

# Vancouver's Twin Tunnels: Almost Full Tilt

As first reported in the October 2005 issue of *Underground Construction*, the benchmark Greater Vancouver Regional District's (GVRD) twin 4.5 mile, 12.5-foot diameter tunnels being built in North Vancouver, British Columbia, are almost in full production. Ironically, at this update, Vancouver was in the midst of the largest boil water advisory in Canadian history. Up to two million people for one day and one million people for another 11 days were advised to drink boiled or bottled water. Record rainfall levels caused numerous slides that dumped tons of material into the Seymour and Capilano drinking water reservoirs raising the turbidity to the point where the effectiveness of the chlorine treatment couldn't be guaranteed. Once the Seymour-Capilano Filtration Plant is complete, the tunnels will bring the unfiltered water from the Capilano reservoir to the Seymour Filtration Plant located in the Lower Seymour Conservation Reserve and then return it to Capilano. Vancouver residents are not expected to face another boil water advisory due to turbidity.

It has taken 24 months to sink the 600-foot entry shaft, build the 500-foot launch chamber and assemble the two new 850-foot long Robbins Gripper tunnel boring machines (TBM's) inside the tunnels. The Raw Water Tunnel that will carry the untreated water from the Capilano Reservoir to the Seymour Filtration Plant has advanced 1,650 feet, while the 'treated' tunnel that will bring filtered water back has advanced about 1,300 feet.

Though still slightly behind schedule, the owner recognizes the many difficulties faced by the contractor. Tom Morrison, senior project engineer for the GVRD tunnels explains, "One of the difficulties is that a TBM is a large, complicated machine that has to operate in a hostile environment. Bilfinger Berger has to assemble and commission two of them at the bottom of a 600-foot shaft."

The new, adjustable TBMs that can produce a 13.8 foot diameter bore arrived on site over a period of three months on 160 flatbed trucks. Setting up the support infrastructure at the bottom of the shaft, has been a huge undertaking. With the fine tuning for the many heavy duty hydraulic

and electric elements still in progress, the units are almost operating at maximum efficiency. While it's still early, the TBMs at full production will produce about 1,250 tons of material per day – equivalent to a substantial underground mine.

## TBM assembly

The TBM itself is 80-feet long and the next 33 feet of the assembly is a bridge conveyor that is built over the rail lines laid down as the TBM advances. The final 740 feet is the trailing gear that supports the TBM including the compressor, generator, ventilation cassettes, a rescue chamber, workshops, pumps, dusting and ventilation systems, operator's cabin, transformers and more. The train includes the locomotive, a man rider, five 7.1 yard muck cars and one flatbed to transport rails and pipes. The refuge trailer is parked nearby and can be coupled to the train in an emergency. The final rail layout at the bottom chamber will allow trains from both of the tunnels to discharge almost without mutual interference.

The original plan was to use traditional drilling and blasting to advance the tunnels 425 feet from the launch chamber and install the TBMs, but Bilfinger decided to change their installation strategy as the TBMs with the necessary back up trains would be much longer. They would now only advance 200 and 230 feet (treated and raw water tunnels respectively) by drilling and blasting, install the TBM so that they could start boring right away, and then continue to install the trailing gear as the room became available. To do this, certain parts have been shunted between tunnels,

and this has proven to be tricky because of the many elements of the machines.

One of the biggest challenges for the owner and the contractor is that this is the first major tunnelling job in Western Canada since the Kemano Completion project shut down in 1991. There is not an experienced labor force, design or even maintenance expertise available locally. Christian Genschel, project manager for Bilfinger Berger Canada explains, "Almost everything we use has been manufactured somewhere else: the crane is from Germany; the lift, pump and



*Top: Set-up for the massive twin tunnels project was extremely complicated. Bottom: Part of the massive dewatering system required on the job.*

locomotives are from Sweden; the TBM's and the wheel loaders are from the U.S.; the 10 miles of 3.5-inch trailing cable has been custom made for us in Italy; and almost half of my hourly paid workforce is made up of men that have international tunneling experience."

There have also been challenges in getting industry specific procedures approved and equipment maintained, particularly where there is no local experience. For example, there were no underground lift standards available so the regulators applied high rise lift standards to the Ailmak Lift that moves up and down the Seymour shaft. Bilfinger had even brought in manufacturing personnel from Sweden to work on the equipment, but they were not immediately authorized to work in British Columbia. These hurdles are all eventually overcome as the project moves forward but it has slowed the work down, Morrison said. "It's been difficult for Bilfinger Berger to get established in what is, for them, a foreign culture. These German guys show up, speaking perfect English, and I have a hard time remembering that they have never been to North America before." (Much of the heavy construction equipment in BC is 'vintage' and finding mechanics that are qualified to work on state-of-the-art equipment is difficult at best.)

#### **Geological conditions**

So far, the rock conditions have been much as predicted, Morrison explains, "We hit a fault where we expected to, although the ground conditions were better than anticipated. From our knowledge of surface geology, we expect to hit others."

During 'good' conditions, water is pumped away from the active mining area at a rate of about 2.6 gallons per second. To prepare for larger water volumes, 2-inch probe holes are advanced about 130 feet ahead of the TBM face alternating from one side to the other. Where higher volumes of water are encountered, the contractor makes a 'fan' of drill holes and pressure grouts the fault. So far this has happened once but more incidents of higher water volumes are expected throughout the length of the tunnels, especially as they come under the Capilano buried valley.

The operation is going 24/7. Bilfinger has two 10-hour shifts per TBM, with a four-hour maintenance shift. Another crew supports the operation at the surface of the shaft. At peak production, there will be 95 hourly paid workers. "We have good days and bad days in both of the tunnels," explains Genschel. "On a bad day, we may only get about 59 - 65 feet per day; at full capacity, we get about 100 feet per day."

Another noteworthy contract tendered for this project is the supply contract for 2.2 miles of steel tunnel liner worth \$34 million (Canadian) that was divided between the GVRD and Northwest Pipe Company of Portland, OR, and Adelanto, CA. Though the installation won't start for another 18 months, a long lead time is needed to manufacture the pipe so scheduled delivery for some 10,000 tons of 10-foot diameter, one-inch thick pipe can start in January 2008.

The safety record on this job has been very good because of a rigorous and effective safety program.

#### **FOR MORE INFORMATION:**

**Pipe:** Northwest Pipe Company, (503) 946-1200, [nwpipe.com](http://nwpipe.com)

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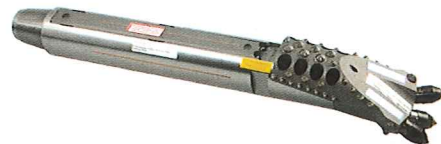
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