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TUNNELING & UNDERGROUND CONSTRUCTION

THE OFFICIAL PUBLICATION OF UCA OF SME WWW.TUCMAGAZINE.COM VOLUME 6 NO 3 SEPTEMBER 2012

Tunneling under Austin

Challenges at Gotthard Tunnel

NAT 2012 highlights

Special Editorial Section from the publisher of *Mining Engineering*

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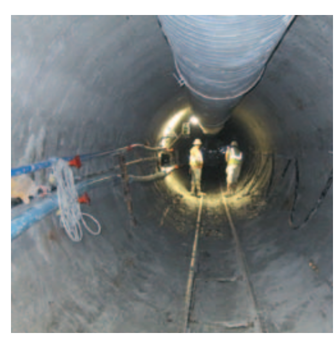

DEPARTMENTS

TUNNELING & UNDERGROUND CONSTRUCTION (ISSN 0026–5187) is published quarterly by the Society for Mining, Metallurgy, and Exploration, Inc., at 12999 E. Adam Aircraft Circle, Englewood, CO 80112-4167. Phone 1–800–763–3132 or 303–973–9550. Fax: 303–973 –3845 or e-mail: sme @smenet.org. Website: www.smenet.org. **POSTMASTER:** Send changes of address to TUNNELING & UNDERGROUND CONSTRUCTION, 12999 E. Adam Aircraft Circle, Englewood, CO 80112-4167. Article copies and back issues available on microfilm or microfiche from Linda Hall Library in Kansas City, Mo. Printed by Cummings Printing Co.

CHAIRMAN'S COLUMN

Change is all around our industry and we should enjoy the ride

While most people might say they don't like change, I think most would agree that change is inevitable. I actually think change is healthy — it keeps things challenging and fresh in most cases. My recent observations of our industry would suggest that we are starting to experience a lot of change and there are many indications that would suggest that we are in for a roller coaster of a ride in the near future.

It is clear that our markets are changing and that's not a bad thing. Personally, I still believe the underground construction market is very strong, and that the future of tunneling and related work continues to expand. But the projects are changing and growing.

It seems that there are many more very large jobs and fewer small jobs these days. While we are still building water and sewer tunnels, we are also seeing rapid growth in highway and transit tunnels being considered in the American market.

And the location of the work seems to be changing as well.

On July 25, California Gov. Jerry Brown gave his stamp approval to a multibillion-dollar project that would see the construction of 56 km (34 miles) of tunnels to carry water from northern California to the southern part of the state (see page 3). This announcement comes as work begins on the $1.35-billion SR 99 Tunnel Project in Seattle, WA, also known as the Alaskan Way project (see page 8). The SR 99 Tunnel Project will be built by the world's largest diameter tunnel boring machine (TBM).

Meanwhile, New York's Metro Transit Authority announced on June 23 that the tunnel boring operations that began in 2007 on 16 projects in New York City have come to an end. The boring work is concluding at the East Side Access Project and caps off 21 km (13 miles) of tunnels bored by a fleet of seven machines.

And the contract types are changing drastically as well. Design Build, P3 and other alternative delivery systems are in the works at projects across the county.

Helping advance much of this change is technology. TBM's are getting larger, see the SR 99 Tunnel Project for an example, and the support systems and electronics are allowing us take on challenges and improve efficiency in everything we do. I wonder how long before we see dependable ground penetrating radar on a TBM? That would shake things up a bit, don't you think?

Funding, economic challenges and government regulations are also driving change in our markets. Big programs have been cancelled in some places, while other programs are currently being approved in other parts of the country. Check out the article by Ray Brainard, Clay Haynes, Steve Long and Robyn Smith (page 33) to see how environmental concerns and regulations had an impact on the construction of the Jollyville Transmission Main rock tunnel in Austin, TX. I agree that it is great for our environment, but we certainly would not have been dealing with issues like this 10 years ago.

Oh, and don't forget, we have a significant election for our president coming up in a couple months — either way that turns out, it is sure to have a significant impact on our industry.

So whether you like change or resist change, it is all around us. I think if we encourage and manage it, we can make it for the better. Enjoy this issue and enjoy the ride. ■

Jeffrey Petersen,
UCA of SME Chairman

Multibillion dollar California water tunnel plans win endorsement of Gov. Jerry Brown

A $14-billion plan to build two water tunnels to divert water from northern California to the south was endorsed by California Gov. Jerry Brown on July 25.

U.S. Interior Secretary Ken Salazar also endorsed the plan that includes two 56-km (34-mile) tunnels that will take water from the Sacramento River near Sacramento and convey it to an existing aqueduct system serving the San Joaquin Valley and southern California.

The plan also includes the construction of three large intake facilities on the Sacramento River. These facilities will divert about 250,000 L^3/sec (9,000 cu ft/sec) of water to the tunnels.

The plan was immediately assailed by a broad range of interest groups, which denounced it as too expensive and potentially detrimental to the environment and to the regional economies that would be affected, the *Wall Street Journal* reported.

"It's a costly adventure that isn't necessary, and the state cannot afford it," said Jim Nielsen, a Republican state assemblyman whose district includes the upper Sacramento River, which empties into the Sacramento-San Joaquin River Delta.

Water has long been a contentious issue in California, partly because people in the northern part of the state, where most of the rain and snow fall, are wary of how much of it they send to the dry south, where most Californians live. The delta can't always transport enough water to satisfy farmers and cities in southern California, and state officials have debated plans to fix the system for the past three decades.

The delta's earthen levees, which control floods and move water, can fail from earthquakes and other causes. Environmental groups say

(Continued on page 4)

CALIFORNIA: Tunnels will deliver water

(Continued from page 3)

the delta's pumps kill endangered smelt and salmon and their lawsuits have prompted courts to cut irrigation, turning fields fallow and putting laborers out of work. The proposed tunnels would bypass the delta, which now serves as a chokepoint for water shipments in the state — and depends for its health on a steady influx of fresh water. The plan was conceived by a group of state and federal agencies, environmental organizations and others convened by the state after 2009 legislation to repair and improve California's aging water infrastructure.

Brown, a Democrat, said the proposed bypass and a mix of environmental improvements planned for the delta "balances the concerns of those who live and work in the delta, those who rely on it for water and those who appreciate its beauty, fish, waterfowl and wildlife."

George Miller, a Democratic congressman who represents part of the delta region, said "the number 1 issue with this project is whether or not the governor and others are prepared to get the best science available."

Officials of the Brown administration said studies already conducted show that the delta's environment would be improved, adding that the plan would be subject to rigorous additional analysis as part of state and federal environmental reviews, said the *Wall Street Journal*.

Many water users south of the delta support the tunnel plan and said time is of the essence.

"Of course there are a lot of uncertainties, but we've got to work through those," said Jason Peltier, deputy general manager of the Westlands Water District, which represents many Central Valley farmers who rely on water shipped through the delta. "If we waited for certainty, we would never do anything."

Other supporters of the tunnel plan include the Los Angeles Area Chamber of Commerce, Orange County Farm Bureau and the Building Industry Association of Southern California. ■

Work resumes at Lake Mead project

Vegas Tunnel Contractors was given permission to resume tunneling activities at the Lake Mead project two weeks after a worker, Thomas Albert Turner, 44, was killed in an accident 183 m (600 ft) below Lake Mead.

The Nevada Occupational Health and Safety Administration gave the go-ahead on June 26 to resume tunneling activities for the construction of a third water intake, the Southern Nevada Water Authority (SNWA) said in a statement.

Turner was killed June 11 while he was working as part of a crew in a tunnel beneath Lake Mead.

According to officials, Turner was helping erect one of a series of large concrete rings that will line the tunnel when one of the rings slipped, ejecting a pressurized stream of dirt, rocks and grout that struck him in the head.

One other worker was injured in the accident, and tunneling activities were suspended while the Occupation Safety and Health Administration (OSHA) investigated.

SNWA spokesman J.C. Davis said Vegas Tunnel Constructors was required to submit a plan to OSHA for approval that outlined changes to procedures that will be taken to avoid another similar accident. The primary changes, he said, involve adding more restraints to the concrete rings while they are being erected to prevent them from slipping.

The June 11 accident was the first fatality involving an industrial accident at the $800 million construction project to build a third intake "straw" at Lake Mead, which has been beset by delays and increased costs since construction began in 2009.

The project was started while southern Nevada struggled through a decade of drought, and plunging lake levels threatened to drop below the existing two intakes at the lake drilled at shallower depths.

Las Vegas depends on the Colorado River reservoir for about 90 percent of its drinking water.

The third intake would allow

(Continued on page 12)

Micropiles – South Ferry Loop Station New York, NY

Fracture & Permeation Grouting – Lower North Outfall Sewer Rehabilitation Project, Los Angeles, CA

Jet Grout Secant Pile Wall – South River Tunnel Project, Atlanta, GA

Jet Grouting – Brightwater Conveyance System, Seattle, WA

Compaction Grouting – Highway 85 Sinkhole above Utility Tunnel, Brighton, CO

Seattle's Alaskan Way Tunnel project breaks ground

Jacobs and Associates was chosen by the Washington State Department of Transportation (WSDOT) to provide construction management support for the $1.35-billion SR 99 Tunnel Project in Seattle, also known as the Alaskan Way project. This 2.7-km (1.7-mile) long tunnel will be built by the world's largest diameter tunnel boring machine (TBM). The tunnel is part of a program to replace the seismically vulnerable SR 99 Alaskan Way Viaduct, a double-deck structure that for the past half century has spanned the downtown waterfront.

Jacobs Associates' services prior to tunnel construction include reviewing and commenting on design submittals, schedule analysis, tunnel systems integration support and assistance with geotechnical monitoring. Jacobs Associates currently provides a resident engineer collocated with WSDOT staff, and a schedule engineer supporting schedule submittal reviews and impact assessment. Construction on the tunnel project began in August 2011, and tunnel boring is slated to start in mid-2013. Subconsultants Parsons Brinckerhoff and Heery International are proposed to augment Jacobs Associates' tunnel inspection staff and provide specialized technical support during future construction.

WSDOT is working closely with its design-build contractor, Seattle Tunnel Partners, a joint venture of Dragados USA and Tutor Perini Corp., which includes local firms Frank Coluccio Construction, Mowat Construction and HNTB Corp. The team has selected Hitachi Zosen Corp. to supply the project's TBM.

On June 6, Washington Gov. Chris Gregoire joined state, federal and local officials for the groundbreaking of the tunnel boring pit in the construction area west of Seattle's stadiums. When completed early next year, the pit will be slightly longer than a football field and about 24 m (80 ft) deep.

"We are making continuous

(Continued on page 12)


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Second Gotthard Tunnel to be built

The Swiss government announced that it will build a second road tunnel through the Gotthard mountain range in central Switzerland, as it unveiled one of the country's largest road infrastructure projects in years, *Reuters* reported.

The existing tunnel, between the Swiss Cantons of Uri and Ticino, is in urgent need of maintenance work, and the government said it had decided to build a second tunnel so that the Italian-speaking Canton of Ticino would not be cut off from the rest of the country. The second tunnel, scheduled to open by 2027 at the earliest, is expected to cost the Swiss federation about $2.91 billion (2.8 billion Swiss francs).

The second tunnel will significantly increase road safety, since it will make it possible to split the two lanes of traffic that currently go in different directions between the two tunnels.

The Gotthard, the main north-south axis through the Swiss Alps, is used by more than five million people and 930,000 trucks each year.

First opened in September 1980, after more than 10 years of planning and construction, it is 16 km (10 miles) long.

In October 2001, a head-on collision in the tunnel between two trucks caused a massive fire, killing 11 and injuring many others. ■

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LAKE MEAD: Completion date now set for 2014

(Continued from page 6)

the region to continue drawing water from the lake, even as water levels continue to drop.

In July 2010, work on a tunnel that would carry water from the straw into the valley's water system was slowed when crews struck a geographical fault, releasing water and muck into the construction area. Attempts were made to stabilize the fault with grout, but after two more leaks, that tunnel was abandoned and crews began excavating a different direction.

A separate access tunnel also being built as part of the project encountered problems this summer when unexpected amounts of water began seeping into the tunnel.

The third intake project was initially scheduled to be finished in 2013, but its completion date has been pushed back until 2014. The accident earlier this month is not expected to affect the project's completion date, SNWA officials said. ■

ALASKAN WAY: TBM to be assembled in 2013

(Continued from page 8)

progress on replacing the aging Alaskan Way Viaduct and today marks a significant milestone," Gregoire said. "I look forward to a new and revitalized waterfront and a safe new passage through downtown Seattle."

The tunnel boring machine is being manufactured in Osaka, Japan by Hitachi Zosen Corp. Crews will test it later this year, then disassemble and ship it to Seattle in early 2013. It will be reassembled inside the launch pit before it starts boring the tunnel in summer 2013.

"This project will not only have immediate benefits by creating jobs, but it will support economic growth for decades to come," said federal highway administrator Victor Mendez.

The tunnel is scheduled to open to traffic in late 2015. When it opens, the remaining waterfront section of the viaduct will be demolished.

"We are well on our way to delivering the SR 99 project and tunnel on time and on budget," said Washington Transportation Secretary Paula Hammond. "We've assembled a top-notch team that is on the cutting edge of tunneling technology and project management. But don't take my word for it: watch us work."

Seattle Tunnel Partners is a joint venture of Dragados USA and Tutor Perini Corp. Key members of the team delivered the comparable 15-m (49.5-ft) diameter Madrid M-30 highway tunnel in Spain. ■

Robbins TBM begins work in Mumbai

A Robbins 6.25-m- (20.5-ft-) diameter main beam tunnel boring machine (TBM) began boring India's 8.3-km (5.2-mile) Mumbai Water Tunnel in June and had bored more than 320 m (1,050 ft) as of July 4, 2012. Unity-IVRCL Joint Venture is the contractor for the basalt rock tunnel, which will alleviate Mumbai's current leakage problems from its aging lines and provide inhabitants with a consistent flow of clean drinking water.

Due to the urban location of the tunnel, the TBM was launched from a 109-m (357-ft) deep shaft,

(Continued on page 16)

The top section of the cutterhead descends into the 109-m (357-ft) deep shaft at the Mumbai Water Tunnel project in June.

ROBBINS: Onsite first-time assembly used in Mumbai

(Continued from page 14)

and its launching sequence included an initial startup excavation of 50 m (164 ft) with vital backup decks connected to the TBM using cables. The first bore began March 30, 2012, and, upon completion, the decks were lowered and a continuous conveyor system was installed for muck haulage and storage.

Onsite first-time assembly (OFTA) was used to assemble the main bearing, lube system, backup decks and horizontal, vertical and stacker conveyors. OFTA saved the contractor time and money by assembling the parts at the jobsite and eliminating pre-assembly at the manufacturing facility in Shanghai, China. The OFTA process took place at the shaft bottom in a 100-m- (328-ft-) long starter chamber and a 50-m- (164-ft-) long tail tunnel. TBM components were lowered into the shaft using mobile and gantry cranes.

Following the initial excavation, V.D. Sharma, director of operations at Unity Infrastructure, said, "Robbins has made an outstanding effort during the excavation, without many difficulties, which speaks to their knowledge and team spirit." Although the lack of conveyors during the initial bore was challenging, current advance rates are averaging 3.5 m/h (11.5 ft/hour).

Difficult ground conditions are expected during excavation, including hard basalt rock, fractured ground and possible water inflows. In preparation, the TBM has been equipped with 482 mm (19 in.) cutters and a probe drill. Rock support has been applied during the initial stretch of tunnel.

Once completed, the Mumbai Water Supply Tunnel will run between the Kapurbawdi and Bhandup areas. The tunnel will provide the city's approximately 20.5 million residents with a reliable water supply, even during the seasonal monsoons that regularly contaminate Mumbai's water resources. ■

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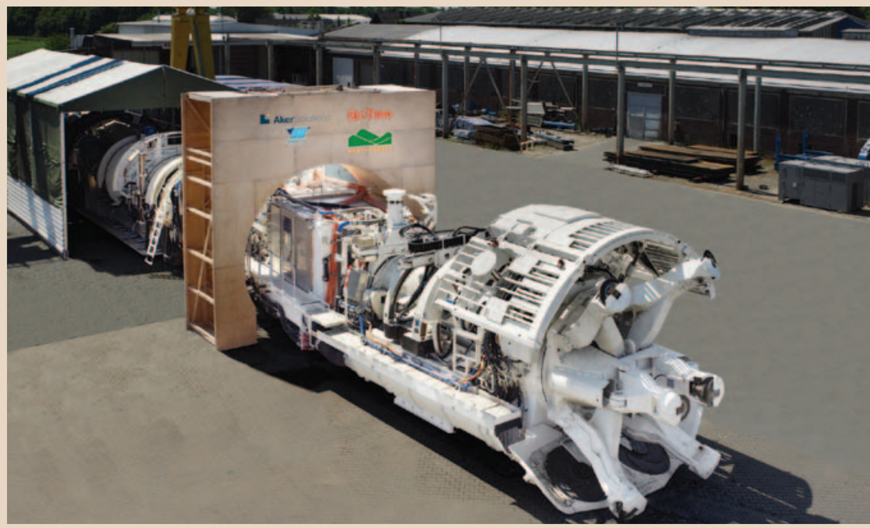
Aker Wirth teams with Rio Tinto for new tunnel boring system for mining

The new tunnel boring system — the mobile tunnel miner (MTM) from Aker Wirth — will be used for mining copper in Australia.



A new tunnel boring system called the mobile tunnel miner (MTM), developed by Aker Wirth, was shipped to Rio Tinto's Northparkes copper mine in southeast Australia in June.

The machine was developed with Rio Tinto as part of its "Mine of the Future" program.

The machine concept combines the flexibility of a roadheader with the robustness of a tunnel boring machine (TBM). To build this machine, knowledge gained from a previous version that was developed and tested by Aker Wirth in the early 1990s was leveraged.

The MTM is flexible and ver-

(Continued on page 20)

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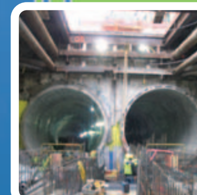
AKER WIRTH: New system to work in Australia

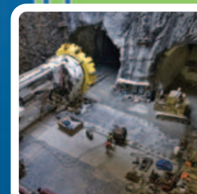
(Continued from page 18)

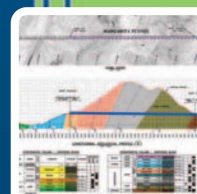
satile. Using the undercutting technology, it is especially efficient at tunneling in extremely hard rock (up to maximum 300 MPa). Another feature of this tunnel boring system is its ability to cut — in addition to circular tunnels — rectangular or horseshoe-shaped cross-sections of up to 6 m (20 ft) bore diameter, eliminating the need to backfill the lower section of the round cross-section.

The machine can be moved flexibly forward with a walking mechanism and backward with a crawler. Aker Wirth engineers employed several swivel joints to attain a radius of just 30 m (98 ft), which is extremely small for a machine of this size and capacity. The tunnel boring system is equipped with support systems for additional strengthening of the tunnel.

Aker Wirth, based in Erkelenz, Germany, was able to draw upon more than 40 years of experience and expertise in underground hard rock mining and tunneling. Einar Brønlund, CEO of Aker Wirth, is convinced that, "We will revolutionize safety and efficiency in underground mining with the new MTM. With this tunnel boring system, Aker Wirth will play a decisive role in shaping the future of the mining industry." ■





Tunnel boring completed on all MTA projects

Tunnel boring operations that began in 2007 and have run consistently since then as part of New York's Metro Transit Authorities (MTA) projects concluded on June 23, when the last of the tunnel boring machines (TBM) completed its work beneath the streets of Manhattan.

Molina, the TBM digging the fourth of four East Side Access tunnels in Queens, came to a halt 2 m (6 ft) underneath the LIRR Main Line in Long Island City, completing its run. The milestone marks the end of tunnel boring for the East Side Access project as well as for all MTA megaprojects.

A fleet of seven 181-t (200-st)

(Continued on page 24)

Seven tunnel boring machines bored out 21 km (13 miles) of tunnel on 16 new tunnels in New York City.

MTA: Seven machines finish work on 16 projects

(Continued from page 22)

TBMs have built 21 km (13 miles) of new tunnels through the mica-inflected granite schist that anchors the skyscrapers of Midtown and through challenging boulder-strewn soft ground in Long Island City, Queens.

Among its many destinations, the muck has been put to use in the foundations for new college dormitories in Jersey City, stable soil under a golf course and fill that created Brooklyn Bridge Park along the Brooklyn waterfront. But what is most important to future generations of New Yorkers is the tunnels are in the place where the rocks and dirt once stood.

"Sixteen brand new, concrete-lined tunnels now exist under New York City where none did five years ago," said MTA Chairman Joseph J. Lhota. "For about 60 years, two generations, the New York transit system was essentially functioning in a status quo, with little action on expansion to meet the needs of a growing region. Today, we are lengthening a subway line, building the first quarter of what will be a new north-south trunk line running the length of Manhattan and realizing a long-held dream of connecting the Long Island Rail Road to Grand Central Terminal. The conclusion of tunnel boring reminds us that New Yorkers remain capable of great achievements."

"Although we've completed tunneling, many components of these megaprojects remain to be completed before service can begin," said Michael Horodniceanu, president of MTA Capital Construction. "In the months and years ahead, workers on all three projects will continue to excavate station caverns. They will build the platforms, stairways, mezzanines, elevators and escalators that will make up the new stations. They will lay tracks and third rail and install electrical and signal systems and communications equipment. They will build facilities that will allow for ventilation, air temperature moderation and emergency access to these new tunnels. Much work remains to be done."

In order to accommodate the boring of East Side Access' final tunnel, the Long Island Rail Road had temporarily canceled three evening rush hour trains and modified the schedules of an additional eight. Now, crews will begin to secure the machine in place, and trains service was expected to return to normal. ■

"Sixteen brand new, concrete-lined tunnels now exist under New York City where none did five years ago. For about 60 years, two generations, the New York transit system was essentially functioning in a status quo, with little action on expansion to meet the needs of a growing region. Today, we are lengthening a subway line, building the first quarter of what will be a new north-south trunk line running the length of Manhattan and realizing a long-held dream of connecting the Long Island Rail Road to Grand Central Terminal."

MTA Chairman Joseph J. Lhota.

Normet announces new technologies

Normet, known worldwide for high-quality in sprayed concrete robotics, concrete transport and other tunneling and mining equipment, now delivers a Total Solutions Package in North America. With its TAM line of construction chemicals, Normet can provide a complete line of sprayed concrete admixtures utilizing state-of-the-art polymers for optimal performance, improved safety and cost control of in-place sprayed concrete. TAM products have been successfully used in the global market for more than 30 years with a specific focus on technologies used in underground construction applications.

Normet has begun domestic production of its core admixtures for sprayed concrete as well as other technologies. Normet also announced that it will begin production at a new state-of-the-art construction chemical manufacturing facility located in Sturtevant, WI in 2012.

TamShot 90 AF — TamShot 90 AF, a liquid alkali-free set accelerator for sprayed concrete applications, is used in tunneling and mining for rapid early strength development without sacrificing ultimate strength and for long-term durability. TamShot 90 AF meets or exceeds the requirements per ASTM, DIN & EFNARC.

TamCem HCA — TamCem HCA is a liquid hydration control admixture for use in sprayed concrete or cementitious grouts where extended “open time” is necessary. Hydration control allows for long concrete transit times or unforeseen job site delays. TamCem HCA enhances the reaction of set accelerators due to full cement chemistry availability. This, in turn, allows for lower overall accelerator consumption. TamCem HCA meets or exceeds the requirements per ASTM C 494 Type B & D and EN 934-2 & EN 934-5.

TamCem 53 & 60 — This new generation of high-range water reducers contain state-of-the-art polycarboxylate ether polymers that are specifically formulated to provide exceptionally high water reduction with enhanced workability and superior slump retention. TamCem 53 & TamCem 60 met the requirements of ASTM Type A & F as well as EN 934-2. In addition to excellent performance in sprayed concrete, TamCem 53 and TamCem 60 also perform extremely well in the manufacturing of precast elements. ■

Mott MacDonald lands large contract

Abu Dhabi Sewerage Services Co. (ADSSC) announced that it has appointed Mott MacDonald to provide contract administration and site overview services for the development of one of the world's largest underground pumping stations.

Located in Abu Dhabi, United Arab Emirates, the pumping station will be more than 100 m (328 ft) deep and approximately 40 m (131 ft) in diameter and will have an ultimate peak pumping capacity of approximately 3.3 million m^3/day.

ADSSC is the service provider for sewerage services and currently owns and operates the sewerage network and treatment plants throughout the Emirate of Abu Dhabi. To address projected growth within the Emirate, ADSSC has developed a comprehensive plan to increase system capacity. The cornerstone of this plan is the Strategic Tunnel Enhancement Programme (STEP), *AMEinfo.com* reported.

The focus of STEP is a deep 41-km (134-ft) long tunnel sewer and several systems of link sewers that will collect and transport wastewater to a main pumping station for onward treatment at the Al Wathba Independent Sewage Treatment Plants (ISPTs). The link sewers will intercept the flows from existing gravity sewers upstream of the existing pumping stations, both on Abu Dhabi Island and the mainland. These flows will be channeled by gravity into the deep tunnel. At the downstream end of the deep tunnel, in the AI Wathba area, an underground pumping station will be built to lift the sewage to the surface, and into newly constructed ISTPs.

Peter Hall, Mott MacDonald's project director, said, "The UAE is the third largest consumer of water in the world after Canada and the USA. There is a daily water consumption rate of nearly 550 L (145 gal) per person in a region that receives less than 1 cm of rain per year. Therefore, management and reuse of wastewater is a critical component to Abu Dhabi's long-term sustainability."

The project is due for completion toward the middle of 2015. ■

FEATURE ARTICLE

North American Tunneling Conference drives value

The theme of the 2012 North American Tunneling conference (NAT) was "Tunneling: Driving Value." This theme best reflects where the tunneling and underground construction industry is today. Major advances that have been made in technologies have provided tremendous improvements in productivity, which, in turn, have allowed the industry to deliver more cost-effective and less disruptive solutions to the nation's infrastructure needs.

Despite a weak economy, domestically and globally, cities and states continue to spend billions on infrastructure improvements. For the underground construction industry, that means more transportation and water, wastewater, storm water projects and other underground structures. And, for each project completed, underground construction and tunneling technology grows.

The NAT conference, put on by the Underground Construction Association (UCA) of SME, provides an outlet for technology transfers among professionals. This year's conference, held in Indianapolis, IN June 24-27, attracted 918 attendees, up from 803 at the last NAT in 2010. The accompanying exhibit also featured 116 exhibitors occupying 140 booths. That was up from 108 booths in 2010. So, the meeting continues to grow as underground construction professionals throughout the world seek to learn from their peers.

Technical programming

The technical program at the NAT included more than 100 presentations in 20 sessions. Each paid attendee received the proceedings of the conference. The book is available from SME. Contact SME Customer Service, 12999 East Adam Aircraft Circle, Englewood, CO 80112 USA, phone 800-763-3132, 303-948-4200, e-mail cs@smenet.org, www.smenet.org; $139 SME member/student member, $189 nonmember.

Steve Kral,
Editor

The 2012 North American Tunneling conference, in Indianapolis, IN, attracted a record 918 attendees and 116 exhibitors occupying 140 booths, also a conference record.

The following is a sampling of a few of the presentations.

Construction of a TBM launch box in a complex urban environment: Contract C-26002 of the new Second Avenue Subway being constructed by the Metropolitan Transportation Authority in New York City was awarded to the S3 JV (Skanska, Schiavone and Shea) in March 2007. The contract includes the construction of two tunnel boring machine (TBM) tunnels, two construction shafts and a TBM launch box.

The construction of the TBM launch box is the subject. The geology of the site is a complex mixture of fill, glacial nonplastic silts and fine sand, glacial till and Manhattan Formation schists and gneisses. The strike of the rock is northeast and it dips steeply to the east.

The launch box was constructed between East 91st Street and East 95th Streets on Second Avenue. It is a 16.8-m (55-ft) to 19.8-m (65-ft) deep decked cut-and-cover structure. The decked roadway is one of the heaviest trafficked commercial roadways in New York City, requiring the decking to be installed in two stages. The northern part of the launch box is entirely in soil, and the excavation is supported by a permanent slurry wall. The top of bedrock rises to the south.

At about the midpoint of the launch box, the support of excavation system (SOE) changes to a temporary secant wall. The buildings along the route are primarily residential, with sidewalk level commercial occupancy. The buildings range from a few new high-rise apartment buildings supported on pile or caissons to numerous four- and five-story fragile 100-year-old unreinforced masonry structures supported on shallow spread footing. The sensitivity of these fragile older structures required the ground water level to be maintained outside the SOE and the SOE wall deformations to be minimized. This paper discusses the critical geotechnical design considerations, construction constraints, building movements and other challenges of the construction of the launch box.

Modern techniques in tunnel ventilation design: The ventilation systems used in tunnels greatly influence important parameters of the overall tunnel design. The earlier the aerodynamic concept and emergency response is taken into account, the more efficient and cost-effective the overall tunnel design will be with regard to safety engineering and electromechanical equipment.

It is shown how conventional methods of ventilation design can be combined with state-of-the-art analysis tools that are not yet common practice in the design process. One-dimensional computational fluid dynamics (CFD) calculations are adopted to simulate ventilation in case of fire and to analyze pressure peaks caused by traffic movements. Three-dimensional CFD is used to investigate three-dimensional flow characteristics.

Inspection and rehabilitation of Oregon's transportation tunnels: In the last decade, the Oregon Department of Transportation (ODOT) implemented systematic condition assessment programs of nine highway tunnels and 24 short-line railroad tunnels. The construction of the tunnels generally dates back to the turn of the last century. Periodic assessments of the highway tunnels during the last 11 years have been used to prioritize budgets and resulted in the rehabilitation of selected tunnels.

The assessment and condition rating of the railroad tunnels included probable construction costs to repair each tunnel. Typically, no construction records are available and bedrock exposures are sparse for the assessment of tunnel conditions. A range of exploration techniques were used to reveal ground and liner conditions and to develop rehabilitation approaches, primarily involving rock dowels, lattice girders, steel ribs and steel-fiber-reinforced concrete.

Design of the SR 99 bored tunnel in Seattle, WA: Upon completion in 2015, the SR 99 Tunnel in Seattle will be the world's largest bored tunnel in diameter. The tunnel has an outer diameter of 17 m (56 ft) and will be constructed with a 17.5-m- (57.4-ft-) diameter TBM. Under a design-build contract, the designer addressed technical requirements for anticipated service load conditions and dual-level seismic design criteria. This paper presents the salient steps in the design of the tunnel and highlights the approaches taken to meet significant design challenges. Emphasis is given to the state-of-the-art seismic analysis and design methodologies.

Reef mining using tunnel boring machines in Nye, MT: The application of TBMs for reef mining is a unique practice with benefits over current mining methods such as conventional drill-and-blast. The Stillwater Mining Co. of Nye, MT operates two platinum group metals mines. The operation is currently using one open-type TBM and is planning to use a second 5.5-m (18-ft-) diameter machine for further mine development. The latest 7.1-km (4.4-mile) bored tunnel will be routed parallel to the ore deposit in competent mafic norite rock, and will be used for the life of the mine operation.

This paper highlights the application and benefits of TBM usage for reef mining, with detailed descriptions from the mine site.

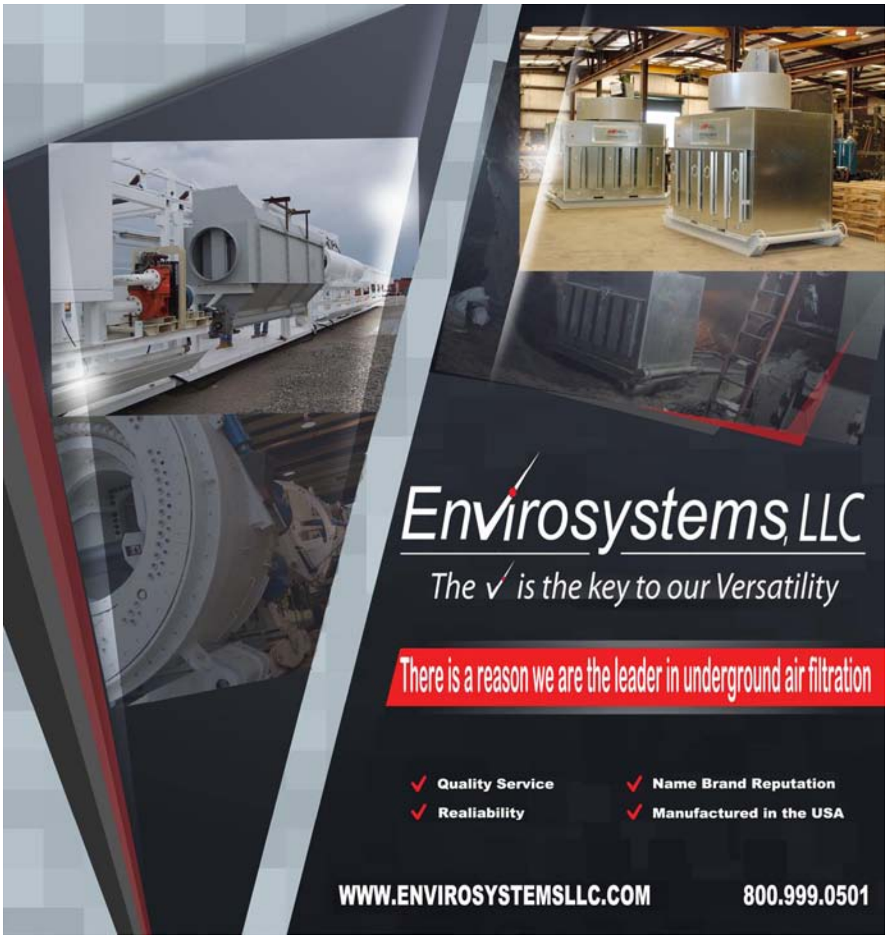
Real-time tunnel boring machine monitoring: State-of-the-art review: The development and affordability of sensing and computation technologies have led to significant advances in real-time monitoring and automation in manufacturing, machinery and construction. The complexity and low tolerance for error in urban underground environments makes tunneling an ideal operation for real-time monitoring. This paper chronicles the monitoring advances implemented into TBMs and their operations in the recent past.

The modern TBM is a well-instrumented machine capable of recording large sets of operational data. The number of recorded parameters often range in the hundreds and span from the cutterhead to the tail of the TBM. Operational parameters measured on a continuous basis include torque of the cutterhead, axial force and displacement in each thrust jack, cutterhead rpm and face pressure (in soft ground TBMs). This data is typically collected with the machine's central control system, e.g., programmable logic controller.

The paper focuses on more recent advances, including TBM-integrated techniques, to image ahead of the tunnel face, cutterhead monitoring, TBM performance parameter sensing and grouting. For each of these areas, the authors describe the monitoring approach, characterize the key parameters monitored and provide sample data sets where appropriate.

Indianapolis deep rock-pump station cavern: This paper presents the final design of a deep rock conveyance and storage tunnel and pump station cavern that will be built about 70 m (230 ft) below ground surface for Indianapolis. The TBM tunnel will run nearly 13 km (8 miles) in limestone with a finished inside diameter of 5.5 m (18 ft). It provides a minimum storage volume of 54 million gallons of untreated excess wet weather overflow.

A pump station is planned for dewatering of the tunnel and discharging the CSO flow to a surface advanced wastewater treatment facility with a firm capacity of 90 million gal/day. The pumps will be located below the invert of the tunnel within a 18-m-wide and 24-m-high (60-ft- wide and 80-ft-high) mined rock cavern. The project also has several deep shafts including the TBM launch/screen, and grit and retrieval shafts, the pump room cavern access/discharge and equipment shafts with inside diameters ranging from 4.8 to 13.4 m (16 to 44 ft).



Cooks Lane Tunnel — selection of tunnel alignment and construction approach (Baltimore Red Line, Maryland Transit Administration): The Cooks Lane Tunnel (CLT) is the shorter of the two tunnel segments of the proposed 22.5-km- (14-mile-) long Maryland Transit Administration's Light Rail Transit (LRT) Red Line now entering preliminary engineering. The CLT segment will connect the proposed at-grade LRT service located alongside Interstate 70 with at-grade LRT service along Edmondson Avenue.

The alignment profile will traverse through full face sound rock, mixed face and soft ground tunneling conditions with rock quality ranging from very poor to excellent. The tunnel will be constructed using retained cut and cut-and-cover sections at the two portals, and a ±1,463 m (4,800 ft) mined/bored section in between. This paper outlines the early stages of preliminary engineering efforts for the tunnel alignment evaluation the evaluation of Sequential Excavation and TBM methods of construction for the mined/bored section.

"Boring" Old Charleston — Tunneling and trenchless technology key to Charleston's infrastructure: How do you replace aging infrastructure in a community surrounded by historic structures and narrow streets already riddled with utilities? You turn to tunneling and other trenchless methods, as Charleston, SC has done for decades. These innovative approaches have helped the Charleston Water System and the city of Charleston solve some of their most daunting wastewater, water and stormwater problems.

Advances in technology and proper management of risks have led to a recent boom in underground construction across the nation. Many utility owners are realizing they have an expanding arsenal of options at their disposal. This paper provides a broad overview and application of various tunneling and trenchless technologies that are currently available and how they can be applied. In addition, it highlights several case studies in Charleston, discussing how this technology has been applied locally and helped the Charleston Water System and the city of Charleston address some of their most difficult infrastructure challenges.

A contractor's guide to Washington, D.C., metropolitan area geology: With the start of the Metro system construction in 1969, the Washington Metropolitan Area Transit Authority (WMATA), in conjunction with its general soils consultant, developed a soils classification system. This system has become a de facto standard for all WMATA construction contracts. Other local geotechnical practitioners have adopted this system, sometimes with slight modification, to suit particular site conditions.

The WMATA (and subsequent) classification systems identify materials using stratigraphic and laboratory properties. Missing from the soil classification system is a description of lessons learned from ground conditions while tunneling. Each soil category contains engineering characteristics used for design and anticipated ground support. Typically, classification systems identify material types and accompanying site-specific geotechnical reports attempt to identify potential ground behavior problems regarding ground support installation. This paper reviews the WMATA Washington D.C.-area soil classification systems for Coastal Plain sediments and develops a soil behavior-based construction guide for area soils.

UCA of SME awards

Three underground con-

Jamal Rostami, right, presents Edward Cording the UCA of SME's Outstanding Educator of the Year award.

David Klug, right, presents the award for Outstanding Individual to James Marquardt.

struction professionals were the recipients of the 2012 UCA of SME awards. Edward Cording, of the University of Illinois-Champaign, received the Outstanding Educator of the Year award during the UCA banquet. Richard Lovat, chair of Lovat Inc., received the Lifetime Achievement award. James M. Marquardt, of J.F. Shea Construction, received UCA's Outstanding Individual award. Biographies of each award recipient can be found in the June 2012 issue of T&UC on pages 34-35. In addition, the UCA Project of the Year award was given to the East Side Combined Sewer Overflow tunnel project in New York.

Also during the NAT, the winners of the Student Poster Contest gave their presentations during the UCA of SME/ITA breakfast. Ebrahim Frrokh, of The Pennsylvania State University, presented "TBM Downtime Analysis." Ehsan Alavi, of Penn State, presented "Cutterhead Wear Study for EPB TBMs in Glacial Soils." And Mahdi Heidari Moghadam, of the University of Texas, won for his paper "Convergence Curve for Tunnels with Hardening Jet Grouting Using Displacement-Controlled Analysis."

Short courses/field trip

Two well-attended short courses were also presented prior to the NAT this year. "Grouting in Underground Construction" presented an overview of the materials, equipment and various grouting methods used in association with underground construction in soils and rock.

"Sequential Excavating Methods in Tunneling" presented an overview of the latest developments in tunnel design and construction by sequential excavations methods.

Participants in the field trip, following the conference, visited Martin Marietta's North Indianapolis underground mine and quarry. In operation since the 1950s, the operation currently produces more than 910 kt/a (1 million stpy) of sand and gravel from an open-pit quarry and an underground mine.

Future meetings

The UCA of SME's annual George A. Fox conference is scheduled for Jan. 22, 2013, at the Graduate Center, City University of New York. And the Rapid Excavation and Tunneling Conference is set for June 23-26, 2013 in Washington, D.C. For more information on both conferences, contact: SME Meetings Department, phone 800-763-3132, 303-948-4200, fax 303-979-3461, e-mail sme@smenet.org, www.smenet.org. ■

FEATURE ARTICLE

Proactive approach to addressing environmental concerns for tunneling under Austin

The Jollyville Transmission Main will be a 10.5-km-(6.5-mile)-long, 213-cm (84-in.) diameter rock tunnel. The tunnel will pass beneath the Balcones Canyonlands Preserve, which was established to protect two endangered bird species, six endangered cave invertebrates and a threatened salamander. To address the sensitive habitat that the transmission main is to pass through, the city of Austin developed an environmental commissioning (EC) process that brought together environmental engineers and scientists, the city's project management team and the designer team to work collaboratively to meet the city's goals of producing a cost-effective design while also protecting the environment. This paper describes the environmental commissioning process and the benefits it brought to the project and environment through some unique environmental mitigation measures to protect this sensitive area.

Ray Brainard, Clay Haynes, Stacie Long and Robyn Smith

Ray Brainard, member UCA of SME, and **Clay Haynes**, member UCA of SME, are geologist and engineer with Black & Veatch and **Stacie Long** and **Robyn Smith** are project engineer and environmental compliance manager with city of Austin, e-mail brainardrc@bv.com.

Background and project description

The 12-month period from October 2010 through October 2011 was the driest year in Texas since 1895, when the state began keeping rainfall records. In the Central Texas area, and in Austin in particular, the situation is no different. The city of Austin is working to provide safe, reliable, high-quality drinking water for the city, with growth projections that predict the population will increase by up to 500,000 people by 2040.

Austin currently has just two operating water treatment plants, Davis, built in 1954, and Ullrich, built in 1969. Together, the Davis and Ullrich plants can handle Austin's current water needs, but there is very little excess capacity at these plants.

A key component of securing the ability to deliver drinking water is the construction of a new water treatment facility in northwest Austin. Water Treatment Plant #4 (WTP4) will draw water from Lake Travis as opposed to the water supply for the existing plants, which is drawn from Lake Austin. The higher elevation of Lake Travis affords the utility the ability to deliver water by gravity as well as electric pumps. This can translate into energy savings of 20,000 MW hours annually, enough to provide electricity to more than 2,000 homes for a year.

WTP4 will consist of a water intake, pump station, pipelines to get water from Lake Travis into the treatment facility and the Jollyville Transmission Main (JTM) to convey water from the treatment plant into the water distribution system. Total project estimated capital cost is $508 million. The JTM is a 10.5-km- (6.5-mile)-long, 213-cm (84-in.) diameter pipeline being constructed at a cost of $90 million.

Unique to the JTM project, the alignment passes through the

Workers put gravel into permeable ring at the Jollyville Transmission Main project.

northern Edwards Aquifer recharge zone, and under the Balcones Canyonlands Preserve (BCP), a 9,700-ha (24,000-acre) nature preserve set aside for native species within suburban Austin, with no public access. While the pipeline will be entirely in a rock tunnel ranging from 30 to 107 m (100 to 350 ft) below the ground surface, the city decided to proactively address the environmentally sensitive nature of the project

Environmental commissioning

Following city council action to fund WTP4, the Austin Water Utility and the Watershed Protection Department (WPD) organized a working group to develop a plan to minimize and mitigate environmental effects of the project and its construction on surrounding natural areas and natural resources. The mitigation work group developed a strategy with three components: environmental goals, monitoring and environmental oversight. The group's efforts were carried forward into an environmental commissioning plan for the JTM.

The EC process, as defined in the EC plan, was developed with an overarching goal of "providing a compliance road map that prioritizes avoiding and minimizing environmental impacts." The intent of the EC plan was to lay out a process whereby environmental goals are established and an ongoing auditing process is then used to help guide the project design team towards obtaining those goals through project planning, design, construction and startup. The EC process occurs throughout the project and involves meetings, reviews, training, oversight inspection, monitoring and other tasks requiring a collaborative effort between the city's project management team, the design team and the EC team.

The environmental goals established for this project present the nature and level of environmental protection beyond typical federal, state and local regulatory requirements that will be targeted. The goals

FIG. 1

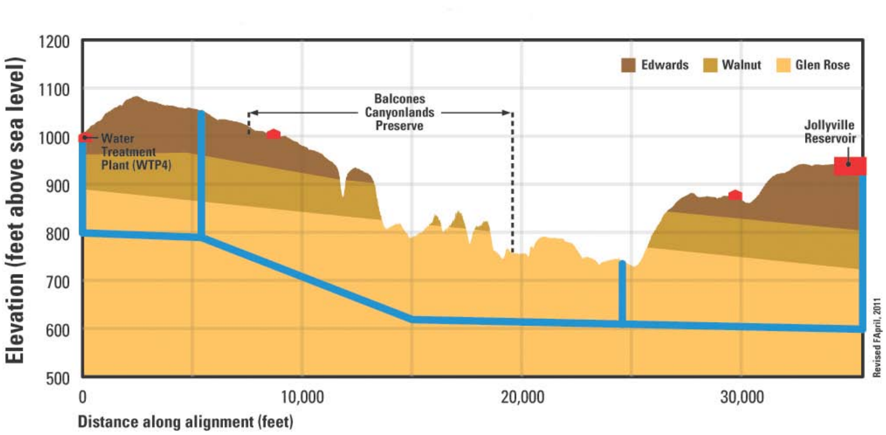
Project plan.

defined in the EC plan include the following:

- Prevent adverse impacts to water quality.
- Maintain existing hydrologic regimes.
- Prevent discharge of pollutants from the sites.
- Meet or exceed the require-

FIG. 2

Jollyville transmission main profile.



ments of the BCP permit.

- Avoid, minimize and mitigate impacts to threatened or endangered species and species of concern.
- Avoid, minimize and mitigate impacts to the Jollyville Plateau Salamander.

These broad goals cover a host of protective measures from storm water runoff to tunnel inflow control.

To accomplish the goals set forth, the city designated an Environmental Commissioning Team from the WPD, which included engineers, hydrogeologists and biologists.

The entities that were responsible for completing this project consisted of the public works staff responsible for completing the project on time and within budget, the environmental commissioning team responsible for meeting the stated environmental goals with no restraints on budget or schedule, and the Black & Veatch design team balancing the goals of both entities to develop both biddable and constructible documents while providing appropriate environmental protections.

Design considerations

Horizontal alignment. The project team performed an extensive evaluation considering a variety of key issues to finalize an acceptable

TABLE 1

Different types of initial ground support for the TBM tunnel.

Support type	Description
Type I	Spot dowels (4-ft long) to support localized ground conditions.
Type II	Two dowels (4-ft long) in the crown every 5 ft with welded wire fabric.
Type III	Two dowels in crown, dowels (4-ft long) at springline with welded wire fabric.
Type IV	Full circumferential steel liner plates and grouted annular space (for water control).

horizontal alignment and determine how best to coordinate activities within the alignment. These issues fell into four primary categories: constructability, environment, community and cost impact to the ratepayers. The goal was to select an acceptable alignment for the JTM project that best balanced these four categories. As the process moved forward, new information became available through public input, additional environmental research and construction review — all of which better guided the decision making process. Input was solicited from citizens, the Austin Water Utility, the BCP secretary and the Construction Manager-at-Risk (MWH Constructors).

After close examination and ranking of each alternative, the highest rated and recommended horizontal alignment (Fig. 1) was presented in the preliminary engineering report. That report also indicated that an all-tunneling alternative was preferred over other alternatives that included a combination of trenching and tunneling construction for the water supply main.

The alignment passes through the BCP (Fig. 2 and the undeveloped land between the Four Points and Spicewood Springs Shafts on Fig. 1) which was established in 1996 to protect the endangered Yellow-Cheeked Warbler, Black-Capped Vireo and six endangered cave invertebrates which include spiders (pseudo-scorpions) and beetles. In addition to these endangered species, there are also 25 cave invertebrates that are "species of concern" that are protected by the Balcones Canyonlands Conservation Permit. The invertebrate species are restricted to Edwards Formation caves (defined as voids with entrances large enough for a human to enter) and mesocavernous voids (not large enough for a human to enter unless modified/enlarged). Additionally, the majority of the alignment is within the Bull Creek watershed, which is the primary locale for the threatened Jollyville Plateau Salamander.

Ground conditions

The JTM project is located along the dissected edge of the Edwards and Jollyville Plateau physiographic provinces of central Texas, situated between the Llano Basin province to the west and the inactive Balcones Fault Zone (BFZ) and escarpment to the east. The Edwards and Jollyville Plateaus represent the upthrown fault block of the BFZ that has been dissected by the Colorado River and its tributaries. Slopes throughout the Edwards Plateau province generally average 5 to 15 percent, with steeper slopes located adjacent to the Colorado River and major tributaries where downcutting through the more resistant geologic formations has occurred.

At a regional level, the sedimentary rock units along the Edwards Plateau generally strike northwest-southwest and dip gently (less than 5°) to the northeast. The two major joint sets in the greater Austin area trend N40° E and N45° W, and two secondary joint sets trend N10° W and N80° E. All of the joint sets have near-vertical dips.

A thin soil veneer, mostly less than 1.5-m (5-ft) thick, covers lower Cretaceous carbonate rocks that are divided into four formations. The geologic formations from youngest to oldest are the Edwards, Comanche Peak, Walnut and Glen Rose and are described below.

The Edwards Formation is present on the highlands on the southwest and northeast ends of the alignment (Fig. 2), reaching a maximum thickness of 33.5 m (110 ft). It is an interbedded sequence of limestone and dolomite. The Edwards is known for its karstic features up to and including caves. Rock Quality Desegnation is lower in the Edwards than the other formations because of the solution voids, with about 40 percent of the core having an RQD less than 75 percent. The majority of the rock is weak to moderately strong, with only about 10 percent having unconfined compressive strength (UCS) more than 4,500 psi.

This formation provides the habitat for the endangered karst invertebrates. Additionally, a majority of the springs that feed Bull Creek and provide the primary habitat for the threatened JPS emanate from the Edwards or at the Edwards/Walnut Formation contact.

The Comanche Peak Formation is present on the highlands on the northeast end of the alignment, reaching a maximum thickness of about 12 m (40 ft). It occurs as a member of the Edwards Formation in this area. The rock consists of interbedded limestone and argillaceous limestone, with limestone beds averaging 1.5 m (5 ft) in thickness, and the argillaceous limestone beds averaging 1 m (3 ft) in thickness. The Comanche Peak apparently pinches out to the southeast, as it is not present in any of the borings or observed in outcrop along the southeast highlands (Fig. 2).

With generally widely spaced joints, more than 90 percent of the rock has RQD values in the good to excellent categories. Rock strength is mostly weak, with more than 90 percent having UCS values of less than 3,500 psi.

The Walnut Formation is present on the highlands on the southwest and northeast ends of the alignment, reaching a maximum thickness of about 33 m (110 ft). The formation consists of a mixture of nodular limestone and argillaceous limestone. With generally widely spaced joints, more than 90 percent of the core has RQD values in the good to excellent categories (>75 percent). Rock strength is mostly weak, with more than 90 percent having UCS values of less than 3,500 psi.

The Glen Rose Formation is present across the length of the alignment, and none of the geotechnical borings penetrated the base of this formation. The Glen Rose, to the depth investigated, consists of interbedded limestone and dolomite, with limestone beds averaging 3 m (10 ft) in thickness and dolomite beds averaging 1.5 m (5 ft) in thickness. More than 90 percent of the core has RQD values in the good to excellent range. Rock strength is mostly categorized as weak, with nearly 95 percent of tests having UCS values less than 3.500 psi.

Two ground water flow regimes are found in the project area: (1) a shallow flow system that occurs in the upper parts of the study area primarily within the Edwards, Walnut and the uppermost Glen Rose formations; and (2) a deep flow system present in the lower Glen Rose Formation.

Precipitation generally enters the Edwards as recharge, where the formation crops out throughout the Edwards Plateau, and moves downward through the Edwards until encountering a less permeable layer. It then moves laterally, primarily discharging as springs and seeps along the hillsides found in the project area. Many of the springs and seeps occur at outcrops of the Edwards, the Edwards/Walnut contact and at Walnut bedding planes. Springs that are present in the upper Glen Rose Formation are also considered to be part of the shallow flow system.

Ground water flow is primarily away from the topographic highs in the shallow flow system. Dye tracing in the Edwards Formation conducted by city of Austin staff indicated estimated ground water flow velocities on the order of tens of feet per day, indicating that flow in this shallow flow system is typical of a karst system.

The second ground water flow regime is the deep flow system within the Glen Rose Formation, which is largely hydrologically disconnected, by either the Walnut Formation or the upper Glen Rose Formation, from the shallow ground water flow system within the Edwards. A downward hydraulic gradient is observed within the deep flow system. Estimated hydraulic conductivities in the Glen Rose are low: the upper 15 m (50 ft) of the Glen Rose appears to be more permeable, but below this zone, the Glen Rose is consistently very tight, often yielding estimated hydraulic conductivities too low to be measured during water pressure tests.

Vertical alignment

Due to the karstic nature and the environmental sensitivity of the Edwards Formation, tunneling in this formation was never considered. Tunneling was considered in the Walnut until it was determined that the argillaceous beds became friable upon wetting and drying. At the 30 percent design level, the tunnel was predominantly in the uppermost Glen Rose Formation. As more investigations were completed, and the ground water assessment was finalized, the vertical alignment was lowered by about 15 m (50 ft) to place it in lower permeability rock and in the lower ground water system to minimize the potential to have any effect on the upper ground water system that supplies the springs creating important JPS habitat.

Ground support

Depending on the ground conditions encountered during excavation, three initial support types, as indicated in Table 1, will be used to support the JTM tunnel. Although the geotechnical data indicates that ground water infiltration will not be high enough to affect the design of the initial support system, a fourth “support” type was specified to control ground water inflows for environmental reasons.

Impacts of environmental commissioning on the project

Communication between the three groups responsible for developing the project was a critical component for its success. The level of communication between the city and design team far surpassed any previous project experience of the participants. Some of the major activities during which communication levels were raised considerably included the following activities.

Several workshops were held to discuss strategies and best management practices for avoidance and mitigation of karst subsurface conditions during shaft construction through the Edwards Formation. This was a twofold issue; one dealing with dry karst features that might provide potential habitat for endangered cave invertebrates, and the other for karst features that might provide ground water flow pathways that feed springs.

Weekly meetings were held to provide updates on the progress of the ground water assessment study being undertaken by the design team. The understanding of the ground water system was a critical environmental concern, and the EC team, through years of studying this system throughout the Austin area, provided valuable insights and direction that led to a more complete understanding.

Daily four-hour-long meetings/workshops were held for a month between the 60 and 90 percent design submittals to discuss possible environmental impacts of the construction and operation of the JTM as the final design became clearer. The discussions were summarized in a document entitled “Jollyville Transmission Main Environmental Commissioning Consensus,” which ultimately became the basis for a specification section covering environmental controls.

Numerous design decisions and design features were influenced or incorporated into the project through the EC process. These included small and large changes, some of which came with a high price tag. The examples described below show the range and scale of inputs into the project. Through the collaborative process, mitigation measures and best management practices were established to meet the EC goals. Some of the results of this process that will affect construction of the JTM include the following:

- Liner plates and annular grout extending through portions of the rock section in the shafts to control ground water inflow. Dewatering could potentially affect down gradient springs, seeps and creeks that provide habitat for the threatened Jollyville Plateau Salamander (JPS).
- Installation of "permeable rings" of gravel in the annular space between the liner plates and shaft walls to keep intact possible ground water pathways that may feed springs, seeps or creeks that provide JPS habitat.
- Shotcrete application on the liner plates for corrosion protection to reduce the possibility of developing vertical flow pathways in the long term. This could potentially change the natural flow patterns and affect down gradient springs, seeps and creeks that provide JPS habitat.
- Pre-excavation grouting at one of the shaft sites to protect nearby seeps and a creek.
- Avoiding the potential for exfiltration of nitrates during drill-and-blast operations at the shafts by requiring that muck is removed in a continuous manner after a blast, that water infiltration into the shaft be pumped out continuously and that a cover be placed over the shaft during rain events if muck is still in the shaft. Nitrates entering the ground water may negatively affect the JPS.
- Inflow "triggers" in the tunnel that if reached, will prompt the installation of liner plates and annular grout to reduce flows to acceptable levels. Excessive dewatering of the rock surrounding the tunnel may affect overlying springs, seeps and creeks that provide JPS habitat.
- The lowering of the vertical alignment of the tunnel to the lower ground water system and to avoid areas of higher equivalent hydraulic conductivity observed during the investigation. This was done to minimize the chance of affecting the overlying springs, seeps and creeks.
- Only Lake Austin water was permitted as a drilling fluid for investigation boreholes due to possible chlorine contamination of springs from drinking water sources. Also, casing was advanced through the Edwards Formation to prevent drilling water from flooding potential karst invertebrate habitat.
- Shaft locations were modified to keep them as far as practical from springs.
- Void mitigation measures were included in the design drawings to isolate and seal off any karstic voids encountered during excavation to minimize effects to cave invertebrates and protect habitat.
- An environmental compliance manager from the city is on site full time during construction to make regular inspections of the environmental aspects of the project.
- Construction workers are trained by the environmental compliance manager to follow the project environmental protocols.
- No site clearing is permitted during nesting season of the two endangered songbirds.

Completed tunnel excavation in Reach 1 of the Jollyville Transmission Main project, where no measureable water inflow was encountered in 1,300 m (4,400 ft) of tunnel.

Conclusions

The environmental commissioning process was a learning experience for all involved. Much of the process involved educating others. The design team held workshops to inform the EC team about the methods of tunneling, the various means available to prevent possible environmental degradation and the realities of construction. The EC team educated the design team about the fragility of the habitat so essential for the threatened and endangered species. The collaborative effort to learn and understand the concerns of each point of view ultimately made the project better, and with a set of contract documents that the entire team was comfortable would provide the appropriate controls to protect the environment. ■

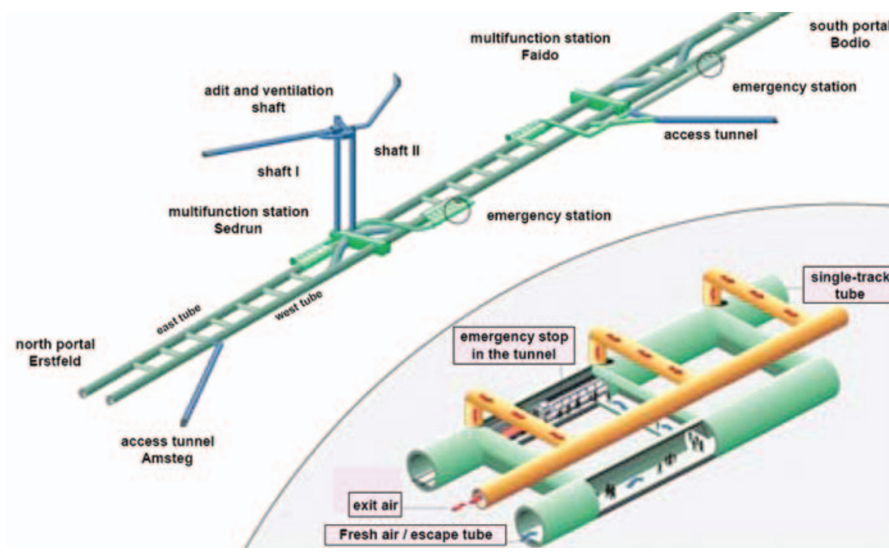
FEATURE ARTICLE

Design and construction challenges of hard rock TBMs at the Gotthard Base Tunnel

The Gotthard Base Tunnel (GBT) is 57 km (35 miles) long and consists of two parallel single-track tubes with an excavation diameter ranging from 8.8 to 9.5 m (28.8 to 31.2 ft). These are interlinked by cross-passages every 312 m (1,000 ft). Two multifunction stations (MFS) are located in the sections Sedrun and Faido, at one-third and two-thirds of the entire tunnel length (Fig. 1). These will be used for the diversion of trains to the other main tube via tunnel crossovers, for the housing of technical infrastructure and equipment and for potential emergency stops.

FIG. 1

Gotthard Base tunnel, tunnel system and emergency stop.



To reduce construction time, the GBT was divided into five sections and was excavated from several sites simultaneously. The tunnel was excavated from the two portals, Erstfeld in the north and Bodio in the south, and also from three intermediate attacks, with their corresponding access tunnels, in Amsteg and Faido and two vertical 800-m (2,624-ft) deep shafts in Sedrun.

The entire underground system comprises a total of 151.8 km (94.3 miles) of galleries and tunnels, of which 66.3 km (41.2 miles), or 43.7 percent, have been excavated by tunnel boring machines (TBM), and 85.5 km (53.1 miles), or 56.3 percent, by drill-and-blast methods.

Michael Rehbock-Sander and Yves Boissonnas

Michael Rehbock-Sander, member UCA of SME, is mining engineer, Amberg Engineering, Ltd., Regensdorf-Watt, Switzerland, **Yves Boissonnas** is civil engineer, Amberg Engineering, Ltd., Regensdorf-Watt, Switzerland, e-mail agerdes@amberg.ch; yboissonnas@amberg.ch.

Geological conditions

From north to south, the tunnel passes through mostly crystalline rock sections, including the Aare massif to the north, the Gotthard massif and the Pennine gneiss zone to the south. The massifs mainly consist of high-strength igneous and metamorphic rock and are intersected by narrow sedimentary tectonic zones. The main geological risks predicted was rock bursts, rock wedge instabilities and squeezing rock. A great part of the tunnel is situated underneath a considerably high overburden: more than 1,000 m (3,280 ft) of overburden over a distance of approximately 30 km (18.6 miles) of the tunnel, more than 1,500 m (4,900 ft) over 20 km (12 miles) and more than 2,000 m (6,500 ft) over approximately 5 km (3.1 miles). The Faido-Sedrun section is reporting the maximum overburden of about 2,400 m (7,900 st) (Fig. 2).

Historic breakthrough

On Oct.15, 2010, the excavation of the longest railway tunnel in the world was completed. After this final breakthrough between the Faido and the Sedrun section, the connection between the North portal in Erstfeld and the South portal in Bodio was established. At about 2 p.m. local time, the TBM in the eastern tube excavated the last meter and broke through into the 'dismantling cavern' on the Sedrun side (Fig. 3).

This cavern was constructed to allow for a subsequent dismantling of the 450-m- (1,476-ft-) long TBM. With a minor deviation of only 8 cm (3 in.) in horizontal and 1 cm (0.4 in.) in vertical direction, this tunnel breakthrough was extremely precise.

Five months later, on March 23, 2011, the second TBM in the western tube reached the section boundary and broke through. This second breakthrough also marked the end of the essential part of the excavation works on this monumental structure.

Preparation of the excavation works

General. This article discusses the experiences gained during the TBM excavation of the main tunnel tubes in the two southern sections, Bodio and Faido, a total of almost 60 km (37 miles) of TBM-driven tunnel.

The two open hard rock gripper TBMs with a diameter of 8.8 m (28.8 ft) were launched in Bodio in November 2002 (eastern tube) and in February 2003 (western tube), respectively. After having excavated 16 km (10 miles) each, they arrived in Faido in autumn 2006, where they were partially dismantled, overhauled and reassembled with an increased diameter of 9.4 m (31 ft) that could be enlarged by shifting up to 9.5 m (31.2 ft). This was necessary because of the expected geological conditions in the 11 km (6.8 miles) of excavation yet to come in the Faido section (Fig. 4).

The excavation works in northern direction were relaunched in July 2007 in the eastern tube and in October 2007 in the western tube.

The following section will be on the most demanding 11 km (6.8 miles) of excavation from Faido toward the final breakthrough in Sedrun.

Technical reports

The TBM drives for the Faido section were extensively prepared in advance. Maximum effort was taken to ensure a safe and efficient operation. Based on geological investigation reports compiled in the 1990s, multiple technical reports were prepared and developed. They contained the following elements:

- Structural safety verifications for the TBM headings.
- Guidelines for rock support types during TBM excavation.
- Instructions for the determination of the rock support to be used.
- Rock-mechanical measurement.
- An investigation strategy for the TBM excavation.

FIG. 2

Gotthard Base Tunnel, geological longitundinal profile.

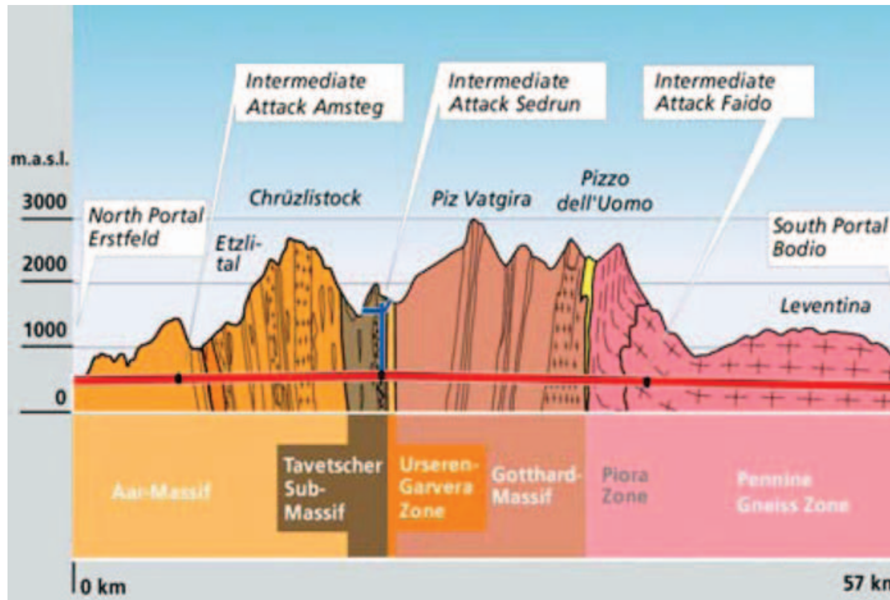


FIG. 3

Breakthrough Faido-Sedrun, Oct. 15. 2010.

An action plan for expected and unexpected problems was produced to reduce the response time in case of complications.

Throughout the entire excavation process, the plans for the advance control, containing all information available on subjects like deformations, geology, water inflow, rock support or advance rates, were updated on a regular basis to allow for a fast collection of the information needed in case of problems.

Action plans

An important part of the preparation was the detailed development of an action plan that was aimed at the prevention of unforeseen events as well as at the reduction of the response time after such an occurrence. This action plan was divided into two sections. The first section displayed the derivation of the event scenarios from the project-related risk analysis. The second part provided a detailed description of the appropriate measures to keep them under control. For instance, if the risk identified in the risk analysis indicated "geological conditions worse than predicted," one of the corresponding scenarios was "larger deformation than allowed in the standard cross-section." For this scenario, measures ranging from a reduction of the planned construction tolerance to a reprofiling of the deformed tunnel section were determined in the second part of the action plan.

The general concept of the action plans can be described as follows:

1. Analysis of the rock conditions and determination of possible hazards related to the TBM drives.
2. Assessment of the risks related to the TBM drives and definition of event scenarios.

FIG. 5

Preventer-protected drilling in the east tube in the zone of the Piora Syncline.

FIG. 4

TBM transport through multifunction station.

3. Evaluation and proposal of suitable measures:
   - Measures to detect events early.
   - Measures to minimize effects of events.
   - Measures to master events safely and economically.

Investigation during TBM advance

During the excavation, there is always a remaining degree of uncertainty in relation to the ground ahead of the face. The costs and overall feasibility of a project are dominated by the geology in place. Therefore, an understanding of the regional geology and hydrogeology is essential.

The aim of the investigations performed during the TBM drive is a safe and undisturbed excavation of the tunnels. The investigation measures shall provide early information about fault zones and water in front of the tunnel face to allow for a preparation of appropriate measures in due time. In particular, jamming of the TBM and uncontrolled inrush of water must be prevented by all means. Due to the high overburden, water pressures of up to 200 bars and temperatures of 48° C (118° F) are possible.

The investigation measures were primarily geared to the exploration of the rock mass and its properties (geology, tectonics, petrography, fault zones and water inrush). Geophysical methods (TSP), percussive drillings and temperature measurements were mainly used over the entire length of each single-track tube. In case of unclear results, additional percussive drillings or core drillings were performed.

In case of potential high water pressures, preventer-protected drillings were implemented (Fig. 5).

Challenges during the excavation

Deformation and reprofiling measures in the west and east tubes. The main hazards in this project were defined as a jamming and/or blocking of the TBM and/

FIG. 6

Deformed steel arch - east tube.

or the backup installations, failure of rock support and undersized remaining cross-section due to insufficient deformation space.

The drive of the east tube was started with a relatively rigid rock support. After some meters though, the rock support was damaged (deformed steel arches, shotcrete failure, Fig. 6) due to deformation. The TBM had entered an unexpected 200-m- (656-ft-) long zone of squeezing rock.

This led to an adaptation of the rock support. A heavy but flexible support type, consisting of yielding steel arches with friction clutches, steel anchors and shotcrete with longitudinal convergence slots (with styrofoam inserts), was chosen and successfully applied. This rock support type was assuring an advance rate high enough to prevent blocking of the cutterhead (Fig. 7).

The west tube TBM was started in October 2007. In December 2007, the first cracks developed in the rigidified shotcrete of the eastern tube on the level of the western TBM, about 600 m (1,968 ft) behind the face. The subsequent drive led to a failure of the rock support in the eastern tube as well as the western tube on a length of several hundred meters.

In the eastern tube, the vaults were demolished as were the pre-cast concrete blocks of the invert that were heaved and torn. The transport logistics for the eastern advance could be maintained, as the invert was stable. A speed reduction was necessary for the trains upon the deformed tracks.

In the western tube, the situation was more critical. The backup installations were in danger of jamming due to the deformation and the invert was demolished.

To assure the trailing of the backup installation, the shotcrete had to be removed by a cutting hammer in overly tight conditions in some places.

In these difficult working conditions, the advance rates decreased to a minimum of 1 m/d (3.2 ft/day). The average advance rate slowed down to 3-5 m/d (9.8-16 ft/day) instead of the previous 11 m/d (36 ft/day). Minor

All the challenges, mainly caused by unpredictable geological conditions, could be handled and managed thanks to the extensive preparation of the TBM drives and the careful implementation of all necessary measures. The consistent risk management of Alptransit Gotthard Ltd. has taken account of all possible risks. Based on this risk analysis, the measures and actions to control these risks were prepared in the action plan.

advance rates also increased the risk of a blocking of the TBM cutterhead due to deformations. Maintenance time was thus optimized to maximize the excavation time.

In order to explain these processes, extensive numerical calculations and back analyses were done. The calculation results revealed that the geological conditions were worse than originally predicted. In addition, the transition zone between an unfavorable flat rock layer and steeper layers of Lucomagno gneisses (the Chièra syncline) was located in a zone about 500 m (1,640 ft) farther north with a higher overburden. Thus, higher rock pressure had to be borne by a weaker rock than predicted. Due to the difficult geological conditions, the tunnel tubes were interacting, against all expectations. The excavation works in the tubes were influencing one another.

As the damages to the excavation support and the already cast invert had developed beyond an acceptable threshold, and since the profile was undersized due to deformation along a considerable distance of the tunnel, a section of approximately 200 m (656 ft) in both tubes was subjected to remedial measures.

As a consequence, a detailed action plan was developed as a guideline for the reprofiling works in the tunnel tubes. Different phases and renovation levels were defined for vault and invert, whereby the major distinction was made between a partial or a total renovation and a reinforced or a nonreinforced lining.

Diagonal cross-passages were excavated to provide access for train logistics through one tunnel, while the

FIG. 7

Longitudinal convergence slot with styrofoam insert.

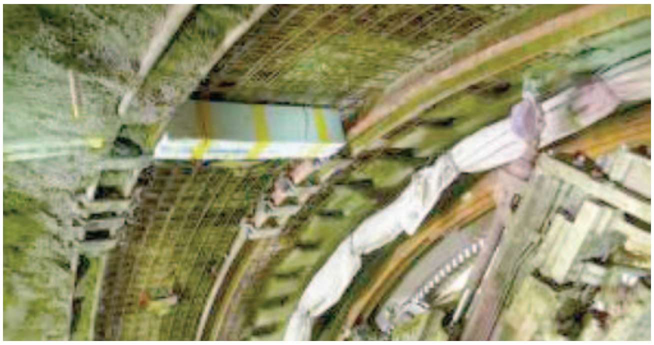


FIG. 8

Standstill of the west tube TBM

second tunnel was being repaired. This allowed for a total closure of the tunnel under renovation and a more effective working process.

The tunnel was enlarged in places, where the displacements had produced unacceptable underprofile, and the support was reinforced. Furthermore, the deformed invert was replaced.

In the eastern tube, the renovation works started in March 2009 and were finished in September of the same year. The works in the western tube began at the end of September 2009 and were completed in June 2010.

Cave-in in the west tube

During the night from March 3-4, 2010, the TBM in the western tube entered a steep fault zone (thickness 6 m or 19.6 ft) consisting of kakirite, cataclasite and broken rock of the Tenelin zone, when an unexpected cave-in occurred in front of the cutterhead. The mucking train was filled after 80 cm (31 in.) already instead of the normal 2 m (6.5 ft) of excavation.

The eastern tube TBM had passed through the Tenelin zone a few months earlier without any major problems.

The first measures taken were a change in the rock support and the installation of steel arches and shotcrete. It was carefully tried in order to continue the drive. The zone was dry and the rock conditions on the last meters excavated were stable. There was no pressure on the shield and no rock burst phenomena were observed.

During the attempt to continue with the excavation works, the TBM conveyed some hundred cubic meters of muck, but did not make any advance. The cohesionless cave-in material was filling the entire cutterhead and the drive came to a standstill (Fig. 8). The cutterhead was filled with loose material.

The working group "TBM" met on March 5, 2010, to examine the cave-in and to decide on the measures to be taken. An investigation drilling program was undertaken to explore the geometry of the fault and of the developed cavity. About 1,300 m (4,265 ft) investigation drillings were executed in the following days. Furthermore, a shield of spiles (several layers with a total length of 1,100 m or 3,600 ft) and 55 m^3 (1,940 cu ft) of concrete seal above the spiles were applied. Perforated spiles were used for the injection of mortar grout (in total 39 m^3 or 1,376 cu ft) to stabilize the loose ground.

Once the measures were taken, a new attempt was made on March 12-13, 2010 to enter the cave-in area and to drive through it, which was not successful. A large amount of loose material was conveyed again, but the TBM could not advance. The driving was finally stopped. A second investigation drilling program was undertaken. The cavity was larger than originally expected. The volume amounted to about 2.700 m^3 (95,350 cu ft) and a height of up to 40 m (131 ft).

The working group "TBM" decided to implement grout injections from a niche to solidify the loose ground in the east tube and to drive a counterattack. All these necessary measures were mentioned in the action plan. As a consequence, this preliminary preparation allowed for a short response time. The use of spiles, the cross-section of the counterattack as well as the rock support needed, the members of the working group "grouting," the required size of the grouting niche, the grouting equipment, including on-site tests, and the ecological compatibility of the grout material had been described in detail in advance.

FIG. 9

Successful restart of the west tube TBM.

The grouting works, using 3,500 m (11,500 ft) of drilling, 103 m^3 (3,637 cu ft) gel injections and 120 m^3 (4,285 cu ft) (corresponding to 70 t or 77 st) of cement grout, began with the excavation of the niche in the east tube in March 2010 and were successfully completed in June 2010. The excavation of the gallery for the counterattack had reached the blocked TBM in the west tube by July 2010. The TBM could be freed and the drive was restarted two days later (Fig. 9). By the end of July 2010, the TBM had passed the zone. The measures to free the west tube TBM needed a total of about 20 weeks' time.

Water inrush at the east tube

The TBM in the eastern tube was faced with large quantities of inflowing water at the beginning of June 2010, while the western tube was blocked in the cave-in. The inflow of water amounted to a maximum of 92 L/s (24 gpm) (Fig. 10).

Thanks to the investigations, the problem had been detected before the TBM entered the zone. The results of the investigations (percussive drilling, temperature measurements) were indicating an aquiferous zone at about 80 m (262 ft) in advance. The TBM was stopped 20 m (65 ft) ahead of this zone and drainage borings (according to the action plan) were executed. Once the drainage measures had been taken, the excavation works continued.

At an overburden of more than 2,000 m (6,500 ft), water pressures can reach up to 200 bars. Therefore, the drainage of the zone is of utmost importance. The TBM drive should not approach water under high pressure, as this could result in a burst of the rock between the water-bearing zone and the tunnel face. Therefore, the reduction of water pressure by means of drainage drills becomes an important safety factor.

The water temperature was of about 48° C (118° F). A major task in this context was to control the climate and to cool the temperature on the working sites to the required maximum of 28° C (82° F) dry temperature. These conditions were difficult for the workers. Appropriate measures had to be taken to guarantee an evacuation and diversion of the water to the portal as well as a cooling of this same before it was fed into the local river.

Conclusion

All of the challenges, mainly caused by unpredictable geological conditions, could be handled and managed thanks to the extensive preparation of the TBM drives and the careful implementation of all necessary measures. The consistent risk management of Alptransit Gotthard Ltd. has taken into account of all possible risks. Based on this risk analysis, the measures and actions to control these risks were prepared in the action plan.

The experience gained during the TBM drives between Faido and Sedrun has shown that these decisions were appropriate. This successful completion was only possible due to the good cooperation between Alptransit Gotthard Ltd., the contractor, the joint venture Gotthard Base Tunnel South (IG GBTS) and all other experts and professionals involved.

FIG. 10

Inrush of water at the east tube.

The TBMs from Herrenknecht, which were employed in this project, have fully proven to be the right choice, both on the part of the owners engineer and the contractor. The contractor, Alptransit Gotthard Ltd., and the engineering joint-venture, IG GBTS, were able to jointly manage even extremely difficult ground conditions with these TBMs in a relatively short time and with reasonable additional effort. The decision to excavate the multifunction station by conventional methods (and to pull the TBMs through the MFS over a distance of 2.5 km (1.5 miles) has also proven right, as the convergence occurring in this area would have exceeded the possibilities of a TBM advance or led to huge additional expenses.

Thus, TBM advance rates were achieved, which could not have been reached by using conventional tunnelling methods. For the financial arrangements regarding fault zones, amicable solutions could be found. In the end, it can be stated that, for the 57-km- (35-miles-) long GBT project, the tunnel meters excavated by TBM were much cheaper than, meters excavated by conventional method, would have been.

Furthermore, it would be advisable for future tunnel projects with similar logistical interdependencies and the possibility of unexpectedly severe deformations (or invert heaving, for example) to reflect upon a "pre-emptive" inclusion of site-logistical transverse galleries, as a "completion-date-observing provision," already at the project planning stage.

The authors thank Alptransit Gotthard Ltd. for the opportunity to publish this report. The authors also thank our joint venture partners Pöyry Infra AG and Lombardi and the construction consortium TAT (Implenia Bau AG, Hochtief AG, Alpine Bau GmbH, Impregilo SpA, CSC) responsible for the two southern sections Faido and Bodio for the good collaboration and supporting in the preparation of this paper. ■

TUNNEL NAME	OWNER	LOCATION	STATE	TUNNEL USE	LENGTH (FEET)	WIDTH (FEET)	BID YEAR	STATUS
Gateway Tunnel project	Amtrak	Newark	NJ	Subway	14,600	24.5	2015	Under study
2nd Ave. Phase 2-4	NYC-MTA	New York	NY	Subway	105,600	20	2015-20	Under study
Water Tunnel #3 bypass tunnel	NYC-DEP	New York	NY	Water	20,000	22	2015	Under design
Water Tunnel #3 Stage 3 Kensico	NYC-DEP	New York	NY	Water	84,000	20	2017	Under design
Cross Harbor Freight Tunnel	NYC Reg. Develop. Authority	New York	NY	Highway	25,000	30	2016	Under study
Silver Line Extension	Boston Transit Authority	Boston	MA	Subway	8,400	22	2014	Under design
Hartford CSO program	MDC	Hartford	CT	CSO	32,000	20	2013	Under design
South Conveyance Tunnel	City of Hartford	Hartford	CT	CSO	16,000	26	2014	Under design
Red Line Tunnel - Phase 1	Baltimore DOT	Baltimore	MD	Subway	9,600	23	2015	Under design
Red Line Tunnel - Phase 2	Baltimore DOT	Baltimore	MD	Subway	32,000	23	2015	Under design
WASA CSO Program Anacostia River Tunnel Northeast Branch Tunnel Northeast Boundry Tunnel Virginia Ave. Tunnel Expan. Dulles Silver Line Phase 2	DC Water and Sewer Authority CSX Railroad WMATA	Washington	DC	CSO CSO CSO Rail Subway	12,500 11,300 17,500 4,000 Various	23 15 23 40 20	2013 2018 2021 2013 2014	Under design Under design Under design Under design Under study
ISCS Dekalb Tunnel	Dekalb County	Decatur	GA	CSO	26,400	25	2013	Under design
Olentangy Relief Sewer Tunnel	City of Columbus	Columbus	OH	Sewer	58,000	14	2013	Under design
Alum Creek Relief Tunnel Phase 1 Phase 2 Phase 3	City of Columbus	Columbus	OH	Sewer	30,000 21,000 25,800	18 14 10	2014 2016 2018	Under design Under design Under design
Black Lick Tunnel	City of Columbus	Columbus	OH	Sewer	33,000	7	2014	Under design
Dugway Storage Tunnel	NEORSD	Cleveland	OH	CSO	16,000	24	2014	Under design
Doan Valley Storage Tunnel	NEORSD	Cleveland	OH	CSO	9,700	17	2015	Under design
Westerly Main Storage Tunnel	NEORSD	Cleveland	OH	CSO	12,300	24	2020	Under design
Lower Mill Creek CSO Tunnel - Phase 1	M.S.D. of Greater Cincinnati	Cincinnati	OH	CSO	9,600	30	2013	Under design
Lower Mill Creek CSO Tunnel - Phase 2	M.S.D. of Greater Cincinnati	Cincinnati	OH	CSO	1,500	30	2015	Under design
Ohio Canal Tunnel	City of Akron	Akron	OH	CSO	6,170	27	2014	Under design
Northside Tunnel	City of Akron	Akron	OH	CSO	6,850	24	2022	Under design
ALSCOSAN CSO Program	Allegheny Co. Sanitary Authority	Pittsburgh	PA	CSO	35,000	30	2016	Under design

TUNNEL NAME	OWNER	LOCATION	STATE	TUNNEL USE	LENGTH (FEET)	WIDTH (FEET)	BID YEAR	STATUS
Pogues Run Tunnel	Indianapolis DPW	Indianapolis	IN	CSO	9,700	18	2016	Under design
White River Tunnel	Indianapolis DPW	Indianapolis	IN	CSO	27,800	18	2016	Under design
Pleasant Run Deep Tunnel	Indianapolis DPW	Indianapolis	IN	CSO	33,000	18	2020	Under design
Fall Creek Tunnel	Indianapolis DPW	Indianapolis	IN	CSO	19,600	18	2020	Under design
Drumanard Tunnel	Kentucky DOT	Louisville	KY	Highway	2,200 x 2	35	2012	Bidders qualified
St. Louis CSO Expansion	St. Louis MSD	St. Louis	MO	CSO	47,500	30	2014	Under design
Mill Creek Peaks Branch Tunnel	City of Dallas	Dallas	TX	CSO	5,500	26	2014	Under design
North Link Light Rail Extension	Sound Transit	Seattle	WA	Transit	35,000	22	2014	Under design
East Link Light Rail Extension	Sound Transit	Seattle	WA	Transit	30,000	22	2016	Under design
Chinatown NATM Station	San Fran. Muni Transit Authority	San Francisco	CA	Subway	340	60	2012	FKCI/Tutor-Saliba JV low bidder
Third Ave. Subway Tunnel	San Fran. Muni Transit Authority	San Francisco	CA	Subway	10,000	22	2013	Under design
San Francisco DTX	Transbay Joint Powers Authority	San Francisco	CA	Transit	6,000	35 to 50	2013	Under design
L.A. Metro Regional Connector	Los Angeles MTA	Los Angeles	CA	Subway	20,000	20	2014	Under design
LA Metro Wilshire Extension Phase 1 Phase 2 Phase 3	Los Angeles MTA	Los Angeles	CA	Subway	42,000 26,500 26,500	20 20 20	2013 2014 2016	Under design Under design Under design
LAX to Crenshaw	Los Angeles MTA	Los Angeles	CA	Subway	12,200	20	2012	Under design
LA CSO Program	L.A. Dept. of Public Works	Los Angeles	CA	CSO	37,000	18	2015	Under design
Freeway 710 Tunnel	CALTRANS	Long Beach	CA	Highway	26,400	38	2016	Under design
SVRT BART	Santa Clara Valley Trans. Authority	San Jose	CA	Subway	22,700	20	2014	Under design/ delayed
BDCP Tunnel #1	Bay Delta Conservation Plan	Sacramento	CA	Water	26,000	29	2014	Under design
BDCP Tunnel #2	Bay Delta Conservation Plan	Sacramento	CA	Water	369,600	35	2016	Under design
Kaneohe W.W. Tunnel	Honolulu Dept. of Env. Services	Honolulu	HI	Sewer	15,000	13	2013	Under design
Hanlan Water Tunnel	Region of Peel	Toronto	ON	CSO	19,500	12	2013	Under design
Downtown LRT Tunnel	City of Ottawa	Ottawa	ON	Transit	21,000	18	2012	Prequalified JV's announced
Second Narrows Tunnel	City of Vancouver	Vancouver	BC	CSO	3,600	14	2013	Under design
Evergreen Line Project	Trans Link	Vancouver	BC	Subway	10,000	18	2012	Prequalified JV's announced
UBC Line Project	Trans Link	Vancouver	BC	Subway	12,000	18	2014	Under design

UCA calls for Executive Committee nominations

The UCA of SME Division seeks recommendations and nominations from all UCA members for interested individuals to serve on the UCA Executive Committee beginning in 2012. Currently, the UCA bylaws allow a 19-person Executive Committee. The members of the executive committee are made up of three officers, chair, vice chair and past chair, and four directors from each of the following areas; engineers, contractors, owners and suppliers. Ideally, the UCA Executive Committee seeks a balanced representation from the four categories. But the committee has the option to have more members serving in one or more categories while having fewer representatives in other areas.

If you would like to nominate someone for consideration, please forward your recommendation to Mary O'Shea, oshea@smenet.org, at SME headquarters by Nov. 1, 2012. Staff will compile all nominations for the UCA Nominating Committee's consideration. The Nominating Committee requests the following information to help with the committee's consideration.

Identify which of the four areas the individual should be considered for service — engineer, contractor, owner or supplier.

Provide a brief biography or resume outlining the person's industry experience and service to UCA and other professional organizations.

Remember that the individual must be a member of the UCA of SME. ■

SCHOLARSHIPS

UCA awards three scholarships at NAT

The UCA of SME Division has awarded three $5,000 scholarships. Andrew Carey and Ryan King received a check and certificate at the North American Tunneling conference in June in Indianapolis,IN. Lee Gagnon received his award at the New Mexico Institute of Mining and Technology.

ANDREW CAREY is a junior at the University of Utah majoring in mining engineering. He has served as historian/treasurer of the SME student chapter at Utah and helped organize field trips to local mines and attended the 2012 Annual Meeting in Denver, CO.

Carey has also served on a university outreach program as an Engineering Ambassador from the Mining Engineering department. The program promotes engineering careers to K-12 students by giving presentations and demonstrations on the different types of engineering fields.

Last summer, Carey completed an internship as an underground miner at the Skyline Mine, an underground coal mine owned by Arch Coal. He completed his MSHA 24-hour and 40-hour safety training for surface and underground mining.

LEE R. GAGNON is a senior at the New Mexico Institute of Mining and Technology majoring in mineral engineering with an emphasis on explosives. He has worked as a resident assistant and as a conference assistant for the university. He has also worked as a lab teaching assistant for the department's surveying course and the introduction to engineering course. His family is originally from Mississippi and was displaced as a result of Hurricane Katrina. He is especially interested in working in underground construction.

RYAN KING is a junior studying civil engineering at The Pennsylvania State University. He comes from a family of engineers who have worked in the tunneling business near New York City for several generations. During the past two summers, King has worked as a heavy construction laborer, a member of Local 731 NYC, for S3-TT Tunnel Constructors J.V. on the underground construction of the #7 subway line extension. ■

PERSONAL NEWS

MARGARET A. (PEGGY) GANSE (SME)P.E., P.G., has joined Shannon & Wilson as a senior associate through the acquisition of her Denver-based company Tunneling Solutions. She is based in the Colorado office and will support the firm's tunneling and trenchless markets across North America. As a geological engineer and engineering geologist with 20 years of experience, Ganse specializes in the ground characterization and design of rock and soil tunnels in the water, wastewater and transportation markets.


GANSE

Ganse serves on the Tunneling Committee of the Association of Engineering Geologists and is a founding member of the Rocky Mountain Chapter of the North American Society for Trenchless Technology. ■

September 2012

18-21, InnoTrans 2012, Berlin, Germany, Contact: Messe Berlin GmbH, Messedamm 22, 14055 Berlin, Germany, InnoTrans Team, fax: 49-0-30-30 38-21-90, e-mail innotrans@messe-berlin.de.

19-21, Colorado School of Mines Tunnel Short Course, Colorado School of Mines, Golden, CO, Contact: Levent Ozdemir, 780 Kachina Circle Golden, CO 80401, phone: 303-526-1905, 303-999-1390, e-mail lozdemir1977@aol.com, website www.csmspace.com.

October 2012

17-20, Tunneling Association of Canada Conference, Hyatt Hotel, Montreal, Quebec, Canada. Contact: Wayne Gibson, conference manager, Gibson Group Association Management, 8828 Pigott Rd. Richmond BC V7A 2C4, phone 604-241-1297, fax 604-241-1399, e-mail info@tac2012.ca, www.tac2012.ca.

More meetings information can be accessed at the SME website — http://www.smenet.org.

16-19, 37th Annual Conference on Deep Foundations, George R. Brown Convention Center, Houston, TX. Contact: Deep Foundations Institute 326 Lafayette Ave. - Hawthorne, NJ 07506, phone 973-423-4030; fax: 973-423-4031, e-mail, staff@dfi.org, website www.dfi.org.

November 2012

12-14, 30th International No-Dig, Sao Paulo, Brazil. Contact: Benjamin Media Inc., 1770 Main St, PO Box 190, Peninsula, OH 44264, USA, phone: 1-330-467-7588, fax: 1-330-468-2289, e-mail kduresky@benjaminmedia.com, website www.istt.com

February 2013

11-14, Microtunneling Short Course, Golden, CO. Contact Microtunneling, Inc., Timothy R. Coss, P.O. Box 7367, Boulder, CO 80306 U.S.A., phone: 1-303-444-2650, fax: 1-303-444-0889, e-mail, timcoss @ microtunneling.com, website www.microtunneling.com.

June 2013

23-26, RETC 2013, Washington, D.C. Contact: Meetings Dept., SME, 12999 East Adam Aircraft Circle, Englewood, CO 80112, phone 800-763-3132 or 303-948-4280, fax 303-979-3461, e-mail sme@smenet.org, website www.smenet.org. ■

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