunnel spoil within the Mount Coot-tha Quarry will occur during the quarry's current operating hours.

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## Tunnel under Perth waterfront

**S**tate Liberal MP John McGrath wants a tunnel built under the Government's Perth Waterfront project amid concerns that the proposed downsizing of Riverside Drive will cause traffic snarls in his South Perth electorate.

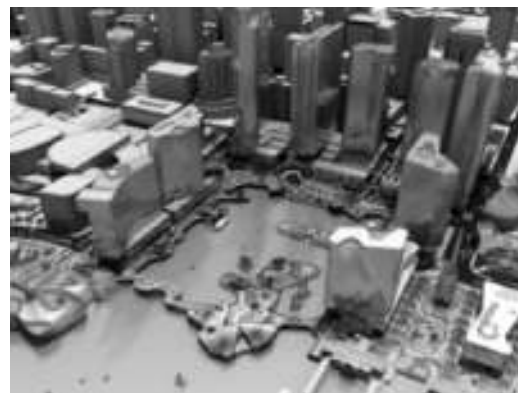
Mr McGrath said that though he supported the project, which will see a river inlet cut into the Esplanade and new developments on its perimeter, he was worried about how a downsized Riverside Drive would cope with the 30,000 vehicles a day it carries.

"We should seriously look at putting a tunnel underneath the water when the inlet is developed," Mr McGrath said. "I honestly believe, and the residents of South Perth believe, the traffic consequences as a result of closing Riverside Drive are going to be quite serious."

He said most of the traffic on Riverside Drive was traffic bypassing the city and if the road became a bottleneck, drivers from Victoria Park and surrounding suburbs would use suburban streets through South Perth, not Riverside Drive and the Causeway. It would be cheaper to build a tunnel while the inlet was being excavated.

Planning Minister John Day said the construction of a tunnel was not in the Government's plans and could add \$300-\$400 million to the project's cost. "However, that will still be possible in the future if a government decides it's necessary," he said. "We don't think it's necessary."

Mr Hyde questioned the project's proposed budget, saying there was no transparency about how the Government could be assured it would make its projected \$170 million from land sales.





## AIRPORT LINK UPDATE

**O**ne of the longest and largest infrastructure projects ever built in Australia is just six months away from completion. The project is now more than 95 per cent complete and remains on schedule for completion by 30 June 2012.

Underground the mechanical and electrical fit out of the tunnels is well underway, while on the surface support facilities are being removed to make way for landscaping as reinstatement takes shape across the project's alignment.

Since November 2008 the project has:

- Spent \$3.75 billion building Airport Link, the Northern Busway (Windsor to Kedron) and the Airport Roundabout Upgrade
- Created 4,500 jobs at peak with more than 3,300 people still employed
- Bored and lined 15 kilometres of tunnel and ramps
- Constructed 25 bridges
- Poured more than 800,000m<sup>3</sup> of concrete
- Upgraded hundreds of kilometres of water, power and sewer services
- Distributed more than 1 million notifications to local residents and businesses
- Provided more than 500 individual mitigation treatments for nearby residents

Airport Link, which is being designed and constructed by Thies John Holland, along with the Northern Busway (Windsor to Kedron) and the Airport Roundabout Upgrade, is part of a massive \$4.8 billion infrastructure investment on Brisbane's northside. The Airport Link will reduce traffic on the local roads, as well as main arterials, by providing divers with the option of a quick and efficient trip to and from the CBD and the Airport. When it opens

next year, it will allow motorists to drive between Bowen Hills and Toombul in less than five minutes, avoiding 18 sets of traffic lights along the way."

### Airport Link health and safety audit

Construction on Australia's longest road tunnel ground to a halt on 30th September 2011 because of health and safety concerns.

A man was struck on the head with a beam the day before and subsequently died. Unions demanded a health and safety audit in the wake of the death, but also because of ongoing issues with the construction site.

Electrical Trades Union spokesman Peter Ong said the site was inspected by union officials, representatives of construction company Thies John Holland and the health and safety officers.

All workers were paid while the audit was being conducted and Mr Ong said he was pleased with the co-operation of Thies John Holland.

The \$5.6 billion Airport Link, Australia's largest road infrastructure project, is due to be completed by mid-2012.

It will connect the Brisbane's central business district with the Clem Jones Tunnel and the East-West Arterial Road which leads to the Brisbane Airport.

The tunnel project, part of a major new toll road, will remove up to 18 sets of traffic lights for motorists travelling from the CBD to Brisbane Airport, reducing travel time by up to 50 per cent, the government said.

It will be the longest road tunnel in Australia, with 5.2km of its 6.7km-length underground.



## Perth City Link tunnelling under way

**W**ork on the Perth City Link took a major step forward with a ceremony to mark the start of tunnelling that will sink the Fremantle train line west of the Horseshoe Bridge. The project will transform the city of Perth

Premier Colin Barnett said the \$360m rail component, on track for completion in 2014, literally underpinned the delivery of the entire Perth City Link vision. "The Perth City Link will fundamentally change the face of Perth and benefit both local people and visitors to our city through reconnecting the CBD and Northbridge for the first time in 100 years," Mr Barnett said.

"This project is expected to attract more than \$3bn of private investment into our State and play a vital role in establishing Perth's reputation as a world-class city. With the Perth Waterfront, Riverside Development, the Perth Cultural Centre and new Perth Stadium, the Perth City Link is part of an era of transformation and I hope all West Australians embrace and enjoy these exciting changes.

Transport Minister Troy Buswell said there would be a number of upgrades to Perth Station, including a new pedestrian underpass, linking all platforms to Perth Underground Station, and a new platform on the Roe Street side. "This project will significantly improve passenger amenity and cater to Perth's growing public transport needs – it will give our 44,000 city station patrons improved connections, better access and faster transfers between services," he said.

"The new platform on the Roe Street side of Perth Station will ensure the Public Transport Authority has greater flexibility to service special events, meet future demand and accommodate new projects like the stadium in Burswood."

## Funding for Maldon to Dombarton Rail Link

**T**he Illawarra region's long awaited Maldon to Dombarton Rail Link has moved from "possible to probable", as the Prime Minister announced \$24.5m in federal funding to progress the project. The Maldon to Dombarton Rail Link would provide more direct access to Port Kembla

The funding would see the preparation of detailed design work for civil, structural, geotechnical and track work commence this financial year, as well as a "realistic" construction timetable and project cost estimate.

The link would involve laying 35km of standard gauge track connecting the Main North South Line directly to Port Kembla via Dombarton, two passing loops, bridges over the Nepean and Cordeaux Rivers and one of Australia's longest tunnels.

Julia Gillard's announcement follows the release of a feasibility study for the project which found the rail line would support New South Wales' resources sector by providing more direct access to Port Kembla. The study found the railway line would also free up capacity along the existing Illawarra Line for additional passenger services.

The government said the funding would see the project become "shovel ready" and once pre-construction activities were completed the project would be considered for inclusion in the government's next *Nation Building Program*. The government's current \$36.2bn *Nation Building Program* covers a six year period from 2008–09 to 2013–14.

The Maldon to Dombarton Rail Link has been talked about for over 30 years. First mooted in 1979 and then cancelled in 1988 by the incoming Liberal Government, the link has the potential to further cement the Illawarra's importance as an "industrial powerhouse", the government said.



# M2 UPGRADE

**S**tart of major tunnelling widening works in the eastbound Norfolk tunnel. The Norfolk Tunnel is being widened to provide three lanes and a breakdown lane in each tunnel tube. This major program of work is expected to take approximately two years to complete.

Noise reducing curtains have been installed at both ends of the eastbound tunnel in preparation for widening work. These curtains are made of sound absorbing material and cover each end of the tunnel to reduce construction noise impacts on the surrounding residences. The curtains are open during the day and closed at night when work is being carried out

To help the flow of traffic during the weekend work in the Norfolk Tunnel, westbound clearways are put in place along sections of alternate routes.

Excavation work in the citybound tunnel started Saturday 5 November and will continue until mid 2012. Weekend excavation work is carried out in addition to the ongoing weekday nightwork.

During these times the citybound tunnel is temporarily closed and traffic is diverted to the westbound lane between Beecroft Road and Terrys Creek Bridge with at least one lane will open in each direction and two citybound lanes available on Saturdays and Sundays, during the daytime.



## Thiess wins \$140 million Sydney cable tunnel contract

**T**hiess has won a \$140 million contract from Ausgrid – Australia’s largest electricity distributor, to deliver the 132kV City East Cable Tunnel (CECT) in Sydney.

At around 3.2km-long, the segmentally-lined, 3.5m diameter tunnel will connect the existing City North substation in Sussex Street to a new substation in Riley Street, Surrey Hills.

Thiess managing director Bruce Munro welcomed the contract as a further endorsement of the Thiess diverse portfolio of tunnelling achievements.

“From our pioneering role building the tunnels of the Snowy Mountains scheme to major road and service tunnels, Thiess is proud to be working with Ausgrid to deliver this vital electricity infrastructure,” Mr Munro said.

This new contract for Thiess follows on the heels of its completion last year of Ausgrid’s City West Cable Tunnel (CWCT), said to have met the client’s expectations, particularly in the realm of safety.

Glen Ashton, Thiess’ general manager of tunnelling, said: “We had no lost time injuries during more than 820 working days and we look forward to delivering the same performance for Ausgrid on the new project.”

Also included in the CECT project is the construction of two concrete lined connectors, an extension to the City South Cable Tunnel, and installation and commissioning of all tunnel mechanical and electrical services.

The project is scheduled for completion in 2015.



## Barangaroo tunnel gap bridged

**T**he planned \$286 million pedestrian access to Barangaroo includes a 200m bridge because access to the waterfront is too steep for a tunnel.

The so-called Wynyard Walk will give 20,000 pedestrians every hour access from Wynyard Station to the \$6 billion Barangaroo waterfront development in “approximately six minutes”.

The steep incline to the water’s edge means the 110m tunnel can’t reach Barangaroo. Pedestrians will instead use a bridge that will stretch from the intersection of Margaret St and Kent St, adjacent to the Sussex Hotel, and down to the new precinct. Barangaroo developer Lend Lease cannot start leasing office space until the Wynyard Walk is complete, due to be in the third quarter of 2015.

“Due to Barangaroo’s location, topography, distance from Wynyard transport hub and the CBD’s congested road network, it is a challenging part of the city to reach,” the document stated. “Delivery of Wynyard Walk is a condition of consent for Barangaroo.” There was no way the tunnel could be built the entire length of the journey, a spokeswoman for the Transport Construction Authority

*The state government has set aside \$51 million for the project this financial year.*

said. “Keeping the pedestrian link underground all the way from Wynyard to Barangaroo would result in a deeper, longer tunnel with limited options for connecting to existing road and footpath networks and the western CBD precinct,” she said.

The new 3.5m-tall and 9m-wide pedestrian tunnel will provide “connectivity and capacity” to meet the demand of up to 20,000 pedestrians an hour by 2026. It will also include the operation of contra-flows – using lanes to direct pedestrians to one side during busy periods.

The state government has set aside \$51 million for the project this financial year.

## Arncliffe tunnel left out of budget

The state government has said it will deliver on its promise of a \$5 million pedestrian tunnel under the railway line at Arncliffe even though no funding was set aside in its first budget.

At present, pedestrians, including students at Al Zahra College, have to use a narrow pathway in the busy road tunnel which has roundabouts on both sides.

Temporary measures to improve safety at the site are being investigated until the pedestrian tunnel is built.

# Sydney north sub-transmission upgrade

**A**usgrid crews have completed the first stage of a multi-million dollar upgrade of the Sydney north sub-transmission network, using HDD to install cables under rail embankments.

The entire project saw over 40 workers, including cable jointers and substation technicians, install more than six km of 33,000 V cable between Ausgrid's Ku-ring-gai sub-transmission substation and its zone substations in St Ives and Lindfield.

During the installation, the cable needed to cross a major railway intersection so Ausgrid decided the best way to minimise railway and traffic disruptions was to employ the use of Trenchless Technology. Ausgrid's Energised Alliance contracted Infrastructure Construction for the No-Dig component of works.

Infrastructure Construction completed three 50m long microtunnels under a major railway line as part of the Ku-ring-gai sub-transmission substation to Lindfield Zone Substation Section of the cable, which was in the south stage of the project.

The company used a horizontal directional drill with a 450mm drill was used to create four separate cores in parallel, carrying a bank of six conduits each. The bore ran from Wolsely Road to Lindfield Avenue in Linfield. Crew worked for approximately a month, drilling at a depth of about 14m below railway line.

Grouting of the bores was carried out by GFWAust using special low thermal rating grout, mixed and placed on site.

Crews have now begun the second stage of the \$A40 million set of works including the upgrade of the existing 132/33 kV Ku-ring-gai STS and a re-fit of the 33/11 kV Lindfield zone substation.

Ausgrid General Manager Transmission Trevor Armstrong said the existing Ku-ring-gai STS and Lindfield zone substation had served the local community well for almost 50 years but were now approaching the time for renewal.

Ausgrid crews are expected to complete the upgrade of the Lindfield zone substation in late 2012.

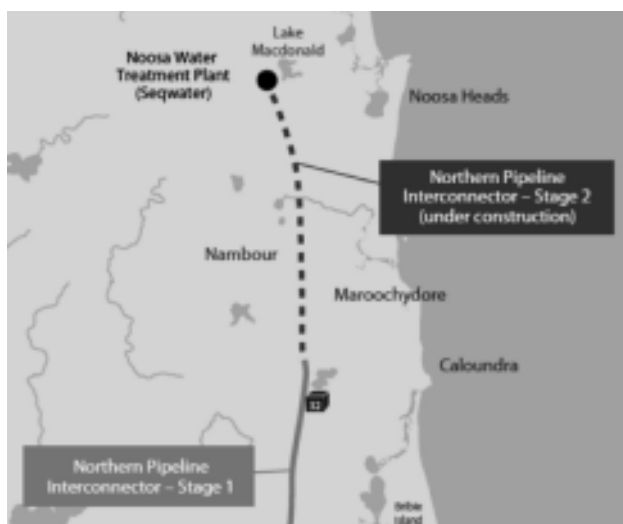
Work on the Ku-ring-gai STS is scheduled to begin this year and is expected to be complete in 2014.

The upgraded substations and new sub-transmission cables will help improve the reliability of power supply to more than 45,000 homes and businesses in St Ives, Pymble, Turramurra, Chatswood, Warrawee, Lindfield, Killara, Roseville, Gordon, Ku-ring-gai and Wahroonga.



*The entire project saw over 40 workers, including cable jointers and substation technicians, install more than six km of 33,000 V cable between Ausgrid's Ku-ring-gai sub-transmission substation and its zone substations in St Ives and Lindfield.*





## Northern Pipeline Interconnector – Stage 2

**M**cConnell Dowell, as part of the Northern Network Alliance (NNA), was awarded the contract for the Northern Pipeline Interconnector – Stage 2 (NPI) by LinkWater. The NPI – Stage 2 is a vital piece of infrastructure designed to help secure the water supply for South East Queensland, including the Sunshine Coast. The works include planning, design, construction and commissioning of approximately 48km of underground, reverse-flow pipeline which will connect the existing NPI – Stage 1 at Eudlo to the Noosa Water Treatment Plant at Cooroy.

The works also include the construction of a balance tank, pump stations, a water quality facility and augmentation to existing facilities.

The pipeline combines both trenching and microtunnelling technology to traverse the 48 km. The key component of the tunnelling scope of works was the design and construction of the Pringle Hill Tunnel.

### Pringle Hill Tunnel

This tunnel was by far the most challenging and was one of the key milestones on the project's critical path. McConnell Dowell's tunnelling team was responsible for the delivery of the Pringle Hill Tunnel.

Initial planning considerations included the following:

- The tunnel alignment and diameter would have to accommodate a 1.29m outside diameter carrier pipe throughout the tunnel length.
- The tunnelling system had to be capable of achieving a single drive length of 1,032m through the vertical curve.

- The tunnel had to negotiate the mountainous sandstone outcrop and a gully formation, resulting in a vertical difference of 63m between the launch and receive ends of the tunnel.
- The site investigations identified significantly varying ground conditions, ranging from residual soil to high-strength, cemented sandstone.

The geological investigation provided the required information for optimum machine selection and slurry system.

Considering this, microtunnelling technology was the preferred solution for the Pringle Hill Tunnel, using a 2.57m outside diameter slurry tunnel boring machine (TBM), which was selected due to its ability to tunnel the distance and to negotiate the considerable vertical geometry. Reinforced concrete jacking pipe was selected to line the tunnel (each 3m long and 2.1m internal diameter).

### Shaft design

The shaft design for the Pringle Hill launch site presented a challenge as it had to accommodate the installation of a 13.5m long carrier pipe, and it also had to have the capacity to resist a thrust reaction force of 1,400 tonnes from the pipe jacking system.

The optimum shape for such a shaft was an ellipse, which due to its circumferential load distribution proved most effective in terms of ground support requirements.

The shaft was originally designed with a thrust wall to the rear of the shaft capable of resisting the 1,400 tonne thrust force.

However, later it was discovered that the ground at the rear of the shaft was unsuitable for resisting this design thrust reaction force. The solution was to transfer the loading into the base of the shaft, as opposed to the conventional method of transferring the load through the thrust wall to the rear of the shaft.





The tunnel alignment has a length of 1,032m in a straight line on the horizontal plane, while in the vertical plane the first 40m was level, followed by a large vertical curve of 8,000m radius with a maximum grade of 9.7 per cent towards the end of the drive. A series of intermediate jacking stations were implemented at 100m intervals throughout the length of the tunnel to reduce the risk associated with rising jacking forces while tunnelling through the vertical curve.

Other considerations which had to be addressed were mechanisms to control the return of the slurry from the slurry lines during the pipe change operations, the logistics of accessing the length of the tunnel for cutter tool changes and maintenance, and ventilation requirements.

The TBM achieved an average productivity rate of 7.5m per shift. This productivity varied depending on the geology and the distance from the launch shaft. The maximum distance achieved in any one shift was 17 m. At the peak of the production advance rate was approximately 9m per shift. The installation of the interjack systems slowed down production, with each interjack taking on average 4.5 hours to install.

In areas where sandstone was predominant, the pressures and excavated materials were monitored to ensure that the cutter tools were performing as expected and inspections could be carried out and changes performed when necessary.

## Breakthrough

Breakthrough was achieved in November 2010 with high accuracy; the drive was less than 50mm off the target point in both the horizontal and vertical planes.

The carrier pipe operations also required careful planning and design to overcome the issues that existed due to the distinctive tunnel characteristics. Considerations included:

- Support mechanism for the 1.29m external diameter mild steel cement mortar-lined (MSCL) pipe within the 2.1m internal diameter enveloper pipe.
- Logistics for the fitout of the tunnel over the 1,032m distance.
- Creating two complete and intact fibre optic conduits over the length of the tunnel.
- Pushing the pipe through the 8,000m radius vertical curve and the additional forces required to push the carrier pipe up the considerable grade.
- Ensuring the MSCL pipe itself was capable of negotiating the vertical curve.
- A mechanism to provide a secondary means of pipe restraint to mitigate the pipe string's tendency to move downgrade during the retraction of the push frame.

The pipes used were 13.5m long, 1.29m in external diameter with a 10mm wall, 2.3mm Sintakote coating and 19mm cement mortar lining. The support mechanism for the carrier pipe combined the use of nylon rollers and steel head restraints. The rollers were spaced at 2m centres and the head restraints at 6m centres. Carrier pipe installation was conducted on a ten shift per week basis.



## Grouting

The key considerations in the planning of the grouting operations were:

- Eliminating the effects of the grout pressure on the exterior of the carrier pipe
- Design and construction of a restraint to hold the carrier pipe when full of water during the grouting operations
- Construction of an annulus bulkhead of sufficient strength to restrain the expected grout pressure
- Logistics of completing the pour from the launch shaft under static head pressure
- Managing bleed water from the grout pour.

The total grout pour consisted of 2,338 cubic metres. With 4.8 cubic metres loads, this equated to 487 trucks. The grout pour took place in four stages.

The first pour was 1,000 cubic metres, the second pour was 930 cubic metres, the third pour was 380 cubic metres and the fourth and final pour was a top-up pour from the reception end and was only 28 cubic metres.

## Conclusion

The Pringle Hill tunnel is an integral component of the NPI project, as it connects the pipeline through a mountainous sandstone outcrop impassable to surface trenching due its challenging topography.

The 2.1m internal diameter tunnel is distinctive on this project, due to the length (1,032 m), the elevation difference between the ends (63 m), and the large volume of grout required to fill the annulus around the 1.29m external diameter carrier pipe.

Despite the challenges encountered, the experience and capability of McConnell Dowell's team addressed each of the challenges and adopted solutions to achieve the safe and productive delivery of the Southern Hemisphere's longest microtunnel.

The successful completion of the Pringle Hill Tunnel was an important milestone for the project, and ensured that the critical path was achieved to tie in with the pipelaying.

# Light rail tunnel for Surry Hills

**T**he state government faces a judgment call over whether to build a light rail tunnel under Surry Hills or a cheaper but slower surface link between the eastern suburbs and the city. Transport planners working on the city's light rail expansion expect the tunnel option to be about seven minutes faster for commuters travelling through Surry Hills. That would be a significant advantage in travel time for anyone using the line to get between Central Station and Anzac Parade and Randwick.

But the faster route would be offset by a significantly higher cost. The tunnel to the eastern suburbs could cost about \$100 million. This would contradict the ethos of light rail as a relatively cheap and simple improvement to transport in the eastern suburbs. It would also make it harder for people in Surry Hills to use light rail. The suburb would in effect be bypassed unless expensive underground stops were built.

The Premier, Barry O'Farrell, has said he would expect to start work on another light rail expansion project in this term of Parliament. His government has already released a list of preferred routes for tram lines through the city centre, to the eastern suburbs and around Sydney University. The city-centre route would run down George Street. An eastern suburbs route would run down Anzac Parade and link to Central Station either underground or above ground through Devonshire Street or another Surry Hills street.

Engineers working for the Transport for NSW project team are looking at the feasibility of the tunnel or surface routes. The government has told industry it expected to finalise a light rail expansion plan by the middle of this year.

The mayor of Randwick, Scott Nash, said: "A tunnel option, while more expensive, would provide a much faster link, which would be welcome news for University of NSW students, Randwick commuters and tens of thousands of cricket and footy fans."



## Sydney Opera House receives new pipes

**S** Sydney Opera House is well under way with a \$152m project to divert delivery vehicles underground and away from conflicts with visitors to the iconic building. Phase one of the NSW Government funded Vehicle Access and Pedestrian Safety project, was let to Seymour Whyte (see picture). It involves diverting the Bennelong drain, a stormwater drain which runs across the Opera House forecourt, serving part of the Sydney CBD.

Geotech investigations indicated substantial sandstone on the forecourt site including the remains of a sandstone quarry used to build Macquarie Fort. This part of the project will run concurrently with podium waterproofing to be seen underway on the Opera House steps in the middle ground of the picture.

The project, managed by the Sydney Opera House building development and maintenance team, is the biggest building project at the Opera House since the building opened in 1973.

The second phase of the project will involve excavating a new access road and loading dock under the forecourt and vehicle concourse and remediation of the existing road to remove kerbs (or "curbs" as an Opera House news release put it) that regularly trip and injure pedestrians.

A ramped access tunnel to the dock would be located below the SOH building and forecourt. A ramped access tunnel, starting about 20m east of the Macquarie St roundabout, will lead to a four truck capacity dock under the forecourt. It will be aligned with the curve of the sandstone Tarpeian Wall at the southern side of the forecourt against the northern boundary of the Royal Botanic Gardens.

The ramp tunnel will be built using cut and cover for most of its length. About 25m at its junction with the loading dock, will be excavated using a TBM so as not to compromise the structural stability of the foundations, to the monumental stairs directly above the tunnel/dock junction.

Most of the loading dock will be under the existing vehicle concourse. Underlain by pre-stressed concrete tie beams which tie the southern extent of the monumental stair beams to the southern structure of the OH, these beams are critical to the safety of the existing OH and must be retained.

It is proposed to excavate under the beams and existing basement areas. During excavation the rock will be cut vertically using a rock saw to minimise horizontal noise and vibration through the rest of the site.

# Gladstone tunnel construction tender

**T**he Arrow Energy Liquefied Natural Gas Project on Curtis Island, Queensland, will soon be requiring construction services to build a coal seam gas transportation tunnel.

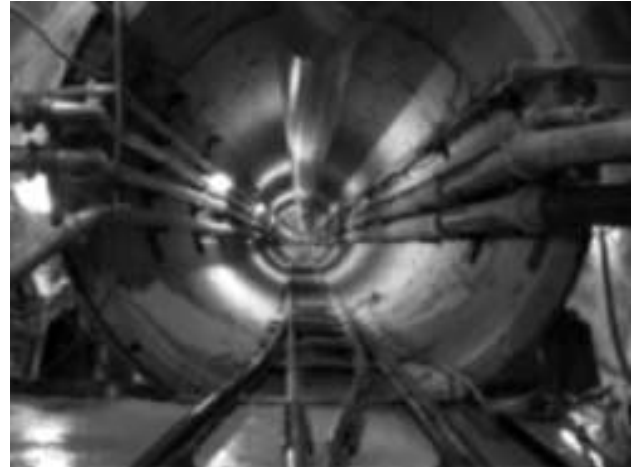
Following Arrow Energy awarding engineering consultancy group Arup a tender for tunnel design, the tender for the tunnel's construction is soon to be released.

The 6km tunnel will have a 4m internal diameter, and house high pressure gas pipeline and other utility services, as part of Arrow's multibillion dollar liquefied natural gas project on Curtis island.

The tunnel's concept will be designed by the Brisbane office of Arup, who will prepare concept design and tender documentation, which will lead to the tender process for the tunnel's construction contract.

Arrow Energy Chief Executive Officer Andrew Faulkner said Arup would begin work immediately on the tunnel's design and specifications.

"The tunnel will have a smaller footprint than if we were to construct a pipeline on the seafloor. There will be



entrance and exit points, but no overwater construction," Mr Faulkner said.

Excavated approximately 35m beneath the Gladstone Harbour seabed, the tunnel entrance will be located in Gladstone's Yarwun area and the exit will be at Hamilton Point on the southern end of Curtis Island. The entire route runs through stable rock.

The tunnel to Curtis Island will be one of the longest offshore tunnels in Queensland and will take approximately three and a half years to build and fit out.

"Australia has a number of experienced tunnelling contractors so we are confident the tunnel will be built to the highest standard," Mr Faulkner said.

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# Sydney sewer rehabilitation a success

**E**ptec has successfully rehabilitated 370m of oviform sewer pipe in the Ultimo Road Carrier as part of Sydney Water's \$A560 million SewerFix program.

Completed in April 2011, the over 100 year-old sewer presented numerous challenges due to its location. Running in close proximity to key Sydney city structures and infrastructure, including the Powerhouse Museum, the light rail corridor, and UTS, the project required a great level of skill for safe and successful completion.

Several major requirements underpinned the project:

- Design, supply and installation of a self-supporting structural liner consisting of a GRP DN600 pipe with a minimum stiffness requirement of SN32,000.



- Hydraulic jacking of pipes in both directions from a centrally-located 6m deep launching pit.
- Jointing of GRP pipes with a flush rubber ring and collar system.
- Watertight connection of the live junctions, despite a total prohibition of any man access into the 600mm diameter GRP liner.
- Injection of a specifically designed grout between the oviform and new GRP liner to ensure it wouldn't 'float'.

## Sewer access

Entry access over the full sewer length was crucial for the detailed survey and clean-up required, however the restrictive 1,220mm high by 810mm wide oviform sewer made access difficult.

Eptec overcame this access restriction by designing and constructing of a series of trolleys to travel along the oviform. The company also designed a hydraulic pipelaunching system capable of jacking GRP pipe in a continuous line of up to 180m within the sewer.

**Minimising impacts** Minimising environmental impacts required careful planning and management, and saw the company install a failsafe continuous flow bypass system along the 370m section of pipe lined. A ventilation system compliant with stringent noise limitations was also installed. Excavation and removal of highly unsuitable soil from the launching pit excavation, and de-silting and removal of hazardous and malodorous material from the sewer was also required.

Eptec liaised closely with key stakeholders over the course of the project, with the most affected stakeholder, the Powerhouse Museum, commending Eptec for creating 'minimal impact' and maintaining the surrounding area to the highest safety and environmental standards.

Sydney Water's performance appraisals and audits on safety, quality, environmental and community relations confirmed that Eptec demonstrated a very high level of technical expertise throughout the course of this successful project.

## Footscray road tunnel link

**A** plan to build a tunnel under Footscray and a freeway connection to the Western Ring Road is tipped to be revived. The Victoria state government will put submissions for funding its major projects to Infrastructure Australia and it's likely to include an east-west freeway connection linking the Western Ring Road and the Eastern Freeway.

The idea was first proposed in a 2008 report by Infrastructure Australia chairman Sir Rod Eddington. The section from the ring road to Dynon Road via a tunnel under Footscray was supported by the former Labor government and badged WestLink.

Also rumoured to be part of the submission is a metro rail tunnel from Footscray to St Kilda Road. LeadWest CEO Anton Mayer said a second river crossing and

transport corridor was vital to the economic development and liveability in the west, a point he raised with federal Infrastructure Minister Anthony Albanese.

"We regard the second east-west corridor as a real game-changer," Mr Mayer said. "These [infrastructure projects] are the bits that are transformative for the west, as was the West Gate Bridge 40-odd years ago, as the Western Ring Road was and as the Regional Rail Link will be. "With the old WestLink, the concept of the tunnel coming out in Brooklyn was a real support for urban renewal. It [Brooklyn] is a piece of real estate that's strategically close to CBD Melbourne and one would think it's got a lot of appeal for a variety of applications."

# City Loop safety fears

**Serious structural problems in Melbourne's City Loop – including cracking tunnel walls, concrete corrosion and poor emergency systems – have been ignored by successive state governments and train operators despite repeated warnings.**

An investigation into the rail tunnel system has revealed that emergency exits are padlocked, with keys held only by station managers, not train drivers. The tunnels are also inadequately equipped for the disabled in the event of a train fire, with emergency walkways too narrow and 1.5 metres below the carriage doors.

A damning 2007 assessment of the loop's emergency infrastructure recommended major upgrades, including elevating the walkways, because evacuation would be

“very restricted”. Most of the recommendations have gone unheeded. A 2001 report revealed the loop was suffering from long-term structural corrosion caused by possible contamination of the original concrete mix.

Damage to concrete plinths was leading to “heavy corrosion” of steel reinforcements, potentially undermining the tracks. At worst, a derailment “must be considered possible”, said the report, commissioned by infrastructure contractor Thiess Infracore.

Transport Safety Victoria has also expressed concern about the 30-year-old loop, after receiving a letter of complaint from the train drivers' union. The letter, addressed to Metro and copied to the Coroner, said drivers had “grave concerns” about the operator's failure to address evacuation procedures.

The drivers say they are not trained for emergencies in the loop. Their occupational health and safety representatives issued Metro with a formal warning that will trigger a WorkSafe investigation.

Metro, which took over the rail system from Connex in 2009, said structural problems with the concrete would be addressed in a rehabilitation program starting in April 2012 and that 6125 sleepers would also be replaced as part of general maintenance. Metro states that two independent reports – one commissioned by government and one by Metro – had concluded that safety standards had been met. “The tunnel has been in safe operation for more than 30 years and, unlike many other underground railways, Melbourne is fortunate to have a walkway throughout the entire length of the City Loop. Once a decision is made to evacuate passengers from a train, the emergency plan is implemented and can be carried out very quickly.

The loop had been tested – including state-of-the-art smoke testing – and emergency exercises completed. “The department believes the potential for a train derailment in the rail loop is extremely low,” it said. “The emergency walkways located in the loop are subject to ongoing maintenance and repair.” Representatives from the government's insurance authority had recently inspected the walkways and found them in an “adequate condition”.

## The Bulimba Creek Trunk Sewer

**The Bulimba Creek Trunk Sewer currently services approximately 20,700 hectares of properties to the south east of the city using 62km of sewer pipes. This project will increase the capacity of the sewer system and cater for the region's growth.**

The upgrade works will extend from the DM Henderson Park to the north of Padstow Road, MacGregor and connect to the trunk main at Coora Street, Wishart, a distance of approximately 4.5km. The new sewer will run alongside the existing trunk sewer line which follows Bulimba Creek, located in the suburbs of MacGregor, Eight Mile Plains, Rochedale and Wishart.

Micro-tunnelling is the method being used to construct this new sewer, which will involve the excavation of a number of deep entry and exit shafts. The new sewer pipe will also need to be connected into the old sewer network at various locations and may involve some open trenching.

Construction started in March/April 2011 and is expected to take approximately 18 months to complete, weather permitting.

Construction to date has included the construction of temporary access roads, site preparation works and the development of excavation shafts to allow the micro-tunnelling machines to install pipes underground.

Micro-tunnelling started in September 2011 at Maisie Dixon Park, Goorari Street, Eight Mile Plains, Boyanda Street and Fulton Street, Wishart.



# Microtunnelling through the Sunshine State

**The newly established town of Pimpana has been connected to the existing Queensland wastewater network by an 820m microtunnelled pipeline.**

The new wastewater pipeline connection had to be microtunnelled in difficult ground conditions, with surface clay mixed with medium to hard sub-surface rock.

Furthermore, the route crossed under water bodies, infrastructure including roadways and existing residential zones and under areas of environmental sensitivity.

For the challenging project, HOBAS jacking pipe was contractor Rob Carr's choice due to its low risk properties. The contractors successfully installed 820m of DN 1400 HOBAS CC-GRP jacking pipe in multiple drives of almost 300 m. The maximum load was just 200 tonnes.

The project entailed construction of deep shafts and manholes, as well as installation of the DN1400 gravity sewer at grades as low as 0.1 per cent.

The project has brought the residents of Australia's Sunshine State a new and improved wastewater system.



## Züblin receives NCE International Tunnelling Award

**The NCE International Tunnelling Award 'Tunnelling Project of the Year' was awarded in Hong Kong last week to Züblin Australia.**

Züblin Australia received the award for its tunnel construction on the Southern Seawater Desalination Plant (SSDP), Western Australia.

The event was attended by over 250 of the world's leading figures in the tunnelling industry. The SSDP will provide 100 billion litres of drinking water a year, securing future water needs for communities stretching from Perth to the Goldfields.

After Western Australia Premier Colin Barnett's decision to double the capacity of the SSDP in August 2011, the plant has a new estimated completion time, with water delivery planned for December 2012.



## The History of Australian Tunnelling

**A colour publication by the Australasian Tunnelling Society**

Over 150 pages of unique Australian tunnelling projects from early 1800s to projects completed in 2009.

*The book is available from ATS Secretariat Sheryl Harrington at Engineers Australia for \$95 +GST*



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- Closing date 30th June 2012
- Winner announced by 31 August, 2012
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# United Undersea – Connecting the Tunnels to Marine Risers at the Victorian Desalination Project

By T Burns – Senior Project Engineer, Thiess Pty Ltd, Sydney

## ABSTRACT

The Victorian Desalination Project is being constructed near the town of Wonthaggi, in the South Gippsland region of Victoria, Australia. Construction of marine works began in January 2010 and was completed in June 2011. The marine works consisted of 4.0m internal diameter inlet and outlet tunnels, four marine risers and four tunnel to riser adit connections.

This paper describes the construction methodology used to connect the tunnels to the marine risers. Connection works included temporary segmental lining support, ground pretreatment, segmental lining breakout, adit excavation and ground support, riser dewatering, glass reinforced pipe installation and concrete encasement.

## INTRODUCTION

### Project overview

The marine works at the Victorian Desalination Project have been constructed to service the reverse osmosis desalination plant. The 1.2km long inlet tunnel supplies seawater to the plant and is connected to two inlet risers that are approximately 850m offshore in Bass Strait. The 1.5km long outlet tunnel discharges brine into the ocean and is connected to two outlet risers that are situated approximately 1200m offshore.

The tunnels were constructed using 4.74m diameter fully shielded slurry tunnel boring machines (TBM). A 230mm thick key, counter key segmental lining was installed as the TBM's progressed. The TBM tunnel invert level at the riser connection locations was approximately RL -42 m, with an estimated rock cover of 17 m.

The glass reinforced plastic (GRP) risers are 2.4m internal diameter and each has been grouted into a 3.3m diameter bored shaft. The design pillar width between riser and TBM tunnel was 3.6 m.

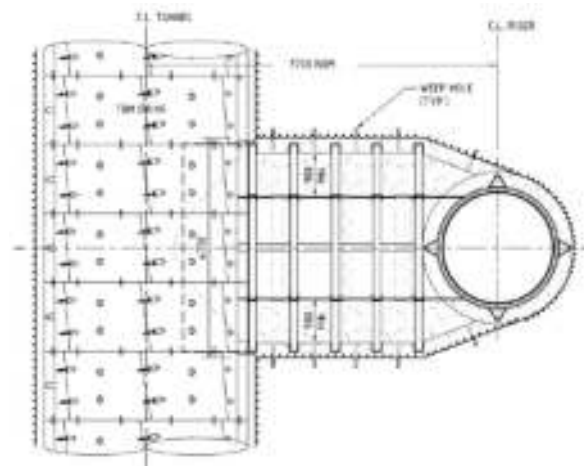


Figure 1: Plan of tunnel to riser connection.

The marine risers were installed and grouted into position prior to TBM excavation passing each riser location. The TBM gantries were removed from the tunnel and then the tunnel connections to marine risers were completed. The connections consisted of an adit excavation between the tunnel and the marine riser. See Figure 1.

### Challenges

The connections between tunnels and risers at the Victorian Desalination Project encompassed many challenges. Geographically, both the tunnel and the risers had to be constructed to the designed position, to avoid the major risk of one hitting the other during the construction phase. To a smaller degree, a misaligned tunnel or riser could have resulted in an overly long adit excavation, which the construction schedule did not allow.

Limited geotechnical information, particularly the lack of physical sampling from the final riser locations presented a significant challenge. The available information indicated the presence of a low to very low strength fine grained sandstone, with varying degrees of jointing and a potential fault zones. The design and construction team responded on a risk management basis, and pursued a ground support design to cater for the worst case geotechnical conditions that could be inferred from the available data.

The potential impacts of groundwater on excavation, ground support and overall stability had to be addressed. At the outset, geotechnical information indicated the potential for direct connectivity between adit excavations and the seabed. A grouting campaign was undertaken prior to excavation to combat the potential 4 bar of ground water pressure.

The confined nature of small scale tunnel works also presented the construction team with a challenge to select the correct equipment. The selection of plant capable of working within the confines of the excavation, but still powerful enough to complete the works was a key factor in the safety and success of the operation.

Lastly, the marine risers were filled with water as part of the construction methodology, so excavation operations had to be controlled to avoid an inadvertent release of approximately 200,000 L of water into the tunnel work area.

### TUNNEL TO RISER CONNECTION

The horizontal connections between the tunnels and each riser were made by excavating a 4.8m wide 4.7m high adit through the segmental lining and across to each riser. Excavation length was 4.5 m. Temporary structural steel rings and framing beams were installed around each future adit opening to resist loads induced from ground pressure, water pressure and grouting pressure. A grouting



campaign was undertaken prior to excavation in order to minimise potential ground water inflows into the excavation. Lugeon testing was undertaken post grouting then excavation commenced. The excavation was undertaken with hydraulic excavator and was temporarily supported by a primary shotcrete layer, steel sets and final shotcrete layer. The riser was exposed from the surrounding grout annulus and was subsequently dewatered. A penetration was cut into the face of the riser to receive the adit-riser GRP mating piece. The GRP liner was extended through into the TBM tunnel and the entire arrangement was backfilled with concrete to the segmental lining profile.

**Geology**

An amount of geological testing was undertaken including onshore boreholes, mapping of Horizontal Directional Drilling for the pilot plant, mapping of horizontal cores, seismic tests and three offshore vertical boreholes. See Figure 2.

The predominant geology in the area of the tunnel to riser connections was defined as moderately weathered fractured sandstone. The rock mass permeability was estimated to be generally low with high permeability zones present should any local fault zones be encountered. Prior to construction commencing, the estimated groundwater inflow in faulted areas was up to 22 L/sec/m of excavated adit length. Some parameters assumed for design purposes were UCS of 2.0 MPa with a working bond capacity of 350 kPa. RMR and Q rockmass qualification systems were used to provide guidance on ground support requirements during the design phase. A lower bound Q value of 0.13 and RMR of 40 (poor) were assigned.

Empirical observations during TBM cutter-head interventions at adit locations confirmed the presence of low strength fine grained sandstone, with saline groundwater flowing freely through the joint sets.

Interface between TBM Tunnel and Risers A critical factor in the works was ensuring that the risers were installed the correct distance away from the TBM tunnel. This was essential to avoid three distinct possibilities:

- Design minimum pillar width not being achieved, resulting in a potentially unstable excavation.

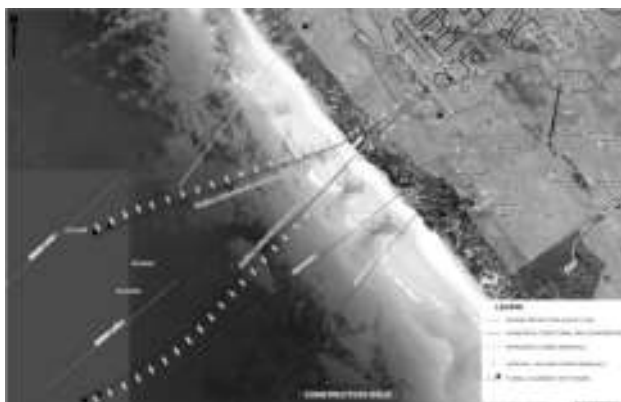


Figure 2: Tunnel alignment.

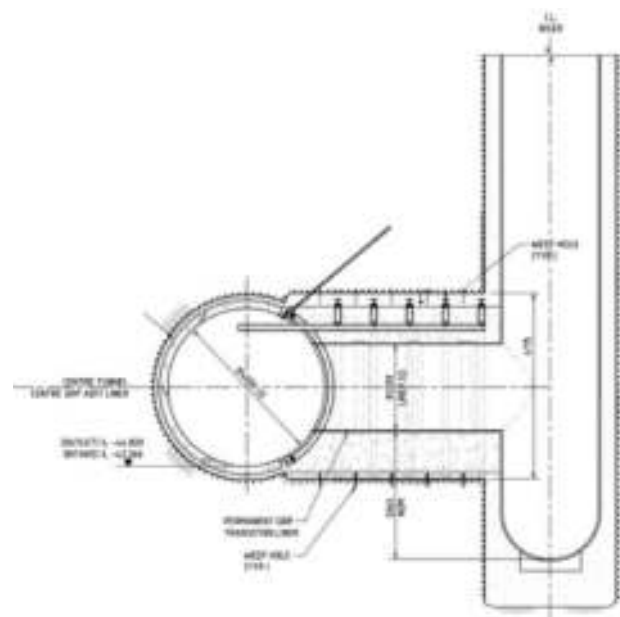


Figure 3: Elevation of riser to tunnel connection.

- Excessive pillar width, resulting in a longer adit drive.
- Collision between TBM excavation and riser installation, with potentially catastrophic results.

Co-ordination between marine and tunnel survey teams was essential to achieve the correct positioning of TBM tunnel relative to each riser. Both marine and tunnel surveys were conducted using the Map Grid of Australia 1994 (MGA94) Zone 55 co-ordinate system. The tunnel survey control network was used to establish the marine survey GPS base station location.

The TBM drive position was also checked independently by way of gyro-theodolite survey.

The jack-up barge used to install the risers was setup twice, first for the two inlet risers and then for the two outlet risers. The horizontal alignment design for inlet and outlet tunnels was modified slightly to accommodate the actual positioning of the jack-up barge. The TBM tunnels and marine risers were subsequently installed within design tolerances of ±50mm and ±150mm respectively. This maintained the design pillar width of 3.6m.

**Excavation Size**

The excavation size was deliberately set such that a 0.9m clearance zone remained outside the adit GRP liner, to facilitate installation. This resulted in an excavation span of 4.8m and height of 4.7m. The overall excavation length was 4.5 m. A panel of 3 segments wide (4.5m wide) by 2 segments high (3.8m high) was removed from the segmental lining to make the adit opening. See Figure 3.

Temporary Support of Segmental Lining Due to the lack of available bond stress in the host rock, a passive support system was adopted to maintain the integrity of the segmental lining during the excavation, grouting and final lining works. The support framework consisted of 250 and 200 UC rings tied together, with the adit opening framed by 250 UC sill and lintel beams. The temporary steel rings extended 4.0m either side of the adit opening, 17 tonnes

of structural steel were installed at each adit location. The 25mm annulus around each steel ring was grouted and wedged to provide load transfer between the segmental lining and temporary works. See Figure 4.

**Grouting**

A grouting campaign was undertaken prior to excavation of each adit. Hydro-geological information indicated the potential for substantial water inflow, should any faulting be encountered. In addition to this, the excavation needed to be suitably dry to allow the application of steel-fibre shotcrete for temporary ground support. The high slake-ability of the rock also warranted precautionary measures to make the excavation as dry and stable as possible.

The aim of each grouting campaign was to block any water bearing joints within 4–5m of the adit excavation line. During TBM excavation, face inspections were undertaken for 20m before and after each riser and it was determined the rock mass had sufficient structure negating the requirement to undertake ground consolidation using traditional cementitious grouting.

The area to be excavated was also grouted, with an aim of sealing any ground water from entering through the riser bore and riser grout annulus. A drilling array with 45mm diameter holes on a 1.5m grid was adopted. 25 primary holes were used at each adit. Secondary holes were used in the spiling bar locations and when re-drilling indicated continued inflow.

Each adit was grouted with a two part urea-silicate resin, injected under pressure of 90–120 bar. The resin had a set time of 2–3 minutes, eliminating concerns regarding wash-



Figure 4: Installation of temporary support at adit.

out. The grouting works were successful. Lugeon testing after grouting resulted in test values of 0–1 lugeons. Subsequent excavation revealed joints full of resin with minor local seepage in places.

**Excavation and Ground Support**

The segmental lining at the adit locations was constructed of steel fibre reinforced precast segments. 32mm diameter 3.6m spiling bars were installed and grouted above the adit crown prior to excavation commencing. The segments to be removed above spring-line were further restrained by rock-bolting them to the face. The segments were then stitch drilled and broken down into small fragments with an excavator – hammer combination. The same plant was used to excavate the material from each round.

The ground support design was developed with risk management always at the forefront. The limited geotechnical information resulted in a ground support design that would cater for the worst feasible conditions based on the available knowledge. For this reason, a passive ground support design of steel fibre shotcrete with steel sets at one metre centres with a one metre advance was adopted.

Excavation proceeded in 1m rounds with each round following a sequence of geotechnical inspection, excavation, 75mm initial shotcrete, installation of 150 UC steel set then 150mm final shotcrete.

Progressive geotechnical inspection during each round confirmed that the rock quality was better than the worst case assumed in the design. Convergence monitoring of the adit opening and adit excavation itself was undertaken during the works on a daily basis. Minimal movement was observed.

A key issue in the excavation was avoiding any mechanical damage to the riser. This was achieved by adding red dye to the annulus grout around the riser, to provide a visual indicator for tunnelling crews that arrival at the riser was imminent. The red dye in the riser annulus grout contrasted well with the predominantly grey sandstone of the area. See Figure 5.

Once the red grout was exposed a controlled probe drill was undertaken to establish the exact distance from the excavation face to the riser. This allowed tunnelling crews to take adequate care and avoided any mechanical damage to the GRP riser.

**Riser Dewatering and Adit GRP Installation**

Each riser was capped at the top with a double isolation seal to avoid inrush of seawater into the tunnels during the adit construction. The primary seal was a steel plate bolted to the top flange of the riser. The secondary seal was a GRP hemisphere, equipped with a hydraulic Pronal seal, seated inside the riser, directly underneath the top cap. These seals provided double isolation between Bass Strait and the crews below.

Each riser was filled with water to facilitate installation and remained as such until the riser was exposed during the adit excavation works. Upon exposing the GRP riser, a dewatering portal was accessed and the tunnel crews



Figure 5: Adit excavation and ground support.

were able to dewater each riser through the use of a valve bank inside the dewatering portal. The valve bank allowed compressed air to be forced into the riser whilst the water was displaced into the tunnel dewatering system to avoid any internal vacuum effects.

Once dewatering was complete a 2.2m diameter hole was cut into the face of the riser and the adit GRP pipes installed. The pipes were installed on sliding cradles and strapped down to resist the buoyancy during concreting works. See Figure 6.

Each adit was formed up to the profile of the original segmental lining and backfilled with a 40 MPa self compacting concrete, placed at a slump of 200 mm. Concreting was completed in successive lifts of 600mm to avoid flotation or deformation of the adit GRP liners.

#### Plant Selection

The available working room, nature of the rock and excavation size dictated the plant selection.

Erection of the structural steel rings to support the segmental lining was undertaken with a 2.5 tonne telehandler equipped with a set erecting attachment and a jib.

Drilling was completed with a Tamrock Micromatic DH103 single boom jumbo drill fitted with an HL300 drifter. The particular machine was selected for its shortened feed rail which allowed increased manoeuvrability underground. A small number of holes were completed with conventional hand held rotary percussive rock drills.

The excavation was undertaken with mini excavators in the size range of 1.7 to 3.0 tonnes. The 3.0 tonne excavator had the dipper arm removed and a hammer attached directly to the main boom. This was the primary machine used for breaking the material from the excavation face. The material was mucked out into 1 m<sup>3</sup> site dumpers with a 1.7 tonne excavator.

Concrete and shotcrete were conveyed to the work front using the same site dumpers used for mucking out. The shotcrete was applied with a Jacon Midjet shotcrete rig.



Figure 6: GRP installed in adit.

#### CONCLUSION

Key elements in the safe and timely completion of the connections between the tunnels and marine risers at the Victorian Desalination Project were:

- Detailed risk assessments and planning of the works well in advance of commencement.
- Developing a design and construction method to suit the worst case scenario based on the available information.
- Experienced personnel at the underground work front.
- Selection of appropriate plant and equipment.
- Regular communication and coordination between the tunnel and marine teams.

The tunnel to riser connections at the Victorian Desalination Project employed many different techniques in underground construction. These techniques allowed four horizontal connections to be made between the TBM tunnels and the water filled riser shafts in a safe and productive manner.

#### ACKNOWLEDGEMENTS

The author would like to thank the Thiess Pty Ltd Victorian Desalination Project Tunnel team, under the leadership of Glyn Edwards, for a challenging and unique experience. The following organisations also provided a valuable and essential contribution to the works:

- Thiess Degrémont Joint Venture – facilitation of the tunnel contract.
- Thiess Pty Ltd Marine team, led by Jonathan Wilson of IOS for the installation of the marine risers.
- Parsons Brinckerhoff Beca Joint Venture – design of the works.
- RPC Technologies – design and fabrication of GRP risers and adit liners.
- RUS Mining – adit grouting.



## Terrace Tunnel in a new light

**W**ellington drivers have a brighter journey through the Terrace Tunnel after new high-tech lights were switched on.

The lights, which are part of NZTA's \$50 million upgrade to the tunnel, will operate round-the-clock and can automatically adjust to outside conditions.

NZTA Wellington state highway manager Rod James said the new lights would "noticeably improve" light levels in the tunnel during the day. The dimming feature was not yet operational. "The new tunnel lighting has been designed to help drivers' eyes quickly adjust to the change in lighting conditions as they enter and exit the tunnel. Once they are fully operational, the lights will be linked to external light sensors that will automatically brighten or dim the lights based on outside conditions. We are still testing the lights, so for now they will be on a single fixed setting."

Other work on the tunnel is still being completed – this includes:

- New coloured wall panels as a visual feature, along with lane control signs.
- An overhead fire suppression "deluge" system, with drains to manage excess water if the system is used.
- A new system in the ceiling to electronically monitor vehicle heights to stop trucks or big loads hitting the tunnel's new equipment.
- New cameras to link in with the NZTA's traffic operations centre to monitor road conditions.

## Aucklanders prefer tunnel to new bridge

**A**ucklanders prefer tunnels to a new bridge across Waitemata Harbour, even at an extra cost of \$1.4 billion, which may have to be paid for from tolls. The draft Auckland Plan says public submissions favoured tunnels between Northcote and the northern end of Spaghetti Junction.

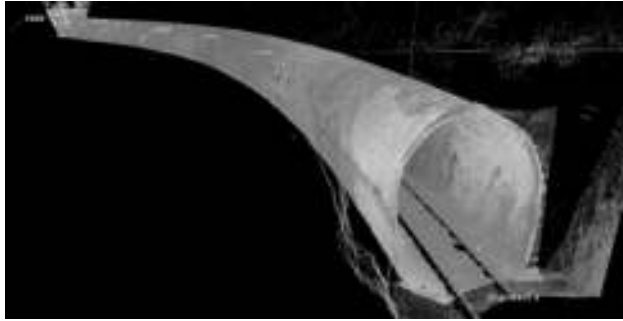
Although these would be motorway tunnels at first, they would run under Wynyard Quarter, leaving open the possibility of a rail link to the North Shore from a station beneath Gaunt St. They would also enable removal of the Victoria Park motorway viaduct, which will be given over to southbound traffic once a cut-and-cover road tunnel through the park opens early next year for vehicles going north to the existing bridge.

A Transport Agency report in March 2011 put the cost of a second bridge at \$3.9 billion and a pair of three-lane motorway tunnels at \$5.3 billion. Agency consultants reckoned a bridge could be fully paid for from tolls of \$6 each way to use it and the existing 52-year-old crossing, and a tariff of \$8 could cover the cost of tunnels.

The Auckland Council plan acknowledges that a new crossing, which it believes will be needed by about 2030, will cost much more than can be provided from traditional money sources. It says the council prefers the proposed crossing alignment, to the west of the central business district. But Council for Infrastructure Development chief Stephen Selwood says an eastern route would divert traffic from the motorway chokepoint and give a more direct link to the port.



Australasian Tunnelling Society website  
[www.ats.org.au](http://www.ats.org.au)



## Johnsonville Tunnel clearance assessment

**W**ith the new Matangi passenger trains confirmed for the Wellington network, there was a need to upgrade the Johnsonville Railway line to allow the new, larger units to replace the 1930s' English Electric trains, which had provided service for the last 80 years.

The Johnsonville Railway was constructed in 1880 and is unique in New Zealand, as well as in world terms, by being considered a "mountain railway". The railway features tight 150m radius bends, maximum grades of 1 in 40 and seven tunnels, including many with curves. Initial evaluations by KiwiRail confirmed that by lowering the rail level and enlarging the tunnels, the new Matangi units would be able to use the line and achieve the much-needed passenger unit upgrade.

The challenge for Aurecon was to accurately model the dynamic performance of the proposed Matangi trains through the tight and winding route to achieve the minimal tunnel upgrade works, as the line was to be kept largely operational throughout the upgrade.

Aurecon worked closely with KiwiRail to define the operational clearance parameters. Then, using 3D terrestrial laser scanning, Aurecon built an accurate, spatially correct model of the tunnels comprising four million scanned points per tunnel. Applying specialist software, Aurecon refined the outputs to produce visual representations of the constraints, the rail height, cant (camber) and alignment. The findings were fully optimised to achieve the required minimal upgrading works.

The work undertaken was exceptionally complex and involved multiple iterations, as the grades and cant of the line had very limited scope for change, due to the desired 40km per hour design speed on the line. The final alignment was selected following clearance assessments at 1m centres. It involved lowering the rail in the order of 350mm through the tunnels and introducing a number of complex rail curves within the tunnels to achieve the required clearances, which were down to 65mm at the floor level of the unit.

The project has set new benchmarks for rail clearance assessments in New Zealand by providing innovative outputs to demonstrate the constraints and exceed quality assurance requirements. Considerable time and cost savings for physical tunnel works were achieved compared with the initial expectations.

In October 2010, the first Matangi unit was tested on the Johnsonville line and proved that the modelling had been a major success. KiwiRail was delighted with the performance by Aurecon, which accomplished an exceptional result.

## More gas tests needed at Caversham tunnel



**T**he failure of gas-monitoring equipment after just one day inside the Caversham tunnel in October 2011 means the month-long testing programme must be repeated.

The former Caversham rail tunnel was used by cyclists and pedestrians after 1910, but was closed by the council in 2006, due to safety concerns about water, sewerage and gas pipes, and electrical cables.

Mr Hyland (Dunedin Tunnels Trail Trust member) has been at the forefront of the campaign to have the tunnel reopened to cyclists and pedestrians, and is a member of a Dunedin City Council working party investigating the tunnel's reopening.

In its annual plan deliberations in May, the council committed \$100,000 to start work on reopening the tunnel, with any further funding to be considered in 2012-13. This was on top of \$30,000 budgeted for a geotechnical report.

Testing gas levels in the Caversham tunnel is an important part of the investigation and gas-monitoring equipment was installed and was supposed to run from October 20 to November 23. However, the equipment failed after just 23 hours.

During that short period it showed a reading consistent with fresh outdoor air. Wind-speed monitoring equipment did function during the month, and showed that the entire air volume of the tunnel was purged every 18 minutes.

If both the Caversham and old Chain Hills tunnels were opened, there would be a flat route right through Dunedin from Aramoana to Henley.

# VICTORIA PARK TUNNEL

**A**uckland's \$340 million Victoria Park Tunnel was officially opened by Prime Minister John Key on November 14th 2011, three months ahead of schedule. Key was accompanied by the Minister of Transport, Steven Joyce, the Mayor of Auckland, Len Brown, and representatives from the NZTA and its project partners when he cut the ribbon to mark the opening.

The Victoria Park Tunnel project will increase the capacity of State Highway 1 between the Auckland Harbour Bridge and Newmarket, one of the country's busiest freight and business routes.

The tunnel is 10 metres below ground and will stretch from St Mary's Bay to Wellington Street. The new route opened to two lanes of traffic on November 14. The third lane will open in March 2012.

Once completed, the tunnel will help carry traffic north to the Harbour Bridge while the existing flyover taking traffic south. It will bring huge gains for Auckland and the wider New Zealand economy, through reduced congestion and faster and more reliable transport times. It will ease congestion for the 150,000 plus vehicles that use this route each day and will eventually reduce journey times by up to 20 minutes.

In 2010 the number of minutes delay per kilometre travelled on Auckland's state highway network during the morning peak period fell by 10.1% compared with 2009 this is considered to be largely the result of the opening mid-year of the Manukau Extension and the Manukau Harbour Crossing on State Highway 20.

"When major road and rail projects which are currently underway are concluded in the middle of this decade, Aucklanders will be experiencing a real step change in how they get around their city," says Joyce.

## Thousands walk new tunnel

The ribbon cutting was followed by a public open day and 17,000 people registered for a walk the new motorway tunnel. It was the maximum number who can safely be accommodated in the 450 metre long duct under Victoria Park. The New Zealand Transport Agency (NZTA) said it was delighted so many people wanted to see it.

Tommy Parker, the NZTA's State Highways Manager for Auckland and Northland, said building something so big in the middle of a city is never easy, and support from the community has made a challenging job much easier. "The open day was our way of saying "thank you" to the community for all the support they have given us," he said. "It has been built to the highest international safety standards, but these tests are essential so that we can be certain for the safety of drivers that all systems will perform reliably if there is an emergency."

## Safety first for 'gold-plated' tunnel

Top line safety measures have been unveiled in the new Victoria Park tunnel, and operators are confident it can



withstand all emergencies from fires to earthquakes. The tunnel will see 60,000 motorists pass through daily, and "gold-plated" measures are in place to ensure the tunnel can operate at capacity at all times.

The \$340 million project has seen cameras erected every 50m along the eastern wall of the tunnel to detect anything from a breakdown to a fire. In an emergency, passengers have three minutes to evacuate through the egress doors located every 25m alongside the right of the tunnel. They lead to a maintenance corridor separated from the tunnel by a 235mm fire-proof wall.

Alongside the doors are also three boxes, one holding an emergency phone, and the other two fire safety equipment, in the event of a breakdown. When opened, they alert the main operations room at Smales Farm, which is the operations centre for most of NZTA's roads.

Emergency response times are estimated at 15 minutes, and a PA system and car radio frequencies will inform motorists what to do should disaster strike. Two separate control centres are located in the maintenance passage. If smoke or fire is detected, the room will be locked down and filled with gas to lower the oxygen content of the room.

The tunnel also houses two jet vents which are able to fan a 70 megawatt fire and to ease the smoke. A 25m deluge pipe also has the ability to pump out 250 tonnes of water in half an hour. "The tunnel has been built to the latest seismic standards," Parker said.



## Victoria Park tunnel country's first to allow hazardous goods

Auckland's Victoria Park motorway tunnel has been rated to take dangerous goods banned from structures such as the Northern Gateway toll road.

That is thanks to a protective shield designed to keep any explosion or fire of up to 1350C from penetrating a dedicated escape route on the tunnel's eastern side.

The New Zealand Transport Agency will allow petrol and chemical tankers and other dangerous goods vehicles though the 450m northbound tunnel, rather than making them take detours through city streets.

To meet the fire rating an innovative system supplied by a Penrose company was needed to seal joints between concrete panels lining the tunnel and to ensure fire or smoke does not get through holes for cables, pipes and wiring.

CSD Sealing Systems director Frank Wiseman said the sealant was designed to expand as fire approached to ensure no gaps were left in the shield. "If there's an inferno inside the tunnel, anyone who makes it safely into the escape corridor must expect to be able to flee the scene without impediment," he said. "The fire won't break through it, or not until its gone past its specification, which is two hours in that sort of heat. There was no other system suitable that would meet the specifications and warranties required to meet this demanding fire rating."

The NZTA confirmed that Victoria Park will be New Zealand's first rated dangerous goods tunnel, although a bylaw has been suspended temporarily to allow petrol and chemical tankers through Christchurch's Lyttelton Rd tunnel for a 10-minute period each night. Dangerous goods carried between Auckland and Northland have to use the coastal highway through Orewa rather than use the Johnstone's Hill tunnel on the toll road.

Agency highways manager Tommy Parker said his organisation believed that, given the highest standards of safety in the Victoria Park tunnel's design, allowing dangerous goods through was preferable to sending them via city and suburban streets.

Operating systems, including roof-mounted jet fans to remove smoke and gasses, and deluge sprinklers, were tested extensively before two of the tunnel's three traffic lanes open. The agency says the sprinklers will be able to swamp the tunnel with 250 tonnes of water an hour, a rate which if maintained over 24 hours would theoretically deliver the equivalent of Auckland's annual average rainfall.

Emergency telephone and exit doors are stationed every 50m along the tunnel, leading to the escape route, which will be pressurised to keep it free from smoke – and mobile phones will be able to work inside it.

### Tunnel gala dinner

Two days before the 450m tunnel was officially opened by Prime Minister John Key, it was host to a swanky charity fundraising dinner for Ronald McDonald House Auckland Trust.



Kitchens in marquees, air-vacuumed tar seal and industrial heaters to warm a 200m section of the tunnel are just some of the logistics organisers face for the dinner with a difference.

Trust chief executive Wayne Howett said it was an association with the New Zealand Transport Agency (NZTA) that led to the idea for the October dinner. "We're thrilled with the opportunity to host this event. Not only will it raise much-needed funds, people will have the opportunity to be a part of history," Howett said.

Diners, who paid \$350 each, walked in after being dropped off at the Wellington St motorway on-ramp and enjoyed an evening of cocktails, food and entertainment by Avalanche City, Lisa Crawley and Annabel Fay. Funds raised will help complete the trust's family accommodation, Grafton Mews.

The 200m area of the tunnel taken up with tables, kitchens, stages and toilets for the dinner was sectioned off to allow it to be heated so guests could comply with the cocktail dress code. The tarmac was cleaned with air vacuums before the event and NZTA held off putting the "cats eyes" onto the road until after the dinner.

## Wellington supports tunnel option

**A** deeply divided Wellington City Council has agreed that it wants a tunnel beneath the Basin Reserve instead of a flyover. The council's Strategy and Policy Committee put forward a tunnel from Buckle St to near the Mt Victoria Tunnel, beneath the Basin Reserve as their preferred option in a submission to the NZ Transport Agency.

The exact cost of the tunnel option which would be met by the Government, is unclear but previous work by the transport agency put the cost of a similar proposal at between \$200m-\$280m.

The fallback option for the council is to support a \$75 million flyover about 20 metres to the north of the Basin Reserve but only if the transport agency agreed to improved mitigation of the visual effects. This could include new buildings to hide the flyover, arcades, artworks, fancy lighting and extensive landscaping.

The council will also ask the transport agency to bring forward the planned duplication of the Mt Victoria Tunnel so that it starts soon after the Basin Reserve project has been completed.

# Milford Sound bus tunnel

**Plans for a \$160 million private tunnel linking Mt Aspiring and Fiordland national parks have progressed to public consultation – but Southland District Mayor Frana Cardno wants the public to block the proposal.**

The 11.3 kilometre one-way bus tunnel would open up a new route to Milford Sound, taking tourists around the northern tip of Lake Wakatipu via Glenorchy then south through the Routeburn and Hollyford valleys. Te Anau, on the current southern route, would be bypassed.

The tunnel is the brainchild of project developer Milford Dart Ltd. Should the tunnel be built, the company would charge tourist buses an access fee.

The Department of Conservation has said that “with appropriate conditions” the impacts of the tunnel were acceptable, but it would take public feedback into consideration before making a decision on whether to grant a concession allowing the tunnel to proceed.

The tunnel, linking Routeburn Rd to Hollyford Rd, would more than halve the travel time for the 500,000 visitors a year from Queenstown to Milford Sound. At present the return bus trip takes nine hours.

Milford Dart managing director Tom Elworthy has said the tunnel could contribute tens of millions of dollars to the New Zealand economy by freeing up tourists for an extra half day of activities.

However, Ms Cardno is urging the public to fight the tunnel plans. “There are so many things wrong with this proposal – the tunnel is inconsistent with the New Zealand Tourism Strategy objectives as it will reduce the duration of stay within New Zealand as well as the daily spend, and will limit visitor flows into the southern region,” she said. Ms Cardno cited inconsistencies with the Conservation Act, National Parks Plan, “underground travel” within a seismically active area, and avalanche risk as reasons the tunnel should be roadblocked.

Mr Elworthy said Milford Dart disputed everything Ms Cardno had used as ammunition to fire up the public. “The tunnel would allow people to spend more time in places like Te Anau,” he said. “The economic gain from tourists on the current route, especially in places like Te Anau, which Ms Cardno seems to be worried about [losing], is negligible because there’s just no time for buses to stop at the moment.”

But Milford Dart says that building the tunnel would not cause a huge environmental impact, and once completed would cut down exhaust emissions because buses had far less distance to travel to the same destination.

## **The Department of Conservation has extended the deadline for public submissions**

Southland Conservator Barry Hanson says that the Department of Conservation has extended the deadline for public submissions because there had been so much public interest in the Milford Dart Tunnel and the Milford monorail projects.

Both projects aim to shorten the travel time between Queenstown and Milford Sound.

Mr Hanson said many people have expressed concern about the applications and they need more time to consider them.

Public responses on the tunnel now need to be with the department by 20 February and on the monorail proposal by 19 March – an extension of 15 working days for each.

There have been 120 submissions on the tunnel idea and 11 on the monorail project.

# Mt Vic tunnel upgrade pushes ahead

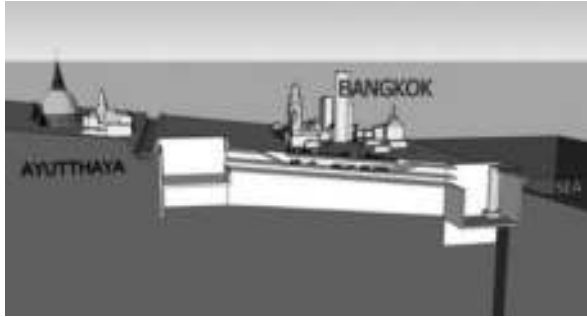
**Mt Victoria is one step closer to being finished, after the tunnel’s suspended ceiling was demolished this week. The 80-year-old internal roof, called a plenum, was deteriorating and needed to be removed as part of the NZ Transport Agency’s tunnel upgrade work.**

The roof formed part of the tunnel’s ventilation system, but will no longer be required with the addition of a new fire safety system, which includes a high grade heat detection system. Wellington state highways manager Rod James said the demolition went exceptionally well. A removable safety platform was

installed under the ceiling to catch falling debris, but the work was completed with little incident.

Completing the work on the Mt Victoria and Terrace tunnels was crucial for the city’s transport system, Mr James said. “The Mt Victoria tunnel is a vital part of the local transport network, so it’s important that we undertake this work with as little disruption as possible,” Mr James said. Work on Mt Victoria is expected to be finished by the end of January 2012, however tunnel closures would continue until March while testing was completed.





## Bangkok flood-prevention plan must include tunnel

**C**onstruction of the 100-kilometre “MUSTS” channel is crucial to saving Bangkok from future floods, the Engineering Institute of Thailand (EIT) has said.

“It stands for Multi-Service Flood Tunnel System. But also, I want to say that it’s a ‘must’ here,” said Suchatchavee Suwansawas, chairman of the Thailand Underground & Tunnelling Group (TUTG) of the EIT.

The subterranean passageway would run under Bang Pa-in-Bang Na Road and carry vehicular traffic during the dry season. MUSTS has many advantages over above-ground solutions. It will require no or minimal land expropriation, was environmentally friendly, caused very little impact on local communities and was not prone to any land-encroachment problems. However, it would need an environmental impact assessment (EIA).

There will be the usual drainage system under the tunnel. Under normal circumstances, it can be open to traffic. However, if there is massive runoff from upstream provinces it will be closed to traffic and turned into a floodway. The water would be directed to the Bang Na area, where it would be easy to drain out to sea.

The mega-project will need up to five years to complete and likely cost about Bt200 billion (\$8.3 billion), which might be considered too expensive.

Bangkok’s eastern flank is no longer protected by water-retention areas. The zone is now filled with Suvarnabhumi Airport, industrial parks and housing estates. “If we are going to push runoff water into the eastern zone, we must do it via an underground system. MUSTS should be linked to the existing network of waterways, like canals and rivers, to expel runoff water efficiently into the ocean, Suchatchavee said.

It is considered that if the government completed the MUSTS tunnel and prepared other anti-flood measures well, Bangkok should be able to escape the wrath of raging floodwaters in the future.

## Chennai Metro Rail

**A**s tunnelling work for metro rail is about to begin, Chennai Metro Rail has started setting up units to make pre-cast concrete tunnel walls at Muttukadu, Tiruneermalai and Vanagaram.

Underground tunnels of metro rail will be reinforced with concrete walls which will shore up the tunnels as it passes underneath busy roads and buildings across the city. These walls will be made in segments using specially designed moulds and will be transported to the work site so that they can be installed simultaneously when machines start boring.

The machine will bore a particular length, then the pre-cast walls will be installed in the bored portion before the machine resumes work. A senior official of metro rail said 12 sets of pre-cast segment moulds have arrived after they were factory-tested in China and Korea. “One set has six cast moulds. The tunnel walls will be made of six pre-manufactured concrete segments. These segments will be interlocked and installed when a machine completes boring a particular length of the tunnel,” he added.

Metro rail has started work to build diaphragm walls to lower tunnel boring machines at Egmore, Washermanpet, Shenoy Nagar, May Day Park and Kilpauk Medical College. Two tunnel boring machines, which have arrived from China, will be lowered at Washermanpet and Shenoy Nagar where diaphragm walls will be completed earlier than other locations. More machines are expected to arrive soon.

Around 22 diaphragm wall panels are made and a guide wall has been completed at May Day Park, while 24 diaphragm wall panels at Shenoy Nagar and 19 others at Washermanpet have been installed. The boring machines will be lowered at these locations when the diaphragm walls are constructed and a pathway tunnel designed to guide the machines to the boring spot is completed.

Work to build underground stations is progressing at a brisk pace along Poonamallee High Road for the Central-Tirumangalam underground section and along Anna Salai for Washermanpet to Saidapet underground stretch. Soil investigations are complete and barricades have been set up to identify and move utilities like electrical junction boxes, water supply pipelines and others.

In the Washermanpet to Saidapet underground stretch, soil investigations have been completed at Government Estate, LIC and Thousand Lights station locations. Metro rail officials have started identifying utilities at LIC, Thousand lights, Teynampet, Chamiers Road and Saidapet stations to move them before work begins.

# Penchala tunnel declared safe

**H**airline cracks that have appeared on the wall of the Penchala tunnel on the Penchala Link Expressway about 20m on the west-bound entrance after the Bukit Kiara toll plaza are “surface peelings and not a structural defect.”

Sistem Penyuraian Trafik KL Barat Sdn Bhd (Sprint) assistant general manager and engineering department head Francisco Anthony Doss assured motorists that the surface peelings were common in tunnels and did not pose a danger to road users. “The primary lining is reinforced concrete of about 150mm thick.

We have monitored the peeling over the past one-and-a-half months. Our observations and engineering tests show that what had formed were just hairline cracks,” he said.

Doss said behind the hairline cracks was a secondary lining that was 400mm to 500mm thick with water proofing material.

“There are anchor bolts holding the whole structure. We monitored the surface peelings for about 45 days as we wanted it to stabilise. Our men have injected concrete epoxy into the cracks to keep moisture from seeping through and to reinforce the waterproofing membrane. Markers have also been put in place for further monitoring efforts,” he said.

The RM150mil tunnel is the widest of its kind in Malaysia covering 710m of the 5.5km Penchala Link Expressway that connects Sungai Penchala to Mont Kiara in the Klang Valley.



Unlike other highway tunnels which used tunnel-boring machines, the Penchala tunnel was bored by using the slower rock-explosion method, due to the unstable rock condition at the site.

Litrak Group head of communications Shah Rizal Mohd Fawzi said the three-lane tunnel was built with numerous safety features like strain gauges, piezometers to monitor stress on the structure, smart lighting and close-circuit television cameras that allows for constant monitoring.

“Moisture that flows out from the wall panels are within permissible limits. There is no unusual water pressure built up along the tunnel. The tunnel’s structural integrity and safety is intact. We conduct monthly inspections to detect any visual abnormalities since the tunnel was opened to traffic in February 2004,” said Shah Rizal.



**Surface peeling:** Cracks that appeared on the left side of the Penchala Tunnel.

## MRT Tuas West Extension

**T**he Land Transport Authority (LTA) has awarded a Tuas West Extension contract to Shanghai Tunnel Engineering Company for S\$190 million.

The contract with the civil engineering contractor from China includes the construction of Tuas Station, an elevated station at Tuas Road, and approximately 2.8 kilometres of elevated MRT viaducts. Shanghai Tunnel Engineering was also involved in the construction of Circle Line, and presently, Downtown Line Stages 1 and 2.

Tuas West Extension, an extension of the East-West Line from Joo Koon station, consists of a 7.5-kilometre long twin-tracked MRT viaduct, four above-ground stations including Tuas Station and a depot. Construction will start by the end of 2012 and is targeted to complete in 2016.



## Mumbai's first road tunnel set to open

**T**he Mumbai Metropolitan Region Development Authority's (MMRDA) one-of-a-kind twin tunnel project is on track and the left tunnel was opened to the public in December 2011. The twin tunnels are being built as part of the Anik Panjarpol Link Road, proposed to improve connectivity between the eastern suburbs and south Mumbai. The 500-metre tunnels are the first in India to be created within a city and to be used for urban transport.

Chief secretary Ratnakar Gaikwad had held a review meeting of all MMRDA projects, urging the agency to expedite work.

The tunnels are being built at a cost of Rs61 crore. They will start at the Bhabha Atomic Research Centre (BARC) mountain and end at Gautam Nagar, near Panjarpol. Each tunnel is 18 metres wide, 10 metres high, and will have four lanes.

The APLR stretches from Anik, Wadala, to Panjarpol, Chembur and is being built at a cost of Rs210 crore. This road, in turn, is part of the Eastern Freeway project, wherein a 22-km road will be built from Chhatrapati Shivaji Vastu Sangrahalaya in south Mumbai to Ghatkopar.

*Each tunnel is 18 metres wide, 10 metres high, and will have four lanes.*

To build the twin tunnels, the MMRDA created a hole through a controlled blast, in a 120-metre high hillock near BARC, making room for the tunnels. Nearly 200 workers cut through the hillock to create the tunnels. Five lakh cubic metres of rock were dug during the excavation.

Work on the right tunnel is still incomplete and was interrupted, as there are 100 structures, including houses, which need to be demolished for construction to be carried out. "We have sought police protection to remove the structures. This will help expedite the project," a senior MMRDA official said. The second tunnel is expected to be complete by mid-2012.



## Undersea tunnel to link JB and Singapore

**A** study is being done on the feasibility of constructing an undersea tunnel to link Singapore and Malaysia.

Iskandar Regional Development Authority chief executive officer Ismail Ibrahim said the tunnel was likely to be about 1km long, slightly shorter than the Causeway. "By going underwater, there is no need to tear down existing structures above the sea and there will be less disruption to movement between Johor Baru and Singapore," he said.

The Causeway, which is about 1.056km long, was completed in 1923 and links the city here to Woodlands on the other side of the Straits of Johor. Between 80,000 and 100,000 vehicles use it daily.

Johor and the republic are also connected via the Second Link, a dual three-lane carriageway linking Tanjung Kupang to Tuas in Singapore. The bridge is about 1.9km long.

Ismail said detailed engineering study on the tunnel would be conducted by consultants appointed by both governments. He said both Malaysia and Singapore had yet to determine the cost of the tunnel, which would not be parallel to the Causeway.

# Singapore underground space masterplan

**I**n land-strapped Singapore, underground space has been named a strategic resource by the high-level Economic Strategies Committee.

A masterplan is in the works to map out possible uses and the Ministry of National Development said details will be released this year.

Underneath the bustling Chinatown lies a vast labyrinth of interconnected tunnels snaking across Singapore. The Downtown railway line, which is being built entirely underground, is part of a decades-long push to go down under in search of space. The result is a subterranean world teeming with activity.

At the basement level, there's a complex network of utility pipes, electrical grids and pedestrian linkways. The Common Services Tunnel, which is located five to 10 metres deep, is a system of tunnels designed to house utility services in the Marina Bay area. Built in 2006, the facility allows for the maintenance and repair of utility, sewage and electrical pipes through specially-constructed access points, without having to disrupt traffic above ground. And 15 to 20 metres deep are the MRT lines and the Marina Coastal Expressway. Just below that, at the 20 metre to 60 metre level, the Deep Tunnel Sewerage System delivers waste water to an underground treatment plant in Changi.

Over at Jurong Island, the Jurong Rock Cavern is being built at about 150 metres below the island. And somewhere in the deeper, darker depths, is the Ministry of Defence's ammunition facility located under Mandai quarry.

But not all of Singapore has rock that is solid enough for cavern developments. Most of it is in the west and central parts of the island lying about 100 metres deep. In the west, there is sedimentary rock while hard granite is found in the central Bukit Timah region.

Thus, the first step is to create a geology office to know where the good rock is located in Singapore. The Singapore Geology Office, which is located within the Building and Construction Authority, was set up in April 2010. Its aim is to create a database of information on Singapore's geology, to facilitate future underground developments.

Most information on Singapore's geology derives from a national survey done in 1976 although the information was updated in 2009. Government agencies and developers looking to build underground either referred to these sources, or commissioned their own studies.

Building and Construction Authority's Geological Office assistant director, Kiefer Chiam, said: "The existing information is quite shallow because it's mainly targeted at infrastructure works like MRT, services or building basements. There isn't much information at deeper levels like 100 metres or more. In order to support the



underground masterplan, we need to know where the good rocks are."

In the immediate term, the focus is on adding more basement-level services like shopping malls and linkways. But as underground construction incurs huge costs, a masterplan is needed to coordinate future uses and integrate them with structures above ground.

Adele Tan, Deputy Director of Planning Policies at Urban Redevelopment Authority (URA), said: "Those are things we have to sort out amongst the agencies. We work closely with each other on it. And where there are conflicts, we have to talk it through and see what are the most optimal alignment and the most cost-effective alignment. As we build more things underground, there will be more competing uses and more conflicts of space. Some of these uses that come later may find that they have to go even deeper to avoid some of the uses that are already there in the shallower surfaces."

The challenge of building underground is not just a technical one. There is also the issue of land rights to consider. In cities like Helsinki for example, private ownership of subterranean land is limited to a certain depth. But in Singapore, the law gives private owners rights to the land stretching all the way down.

It is not a problem currently because the Rapid Transit Systems Act gives rail authorities the right to go through private land. But this may have to be reassessed along with other regulations such as safety codes and utility plans. Ms Tan said URA is studying other cities for models it can adapt.

URA is also studying how other cities pay for underground developments. In Japan for instance, the government shares the cost with private developers. Unlike places like Hong Kong, Norway and Japan, Singapore's good rock is buried deep underground, and are much more expensive to access.

Ms Tan said: "As we have a better understanding of our space underground, we can then develop this underground space plan progressively. We can identify suitable uses to put underground and put them in the right places as well, so that we can save land."

Singapore's subterranean expansion is still in its early stages. Urban planners are laying the ground for future development, a process that will take years. And if they succeed, it will open up many more possibilities on how Singaporeans use the space above to live, work and play.

# SMART Tunnel for Manila

**A** lawmaker from Metro Manila has proposed the putting up of a Malaysian-type Stormwater Management and Road Tunnel (SMART) on EDSA to ease motor vehicle travel and help surrounding communities deal with potential flash flooding.

House Deputy Majority Leader and Pasig City Rep. Roman Romulo urged the Department of Public Works and Highways (DPWH) to study the feasibility of building under EDSA a dual-purpose tunnel patterned after Kuala Lumpur's SMART storm drainage and road structure. "The only option left is to construct a new motorway beneath EDSA, since it can no longer be widened, and we already have the Metro Rail Transit line over the main road," he said.

Romulo was reacting to the DPWH's plan, bared in a congressional budget hearing, to build either an elevated highway over EDSA, or a tunnel below it, to relieve traffic. Malaysia put together its 9.7-kilometer SMART, a key national project, at a cost of US\$ 515 million or about P22 billion at the current exchange rate. "Assembled over four years, their SMART is basically a motorway and stormwater tunnel in one that could be duplicated here," said Romulo.

Under normal conditions, he said, the two-channel tunnel serves as a motorway for light vehicles. During the wet season, Romulo said the tunnel has two modes. In the first mode, with light rainfall, some floodwater may be diverted into the lower bypass channel, while the upper section remains open to motor vehicle passage.

In the second mode, in the event of extreme storms, the upper channel is totally closed to all motor vehicle traffic and automated water-tight gates are opened to divert floodwaters. "We have to change our way of life, even the way we design new roads, if we are to cope with brutal weather conditions, including excessive rainfall and severe floodwaters, in the years ahead," said Romulo.

Once established as workable, he said the SMART project could be among the ventures lined up for implementation under the administration's public-private partnership (PPP) strategy.

# LTA Emergency exercise

**T**he Land Transport Authority (LTA), together with the Singapore Civil Defence Force (SCDF) and Singapore Police Force (SPF) conducted an emergency exercise in the new road tunnel at Woodsville Interchange in December.

LTA said the exercise is part of its ongoing efforts to enhance operational readiness and coordination between the various agencies in dealing with potential incidents in Singapore's road tunnels.



# Penang sea tunnel link

**T**he Penang government will pay developers with prime land around the tourist belt area of Gurney Drive to construct three by-pass highways and a sea tunnel linking the island to the mainland.

Chief Minister Lim Guan Eng said the RM8bil project would be the state's biggest infrastructure exercise and is meant to resolve the island's severe traffic congestion problem.

The proposed traffic-alleviation projects are a 6.5km sea tunnel connecting Gurney Drive on the island to northern side of Butterworth, a 4.2km road from Gurney Drive to the Tun Dr Lim Chong Eu expressway by-passing the city centre, a 4.6km road linking Bandar Baru Air Itam to the same expressway and a 12km dual-carriage road from Tanjung Bungah to Teluk Bahang to pair with the existing coastal road.

"We estimate that the projects will cost RM5bil to RM8bil depending on the bids from prospective contractors," he told a press briefing. He said the "competitive land swap" payment will be a win-win situation for both the state government and the developers. "The state government does not have to pay money and the developer gets prime land that will triple in value after the projects take place," Guan Eng said. He added that developers could also propose to implement toll payments to recover costs. Lim said that the projects would undergo a lengthy feasibility study and construction is only expected to commence in 2015. "We target the completion to be in 2020, although it can be completed earlier," said Lim.

# HCC achieves day lighting of Pir Panjal Railway Tunnel

**H**industan Construction Company achieved a major break through of day-lighting the Pir Panjal Railway Tunnel, constructed in the rugged terrain of Pir Panjal Mountains in Jammu & Kashmir.

The tunnel is part of the ambitious Udhampur – Srinagar – Baramulla rail link project of Northern Railways. At 10.96 kilometers long, the Pir Panjal Railway Tunnel is India's longest and Asia's 2nd longest tunnel, aimed at reducing the travel distance between Quazigund to Banihal to only 11 kilometers and providing a hassle free travel up to Baramulla.

HCC was awarded the contract of Pir Panjal Railway Tunnel in August 2005 at a contract value of INR 391 crores. The engineering work included, construction of a tunnel having a finished width of 8.405 meters and height of 7.393 meter with a provision of 3 meter wide concrete road inside the tunnel throughout the length for maintenance & emergency relief purpose, and also construction of 772 meter long access tunnel section.



Due to the changing geological strata of the young Himalayan rock, New Australian Tunnelling Methodology was adopted for the construction.

## Project Highlights In Brief

1. Longest Transportation Tunnel in India (1096 km).
2. Provision of 3m wide concrete road inside the tunnel throughout the length (10.96 km) for maintenance & Emergency relief Purpose. This road is constructed adjacent to the railway track.
3. The Pir Panjal tunnel passes approx 440m below the existing Jawahar Road Tunnel.
4. The alignment of Fir Panjal tunnel crosses the NH – 1A at three locations.
5. First large scale use of NATM method in India.
6. Usage of Road headers adopted for the first time in India.
7. Highest overburden of 1100 m
8. Usage of geotechnical Instruments for routine monitoring, assessing the stress redistribution and stabilization before final Lining.
9. The total Excavation Quantity is of 11 lacks cum. Rock bolting of 3,15,000 m.
10. Progressed Parallel activities (such as overt lining & excavation works) by introducing Invert Bridge

## Vietnam tops region in new bridges and tunnels

**V**iet Nam has been listed among developing countries expected to lead the region in transport infrastructure growth next year, according to a report from Construction IQ, a division of the New-York-based International Quality and Productivity Centre.

In its Land Transportation Outlook 2012, which focuses on the growth and development of tunnel and bridge construction in Asia, Construction IQ outlines project pipelines in Asia, revealing the largest infrastructure investments were gravitating towards the developing economies of mainland China, Viet Nam and India.

The report attributes the growth to the high number of urbanisation and modernisation initiatives being pursued by the governments of these countries. However, infrastructure investments in these

developing economies are also impeded by heavy red tape which increases overall costs and delays project implementation, said the report.

Notwithstanding these challenges, the overall outlook for the region remained positive as stronger bilateral relations between regional trading partners continued to drive road and infrastructure investments aimed at connecting far-flung regions, such as expansion of the Asia Highway network that would eventually connect Southeast Asia with China and key Central Asian economies.

Among developed economies in the region, meanwhile, notable bridge and tunnel projects included the US\$9.7 billion Seoul underground road network project in South Korea and the \$11.3 billion Macau-Zhuhai Bridge project in Hong Kong.

## Pan-Asia Railway – Xiushan Tunnel completed

**T**he Xiushan Tunnel of the Yuxi-Mengzi line of the Pan-Asia Railway was successfully completed on the morning of January, 10th 2012. This is Yunnan province's longest railway tunnel.

The Xiushan Tunnel is more than 10,300 meters long, and ranks second among high-risk tunnels around the country. It is located in an area full of seismic activity in Tonghai County, Yunnan Province. The region is famous for its complex geological conditions, frequent changes of surrounding rocks, water and mud bursts, making construction extremely difficult.

The Yuxi-Mengzi line, the key part of Eastern Line of the Pan-Asia Railway under planning and construction, has a full length of 141 kilometers and is designed as a first class national electrified railway with a design speed of 120-kilometer per hour.

The total investment for the line amounts to 4.5 billion yuan. After being put into operation this year, the Yuxi-Mengzi Railway will become the first domestic section of the Pan-Asia Railway in operation and will play an active role in facilitating land trade between China and the ASEAN.



## Neelum Jhelum Hydropower Project

**P**akistan Water and Power Development Authority (WAPDA) is deploying two state-of-the-art tunnel boring machines (TBMs) at a cost of Rs8 billion on the strategically important 969 MW-Neelum Jhelum Hydropower Project. This will reduce construction period of the project by about 18 months, resulting in an estimated benefit of Rs.60 billion. The two German-manufactured TBMs, being imported by the contractor, are expected to reach Pakistan soon.

The scheme consists of underground powerhouse, diversion tunnel, de-sander and main tunnels. The Neelum Jhelum Hydropower Project, scheduled to be completed in 2016, will provide about 5.15 billion units of electricity annually to the national grid. He further said annual benefits of the project have been estimated at Rs45 billion, adding that the project will pay back its cost in about seven years. Overall progress on the project stands at 30 per cent. Some 18.5-kilometer long tunnels and adits have so far been excavated; while the crucial diversion tunnel to divert the river Neelum has also been completed in October 2011 in a record time of two years. Construction work on all the three sites is in full swing. The powerhouse is progressing as per schedule, while work on transformer hall is ahead of schedule. Redesigning of the project in the wake of devastating earthquake of 2005, delay in acquisition of land and unstable supply of electricity have been the major challenges for the project and increased the initial proposed costs.

Australasian Tunnelling Society website  
[www.ats.org.au](http://www.ats.org.au)

# CHINA'S NUCLEAR MISSILE TUNNEL SYSTEM



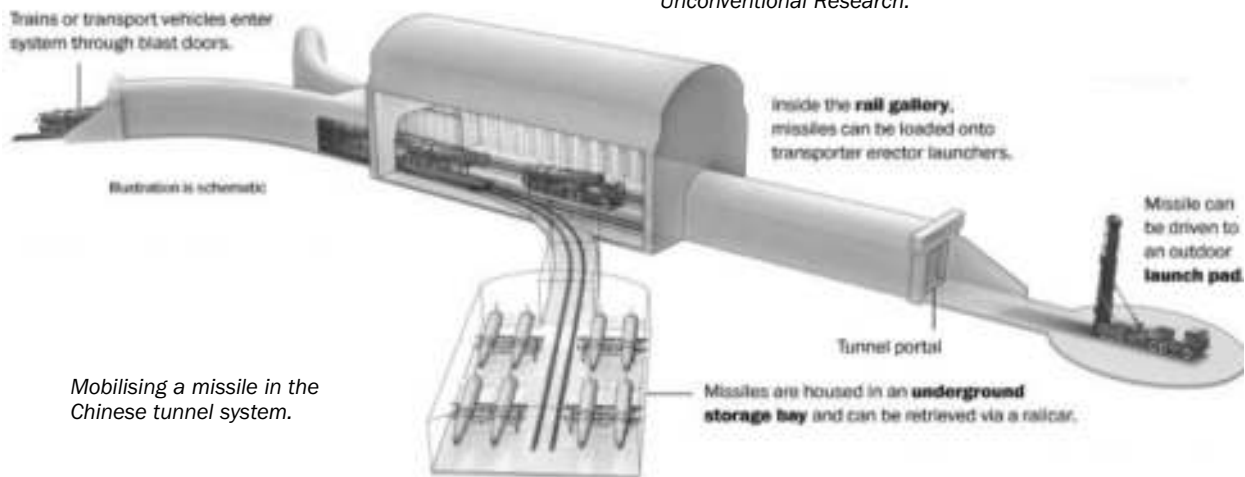
**T**he military branch in charge of China's nuclear arsenal has acknowledged building a network of tunnels more than 3,000 miles long. For the past three years, a team of Georgetown University students has studied those tunnels, led by their professor, a former senior Pentagon strategist. Using translated documents, satellite imagery and online video reports, the students and their professor concluded that China could have many more nuclear weapons than previously assumed hidden in those tunnels.

Each network of tunnels leads out to multiple redundant openings in case of attack, in which an enemy may try to block missiles from getting out to launch.

The students based their findings on not only traditional sources such as major books, journals and strategy manuals, but also on non-traditional sources, including the mapping software Google Earth, Chinese television coverage and military websites and blogs.



*Unconventional Research.*





# Tunnel Dreams: Linking Korea and Japan

**T**he Construction and Economy Research Institute of Korea, an industry mouthpiece, is again raising an age-old dream of Korea's construction industry, a 235-km tunnel linking Korea and Japan.

The proposal for a Japan-Korea tunnel has been on the table since at least 1917, and by August 1942, at the height of Japan's Greater East Asia Co-Prosperity Sphere, the South Manchurian Railway Co. planned an 8,000-km rail network stretching from Manchukuo to Singapore. Japan's defeat in World War II put that notion on a rear burner. It has been revived periodically, but Korean news media outlet the Chosunilbo reported in 2007 that construction would cost an astronomical 60 trillion (US\$52.1 billion) to 100 trillion (US\$88.8 billion) and take 15 to 20 years to complete. That is more than five times the cost and three times the construction time of the Channel Tunnel between the UK and France, which has the longest undersea portion in the world.

The shortest straight-line distance between Korea and Japan, using the strait islands Iki and Tsushima, is about 128 km. But the tunnel would have to be much longer. It would be designed to become a part of the Asian Land Transport Development project endorsed by the ESCAP commission, which comprises the Asian Highway, Trans-Asian Railway and a series of land transport projects intended to would create a huge system stretching all the way west across Asia to Europe and down to Singapore in the south. The tunnel would make it possible to drive from Fukuoka, Japan to the UK.

Korea has many mountains and many tunnels. The Jungang Highway tunnel is 4,400 meters long. Seoul Subway Line 5 is nearly 50 km. The bullet train Gumjeong tunnel is 20km long. Japan has serious tunnelling pedigree,



too. As long ago as 1880, an 868 meter tunnel – the aggregate achievement of imported technologies – was completed at Kurikoyama. The 22,000 meter Daishimizu was the world's longest tunnel at the time of its completion in 1978.

Then there's the Seikan tunnel. The Japanese public called for a massive coalition of engineering and investment to be brought about in order to attenuate the future risks of crossing the Tsugara Straits following a 1954 Toya-Maruferry accident in which 1430 people died. Any comparative exercise using the Seikan's numbers illuminates the formidable scale of a Korea-Japan tunnel. The 168,000 tons of steel used is enough for 42 Tokyo Towers. Its 21,540 track slabs are, if stacked, 1.2 times the height of Mount Fuji. It required 2,860 tons of explosives. A staggering 13.8 million workers were involved in the Seikan's construction –about a quarter of the then-working population of Japan. So ponder the resources a 235km tunnel linking Korea and Japan might involve.

## Plan to build 11 tunnels on Pakistan-China border

The Union government is planning to build 11 tunnels in the strategically important road stretches close to the Pakistan and China borders. Two more tunnels will be built in Uttarakhand to improve connectivity in the hilly state. These all-weather tunnels, which will be built by the Border Road Organization (BRO), would cover about 89km. These tunnels are expected to help rapid mobilization of troops and equipment besides providing better connectivity to local residents, officials said.



# Wuhan and Chinese Tunnel Vision



**W**uhan, like many other cities in China, has a view of the future that is to some extent tunnel-visioned. The city of 9 million people in Central China has just published an ambitious plan: every year from 2012 to 2017 it will build a new subway line. At the end of 2017, the new subway system will stretch over 215 kilometers.

Ten Chinese cities now have a total of 31 subway lines, stretching more than 800 kilometers. Recently the State Council ratified municipal subway construction plans for 22 cities with an investment of more than 882 billion yuan (\$139 billion, 106 billion euros).

Clearly, China has become the world's largest underground railway construction market. However, the subway boom in a developing country like China has raised questions at home and abroad, with critics questioning the necessity of building them in so many cities, with the heavy loads of local government debt that they bring.

While subway construction seems to have unstoppable momentum now, it does raise issues that ought to be carefully considered. In the US, when the automobile industry was booming the construction of public transport focused on cars. Many years later governments worldwide agree that subways offer critical help in alleviating pressure on public transport.

Now in metropolises worldwide, the volume of subway transport accounts for more than 50 percent of public transport patronage. In some cities the rate exceeds 70 percent. For example, Paris has a population of more than 10 million, and an annual traffic volume of 1.2 billion. Nearly 70 percent of those people use subways. In Tokyo, the rate can be as high as 86 percent. And many cities with populations of less than 1 million, such as Boston, Ottawa, and Frankfurt, have vigorously expanded their subway systems.

So it can be seen that with the rapid growth of China's economy as well as the urban population, the country needs to expand subway construction in some cities that have the right conditions. Local governments need to carry on this project with a perspective that looks far into the future.

According to statistics, China's rate of urbanization rose from 30.5 percent to 46.6 percent between 1996 and 2008. The rate is expected to increase to 60 percent in 2020. China will then have 620 million people living in cities,

among whom more than 480 million will live in metropolises that have more than 1 million inhabitants.

The total number of those in China living in cities is nearly double that of the total US population, and a quarter more than that of the European Union. The annual net growth of Chinese urban population ranks first in the world, as does the scale of urbanization.

Among the 655 cities in China, 23 have population exceeding 2 million, and 35 have population of between 1 million and 2 million. The sheer size of cities is pushing local governments to invest more on subway building to reduce transport pressure. So there is nothing less surprising than seeing many Chinese cities digging underground to provide solutions.

More and more Chinese are looking forward to having subways in their cities. Last year a study was made of people's preferences in public transport, and 60.6 percent of the surveyed hoped to build or expand subways in their cities, which, they said, are convenient, environmentally friendly and punctual.

As is the case elsewhere, subways in China are built to serve the public rather than to generate profit, and the underground railways are helping to push the process of urbanization, narrow the gap between urban and rural areas, and boost the development of local economies. Subway construction has also helped deliver social development and environmental protection.

So subway projects should not simplistically be judged by the bottom line. Unlike most subways in the world that lose money every year, the system in Hong Kong is an exception. So in talking about building subways the emphasis should be placed on improving the environment, whether that be to do with matters of space, traffic, ecological or social concern.

Wuhan is a typical Chinese metropolis whose layout is changing from "main city and scattered satellite towns" to "main city zone and newly developed areas".

In such an open city structure, only a complete subway system can effectively support the development of the main city area and the inter-connected newly developed areas. There is no doubt that the huge subway project in Wuhan will boost the city's development. Subway traffic will account for more than 35 percent of public transport. As interchanging becomes more convenient, the

importance of public transport will increase, and as the time to make long-distance trips is reduced traffic congestion will be eased. This in turn will help new city districts and key industries to develop.

In cities such as Shanghai, Chongqing and Chengdu, subway lines have halved commuting times and local residents can traverse main city zones in half an hour.

At the same time, the investment environment in Shanghai, Chongqing and Chengdu has improved markedly. For example, Chengdu, a city in Southwest China, is trying to build an international garden city, with one important step being to expand the subway. It is planned to have nine lines operating in 2020. Those lines will not only reduce the pressure on public traffic but connect the scattered towns with the beautiful scenery around Chengdu. Already, thanks to the subway, many small towns around the main city zone are in the “half-an-hour business zone” of Chengdu.

None of this is to say that a boom in subway building does not throw up problems. While a system does exist for examining and approving plans for subways in China some cities have fallen short of the mark in this regard. For some officials, ostentatious subway projects are even regarded as a badge of honour in flaunting their achievements. That can result in unrealistic schedules that pose risks to safety and to the environment.

## Yellow River ‘Throat’ tunnel completed

**A** tunnel beneath the Yellow River, China’s second longest, has been completed for the eastern route of the country’s giant south-north water diversion project.

Water diverted from the Yangtze, China’s largest river, along the eastern route will flow through the tunnel to the parched northern provinces of Shandong and Hebei as well as Tianjin Municipality, the Shandong Provincial Construction Management Bureau of South-to-North Water Diversion Project said.

Dubbed the “throat” of the eastern route, the 585-meter-long tunnel, 9 meters in diameter and up to 70 meters deep, will divert 442 million cubic meters of water annually. The eastern route cost 613 million yuan (US\$97.2 million) and work lasted four years.

The south-north water diversion project was first conceived by Mao Zedong in 1952 and the State Council approved it in 2002. The project, with an estimated total cost of 500 billion yuan, has aroused global concerns over land use, possible regional climate changes, environmental damage, impact on agriculture and human suffering through relocations.

The project plans to divert 44.8 billion cubic meters of water annually to north China by 2050. The 1,467-km-long eastern route began in 2002 and is expected to supply water by 2013.

## Lowari Tunnel

**T**he people of Chitral for whom traveling out of the district in winters was a nightmare till three years back, are now enjoying the benefits of the Lowari tunnel.

The idea of a tunnel through the mountains of Lowari to provide road access was first presented in the West Pakistan Assembly in 1956 by Chitral’s representative Ataliq Jafar Ali Shah, who pursued it despite the idea being termed unfeasible by the then government. In 1965 again as Member of the assembly he took it up as his passion and priority but it didn’t work and he didn’t give up.

It was in 1973 that as an MNA, the late Ataliq got a unanimous resolution passed in the National Assembly demanding immediate construction of the Lowari tunnel. The resolution was supported by both the Govt and opposition leaders including stalwarts of the time Khan Abdul Qayum Khan, Molana Mufti Mehmood, Khan Abdul Wali Khan, Mumtaz Dolatana, Nawabzada Nasrullah Khan etc. As a result, the Govt of ZA Bhutto shaheed initiated the construction of the tunnel. However after the ousting of the government the project was abandoned.

New priorities cropped up with time. It was in 2004 that the then President Musharraf’s government with an aim to connect Pakistan to Central Asia, reinitiated the tunnel at the same place and same design and today we can use the tunnel to our relief.

Besides passengers, the transportation of everyday usage goods, post and parcels, newspapers, medicines etc have all added to make life easier than, when we did not have the tunnel. The takeover of management of the tunnel by the FWO has made travelling through the tunnel more like it and people are now actually enjoying the blessings of the Lowari tunnel

Meanwhile Senior Minister Khyber-Pakhtunkhwa and parliamentary leader of ANP has told the provincial assembly that work on Lowari Tunnel is in its final stages, but that work on it had stopped due to chilly season and snowfall.





## Kohat tunnel

**B**uilt at a cost of Rs6 billion, the Kohat Friendship Tunnel has virtually been turned into a black hole due to non-repair of lights and the exhaust system, which were damaged by militants, causing nuisance to passengers.

Sources said that the National Highway Authority failed to renovate the tunnel connecting Peshawar with the southern districts of Khyber Pakhtunkhwa for the last few years though it's been generating road tax worth millions every month since its opening in 2003. The contractor company closed the tunnel for repair in its first phase for 10 days in April last year.

The NHA had decided in 2009 to float tenders to install new lights and exhaust system with a cost of Rs400 million after it was damaged by militants in 2008. But although

they claimed Rs7.5 million, little repair work has been carried out which turned into a dispute between the NHA and the company. The exhaust fans, imported by the Japanese construction company, were sold for scrap, but new ones had not been installed.

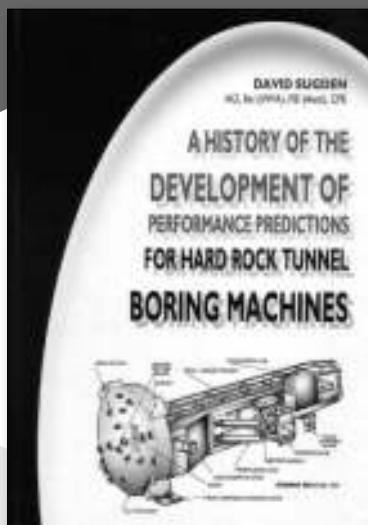
Some sources claim that some of the exhaust fans and lights were in working condition, but due to negligence in annual repairs they developed irreparable faults. The price of one exhaust fan was Rs10 million whereas the lights had to be imported from Italy.

At the time of the tunnel's construction it was proposed that with the increase of rush, a second tunnel would be built by the NHA, which had got the training from the Japanese company. In that time the NHA had said that the second tunnel would be constructed in 2011, but the number of vehicles using the tunnel passed the limit within three years of its opening. The 1.89-km tunnel has cut the travel time between Kohat and Peshawar by 20 minutes and unlike Kotal Pass it allows longer goods vehicle to pass through it.

Now the railways department is considering constructing a new tunnel and starting a train service between the southern region and Peshawar. Thousands of people daily go to Peshawar offices and return the same day. Similarly, people also go to Peshawar to catch a train for Karachi. Besides thousands of students the overseas Pakistanis would also get a convenient mode of transportation from Peshawar to southern districts with the launch of train service.

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## Algeria's long-awaited metro

**T**housands of people have used the underground metro in Algeria's capital, Algiers, after it finally opened 28 years after construction first began.

The 10-stop, 6.5km (four mile) line is only the second rail system of its kind in Africa, after the one in Cairo.

After work began in 1982, work was halted because of an economic crisis and a decade-long civil war. Algeria went through 10 years of civil unrest as government forces fought an Islamist insurgency and as many as 250,000 people lost their lives.



The first passengers were able to use the metro a day after it was officially launched by President Abdelaziz Bouteflika. Security was tight when the metro opened, though many of the police officers were showing passengers how to use the ticket machines and escalators.

Algerians are reported to be proud of their new rail network, which connects Algiers' Central Post Office to the suburb of Kouba.

Work on the project was first interrupted when a collapse in worldwide oil and gas prices sent Algeria's economy into free fall. The country is the world's fourth-largest exporter of natural gas. The metro cost an estimated 90bn dinars (\$1.2bn; £750m) to build.

A single journey will cost 50 dinars (\$0.67; £0.47) – a price many Algerians have complained is too high.



## Abu Dhabi opens more sections in tunnel project

**A**bu Dhabi authorities have opened more sections of a Dh5billion tunnel project to traffic as they are pushing ahead with plans for a full completion. Officials said more than 80 per cent of the entire project has been completed and they expect the tunnel and surface roads to be fully operational nearly four years after the project was launched.

The parts which recently opened are located between Khalifa, Hamdan, Salam and Mina streets in the heart of the capital while the tunnel itself has yet to be opened for traffic, officials in Abu Dhabi municipality said. "This project will largely contribute to easing traffic congestions in the city.....it will also improve the environment by reducing emissions as the tunnel means much fewer cars will be on the surface road," said Abdullah Saeed al Shamsi, director of the infrastructure division at the municipality.

The Salam street tunnel on the capital's eastern flank had been due to be completed at the end of 2010 but was delayed because of technical and topographical reasons, according to the municipality. "The project will be fully commissioned at the end of the year or in early 2011..... there has been a delay in some areas but this is normal in such big projects anywhere," said a municipality official. He cited such factors as a large network of power and water cables and pipes, which he said had to be avoided during the construction process. Another factor is that the tunnel passes under a densely populated area, which means it is being constructed in a difficult topographical environment.

South Korea's Samsung Construction is carrying out the project, which will also link the mainland to the nearby Reem Island, where at least 100,000 inhabitants will live. The causeway to the island has already been completed. More than 2,000 workers have been involved in the construction of the three-km tunnel, which starts from the eastern entrance of Abu Dhabi city and runs under Alsalam street towards Port Zayed on the western tip of the capital. Around two kilometres of the tunnel would be embedded nearly 15 metres underground while the rest would be open and near the surface level. Officials said the tunnel is part of a long-term blueprint by Abu Dhabi to expand its inhabited areas and road networks to cope with a sharp rise in the population, which officials expect to nearly triple in the next 20 years.

# RIKOTI TUNNEL – GEORGIA

**G**eorgian President Mikheil Saakashvili has opened a rehabilitated Rikoti Tunnel. Emphasizing the importance of tunnels for connecting different parts of Georgia, especially in the mountains, President Saakashvili stressed the importance of the main highway connecting the east and west regions of the country. Worrying about the situation at Rikoti before the Rose Revolution in 2003, Saakashvili recollected the poor infrastructural conditions of the main highway. Welcoming modernization of the tunnel the president expressed his gratitude towards the World Bank for sponsorship and local workers for implementation of the project.

“It is always harder to reconstruct the tunnel rather than building a new one considering the internal infrastructure,” said the president sharing future infrastructural plans about Svaneti, Racha, Kazbegi and Adjara. Having walked the tunnel with Ramaz Nikolaishvili, the Minister of Regional Development and Infrastructure in ten minutes, the president said they would start constructing a four times longer tunnel in Stepantsminda, Kazbegi region in autumn, 2012. “Georgia is a mountainous country and we are facing new challenges nowadays,” Saakashvili said emphasizing the benefits of tunnels which can effectively shorten routes. “Roads are a great economic stimulus for uniting the country and overcoming the feudal mentality and dismemberment within the country,” he stated.

Saakashvili also hoped that local workers would consider the experience of foreign specialists, and master construction skills so well that soon they would start building similar tunnels abroad. The 1,750-meter long tunnel, equipped with modern facilities, has been reconstructed under the special patronage of Minister Nikolaishvili who emphasized the benefits of the restored tunnel. A modern lighting system, emergency telephone points, and video surveillance are part of international standards which according to Minister Nikolaishvili have made the rehabilitated Rikoti tunnel so special.

The USD 43 million restoration process engaged 250 workers from the regions, who dealt with construction since July, 2010. The passengers welcomed the opening of the main Georgian highway. Stressing he would keep the promise of building more tunnels in the mountainous parts of the country, Saakashvili wished health to the Minister of Infrastructure, who had taken the responsibility to ensure safety in the newly reopened Rikoti Tunnel.



## Eisenhower Tunnel fire system upgrade

**C**olorado transportation officials are hoping to convince Congress to pay for a \$20 million fire-suppression system inside the Eisenhower-Johnson Tunnels on Interstate 70 west of Denver.

It would be an advanced foam-spraying system capable of putting out fires automatically before they can spread, according to the Colorado Department of Transportation. It's an effort to make I-70 safer for trucks carrying hazardous materials through the Rockies.

The fire-suppression system the state wants to install is designed to automatically douse flames before they can spread and claim lives in the tunnel. Without that system, the state sends tanker trucks with hazardous cargo around the tunnel on a route the trucking industry hates to use over Loveland Pass.

With one lane each way, the steep and often icy highway has switchbacks, hairpin turns and little or no shoulder. CDOT doesn't like sending the trucks over the bypass.

CDOT says all of Colorado's members of Congress are supportive of the project, but it's unclear if they can win enough support from the rest of Congress to get the fire suppression system installed.

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## Toronto City Airport pedestrian tunnel

**T**he pedestrian tunnel linking Toronto to the Billy Bishop island airport is in its final design stages and construction will start soon, says the president of the Toronto Port Authority.

Geoff Wilson confirmed that a groundbreaking ceremony for the public-private partnership tunnel is set to take place sometime in February, with construction expected to take two years.

Late last year the TPA announced that Forum Infrastructure Partners, which includes PCL, Arup and Technicore, will design, build, finance and maintain the tunnel. While final details are still being ironed out, Wilson said the structure will be a “spectacular piece of infrastructure.”

The tunnel will be 240 metres long, both above and below ground. Passengers going into the tunnel from the Toronto side will enter the tunnel through a pavilion and head down through elevators. There will also be “dramatic” elevator banks that head straight into the terminal.



## Squirrel Hill Tunnels Renovation

A multi-year renovation of the 56-year-old Squirrel Hill Tunnels on Interstate 376 gets underway in the spring. The \$50-55 million project includes repairs to the tunnel walls, removal of the ceiling and increasing clearance, repairs to the arched roof, removal and replacement of wall tiles, repairs to the concrete surface, milling and resurfacing the tunnel roadway, repairs to the drainage system and leaking expansion joints, new temperature and carbon monoxide monitors, and new cameras. Work is to be finished by winter 2015.

## NYC plans \$2 billion project to bypass section of leaky water tunnel

**N**ew York City plans to spend \$2.1 billion to fix leaks in the Delaware Aqueduct, one of the underground tunnels bringing drinking water to the city from its upstate reservoirs.

The tunnel has been leaking since the 1990s and currently loses up to 35 million gallons of water each day.

The city's Department of Environmental Protection has released a Draft Environmental Impact Statement detailing the planned project, which is to start in 2013.

Under the plan, the DEP will break ground in 2013 to make a tunnel around a section of the aqueduct that's leaking into an area around Newburgh. The 2.5 mile long tunnel is to be finished by 2021. The DEP also plans to repair leaks in the Town of Wawarsing from inside the existing tunnel.



## D.C. to build sewage tunnels to cut pollution

**T**he District of Columbia is preparing to start building underground tunnels big enough for Metrorail cars. But the only things that will commute through these pipes are stormwater and sewage.

Officials with the D.C. Water and Sewer Authority, which operates the Blue Plains Advanced Wastewater Treatment Plant, are to break ground next week on the \$2.6 billion project, which is meant to end to polluted discharges into waterways.

The city will build two tunnels as part of the project. The Anacostia tunnel will extend from Blue Plains along the Anacostia River to near RFK Stadium.

Another tunnel will run 120 feet underground alongm Street SE between Ninth and 14th streets. The pipes will retain stormwater from heavy rains so it can be treated to remove filth before being released into the Anacostia and Potomac rivers, as well as Rock Creek.

The District operates a single pipe to handle a combination of stormwater and sewage in a third of the city. It performs poorly during rains. Overwhelmed by a mixture of stormwater and wastewater, it threatens to bubble back up into the toilets and sinks of homes and businesses.

D.C. Water releases the untreated waste into waterways to avoid the backup. About 75 times per year, 1.5 billion gallons of untreated wastewater is dumped in the Anacostia, 850 million gallons is released into the Potomac, and Rock Creek receives about 52 million gallons of untreated overflow, according to D.C. Water.

The Anacostia is one of the nation's dirtiest urban rivers, and the Potomac is heavily polluted. The tributaries contribute to fouling the Chesapeake Bay with nitrogen and phosphorous that create muck and "dead zones" that rob oysters, mussels and fish of oxygen.

When the new pipes are completed, the combined sewer will divert water to them Street pipe, which will feed it to Blue Plains for treatment. Construction of that pipe will affect traffic on a busy stretch ofm Street near Nationals Park. Parts of the project are scheduled to be completed in 2018, but it won't be totally completed until 2025.



## Hitachi Zosen to supply Alaskan Way TBM

**F**ollowing the recent signing of a contract with Seattle Tunnel Partners (STP), Japan-based Hitachi Zosen Corporation will supply a TBM to bore the US\$1.35 billion SR 99 tunnel project (Alaskan Way) in Seattle. Three other firms also vied for the contract, but Hitachi was chosen having satisfied technical requirements, support capabilities, price and schedule.

Hitachi can now complete the final design of the 17.5m-diameter machine, which will be barged to Seattle and assembled in early 2013. According to Washington State Department of Transport (WSDOT), the TBM will be launched from a pit near the Seattle sports stadiums where crews have already started demolishing the southern half of the viaduct.

In July 2011, Hitachi signed a letter of intent with STP – WSDOT's design-build contractor for the project. This allowed the Japanese TBM-maker to begin its preliminary design soon after. WSDOT says it will pay STP approximately US\$80 million for the machine, an amount included in the project's US\$1.35 billion contract.

Utility relocation and other preliminary tunnel work is about to take place, with excavation of the tunnel launch pit commencing next year, followed by tunnel boring in mid-2013. The tunnel is scheduled to open to drivers in late 2015.



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# \$66B Tunnel to Connect Russia and America

**I**n what is likely to be the realization of a much desired infrastructure dream project linking Russia and North America, the construction of the world's longest tunnel, spanning the Bering Strait, was approved by the Russian Government late last year.

The 65 mile long tunnel, twice the length of the British Channel Tunnel that connects Britain and France, is being planned to be built in three sections and will pass under the Big Diomedes and Little Diomedes islands in the Bering Strait. The cost of building this Bering Strait Tunnel is being estimated at around \$65 billion.

The project is envisaged as being part of the much larger 3,700 mile railroad project that is being built to connect Yakutsk in Russia to Canada's British Columbia and will offer a highway, high-speed rail tracks, a fiber optic network as well as pipelines for oil and gas.

## Project History

The idea of a direct rail route and bridge spanning across and linking North America with the EuroAsian region was first conceived more than a century ago in 1905 by Tsar Nicholas II. With technological limitations at the time however, constructing such a mammoth-scale project was not possible. Neither Siberia nor Alaska currently has rail route links that connect the farthest points of their respective territories.

The project, recently approved by the Kremlin, has been revived after being shelved earlier in 2007. The project, reportedly brought to the discussion table by Aleksandr Levinthal, a high-profile Russian politician at a conference that focused on the development of Russia's northeastern rail infrastructure, will be in the form of a PPP – private public partnership.

According to a statement made by Viktor Razbegin in an interview to Russia Today, an official from the Russian Ministry of Economic Development, "The project is already underway... The rail track to Yakutsk that we have been building for the past 15 years has always been seen as the first part of the road. It will be finished in just about a year."

Expressing some concern over political hurdles that yet need to be overcome, Razbegin added "However, the most important is the political decision which hasn't been taken yet. There are multiple countries involved, and it will be hard."

And yet, while the project looks more real than ever before, it will be a long wait before the entire link starts

functioning across its different components. Estimates say that the tunnel alone will require 15 years to be built, while the entire network, including the railway system which needs to be constructed on both sides of the Bering Strait is likely to be complete by 2045.

## Logistical Benefits

Given the strategic role a direct rail link between North America and Russia would play towards boosting trade and tourism, the Bering Strait tunnel is obviously expected to offer immense economical and political advantages.

The manner in which this project is being planned, the rail link will literally connect the Siberian interior with the US east coast, resulting in a railway network across 3/4 of the Northern Hemisphere. What this means is that tourists would be able to travel overland, from Europe to New York city, with the journey helping save travelling time while also opening up an entirely new experience across landscapes and climates.

Contributing significantly towards transporting raw materials from inland Siberia to the US and beyond, the tunnel will present the potential for freight rail to carry up to 100 million tons annually.

In addition these direct infrastructural benefits, the Bering Strait tunnel is also likely to facilitate an impressive energy generation by helping develop a link between North America and Asia for renewable energy transmission. Proposed tidal energy plants could provide 10 gigawatts of energy and a string of wind power fields could churn a constant supply of clean energy.

## WVU tunnel plug

**W**est Virginia University researchers have conducted a successful test of a plug aimed at isolating sections of transit or rail tunnels in the event of an emergency.

The Morgantown school says the test was done by researchers with the College of Engineering and Mineral Resources. The Resilient Tunnel Plug is meant to be used in response to events such as flooding, the release of chemical or biological agents, or other threats.

The plug is an inflatable structure capable of blocking the flow of pressurized liquid and gas through a tunnel. Testing was performed in WVU's full-scale tunnel facility.

Development of the technology is conducted in partnership with the Pacific Northwest National Laboratory and ILC Dover under the sponsorship of the Department of Homeland Security.

# CHICAGO'S DEEP TUNNEL

**F**ederal and state authorities recently unveiled a legal settlement intended to finally complete the Deep Tunnel, the Chicago region's massive flood- and pollution-control project.

Relief from swamped basements and sewage overflows still is years away, however. The deal brokered by the U.S. and Illinois Environmental Protection Agencies and U.S. Department of Justice formalizes deadlines to finish sections of the Deep Tunnel, but the entire system won't be completed until 2029.

Most of the settlement adds legal teeth to the Metropolitan Water Reclamation District's latest construction schedule for the Deep Tunnel, which has been repeatedly delayed by funding woes and engineering hurdles. Officials broke ground on one of the nation's most expensive public works projects nearly 40 years ago.

While the water reclamation district keeps working on two massive flood-control reservoirs, it will also be required to invest in more small-scale "green infrastructure" projects that allow storm runoff to seep into the ground rather than drain into sewers.

Local officials once scoffed at the idea, now considered critical for a city built on a swamp. Under the settlement, if the district misses deadlines for completing portions of the Deep Tunnel reservoirs, it must build more rain gardens, green roofs, pervious pavement and other projects to sop up stormwater.

Environmental groups that sued for improvements were more cautious. They called the required green infrastructure projects limited compared with the scope

of the region's flooding problems and lamented that it still will take decades to finish the Deep Tunnel.

Like many older cities, Chicago long ago built sewers that combine waste from homes and factories with storm runoff. When it rains, neighbourhood sewers quickly fill up and spill into local streams through overflow pipes. If waterways are saturated to capacity, locks and gates to Lake Michigan are opened to curb flooding of streets and basements.

Deep Tunnel was supposed to fix the problem. But the Tribune reported in March that billions of gallons of bacteria-laden sewage and runoff still routinely pour into the Chicago River and suburban waterways during and after storms. Lake Michigan, long considered the sewage outlet of last resort, has been hit harder during the past four years than it was in the previous two decades combined.

Taxpayers already have spent \$3.3 billion on the Deep Tunnel. The first section, a 130-mile labyrinth of giant tunnels, went online in 2006 and was designed specifically to "eliminate waterway pollution." But while building the project, district officials realized they would need to rely more on flood-control reservoirs at the end of the tunnels.

District officials say Chicago's system will improve once a reservoir in south suburban Thornton is completed in 2015. Another reservoir in southwest suburban McCook – 11 times larger than Soldier Field – will store floodwater from an area that stretches from Wilmette through Chicago to Cook County's southwest suburbs. Part of the converted quarry is scheduled to be done by 2017, and the settlement requires the entire project to be completed by 2029.

## Port of Miami TBM fired up

**T**he \$45 million TBM has been fired up, its systems tested and all is go to start drilling the \$1 billion Port of Miami tunnel.

A day after receiving the final environmental permit from state regulators, Miami Access Tunnel, the project concessionaire, set the start of drilling.

The machine is expected to take six months to reach the port's Dodge Island, and six months to dig the separate return tunnel to Watson Island.

To speed issuance of the permit, MAT officials temporarily dropped one controversial aspect of the plan: depositing tons of soil from the dig on ecologically sensitive Virginia Key, where the city of Miami hopes to use it to cap an old landfill as part of an environmental restoration project.



MAT expects to apply for a permit modification once the first few thousand cubic yards of soil from the dig is tested for contaminants. MAT and city officials say sample borings came up clean and they expect the soil to pass environmental muster for use on the island.



## CrossRail

### First tunnel boring machine unveiled

**E**urope's largest construction project has unveiled the first of eight, TBMs that will construct the new Crossrail tunnels under central London.

To construct the 21km of twin-bore tunnel required for Crossrail, eight tunnel boring machines will be required and will undertake ten individual tunnel drives to construct the 6.2m diameter tunnels. The TBMs will bore the tunnelled section of the 118 kilometre rail line that will link Maidenhead and Heathrow in the west with Shenfield and Abbey Wood in the east. The TBMs will run 24 hours a day, 7 days a week stopping only for scheduled maintenance.

The 140 metre long, fully assembled tunnel boring machine is currently undergoing factory testing. The machine will then be dismantled and shipped to London where it will be re-assembled at Westbourne Park ahead of tunnelling commencing from Royal Oak in March 2012.

The eight Crossrail TBMs are being manufactured by Herrenknecht AG, Germany who also manufactured tunnel boring machines for the Jubilee Line Extension and the Docklands Light Railway (DLR) Extension to Bank.

Following the launch of the first TBM in March 2012, a second TBM will be launched from Royal Oak a few weeks later. The remaining TBMs will be launched from Limmo Peninsula in the Royal Docks heading towards Farringdon in late 2012; from Pudding Mill Lane and Plumstead in 2013 and from Limmo Peninsula to Victoria Dock in 2014.

When completed, Crossrail will bring an extra 1.5 million people within 45 minutes journey of London and reduce cross London journey times.

Construction of the concrete segment factory for the western running tunnels between Royal Oak and Farringdon is now complete at Old Oak Common. The plant began manufacturing over 70,000 segments for the western tunnels in January 2012.

Chris Dulake, Crossrail's Chief Engineer said: "Crossrail tunnelling will get underway in March 2012 when the first of eight tunnel boring machines will begin burrowing below the streets of London. Work is continuing across the Crossrail route to prepare for construction of the major new rail tunnels. The new Tunnelling and Underground Construction Academy has welcomed its first students and will train at least 3,500 people with the skills required to work below ground while the first of the tunnel segment manufacturing plants will shortly commence full operations."

### First tunnel portal complete

Crossrail has announced that the first of five tunnel portals as part of its new route has been completed ahead of schedule. The portal at Royal Oak will provide access for boring machines when they begin in spring 2012.

Meanwhile, construction of the Pudding Mill Lane portal has also commenced, while preliminary work has begun at the Plumstead and North Woolwich sites. The final portal at Victoria Dock will not be started until autumn 2012.



## Tyne Tunnel safest in UK

**A**n emergency exercise was staged in the original Tyne Tunnel just weeks before it reopened to traffic. The 1967-built tunnel was closed for eight months as part of the £260m New Tyne Crossing project, so it could be refurbished. The original fittings and walkways have been stripped out and replaced with state-of-the-art equipment, bringing the 44-year-old tunnel up to the same operating standards as the new Tyne Tunnel, which opened in February 2011.

The region's emergency services have worked with tunnel operator TT2 to develop a major incident plan, which was tested with a mock accident.

Ron Henderson, operations manager at the Tyne Tunnel, said: "I'm very pleased with the way the exercise has gone. Our staff found it invaluable as it allows them to test their reactions to a potentially serious incident to the full. The outcomes of the exercise have provided great reassurance ahead of the refurbished tunnel's commissioning. It's fantastic to be able to offer our customers the safest tunnels in the UK."

The emergency exercise featured a simulated chemical spill towards the northern end of the tunnel.

Tyne and Wear Fire and Rescue Service station manager Graeme Hurst said: "We sincerely hope an incident like this will never occur, but we do need to be prepared for worst-case scenarios. Fighting fires in tunnels is one of the most difficult types of incident to deal with. We have worked closely with TT2 over a number of years to install fire suppression systems in the tunnels. We are leading the way, with the Tyne Tunnels now being the safest in the country."

In addition to the specialised safety systems installed in the refurbished tunnel, a dedicated escape passage has been built. Paul Fenwick, project director, said: "Fitting the existing tunnel with a separate escape passage presented a real challenge at the design stage. The new features introduced through the refurbishment works have transformed the safety rating of the tunnel."

Trevor Jackson, managing director for TT2, the New Tyne Crossing concessionaire, said: "We are very grateful for the continuing support we receive from the emergency services and the Tyne and Wear Emergency Planning Unit. Their assistance has been invaluable, not only in helping us to test the emergency response at the Tyne Tunnel with an event like yesterday's, but also in working with us over previous years to develop a comprehensive safety plan for the tunnels."

## Turning tunnels into musical instruments

**T**he damp, dingy tunnels below Waterloo station in London are hardly your typical concert hall. But in September 2010, as part of the Mindful exhibition, artist Oliver Beer brought a choir down to create ethereal music by turning the space into a giant musical instrument. To make the space resound, the singers needed to tap into the natural resonant frequencies of the building. "You sing a high to low range of notes and you listen acutely," explained Beer, as he prepared for the inaugural performance. "At one point, if you sing really quietly under your breath, so that it's just a whisper of a note, suddenly it gets amplified and the whole room zings with something you don't believe you've created."

It's not the first time that Beer has attempted to make a space sing. As part of an ongoing series of performances and films called The Resonance Project, he has visited monasteries, the glass tunnel in the Pompidou Centre in Paris and, most recently, the sewer tunnels in Brighton. But this performance is the most intimate yet; it takes place in total darkness. Since the tunnels have an irregular shape, the resonant frequencies vary in different spots, so Beer asks the audience to walk around the choir. In certain sweet spots, the space rings.

After an hour-long practice, the performers were ready and an audience of 30 people were allowed to enter the darkened space. As the choir began to sing the canonical motif composed by Beer, we were quickly immersed in sound. Without being able to see your surroundings, it did actually feel like moving around the belly of a musical instrument. Interestingly, the lower male voices seemed to hit the resonant frequencies more often than the higher-pitched female ones.

Beer was pleased with the effect and hopes to continue exploring the natural resonance of different spaces; in particular he hopes to perform in the whispering gallery in St Paul's Cathedral. But he would also like to collaborate with mathematicians to accurately calculate resonant frequencies, to better predict the sound that will emerge. "For me," he says, "it's as much an aesthetic experience as it is a scientific one".

# London Underground's District Line roof strengthening

**I**n what is said to be the UK's largest application of ultra-high modulus composite reinforcement has been used to strengthen 90 cast iron beams supporting a covered way where London Underground's District Line runs under Victoria Embankment Gardens.

LU was concerned that the 7500mm x 500mm cast iron beams over the 19th century cut-and-cover tunnel could be overstressed if subjected to an unforeseen overloading. It sought a strengthening method which offered minimal impact on headroom, and which could be installed in 4h night-time engineering slots when trains are not running.

Reinforced steel was deemed too thick to be viable, so CarboDur Ultra High Modulus carbon fibre reinforced polymer from Swiss firm Sika was chosen.

The 7300mm x 200mm x 47mm thick plates were produced to exact dimensions, with end tapers to minimise peel stress and cut-outs where needed.



Specialist contractor Concrete Repairs Ltd grit-blasted the iron beams and prepared them with primer and resin before gluing the polymer plates to the beam sides and undersides, achieving an average of two beams per night.

## Automated Ventilation Control System in major tunnel construction

**I**denetec Solutions, a member of Identec Group, has announced the expansion of its Personnel Safety Solution Portfolio to include integrated Ventilation Control Systems for underground environments. The recent award of a ventilation contract for the six kilometer rail tunnel in Sweden's Norra Länken, further solidifies Idenetec Solutions leadership position as a personnel safety solution provider to the Tunnel and Mining industries.

Already deployed and operating, Idenetec Solutions automated Ventilation Control System was selected by Trafikverket, the Swedish agency responsible for the entire country's transportation systems including roads, rail, sea and flight. Destined to be a main transportation artery in Stockholm's center, the six kilometer rail tunnel relies on Idenetec Solutions automated Ventilation Control System to manage and monitor airflow. Notorious for their complexity, Tunnel and Mining industries deal with toxic materials, gases, dust, heat and humidity in enclosed underground spaces. Real time operational data and control is crucial for the safety of all personnel.

"The safety of personnel in underground environments is paramount," states Frank Wehus, General Manager, Idenetec Solutions Center of Excellence, Norway.

"By integrating automated Ventilation Control Systems with our Watchertunnel application, we are able to deliver a robust system that proactively responds and anticipates the requirements of underground environments."

Through the deployment of electrochemical sensors, Idenetec Solutions automated Ventilation Control System enables the constant monitoring of toxic gases, hydrogen and oxygen. Highly robust, the systems' infrastructure features a watertight design that protects against dirt and other contaminants. Furthermore, by integrating the Ventilation Control System with Watchertunnel, the system is able to anticipate and respond in a proactive capacity by monitoring the location and movement of all persons underground. Real-time alarms are dispatched when the sensors detect abnormal substance levels which instantly trigger an appropriate operational response.

"By combining deep Tunnel and Mining industry expertise along with a commitment to delivering innovative, relevant, and easily integrated solutions, we are able to provide uncompromising functionality and high value for our customers," states Gerhard Schedler, President and CEO, Idenetec Solutions.

# National Grid's London power tunnels

**A**n ambitious tunnelling project will help the UK's capital city keep up with rising electricity demand. Deep beneath the busy streets of north London, one of the largest engineering projects that the capital has seen in the last 50 years has reached a major milestone. In November 2011 at an underground site beneath Haringey, National Grid began assembling a 100m-long tunnel boring machine (TBM) – nicknamed 'Cleopatra' by local school children – that will spend the next four years creating the passages that will carry London's future electricity supply.

London currently accounts for 20 per cent of the UK's electricity usage – a demand that is increasing by between three and five per cent every year. In order to supply the city's substations with the necessary energy to keep up with demand, National Grid is constructing more than 30km of underground tunnels that will carry the 400,000V transmission line cables needed. One of the tunnels will also carry additional 132,000V cables to supply the distribution networks and so will need to be a metre wider.



'We're replacing old assets and increasing capacity, making sure we're looking at what the energy network is going to be doing in five, 10, 20 years' time,' said National Grid project manager David Luetchford. 'We'll be getting more from the east coast [for example]. The energy flows will change across the whole country over the coming years with renewables, and that affects everything.'

The 3m and 4m-wide tunnels will connect substations in Wimbledon in the south, Hackney in the east and Willesden in the west with St John's Wood, just north of central London. They will run underneath the Thames, Regent's Park and some of the most densely populated residential areas – and most expensive real estate – in the country. National Grid hasn't attempted a project of this

size and complexity since installing the SuperGrid in the 1960s, but it has some compelling reasons for thinking big.

Instead of digging up and replacing the old cables that are buried under the roads – adding years of roadworks to London's already chaotic transport network – the infrastructure company is creating an easily accessed space that will allow cable installation and maintenance to be carried out without any disruption to the public. It will also have room for additional cables that could be laid to meet future demand.



The tunnels will be deep enough that no noise or vibration will be heard or felt on the surface, meaning the crew will be able to work 24 hours a day, five days a week, to get the job done. Many London residents won't know it's going on at all, and those who live above the tunnels will only be aware of the work thanks to a substantial communication campaign by National Grid. But this has also meant major planning and surveying by the company and its main contractor, Costain, to navigate under – and occasionally over – London's existing sub-surface infrastructure.

The depth of the tunnels will vary between 12m and 60m, said Luetchford. 'The shallower you are, the more clashes there are with other tunnels. We're probably one of the deepest tunnels in London on average, because we go under the Underground in places but sometimes we go over. We've had to take the future position of Crossrail into account, and the future position of Tideway [the super sewer project] as it happens.'

Before any work could start on the tunnels themselves, 12 shafts were needed along the route, 10 of which have been started and four finished. The 15m-wide shafts, which provide access and ventilation, are up to 4km apart and will create a route map for the TBMs. 'By having those shafts in place, we make sure we don't tunnel any further than necessary,' added Luetchford. 'You design a temporary ventilation system for the tunnelling operation where you force air down to a ventilation duct at the face so you have fresh air at the face and a draft coming all the way back.'

But a permanent system is also needed to keep the cables cool, and that adds to the substantial amount of planning permission and easements that need to be secured. 'You don't need planning permission for what you're doing underground, but you need it for the surface structures,'

said Luetchford. 'Each shaft has a head house with a fan arrangement in it and then you need planning permission for the substations themselves.'

Getting a 100m-long tunnelling machine down the shafts would be quite a challenge, so the TBMs are put together underground, starting in a 60m-long concrete launch tunnel built by mechanical excavators. 'The machine comes in a series of bits, with a maximum length of 10m, and that process can take three to seven weeks,' said Steve Meadowcroft, Costain's tunnelling operations director.

Although building the machine is designed to be 'as close to plug and play as it can be', the launch is the hardest part of the process, he said. 'The difficult thing with tunnelling is getting it going. Once you get the first 2km out the way, the rest of it follows from there. You're establishing a cycle; you're establishing methods; you're getting the machine to work at its best. We have to launch the TBMs five times over the course of the project.'

The two machines are supplied by Caterpillar in Canada and Herrenknecht in Germany. Both operate at a speed of around 200mm/min, laying the concrete segments of the tunnel behind them as they go. Even though they can operate at between 300m and 400m a week, the team will likely take until at least 2014 to complete the tunnels.

But what makes modern tunnelling easier than with previous generations of TBMs is the electronic – rather than hydraulic – control systems. 'There are a lot more readouts that they can give you,' said Meadowcroft.



*Getting a 100m-long tunnelling machine down the shafts would be quite a challenge, so the TBMs are put together underground, starting in a 60m-long concrete launch tunnel built by mechanical excavators.*

'You can connect them directly via the internet back to the manufacturer, so if you have drive diagnostic issues you can speak to the manufacturer, which can look at the diagnostic as well. You get a greater degree of control and you can give the client greater feedback in terms of what the machine is doing.'

Information on the machines' progress will likely prove especially useful thanks to the relatively soft clay soil found underneath London. In order to minimise any surface disruption or 'settlement', the TBMs will use a process known as earth pressure balance (EPB), which involves putting pressure on the face of the tunnel behind an airlock in order to stabilise it.

Once the waste soil 'arising' have been passed down the TBM gantries and conveyed out of the tunnel, they will be put to a relatively unusual good use: sealing contaminated ground at former gas-holder sites in the city. 'We're taking all of our soil – London clay, which is impervious so a good sealing agent – and using it in gas-holder sites around London that will be decommissioned over the coming years,' said Luetchford. 'It cuts down the hauling distances so reduces the carbon footprint and it makes it into a useful material.'

None of this can happen quickly, however, and it will be 2016 before the first tunnel is energised and 2018 before the project is complete. But this is infrastructure built to last. 'The transmission network will always continue to develop,' said Luetchford, 'but these particular assets will be in place at least for at least the next 50 years.'



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# UK High-Speed Trains Will Tunnel Underground

**The biggest leap forward in Britain's rail network since the 19th century has been announced with a £32.7bn investment in high-speed rail linking London with Birmingham, Manchester and Leeds. The HS2 high-speed rail scheme would build critical infrastructure, providing vital capacity and faster journeys on trains carrying up to 1,100 passengers each.**

The network, to be running by 2026 and completed by 2033, will almost halve some journey times between England's biggest cities and make it significantly quicker to travel from the north of England and Scotland to London.

The Department for Transport unveiled several tweaks to the first stage of the HS2 route to mollify opponents in the wealthy commuter belt north and west of London. An important concession is the building of extra tunnels in the picturesque Wendover area which will minimise disruption to the landscape and everyday life. Construction work will not start until 2017 at the earliest, with the first stage of the route seeing trains in 2026.

The government confirmed that a link would be created in north London to the existing high-speed line to the Channel tunnel, meaning Birmingham could see direct high-speed services to Paris and Brussels in 14 years' time.

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*The network, to be running by 2026 and completed by 2033, will almost halve some journey times between England's biggest cities and make it significantly quicker to travel from the north of England and Scotland to London.*

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The last time a whole new line had been built was the grand central main line in 1899. Since then, the rail network has been used in a way the Victorians would be proud of.

The transport secretary admitted the high-speed option would cost "around 10%" more than the alternative of upgrading the present infrastructure and trains but said the benefits would be substantial. She likened her decision to that of postwar planners choosing motorways rather than better A-roads. Almost 55,000 people responded to the public consultation, she said, with strong feelings on both sides. The government will also be offering an improved package of measures to reassure homeowners, including streamlined claims schemes for blight and compensation, and before and after surveys for those near tunnelling work.

The economic case has long been questioned by opponents, but the government – while slightly downgrading its forecast for returns on investment – insisted the budget would not increase and the new "green tunnels" would save money by reducing the amount of earth removed from the Chilterns. Greening claimed the first phase alone would create 40,000 jobs.

## Key points

- HS2 trains will be up to 400m long with 1,100 seats
- An extra 26,000 passenger seats each hour on intercity routes
- Trains to travel at up to 250mph
- Birmingham to London journeys now set to be 45 mins instead of 84 mins
- More than 22 miles of tunnel on the route
- A spur to Heathrow will be built by 2033

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## Stonehenge tunnel idea resurrected

**The idea of building a tunnel under Stonehenge has been resurrected by a consortium of council leaders from across the South West. Wiltshire was among the authorities represented at a summit meeting to discuss A303 improvements, organised by Somerset County Council. They discussed ways to raise the £1billion needed to widen the remaining single lane sections of the road between Wiltshire and Devon. The tunnel, which would have cost more than £500million at the last count, is one of five separate schemes they believe are needed.**

Somerset's leader Ken Maddock believes there is scope to seek new funding in the light of Chancellor George Osborne's autumn statement, which said that pension funds could be used to fund up to £20billion of infrastructure schemes.

He said: "This is a fabulous opportunity to put a joint bid together that will bring huge benefits to the whole of the West Country."

The 2.1km tunnel plans were shelved in 2007 after the government said the soaring cost was not justified.





## New road tunnel under River Thames within decade

**L**ondon mayor Boris Johnson will deliver a new tunnel for road traffic under the Thames in the east of the capital within the next 10 years.

The proposed tunnel, between the Greenwich peninsula and Silvertown in the Royal Docks, will have a capacity of 2,400 vehicles an hour in each direction, and will relieve pressure on existing tunnels at Blackwall and Rotherhithe to the west.

Speaking to London government leaders, Mr Johnson described the tunnel as part of a package of transport investment to support the capital's growth.

He also promised that a new ferry crossing between Beckton and Thamesmead at Gallions Reach will be open for traffic by 2017, creating a further transport link in east London.

Transport for London will begin preliminary consultation work on the Silvertown Tunnel in February 2012. Mr Johnson is also pushing ahead with preparations for an extension to the Northern Line of the London Underground to Battersea, which has not previously been served by the Tube.

AA president Edmund King said: "The Thames is a barrier to mobility, employment and enterprise in east London. The Seine in Paris has almost twice as many river crossings as we have over or under the Thames. This proposed new tunnel is most welcome and could do much to alleviate congestion and emissions around the Blackwall Tunnel. It is not good for the environment having traffic waiting 20 minutes to use the Blackwall Tunnel. We support these proposals although it remains to be seen how the tunnel will be paid for."

Friends of the Earth's London campaigner, Jenny Bates, said: "A new road tunnel and car ferry will bring misery to Londoners by creating more noise, more traffic and more pollution. If Boris Johnson wants to keep his pledge to make London the world's greenest capital, his transport policy needs to go in a different direction."

In the November 29 statement, Mr Osborne said: "The Government will work with the Mayor of London and Transport for London to explore options for proposed additional river crossings, for example at Silvertown, and we will support the extension of the Northern Line to Battersea in partnership with the private sector."

## Thames Water thinks again about sewer

**C**ampaigners against the Thames Tunnel received a boost when an inquiry announced the controversial scheme should be reviewed.

The Thames Tunnel Commission, led by environmental expert Lord Selborne, concluded previous evidence that the 20-mile long tunnel was the only solution to London's pollution problems was 'out of date' and urged Thames Water to look at 'smarter' and greener alternatives.

Lord Selborne said greener options to the tunnel hadn't been properly explored and that Britain should adopt the American view, pointing to the evidence of the water commissioner for Philadelphia, who believes expansion of traditional sewage overflow systems is not sustainable. A greener approach to water management, encompassing biodiversity, a reduction in green house gas emissions and improvement in aquatic ecosystems, can all bring 'significant and measurable improvements'.

Lord Selborne said a full length tunnel would not solve all the problems of pollution and pointed out that of the 18 sewer overflow points along the proposed route of the Thames Tunnel, only 10 were deemed to pump out unsatisfactory levels of effluent. The cost of the tunnel could be 'expected to rise' beyond the £3.6bn estimated in 2008, while the cost is even more if the £1bn being spent on upgrading the 'successful' Lee Tunnel and the Beckton works is taken into account.

"We are not anti-tunnel, we are simply saying we need a multifaceted, multi-strand approach as employed by other countries," he told the conference, later adding: "Our forensic analysis shows there is a body of evidence pointing to the fact there is a smarter way to make the Thames cleaner. A shorter tunnel, combined with green infrastructure solutions that are built incrementally in the medium to long term, would be both compliant with EU directives and less costly and disruptive to Londoners."

Chris Binnie, who formerly worked on the sewer plans, said a smaller tunnel was feasible but warned west London needs it most, saying there was 'no alternative' but to build a tunnel between Hammersmith and Heathwall due high levels of discharge in the area. Thames Water said it was going explore Lord Selborne's findings.



## Finne Tunnel – Slipformed rail tunnel bed

**W**ayss & Freytag Ingenieurbau is currently at work constructing the 7km long Finne Tunnel through Germany's Schnecktal valley. Having completed the bore, the contractor is now using a Gomaco Commander III to finish the twin-tube rail tunnel's track bed and walkway.

The Finne Tunnel is part of a new 123km high-speed rail link between Leipzig and Erfurt, Germany, which will see trains reach speeds as high as 300 km/h. Initial construction began in April 2008 using two 10.8m diameter tunnel boring machines (TBMs). Now they have been excavated and lined, Wayss & Freytag has moved on to the slipforming phase, for which it has selected a four-track Commander III paver and Leica Geosystems 3D control system, rather than a traditional string line.

The concrete is a dry, low slump mix with a low percentage of cement as Wayss & Freytag project manager Christian Korndörfer explained, "We had concrete with less cement because of the size and depth of the applications. The floor is over 1m thick and we didn't want the concrete curing process to generate too much heat inside the tunnel or result in any cracking within the concrete."

Rather than delivering the concrete to the paver using traditional mixer trucks, which would have to have backed-up all the way to the work area, Wayss & Freytag developed a faster two-part solution. The floor of the tunnel was paved in a special sequence.

A weekly paving production goal of 1000m was established, with an average paving goal of 250m per day. At the beginning of each week, the four-track Commander III was set up to pave 1000m beyond the section completed the week before. The concrete trucks drove in forward gear on the completed tunnel floor to a turntable at the end of the section. The turntable then rotated the three-axle trucks 180 degrees so they could drive in reverse to the paver, dump their load of concrete in front of the Commander III, and then drive out of the tunnel in forward gear.

Operating the paver itself required some interesting adaptations. "The tunnel floor is 6m wide. In the circular tunnel, at its deepest point in the centre, the floor was 1050mm (41.3in). We turned all four tracks on the Commander III to 35° angles so the paver could drive on the round walls," said Mr Korndörfer.

The slipform mold was designed for a drainage channel in the tunnel floor. The channel measured 180mm deep and 720mm wide at the top tapering down to 540mm wide at the bottom. A height tolerance of +/- 10mm had to be met on the new tunnel floor to ensure the accurate installation of the future track rail. In the event, a tolerance of +/- 3mm was achieved.

The second phase involved Wayss and Freytag converting their Commander III to a three-track paver to slipform a walkway against one wall of each tunnel. Gomaco built a variable height, variable width walkway mold and hopper to accommodate changes in the tunnel wall face. The top width of the walkway varied between 1.05m and 1.75 m, and the height changed between 0.6m and 0.95 m.

"The walkway was a much more challenging profile to slipform than the tunnel floor," Mr Korndörfer explained. "It had to be placed with 100 % accuracy and the Commander III slipformed the walkway very well. We had no problems and were able to achieve production rates from 170 to 200m per day.

## The History of Australian Tunnelling

A colour publication by the Australasian Tunnelling Society

Over 150 pages of unique Australian tunneling projects from early 1800s to projects completed in 2009.



The book is available from ATS Secretariat Sheryl Harrington at Engineers Australia for \$95 +GST

# Germans and Danes Split over Undersea Link

**D**enmark plans to build a 20-kilometer tunnel under the Baltic Sea to Germany in what would be the largest infrastructure project in Europe and one of the world's longest undersea tunnels. Most Danes support the project, but resistance is growing on the German side.

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The issue is whether Lolland and Fehmarn -- in other words, Denmark and Germany -- should be linked by a tunnel or a bridge. Or whether everything should remain as it is. It also has to do with two kinds of politics.

Hendrick Kerlen, the German, opposes a fixed link. In fact, he thinks a tunnel would be just as absurd as a bridge. Whilst Steen Lykke, the Dane, works for Femern A/S, the Danish state-owned company tasked with realizing the project.

Kerlen and Lykke are engineers, both well over the age of 60. They have both had successful careers and worked abroad for many years. They share similar views of the world: Both men are cool-headed, rational and interested in feasible projects. They actually should be allies. The problem is that Lykke's answers don't match Kerlen's questions.

Lykke, heads the planning team at Femern A/S. He is supported by an ornithologist, a marine biologist and a Norwegian expert in tunnel-related claustrophobia.

The German opponents to the tunnel project have dubbed it "Fehmarn 21," putting the planned tunnel in the same category as a number of other controversial major projects in Germany, such as the railway station in Stuttgart (known as "Stuttgart 21"), the Berlin Brandenburg Airport and dredging the Elbe River in the port of Hamburg. The number 21 has come to represent the hubris of planners and the self-confidence of the country's citizens. It takes a project that appears to have cleared all the necessary hurdles and puts it in question again.

The Danes had examined four options for creating a fixed link between the two countries, and for a long time it looked like they would favor a bridge but the government has now decided in favour of a tunnel.

It's an enormous, groundbreaking project: nearly 20 kilometers (12.5 miles) long, 40 meters (130 feet) wide, nearly 10 meters high -- and expected to cost at least 5.5 billion (\$7.2 billion). Four tubes are planned: two



for the highway, each with two lanes, and two for the railway, each with one track. The tunnel would consist of huge concrete elements assembled on land and lowered by boats into a colossal trench on the Baltic seafloor. It would be one of the longest immersed tunnels ever built.

## Technical Answers to Political Questions

Lykke, the Danish engineer, talks about fresh air supply and emergency management, about colours and projected images of flocks of birds that would accompany vehicles in the tunnel. He mentions LED lights installed in the walls, which could create soothing lighting effects to combat claustrophobia. The seafloor would be dredged and millions of cubic meters of silt and soil moved to make way for the immersion of thousands of tons of heavy tunnel elements. The marine biologist says that if everything was done right the impact on the environment would be temporary.

In the beginning, the belt link was a German-Danish joint venture. Until now, only a ferry line has connected the two islands of Lolland and Fehmarn. The trip takes three-quarters of an hour and costs 66.50 when traveling with a car. The proposed fixed link would reduce the travel time, just as it does with the Øresund Bridge, which has connected Denmark and Sweden since 2000. The idea is to connect Denmark and Germany in a way that is fitting for a world that is becoming increasingly interconnected. The distance between Lolland and Fehmarn is considerable, roughly 20 kilometers.

In 2004 the Danish transport minister commissioned a study to determine the project's cost-benefit ratio. The study calculated a ratio of 1:1.25. "The World Bank would say that this is a marginal project," says Kerlen, and smiles thinly. "It was clear right from the start that the interests of the construction industry are behind this.

# Underground coal mines in NSW face the greatest threat

**A**ustralian Coal Association chairman John Pegler said the carbon tax could force the premature closure of 17 per cent of current black coal mines in Australia. "The carbon tax will put at risk over 21,000 jobs within 10 years in coal mining and related businesses," he said. Underground coal mines in NSW face the greatest threat, with 12 of the 30 current mines at risk of premature closure, he said.

Even if a mining or exploration company does not directly fall within the carbon price scheme, and is therefore not directly liable to pay the carbon price on their emissions, there will still be an impact on their cost of carrying out mining and exploration activities due to general cost increases likely to be caused by the introduction of the scheme.

Research suggests modest EPS impacts overall, with domestically focused coal miner Macarthur Coal feeling the pinch more than diversified miners Rio Tinto, Xstrata and BHP Billiton.

## Whitehaven mine delayed

**W**hitehaven Coal's crucial new underground mine at Narrabri has been plagued by labour shortages that have already delayed development by four weeks or about 1400 metres.

The flagship NSW mine was struggling to attract enough experienced underground miners, which could lead to longwall production being delayed by eight weeks to mid-April, the company said in a statement. It has started training its own employees in longwall operations, a coal mining technique used widely in Australia.

The company, one of Australia's largest coal producers and among the top 100 ASX-listed companies, is spending \$300 million developing an underground mine at Narrabri and the open-cut Vickery mine. The northern NSW-based miner produced 1.35 million tonnes of sale-able coal in the three months to September 30, compared to 1.09 million tonnes (Mt) in the same period last year.

Whitehaven's four open cut mines in NSW's Gunnedah Basin produced at an annual rate of 5.2 million tonnes per annum of saleable coal in the September quarter.

## Higher royalties on coal miners due to carbon tax

**A**ustralia's New South Wales plans to increase the royalties it receives from coal miners operating in the state to offset extra costs to the state's electricity generators due to the federal government's proposed carbon tax. The state's Treasurer, Mike Baird, said in his first budget that New South Wales will outline changes to its coal royalties regime after the Australian government finalizes legislation for its carbon tax and Minerals Resource Rent Tax -- expected by the end of 2012.

"To address the negative financial impacts on New South Wales of the carbon tax, coal royalties in New South Wales will be increased. The increase will only apply to firms that are subject to the Australian government's proposed Minerals Resource Rent Tax," the Liberal-National coalition government, which took power in New South Wales in March 2011, said in its budget statement. This will affect companies such as Gloucester Coal, Rio Tinto unit Coal & Allied, and Xstrata.

The MRRT, scheduled to come into force on July 1, 2012, imposes a gross rate of 30%, equivalent to a net rate of 22.5%, on the profits of coal and iron ore producers. The carbon tax, which will also come into effect on July 1, 2012, is expected to cost New South Wales power generators A\$400 million (\$423 million) in the year to June 30, 2013, according to the budget statement.

Most of New South Wales' coal-fired power plants are operated by state-owned power companies Delta Electricity and Macquarie Generation. "The Australian government has not provided compensation to New South Wales for these negative financial impacts, whereas compensation for privately-owned generators in some other states has been foreshadowed," the state government said, referring to the carbon tax.

Royalties are levied by Australian state governments on the value of coal production and present royalty rates in New South Wales are 6.2% for underground mines that are more than 400 meters deep, 7.2% for mines less than 400 meters deep and 8.2% for open-cut coal mines. Around 95% of the Australian state's mining royalty revenue comes from coal miners and the New South Wales government is forecasting its revenue from mining royalties will rise to A\$2.1 billion in the year ending June 2013 from A\$1.7 billion in the year ending June 2012.

# Fossey Underground Ore Body

**The company is bullish that the Hellyer Mine project has a positive outlook and work is ongoing to make the project more robust. In addition, Bass Metals continues to drill at the Fossey East deposit where it is looking to extend the ore body further.**

The mining of high-grade stope has lifted the overall head-grade and the mill is operating well with zinc head-grade now averaging 5.6% for the campaign, up 14% on previously reported levels.

The fourth milling campaign has been underway since the 23rd of May 2011.

Mike Rosenstreich, Bass' managing director, said, "the company has a high-grade polymetallic project with excellent potential to grow through exploration success. Recent technical challenges are clearly manageable, as indicated by the improved ongoing operational performance, and we are working hard to make the project even more robust."

The company is still reviewing and assessing the overall financial and longer term operational plan, but considers it to be sound. The high-grade nature of the mineralisation provides the flexibility to consider modifications to the underlying mine plan should the need arise.

The company is now focusing on the infill diamond drilling program currently being modelled. To date about 120,000 tonnes of ore has been mined representing 11% of the Fossey Mine Plan and therefore only still a small sample of the overall resource. The original Fossey Mine Plan was based on the 25 metre spaced diamond drilling undertaken from surface; the grade-control diamond drilling from underground to infill that spacing was completed on 30 May 2011. Work is in progress to complete the logging and assaying of that grade control drill-core and update the current resource model to reconcile with production to date and if necessary

produce a revised Mine Plan. Ore haulage from the mine for this campaign so far is about 61,400 tonnes and is currently being sourced from three stopes on the 465 level. The company said two of these stopes (one high-grade one lower-grade) are performing as planned with respect to tonnes and grades, with the third traversing an unpredicted lower grade zone resulting in the overall mined grades falling unexpectedly.

Bass Metals has since been focusing on mining the other high-grade stope, and this has resulted in a higher and more consistent feed grade to the mill, trending close to the original planned head grade of 6% zinc for the current campaign.

.....  
*The company is now focusing on the infill diamond drilling program currently being modelled.*  
.....

There are only 70 metres of decline development remaining to complete access to the base of the planned mine, which will enable establishment of the main 445 ore extraction level and a final permanent water pumping station. Decline development and 445 level access development has been delayed by several weeks due to the water-in rush event reported on 7 June.

The water flow, whilst still at high (100 litres/sec) levels, is being well managed and the current dewatering rate for the mine is estimated to be 160 litres/second, well below the overall expanded dewatering capacity of 300 litres/second. Importantly, level development on the 445 level and in the decline resumed soon after.

## First production at Ernest Henry underground

**With the open cut operation complete, Xstrata has commenced production from the underground extension of the Ernest Henry mine. The underground extension has also seen the start of magnetite processing, making Ernest Henry the first iron ore concentrate producer in Queensland.**

Operations at Ernest Henry will be extended by the extension to at least 2024, according to Xstrata.

The project cost \$589m. During the first phase of underground operations, ore will be trucked via a decline at rates of approximately 3mtpa producing about 25,000t of copper and 35,000 ounces of gold in concentrate.

Following the commissioning of the underground shaft in 2013, production will ramp up to 6mtpa producing 50,000t of copper and 70,000 ounces of gold in concentrate.

Ernest Henry Mining's general manager Myles Johnston said the major shaft underground mine and magnetite processing plant will generate hundreds of permanent jobs. "The project creates 330 jobs during the construction phase and 400 full-time jobs from 2013, extending the operations by at least another 12 years."

## Local miners show gold in Victoria

**V**ictoria is not regarded as being in the fast lane of Australia's two-speed economy but a couple of miners are proving there's life yet in the state's gold industry.

Castlemaine Goldfields produced its first bar at its Ballarat gold project this week and plans to produce 50,000 ounces a year. Octagonal Resources has also announced it would start mining an underground mine further east at Maldon after already committing to developing an open pit mine in the region.

While Western Australia now produces about three-quarters of the nation's gold, in the mid-19th century Victoria dominated global gold production, with Ballarat the top producer, which led to Australia's population nearly tripling.

Castlemaine is mining below the original 19th century Ballarat gold mine about 300 metres underground. The original mine produced nearly 12 million ounces in the 1850s, Castlemaine chief executive Matthew Gill said. "Victoria's been a great source of gold, which would suggest that unless people found and mined everything, you've got to think that there's still some prospectivity there. Lihir Gold bought it (the mine) in 2007 and it was owned by Ballarat Goldfields before that, but it could not meet Lihir's high production rate of more than 200,000 ounces, so they sold it for \$4.5 million. We're looking at quality over quantity and hope it's a case of third time lucky," Mr Gill said. The production of a 260 ounce gold bar on Monday was a "great milestone", he said. Castlemaine has no debt and \$28 million in the bank along with a 120km area to explore.

Octagonal Resources' assets are also in central Victoria and were bought in 2008, in the wake of the financial crisis, from Alliance Resources, which wanted to focus on uranium. Octagonal's managing director Anthony Gray said he hoped to start producing up to 30,000 ounces a year by 2013/14, particularly as gold prices were at record highs recently around \$US1,800 an ounce. The company listed on the Australian Securities Exchange in January. "We are very optimistic, you can certainly make a business out of gold in Victoria".

So why has Victoria become so quiet on the gold front. Mr Gill says there is a view that it is difficult to extract the gold but he thinks with the right application of people, technology and mining effort, "you can make it work". He also says a lot of gold is still being produced in Victoria, but most of it is being done by Canadian miners such as Northgate.

## ABB win hoisting contract at George Fisher mine

**A**BB recently won USD 24 million order to supply a complete ore hoisting solution for Xstrata Zinc's George Fisher mine located near Mount Isa in northwest Queensland, Australia. The ground mounted friction hoist will carry ore from a depth of 1,135m and help increase GFM's production by 30% per year by 2013. Xstrata Zinc's resources in and near Mount Isa, including GFM, comprise the world's largest known zinc resource base with an estimated 600 Mt of ore and 36 MT of contained zinc metal.

In addition to increasing production capacity at the mine, ABB's integrated hoist solution will operate at the highest levels of reliability and safety.

ABB will design, supply and commission all the electrical and mechanical equipment for a new ground mounted mine ore hoist system. At speeds of 16 m/s, the hoist will raise 600 tonne per h of ore per hour from a depth of 1,135 m. ABB's state of the art ACS 6000 medium voltage drive system, which controls torque and speed to enable energy-efficient ore haulage, will power a 9,000 kW synchronous motor to run the hoist. The hoist design will minimize impact on the surrounding power network.

ABB will also design and supply the bottom dump ore skips with inspection platforms, the rope deflection sheaves and a skip dumping system. ABB's System 800xA AC800M industrial controller will manage and control the entire mine hoisting system from the loading conveyors to the surface ore dump station.

Reliable performance of the hoist is critical to the safety and financial success of the mine operation. ABB's proven maintenance, lifecycle support services and expertise in delivering more than 600 new mine hoist systems worldwide, were important factors in securing this contract. Delivery is scheduled to be completed in the second half of 2013.

Xstrata's AUD 274 million expansion of GFM will increase zinc production to 4.5 million tonne per year. The project involves sinking the second hoisting shaft, using large diameter raise boring technology, to service the northern area of the mine. It also includes the installation of an underground crushing and ore handling facility and upgrades to power and ventilation facilities.

The expansion project had been encouraged by 126% increase in zinc reserves from 33 Mt when Xstrata acquired the operation in 2003 to 76 MT in 2010. While the increased production rate will reduce the mine life by 5 years to 21 years, the orebody remains open at depth to the north of the mine.

# Woodlawn expansion

**T**riAusMin will complete a non-brokered private placement to raise almost A\$4 million to fund exploration drilling on the Woodlawn Underground Project in New South Wales to increase the base and precious metals resource.

The company will issue up to 47 million shares at C\$0.085 (A\$0.082) to sophisticated Canadian, Australian and American investors. TriAusMin plans to use the funds to outline additional high grade base and precious metal resources below the resources currently defined at the past producing Woodlawn Mine, as well as fund continued drilling on the Lewis Ponds Project.

The company is working towards re-establishing underground mining at Woodlawn. Historical production from the former mine was approximately 13.8 million tonnes at 9.1% zinc, 3.6% lead, 1.6% copper, 0.5 grams per tonne (g/t) gold and 74g/t silver. Meanwhile, drilling is ongoing at the Lewis Ponds Base and Precious Metal Project in New South Wales as TriAusMin works to expand the existing resource.

Lewis Ponds has an Indicated Resource of 6.35 million tonnes at 2.4% zinc, 0.2% copper, 1.4% lead, 1.5g/t gold and 68g/t silver, and an Inferred Resource of 0.27 million tonnes at 3% zinc, 0.1% copper, 1.9% lead, 1.1g/t gold and 96g/t silver in the Tom's and Main Zone deposits.



TriAusMin will also allocate funding to the completion of the metallurgical test work, front end engineering work and the environmental permitting application for the Woodlawn Tailings Retreatment Project. The Woodlawn Retreatment Project is expected to process approximately 11 million tonnes of tailings produced by the former Woodlawn Mine. The project's planned production rate is approximately 1.5 million tonnes per annum with an expected mine life of about 7.5 years.

## Aboriginal dissent intensifies over Cape York coal mine

**C**ape York Aborigines have consented to the development, construction and operation of the peninsula's first coal mine, despite concerns about the destruction of sacred burial sites and dugong habitat.

Despite the dissent of a few, the majority of traditional owners support the signing of an Indigenous Land Use Agreement, consenting to the mine Aust-Pac Capital wants to build a small-scale underground coking coal mine on Aboriginal land in the Laura basin, 150km north-west of Cooktown

The miners still need to prepare an Environmental Impact Statement and be granted approval by the state and federal governments, but achieving Aboriginal consent is a key step towards getting the project up and running by 2014, as planned.

Aust-Pac Capital says it developed the mine plan after an approach by the Kalpowar Aboriginal people who wanted to develop economic opportunities on their

homelands. The company estimates the mine will create 200 full-time jobs for local people and would have a minimum life of 30 years, mining 1.5 million tonnes annually. The Cape York Land Council has insisted the consultation process has been thorough and no damage to cultural sites would be done.

But some traditional owners, such as Bernie Hart and father and son Paddy and Gavin Bassani, say they fear the mine will cause environmental and cultural damage. They engaged solicitor Derek Perkins and a Brisbane-based barrister to represent their interests at the meeting, and challenge the signing of the ILUA.

Mr Perkins says the next step was to consider opposing the registration of the ILUA with the Native Title Tribunal. Gavin Bassani said the mine would affect his clan's sea country, home to a large pod of dugongs. "There's a huge pod of dugongs that live and breed in that bay ... and now we're facing a coal mine right through the guts of the Flinders Island area," Mr Bassani said.

## Boost for NZ West Coast Mines Rescue

**D**evelopment West Coast is to steer the \$1 million that it promised to the public fundraising effort in the aftermath of the Pike River Mine disaster to the construction of a multi-purpose Mines Rescue training facility.

DWC, a fund set up by Government in the wake of the demise of native logging, put the money aside in a Pike River Distribution Fund. Fund chairman and DWC trustee Mark Lockington said today the trust felt it was important to recognise the severity of the disaster and its impact on families, the community and the West Coast economy.

“DWC believes the training facility will be a real and enduring benefit to the Coast,” Mr Lockington said. “This is a meaningful way we can assist the mining industry and the local economy. It was hoped the Pike River Distribution Fund could be used to stimulate and develop business activity on the West Coast, especially those supporting the mining industry. We saw this training facility as an ideal way to achieve those aims.”

New Zealand Mines Rescue Service general manager Trevor Watts was delighted with the decision. “The training centre will allow us to provide the industry with a state-of-the-art training facility, while still maintaining our core capability as a rescue organisation. The more education and knowledge in the industry the more we can raise safety awareness with the ultimate aim of preventing incidents from occurring,” he said.

Currently, Mines Rescue operates a small training facility at Rapahoe including a small underground training tunnel. The new facility, at the same site, will be purpose-built with the potential to include a virtual reality training theatre, allowing miners to experience real life dangers in a controlled environment.

## Osborne Copper-Gold Project

**I**vanhoe Australia continues to progress its Osborne facility with the key focus on commencing copper and gold production in March, 2012.

All major refurbishment work on the Osborne processing facility was completed in December 2011. Underground development at Osborne and Kulthor continued on schedule, sufficient ore will be stockpiled on surface by February 2012 to sustain mill throughput from production commencement. Decline development work commenced at Starra 276 as ore from this deposit will form one of the key ore sources for the Osborne Copper Gold Project in 2013.

## Boggabri farmers want coal mining sent underground

**F**armers in north-western NSW are pushing for an underground coal mine to replace an existing open cut mine. Boggabri Coal's plans to extend the life of its current mine by 21 years are being considered by the Department of Planning. Farmers are worried the expansion will adversely affect local agriculture, push down property prices and drive people from the district.

The company's executive general manager Peter Wilkinson says another call for the mine's extension to be considered in the light of other local mining development isn't justified. “I don't think it is. I think it's justified the potential cumulative impacts,” he said. “Certainly our project is already operating. Maules Creek have their project out on public display, but I think each project needs to be looked on their merits but also at the same time the cumulative impacts are being considered.”

## Underground Mining resumed at the Historic Morning Star Goldmine

**M**orning Star Gold NL has resumed underground mining at its 100% owned Morning Star Goldmine in Victoria's historic eastern goldfields. The Morning Star Goldmine was one of Australia's biggest gold mine in the 1940s.

Its production recommenced in 2011 for the first time in nearly 50 years. Morning Star Gold NL plans to increase the production rate during 2012-13, targeting 80 kilo tonnes per annum throughput at its onsite processing plant with grades expected to range at 10-15 grams/tonne.

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# Charges laid over Pike River mine disaster

**C**harges have been laid against three parties in connection with the deadly Pike River mine disaster in New Zealand.

It has been almost a year since 29 miners and contractors were killed in the mining accident. The men died when a series of explosions rocked the underground coal mine on the west coast of the South Island in November 2010.

The labour department says it has laid 25 charges against three parties. A court had initially suppressed his name, but this order has been lifted. Mr Whittall, the mine chief executive, is currently the only individual charged, along with corporate parties, Pike River Coal firm – now in receivership – and VLI Drilling, an Australian drilling contractor. Mr Whittall's lawyers say he is "saddened" by the allegations and will fight all the charges laid against him. Each of the charges carries a maximum penalty of \$190,000.

The Pike River Royal Commission will next week begin its third phase of hearings. Its final report is due by April 2012.

The disaster, caused by a build up of methane in the mine, claimed the lives of 24 New Zealanders, two Australians, two Britons and a South African man. Their remains are still entombed about 2.5 kilometres into the colliery, with recovery teams so far unable to reach them because of fears volatile gases remain in the mine shaft.

An inquest into the deaths found the miners probably died during or soon after the first explosion in the mine on November 19 2010.



## Pike mine still lethal

Receivers for Pike River coal mine are adamant the mine remains unsafe to recover the bodies of 29 men killed in a fatal explosion 13 months ago, despite claims to the contrary.

John Fisk, of PricewaterhouseCoopers, said that high gas levels in the mine's 2.4-kilometre tunnel and main working section made it potentially lethal, despite being inert. Reclamation of the tunnel was hoped to be completed by the end of February but it could be several years before the men's bodies were recovered, if at all, he said. The tunnel was full of nitrogen and other toxic gases, while the mine's main working part was full of methane.

The mine's statutory mine manager, Steve Ellis, was unwavering in his refusal to allow Mines Rescue Service or others to walk down the tunnel in respirators to the rockfall until it was reventilated. Delays had struck efforts to reclaim the tunnel, which was the first step towards body recovery.

A borehole was being drilled into the tunnel, further out from the rockfall, and foam would be pumped down to remotely seal it, which would allow the tunnel to be reventilated. Once that was completed, Fisk said the next step would be considering how to safely enter the main working area to retrieve the men's remains. "Until you've got closer to the rockfall, it's very difficult to come up with anything more than concepts of how you will get into the mine."

It would be up to the mine's new owners to work out a body recovery plan, which would be part of the sale agreement to use "best endeavours" to retrieve the bodies. "We expect the purchaser to prepare a detailed plan and timetable, use best endeavours to carry out body recovery and to have set aside funds to be used for that purpose." The likely option would involve tunnelling around the rockfall and drilling or blasting into the main working area.

Fisk said that was technically difficult, time-consuming and very dangerous. If oxygen mixed with methane in the mine and reached explosive levels, all it needed was an ignition source to cause a huge explosion.

The mine's sale had also struck delays and would not happen until later in 2012.

Bernie Monk, a spokesman for some of the Pike families, said the engineer employed by the families was happy with the tunnel reclamation plans. However, he believed body recovery would be several years away with no plans yet in place.

# Solid Energy unveils new West Coast mine plan

**S**olid Energy has announced plans for a new underground and open-cast coal mine employing up to 150 people, inland from Spring Creek Mine on the West Coast.

The news was well-received in Greymouth this morning, with hopes it will bring the town a much-needed boost after the Pike River Mine disaster.

Solid Energy said the proposed new Liverpool Mine, uphill from the old mining township of Rewanui, would complement, not replace, the Spring Creek underground mine at Dunollie. Potentially, it would provide jobs for 15-20 years.

If exploration goes well the new mine could be producing coal as early as 2014 or 2015, from a series of small open-cast and underground mines.

The State-owned enterprise has applied to the Grey District Council and West Coast Regional Council for resource consents to explore what it says is a "substantial resource of export-grade hard coking coal". If the exploration consents are granted and the next phase of feasibility assessment supports further investment, Solid Energy will seek mining consents next year.

Chief operating officer Barry Bragg said work so far suggested a combined underground and open-cast mining operation over 15 to 20 years, producing up to 500,000 tonnes a year of hard coking coal for the international steel market. "The Liverpool coals would complement those produced by the nearby Spring Creek underground mine and Stockton open-cast mine in Buller, increasing our export coking coal portfolio for the international market."



The Liverpool project, within Solid Energy's Mount Davy mining permit in the Upper Seven Mile Valley, is in an area which was mined from 1913 until 1985. In recent years, Solid Energy has intensified exploration in the area and now has five drill rigs working on it.

In the 2011 financial year, the company financed a 40-hole programme which delivered more than 9400m of drilling. The consent application says ground drilling has not provided all the answers Solid Energy wants.

A 600m exploration tunnel at the northern extent of the old Liverpool 1 Mine would let staff assess the frequency of faulting, and have a good look at the strata.

Upper Seven Mile is about 8.5km from Dunollie. A 2.5km-long gravel access road would be required, but it would not be visible from most public viewpoints, including State highway 6, Rapahoe, Dunollie or Runanga.

The Rewanui area was first explored in 1906, a horsedrawn tramway was started in 1907, and before long the Liverpool No 1 Mine had started, followed by No 2 and No 3.

## Roof fall at Moranbah North

**A**nglo American's flagship Moranbah North longwall mine in Queensland has suffered a roof collapse just days after a visit by the company's metallurgical coal chief executive Seamus French and the board of the global parent company.



The roof fall stopped production at the mine on Monday 7 November 2011 and is now the subject of an investigation involving the company, contractor Mastermyne, the Construction Forestry Mining Energy Union and the Department of Employment, Economic Development and Innovation. No one was injured and safe recovery operations have commenced in consultation with the Mines Inspectorate and the Department of Employment, Economic Development and Innovation.

Mastermyne's North Moranbah development contract, along with its Oaky Creek conveyors and Newstan conveyors drivage contracts, were major contributors to the company's \$164.83 million in revenue in 2011, which was up 26% on its initial public offering prospectus forecast and 68% higher than its 2010 result.

Mastermyne's Moranbah North drivage roadway development contract was signed with Anglo in October 2010. Anglo's Moranbah North umbrella contract with Mastermyne was also renewed for another two years, with a two-year extension option.

# Aussie mine inspector blasts Huntly

**A**n Australian mine safety expert has denounced the New Zealand coal-mining industry saying management's reaction to the recent gas spike incident at Huntly East was well below 21st century standards. The comment came the same day a Labour Department high hazard unit inspector met Solid Energy as it continued its investigation of the incident at the Huntly East Coal Mine.

Tim Whyte, the Construction, Forestry, Mining and Energy Union's Queensland district check inspector spoke out against the November 11 incident in which miners continued working underground after methane gas levels went up to an explosive 5 per cent in one area.

Mr Whyte said if methane gas levels reached 2.5 per cent anywhere in a Queensland mine, the mine was evacuated. "It's unacceptable to reach 5 per cent and still have people working underground," he said. By contrast, evacuation would only occur at Huntly East if one area spiked to 5 per cent or more and the cut-off safe level of 1.25 per cent level was reached in other areas. Mr Whyte said evacuation was important as a methane gas explosion in one area caused a "pressure wave" which could spark coal dust, causing an explosion that would travel at "2.5 kilometres per second" if there was not enough non-flammable stone dust covering the coal dust. It would rip through the mine in a matter of seconds," he said.

Comparing Queensland coal-mining legislation with New Zealand's generic mining legislation was like "chalk and cheese". He was strongly opposed to bonuses for achieving targets, and said in Queensland, where base pay rates were significantly higher, bonuses could be earned for a charity, so there was incentive to work hard without "encouraging people to take short cuts".

There had been a noticeable increase in the number of New Zealand miners moving to Australia since the Pike River tragedy when 29 mine workers died on the West Coast last year. He said Kiwis found the safety standards in the Australian mines "a real eye opener". "If it's not safe we don't do it, no matter what."

*There had been a noticeable increase in the number of New Zealand miners moving to Australia since the Pike River tragedy when 29 mine workers died on the West Coast last year.*

# Women rush to be underground miners

**A**n initiative by the Queensland Government to increase opportunities for women in the mining sector, by providing training and 10 paid jobs. In the first of its kind in Australia, the successful women will be employed as underground coal miners at BMA's Broadmeadow site near Moranbah in the Bowen Basin, with salaries in excess of \$80,000.

Project co-ordinator from WDS, Sally Reinhart, says the women will first spend two weeks living together at the Salvation Army's Riverview Farm, near Brisbane. "What it's meant to represent is being away from the family and living with people who you haven't necessarily made the choice to live with, but they are part of your away from home life, and it gives people a taste of what they're going to be in for when they go to a camp accommodation."

# Tasmania's Beaconsfield Mine to close

**T**asmania's Beaconsfield underground mine is to shut down next year. The Chief Executive Officer of BCD Resources, Pert Thompson, said that the company had decided to close the gold mine as it was not economically viable to mine below the current depth of 1210 meters at today's gold prices.

The mine was made infamous by the 2006 underground collapse which cost the life of Larry Knight and entrapped Brant Webb and Todd Russell. Mining operations were restarted at the Beaconsfield mine in June 2007. This was approximately 14 months after the fatal rock fall. Although the mine was finally making a profit for the company the management has decided to shut it down.

The formal company statement from BCD Resources mentioned that the company will continue to review the mine plan and mine life should the gold price continue trending upwards. The current production costs were at Australian \$1,000 per ounce of gold.

The closure of the mine will affect 103 full time employees at the mine as well as 16 casuals and 32 contractors. Chairman Michael Botting said that in the longer term, the board looks forward to re-utilising its major asset, the Beaconsfield process plant, by leveraging into an undeveloped refractory deposit.

# Restart of Mt Windarra nickel mine

**P**oseidon Nickel is proposing to restart operations at the existing Mount Windarra nickel mine in Western Australia at a production rate of 500,000 mt/year of ore over an initial mine life of six years.

The Australian explorer has submitted a detailed mining proposal to Western Australia's department of state development seeking approval to both restart mining operations and to build a 700,000 mt/year nickel sulphide concentrator.

The concentrator would process ore from Mount Windarra and also from the nearby Cerberus deposit.

Production of first concentrate from the refurbished Mount Windarra mine is scheduled in 2013.

Poseidon said it plans to submit applications for other mining, environmental and works approval, including a separate mining proposal for the Cerberus deposit, before the end of this year. A response from the state government



is expected within two months after submitting the final application, the company said.

Construction time for the concentrator plant and associated infrastructure is estimated at 12 months, Poseidon said.

The Windarra project, including Cerberus, has a resource base of 6.6 million mt of ore at an average nickel grade of 1.67%, according to the company. The Mt Windarra underground mine and the Cerberus deposit are contained in the same tenement package located 260km from Kalgoorlie in the northern gold fields of Western Australia.

Mount Windarra first produced nickel concentrate in 1974. Mining ceased in 1990 due to historically low nickel prices, after the production of 5 million mt of ore at an average grade of 1.59% for 80,000 mt of nickel metal.

## Spotted Quoll nickel mine begins underground operations

**A**ustralian nickel producer Western Areas said it has produced the first parcel of high grade nickel ore from its Spotted Quoll stage-one underground mine.

Production is expected to ramp up steadily over the next few months, said Western Areas. The company is conducting a scoping study to evaluate the potential of increasing Spotted Quoll's production rate from the current target of 10,000 mt/year nickel in ore to up to 15,000 mt/year. Results of the study are expected to be announced next month. With production commencing from the underground mine, Spotted Quoll's Tim King pit will cease mining operations in the first quarter of next year.

Spotted Quoll, together with the Flying Fox mine, support Western Areas' wholly owned Forresteria nickel project 400km east of Perth. The company

produced 4,258 mt and 3,400 mt of contained nickel, respectively, from Flying Fox and Spotted Quoll's Tim King pit during the July-September quarter.

Flying Fox and Spotted Quoll are among the world's lowest cost nickel mines, according to Western Areas, which aims to develop five mines for its Forresteria project to achieve a total production of 35,000 mt/year of nickel. Other mines being developed include Cosmic Boy and Diggers South, located 20km and 40km south of Flying Fox, respectively. Western Areas has an ongoing contract to sell 10,000 mt/year of nickel in concentrate to BHP Billiton.

It also has a contract for 25,000 mt over a two-year period with China's Jinchuan Group, but the company expects to fulfil the total volume requirement in February, or just 19 months after the first shipment was sent to China.

## Work in full swing at Lady Loretta mine

**X**strata Zinc has commenced construction of the new high grade zinc-lead-silver Lady Loretta deposit, 140 kilometres north-west of Mount Isa. Work is underway to develop the underground services and surface infrastructure of the \$246 million project, which is planned to be operational by the end of 2013.

The first major milestone for the construction phase was successfully reached in September 2011 with the start of the underground decline.

Lady Loretta is a strategic asset within the Australian zinc portfolio. Its higher grade zinc improves the overall quality of the Mount Isa resource base and increases annual average zinc production from the region by around 20 per cent to 100,000 tonnes.

The deposit is well defined. Four feasibility studies and more than 70,000 metres of drilling have identified an unusual and challenging syncline shape to the ore.

A new village will be built over the next two years to accommodate the operational workforce. It will include premium air-conditioned accommodation units, a pool, gym, messing facilities and general store. The mine will create jobs for up to 230 contractors at peak of construction in 2013, followed by a similar number of permanent operational employees when operational. As a new mining team, Lady Loretta offers a unique opportunity for experienced hard rock miners and professionals to join a mine which by its very nature demands high performance.



## Awaba colliery to close

**C**entennial Coal had slated closure of the mine for the end of the 2011 as coal reserves will reportedly be exhausted. According to Centennial Coal's general manager of external affairs, Katie Brassil, the closure will bring the end of an era of mining in the region.

"The mine was originally state owned, and began operating in 1948 supplying coal to Wangi Wangi Power Station.

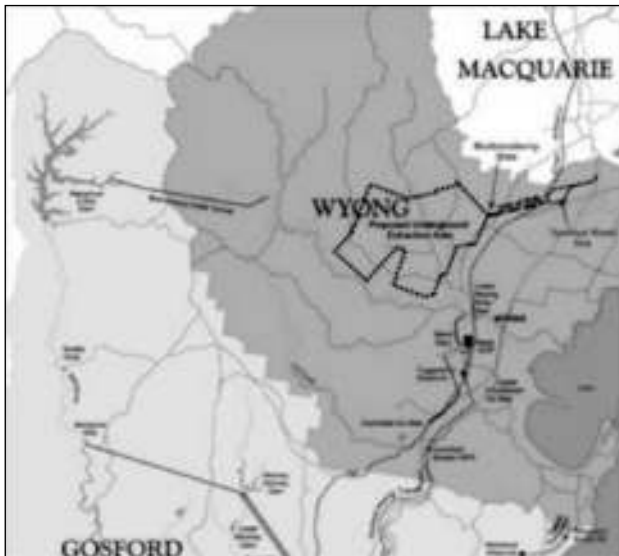
"In 2002 Centennial purchased the mine and over the past nine years have broadened the operations to include exports. Today, the mine supplies Eraring Power Station and services the export market," Brassil stated.

In 2010, the mine produced more than 800 000 tonnes of coal, but with reserves exhausted in the immediate area mining will cease, however the pit top infrastructure will be used to support the proposed Newstan Lochiel project.

While the Awaba coal mine has run for more than 75 years, it has always been a relatively small operation, with less than 100 employees currently working at it and a planned production of only around 815 000 tonnes for 2011.

Eleven of the miners at the site will retire at the end of the year, while the rest will begin work at Centennial's other Lake Macquarie mines.

The Newstan Lochiel project, which was formerly known as Awaba East, is adjacent to the existing Newstan coal mine, and has a potential four million tonne ROM longwall which is expected to produce around 3.2 million tonnes of saleable.



## Central Coast coal mine back on the agenda

**T**he underground coal mine was originally rejected in March 2011, just prior to the state election. Kerry Heywood, Wallarah 2 general manager, said the mine's owners met with NSW premier Barry O'Farrell who had "reiterated the government's commitment to merit based planning processes".

The proposal for the underground coal mine was previously rejected by planning minister Tony Kelly.

Soon after this Craig Thomson, Federal member for Wyong, where the mine is located, called for the state government to ban all coal mining in the region. Dobell Federal Labor MP Craig Thomson said the government must legislate "to stop coal mining once and for all in the valleys of Wyong Shire".

The rejection and Thomson's statements were welcomed by environmentalists, Lake Macquarie mayor and fellow MP Greg Piper, who was against the mine, stated that it was rejected on "very doubtful reasons".

At the time of the coal mine's proposal rejection, Wallarah 2 director Peter Hayes said that the company is currently "reviewing the statements by the Government, and hadn't given up on the mine yet". KoRes has now re-commissioned studies for its re-application, which will go to the NSW Department of Planning next year.

## South Kalgoorlie expansion

**T**he board of gold miner Alacer Gold has approved a A\$25-million budget for the first stage expansion of its South Kalgoorlie operations, in Western Australia. The firm would spend the budget on ongoing underground mining feasibility work, ordering long-lead time items for a new treatment plant and processing the cutbacks of the HBJ North and Mount Martin open pits.

It was envisaged that the new 2.5-million-ton-a-year processing facility would replace the 25-year-old 1.2-million-ton-a-year Jubilee plant, thereby doubling gold production to 200 000 oz/y. The new plant would be commissioned in early 2013.

The processing facility would become a treatment hub for ore from various openpit and underground mines from within the 100%-owned South Kalgoorlie operations tenements, as well as the Frog's Leg mine. "We are systematically and prudently progressing South Kalgoorlie towards reaching its targeted gold production of 200 000 oz/y, an important part of our goal of becoming an 800 000 oz/y gold producer by 2015," said Alacer president and CEO Edward Dowling.

He added that the South Kalgoorlie operations were located in a prolific and "extremely well-endowed", but under-explored gold district that Alacer believed would yield further significant gold discoveries. "We are working towards building a larger treatment facility that will provide a cost-effective basis for processing known resources and new discoveries in a manner that creates substantial shareholder value over time," said Dowling.

The mix of the ore would vary as exploration of Alacer's large South Kalgoorlie tenements progress over time and mining studies were completed on various resources. Dowling said that Alacer was currently evaluating various scenarios to increase and optimize gold production at South Kalgoorlie. At the current rate, the initial ore mix for the expanded plant would include around 1.5-million tons a year from the HBJ lode, 0.4-million tons from Frog's Leg and 0.6-million tons from other mines.

Meanwhile, Dowling also said that following the completion of feasibility studies for several openpits, the new South Kalgoorlie reserve was estimated at around 13.1 million tons, containing some 761 000 oz. This reserve did not include HBJ or Mount Marion resources, which were potentially mineable through underground methods, and were the subject of ongoing feasibility studies expected to be announced in the second quarter of 2012. The new South Kalgoorlie reserve represented a 96% increase over the previously published reserve of 389 000 oz, and took into account mining depletion of 164 000 oz subsequent to the release of the previous reserve.

## Red October underground gold mine development

**S**aracen Mineral Holdings is on track to reach ore on the 290 level at the Red October gold project in Western Australia within days after a record 240 metres of development was achieved in December 2011.

Red October was formerly an open cut mine run by Sons of Gwalia, which produced 5.39 million tonnes at 6.5 grams per tonne (g/t) gold. Saracen has identified an underground resource at the mine of 1.5 million tonnes at 4.2g/t gold for 208,000 ounces of gold, open at depth and along strike to the south.

A trial underground mine development program is in progress at Red October, including trial underground mining to confirm the geological interpretation and underground designs and an extensive underground diamond drilling campaign to delineate and expand the resource at depth and along strike.

Since portal access was established on October 1, 2011, 460 metres of development has been completed. Development recently reached ore at the 300 level, with improved ground conditions and multiple development headings available now that ore has been reached.

Underground diamond drilling is set to begin in January 2012, with more than 18,000 metres of drilling planned to provide grade delineation and resources extensions. A second jumbo will be mobilised to site this month to develop ore drives while the existing jumbo focuses on the decline and development of the hanging wall drill drive. Construction of a 40 kilometre haul road between Red October and Safari Bore is progressing well.

## Cloncurry Mine Commences Underground Operations

**T**he new underground copper mine near Cloncurry, Queensland, Australia being developed by Xstrata saw work commence this week. The previous open cut mining site is being converted into an underground operation in a bid to extend the life of the mine until 2024.

The mine which is located in the Ernest Henry project about 40km north east of Cloncurry is being extended underground at a cost of \$600 million, said that general manager Myles Johnson. Mr Johnson added that when they have the shaft mine running at full capacity, it will be hoisting rock at a rate of six million tonnes a year.

As per estimates made by Xstrata, the first phase of underground operations will give about 25,000 tonnes of copper and 35,000 ounces of gold. This is just the start for 2012 as by 2013 the ramping up of the production is likely to bring in a yield of 50,000 tonnes of copper and 70,000 ounces of gold in concentrate.

Myles Johnson also said that the mine will be a big part of Queensland over the next 12 years as the mine will provide jobs for 350 people during construction, and 400 people when it's at full capacity. The Swiss mining giant hopes to have a mix of local and fly- in fly- out mine workers.

## Integra Mining Trials Underground Mining

**I**ntegra Mining Limited has released the assays of the follow up diamond drilling at its Imperial prospect. The assays returned high grade gold copper intersections at 6.2 metres at 13.43 grams per tonne of gold and 1.5% of copper.

The Imperial prospect is located 500 metres north west of the Majestic gold deposit. It is hosted in the same granodiorite unit that hosts the Majesti deposit and has a similar series of porphyry dykes. Results include 19 metres at 4.39 grams per tonne of gold, including 2 metres at 7.37 grams per tonne gold and 1 met at 40.81 grams per tonne and 4 metres at 3.13 grams per tonne.

Integra Mining made the transition from gold explorer to producer in September 2010 when it

made its first gold pouring at the Randalls Gold Project. The project remains the flagship project while the company continues to build up its mineral portfolio in Western Australia.

Integra Mining is waiting for regulatory and board approvals before beginning trial underground mining at the Cock- eyed Bob gold deposit. The trial hopes to demonstrate the potential for long term production from underground sources at the Randalls Gold Project as well.

If the trial is successful the company will begin underground development at the Maxwells gold deposit which is currently being operated as an open pit mine.

## Sandvik delivers 14 LHDs to Cadia East project

**S**andvik Mining and Construction has been awarded a contract for the supply of 14 LH517 LHDs (load-haul-dumps) for the initial production phase of Newcrest Mining's Cadia East mine near Orange in the NSW Central West.

The LH517, powered by a Volvo TAD 1361VE engine rated at 285 kW, has a tramping capacity of 17.2 tonnes, and can handle bucket sizes from 6.5-8.6m<sup>3</sup>.

The Cadia East project involves the development of the massive Cadia East deposit – one of the world's largest gold deposits – into Australia's first panel cave. The mine will be the deepest panel cave in the world and Australia's largest underground mine.

The Sandvik LH517s will be deployed in Cadia East's initial production phase, and are being delivered between now and October 2012. The machines will be equipped for fully autonomous operation, in conjunction with Sandvik's underground mining AutoMine system.

According to Tim Redmond, Sandvik Mining and Construction's underground mining sales manager, Sandvik has a strong relationship with Newcrest and is a long-standing LHD supplier. "Newcrest's huge Cadia Valley Operation is now among the largest users of Sandvik LHDs globally. Service and support for the new loaders is being carried out both by Sandvik's Orange service centre, plus an onsite product support team in the Cadia Valley.



## Tritton Copper Mine Implements Gemcom InSite

**S**traits Resources has implemented the Gemcom InSite(TM) mine production management solution at its Tritton Copper Mine. The Tritton underground copper mine has been in operation since 2004.

Located near Nyngan in New South Wales, Australia, the mine produced a total of 23,936 tonnes of copper in FY2011. Tritton turned to InSite to provide a single solution to the operation's data management requirements. The software's data integration and data reconciliation functionalities have eliminated their reliance on time consuming, manual entry spreadsheets and provided a centralised database for the entire site.

Consolidating data tracking into one central repository has streamlined Tritton's processes and will increase productivity across the operation. The ability to track material movements and stockpiles ensures accurate reporting of actual production activities against targets. Additionally, InSite's production system links data throughout the mining system, significantly simplifying reconciliation and reporting processes.

Tritton were already utilising several Gemcom products. InSite provides confidence in data accuracy, while its superior data integration capabilities will save the operation large amounts of time on data entry, eliminate errors, and ensure they make efficient use of their systems serving to increase Tritton's productivity.

InSite records and evaluates data for service, support and production activities from the mine through to saleable product. Organisations are provided with confidence in data accuracy which results in cost savings, as well as visibility into all areas of production which allows mine and plant operations to rapidly respond to changing conditions.

### About Gemcom

When mining companies seek to increase mine productivity, they turn to Gemcom for technology and services. The Company is home to world-renowned mining solutions like GEMS, Surpac, Minex, Whittle, and InSite, and to industry thought leaders who are pushing the boundaries of what's possible in mining. Established in 1985, Gemcom has a global reach delivering comprehensive solutions in all major mining centres in more than 130 countries. Every major mining company, including BHP Billiton, Codelco, De Beers, Newmont and Vale is a Gemcom client. Through a combination of organic growth and strategic acquisitions, the Company has become the largest global supplier of mining software solutions.

For more information, visit [www.gemcomsoftware.com](http://www.gemcomsoftware.com).



# Conveyor belt problems – Spying a solution

**C**onveyor belts carry all the important material to where it is needed in the quickest and most efficient way possible, but what happens when they stop? A belt breakage instantly stops operations and results in businesses hemorrhaging lost revenues.

Mines typically inspect belt conditions by walking along the belt, but this is a hazardous and time consuming job as belt length can be ten kilometres long, and some parts may not be accessible at all. Miners often outsource belt inspection to specialised companies, with inspection periods varying from a week to even a month. This approach is expensive and can be unreliable due to the limitations of manual inspection.

Australian company BeltSpy has developed an inspection system that utilises machine vision technology to monitor and maintain conveyor belts in underground mines. It is designed for use during production hours under full conveyor load conditions. Beltspy's inspection system is comprised of a high speed digital camera for every belt (with two cameras for double sided installation), a dedicated underground server for each belt, a single workstation, and associated components.

The system uses an image processing algorithm to automatically detect and flag clip joints; splice joints; damaged belt surfaces; and damaged edges, which collectively come under a Points of Interest (POI) umbrella. The system maintains these precise belt metrics relative to a reference location (RL). The locations of the POI's distance from the RL are compiled by the system, providing instant access to the POI images. It also allows for sequential and random belt image browsing.

The single workstation located on the surface allows an operator to inspect the carry and back sides of all belts in the mine by analysing high resolution images anywhere along the belt, and access to images of any flagged locations. The operator's workstation uses a two-monitor configuration for both carry side belt inspection or a three-monitor configuration if both sides of the belt need to be inspected.

The first monitor is used to control system activity and depicts the graphical representation of the conveyor with all the POI placed on it, while the last two monitors focus on rendering belt fragments (around one metre in length) for carry and back sides, with both images synchronised.

Flagging can be carried out manually or automatically. An analysis tool allows the potential damage to be flagged during full production periods, allowing for conveyor downtimes to be fully focused on maintenance activities. It also allows for online monitoring of damage, providing predictive maintenance capabilities.

Operators can also visually compare two images of the same location taken at two different times, so that the user can analyse historical changes in the belt's condition. The operator can take full belt images at any time and the system can be scheduled to take belt images automatically at pre-defined times every day.

There is no limit of the number of belt condition images that can be stored, with images uploaded in approximately 100 milliseconds. The BeltSpy system also allows for the monitoring of the development of failing belts in real time until downtimes can be scheduled.



## The History of Australian Tunnelling

**A colour publication by the Australasian Tunnelling Society**

Over 150 pages of unique Australian tunneling projects from early 1800s to projects completed in 2009

The book provides unique insights in the construction of water, sewer, cable, road and rail tunnels, underground storage and defense facilities.

The book also includes a comprehensive database of nearly 300 tunnelling projects.

*The book is available from ATS Secretariat Sheryl Harrington at Engineers Australia for \$95 +GST*



## Cosmo Main Ventilation Shaft

**C**rocodile Gold has announced two important milestones at its Cosmo Underground Mine in the Northern Territory. First, the excavation of the primary ventilation shaft has been completed. Second, a mine planning study on the wider, higher grade zone identified by recent delineation drilling has been completed which will lead to a change in mining method.

The excavation of Cosmo's primary ventilation shaft (RB1) has been successfully completed and secondary ventilation fans have been installed in preparation of the commissioning of the primary ventilation network. The Company anticipates the full commissioning of the ventilation shaft in the third week of December 2011. Once complete, the Company can accelerate level development and move towards stope production.

As part of the Cosmo underground operation ramp up, and in preparation for ore stoping in the first quarter of 2012, two new 50 tonne capacity trucks have been delivered to site and are being commissioned. This brings the total mining fleet to operational levels in preparation for the start of mining and to allow scheduled development to double in the first half of 2012.

Crocodile Gold has also completed mine planning for the wider and higher grade Cosmo East Zone, as recently announced in the press release dated October 11, 2011. The updated mine plan will incorporate a transverse mining method in wider and higher grade areas due to increased thicknesses. The transverse mining method is more appropriate for this wider mineralized zone and will have the net effect of increasing the size of the production stopes from 2,800 to 8,500 tonnes. The Company anticipates that using the transverse mining method will positively impact the Company's gold output and production costs during the initial stages of the Cosmo ramp up. This change in mining method is also expected to improve the resource to reserve conversion by providing maximum extraction from this higher grade core. The extent of the wider mineralized zones will continue to be tested as part of the ongoing delineation drilling program.

## NSW Gold mine gets go-ahead

**T**he NSW Planning Assessment Commission has given the final approval for the Dargues Reef Gold Mine, at Majors Creek, near Braidwood.

The Dargues Reef Gold Mine Project comprises a new underground gold mine and associated infrastructure at Majors Creek, approximately 13km south of Braidwood in the Southern Tablelands. Historically extensive mining occurred in the area and both abandoned mine shafts and alluvial works occur on the site.

The project includes extraction and processing of up to 355,000 tonnes of gold ore a year, for up to 7 years, with:

- a box cut portal and decline, fuel store, ventilation rise, power and water supply;
- a processing plant and office area which would include an integrated run-of-mine (ROM) pad/temporary waste rock emplacement, crushing, grinding, gravity and floatation circuits, site offices, workshop, laydown area, ablutions facilities, car parking, and associated infrastructure;
- a tailings storage facility;
- a water management system, including 8 dams and an associated water reticulation system;
- a site access road and intersection to allow site access from Majors Creek Road; and ancillary infrastructure, including soil stockpiles, core yards, internal roads and tracks and surface water management structures.

Processed ore would be transported from the site by road and the site would be progressively rehabilitated.

The Commission has considered the Director-General's Environmental Assessment Report, addendum and revised recommended conditions of approval. The Commission is satisfied that the mine will have a significant economic benefit for the region and that the environmental impacts of the proposal can be adequately mitigated or managed by a suite of stringent conditions. Consequently, the Commission has determined to approve the project subject to the recommended conditions.

In anticipation of receiving approval for the Dargues Reef Gold Project under Part 3A of the NSW Environmental Planning and Assessment Act 1979, Cortona has already completed most pre-construction activities and awarded key construction and mining contracts for the Project, enabling it to move swiftly and seamlessly into project execution."

"There couldn't be a better time to be building a new gold mine with the gold price recently touching record highs of over A\$1,800 per ounce, and we are very much looking forward to getting on with the job of building Australia's newest gold mine," Company's Managing Director, Peter van der Borgh said.

# Gold price boom boosts OCG

**S**outh Island gold miner OceanaGold is reaping the rewards of a boom in gold prices this year, with a record average gold price of US\$1706 (NZ\$2085) an ounce in the September quarter.

But the mine's operations at Macraes in the South Island were hampered by two big snowstorms over winter, with the total amount of rock mined down 5 per cent on the previous quarter. OceanaGold operating earnings jumped 31 per cent to US\$43.3 million in the quarter.

OCG is now forecasting production for the full year at the lower end of the guidance range of 255,000 to 270,000 ounces of gold. Net earnings for the quarter were US\$10.9m for the third quarter, up 163 per cent on the previous quarter.

The record average gold price for the quarter was up US\$160 from the previous quarter and provided an expanded cash margin of US\$750 an ounce, up 20 per cent. Cash costs rose US\$35 an ounce over the previous quarter, mainly as a result of a rising New Zealand dollar and less gold produced. Total revenues for the three months were more than US\$103 million.

The company's South Island mines at Macraes goldfield and Reefton produced more than 59,000 ounces of gold in the quarter, which the company said was slightly below expectations. That was because of a combination of heavy



snow at the Macraes mine and a slower than expected ramp-up of mining at Reefton on the West Coast.

The East Otago Macraes goldfield includes an open-pit and an underground mine. The goldfield was hit by two big snowstorms in August and September, closing access roads for several days, affecting open-pit operations. A skeleton crew operated the process plants with lower grade stockpiles. The underground Frasers mine lifted production in the quarter. For the year to date, revenue for the three quarters was US\$289m, up 36 per cent on the same period a year ago, again driven by a higher gold price.

## Australia coking coal mine extended

**G**ujarat NRE Coking Coal has been granted a three-year extension for longwall mining at its NRE No 1 underground coking coal operation in the southern coalfield of New South Wales. The approval was issued by the Planning Assessment Commission – New South Wales' new arm's-length planning agency for large-scale infrastructure projects – on advice from the government planning department.

The PAC approval allows Gujarat NRE Coking Coal to continue the extraction of 1 million mt/year of coking coal from the Bulli and Wongawilli coal seams for the next three years; to continue trucking mined coal to the Port Kembla terminal; and to pursue A\$122 million (\$124 million) in upgrades to the colliery's infrastructure, the company statement said.

Gujarat NRE exports the coking coal as run-of-mine, unwashed coal from Port Kembla, where it is primarily shipped to Indian coke plants. According to an October report from the New South Wales planning and infrastructure department, it received 23 submissions, of which 15 objected to or raised concerns about the extension project. The mine sits about about 70km (43 miles) south of Sydney.

Despite this level of concern, the NSW planning department recommended the PAC approve the project. "On balance, the department believes that the project represents a logical progression of Gujarat's existing mining operations at NRE No. 1, is satisfied that its benefits sufficiently outweigh its costs and it is able to be conducted in a manner consistent with the objects of the Environmental Planning and Assessment Act," the NSW planning department said in a report posted on its website.

Arun Jagatramka, executive chairman of Australian-listed Gujarat NRE Coking Coal said in a statement that the planning approval had given additional security to 350 workers at the NRE No. 1 colliery and would create new jobs.

Gujarat NRE Coking Coal has plans for an additional A\$250 million expansion of the NRE No. 1 underground mine involving longwall mining in the western area of its mining lease that would extend the mine's working life by 18 years. NRE No. 1 mine, formerly the South Bulli Colliery, has been an underground coal operation since the 19th century until production ceased temporarily in 2004. It restarted in 2005 after the mine was sold to Gujarat NRE, according to the planning department report.



## Reducing personnel exposure in underground mining

**W**orking in an underground mine environment exposes workers to safety and health risks including diesel particulate emissions, dust, noise, falls from height, falls of ground and mobile equipment interactions. As part of its commitment to ensuring no worker is harmed on site BHP Billiton's Cannington mine in Queensland, Australia has introduced technology enabling the surface teleremote operation of underground loaders, reducing operators' exposure to these risks.

Underground loader operators move ore produced by blasting which at times requires the loader to operate inside open stopes.

Traditionally Cannington used remote operating systems that removed operators from inside the loader cabin but required they remain underground to maintain line of sight with the loader.

As a first step towards reducing operator exposure Cannington introduced a teleremote control system to operate loaders remotely from inside an underground light vehicle. This system enabled the operator to be removed from the cabin of the loader and also from the immediate area in which the loader was operating.

Recently the Cannington team took the system to the next level, working with third-party technology providers to implement a teleremote system that

allows the loaders to be operated from the surface of the mine. This technology significantly reduces loader operator exposure to the underground environment and associated hazards.

The surface teleremote system comprises a number of underground teleremote loaders and electrical infrastructure connected via fibre optic cable to a surface control room.

The technology enables multiple underground loaders to be operated simultaneously from the surface. It also increases production time of loaders as they can continue to be used during blasting times.

The most recent phase of the project involved introducing a teleremote guidance system. This system allows the loader to 'see' its own path of travel and effectively guide itself through its tramway with minimal assistance. This additional capability will reduce the reliance on the operator to guide the loader remotely at all times, decreasing equipment damage from impact with tunnel walls.

It is expected the technology will also aid fatigue management by reducing exposure to the safety and health risks of the underground environment and alleviating extended periods of concentration. The introduction of this system has been well received by operational personnel and the Cannington team plans further rollouts of the technology to other underground equipment.

# Automation: Leading the way

**A**ustralia's rapidly expanding multi-billion dollar mining technology and services industry is leading the drive for innovations to boost productivity and efficiency.

As Australian mining exports increase, mining companies are investing significant resources into the development and implementation of remote automation and unmanned machinery to meet this demand.

The isolated geographical locations of many Australian mines, in addition to safety considerations, make remote automation and unmanned machinery an attractive option for mining companies. While traditional automation and robotic technology in the mining industry has comprised standalone autonomous equipment managing a selected process, today it is possible to connect these discrete processes resulting in an integrated, productive mining environment.

The development of smart technologies that enable remote automation and robotics to be available for mining applications is central to driving productivity and efficiency gain. The advancement of technology during the past 10 years, in particular improvements in central processing unit capacity, access to smart technologies, and advanced sensor technology, has enabled the framework for intelligent software development.

## Development of intelligent systems

The notion of intelligent software has existed for a long time, but a paradigm shift is occurring in how critical and complex automation systems are designed, configured and controlled. Today, to achieve 'artificial intelligence' is the ultimate goal. A system where the intelligence of machines is such that traits like reasoning, knowledge, planning, learning, communication and perception; provide equipment with the ability to move and manipulate objects to improve commercial outcomes.

In the beginning, an individual computer would perform a sequential task or series of tasks; this progressed to the development of parallel processing which enables a synchronised, coordinated computing platform such as connection to network. Parallel processing is much faster than sequential processing, with large-scale multithreading capabilities allowing for simple repetitive calculations on vast amounts of similar data. Holonic multi-agent systems are composed of autonomous software entities and display increasing complexity; they have the ability to simulate a



.....  
*A system where the intelligence of machines is such that traits like reasoning, knowledge, planning, learning, communication and perception; provide equipment with the ability to move and manipulate objects to improve commercial outcomes.*  
.....

system or to solve problems and to allow for invaluable integration of technologies in a mining environment.

Currently, the highest level of system capability in operation is referred to as autonomous, cooperating agents. These agents have increased system complexity; able to make collaborative decisions and display the ability to re-configure parameters dynamically. Technology has come a long way but still has its limitations, particularly in supplying technology to continuous operations in remote areas to minimise human involvement. The development of mining machinery displaying 'artificial intelligence' is the ultimate goal. Intelligent systems integrated into machinery that can adapt to environmental conditions, evolve to overcome challenges and self-heal to prevent downtime are being actively developed. Equipment that can interact with its environment and adapt appropriately to increase productivity and sustainability in mining will be a valuable resource.

Australasian Tunnelling Society website  
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**M**ining is a dangerous occupation, and South Africa's hard rock (gold and platinum) mining is more dangerous than most (but not all) types of mining. In the period January 1 to August 15 this year, 76 South African miners lost their lives in workplace accidents. The total for the whole of last year was 128, and for 2009 the toll was 168.

The trend is, fortunately, downwards. And the death toll has fallen hugely over the past quarter century – it stood at 865 miners in 1986. But, even if South Africa reduced its mine fatality rate to international standards, that would still work out at 34 deaths a year (assuming no further decline in the size of the country's mine workforce).

The very great depths of South African gold mines are a key factor regarding these deaths – gold miners work in a remote and hostile environment. Naturally, there is a widespread desire to increase the use of technology in South African mining.

## The Rise of the Robots

Robots. A concept created and popularised by science-fiction. But the first real working robot bore no resemblance to the humanoid robots beloved of science-fiction. This was Unimate, developed by the Unimation (Universal Automation) company in the US. Unimate, which entered service on a General Motors assembly line in 1961, was the forerunner of all of today's industrial robots and, being in the form of a large mechanical arm, also set the format that most such robots still follow.

More recently, however, a new field of robotics has opened up – field robotics. “In science fiction, robots have true artificial intelligence; unlimited working environment, like humans; can learn [are not pre-programmed] and can work cooperatively alongside humans. In reality today, the traditional ‘home’ of robots is a production line, with repetitive work, fully controlled environment and no interaction with humans, because it is not safe. Such robots are unaware of what is around them. They just do their tasks. Field robotics is relatively new. Field robots are in-between industrial robots and science fiction. They operate in unstructured environments but in limited roles. They can act autonomously. Some can operate with people safely. Some have limited learning ability,” explains Council for Scientific and Industrial Research (CSIR) mining robotics project manager Liam Candy.

Internationally, rapid progress has been made in field robotics technology over the past decade, given a huge impetus by the demands of war. (Field robotics is currently focused mainly on unmanned air vehicles, vessels, and ground vehicles.) US technology market research company ABI Research has calculated that \$5.8-billion was spent on military robotics worldwide last year and that this figure will increase by 70% to more than \$8-billion in 2016. In addition, there is lesser but still significant civilian investment in field robotics, for cargo handling, mining and agricultural applications, among others.

South Africa cannot match the scale of the investments, military or civil, being made overseas. Yet the country cannot ignore field robotics either. It is becoming too important, too dynamic, a field, relevant to many areas of human endeavour. As a result, the CSIR is undertaking research into field robotics, through the formation of the Mobile Intelligent Autonomous Systems (Mias) group. “This is an emerging research area for the CSIR, so it is different from a competency area,” explains Mias group leader Dr Simukai Utete. “Our group targets niche areas which address national needs, niche areas which are of relevance to [our] society – for example, mining. We are very concerned about capacity development in robotics.”

“Regarding robotics in mining, the [world] leader is probably the Australian Centre for Field Robotics (ACFR),” reports Candy. “It has developed a Load Haul Dump (LHD) vehicle that is partially autonomous – after being loaded, it proceeds autonomously to exit from the mine. The ACFR has also developed a partially autonomous dragline, an automated bucket loader and automated charging of blast holes.”

Other leading players in mining robotics research are The Robotics Institute of Carnegie Mellon University (in Pittsburgh in Pennsylvania in the US), with its Groundhog autonomous vehicle (used to do three dimensional mapping of abandoned coal mine tunnels in conditions too dangerous for humans); Sandvik of Sweden, which has developed an autonomous LHD vehicle; Atlas Copco, also of Sweden, which has also developed an almost fully autonomous LHD (called a Scooptram in North America); and Anglo American plc, as part of its 2030 Mine project. Most of the systems developed to date are for use in open cast operations, because these pose far fewer difficulties than underground operations.

### From PackBot to MineBot

The CSIR Mias group has four research areas – perception, planning, navigation and machine learning. Its projects are carried out in the areas of mining robotics, “mule” robotics (unmanned cargo carrying ground vehicles – see Engineering News September 16, 2011), intelligent manipulation and active vision for autonomous systems.

“We develop the autonomy (intelligence),” says Utete. “We often buy in the platforms. We are very much about codevelopment with other research and industrial partners. Our research is not focused on sensor design. We take data from different sensors and integrate it using sensor fusion for different applications.” Some of the sensors employed (bought in) by the CSIR Mias team are very expensive, but it is expected that, as the global demand for them increases, the costs of the sensor packages will fall.

“In mining robotics, we work on robot systems that could be applied in a mine environment,” she explains. “It’s a project we work on jointly with the CSIR Centre for Mining Innovation (CMI) and with the CSIR Mechatronics and Micro-Manufacturing (MMM) competence area. Jeremy Green of the CMI is principal investigator for the Mine Safety Platform project (which enters its final year next year). Mias is working on intelligent autonomy for the platform while CMI develops the sensor suite and the MMM group develops a low-cost platform.”

“There are few mines in the world like South African gold and platinum mines,” highlights Candy. “Hard rock mining happens in a cycle – drill, blast and clean. In between when they blast and when they remove the ore (clean) they have to do a safety inspection. At the moment that’s conducted by people and it’s quite a dangerous task. What we are hoping to do is have a robot that can go in and automatically do a preliminary inspection and generate a risk map for the miners who have to go in after the blast. Basically, we want to take a human being out of a really dangerous, dirty, job and put him in a safe area.”

To put it more formally, the CSIR Mias group is seeking to develop a fully autonomous robot that can evaluate hanging wall (tunnel ceiling) stability. This is not easy. Such a robot needs to know where it is and where it wants to go (summed up by the term localisation), what the environment around it is like (mapping), how to plan a route through that environment (path planning or navigation), and how it should proceed (motion planning).

*They can climb stairs, climb over rubble and operate in narrow passages. They operate either by remote control or semi-autonomously and more than 3 500 have been produced so far.*

To save time and money, the research group acquired an in-production field robot of a proven, reliable, tough design to act as the initial platform for their proposed machine – the abovementioned Mine Safety Platform (MSP). The robot they bought is a PackBot 510, manufactured by US group iRobot. PackBot 510s are military tactical robots, normally employed for explosive ordnance disposal, surveillance and reconnaissance, route clearance and hazardous materials detection missions. They can climb stairs, climb over rubble and operate in narrow passages. They operate either by remote control or semi-autonomously and more than 3 500 have been produced so far. However, the CSIR MMM competency area is currently developing a low-cost robot platform that could be used in mines in the future, instead of having to employ adapted overseas designs.

Turning a semi-autonomous robot which operates above ground or in shallow tunnels into a fully autonomous robot that operates deep underground is quite a challenge. “You can imagine, if you’re doing above ground robotics, you have, for starters, the advantage of GPS [Global Positioning System]. Even though GPS, even differential GPS, struggles to tell you with pinpoint accuracy where you are, even the crudest GPS can tell you your location within 100m or 200m – it can give you a global location,” states Candy. “When you’re underground, you have nothing like that. You’re in an environment that has no beacons, very few distinguishing features and not much in the way of landmarks. Basically, it’s dark, it’s wet and it’s muddy. It’s difficult to identify one position underground from another.”

An underground mine environment cannot, in practice, be instrumented to provide a control and navigation network for robots. “We need the intelligence to be on the machine,” he affirms. “We’re doing the preliminary work on solving the problems around mapping, path planning, motion planning and localisation.” To fulfill these functions, the Mias team is focusing on using laser sensors (which function similarly to radar, but on a different part of the electromagnetic spectrum), Time of Flight cameras (which provide three-dimensional surface information of an object in real time) and inertial sensors.

“And then we’ve got some novel localisation schemes, involving RFID [radio frequency identification] tags, for example. Some of these are quite new techniques and

some of them are quite cutting edge techniques.” One concept being developed is Simultaneous Localisation and Mapping using RFID, or Slam RFID. RFID tags, used in shops as security tags attached, for example, to clothing, are cheap and easy to acquire. They could be scattered throughout a mine and the MSP could build up a map by detecting and remembering the individual tags. After blasting, when the ore was removed, the surviving RFID tags would go with it, which would allow mine management to track the ore and know what ore came from what part of the mine.

Of course, it is not just a matter of hardware. There is also the need to write the software which will allow the MSP to process the data it receives and decide what to do – to think in a very basic manner (like, perhaps, an insect).

The first demonstrator model of the MSP is due to undergo initial underground trials within the next few weeks (before of the end of the year). “This will be our baseline MSP, not a final production model, and this will be our first milestone,” avers Candy.

### Gas! gas!

The Mias has a second mine safety project that would make use of the MSP. This is concerned with the remote underground monitoring of toxic gases in underground mines. “Underground mine terrains are restricted and can be dangerous due to poisonous gases and dust following blasting,” points out project leader Dr Isaac Osunmakinde. Examples are Black Damp, which is a mixture of dust, carbon dioxide and molecular nitrogen, which is heavier than air and displaces oxygen, and so can cause asphyxiation; and methane, which is often released during coal mining and is lighter than air – it also displaces oxygen and is highly explosive.

There are, of course, effective safety measures and procedures in place, but these can always be improved. But achieving such improvement requires better knowledge of the behaviour these gases and dust in the confined spaces of underground mines. “The objective of this project is to understand the suspension of toxic gases and dust in air,” he explains. “This will generate the knowledge to answer the question of whether toxic gas concentrations are high, low or have disappeared, and allow the creation of maps to show which areas of a mine are safe and which are dangerous.” In turn, this will allow the development of better accident prevention measures and improve the safety of miners.

To achieve these objectives, the Mias group is developing a real time gas monitoring system, which will have static and mobile versions. The intent is that the mobile monitors will be mounted on the same basic robot as the MSP, and it is likely the same basic robot will be used, when necessary, to deploy static monitors as well.

The fundamental aim of CSIR Mias mining robotics research is to increase the safety of miners and reduce the death toll in the industry. It is not aimed at displacing workers with machines, unlike in other countries which have high labour costs and career options that are much more attractive than mining.

# Automation increases safety and efficiency in mining

**The application of automated systems can make a significant contribution towards increasing the efficiency and sustainability of mining operations. The introduction of automation to mining operations can help improve the quality of the work environment for employees by reducing their exposure to potentially dangerous situations.**

Recent advances in automated control equipment and robotics are expected to result in major improvements in the efficiency and safety of mine machinery. ‘Smart Devices’ for automation generally consist of an embedded processor, sensors, logic and communications parameters. These devices provide improved control capabilities and can provide significantly more information on the operation and health of system components and the condition of the automation process.

A mining environment is an amalgamation of a set of related processes from drilling, blasting and transporting material through to crushing, grinding and to processing and transportation of production output. Incorporation of remote automation involves the use of sensors that are able to provide data required to control mining and processing operations.

Advances in data processing technologies have met the requirement created by these sensors to analyse individual signals and integrate information from different sensors. Intelligent software development allows computers to autonomously, or at least semi-autonomously interpret the data in ways that can alter parameters of machinery during the mining operation.

The use of software agents in automation allows for the design of more flexible and smarter control architectures. By leveraging an agent communication layer (ACL) on top of communication networks such as EtherNet/IP, a system is able to achieve coordination of dissimilar systems. These ACLs contain a set of message parameters allowing for excellent automation control. The message parameters that are required for effective agent communication will vary according to the situation. Intelligent parameters for the mining industry often includes features such as embedded diagnostics, communications, calibrations and control activities typically performed in a programmable logic controller (PLC) or other distributed control system.

The concept of associating functional system elements with an intelligent agent, provides the basis for excellent system operation, and performance even when unexpected component failure, environmental changes, workload changes, or altered system operating objectives



occur. The automation of increasingly complex, critical coupled systems can place a significant demand on centralised automation systems. Intelligent agents can be used to identify faults and then to collaborate and implement a loss mitigation and recovery strategy or a self healing process. Full functionality can be restored by intelligent agents when the faulty element is repaired, therefore reducing costly downtime and increasing productivity of a mine.

### Automation

Automated control technology has already been applied to drilling operations, allowing an operator to set up and operate the equipment remotely. This removes the operator from potentially dangerous zones on the drill rig, open cut or underground mine and increases overall efficiency of the mining operation. Driverless haulage trucks are being developed for open pit mines. Artificial intelligence – incorporating GPS systems, wireless communication and object avoidance sensors enable these trucks to either drive themselves or be driven by an operator at a computer panel away from the mine site. Computer systems that provide information about the velocity and position of the vehicle can prevent accidents and increase the lifetime of the machine. Production loss can be minimised as breakdown frequency declines resulting in improved productivity and profitability in mining.

A significant challenge facing mining today is the increased global demand for minerals and metals while available resources are becoming harder to access due to location and harsh environments. Automation can help to provide a solution by providing streamlined processes for extracting ore, while reducing the exposure of workers to health risks. New sensing technologies such as GPS, radar and laser systems being incorporated into robotics will have an increasing impact on the safety, predictability, precision and efficiency of mining.

### Energy efficiency and sustainability

Automation enhances energy efficiency by reducing variability and increasing consistency in the operation of mining equipment. By using intelligent sensor technology, situational awareness of mining equipment such as a smart drill or driverless truck, can increase productivity and sustainability of the mining operation. There is also a link between automation and emissions reduction resulting from the more consistent

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*Automated control technology has already been applied to drilling operations, allowing an operator to set up and operate the equipment remotely.*

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operation of equipment. Many benefits stem from this, including reduced fuel use, greenhouse gas emissions and operating costs.

The use of robotics in mining will minimise environmental impact by allowing for more selective mining. Environmental monitoring systems can use computerised instruments with wireless communications to accurately monitor and analyse variables such as ground water levels, underground ventilation and temperature changes. These monitoring systems allow companies to monitor and record the environmental impact of their mining activities.

Intelligent devices allow for the control of machinery to optimise and reduce energy and water consumption – valuable resources for the mining industry. Advanced algorithms that can increase embedded computing and distributed intelligent devices are able to provide superior system operation. Advances in intelligent devices have provided automation, control, optimisation and information solutions offering measurable results. Communication with the business enterprise platforms addresses the need for advanced data collection and analysis that facilitate energy-efficient practices.

### Future directions of intelligent agents in mining

Advances in intelligent software have lead to significant improvements in automation of processes and development of robotic devices for the mining industry. Mine sites are increasingly adopting robotics to remain at the forefront of mining technology development. Areas of continued focus include advanced analytical techniques to improve maintenance outcomes and efficiency; location awareness of vehicles and equipment, and improved process automation.

Computing platforms are required to operate at faster speeds while continuing to operate under the harsh and extreme conditions found at a mine site. In addition to increased computer power, new algorithms for signal processing, perception and control are being actively developed to help increase the safety, precision and efficiency of mining.

Innovations in information technologies are required to meet the increasing demand for Australian mining exports. A single company cannot do it all; Rockwell Automation recognises the importance of partnering with end-users, consultants, industry specialists and third-party manufacturers to achieve common goals in equipment control. Advanced control technology has taken on new level control algorithms which will take advantage of gaming software for visualisation and self healing software to make adaptive changes to production.

Continued investment in this area will provide the mining industry with greater productivity and improved safety and sustainability.

The ultimate goal is to develop evolutionary, self-healing machinery and equipment that can effectively and efficiently interact with the mining environment.

# Homer Tunnel

**T**here was no road access to Milford Sound until the 1.2 kilometre Homer Tunnel pierced the mountains that divided the sound from the Hollyford Valley. This photograph was taken soon after work started, in 1935. The war interrupted work, and the tunnel was not completed until 1953

The Homer Tunnel had many unusual construction difficulties. The Hollyford portal, at an elevation of 3,000 ft, is at the foot of vertical rock faces 2,000ft high, at the head of a glaciated valley. Destructive snow avalanches, accompanied by tremendous air blasts, caused several fatal accidents and often damaged outside installations, including the destruction of the substantial reinforced concrete shelter which extended some 10 chains out from the portal. The air blasts have been known to shear off 12in. hardwood poles 4ft above ground level, blow over a crawler tractor weighing 4 tons, and shear off 20-in-diameter beech trees without uprooting them. The tunnel, 20ft by 12ft in cross section, had to be driven down hill on a grade of 1 in 10 through some 3,500ft of extremely hard granite-type rock. When the tunnel was completed, the rock continued to “pop” in places, and so regular scaling of loose rock had to be carried out. Rock bolting was also used.



Australasian  
Tunnelling Society  
website  
[www.ats.org.au](http://www.ats.org.au)



## Launceston water supply

**I**n 1857 Launceston's fledgling municipal council constructed its first reticulated water supply which still serves the city centre. This economical gravity scheme brings water to the city from the St Patricks River about 18km east of Launceston.

Mr W R Falconer, the Director of Public Works in Hobart, was appointed to design and superintend the construction of the scheme. Mr William Huttley was appointed by the Council to act as Resident Superintendent of Launceston Waterworks, to assist Mr Falconer.

The tunnel excavated through a saddle is some 154 metres long, with additional cut and cover sections taking the overall enclosed length to 210 metres. Construction of the tunnel was contracted to a Mr Henry Newman.

The new scheme replaced sometimes brackish or muddy water delivered in barrels. The social benefits were enormous as it provided clean water, better hygiene, street flushing and public drinking fountains.

A water-borne sewerage disposal scheme became possible. As you would expect over such a long period, there has been some expansion and upgrading. Additional trunk mains to the city were installed. The diversion dam on the St Patricks River was replaced with a concrete gravity weir in 1888 and the tunnel was lined with concrete in 1912.

A water treatment plant was installed in 1925. Then, after 110 years of service, the water race was rebuilt as a concrete-lined channel to increase its capacity. The scheme was recognised with a plaque was awarded by the Institution of Engineers, Australia on the 150th Anniversary of the scheme.

# Springvale Tunnel, Evandale, Tasmania

**E**vandale is situated in Tasmania, on the South Esk River 20km south of Launceston and 5km from the main highway and Launceston Airport.

Originally established as a military post in 1811, it was known variously as Collins Hill, Patersons Plains, Gordon Plains, and Morven before the town's name was changed to Evansdale and eventually to Evandale in 1836 in honour of Tasmania's first Surveyor-General, G.W. Evans and declared a municipality in 1865.

In 1836 a plan was hatched to provide water to Launceston from the South Esk River. A convict station was established at Evandale for this purpose, but attempts to tunnel through a hill as part of the scheme were fraught with difficulties and the first stage of the project was abandoned.

A second tunnel was subsequently commenced with the tunnel to run from the South Esk River, under Evandale and to surface on land owned at the time by Captain Barclay to the east of Evandale. From this point the water was to travel by 'Open Race' to Windmill Hill in Launceston by gravity and then to the Community and the Port.

The reasons for this second tunnel and race being abandoned have not been definitively established to date, and it is possible that a number of factors may have contributed to the abrupt end of what has been described as 'Tasmania's most ambitious convict project ever undertaken'.

A study by Mineral Resources Tasmania in 2002 suggested that the tunnel was excavated by skilled miners, at least in part, and not by unskilled labour, because of the pick marks on the walls and their smoothness, regularity and cleanliness. The tunnel walls and backs have been carefully trimmed and smoothed by the careful use of 'cousin jack' picks, chipping and trimming the rougher edges from the walls.

The tunnel is reported to be 160 yards (approximately 160 metres) long and trends approximately 175 degrees magnetic (taken at entrance) or almost due south. It was examined for a distance of approximately 90 metres. The



tunnel is basically square in cross section and measures approximately 1.7 metres wide by 1.5 metres high. The tunnel dimensions are significantly modified in the section closest to the entrance because the unstable weathered basalts have collapsed in places.

The tunnel has been driven along the contact between a layer of Tertiary terrestrial mudstone (light khaki brown in colour and finely bedded) and dark greenish grey basalt that is occasionally vesicular. The basalt comprises the upper part of the drive and forms the 'backs' (or roof) while the mudstone forms the floor.

It is considered that the engineers who designed this scheme chose the site of the mudstone-basalt contact for their tunnel because it made for cheaper and easier mining. The mudstone and basalt contact is exposed in the hillside cutting at the site of the former convict barracks at Springvale and it is possible that the engineers were aware of it. This location may have lessened the requirement for explosives, facilitated hand excavation and thereby lowered the mining costs. Lowering the floor of the tunnel by one metre would have placed the entire excavation in mudstone with the solid basalt as the roof. This could have been a very stable tunnel. In fact, the far end of the tunnel is in solid fresh basalt and it is in a remarkably clean and stable condition.

The tunnel was recognised by an Historic Engineering Marker by The Institution of Engineers, Australia and Evandale History Society in 2002.

# Tasmania tunnel mystery



**D**erwent Valley Council is denying claims that convict works unearthed during a recent road reconstruction is instead a tunnel pre-dating the Port Arthur site.

Workers say they came across the hidden structure while rebuilding Burnett St at New Norfolk. They called the Derwent Valley Council, which inspected the find and then instructed the workers to cover it and continue sealing the road.

Council general manager Stephen Mackey, who attended the site, said he was not convinced the structure was a tunnel. He said he believed it was a heritage stormwater drain. "We did not destroy it. There was no damage. It's still intact," Mr Mackey said. However, workers have reported that the tunnel was damaged during roadworks and sections of each side had caved in. They said they were instructed to cover the opening with a steel plate before sealing the road with asphalt.



New Norfolk historian Peter Williams said he knew of at least two tunnels that extended from the historic Bush Inn one of the oldest hotels in Australia to Willow Court, which was originally built to house invalid convicts. He said he believed the tunnels were used to transport the convicts from boats on the River Derwent to Willow Court and that the structures predated Port Arthur by at least three years.

The Port Arthur penal settlement began life as a small timber station in 1830. From 1833 until 1853, it was the destination for hardened criminals from Britain. Mr Williams said officers at the time were not allowed to be seen drunk in the streets so would have used the tunnels to get back to the barracks at Willow Court. Bush Inn licensee Tom Atkins has a 2m tunnel entrance in the basement of his hotel, which has been blocked off. He said old-timers at the hotel often claimed the tunnel ended at Willow Court and was high enough for a man to stand in.

## Picnic Point Cable Tunnel

**I**nstallation of 330,000 volt cables between Sydney South Substation (near Picnic Point) and Beaconsfield West Substation in Alexandria was carried out in 1978. The \$7.5 million project was the largest 330 kV cable installation in Australia at that time and one of the longest cables of similar voltage in the world at 19.5 km.

A specially made TBM was used by Pipeline Boring Pty Ltd to tunnel under two small hills at the southern end of the route. This was the earliest TBM tunnel to be carried out in Sydney's Hawkesbury Sandstone.



# Port Adelaide smuggler tunnels

**G**host tour operator Laurie Pearce, in the cellar at Dockside Tavern in Lipson St, is calling for information on supposed 19th century tunnels that run beneath Port Adelaide.

They were the underground lairs of smugglers and publicans, used to transport liquor and drag drunken men from hotels to the wharves to be made sailors against their will. But is the supposed network of 19th century tunnels running beneath Port Adelaide still there to be discovered ... or mere myth? Local ghost tour operator Laurie Pearce is determined to find out.

Mr Pearce says clients are constantly asking him about the existence of tunnels and is calling for anyone with historical information to come forward. "It just adds to the mystery of Port Adelaide – do they exist or don't they?" says Mr Pearce, who believes the tunnels, if there are any, could be a tourist drawcard. "If there are tunnels or sections of underground buildings we could access, it would attract lots of people."

Port Adelaide Historical Society secretary Laurie Shields says the Port's original homes and pubs were "built very, very low on the mud", with the whole area later raised several metres to avoid flooding and new buildings often put right on top of old ones. "There are areas where there are whole rooms beneath present levels," he says.

But Mr Shields says basements and cellars are a far cry from a network of tunnels. "It's not supported by fact. But one persistent story is of a tunnel starting beneath the Royal Arms Hotel, connected to the Port Dock Brewery Hotel and the waterfront.

Former Tourism Port Adelaide chairman and Port Dock Brewery director John Cowled says he concocted the tale himself about 10 years ago as part of a story about the fictional smuggler Black Bart, to help promote a new beer of that name. He says there are likely old sewerage pipes beneath the Port that have been "romanticised" into smugglers' tunnels.

Railway Hotel owner Fred Hiscock is another non-believer who says there would have been no point trying to build tunnels under the original Port, as they would have been flooded at high tide.



## Makahu Tunnel

**A** pack track was all that originally joined Strathmore and Makahu, a community that was settled in 1896. By 1902, a dray road was completed to replace this, but it was harsh, and the route over the hill was seen as a formidable obstacle. The erection of the Makahu Co-operative Dairy Factory a few years later embellished the need for a better access route for the produce to be able to be easily carried out.

In 1907, this was dealt to with the building and opening of the Makahu (or Brewer Road) Tunnel. The settlers worked hard, making full use of picks, shovels, wheelbarrows and explosives to eliminate the steep grade. People protested that the tunnel had been built too near the top of the hill to be at all worthwhile. However, the 166 metre tunnel made the journey more than 3km shorter, and saved travelers from battling the windy hill route.

The tunnel was originally made out of an interesting construction of wood, with a timber lining. However, by 1919 the wood had rotted through and the tunnel collapsed at the Makahu end. It was closed for two years while work was done to re-line the tunnel with more solid concrete pillars to ensure no further cave-ins were possible.

Throughout the years, the locals have held numerous impromptu "parties" inside the tunnel, which occasionally forces travellers to join in, or wait until the end to get through.

In 1998 a major upgrade of the tunnel was carried out by contractor Mc Mackenzie and his team. This had a total cost of \$500,000 and included lowering the tunnel floor by 1.4 metres to give triple-deck stock trucks access to the road, installing new support struts, and strengthening the tunnel soffit with 150mm of reinforced concrete.

The upgrade took a total of four months, and was reopened with a ribbon being cut by locals Jim Hopkirk and Danica Wood (who were descendents of settlers who protested the delay in fixing the tunnel in 1920) on 22 July 1998.

Today, the tunnel acts as an access point to the Makahu and Puniwhakau communities, the Te Wera Forest, Aotuhia Station, the "Bridge to Somewhere" and a large proportion of the Whanganui National Park, including the Matemateaonga Walkway.

# Lyttelton WWII underground storage



**A**erial pictures of Christchurch earthquake damage show the old WWII tunnel at the Port of Lyttelton. In the 1950s the area was known locally as Windy Point and part way up the scarp face below the Summer Road and the Time Ball Station is a concreted opening in the hillside which goes deep into the hillside. There were branch tunnels, some huge in size and in length.

Information on the tunnels' history is very sparse. Baden Norris Lyttelton Historical Museum curator says he recalls seeing the tunnels being built during World War II. As a young lad he had seen the construction work under way from the harbour ferry as he crossed to Lyttelton to attend school. But this was secret wartime work.

Inquiries to the New Zealand Defence Force HQ in Wellington revealed a few small references to the tunnel project. Defence Department records held this succinct summary:

“Additional facilities for fuel oil storage at Lyttelton was recommended by Chiefs of Staff in June, 1943. Two months later, War Cabinet approved the construction of two underground tunnels each capable of holding 6000 tons of oil. These were driven 500 feet into solid rock, the dimensions being 20 feet 6 inches (6.2 metres) wide and 32 feet and 9 inches (9.9 metres) from the floor to the crown of their arch. The work was about 37 per cent complete (excavation 70 per cent) when construction was stopped in September, 1944. The expenditure incurred amounted to [PndStlg]68,291.”

Archives New Zealand in Wellington has a file of about 600 pages of information on the Lyttelton Fuel Oil Tunnels. These previously secret files are now declassified. Apparently the project was first mooted by the Wartime Cabinet in 1942, but work only commenced in 1943.

It was felt that should the Pacific war theatre push southwards, Lyttelton would need to become the southern bastion for the Allied Naval Fleet. A 12,000 ton cache of ship fuel oil was thought necessary and it needed to be safe from enemy attack.

New Zealand was still strongly regarded as a Dominion of Britain and much of the tunnel project's planning was

done in Britain. Considerable dialogue took place with the Home Office and the Royal Navy in England. The New Zealand side of the operation was a joint effort between the Government, Office of the Navy, and Department of Public Works. The Christchurch works manager was the local operational director.

The records disclose the difficulty experienced in getting sufficient numbers of experienced tunnellers to build the tunnels. The work was done by 25 tunnellers working three shifts and on two faces within the Lyttelton hillside. It was hoped to finish the work in eight months, but work ran behind schedule and was heading towards taking 18 months. Efforts to hire another 25 tunnellers were unsuccessful as work was also under way on the underground elements of the Tekapo Power scheme and on other work in Wellington.

Tunnel designs indicate the tunnels were planned to fuel ships by gravity flow through a 46cm (18”) pipeline. The tunnel floors are 38.24m (125.5 feet) above the survey datum point of the former Lyttelton Harbour Board. Gladstone Pier is 13.25m (43.5feet) above the datum point. This gave a fall of 25 metres (82 feet) for supplying fuel to shipping. The old Lyttelton Harbour Board datum point is set at what is termed MLW Spring – or in other words at Mean Low Water in the Spring tidal range.

When work was halted in 1944, the tunnels were incomplete. The Allies were winning and the fuel dump was no longer likely to be needed.

The access tunnel pilot drive of 61.57 metres was complete and the first eight metres and portal area were concrete lined. This access pilot drive was 3.65 metres wide and with 1.22 metre walls running up the arched ceiling, which was also about 3.65 metres high. Chamber No 1 was completely excavated for its full 152 metre length. The roof was 12 metres high and the width 6.7 metres. Chamber No 2 was excavated for its full length, but only with a pilot drive prior to honing the full dimensions as in Chamber No 1. The initial pilot drive was 3.5 metres wide and 3.35 metres high.

Also uncompleted was concrete lining of the two storage chambers to the height of their walls. They also lacked the

pipings that would take the fuel oil to the ships below. These pipes and pumps were standing by ready to be installed but were later disposed of.

When work stopped, 13,863 cubic metres of rock had been removed. To complete the works, 19,989 cubic metres needed to come out, so they were 70 per cent completed. But despite being mothballed, the project was not yet dead. Records several years later show that in 1951 and 1952 there was debate over whether the tunnel-based fuel storage project should be resurrected.

It appears that in the Cold War climate the government and Navy believed a need still existed to have strategic fuel oil storage. Discussions took place with private businesses on completing the underground storage facilities. Oil companies of the day, including Esso (Mobil today), Vacuum Oil (now part of Exxon Mobil), and BP were invited to indicate their interest. But they decided it

would cost too much to finish the job. To stop any risks to casual explorers, a grill was installed at the portal.

Lyttelton's World War II fuel storage tunnels were not unique. Similar facilities were installed elsewhere, including Auckland, New South Wales, Scotland, and a massive multi-purpose system by the Americans at Malinta in the Philippines. All of these were concrete-lined tunnels with feeder pipes and pumping equipment. Some have suggested the recent severe earthquakes may have destroyed the tunnels. However, the way the Lyttelton rail and road tunnels have escaped relatively unscathed suggests the fuel tunnels have probably survived.

Cashin Quay is now generally out of bounds. One harbour official has suggested that alternative access to the tunnel system could be achieved by forming a secure trackway down to the portal from the Sumner road above.

## Victorian secret tunnel found at Sassoon hospital

**L**abourers carrying out digging work to make lift pathway stumble upon tunnel leading to unused basement in 144-year-old Victorian-era structure

Labourers of the Public Works Department working on a lift pathway at the Sassoon General Hospital stumbled upon an important piece of history recently. They found a tunnel leading to an unused basement in the building. The 144-year-old building, which was constructed between 1863 and 1867 in the Victorian Gothic style of architecture, is a Grade I heritage site.

The two-storey building made of basalt has huge staircases, big halls and wide corridors. This building houses various departments, including ophthalmology, psychiatry, burns treatment, tuberculosis and plastic surgery ward. Dr Ajay Chandanwale, Dean of Sassoon Hospital, said the tunnel led to a basement. "It may have not been used for the last 100 years," said Chandanwale. "This is the first building of the Sassoon hospital and the most beautiful in the campus. The tunnel and the basement room are part of the structure. We have asked the PWD workers to ferret out the soil and clear the place. Details will be known only after the digging work is over."

The PWD labourers were carrying out the digging work to make a pathway for a lift. Chandanwale ruled out any speculation that the construction work may damage the old heritage structure, which is against rules.

He said the ophthalmology ward was located on the first floor and patients with eye problems needed to have a proper lift to reach the ward for treatment. "The hospital has earmarked Rs 10 lakh to fit a huge lift capable of holding 14 persons," he said. D G Kulkarni, superintendent of Sassoon hospital, said no heritage rule set by the Archeological Society of India was being violated. "There will not be any damage to the old structure and it (construction of lift) will not make the place ugly," he



*Deep, dark secret: The tunnel that was discovered recently in the 144-year-old building of the Sassoon General Hospital. Pic/Krunal Gosavi.*

said. U B Puri, PWD engineer who is monitoring the entire work, also said there was no violation of rules and work would be done without damaging the old structure.

### PMC says

Avinash Sohani, member of the PMC Heritage Cell, said permission to erect a lift way had been approved by members of the earlier heritage cell in 2010. "I don't know any other details and on what basis permission was given to the hospital," he said.

### Written on Sassoon foundation stone

Founded for the relief of the suffering poor of Poona by a philanthropic individual whose name it bears and who munificently contributed Rs 2,13,000 towards its erection and endowment. It was designed by Captain H Saint Clair Wilkins R.E. (Royal Engineer). Commenced: 1863 Completed: 1867. Total cost of construction: Rs 3,10,060.



## New Zealand Railway Tunnels

**O**ne of the first tunnels built in New Zealand connected Christchurch with its port of Lyttelton by single-track railway. It was begun in 1861 and cost £200,000 for a total length of 1½ miles. A two-lane road tunnel has now been built only a few chains away and almost parallel to the rail tunnel. It cost £3 million for 1½ miles (with ancillary works) and was completed in February 1964.

The construction entailed precise surveying and levelling, drilling and blasting of rock, earthmoving, draining, concrete lining, lighting and ventilation – this last a most important consideration in road tunnels. This tunnel is fully ventilated using the “cross-ventilation” system with inlet and outlet exhaust fans, each capable of moving 320,000 cu. ft. of air per minute. Electric monitoring and measuring devices will quickly detect noxious gases (especially carbon monoxide) and, by remote control of ventilating machinery, will keep them below danger level. The tunnel is lined throughout with ceramic tiles and has special lighting installed. There are 2½ miles of special approach roading, with bridges, toll plaza, traffic stations, and roundabout. The tunnel itself and its buildings contain interesting (and for New Zealand entirely novel) uses of precast, pre-stressed concrete. The breakthrough took 12 months; an average of 23ft of completed tunnel was driven each day (800 cu. yd. of rock excavated) by a three-shift construction team.

The construction of the Otira Tunnel through the Southern Alps has had possibly a greater influence than any other single factor on the development of the West Coast of the South Island. This single track railway tunnel is 5 miles long approximately. It was begun in 1908 and,



after many difficulties, finished in 1921. It is 15ft 6 in. high and 15ft wide. There are no lights in the tunnel. Natural ventilation has proved sufficient, as the railway is electric.

The Tawa Tunnels, giving better railway access from the west coast of the North Island to Wellington, were excavated only with great difficulty. The two tunnels aggregate 3½ miles in length and are on a grade of about 1 in 120. The finished dimensions of the tunnel inside the 2ft-thick concrete lining are width, 26ft and height, 20ft. The dangerously unstable and variable nature of the ground made it necessary to “timber” the whole tunnel immediately after excavation. Each of the 8ft long arch segments making up a “set” was cut from 10in. × 10in. timber; the spacing of these sets was generally at 5ft 3in. centres, but at times it was necessary to place them at 1ft 4in. centres—almost touching. These tunnels were completed in 1937.

The 5.46-mile railway tunnel through the Rimutaka Ranges 30 miles north of Wellington was driven through better country. The contractor was therefore able to use “full face” mechanised excavation techniques throughout, the maximum progress being 425ft of excavation in a week. The tunnel was begun in October 1953 and completed in November 1955. It is 15ft 4in. wide and 17ft high.



### Longest

The longest railway tunnel in New Zealand is the 8879m long Kaimai tunnel at Aputa on the East Coast Main Trunk Line. This tunnel was opened in November 1980 replacing the longer Karangahake Gorge route.

The second longest railway tunnel in New Zealand is the 8798m long Rimutaka tunnel between Wellington and the Wairarapa. This tunnel replaced the Rimutaka incline in 1955.

The third longest railway tunnel in New Zealand (and the longest railway tunnel in the South Island) is the 8566m long Otira tunnel through the Southern Alps between Arthurs Pass and Otira. This tunnel is on a continuous 1 in 33 grade and was opened in 1923.

The 4th longest railway tunnel in New Zealand (and the longest double-track tunnel in New Zealand) is the 4324m



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*The shortest railway tunnel in New Zealand, not constructed by the cut and cover technique, is a 39.83m long tunnel between Staircase and Avoca on the South Island Midland Line opened in 1906.*

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long Tawa No.2 tunnel between Wellington and Tawa. It was opened in 1935 for goods trains on one line and in 1937 for all traffic.

The 5th longest railway tunnel in New Zealand is the 2989m long Tikiwhata tunnel between Wairoa and Gisborne opened in 1943. The 6th longest railway tunnel in New Zealand is the 2596m long Lyttelton tunnel through the Port Hills between Christchurch and Lyttelton opened in 1867. The 7th longest railway tunnel in New Zealand is the 2091m long Turakina tunnel between Marton and Wanganui opened in 1947.

### Shortest

The shortest railway tunnel in New Zealand, not constructed by the cut and cover technique, is a 39.83m long tunnel between Staircase and Avoca on the South Island Midland Line opened in 1906. The 2nd shortest railway tunnel in New Zealand, not constructed by the cut and cover technique, is a 42.05m long tunnel at the Woodville end of the Manawatu Gorge opened in 1891. This tunnel was opened out in 2008.



## Karangahake Gorge

**I**n the early 20th Century the Public Works Department chipped, ripped and blasted their way along the Karangahake Gorge, building three bridges and a tunnel so freight-laden steam trains could cross from Waikato through a gap in the hills to Waihi.

For more than 70 years, the gorge was a celebrated feature of the East Coast Main Trunk Line. The steam locomotive hissed and writhed round the foot of the black hill; firebox flashes bounced off the face of the crew; the searchlight played on the river and cliffs. It passed through quickly, leaving silence, darkness and coal smoke.

Goods trains stopped using the gorge section in 1978 when it was made redundant by the shorter Kaimai Tunnel route between Hamilton and Tauranga. However, in the gloom of losing a hard-won asset, some people saw a nugget twinkling in the grey gravel track ballast. They pushed to keep the route as a public treasure – at a time when the concept of recreational walkways was new.

The NZ Walkway Commission approved the idea of the section between Waikino Station and Waihi going to the Goldfields Railway, and the Waikino-Paeroa section, including the gorge, going to the Department of Lands and Survey.

A decade of planning, work and raising donations went into replacing the road of iron in the gorge with a 2m wide trail called the Historic Karangahake Gorge Walkway. It was opened in stages from 1985, using local labour and subsidised temporary work scheme workers under rangers' supervision.

A 1km long railway tunnel was cleaned and fitted with electric lights to give an eerie short loop option for the riverside stroll from Karangahake Hall to Waikino Station. Bridges were restored or replaced for foot traffic.

Signage and displays and uncovered ruins commemorated the gold mining days and townships where once thousands of people worked and lived.

Now, walkers share it with cyclists.

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# Secret passageways of old Darlinghurst Gaol

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**T**he passageways were beneath the Marist Brothers College. Crawling along on your belly, you entered into a small cell, only 3 feet high, which had shackles on its walls.

There was one entrance to the tunnels under the staircase in the school, which at the time was a broom closet, and there was another entryway in a room the brothers' used briefly for music lessons. Yet another entrance was located in the house where the brothers.

The tunnels were first discovered one day in 1968 by schoolkids who noticed a crack in the floorboards of the broom cupboard, they lifted them up and discovered a tunnel down in to the dark.

They investigated the tunnels with a torch. The tunnels were about 2 feet wide and made of lime and there were small rooms about 8 feet wide with shackles on the wall. They would mainly access the tunnel through one of the manholes that was in the art class.

East Sydney Technical College was built within the grounds of the old Darlinghurst Gaol in 1921, about seven years after the penitentiary closed.



*Stephen Hickmott one of the schoolboys who found the tunnels.*



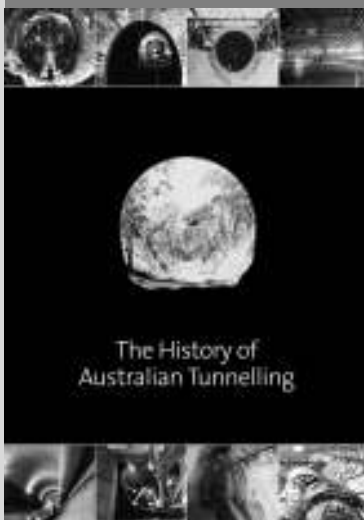
*Marist Brothers College Class of 1965.*



Rumour has it that there was a tunnel from the gaol leading all the way down to the corner of Bourke and Liverpool Streets, which is home to an 1850s Victorian Georgian house, known as either Claremore or Claremont Lodge. Recent excavation work on the site of the old Technical college has revealed some old tunnels.

An excavation contractor working at the technical college were fixing a sewer main about 5m underground, close to the entrance on Forbes Street when they got about 3m down they apparently started to hit the side of some very large lime and sandstone boulders. They wondered why they had found such large carved sandstone boulders so far down.

One of the labourers then noticed a gap in the sandstone blocks that were now at his eye level, just big enough to fit your fist through (as shown in the photo above). The contractors then moved one of the boulders out of place with their excavator and revealed a long tunnel about 3 foot-wide with limestone walls as far as the torch would shine.



## The History of Australian Tunnelling

**A colour publication by the Australasian Tunnelling Society**

Over 150 pages of unique Australian tunneling projects from early 1800s to projects completed in 2009

The book provides unique insights in the construction of water, sewer, cable, road and rail tunnels, underground storage and defense facilities.

The book also includes a comprehensive database of nearly 300 tunnelling projects.

*The book is available from ATS Secretariat Sheryl Harrington at Engineers Australia for \$95 +GST*



## TUNNELS OF THE SOMME

**T**hey are a hidden maze of tunnels where a bloody underground war was played out in terrifying darkness and where the bodies of 28 heroes lie entombed forever.

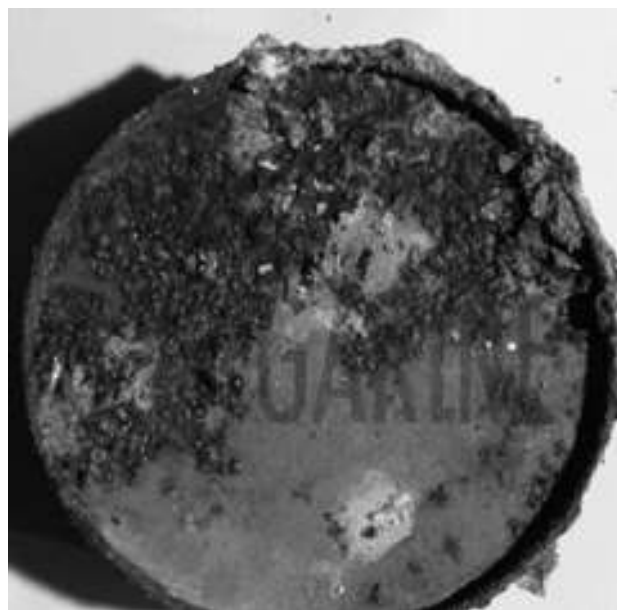
Now, after lying practically undisturbed since troops laid down their arms in 1918 the secrets and tragedies of the labyrinth are finally being revealed thanks to work by archaeologists.

Since January 2011, the Anglo-French La Boisselle Study Group has been working with historians to open up and explore the tunnels to discover more about the lives of the men lost in them.

The passages, named the Glory Hole by British troops, run under and around the sleepy village of La Boisselle in northern France, which was of huge strategic importance to the 1916 Battle of the Somme.

The infamous four-month battle claimed the lives of millions, including 420,000 British soldiers – all for just a few yards of territory.

Twenty eight tunnellers died in the passages between August 1915 and April 1916 and their bodies now lie permanently buried within the collapsed tunnel walls.



*Finds: A French soldier's metal drinking cup, and a margarine tin issued as part of the ration were found*

.....  
*The passages, named the Glory Hole by British troops, run under and around the sleepy village of La Boisselle in northern France, which was of huge strategic importance to the 1916 Battle of the Somme.*  
.....

## THE TUNNELS

- Three feet wide
- Made of chalk
- Ran under land a quarter of a mile square
- Nick named the Glory Hole
- It is thought there are four miles of tunnels, belonging to the French, German and Brits

From bottles of drink and tins of food, graffiti, helmets, picks and bits of shrapnel, he discovered all sorts of eerie reminders of these lesser known heroes of the Great War.

Almost 90 years ago the passages would have been full of tunnellers digging, laying explosives, and bringing soil to the surface aided by a recently discovered small railway – all with the Germans often just yards away doing exactly the same.

A poem scrawled on a wall reads: 'If in this place you are detained; Don't look around you all in vain; But cast your net and you will find; That every cloud is silver lined.'

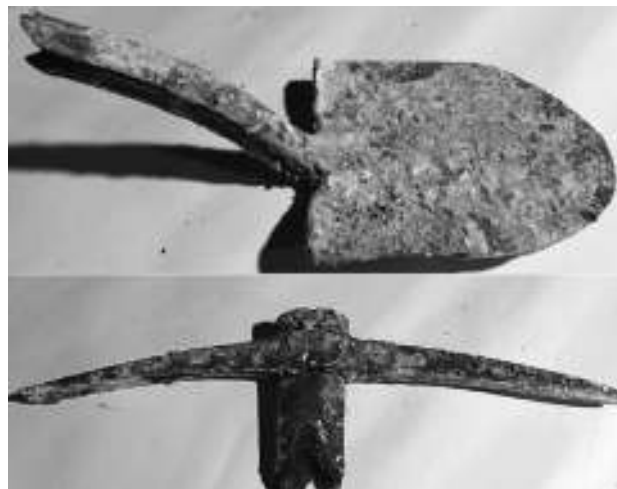
On 28 September 1914 the German advance was halted by French troops at La Boisselle. The two sides fought for the possession of the civilian cemetery and farm buildings. In December that year, French engineers began tunnelling under the ruins which sparked the prolonged battle below ground lasting until 1916.

Both sides tried to probe underneath each other's trenches, setting off explosives to undermine fortifications, working at a depth of about 12 metres. The Tunnelling Companies sent in miners to deepen these tunnels and crater system to 30 metres while above ground infantry occupied trenches just 45 metres apart.

At the start of the Battle of the Somme La Boisselle stood on the main axis of British attack. To aid the attack they placed two huge mines, known as Y Sap and Lochnagar, on either flank, but they failed to neutralise the German defences in the village.

The village was eventually captured from the Germans on July 4.

Military mining was key to tactics of both the Allies and the Germans during the conflict with tunnellers digging and laying explosives to undermine each other's



*A shovel carried by infantrymen and below special strengthened pick used by the miners.*

fortifications. During the 1917 Battle of Messines, 10,000 Germans were killed after 455 tons of explosive was planted in 21 tunnels. And, two years earlier, in October 1915, 179 Tunnelling Company began to sink a series of deep shafts to try and stop German miners approaching beneath the British front line.

At a location known as W Shaft they went down from 30 feet to 80 feet and began to drive two counter-mine tunnels towards the Germans. But they heard sounds of German digging getting louder and explosives were prepared and planted. Company Commander Captain Henry Hance spent six hours listening and worked out the Germans were 15 yards away.

However, 24 hours later the Germans set off their explosives. Carbon monoxide gas was released by the huge explosion proving fatal for the tunnellers working underground.

## Birdsong on the BBC

The new BBC TV adaptation of *Birdsong* – starring Clemence Poesy as Isabelle Azaire and Eddie Redmayne as Stephen Wraysford – depicts the horrors of tunnel warfare in World War I.





## Nazi tunnel opened in Poland

**A Nazi tunnel in Poland built using forced labour has been opened for the first time since the Second World War. The tunnel is part of an underground mining and construction project code-named *Komplex Riese* by the Nazis.**

According to Project Riese, an international group of historians exploring the area in question, “extensive construction work on a number of underground shelters and tunnels” took place in the Owl Mountains between 1943 and 1945.

According to Project Riese, the complex was intended to be used as a refuge for the leading members of the military as well as a safe place for certain industrial facilities. “German sources suggest that they were supposed to be turned into a huge underground shelter covering more than 35 square kilometres, with one of Adolf Hitler’s Führer Headquarters at its centre”.

Waldemar Lyczak, a worker helping to open the tunnel, told a television crew that much of it was blocked by rubble. “We’ve been successful because we had to dig through part of it that had collapsed which wasn’t as big as we thought,” he said. “We went several dozen more kilometres down the tunnel and unfortunately came across another collapse.”

The construction work was done by forced labourers from concentration camps. Many of them died of disease, malnutrition, exhaustion, or mistreatment by guards. “The Germans were keen to make progress and forced the prisoners to be obedient,” said Lyczak. “Many suffered ill health or died here to make the tunnels.”

The tunnel is the latest in the system to be opened. According to Project Riese, three others are run by private owners and can be visited by tourists.

## Victorian Scotland-Ireland undersea rail link plan

**A rail consultant has told of his surprise at finding a Victorian engineer’s proposals for a rail link between Scotland and Ireland.**

Edinburgh-based David Spaven believed the plans for a tunnel, causeway or an undersea bridge between Stranraer and Belfast were not widely known today. The plans feature in a new book, *Mapping the Railways*, Mr Spaven has co-written with author Julian Holland. It also includes abandoned ideas for light railways on Skye and Lewis.

Published for the *The Times* by Collins, the book has been described as the most comprehensive collection of British railway maps dating from 1819 to the present day.

Mr Spaven worked as a British Rail manager for 18 years until 1995. He stood as a Green Party candidate in Glasgow Maryhill in 1987 and was the first chairman of transport campaign group *Transform Scotland*, and has also been involved with congestion charge support group *Get Edinburgh Moving*.

The book is his latest collaboration with Mr Holland, a railway writer and photographer. “There was a short window of opportunity for these railways to be built”

Much of the Scottish material was drawn from maps held by the National Library of Scotland in Edinburgh.

The undersea rail link, proposed by engineer Luke Livingston Macassey, came to light during Mr Spaven’s research of Victorian-era railway maps and plans.

He said: “The book has been a fantastic journey of discovery for me. One of the big surprises was a prospectus for a tunnel under the North Channel between Stranraer and Belfast. At first I thought it was a Victorian spoof, but through more research I found the person behind the idea was a competent and well regarded engineer.”

According to *Mapping the Railways*, the proposals published in 1890 were for a rail link using either a tunnel, a submerged “tubular bridge” or a solid causeway.

The engineer said the rail connection would quicken travel between Scotland and Ireland and would also spare people “the horrors of 20 miles in rough seas”.

# The Power of Water

DAVID LEES

Set in Australia, Laos and Thailand, *The Power of Water* explores the many ways in which our lives are affected by water, from the devastation of floods and tsunamis, to the excitement of surfing or the sensual effect of a hot, steamy shower.

The story follows the intertwining lives of Paul Johnson, a 33-year-old Australian Civil Engineer, and Abdul, a young Malaysian orphan. Through their experiences we follow Paul's career and relationships, and Abdul's journey as he explores his faith and seeks out his life's direction.

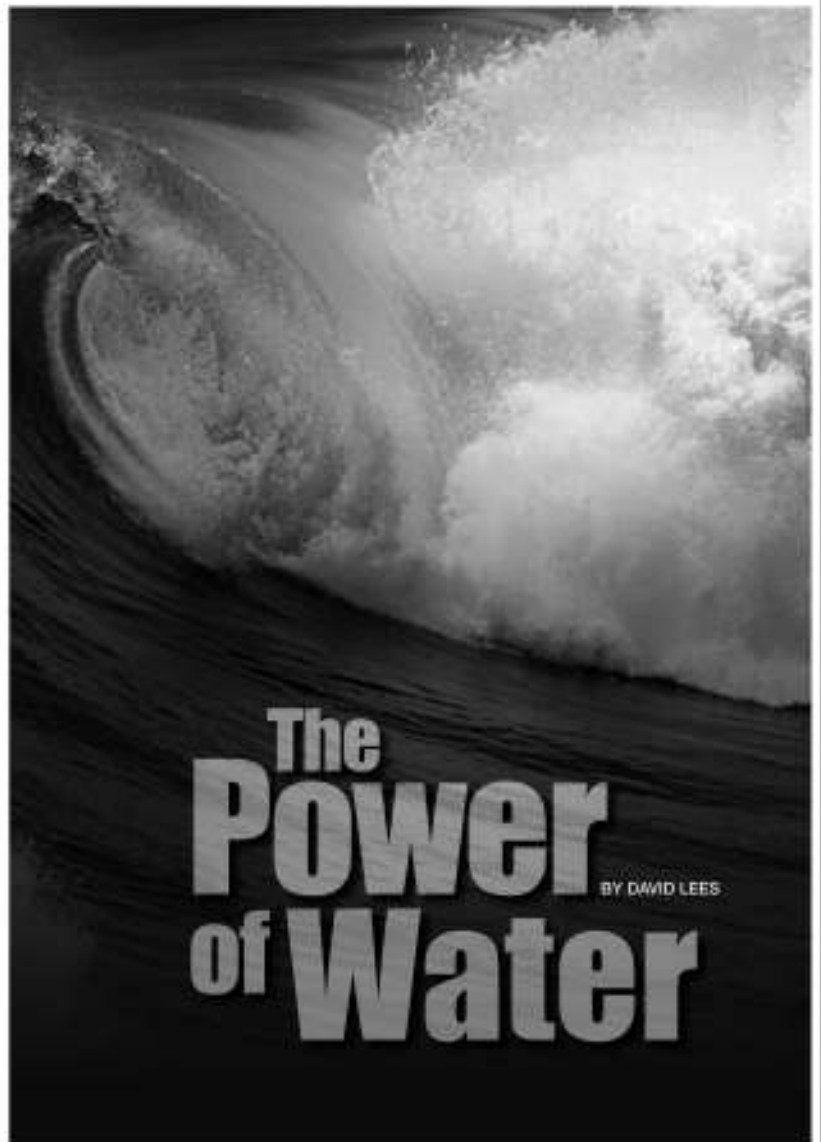
The company Paul owns is working on the construction of a new dam at Kangaroo Creek in Northern New South Wales, however, the main contractor is trying to cheat him, which culminates in a courtroom confrontation. In parallel, Abdul becomes involved with an extremist group exploring Australia's total dependency on water and how this can be used as a weapon of terrorism.

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## Attempts to recreate 'Great Escape' tunnels humble modern engineers

**T**he labour took months rather than years and a workforce of barely 100 men. As for materials, there were none, beyond what the captured Royal Air Force fliers who built them could scavenge, scrounge or improvise.

But by the measures of ingenuity, courage and persistence, the tunnels built almost 70 years ago in sandy scrubland near the small town of Zagan, 130 miles southeast of Berlin in what was then Hitler's Germany and is today western Poland, were a legendary feat of engineering, although on a miniature scale.

Chronicled by the 1963 movie "The Great Escape," the tunnel building is one of World War II's great stories. In the decades since, the legend of the allied fliers' mass breakout on the night of March 24, 1944, together with the ingenious planning and the Nazi retribution that

followed – 73 of the 76 escapees recaptured, and 50 of them summarily executed on Hitler's orders – has, in a way, eclipsed reality.

In an effort to establish more clearly how the escape was accomplished – and, in a sense, to reclaim the narrative of the breakout – British-based engineers, battlefield archaeologists and historians travelled into the pine forest outside Zagan last summer to unearth the secrets buried there for a documentary by Wildfire Television in London that was broadcast in late 2011 in Britain. They were accompanied by modern-day Royal Air Force pilots, as well as veterans of wartime bombing raids, now in their 80s, who helped build the tunnels at the encampment known as Stalag Luft III.

The team's task was to employ reverse engineering by uncovering the tunnels and what remained of the



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*Chronicled by the 1963 movie "The Great Escape," the tunnel building is one of World War II's great stories. In the decades since, the legend of the allied fliers' mass breakout on the night of March 24, 1944, together with the ingenious planning and the Nazi retribution that followed – 73 of the 76 escapees recaptured, and 50 of them summarily executed on Hitler's orders – has, in a way, eclipsed reality.*

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tunnellers' jury-rigged equipment to replicate the wartime fliers' ingenuity. Ultimately, the team members were stunned that, even without the menace of the ever-watchful Nazi camp guards, they were unable to match their wartime counterparts fully, particularly in the most crucial skill, digging a tunnel 30 feet below the camp surface without repeated collapses of the sandy soil above.

For years, veterans and others have pored over the camp's ruins, laying memorial stones amid the outcroppings of broken brick and concrete scattered among the pine trees, all that remains of the 60-acre site built by the Germans to house 10,000 captured fliers. But no group matched the expertise of the 2011 team, which went determined to lay bare what Hugh Hunt, a Cambridge University engineering professor, described as "the final secrets of a remarkable story."

A maverick Australian affectionately nicknamed Dr. Screwloose by his colleagues, Hunt went to Poland as a consultant to the current RAF pilots, including some with combat experience over Iraq and Afghanistan. Their task was to use insights gleaned from the digs at the sites of wartime tunnels known as Harry and George to build a new 35-foot tunnel they called Roger, after the squadron leader Roger Bushell, the principal organizer of the 1944 escape and one of those executed by the Nazis.

"What those men did at Stalag Luft III was an astonishing feat of improvisational engineering," Hunt, 50, said in an interview at Cambridge's Trinity College. "Their resourcefulness was beyond belief. It wasn't a case of one man's genius, more the accomplishment of a team, one man's skills complementing another's. And they had one precious resource, time. If you have time, somebody will eventually come up with something, and the others will say, 'Let's give it a go.'"

Like others who joined in the expedition to Zagan, Hunt has little quarrel with the escape story as told in the film version, which was based on Paul Brickhill's book of the same name, partly because the tunnellers' real-life drama required little embellishment. The wartime camp, for one thing, did not have a Virgil Hiltz, the irrepressible U.S. flier played by Steve McQueen, and there was no climactic sequence like his flight from German troops on a stolen BMW motorcycle and entanglement in a border fence, one of cinema's great chase sequences.

The plan to dig down to the workshop at the starting point of the tunnel known as Harry, where the wartime fliers began their effort to tunnel beneath the barbed wire, was aborted when engineers failed repeatedly to prevent tons of sand from collapsing their own access tunnel. But Hunt and his team struck gold in the excavation of George, a tunnel built under the camp auditorium after the escape and designed to give inmates a place to hide as Nazi control east of Berlin collapsed before advancing Soviet troops.

Their dig yielded a set of rusting trolley wheels, the metal scavenged from remnants of a campsite stove and a coil spring taken from a prison gramophone; wood paneling for the tunnel's roof and sidewalls, fashioned from the prisoners' bed boards; and a ventilation pump with a bellows and piping made from a prisoner's kit bag, ice hockey sticks and tins of powdered milk. The piece de resistance was a rusting radio made from a biscuit box, the wiring stolen from the prisoners' huts and batteries scrounged from German guards.

The contemporary Royal Air Force fliers built Roger, the replica tunnel, but in a trench just beneath the surface; anything deeper was deemed too dangerous. With Hunt, they fashioned a trolley system, given its first run in the new tunnel by Frank Stone, 89, a camp veteran involved in preparing the 1944 escape plan. The 2011 team also built a replica of the original tunnelers' ventilation system, with facsimiles of wartime milk tins and a World War II kit bag.

Stone, maker of the biscuit-tin radio found in the excavated remains of tunnel George, was one of those still waiting for his turn to escape when a German guard spotted one flier scrambling from the tunnel exit into the pine trees. He remained a prisoner until the camp was liberated in 1945, with a lifetime to grieve for the men who made it, if only briefly, to freedom.

"People say to me, 'How unlucky you were,'" he told the documentary makers. "But I say, no, I was lucky to have taken part in it at all."

# Back to mine school

**P**erth's Curtin University has announced a plan to revitalise its Western Australian School of Mines in Kalgoorlie. The \$A225 million plan has been developed to attract students to the school and to improve infrastructure.

WASM is one of the largest mining engineering schools in Australia. It has two campuses – one in Perth and the other in Kalgoorlie. The Kalgoorlie campus has 450 students. Of those 120 are international students, with the majority of them coming from China. Students choosing to study the four-year mining engineering course can spend the first and second year at the Perth campus but must complete their final years in Kalgoorlie.

WASM director Steve Hall, who is a former graduate of the school, said Curtin intended to produce quality graduates for the industry and expected the school to continue recruiting international students. "We have to be



realistic; it is likely that our international numbers will grow faster than our domestic numbers," Hall said. "We would like to be more successful in attracting students [from] across the Nullarbor."

WASM finds itself competing with some very good eastern states mining schools. What usually happens is eastern states students complete their degrees in the east before coming to take jobs in the west. Hall believes, however, that Curtin can look slightly further east and draw students from New Zealand – since there are no mining schools on the shaky isles.

There are 130 student rooms at the Kalgoorlie campus. These rooms are more than 40 years old. Curtin plans to increase the amount of rooms to 180. All the expectations of students move on so the new buildings are designed with shared ensuite bathrooms between two people, and six rooms to a block with a shared kitchen and lounge. It will be state-of-the-art accommodation.

WASM suffered a decline in student intake during the global financial crisis and was predicting a lower number of graduates in the next few years. Hall said it was important industries continued to work with and offer students and graduates employment and vacation work. "Unfortunately when the next boom [is on] or the boom is hotting up industries are turning to us to supply more graduates, unfortunately that is often at a time when our graduates are relatively few in number." Hall said WASM graduates were not having any problems finding jobs. "Virtually 100 per cent if not 105 per cent are employed before they graduate," he said. "I say 105% because some of them are holding two contracts by the time they graduate."

## Parsons Brinckerhoff builds geospatial team capacity

**P**arsons Brinckerhoff's Australia-Pacific Geospatial operations have been strengthened with the appointment of Phil Punter to the role of Principal GIS consultant in Brisbane, and Perth-based Peter Houwen, as the new Team Manager for Western Australia, South Australia and Victoria.

Well respected in the geospatial industry, both Mr Punter and Mr Houwen worked at ESRI Australia delivering a wide range of projects to both the public and private sectors across the country.

Parsons Brinckerhoff Geospatial Section Executive Simon Davies said Punter's and Houwen's experience in the utilities, mining, transport, science & broader engineering sectors will extend the company's capability and capacity to provide high level strategic services, project management and innovative solutions to clients during delivery of large infrastructure projects.

"With a number of large asset management projects in the pipeline, Phil's and Peter's appointment will strengthen our resource base and bring a wealth of knowledge to the team that has grown significantly over the past five years.

# AUMS claims development mining world record

**I**n July 2011, three crews operating a Sandvik jumbo set a world record for development mining in Mali, west Africa. The crews fully bolted and meshed, to Australian standards, in 5.0m x 5.0m headings to construct a 603.1m advance in a single month.

AUMS is an Ausdrill and Barmenco's JV initiative, which stands for African Underground Mining Services. Barmenco business development and commercial manager, David Noort, was gushing in his praise of the efforts at Randgold Resources' Gara project, at the Loulou mine.

"One jumbo installing its own rockbolts and full mesh to achieve this advance within one month is singularly one of the most spectacular feats of development mining performance I have come across."

Adding to its achievement, AUMS has won a new development contract at Randgold's Yalea project located at its Loulou mine in Mali.

AUMS is to construct a portal and decline designed to access the ore body below the existing mining operations. This will mean a shift to a new method of mining at the ore body.

According to Barmenco, an additional contract at Yalea is likely. AUMS has secured a further production contract, also at the Loulou mine, for Randgold's Gara project.

In previous work at Gara, AUMS has completed over 5kms of development in a single jumbo operation, since commencement of works in April 2010.



## ATS Meet Annabell & Joyce

**50 members of ATS were treated to a the spectacular and rare sight of a fully assembled 12m TBM when they visited the Herrenknecht site at Hemmant on the Brisbane River in late November 2011. We were also fortunate enough to witness the cutter head being rotated.**

The tunnel boring machines will next year begin to dig the \$1.7 billion Legacy Way from Toowong to Bowen Hills. They have been named Annabell and Joyce, honouring the families of two Brisbane war heroes. Lord Mayor Graham Quirk announced the names of the two tunnel boring machines earlier in the week, outlining the future plans for the Legacy Way tunnel.

"The TBM names are a fitting tribute to the inspiration provided by those who have served in our armed forces and the courage and resilience shown by their families," Cr Quirk said.

Work will begin at the western end of the tunnel near Mt Coot-tha from early next year after site testing and commissioning is finished.

The machines have been recycled from parts from similar ones used on the Clem 7 tunnel, meaning a multi-million dollar saving for ratepayers, Cr Quirk said.

ATS would like to thank Herrenknecht for being such great hosts.

.....

*The tunnel boring machines will next year begin to dig the \$1.7 billion Legacy Way from Toowong to Bowen Hills.*

.....

# ATS Queensland Group Report

**T**unnelling activity continued at strong levels in Brisbane through 2011. The Airport Link Northern Busway continues although most tunnelling work is now complete. Legacy Way (aka Northern Link) has now started with TBM tunnelling due to commence early next year. The \$8B Cross River Rail project has been delayed as a result of the recent Brisbane floods.

In October 2011, elections were held for a new local committee. Sixteen nominations were received and in consultation with EA it was decided to accept all nominations resulting in a new committee as follows:

Andrew Day	Thiess Pty Ltd
Alan Robertson	Ausrocks
Bradley Thompson	Brisbane Motorway Services
Christophe Bragard	ARUP
Brendan Henry	John Holland Tunnelling
Craig Roberts	BOSFA Pty Ltd
Simon Strong	Herrenknecht Pty Ltd
Warren Mahoney	BASF
Bruce Embery	Seymour Whyte Constructions
Jurij Karlovsek	University of Queensland
Jeremy Kruger	Thiess Pty Ltd
Matthew Norbert	GHD
Scott Keniston	Bamser
Paul Barraclough	Parsons Brinckerhoff
Diane Mather	Thiess John Holland JV
Ben Ferri	Stratacrete Pty Ltd

## Technical Activities

Date	Speaker	Topic
February 2011	Dale Gilbert et al, Transcity	Northern Link – The Winning Solution
April 2011	Charles MacDonald, BrisConnections	Airport Link Progress Update
May 2011	Glyn Edwards, Thiess	Constructing the Tunnels for the Victorian Desalination Plant
June 2011	Dr Harry Asche, Aurecon	Tunnelling Opportunities in New Zealand
June 2011	n/a	Site Visit to Airport Link Jacked Boxes
September 2011	Nagen Loganathan, PB	A new approach for assessing tunnel induced impact on adjacent structures
October 2011	Ian Cameron, PB Una McElvaney, Bamser	Pipejacking in SEQ – Two Case Studies
November 2011	Les Louis	New Austroads Guidelines for Tunnel Design
November 2011	n/a	Site visit to Herrenknecht factory to inspect trial assembly of tunnel boring machines (TBMs) for Legacy Way

Our monthly technical sessions continue to attract audiences of between 60 and 100.

## Other Activities

Date	Topic	Remarks
October 2011	ATS Industry Golf Day, St Lucia Golf Links	The second ATS Industry Golf Day held in Brisbane in October was a great success. 77 players teed off in the Ambrose event at St Lucia Golf Links. The event raised \$12,400 for the Royal Brisbane and Women's Hospital Foundation – almost double that raised last year.
November 2011	Qld Tunnelling Code of Practice Consultation	The ATS was invited by Qld Workplace Health & Safety to comment on the proposed update to the code due for release in January 2012. Following consultation with our members, a 15 page submission was prepared which resulted in several significant changes.

## Other Comments

In addition to the technical sessions, our local committee conducted three breakfast meetings and an AGM was held in October. Engineers Australia Queensland continues to support us by providing a superb venue for our technical sessions and also a videostreaming service via their EAQ website.

**Andrew Day**  
Chair, Queensland Group



ATS 2011 Golf Day: Trophy Winners from team Ausrocks.



ATS Site Visit to Herrenknecht, Brisbane.

# ATS Victorian Group Report

The Victorian Group has commenced the new years on an active note with the formation of an organising sub-committee for the next ATS Tunnelling Short Course, currently planned for later this year. The sub committee is chaired by Malcolm Dixon, with committee members being Andrew Kindred, Bruce Grant, David Grist, John Main and Tony Bennett. AusIMM have been engaged as the course organiser with the initial task being to confirm dates and venue.

Our technical program for 2012 is well advanced with the schedule for the first half of the year being as follows:

29th February 2012	Durability in the tunnelling environment
28th March 2012	Philippines Hydro
17th April 2012	Pipe jacking at Sandgate and Bulimba Creek
30th May 2012	AustRoads guidelines
14th June 2012	Dewatering and groundwater (joint meeting with AGS)

The committee looks forward to being able to deliver a comprehensive and varied technical program to our local membership as well as working closely with Industry and Key tunnelling practitioners in the development of an interesting and relevant program for the Tunnelling short course.

**Ed Taylor**  
**Chair, Victorian Group**

# ATS WA Chapter Report

Since October 2011, the WA Group has held 2 technical sessions:

- 10 November 2011 – Construction Monitoring of Crossrail Tunnel Project, London, UK (Hai-Tien Yu, ITM-Soil)
- 21 November 2011 – Highlights and Challenges in Mechanized Tunnelling With Focus on Large Diameter TBM Technology (Karin Böppler, Herrenknecht AG)

Both sessions involved international speakers.

The Public Transport Authority of Western Australia Perth City Link Rail Project involves lowering the Fremantle rail lines into cut and cover tunnel above the existing Joondalup line bored tunnels, eventually to be followed by lowering of the Wellington Street Bus Station underground to enable redevelopment of the Perth Rail Yard land for public open space, residential and commercial towers and other civic developments. The first stage of the project, lowering the Perth to Fremantle rail lines and constructing a pedestrian tunnel under the Perth Central Station heritage buildings, platforms and tracks commenced in March 2011 and is being undertaken by the Perth City Link Rail Alliance (John Holland-GHD-PTA), with foundation works including CFA piling, Slurry and Diaphragm walls, Cutter Soil Mixing and grouting works in full swing. Project completion is scheduled for 2014.

The Desal 2 Project at Binningup, about 1.5 hours' drive south of Perth has recently been commissioned. The two

intake and one outlet pipelines from the plant to the beach and extending about 500m under the ocean were successfully constructed by Zublin Australia using two slurry tunnel boring machines and pipejacking technology to cover a distance of about 900m for each tunnel. Wet recovery techniques were used to retrieve the TBMs from offshore. For this project, Zublin Australia won the New Civil Engineer and AITES/ITA International Tunnelling Award 2011 for "Tunnelling Project of the Year" in the category of projects less than US \$100M and also the Civil Contractors Federation Earth Award for 2011. The prestigious international award was selected from a field of 74 projects from around the world.

Several oil and gas projects are either considering or well advanced with a TBM tunnel/pipejack shore crossing to bring product pipelines safely onshore. A 2.5m diameter pipe jack tunnel approximately 1.0km long with water depth at the recovery site of around 20m has recently been awarded to Theiss tunnelling for the Wheatstone LNG project.

The WA Group Committee comprises 6 members (Craig Adamson, Mike Bluck, Gary Goodall, Eric Hudson-Smith, Peter McGough and Barry Moore) and meets monthly. The Group has over 60 individual members plus 6 company memberships registered in WA. Keep an eye on the ATS website for future event details.

**Eric Hudson-Smith**  
**Chair, WA Group**

# ATS Sydney Group Report

**The Sydney Group finished last year in November on a high note with a presentation on the construction and monitoring of the Cross Rail Project, London. With the potential for the North West Rail Link in Sydney starting late this year perhaps we will also have our own, though more modest, mega project.**

There are currently a few smaller tunnelling projects underway in NSW, though no less interesting or challenging. These include the M2 Motorway tunnel widening by 3.6m in both the east bound and later the west bound tunnels, the high profile though modest, ramp, underground truck turning bay and short driven tunnels at part of the Sydney Opera House upgrade, known as the VAPS project. This project was award late last year. And also late last year the 3.2km long, 4m diameter, City East Cable Tunnel started construction. Up north we have the 350m long twin road tunnels at Byron Bay, on the Pacific Highway and back in Sydney there is the Wynyard Walk pedestrian tunnel currently at tender stage. The first stage of the Northern Freight Corridor will be out to tender soon and includes a shallow cover tunnel. The South West Rail Link project is under way and also includes shallow cover railway tunnels, but under the Hume Highway not active railway lines.

This year's technical sessions started with a talk titled, Specification and Performance of Steel Fibre Reinforced, with much emphasis and the test results and later debate about the statistical methods used to assess the wide range of results. The tunnel lining performance well despite what the statics might imply. The attendance at this meeting was around 50 people, but one of the goals of this year's committee will be to increase the attendance numbers above this figure. So please encourage your colleagues to attend. We have locked in the Victorian Desal Project for the next technical session on the 18 April.

In 2014, the 15th Australasian Tunnelling Conference will be held in Sydney. So I would encourage all those potential paper writers and speakers out there to put this in your diary.

**Ted Nye**  
**Chair, Sydney Group**

## Civil and Structural awards

The Civil and Structural Colleges announced their 2011 awards last week.

The Civil College winners are:

**Andrew Leventhal** – Sir John Holland Civil Engineer of the Year

**Scott Smith and Paul Kim** – W H Warren Medal

**Christopher Davidson** – Rod McGee Medal

**Professor Buddhima Indraratna** – Transport Medal

The Structural College winners are:

**Dr Samia Guiguis** – John Connell Gold Medal

**Siavash Hashemi and Riadh Al-Mahaidi** – R W Chapman Medal.



*Andrew Leventhal from GHD is the 2011 Sir John Holland Civil Engineer of the Year.*

**T**he Working Groups are at the core of ITA activities and work of animateurs is valued highly. ITA wants to have a positive environment for joint interest in the working groups and a productive collaboration for the better of the tunnelling community.

Within a Working Group everybody is there on a voluntary basis and is putting in a lot of work and this should be better recognised.

### Working Group 2: "Research"

Animateur: Eric Leca (France), Vice-Animateur: Chungsik Yoo (South Korea), Tutor: Soren Eskesen (Denmark).

**Participants:** 14 members from 12 countries present: Austria (1), China (1), Czech Republic (1), Denmark (1), Korea (1), France (2), Italy (2), Japan (1), Netherland (1), Spain (1), Sweden (1), and United States (1).

#### On-going activities

- Monitoring and Control during Underground Works
- Site investigation
- Risk management
- High Performance Concrete for Tunnel Lining

#### Status of recommendations in preparation

- Recommendation on Monitoring and Control:  
The final draft taking account of all comments by the ExCo reviewers as well as suggestions by members of Working Group 2 is being finalised and forwarded to the ExCo for publication.
- Recommendation on Strategy for site investigations for tunnelling:  
Works are in progress as part of the joint initiative with ISRM.  
  
A sub-group has been formed among the members to expedite the work progress and to obtain additional support within Working Group 2.

**Works on Risk Management** are in progress. A first draft of the section on "Terminology" based on the approach by AFTES in France is being prepared. Case history data sheets are being collected from member nations (US, Korea, Italy, Netherlands, Sweden, China, and Austria).

#### Works on High Performance Concrete Tunnel Lining

- Development of a high level document incorporating international experience is being prepared

#### Sustainable Development

- A sub group has been formed to collect relevant documents from various countries for review.

### Working Group 3: "Contractual Practices"

Animateur: Arnold Dix (Australia), Vice-Animateur: Martin Smith (Switzerland), Tutor: Olivier Vion (France).

**Participants:** 19 members from 13 Countries: Australia, South Africa, Norway, Switzerland, Thailand, France, Columbia, Italy, Hungary, Sweden, Egypt, Turkey, United States.

"Lessons for more effective subsurface contracting: An Evaluation of the FIDIC, NEC3 SIA (and 2 other Contracts) using both the ITA Contractual Practices checklist and real project examples and Experience" is being prepared.

### Working Group 5: "Health and Safety in Works"

Animateur: Donald Lamont (UK), Vice Animateur: Martin Vogel (Switzerland), Tutor: Ivan Hrdina (Czech Republic).

**Participants:** 7 members from Australia, Denmark, Germany, Singapore, Switzerland, UK, USA.

#### Documents

- Documents being prepared include: "Guidance on the safe use of temporary ventilation ducting in tunnels", "Safe working in tunnelling", "Guidelines for good working practice in high pressure compressed air", "Guidelines for shaft construction" (in cooperation with SANCOT).

### Working Group 6: "Repair and Maintenance of Underground Structures"

Animateur: Henry Russell (USA), Vice-Animateur: René van den Bosch (Netherlands), Tutor: Yun Bai (China).

**Participants:** 6 member Nations: Belgium, Denmark, Netherlands, Germany, South Korea, United States of America.

The Working Group is to be split into 2 separate entities:

- Fire Protection – Fire suppression systems: Addendum to Roads Document/s.
- Repair and Maintenance – Ground water intrusion control: Chemical / particle grouting, Grout Properties, Case Histories.

A report has been published in May 2010: "Guidelines for Structural Fire Resistance for Metro Tunnels".



### Working Group 9: "Seismic Effects"

Animateur: Wenge Qiu (China), Vice-Animateur: Gary Kramer (Canada), Tutor: Daniele Peila (Italy).

**Participants:** 8 persons from five countries: Peila Daniele from Italy (Tutor), Jian Zhao from Switzerland, Michel Deffayet and Marco Russo from France, Iura Tomomi and Mizutani Toshinori from Japan, Wenge Qiu (Animateur) and Hui Hu from China.

#### Work carried out

- Review and discussion of two former reports (1987 – Aseismic Design of Underground Structures, 2001 – Seismic design and analysis of underground structures)
- Update records of damage on tunnels by earthquakes: 2008 China Wenchuan earthquake and 2011 Japan Miyagi earthquake
- A new guideline will focus on urban underground structures, especially shallow buried and mountain tunnels, especially long tunnel at great depth (portals, bodies at great depth or crossing active faults) which requires collecting existing guidelines, norms, regulations and papers etc, especially from the member nations, famous design companies and experts, etc.

### Working Group 11: "Immersed and Floating Tunnels"

Animateur: Christian Ingerslev (USA), Vice-Animateur: Jonathan Baber (UK), Tutor: Yann Leblais (France).

**Participants:** 24 attendees from 8 countries.

#### Activities during Past Year

- "Owner's Guide" – parts now ready for the web site:
- 2-day Seminar in Abu Dhabi on "Design & Construction of Immersed Tunnels"
- Keynote Lecture at ISAB-2010 (October) "Immersed and Floating Tunnels"
- Outline of Environmental Paper

#### Proposed Activities for next 12 months

- Prepare Environmental Paper (glossy booklet)
- Updating of Catalogue of Immersed Tunnels
- Preparation and publication on web site of the next 14 topics for the Owner's Guide
- Prepare immersed tunnel hand-outs for next Annual Congress

### Working Group 12: "Sprayed concrete use"

Animateur: Atsumu Ishida (Japan), Vice-Animateur: Odd-Bjorn Kleven (Norway), Tutor: Felix Amberg (Switzerland).

**Participants:** Twenty-three participants from fourteen member nations: Brazil, Czech Rep., Finland, France, Germany, Italy, Japan, Korea, Norway, Spain, Sweden, Switzerland, Thailand, United Kingdom.

#### Current Activities

- preparation of draft report "*Fiber-reinforced sprayed concrete*"
- circulation of draft paper "*Durability of sprayed concrete; Routine testing*"
- Formation of new sub-group to investigate sprayable water proofing system
- Development of nozzle-man certification scheme

### Working Group 14: "Mechanization of excavation"

Animateur: Lars Babendererde (Germany), Vice-Animateur: Brian Fulcher, Tutor: Chun Nam Ow – Report presented by Brian Fulcher, Vice-Animateur of the Group.

#### Challenging Projects From Year 2009

1. Shanghai Yangtze Road Tunnel, China
2. Shanghai Shangzhong Road River-crossing, China
3. Shanghai East Fuxing Road Tunnel, China
4. Uetliberg Railway Tunnel, Zürich, Switzerland

#### Challenging Projects From Year 2010

5. Trans-Bay Gas Pipeline, Futtsu City, Japan

#### Challenging Projects From Year 2011

6. Galleria Sparvo, Castiglione dei Pepoli (BO), Italy
7. Dez to Ghomroud Water Conveyance Project, Long Tunnel Lot 1, Iran
8. Lot 2, 3 & 4, Iran
9. Lot 5, Iran

#### Preparation of Guidelines and Specifications

- Selection of TBMs
- Application Technologies
- Guidelines on Machinery

#### Combined effort with other Working Groups – "Key Issues in Tunnelling"

**Purpose:** General and unbiased orientation on the different tunnelling technologies.

### **Working Group 15 “Underground Construction and the Environment”**

Animateur: Jan Rohde (Norway), Vice-Animateur: Yoshikazu Ota (Japan), Tutor: Amanda Elioff (USA).

**Participants:** 6 Member Nations: Italy, Japan, Korea, Russia, and USA (one attended via Skype).

**Aim:** Provide an international synthesis of environmental impacts (whether beneficial or detrimental) that tunnel construction has on the environment and associated mitigation measures and regulations. Example case histories are provided to illustrate/illuminate/demonstrate impacts and mitigation in the particular environment of the subject membership projects.

#### **Progress/Report of information Collected from Member Nations**

- Bulgaria Sophia Metro
- Iran Water Conveyance Tunnel
- Japan (1) Road tunnel in urban area (2) Example of environmental friendly tunnelling (3) Metro Tunnel (4) Collection of data on environmental protection during construction
- Norway Road tunnel
- Russia Road tunnel with combined utilities
- USA (1) Road tunnel (2) Water conveyance tunnel

Total of 10 projects from 6 member nations.

### **Working Group 17: “Long Tunnels at Great Depth”**

Animateur: Gérard Seingre (Switzerland), Vice-Animateur: Jinxiu (Jenny) Yan (China), Tutor: Rick Lovat (Canada).

**Participants:** 10 members from 10 different countries: Argentina, Canada, China, Colombia, Italy, Japan, Norway, Slovenia, Sweden and Switzerland.

Preparation of presentations on projects and review of state of advancement of exiting project:

- White paper on financing mega-project: goal
- Preparation of report on Adits access galleries and shafts

### **Working Group 19: “Conventional Tunnelling”**

Animateur: Heinz Ehrbar (Switzerland), Vice-Animateur: Robert Galler (Austria), Tutor: Markus Thewes (Germany).

**Participants:** thirteen delegates coming from eleven member nations.

Two presentations have been prepared – “*Traditional Practices of Conventional Tunnelling in Urban Environment in the United States – Central Subway*

*Project, San Francisco, Chinatown Station”* by Nasri Munfah and “*Design-Bid-Build versus Design-Build Contract Comparison*”.

**Report being prepared:** *Guidelines on Contractual Aspects of Conventional Tunnelling.*

### **Working Group 20: “Urban Problems – Underground Solutions”**

Animateur: Wout Broere (Netherlands), Vice-Animateur: —, Tutor: Pal Kocsonya (Hungary)

**Participants:** Nineteen participants from Singapore, France, USA, UK, Netherlands, China, Japan, Hungary, Finland, Australia, Sweden, Switzerland, Russia.

#### **Final draft report being prepared**

- Executive Summary
  1. Typical Urban Problems
  2. Underground Solutions
  3. Decision Making Process
  4. Summary
- Appendix of Exemplary Projects

#### **Urban Problems**

- Crowding and lack of space (for work and recreation)
- Architectural quality
- Safety, security, and protection against natural disasters
- Traffic congestion
- Environmental conditions such as noise and air pollution
- Flooding
- Sewage conveyance and treatment
- Aging infrastructure and distribution of resources

#### **Underground Solutions**

- Road and rail tunnels
- Parking
- Drinking water storage and production
- Storm water relief
- Energy and goods distribution
- Short and long term storage
- Recreational facilities, leisure and shopping
- Office space and housing

# Australian Shotcrete Society – AuSS

## ATS Shotcrete Group

### Group Report – 2011 and beyond

#### 1. Membership AuSS

The ATS listing of people who had an interest in the Shotcrete group was supplied by Sheryl, (many thanks). At present Warren Mahoney is correlating these with our own AuSS list as well as our mailing list for the American Shotcrete Association magazine. Aim is to have an up to date, accurate membership list.

#### 2. Promotional Activities – Shotcrete in general construction

The use of shotcrete, to this day, still does not have any relevant Australian Standards. The AuSS guide is practically the only “handbook” on shotcrete available to the construction industry, apart from some international codes etc.

One suggestion is to lobby Standards Australia regarding the inclusion of shotcrete in the Australian Standards for concrete, specifically AS 3600. This will be pursued by the Chairman, (Stefan Bernhard) with the Concrete Institute of Australia and Standards Australia in 2012.

#### 3. Architectural Shotcrete

In line with the promotion and expansion of the use of shotcrete in the civil construction business, a meeting was held with the RTA in Sydney. The RTA have historically used shotcrete mainly for non aesthetic/architectural works. Discussions took place regarding the B82 code of works for shotcrete finishes, and the Society outlined that some excellent architectural finishes can be achieved with shotcrete using the correct skilled contractors and products.

#### 4. Training – Nozzleman Certification

The ongoing problem of suitable, trained and competent shotcrete applicators, (nozzlemen) for the mining and civil tunneling industry is a real problem for the industry. The Society has decided to adopt the EFNARC global training and certification programme, and adopt this into Australia. To date, several mining and civil contractors have put their personnel through the EFNARC training program in Europe. Two members of the AuSS committee attended the EFNARC training program in Switzerland, Ben Ferri and John Kennedy, in October 2011

The long term intention in the future is for the AuSS to set up a system whereby we develop our own Australian certification system, involving the committee and current EFNARC trained people, and via several workshops produce an Australian package for nozzlemen. This is quite a formidable task, but one that the Society feels is essential in Australia for the professional promotion of good quality shotcrete application.

#### 5. Web site

A future AuSS website is to be a major agenda item in 2012.

#### 6. CIA National Seminar Series

A “roadshow “ was carried out at the bequest of the CIA, which consisted of various members of the AuSS giving presentations on a variety of topics associated with shotcrete. It was also a good opportunity to promote the Shotcrete Guide that the AuSS produced. National seminars were held in Brisbane, Sydney, Adelaide, Melbourne and Perth. The feedback via the Concrete in Australia Magazine, volume 37 was excellent, with high praise for the depth and technical expertise displayed by the AuSS presenters.

#### 7. Next Activity

The next activity was to be a joint seminar on shotcrete with the West Australian Ground Control Group in Perth, November, which has been deferred till 1st quarter of 2012.

**John Gelson**  
Shotcrete Group Representative

### ITA PUBLICATION

## An Owners Guide to Immersed Tunnels

The objective of this Guide is to answer the following question: *What does an Owner need to know and document for the planning, construction and operation of an immersed tunnel?*

The Guide will give owners confidence to consider an immersed tunnel as a realistic alternative for crossing waterways and help them achieve the quality and standard of construction they are accustomed to or desire. While an immersed tunnel is a specialist field within civil engineering, its planning, construction and operation follow the same established procedures for any major infrastructure project. This Guide is written with the intention of demystifying the complexities of an immersed tunnel and to help an owner identify the aspects of an immersed tunnel that need particular attention. As such, the Guide is immersed tunnel specific and does not discuss routine construction practices.

## ITA COSUF AWARDS

The ITA COSUF award is granted annually to a student or young researcher who has recently completed an outstanding research work in theory and / or practice in the area of operational safety or security of underground facilities.

The award is ceremoniously presented and handed over by ITA COSUF chairman at an ITA COSUF event. The chairman outlines the reasons for the decision and congratulates the winner. The award consists of a certificate, a medal and Euro 500 in cash. The award winner is invited to present his/her work at the same event. Additionally, he/she is asked to draft a 2 page contribution for the ITA COSUF Newsletter.

The winner of the award is selected by the ITA COSUF steering board. Eligible for the award are those works that are specifically aimed at safety or security of underground facilities in operation, preferably reflecting an interdisciplinary approach. Among other criteria, the selected works should:

- describe new aspects in the area of safety in operation and security in underground facilities,
- have been completed for no more than two years before the time of the application,
- be of outstanding quality, including clear and concise descriptions of the objectives, scientific base, work steps, results achieved and their relation to the current state of the art,
- be significant and represent a unique contribution.

Candidates need not be ITA COSUF members. Applications for the award may be sent to a member of the ITA COSUF steering board or preferably to the ITA secretariat. They should include:

- curriculum vitae,
- description of work done in the field of safety in operation and security in underground facilities,
- documents and publications produced by the applicant,
- any other document, certificate, etc. deemed useful to support the application.

### ITA COSUF AWARD 2012

The deadline for application is 29 February 2012.

The selection of the winner will be made by the steering board by mid April 2012.

The award will be handed over at the ITA COSUF workshop which will take place on 22 June 2012 in Rome. The nominee will give a short presentation of his/her work at the workshop.

## Hungarian society organising Euro conference

**Technology TBM-driven tunnels Microtunnelling Other tunnelling methods Drill & Blast tunnels**

ITA-AITES has endorsed the 1st Eastern European Tunnelling Conference (EETC) 2012, to be held in Budapest, Hungary, on September 18–21. Organised by the Hungarian Tunnelling Association (HTA), the conference will provide a forum to discuss current practice, tunnelling trends and research. The organisers say it will provide professional engineers with an ideal opportunity to achieve beneficial business and professional relationships among the eastern European tunnelling fraternity.

On the third day of the conference, delegates will have the opportunity to visit the nearly completed new metro line and see a presentation of Szent Gellért tér station, situated under the river Danube. Abstracts for the conference should be submitted by January 2, 2012; notifications of acceptance will be received by February 2, 2012, and full paper submissions will be required by April 2. [www.eetc2012budapest.com](http://www.eetc2012budapest.com)

## Work Health and Safety Regulations and Codes of Practice for Mining

**S**afe Work Australia apparently are coordinating implementation of Work Health and Safety Regulations and Codes of Practice for Mining which are advancing through various stages of public comment – see website below:

<http://safeworkaustralia.gov.au/Legislation/PublicComment/Pages/Draft-model-WHS-Regulations-and-CoP-for-Mines-Public-Comment.aspx>

There are some 17 documents in the series. This represents a major achievement in cooperation between states and apparently will soon be implemented Australia wide as a Federal Govt initiative. I'm not sure if they are aware of the NSW and Qld COPs for Safety in Tunnelling and whether the different documents complement or contradict each other. I note that the Qld and NSW COPs seem to only apply to Civil Engineering tunnels, whereas the Safe Work Australia documents relate to mines only... perhaps they should stay separated as they currently seem to be.

# 3rd Brazilian Congress on Tunnels and Underground Structures

International Seminar “South American Tunnelling – SAT 2012”

**DATE: March 20th to 22nd, 2012 – PLACE: São Paul /SP**

*The 3rd Brazilian Congress on Tunnels and Underground Structures and the International Seminar “South American Tunnelling – SAT 2012” will be held between the 20th and 22nd of March, 2012 at Centro Fecomercio de Eventos, located at Rua Dr. Plinio Barreto, 285 – 1st floor in Sao Paulo – SP*

Brazil is enjoying today one of its most promising phases, with the eyes of the world focused on the potential growth of its economy and the implementation of major international events such as the World Cup in 2014 and the Olympic Games in 2016. At the same time, the country is facing the need for massive investments in infrastructure, whether to ensure the growth of its economy, or to improve the degree of social development of the population, which is becoming more and more urban.

In this scenario, the implementation of large projects arises, such as the Belo Monte hydropower plant, the high speed train linking Rio de Janeiro-Sao Paulo-Campinas (TAV), transposition of the Sao Francisco river, investments in Pre-Salt and urban mobility works, mainly in large cities. The time is, therefore, very suitable for tunnelling engineering, which will play a major role in the country's development. It is in this scenario that the Brazilian Tunnelling Committee – CBT, of the Brazilian Association of Soil Mechanics and Geotechnical Engineering – ABMS – is pleased to invite you to the 3rd BRAZILIAN CONGRESS ON TUNNELS AND UNDERGROUND STRUCTURES – 3rd CBT – and the 2012 International Seminar “SOUTH AMERICAN TUNNELLING – SAT’2012” to be held in São Paulo, between 20th and 22nd of March 2012.

Eleven topics, deemed essential for professionals who work in the underground structures area, will be addressed, promoting discussion, exchange of experiences and technical update, besides the presentation of new technologies and trends in design and construction.

In addition to the presentation of technical papers from Brazil and South America, repeating the success of the 2nd Congress held in 2008, lectures by distinguished national and international experts will be given, current topics will be discussed, as well as exhibition of products, services and equipment, and technical visits.

Two days will be reserved for a refresher course and training in the area of tunnelling, to be taught by Brazilian and international renowned professionals in tunnel engineering.

## TOPICS

- Urban Planning and Use of Underground Space
- Geological Investigations, Basic Data, Hydrogeological and Geotechnical Aspects
- Design and Backcalculation
- Support, Materials and Lining
- Underground Excavations in Mining, Oil and Gas
- Case History and its Lessons
- Environment and Underground Works
- Operation, Maintenance and Recovery
- Contracts, Insurance and Risk Management
- New Technologies and the Environment
- Underground Storage

<http://www.tuneis.com.br>

## 3rd annual Tunnel Design & Construction Asia

### Focus Day – Asian Metro Rail Infrastructure:

27 February 2012

**Main conference:** 28–29 February 2012

**Site visit:** 29 February 2012

**Technical masterclasses:** 1 March 2012

**Venue:** Hong Kong Convention & Exhibition Centre

**19 CPD points for engineering professionals**

For the first time, the **3rd annual Tunnel Design & Construction Asia** will be co-located with the **3rd annual Bridges Asia**, assembling regional asset owners, global contractors and engineering firms.

Present at the conference are **ADB, Govt. of Maharashtra, India, Ministry of Energy, Green Technology & Water – Malaysia, Manila Water Company – Philippines, Drainage Services Dept – Hong Kong, SP Powergrid, Malaysian Highway Authority, NHPC India, Public Works & Highways – Philippines** and many others.

Major EPC contractors and AEC firms will also be presenting their best practices in developing cost effective civil infrastructure.

### Focus Day – Opportunities in Asian metro rail infrastructure

To attend and meet metro rail owners from India, China, Hong Kong, Vietnam and Malaysia who will be presenting new projects and expansions, enquire here.

Early bird discounts from now till **1 November 2011**. Special packages are also available for governments and company group bookings for both **Tunnel Design & Construction Asia** and **Bridges Asia**. Get in touch today for the full details:

**Telephone:** +65 6722 9388

**Email:** [enquiry@iqpc.com.sg](mailto:enquiry@iqpc.com.sg)

Regards,

**IB Saravanan**

Conference Director, IQPC Worldwide

Australasian  
Tunnelling  
Society website  
[www.ats.org.au](http://www.ats.org.au)

## 34TH INTERNATIONAL GEOLOGICAL CONGRESS

5–10 AUGUST 2012 – BRISBANE, AUSTRALIA

[www.34igc.org](http://www.34igc.org)

### A MAJOR SHOWCASE FOR AUSTRALIA'S RESOURCES SECTOR

The International Geological Congress, which is held in a different country every four years, is the pre-eminent global geoscience event, attracting thousands of delegates from over a hundred countries. Australia is hosting the 34th International Geological Congress (IGC) at the Brisbane Convention and Exhibition Centre from 5 to 10 August 2012, on behalf of the Oceania region. Consistent with Australia's profile as a leading global resource economy the Congress will have a strong mineral and petroleum focus.

This represents a once in a generation opportunity to showcase Australia's geosciences and to network with high profile international geoscientists.

The 34th IGC will feature a wide-ranging scientific program under the overall Theme 'Unearthing our Past and Future – Resourcing Tomorrow' which recognises the crucial contributions of the geosciences in meeting societal needs and sustaining planet Earth. Roughly 40 percent of the scientific program will be of direct interest to the resources and energy sectors: there will be several Symposia on minerals, petroleum and energy over each of the five days of the Congress.

Other features will include field trips throughout Australia and the region, a large GeoExpo featuring commercial, government and academic exhibitors (over 40% of the premium booths have sold already), training and professional development workshops, and an education and outreach program.

The 34th IGC is organised by the Australian Geoscience Council (AGC), the peak body for the major professional and learned societies. These societies are investing in this major event, which will take the place of a number of their regular meetings in 2012.

**IGC website:** <http://www.34igc.org>

Plenary sessions include:

- The Earth and Man: Living with a Restless Earth
- What does the geological record tell us about past climates in relation to projected climate change?
- Energy in a carbon-constrained world
- Resourcing Tomorrow: Meeting the needs of a growing population
- Digital Earth – The information explosion

Confirmed Plenary Speakers include:

Professor Iain Stewart (BBC's How Earth Made Us series), former Shell chairman Lord Ron Oxburgh and Vale's Executive Director for Exploration, Energy and Projects Management, Eduardo Ledsham.

Themed “**Underground Space Development – Opportunities and Challenges**”, ACUUS 2012 will put the spotlight on unprecedented opportunities for improving urban infrastructure and urban livability. Topics to be explored are comprehensive, ranging from top level management issues like master planning, legal framework and government policies, cost benefit analysis to operational issues including architectural design, site investigation and geo-planning and geotechnical and rock engineering.

**Themes & topics:**

Master planning	Innovations and technology advancement
Architectural design for liveable underground space	Research and support
Safety, health, and the environment	Underground transport systems
Legal framework and government policies	Deep caverns and mined space
Reasons for going underground	Earth-sheltered buildings and pedestrian networks
Cost-benefit-analysis	Industrial and commercial applications
Socio-economic issues	Underground space as a strategic resource
Site investigation and geo-planning	Utilisation of underground space and case studies
Geotechnical and rock engineering	Special projects

- Discover new opportunities amid a re-focus on developing urban underground space as part of sustainable development.
- Understand special challenges faced in creating underground spaces – be it technical, economic or design - in order to address human psychology of underground habitation.
- Appreciate these challenges from different points of view, from planners to developers to the engineers.
- Expect engaging discussions and exchanges among planners, engineers, researchers and policy makers from renowned organizations and associations around the world.
- Expand your horizons with our technical programme, technical visits, exhibition, social programmes, pre-conference workshops, short courses and special sessions tailored for you.

A highly regarded knowledge platform for industry players for the last 12 years, ACUUS 2012 is truly an event not to be missed.

Attractive packages for exhibition and sponsorship are available for organizations that wish to showcase and market their services and products in the rapidly growing markets in the region. [Find out how.](#)

For updates of **ACUUS 2012 Singapore**, please visit our website at [www.acuus2012.com](http://www.acuus2012.com) or contact the Conference Secretariat at email: [info@acuus2012.com](mailto:info@acuus2012.com) or tel: 65 6271 2453.

# Narrow Vein Mining Conference 2012

## Working Smarter Through Technical Collaboration

26–27 March 2012 | Perth, Western Australia

Narrow vein mining operations form a relatively small, but important part of the global mining industry principally focused on commodities such as gold, silver and tin. The skills and expertise required to manage these resources are arguably highly specialised and relatively rare at this time. The challenges of narrow vein deposits include: dealing with issues of complex geology; high nugget effect; ore/waste misclassification; high planned and additional dilution; the need for selectivity; high-stress conditions; low tonnes per vertical metre; and complex metallurgy. Today, there is an overarching need for lower costs, mechanisation and a zero harm environment.

The purpose of this Conference is to bring together all involved in narrow vein mining, including geologists, mining/geotechnical engineers, and metallurgists.

### Dr Simon Dominy FAusIMM (CP)

Snowden Group/WA School of Mines, Conference Chair

## TECHNICAL PROGRAM

The theme for Narrow Vein Mining 2012 is “working smarter through technical collaboration”.

- Sinclair Underground Nickel Project – Lessons Learnt Discovering the Phoenix —m J Ireland, D P Horne and S J Simpson
- The Use of High-Pressure, Water-Hydraulic (Hydropower) Technology in South African Narrow-Reef, Hard-rock Mines — P Fraser
- Conditional Simulation of a Folded Lode-Style Gold Deposit — A Richmond Correlation as a Gold Path Finding Tool at Maldon, Victoria — J Krokowski De Vickerod and G B Ebsworth
- Continued Observations of Rock Mass Behaviour in Response to Stopping at the Tasmania Mine, Beaconsfield, Tasmania — P B Hills and R J Walton
- Underground Pre-Concentration — G Domingo, B Murphy and J van Zyl
- Utilisation of the Alimak Raise Climber in Narrow Vein Mining at Quadra FNX’s Morrison Deposit — J Huffman
- Pilot Study on Blast Movement Monitoring — B L Mwanishi

### PRE CONFERENCE TOUR

**Goldfields Narrow Vein Mining Tour, Friday 23 – Sunday 25 March 2012**

This two day tour will include site visits to a number of key operations throughout Karlgoolie, Western Australia. Covering site visits to narrow vein operations in the Coolgardie, Karlgoolie and Kambalda regions.

### PRE CONFERENCE WORKSHOP

**Narrow Vein Geology, Sunday 25 March 2012**

Presented by Snowden this one day workshop offers participants an Introduction from orebody knowledge through to how to control ore in narrow vein operation.

- Orebody knowledge and characterisation
- Application of historical data during evaluation of brownfield sites
- Evaluation and development approaches
- Bulk sampling and trial mining methods
- Designing and implementing grade control
- Interfacing between geology and mine design
- Case studies

### PRE CONFERENCE WORKSHOP

**Mine Design and Geotechnical Aspects, Sunday 25 March 2012**

Presented by AMC Consultants this one day workshop will provide participants an introduction to the design and operation of narrow vein Mining projects.

- Ground conditions assessment and implications for design
- Geotechnical considerations
- Basic design principles
- Mining method options
- Extraction sequences
- Backfill
- Access and Ventilation
- Equipment Selection
- Case studies

### SPONSORSHIP & EXHIBITION OPPORTUNITIES

Showcase your business at the Conference and exhibit at the Conference. The trade will be held in association with the event and will provide an excellent opportunity for companies to display their products and services to the participants.

- AMC Consultants
- Archimedes Financial Planning
- Barrick Gold
- Gekko Systems
- Innovative Mining Products t/a New Concept Mining
- Mancala Pty Ltd
- Minesight Applications
- Snowden
- Steinert

### Event Management: The AusIMM

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## Designing and Building Cost-Effective, Durable and Safe Tunnels for the Region

“The Russian Construction Industry was worth £35 Billion in 2007 and is predicted to be worth £85 Billion by 2013”\*

The construction industry is booming, but along with this boom and **increased investment** comes challenges to meet specific build needs in short time frames. These new projects are stemmed from the **need for transport infrastructure**, not only for the countries export materials, but to prepared for the huge influx from tourists who will visit some of the largest sporting events the world has ever seen in Russia over the coming years.

Tunnel and underground construction is a major part of this, spanning road, rail and many other larger construction projects. This is why Construction IQ brings you the latest in our global Tunnel series, and latest in our Russian Construction series: Tunnel and Underground Construction Russia and CIS, which will take place in **Istanbul 23–25 April 2012.**

This outstanding summit agenda will offer you:

- First Russian and English language world class meeting between Russian and European tunnel constructors.
- Top project case studies from Russia, Europe and beyond – get insight into most challenging tunnel projects to date: 2014 Winter Olympics in Sochi, the Crossrail project in the UK, Coal Railway in Tyva Republic
- Perfect mix of tunnel owners (federal and regional), constructors and designers to create an effective dialogue between all participants of tunnel project
- Opportunities in the Russian market explained by the project owners from Russia
- Exclusive site visit to the most significant infrastructure development in Turkey. A superb learning and networking opportunity with designers and constructors of the project.

Leading tunnel experts presenting at the conference include:

- > **Silvano Maccan**, Project Manager – Sochi Winter Olympic Games Projects, Geodata
- > **Alun Thomas**, Principal Engineer, Mott MacDonald
- > **Chris Dulake**, Chief Engineer, Crossrail Limited



ROYAL OLYMPIC HOTEL

# International symposium Practices and Trends for Financing and Contracting Tunnels and Underground Works

22-23  
MARCH  
2012  
ATHENS



## “PRACTICES AND TRENDS FOR FINANCING AND CONTRACTING TUNNELS AND UNDERGROUND WORKS”

The Greek Tunneling Society (GTS) is organizing, with the official endorsement from ITA, a two-day international symposium on **“Practices and Trends for Financing and Contracting Tunnels and Underground Works”**. The symposium will take place at the ROAYAL OLYMPIC HOTEL in ATHENS from **22 to 23 March 2012**.



The recent financial crisis has affected the construction industry and of course tunnelling projects to varying degrees. Confrontation of the crisis and its consequences requires new tools, but especially an overstepping of the prevailing thinking from all involved parties. The Symposium on Financing and Contracting is of particular interest to us and we believe to the rest of the world, as more and more pressure is applied to the financing of tunnelling projects. Many countries are searching for better ways to finance new tunnels and for effective tools to contract these projects.



The Symposium will provide an international forum for all involved parties and stakeholders, for exchanging views, experiences, skills, ideas and achievements on the critical issues of Financing and Contracting of Tunnels and Underground Works.

The GTS is pleased to invite you to this Symposium on **“Practices and Trends for Financing and Contracting Tunnels and Underground Works”**, which offers a number of remarkable features:

- Symposium venue is at the heart of archaeological sites of Athens, near the Acropolis and the new museum and at the same time outside the busy city center.
- A strong (and preclusive) focus will be placed on Financing and Contracting issues for tunnels and underground works
- Several distinguished and prominent international experts will give invited lectures
- People from the EU financing institutions, banks, insurance sector and many representatives from the national ITA members, have been invited to participate
- An open invitation to Public and Local Authorities, for which tunnel and underground works activity is becoming a pressing critical issue.

We aim at a very warm welcome in our symposium and look forward to seeing you in Athens.



### GREEK TUNNELLING SOCIETY

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**Using Underground Space In Urban Areas In South-East Europe**

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Hotel-Congress Center Valamar Lacroma  
 April 12-14, 2012, Dubrovnik, Croatia



## 2<sup>nd</sup> China International Trenchless Technology & Tunnel and Underground Space Equipment Exhibition (TTUS 2012)

第二届中国国际非开挖技术装备与隧道及地下空间设备展

Date: March 9-11, 2012

Venue: China Import and Export Fair-Pazhou Complex

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China Municipal Engineering Association

Guangdong Society for Trenchless Technology

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Colombian Institute for Subterranean Infrastructure Technologies and Techniques

Bulgarian Association for Trenchless Technologies



# The Power of Water

BY DAVID LEES

Set in Australia, Laos and Thailand, *The Power of Water* explores the many ways in which our lives are affected by water, from the devastation of floods and tsunamis, to the excitement of surfing or the sensual effect of a hot, steamy shower.

The story follows the intertwining lives of Paul Johnson, a 33-year-old Australian Civil Engineer, and Abdul, a young Malaysian orphan. Through their experiences we follow Paul's career and relationships, and Abdul's journey as he explores his faith and seeks out his life's direction.

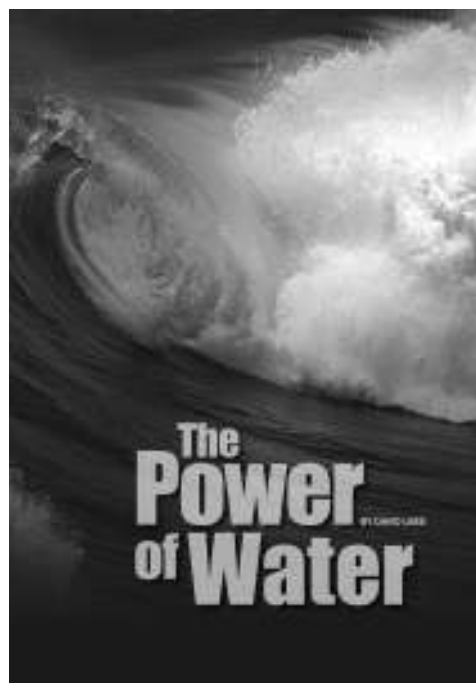
The company Paul owns is working on the construction of a new dam at Kangaroo Creek in Northern New South Wales, however, the main contractor is trying to cheat him, which culminates in a courtroom confrontation. In parallel, Abdul becomes involved with an extremist group exploring Australia's total dependency on water and how this can be used as a weapon of terrorism.

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# ATS Tunnel Database

## NEW SOUTH WALES

Project: City Relief Line			
<b>Client:</b> SMA	<b>Designer</b> PB/Arup	<b>Contractor:</b>	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	5km priority tunnel is proposed to be constructed from Eveleigh to Wynyard, separating western services from inner city trains	<b>Current status:</b>	Transport NSW is starting alignment and design studies for the project and will investigate a number of alignment and construction options

Project: Central Coast Rail Upgrade			
<b>Client:</b> RIC	<b>Designer</b> Connell Wagner (Concept) – complete	<b>Contractor:</b>	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	Hornsby to Hawkesbury. 11.5km twin 8m dia. Rail tunnels.	<b>Current status:</b>	EIS complete. Unlikely to proceed in short to medium term

Project: F3 to M2 Road Tunnel			
<b>Client:</b> RTA and Federal DOTARS	<b>Designer</b> SKM (preliminary design)	<b>Contractor:</b>	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	8km road tunnel to connect the southern end of the F3 Freeway with the M2 Tollroad	<b>Current status:</b>	Preferred corridor selected. Preparing the Terms of Reference for development of a concept proposal. Construction timetable for the project is yet to be established.

Project: M5 East tunnel widening			
<b>Client:</b> RTA	<b>Designer</b>	<b>Contractor:</b>	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	Provision of additional four new lanes in a driven tunnel next to the existing the M5 East tunnel	<b>Current status:</b>	Reference design underway

Project: M4 East Link			
<b>Client:</b> RTA	<b>Designer</b> Connell Wagner	<b>Contractor:</b>	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	5.5km long, privately funded, road tunnel to connect the eastern end of the M4 Motorway with the CityWest Link.	<b>Current status:</b>	On hold awaiting funding

Project: F6 Transport Corridor			
<b>Client:</b>	<b>Designer</b>	<b>Contractor:</b>	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	20-kilometre motorway from the Sutherland Shire to the city. Tunnelled section between Port Hacking Road at Sylvania and Loftus	<b>Current status:</b>	Economic Impact Study complete. Unlikely to proceed in medium term

<b>Project: Bells Line of Road</b>			
<b>Client:</b> RTA	<b>Designer</b> Maunsell	<b>Contractor:</b>	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	1.2km tunnel to remove 13% grade near Kurrajong	<b>Current status:</b>	On Hold

<b>Project: Busby's Bore Project</b>			
<b>Client:</b> Clean Up Australia	<b>Designer</b> KBR	<b>Contractor:</b>	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	Connection to Busby's Bore and underground water storage in disused St James Railway Tunnel	<b>Current status:</b>	Concept design

<b>Project: Hill M2 Upgrade</b>			
<b>Client:</b> Transurban Group	<b>Designer</b> HBO & EMTB in association with T ract Consultants	<b>Contractor:</b> Leighton Contractors	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	Rock bolting of the existing tunnel. Widening works using an excavator, including widening of the batters (rock walls) on both approaches to the tunnel. Placement of new electrical and services trenches	<b>Current status:</b>	Under construction

<b>Project: South Sydney Freight Line</b>			
<b>Client:</b> ARTC	<b>Designer</b>	<b>Contractor:</b>	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	<ul style="list-style-type: none"> <li>• 30km single track running parallel to the Main South line between Sefton railway station and Macarthur railway station</li> <li>• Cut and Cover tunnel at Sefton. Required to carry the SSFL underneath the existing Bankstown Line</li> <li>• Underground proposal through Cabramatta Railway Station.</li> </ul>	<b>Current status:</b>	Tenders currently being reviewed

<b>Project: City East Cable Tunnel</b>			
<b>Client:</b> EnergyAustralia	<b>Designer</b> AECOM	<b>Contractor:</b> Thiess	<b>Managing Contractor</b>
<b>Scope of work:</b>	3.2km TBM tunnel from Surry Hills to Sydney CBD including connections to existing and proposed substations	<b>Current status:</b>	\$141 million tender Awarded to Thiess

<b>Project: Wynyard Pedestrian Tunnel</b>			
<b>Client:</b> Barangaroo Delivery Authority	<b>Designer</b> PB	<b>Contractor:</b> TBA	<b>Managing Contractor</b>
<b>Scope of work:</b>	\$286 million pedestrian access to Barangaroo	<b>Current status:</b>	Out to Tender

<b>Project: North West Rail Link</b>			
<b>Client:</b> NSW Gov't Transport Construction Authority (TCA)	<b>Designer</b> AECOM	<b>Contractor:</b> TBA	<b>Managing Contractor</b> TBA
<b>Scope of work:</b>	23km long northwest rail link, which includes 15km of deep, underground twin tunnels stretching from Epping to Kellyville	<b>Current status:</b>	Tender expected Q4 2012

<b>Project: South West Rail Link</b>			
<b>Client:</b> NSW Gov't Transport Construction Authority (TCA)	<b>Designer</b> SMEC, KBR, GHD	<b>Contractor:</b> John Holland	<b>Managing Contractor</b> John Holland
<b>Scope of work:</b>	Rail underpass under Hume Highway (80m long) between Glenfield and Leppington	<b>Current status:</b>	Detailed Design

<b>Project: Pacific Hwy Tintenbah-Ewingsdale Upgrade, St Helena Tunnel</b>			
<b>Client:</b> RTA	<b>Designer</b> TBA	<b>Contractor:</b> Baulderstone Hornibrook	<b>Managing Contractor</b>
<b>Scope of work:</b>	Twin 350m long three lane road tunnels.	<b>Current status:</b>	Tender awarded to Baulderstone Hornibrook

<b>Project: Sydney Opera House Vehicle Access and Pedestrian Safety Project</b>			
<b>Client:</b> RTA	<b>Designer</b> ARUP	<b>Contractor:</b> John Holland	<b>Managing Contractor</b>
<b>Scope of work:</b>	Cavern under Opera House forecourt for loading dock	<b>Current status:</b>	Tender awarded to John Holland

<b>Project: Maldon to Dombarton Rail Link</b>			
<b>Client:</b> RTA	<b>Designer</b> TBA	<b>Contractor:</b> TBA	<b>Managing Contractor</b>
<b>Scope of work:</b>	Long tunnel to provide more direct access to Port Kembla	<b>Current status:</b>	\$24.5m in federal funding provided

## QUEENSLAND

<b>Project: Airport Link &amp; Northern Busway</b>			
<b>Client:</b> Queensland Government	<b>Designer:</b> PB Arup	<b>Contractor:</b> Thiess/John Holland JV	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	\$4.3B PPP project. Construction of road tunnels and a busway including Australia's longest road tunnel at 6.7km long	<b>Current Status:</b>	Target completion June 2012.

<b>Project: Legacy Way Tunnel</b>			
<b>Client:</b> Brisbane City Council	<b>Designer:</b> GHD, URS, Cardno	<b>Contractor:</b> Transcity – Acciona, Ghella, BMD Construction	<b>Supervising Engineer:</b> GHD
<b>Scope of work:</b>	2 x 4km road tunnels from Toowong to Milton. Additional 550m x 4.8m x 4m Conveyor Tunnel (drill and blast) to transport tunnel spoil into Mt Coot-tha quarry.	<b>Current Status:</b>	Worksites established preparing for the start of TBM tunnelling from western end in August 2012. Portal construction underway at eastern and western ends. Conveyor Tunnel 55% complete by WDS and Perfect Shafts.

<b>Project: East-West Orbital Tunnel</b>			
<b>Client:</b> Brisbane City Council	<b>Designer:</b>	<b>Contractor:</b> TBA	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	Tunnel joining Toowong to Everton Park	<b>Current Status:</b>	Feasibility study in progress

<b>Project: East-West Link Tunnel</b>			
<b>Client:</b> Brisbane City Council	<b>Designer:</b>	<b>Contractor:</b> TBA	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	Completion of inner city ring road connecting. 6km from Pacific Highway to East-west Orbital Tunnel (complete 2031).	<b>Current status:</b>	Review of traffic demand being completed. Scheduled to be built after 2026 but may be brought forward.

<b>Project: Toowoomba Bypass</b>			
<b>Client:</b> Queensland Department of Transport and Main Roads (DTMR)	<b>Designer:</b>	<b>Contractor:</b> TBA	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	42km road costing \$1B+ will include 735m twin tube tunnel at top of Great Dividing Range	<b>Current status:</b>	Pilot tunnel completed. Project on hold awaiting funding.



<b>Project: Cross River Rail</b>			
<b>Client:</b> DTMR	<b>Designer</b> TBA	<b>Contractor:</b>	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	A 19km proposed corridor would include a tunnel under the Brisbane River and new stations, running from Salisbury, in Brisbane's south, to Woolloowin, in the north, via Woolloongabba, the CBD and Bowen Hills. \$8.2B project.	<b>Current status:</b>	Feasibility study is continuing

<b>Project: Stafford Road Tunnel</b>			
<b>Client:</b> DTMR	<b>Designer</b>	<b>Contractor:</b> TBA	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	Urban motorway tunnel under Stafford Road to connect the proposed North West Transport Corridor and Inner Orbital with Airport Link	<b>Current status:</b>	Planning complete and included in the Western Brisbane Transport Strategy

<b>Project: Kingsford Smith Tunnel</b>			
<b>Client:</b> Queensland Main Roads	<b>Designer</b>	<b>Contractor:</b> TBA	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	Tunnel to link traffic from the Gateway Motorway and Australia Trade Coast to the Inner City Bypass	<b>Current status:</b>	Proposed. Design options developed

<b>Project: Auchenflower Sewer Upgrade</b>			
<b>Client:</b> Queensland Urban Utilities	<b>Designer</b>	<b>Contractor:</b> TBA	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	Microtunnelling to install new pipes along Torwood Street, Eagle Terrace, under the railway line into Roy Street and Lang Parade, connecting to the sewer system on Coronation Drive. \$9.2M.	<b>Current status:</b>	Commenced, Work is due for completion by mid-2012.

<b>Project: Curtis LNG Project</b>			
<b>Client:</b> Queensland Urban Utilities	<b>Designer</b> Arup	<b>Contractor:</b> TBA	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	Tunnel crossing to Curtis Island. 6kms at 4m diameter.	<b>Current status:</b>	Design awarded to Arup

<b>Project: Bulimba Creek Trunk Sewer Upgrade</b>			
<b>Client:</b> Queensland Urban Utilities	<b>Designer</b> Queensland Urban Utilities	<b>Contractor:</b> John Holland	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	1.5km of DN120 pipe jacking 30km of DN800 pipe jacking and 48 manholes	<b>Current status:</b>	Under construction

<b>Project: Wooloongabba Trunk Sewer Upgrade Part B</b>			
<b>Client:</b> Queensland Urban Utilities	<b>Designer</b> Queensland Urban Utilities	<b>Contractor:</b> TBA	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	5.5km of sewer pipeline up to 1200mm diameter	<b>Current status:</b>	D&C Tenders submitted

## WESTERN AUSTRALIA

<b>Project: Perth Airport Rail Link</b>			
<b>Client:</b> Public Transport Authority	<b>Designer</b> AECOM (study)	<b>Contractor:</b> N/A	<b>Supervising Engineer:</b> N/A
<b>Scope of work:</b>	Twin track electrified passenger heavy rail route from Midland Line near Bayswater Station to a new possible terminal station at High Wycombe. Route to service growing Office and Industrial Park with underground station near current Domestic Terminal. Tunnel options extend under main airport runway to new underground station at International Terminal, continuing eastwards under future runway to High Wycombe (total track length up to 10km, approx half in cut and cover and bored tunnel).	<b>Current status:</b>	Pre-feasibility Studies including preferred route identification and preliminary costing, report submitted.

<b>Project: Woodside Browse Gas Pipeline Shore Crossing</b>			
<b>Client:</b> Woodside	<b>Designer</b> Atteris	<b>Contractor:</b> TBA	<b>Supervising Engineer:</b> N/A
<b>Scope of work:</b>	TBM pipejack or segmentally lined tunnel up to 2km length in up to 20m water depth carrying 3 LNG pipelines onshore.	<b>Current status:</b>	Expressions of Interest have been submitted and Woodside is currently reviewing.

<b>Project: Northern suburbs sewer</b>			
<b>Client:</b> Water Corporation	<b>Designer</b> N/A	<b>Contractor:</b> DM Civil	<b>Supervising Engineer:</b> N/A
<b>Scope of work:</b>	4.4km section of sewer pipe through the suburbs of Woodvale, Kingsley, Madeley and Wanneroo,	<b>Current status:</b>	Sewer construction completed

<b>Project: The Perth City Link Project</b>			
<b>Client:</b> Public Transport Authority	<b>Designer:</b> N/A	<b>Contractor:</b> JHG-GHD	<b>Supervising Engineer:</b> N/A
<b>Scope of work:</b>	Lowering twin Fremantle lines underground in cut and cover tunnel above existing Joondalup line bored tunnels west of Perth Central Station. Includes new pedestrian underpass beneath all tracks and platforms within Perth Central Station. Lowering of Wellington Street Bus Station underground with bus access ramp to west.	<b>Current status:</b>	Perth City Link Rail Project Awarded to John Holland-GHD Joint Venture in March 2011. Rail lowering project due for completion in 2014. Bus station lowering project due to follow, with completion by 2016.

<b>Project: Wheatstone gas pipelines Shore Crossing Tunnel</b>			
<b>Client:</b> Chevron	<b>Designer:</b> Atteris	<b>Contractor:</b> Thiess	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	TBM pipejack tunnel planned for carrying LNG gas pipelines through surf zone and shore crossing into Plant site	<b>Current status:</b>	

<b>Project: Southern Seawater Desalination Project – Subsea Pipejack Tunnels</b>			
<b>Client:</b> Southern Seawater Alliance	<b>Designer:</b> An Alliance comprising Water Corporation, Technicas Reunidas, Valorizia Agua, AJ Lucas and Worley Parsons.	<b>Contractor:</b> Zueblin Australia	<b>Supervising Engineer:</b> N/A
<b>Scope of work:</b>	Three TBM pipejack tunnels approx 900m long under coastal sand dunes (approx 400m) and out to sea (500m). Two Herrenknecht slurry TBMs used with bored diameters 3.0m and 2.4m. TBMs retrieved from below seabed.	<b>Current status:</b>	Tunnels completed

<b>Project: Perth Waterfront Project</b>			
<b>Client:</b>	<b>Designer:</b>	<b>Contractor:</b>	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	\$300-\$400 million tunnel beneath Riverside Drive	<b>Current status:</b>	Proposed

# VICTORIA

<b>Project: Melbourne Metro</b>			
<b>Client:</b> DoT	<b>Designer</b> TBA	<b>Contractor:</b> TBA	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	Stage 1 – new rail tunnel between Dynon in the west and St Kilda Road near Domain with new stations in North Melbourne, Parkville, and St Kilda Road. Stage 2 – linking Domain to the Caulfield corridor	<b>Current status:</b>	Under review

<b>Project: East-West Tunnel</b>			
<b>Client:</b> VicRoads	<b>Designer</b> TBA	<b>Contractor:</b> TBA	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	Potential tunnel under Carlton and Royal Park running from the Tullamarine Freeway to the Western Ring Road	<b>Current status:</b>	In progress

<b>Project: WestLink — Stage 1</b>			
<b>Client:</b> LMA	<b>Designer</b> Aurecon/AECOM/GHD	<b>Contractor:</b> TBA	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	3.5km tunnel stretching from the ports area to Paramount Road, West Footscray	<b>Current status:</b>	On hold

<b>Project: Northern Sewer Project</b>			
<b>Client:</b> Melbourne Water	<b>Designer</b> SKM/Jacobs	<b>Contractor:</b> JHG	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	Stage 1 – 8km of 1.6m and 2.5m diameter sewer tunnels. Stage 2 – 4.5km and 1.8km diameter sewer tunnels	<b>Current status:</b>	Tunnelling complete

<b>Project: Hoddle Street Tunnel</b>			
<b>Client:</b> Vic Roads	<b>Designer</b> GHD	<b>Contractor:</b> TBA	<b>Supervising Engineer:</b> TBA
<b>Scope of work:</b>	Tunnel would run from the Eastern Freeway to Wellington Parade, near the MCG.	<b>Current status:</b>	On hold

<b>Project: Wonthaggi Desalination Plant</b>			
<b>Client:</b> Department of Sustainable Energy	<b>Designer</b> GHD	<b>Contractor:</b> Thiess Degremont	<b>Supervising Engineer:</b> TBA
<b>Scope of work:</b>	Desalination plant will include intake and outake tunnels offshore up to 2.5km long	<b>Current status:</b>	Tunnelling complete

<b>Project: Melbourne Main Sewer Replacement</b>			
<b>Client:</b> Melbourne Water	<b>Designer:</b> GHD	<b>Contractor:</b> John Holland	<b>Supervising Engineer:</b> Aurecon
<b>Scope of work:</b>	\$220 million 2.3km 1.8m diameter new sewer includes six shafts 10–15m deep and 142m crossing of Yarra River	<b>Current status:</b>	Tunnelling complete May 2011, project completion in 2012

<b>Project: Frankston Drainage Improvement Project</b>			
<b>Client:</b> Melbourne Water	<b>Designer:</b> GHD	<b>Contractor:</b> Winslow Infrastructure	<b>Supervising Engineer:</b> GHD
<b>Scope of work:</b>	1.5 kilometre 3m OD tunnel with 2.5m dia concrete stormwater pipeline from Monash University to Kananook Creek.	<b>Current status:</b>	Complete

<b>Project: North East Link</b>			
<b>Client:</b> LMA	<b>Designer:</b> GHD	<b>Contractor:</b> TBA	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	Potential road tunnel from Greensborough to Bullen linking the Western Ring Road to the Eastern freeway	<b>Current status:</b>	Not before 2018

<b>Project: Bendigo CBD</b>			
<b>Client:</b> VicRoads	<b>Designer:</b> GHD	<b>Contractor:</b> TBA	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	A 3.5km road tunnel under the Bendigo CBD	<b>Current status:</b>	Proposed

## SOUTH AUSTRALIA

<b>Project: Adelaide Desalination Plant</b>			
<b>Client:</b> SA Water	<b>Designer:</b>	<b>Contractor:</b> Winslow Infrastructure	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	11.5km pipeline from Port Stanvac to the Happy Valley water treatment storage facility including 6 tunnel bores ranging from 30 to 160m	<b>Current status:</b>	Tunnel works complete.

## NORTHERN TERRITORY

Project: Darwin Water Main			
<b>Client:</b> Darwin City Council and the Department of Planning and Infrastructure	<b>Designer</b>	<b>Contractor:</b> Winslow Infrastructure	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	Construction of several major water mains will take place in two stages. Stage 1 includes installing 1.2km of 450mm steel pipe. Stage 2 includes the installation of 9km of 450mm steel water in Darwin's CBD.	<b>Current status:</b>	Complete

Project: Kilgarif Power and Water			
<b>Client:</b> Power and Water	<b>Designer</b>	<b>Contractor:</b> Sitzler Brothers	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	\$A4.3M to bore under major road and rail crossings	<b>Current status:</b>	Complete

## TASMANIA

Project: Hobart City Tunnel			
<b>Client:</b> Hobart City Council	<b>Designer</b>	<b>Contractor:</b> TBA	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	Tunnel from the Southern Outlet at Davey St to Brooker Ave under West Hobart and North Hobart, and a second stage through the Queen's Domain to the Tasman Bridge.	<b>Current status:</b>	Proposed.

## NEW ZEALAND

Project: Homer Tunnel Upgrade			
<b>Client:</b>	<b>Designer</b>	<b>Contractor:</b>	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	2 Lane tunnel	<b>Current status:</b>	In planning

Project: Victorai Park Tunnel			
<b>Client:</b> Transit NZ	<b>Designer</b> V Formation (Fletcher Construction, Beca Engineering, Higgins Contractors and Parsons and Brinckerhoff)	<b>Contractor:</b>	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	440m long 2 Lane tunnel	<b>Current status:</b>	Complete

<b>Project: Waterview Connection</b>			
<b>Client:</b> NZTA	<b>Designer</b>	<b>Contractor:</b> Fletcher/MacConell Dowell/Obayashi	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	Linking of Southwestern Motorway (State Highway 20) and the Northwestern Motorway (SH16), including twin three-lane tunnels	<b>Current status:</b>	Awarded

<b>Project: Milford Dart Tunnel</b>			
<b>Client:</b> Milford Dart Co.	<b>Designer</b> URS	<b>Contractor:</b>	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	10.2kms of 5m diameter tunnel for single lane bus route or rail	<b>Current status:</b>	In planning

<b>Project: North Bank Tunnel</b>			
<b>Client:</b> Meridian Energy	<b>Designer</b> URS	<b>Contractor:</b>	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	36kms of 12m diameter headrace tunnel & hydro power station	<b>Current status:</b>	In planning

<b>Project: Britomart rail loop</b>			
<b>Client:</b> Auckland Regional Transport Authority	<b>Designer</b>	<b>Contractor:</b>	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	A 3.5km loop linking Britomart with the current western line. Three new underground stations at Aotea Square, Newton and K' Road.	<b>Current status:</b>	Planning and conceptual design in progress

<b>Project: Wellington Northern Corridor</b>			
<b>Client:</b> NZ Transport Agency Board	<b>Designer</b> AECOM, Parsons Brinckerhoff and Beca	<b>Contractor:</b>	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	Four lane expressway from Levin to Wellington Airport including duplication of Mount Victoria and Terrace tunnels.	<b>Current status:</b>	In planning

<b>Project: Tauranga Tunnel</b>			
<b>Client:</b> Local Govt	<b>Designer</b>	<b>Contractor:</b>	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	Three routes for a road tunnel through the Kaimai Ranges, linking Tauranga with the Waikato.	<b>Current status:</b>	Currently being investigated by the NZ Transport Agency

<b>Project: Central Interceptor Project</b>			
<b>Client:</b> Local Govt	<b>Designer</b> AECOM	<b>Contractor:</b>	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	New sewer tunnel approximately 14 kilometres in length from central Auckland to Mangere Wastewater Treatment Plant	<b>Current status:</b>	Design in progress — construction to be completed by 2025

<b>Project: Nevis Tunnel</b>			
<b>Client:</b> NZ Transport Agency	<b>Designer</b>	<b>Contractor:</b>	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	Tunnel to replace a rockfall-prone stretch of highway at the Nevis Bluff, midway between Cromwell and Queenstown.	<b>Current status:</b>	Concept

<b>Project: Waitemata Harbour</b>			
<b>Client:</b> NZTA	<b>Designer</b>	<b>Contractor:</b>	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	Potential tunnel route between the central city and the North Shore would cost from \$4 to 5.3 billion	<b>Current status:</b>	Concept

<b>Project: Welcome Bay Tunnel</b>			
<b>Client:</b> NZTA	<b>Designer</b>	<b>Contractor:</b>	<b>Supervising Engineer:</b>
<b>Scope of work:</b>	Tunnel or roundabout proposed	<b>Current status:</b>	Proposed