T&UC

TUNNELING & UNDERGROUND CONSTRUCTION

THE OFFICIAL PUBLICATION OF UCA OF SME   WWW.TUCMAGAZINE.COM   VOLUME 2 NO 4 DECEMBER 2008

EPB TUNNELING IN CANADA

Excavating New York's East Side Access

Tunnel Demand Forecast

Special Editorial Section from the publisher of *Mining Engineering*

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COVER STORY

CONTENTS — This issue focuses on water and sewage. The first feature describes the use of earth pressure balance tunneling to minimize dewatering at three projects in Toronto's York region, page 22. The next feature examines the fast track design and construction of an emergency tunnel to bypass a collapsed sewer in Richmond, VA, page 28. Cover photo courtesy of Lovat.

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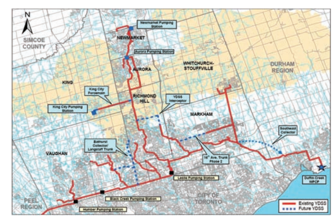
FEATURE ARTICLES



DEPARTMENTS

CHAIRMAN'S COLUMN

UCA committees need your input

It is that time of year when you should have received your membership renewal notice. If you have not received a notice, than please sign up on the uca@smenet.org Web site under tab "Join UCA."

Membership in the Underground Construction Association (UCA) of SME is growing. This is due, in part, to a strong industry and demand for the services of our corporate and individual members. Please enlist your colleagues to maximize the networking, technology exchange, access to publications, and latest developments around the United States and worldwide.

The UCA of SME is actively involved in establishing education and training to meet the resources demands. To augment those programs, the new Student Outreach Committee has been established to open a communication channel about the career opportunities and the interesting world of underground planning, design and construction with the K-12, university and post-graduate programs.

In 2008, the UCA Student Scholarship Fund was established by the UCA executive committee. It will be funded from a portion of the proceeds from the biannual North American Tunneling (NAT) Conference in addition to separate fund raising requests. These funds were used to fund the Student Paper competition awards and travel and attendance of three finalists at the NAT Conference last June. Formal guidelines and application procedures for the dispersal of these funds are currently under development.

The executive committee needs your thoughts and participation on two new committees. The first is Student Outreach, including UCA Scholarship. Contact current chair Brenda Bohlke, Myers Bohlke Enterprise LLC. Other members include Greg Raines, MWH; Jeff Peterson, Kiewit; Paul Scagnelli, Schiavone and Jamal Rostami, Penn State. To join, send an e-mail to ucachair@smenet.org. The second committee is the Education and Training Committee. Contact current chair Bill Edgerton, Jacobs Associates.

This issue of *T&UC* includes the revised UCA bylaws (page 37). Changes were made to improve the clarity, improve consistency and align the bylaws with the structure and operations of the organization. The revised bylaws and any new comments will be taken up for consideration at the January meeting of the UCA executive committee.

The UCA executive committee has put out a call for nominations for Lifetime Achievement Award and Outstanding Individual of the Year. Please take a moment from your busy schedules to recognize one of your colleagues and role models you think is deserving of recognition for their contributions to the underground industry. Nominations can be sent to me. These awards will be presented at the Rapid Excavation and Tunneling Conference (RETC) in Las Vegas, NV in June 2009.

In a few weeks, the annual George A. Fox conference will be held again in New York City, where the underground industry continues planning, design or construction of a number of legacy projects. Some of them include the Second Avenue Subway, the No. 7 line, the WTC redevelopment; The Trans-Hudson Express; and the New York Third Catskill Delaware Aqueduct. We continue to learn about large bore tunneling technology and its adaptation to mixed-use facilities, including highway, transit and flood control.

At the 2009 Fox conference, we expect to hear about some of the largest cavern excavations currently

Continued on page 40

Brenda Bohlke,
UCA of SME Chairman

New York-New Jersey rail tunnel clears environmental hurdle

The multibillion dollar New York-New Jersey rail tunnel project has won federal environmental approval.

The Federal Transit Administrations (FTA) approval of the final environmental impact statement for the $8.7 billion project was published in the *Federal Register* on Nov. 8.

Following a 30-day comment period, the FTA can issue a record of decision, formally concluding the environmental study process and opening the door for New Jersey to receive federal matching funds.

The project, also known as Access to the Region's Core (ARC), will double train capacity into and out of Manhattan by adding two single-track tunnels under the Hudson River, expanding Penn Station in New York and completing track and signal improvements along the Northeast Corridor line between Newark and New York.

New Jersey Gov. Jon S. Corzine estimated that thousands of jobs will be created before and during the construction phase, expected to start next year.

The state and Port Authority of New York and New Jersey have committed $5.7 billion, and are seeking $3 billion in federal matching funds. ■

Another Big Dig suit settled

The U.S. Attorney General's office has reached a $21-million agreement with Modern Continental for damages resulting from the fatal tunnel collapse in June 2006.

The agreement, which must be approved by a bankruptcy court, would also bar the construction contractor from doing any further work on the Big Dig.

Modern Continental, which has filed for bankruptcy, installed the bolts in the tunnel ceiling panels, which collapsed on June 10, 2006.

The U.S. Attorney's office in Boston brought several criminal charges against Modern Continental earlier this year, saying it knew the ceiling bolts were coming loose but glossed over the problem until the collapse. ■

California voters approve transit funding

Simultaneous approval of a high-speed rail line to link California's two major cities and a package of subway, light rail, highway and busway expansions in the state's most populous county marks "a huge step forward," said Dario Frommer, a member of the California Transportation Commission.

On Nov. 6 voters passed Proposition 1A and Measure R.

Proposition 1A is a statewide initiative to raise $10 billion as a down payment for a bullet train route that could ultimately stretch from Sacramento to San Diego. Total costs to the state will be roughly $45 billion, with complementary funding coming from the federal government and private investors.

Measure R will impose a half-cent sales tax increase in L.A. County in order to raise during its 30-year lifespan $30 billion to $40 billion, depending on how consumery southern Californians feel during the next three decades.

However, state and federal lawmakers could pull back existing and anticipated matching funds for transportation projects because of the nation's deepening economic crisis.

Even with the new ballot measure money, including nearly $10 billion for the bullet train from the Bay Area to southern California, some projects could be delayed or in jeopardy if current transportation allotments are cut back, Frommer said. "It's very complicated."

The Gold Line light rail extension to the San Gabriel Valley would probably be one of the first projects built, along with the Expo Line from Culver City to Santa Monica.

The Green Line rail extension to Los Angeles International Airport, still needs a commitment from the airport to build a people-mover system to get travelers from the train station to the terminals.

Even if all goes well for the proposed 355 km/h (220 mph bullet train, it will not be completed for at least 10 years, though some parts will be ready sooner. The first phase is supposed to wind from Anaheim through Los Angeles to Palmdale, then up the Central Valley to San Francisco. ■

Arrowhead tunnel breakthrough was five years in the making

A nearly five-year journey that took place as deep 460 m (1,590 ft) below the San Bernardino mountain range in southern California concluded on Aug. 20 when a 137-m (450-ft) tunnel boring machine (TBM) emerged from under the mountains. The TBM left behind a 6.1-km (3.8-mile) tunnel as part of a large-diameter regional water line that will help improve the quality and reliability of imported water serving nearly 19 million southern Californians.

As part of the Metropolitan Water District's Inland Feeder project, the Arrowhead West tunnel, between Waterman and Devil canyons, is the last major piece of the $1.2-billion project that was designed to boost southern California's supply. The breakthrough marks a major step in completing a 71-km (44-mile) water line.

The 6.1-km (3.8-mile) Arrowhead West tunnel is the last of three needed for the 71-km (44-mile) inland feeder, a high-capacity, gravity-fed water delivery system stretching from the foothills of the San Bernardino Mountains to Metropolitan's Colorado River Aqueduct in the Riverside County community of San Jacinto. Mining on the other two project tunnels — the 6.9-km (4.3-mile) Arrowhead East tunnel and 12.8-km (8-mile) Badlands tunnel — was completed last May and in July 2001, respectively.

When completed in 2010, the inland feeder will provide Metropolitan the flexibility to deliver water when available from northern California during wet periods.

The feeder also will improve the quality of southern California's water supply by allowing more uniform blending of water from northern California with Colorado River supplies, which have a higher mineral content.

At a cost of $9 million each, two Herrenknecht hard rock tunnel boring machines (TBMs) were used to bore the Arrowhead tunnels. The machines were designed to bore through anywhere from 3.05 to 24.4 m/d (10 to 80 ft/d). GPS and laser-guided survey system tracked its progress. Although laser technology helped guide the cutter face, a human operator applied the right amount of pressure to various locations on the rock face to keep the machine and, therefore, the tunnel on course.

When bored out, the tunnel is 5.8 m (19 ft) in diameter. With concrete segments installed, it shrinks to 3.66 m (12 ft). A bolt and gasket system was employed between the reinforced concrete tunnel segments. The segments have been produced at a Traylor/Shea/Ghazi plant and were fitted with Phoenix sealing gaskets.

First envisioned in the late 1980s, the $1.2-billion inland feeder will deliver water to be stored in surface reservoirs, such as Metropolitan's Diamond Valley Lake near Hemet in southwest Riverside County, and ground water basins for later use.

Metropolitan general manager Jeff Kightlinger said the project will help Southern California cope with future weather pattern uncertainties, which may bring more rain and less snowpack to northern California, and longer periods of drought to southern California.

Gene Koopman, chair of the Metropolitan board's Engineering and Capital Programs Committee and Inland Empire Utilities Agency representative on the MWD board, called the feeder "one of the most demanding construction projects" in the agency's 80-year history.

"Construction of the Arrowhead west and east tunnels was challenging, not only due to the physical constraints of mining in such extremely difficult geologic conditions and so close to several earthquake faults, but also because of other hazards unique to southern California that were encountered — fires and flash floods," Koopman said. ■

Robbins overcomes high overburden at Olmos

A 5.3-m (17.4-ft) Robbins tunnel boring machine (TBM) is boring a 13.9-km (8.6-mile) long tunnel through the Andes Mountains, beneath 2,000 m (6,500 ft) of hard, potentially squeezing rock.

The Olmos Trans-Andean tunnel in Peru has been more than 100 years in the making, with several attempts made in the 1950s using drill-and-blast techniques. The tunnel, more than 20 km (12 miles) long in total, will transfer water from the Huancabamba River on the eastern side of the Andes to drought-ridden areas on the Pacific Ocean Watershed.

The main beam TBM was launched in March 2007 for subcontractor Odebrecht Peru Ingenieria y Construccion, S.A.C (OPIC). General contractor Concesionaria Trasvace Olmos, S.A. won a 20-year build-operate concession from the Peruvian national government and Lambayeque Regional government in July 2004.

The machine is boring in complex geology consisting of quartz porphyry, andesite and tuff from 60 to 225 MPa (8,700 to 32,600 psi) UCS. More than 400 fault lines are present along the entire tunnel, including two major fault lines approximately 50 m (160 ft) wide. The overburden has created another problem — high in-tunnel temperature, predicted to exceed 54° C (130° F). To cope with the high temperature, Robbins has designed the machine with a unique ventilation and air-cooling system. Two interacting systems are being used to cool the tunnel to 32° C (90° F) or below. The high jobsite elevation (1,080 m or 3,500 ft) results in less dense air and less heat transfer capacity per cubic meter of air. Sso the two systems will make it possible to blow more air into the tunnel for a maximum cooling effect.

In addition to the challenging geological conditions, a flood in April 2008 covered the jobsite in a thick layer of mud and debris and washed out the only access road leading to the construction area. Despite the three-week delay, the machine is still on schedule for a projected finish in March 2009. The machine is now averaging 3.2 m/h (10.5 ft/h), with production rates of up to 38.3 m/d (126 ft/d). As of August 2008, the TBM had advanced 6,000 m (20,000 ft).

By March 2010, the first phase of the tunnel project will be operational and will supply more than 2 billion m^2 (500 billion gal) of water annually for irrigation of 560 hm^2 (130,000 acres) of farmland. The second phase will involve construction of at least two more drill-and-blast tunnels and two stations for hydroelectric power. The facilities will be capable of generating 600 MW each. ■

Mexico City plans for $1.27 billion tunnel

A centuries-old drainage problem that has a plagued Mexico City will be addressed with a US$1.27-billion tunnel that will remove rainwater from the nation's capital.

The proposed tunnel will be 62 km- (39 miles) long and 7-m (23-ft) in diameter.

Mexico City is sinking because of ground water extraction. And it is vulnerable to flooding because it sits in a mountain-ringed valley with no natural exit for rainwater. The city already has some large underground drainage tunnels, but they are aging and vulnerable to heavy storms.

Mexico City is largely built on the soft soil of a former lake bed and has been hit by periodic floods since it was founded by the Aztecs in 1325.

After the Spaniards conquered Mexico in 1521, the lakes were drained and the first rudimentary drainage channels were built.

Because the city is sinking, the existing tunnels no longer dislodge water by gravity. Instead, the wastewater — a mixture of raw sewage and runoff — must be pumped out of the valley. The new system would help to remedy that. ■

Herrenknecht TBMs reach their target in Shanghai

The Herrenknecht Mixshield S-318, one of the two largest tunnel boring machines (TBM) in the world with a diameter of 15.43 m (50.6 ft), reached its target shaft on the Yangtze River island of Changxiang in Shanghai, China on Sept. 5, 2008.

The machine excavated the nearly 7.5-km- (4.6-mile-) long tunnel tube in highly water-bearing construction ground in 20 months. On May 28, 2008, an identical Herrenknecht Mixshield S-317 reached its target shaft.

Using the two high-tech giants from Schwanau, the shell of the two parallel running large diameter tunnels, which are scheduled to be opened for car and subway traffic for the 2010 World Exhibition, could be completed 10 and 12 months ahead of schedule, respectively.

At the beginning of September, the red carpet was rolled out for politicians and construction experts when Shanghai's vice mayor, Jun Shen, announced the successful completion of tunneling at the "Shanghai Yangtze Under River Tunnel." Following final completion, both tunnels will accommodate a three-lane road on the upper level and a subway line on the lower level. The completion of tunneling work ahead of schedule provides the ideal conditions to open the tunnel on time for the 2010 World Exhibition in Shanghai.

A Herrenknecht TBM's used to tunnel under the Shanghai Yangtze tunnel.

With an overburden of up to 65 m (213 ft), the machines burrowed their way through sand, clay and ground water with water pressures of up to 6.5 bar. Weekly tunneling performances of up to 142 m (466 ft) of constructed tunnel were reached, performance per day was up to 26 m (85 ft).

The machines weigh 2.3 kt (2,535 st) and are 125-m- (410-ft-) long. On a route of 7.5 km (4.6 miles), they deviated only 2.7 centimeters from the ideal line. Now, the two tunnels of the "Shanghai Yangtze Under River Tunnel" connect the Shanghai district of Pudong with Changxiang island on the Yangtze River. From 2010 on, the combined road and subway tunnels will reduce the traveling time between Shanghai and the Yangtze River island Changxing from one hour to 20 minutes and replace the existing ferry connections.

The two breakthroughs at the "Shanghai Yangtze Under River Tunnel" are an important milestone in mechanized tunneling. They constitute an impressive success for both the Changjiang Tunnel & Bridge Construction, Ltd. and the partnership between Shanghai Tunnel Engineering Co., Ltd., Bouygues TP and Herrenknecht, the technology and market leader in mechanized tunneling from Schwanau (southern Germany). ■

The Herrenknecht S-318 is one of the largest TBM's ever assembled.

World Tunnel Congress focuses on tunneling in India

by Brenda Bohlke, UCA of SME Chairman

The World Tunnel Congress (WTC)is sponsored by the International Tunneling and Underground Space Association (ITA). The 2008 congress was held in Agra, India at the end of September. This was my first time attending the WTC as U.S. representative for the U.S. at the General Assembly. It is comprised of representatives from more than 58 member nations.

More than 1,000 WTC attendees focused on the tunneling in India as the host country. This is quite a compelling story. The tunnel demand in India is driven by extensive hydropower development, as well as transportation, water and sewer conveyance to meet the needs of the one of the world's most populous countries.

In addition to India's underground space activities, presentations at the WTC also covered developments on the global stage that was relevant to all attendees. Some of the topics included contracting practices to meet the local conditions and demand and protect all parties involved; fire life; general safety in tunneling; new specifications for shotcrete; social and economic justification for building infrastructure underground; advances in conventional methods; and immersed tunnels and tunnel boring machines.

Pictured from left to right are Henry Russell, Parsons Brinkerhoff; William Hansmire, ITA Animateur of Working Group on Tunnel Rehabilitation; Amanda Elioff, ITA Animateur of the Working Group on Sustainability; Brenda Bohlke, Chair of UCA, ITA US representative and Christian Ingerslev, ITA Animateur of the Working Group on Immersed Tunnels.

Many of those topics are the focus of 20 Working Groups that draw upon the collective knowledge, expertise and experience of the individual members from the countries around the globe. It is important that the United States be represented at the table to learn about the differences and similarities, and to add to the world source documents that can be referenced to assist us in making our cases for or against adopting methods, technology or management ideals not previously used locally when working with prospective and active owners, and ensuring that professionally, we are maintaining our technological and contractual edge. Visit www.AITES.org to review the various workings groups and valuable publications.

Bill Hansmire of Parsons Brinkerhoff presented a paper at the WTC.

The United States is well represented on the ITA working groups. A number of the current working groups are led by U.S. representatives. Many of the technological advances in tunneling have been demonstrated in the tunnels of the member nations, years before we were able to adopt these methods in the U.S in Budapest, Hungary in May 2008. ■

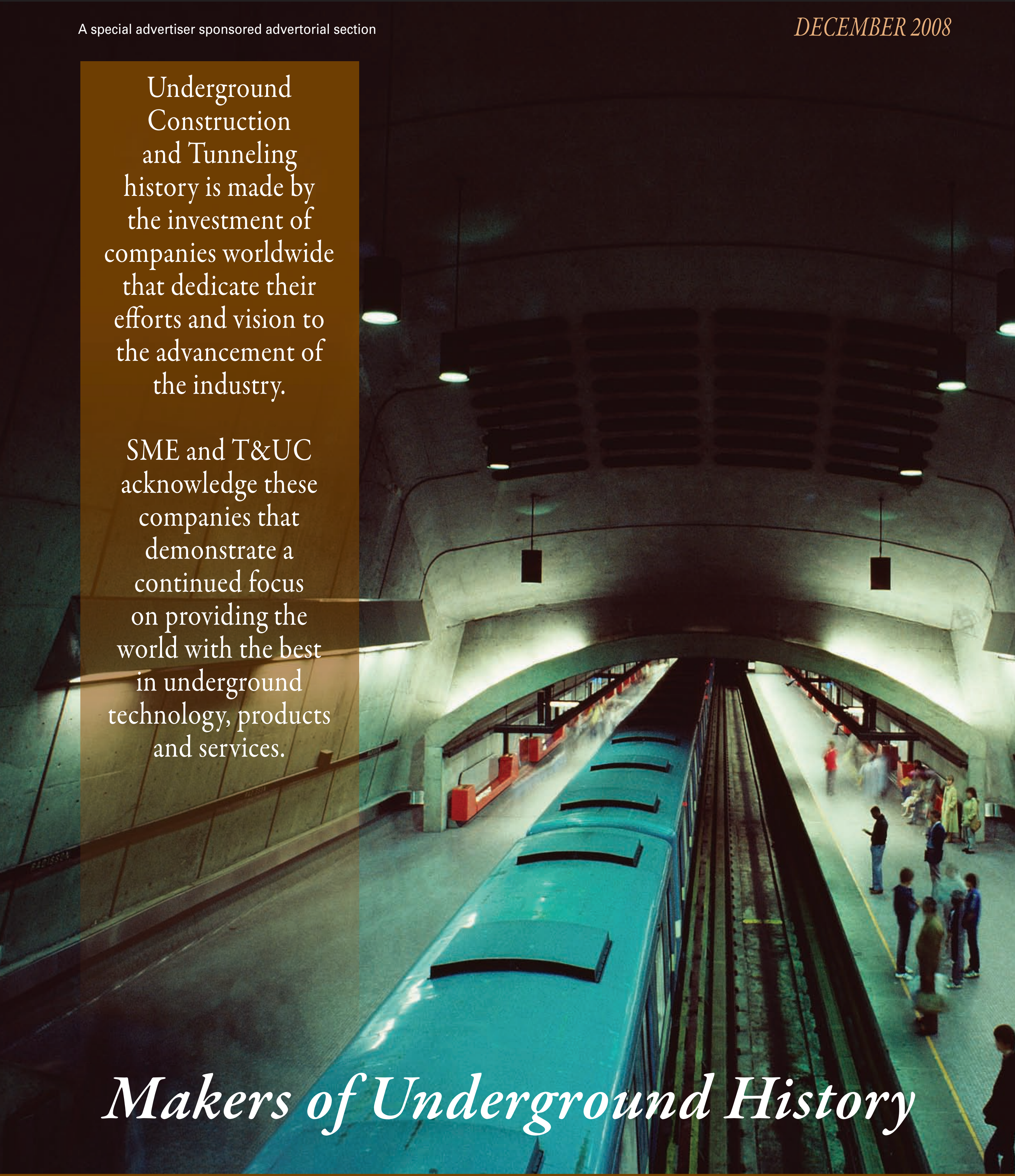
The World Tunnel Congress was held in Agra, India, which is home to the Taj Mahal.

T&UC

BUSINESS PROFILES

A special advertiser sponsored advertorial section

DECEMBER 2008



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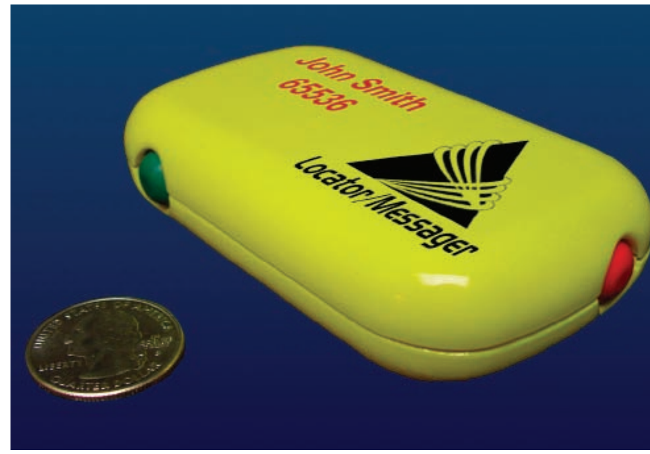
Playing a Role in Landmark Pittsburgh Tunneling Project

Leading industrial communications provider Wholesale Mine Supply and its division, HC Global, are working on a joint venture with Gomez Tunneling and world tunneling expert Rick Gomez to provide two-way radio communications to the tunneling project that will extend Pittsburgh's "T" rail line under the Allegheny River and connect the city's downtown region with Heinz Field and PNC Park.



WMS President Bill Hensler said he saw an opportunity in the tunneling environment that was similar to what it was already doing with much success for the underground mining market.

"We are the world leader in underground mining communications, with 143 systems in mines across the United States," said Hensler. "We have system in tunneling jobs across the USA in sites in Seattle, at the Hoover Dam, and in Cleveland, Pittsburgh and Nashville, just to name a few."

The VARIS leaky feeder network system planned for the project will be the first in the world to communicate to a tunnel boring machine located under ground and provide both leaky feeder communications and Ethernet capabilities over the same cable. The system will also provide two-way radio communications to both the underground and surface areas of the job site.

"Using our VARIS leaky feeder network with Ethernet, we are able to communicate from Pittsburgh to Germany so the engineers in Germany can see the machines operating Navigation System and control the machine," said Hensler.

Hensler said that WMS and HC Global, who seek to be a complete turnkey communications provider to the international tunneling industry – much like the industry-leading position it currently holds in mining – will provide their own brand of American Radio Communications (ARC) that have been modified specifically for the project to be both waterproof and provide the utmost in effectiveness within extreme conditions.

"Alan Quinn was our system designer on this site and did a great job of working with the TBM provider and onsite personnel to link everybody together," Hensler said of the project, which is set for completion in 2010.

WMS's VARIS/Becker systems have several safety-and production-enhancing benefits, including the use of a single cable to distribute wired or wireless voice, video, and data signals to an underground work force and equipment, miner tracking using RFID tags and interrogators, and easy maintenance and expansion.

Wholesale Mine Supply, based in North Huntingon, Pennsylvania, is a leading communications provider for the tunneling and underground mining industries and the largest supplier of two-way underground communications. It has more than 85 systems in American mines alone and 25 years of experience in the servicing of mining and tunneling.

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Mining Equipment builds new Jetair Axiflow Fans up to 500 horsepower and 84-inch diameter. They developed a line of Super-Silenced™ Fans that run quieter and take up less space than other integrated fan and silencers. They also roll steel ventilation ducting on-site. Ducting as small as 12-inch and as large as 84-inch can be rolled.

Mine Hoists International is a fully-owned subsidiary of Mining Equipment. Based in North Bay, Ontario, Mine Hoists boasts the largest selection of used mine hoists and stage winches in the world. MHI has more than 35 mine hoists in inventory and 60 stage winches up to 80,000 lbs. capacity.

Mining Equipment, Jetair and Mine Hoists International are currently doing business in North and South America, Australia, Asia, Africa and Europe. To learn more about Mining Equipment, visit their website at:
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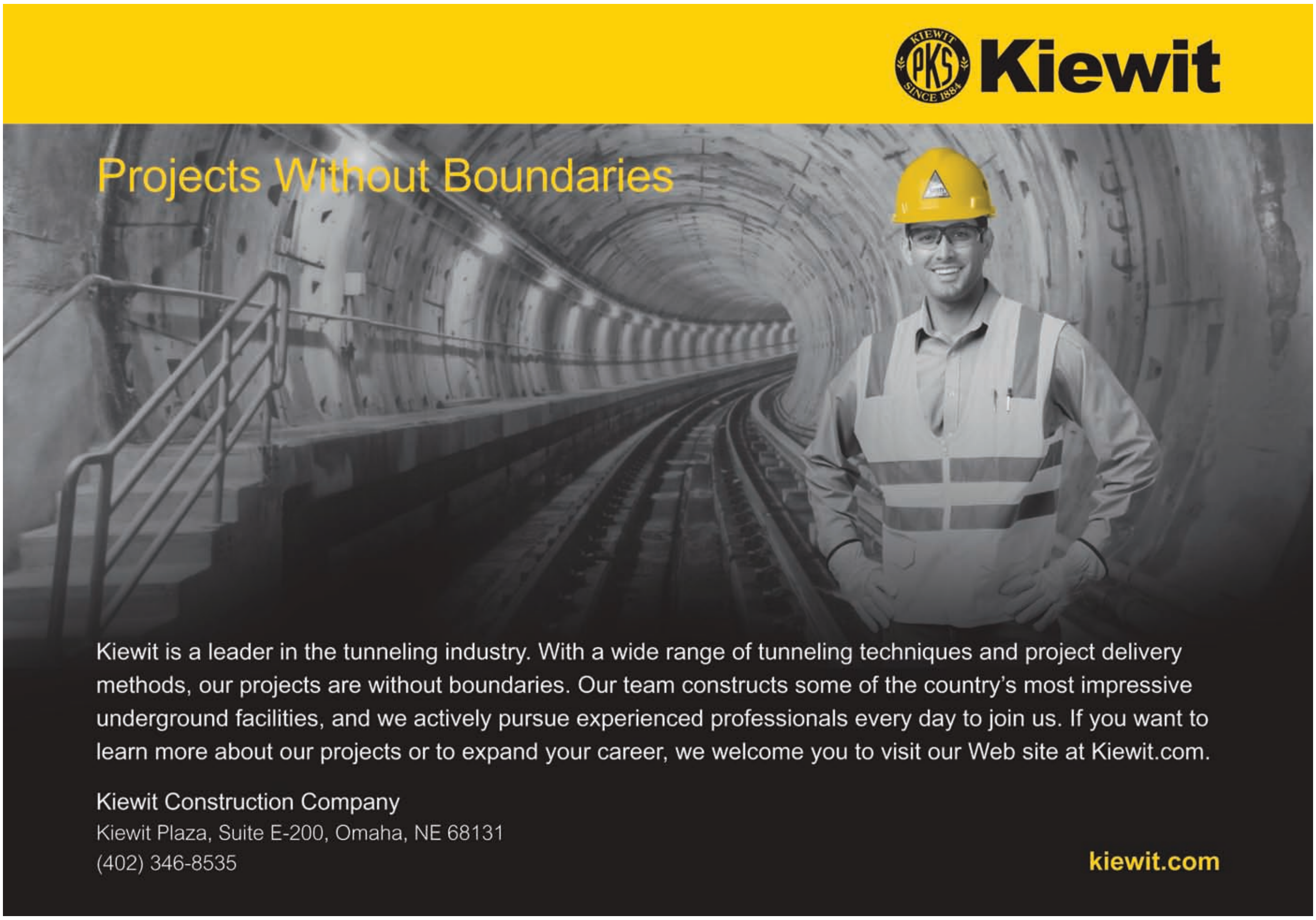

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New Geofoam SP – Pervious Cellular Concrete

Use of cellular lightweight concrete continues to increase worldwide. New products from the Innovations Lab of Cellular Concrete LLC are helping to drive this powerful trend, including the introduction of Geofoam SP, a synthetic foaming agent for producing pervious cellular lightweight concrete, which helps developers, specifiers, and project owners to economically meet the goals and demands of sustainable, effective land use.

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For more information or to speak to a representative about your options, please feel free to contact us at 1-800-691-6601 or info@strata-safety.com. You can also visit us at www.strata-safety.com.

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Strata chambers at production facility in Maryland

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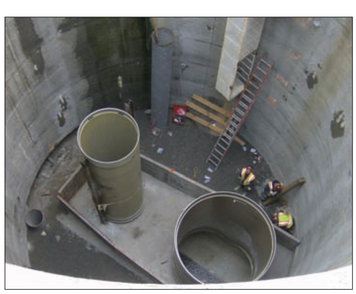

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TUNNEL NAME	OWNER	LOCATION		TUNNEL USE	LENGTH (FEET)	WIDTH (FEET)	BID YEAR	STATUS
County Grounds Tunnel	Milwaukee Metro Sewerage District	Milwaukee	WI	Flood management	2,700	17	2008	Rebid late 2008
Bi-County Water Tunnel	Washington Suburban Sanitary Commission (WSSC)	Laurel	MD	Water	28,000	10-12	2008	Advertising fourth quarter 2008
Lake Mead IPS 2 Connection	Southern Nevada Water Authority	Las Vegas	NV	Water	Tunnel 600 Shaft 380	Tunnel 14 Shaft 28	2008	Awarded to Barnard Construction
River Mountain Tunnel #3	Clean Water Coalition	Las Vegas	NV	Wastewater	44,000	15	2008	Under design
CWC Reach 3	Clean Water Coalition	Las Vegas	NV	Wastewater	7,500	15	2008	Under design
DRO-2 tunnel	Detroit Water & Sewer Department	Detroit	MI	Wastewater	6,400	21	2008	Vinci/Frontier-Kemper low bidder
Mission Trails # 1 tunnel # 2 tunnel	SDCWA	San Diego	CA	Water	2,000 2,875	11 11	2008 2008	Awarded to LH Woods
New Crystal Springs Bypass Tunnel	S.F. Public Utility Commission	San Francisco	CA	Water	4,200	13	2008	Shank/ Balfour-Beatty low bidder
Upper Rouge CSO North Segment South Segment	Detroit Water & Sewage Authority	Detroit	MI	CSO Sewer	18,500 18,500	30 30	2008 2008	Bids due 11/20/08 Kenny
Sewer replacement	Miami Dade	Miami	FL	Sewer		5	2008	Under design
Market St. Drainage Improvements	City of Charleston	Charleston	SC	Sewer	3,000	10	2008	Under design
South River Tunnel	City of Atlanta	Atlanta	GA	Wastewater	9,000	14	2008	Bid 10/2008
Drumanard Tunnel - Pilot Tunnel	Kentucky DOT	Louisville	KY	Highway	2,200	12x12	2008	Rebid late 2008
ESA Queens Bored Tunnel	NYCTA-MTA	New York	NY	Subway	10,500	20	2008	Bids 09/12/2008
Corvalis to Fox Mill Water Main	Fairfax County Water Authority	Fairfax	VA	Water	8,600	8	2008	Advertising 10/01/2008
WASA CSO Program - Phase 1	DC Water and Sewer Authority	Washington	DC	CSO	63,360	23	2008	Program manager consultant selected
Portsmouth, Segment 2	Bureau of Environmental Services	Portland	OR	Sewer	6,000	9 to 11	2008	Advertising late Oct. 2008
Western Regional Conevyance Tunnel	N. KY Sanitation District #1	Covington	KY	Sewer	36,000	13	2008-2012	Bids 3Q 2008
Port of Miami Tunnel	Florida DOT	Miami	FL	Highway	4,000	36	2008-12	PPP - Awarded, in negotiation
Port Mann	Greater Vancouver Regional District	Vancouver	BC	Water	3,300	10.5	2009	Advertising May 2009

The editor's of *Tunneling & Underground Construction* encourage UCA of SME members to submit projects to the online Tunnel Demand Forecast at www.smenet.org, log in as a member. The items will be posted on the online TDF once they are verified.

TUNNEL NAME	OWNER	LOCATION		TUNNEL USE	LENGTH (FEET)	WIDTH (FEET)	BID YEAR	STATUS
SVRT BART	Santa Clara Valley Trans. Authority	San Jose	CA	Subway	22,700 twin	20	2009	Under design
Bay Tunnel	S.F. Pub. Utility Commission	San Francisco	CA	Water	25,000	9	2009	Advertising May 2009
Harbor Siphons Tunnel	NYC-DEP	New York	NY	Water	10,000	10	2009	Advertising 1Q 2009
W. Corridor LRT Tunnel	Transit Authority	Denver	CO	LRT	280 x 2	18	2009	Under design
Belmont-Southport Plant Connection	City of Indianapolis DPW	Indianapolis	IN	Sewer	29,000	12	2009	Bid late 2009
Palisaides Tunnel	NJ Transit Board THE Tunnel Program	Newark	NJ	Subway	5,400 x 2	20	2009	Under design
Univ. Link Light Rail Ext. UW Tunnels Capitol Hill Tunnels	Sound Transit	Seattle Seattle	WA WA	Rail Rail	12,000 x 2 3,800 x 2	22 22	2009 2009	Advertising 02/2009 07/2009
New Irvington	S.F. Public Utility Commission	San Francisco	CA	Water	18,200	12-13	2009	Advertising 09/2009
Caldecott 4th Bore	CALTRANS	San Francisco	CA	Highway	5,000	50	2009	Advertising 02/2009
Sunnydale Tunnel	S.F. Public Utility Commission	San Francisco	CA	Sewer	3,900	8 to 11	2009	Advertising 03/2009
Lee Road Relief Sewer (LRRS)	Northeast Ohio Regional Sewer District	Cleveland	OH	CSO	4,250	6	2010	Bids 4Q 2009
Euclid Creek Tunnel	Northeast Ohio Regional Sewer District	Cleveland	OH	CSO	18,000	24	2010	Under design
Snapfinger Interplant CSO Tunnel	DeKalb County	Atlanta	GA	Wastewater	26,400	28	2010	Under design
Drumanard Tunnel	Kentucky DOT	Louisville	KY	Highway	2,200 x 2	35	2010	Under design
Near Surface Interceptors	Narragansett Bay Commission	Providence	RI	Sewer	19,500 11,000	3 to 6 3 to 6	2010	Final design
Alum Creek Relief Sewer (1 of 3 phases)	City of Columbus	Columbus	OH	Sewer	26,000	10	2010	Under design
Water Tunnel # 3	NYC Dept. of Envir. Protection	New York	NY	Fresh water	24,000	20	2010	Under design
LBJ Highway	Texas Dept. of Transportation	Dalls	TX	Highway	5,300 x 2	60 x 35	2010	PPP - bidding
Kicking Horse Canyon	BC Dept. of transportation	Golden	BC	Highway	4,800 x 2	45 x 32	2010	Under design
New York City Tunnel	NJ Transit Board THE Tunnel Program	New York	NY	Subway	6,000 x 2	20	2010	Under design
The 34th St. Cavern and Station	NJ Transit Board THE Tunnel Program	New York	NY	Subway	2,200	60 x 60	2010	Under design
Waller Creek Tunnel	City of Austin	Austin	TX	Flood Control	5,708	22 to 26	2010	Final design phase

FEATURE ARTICLE

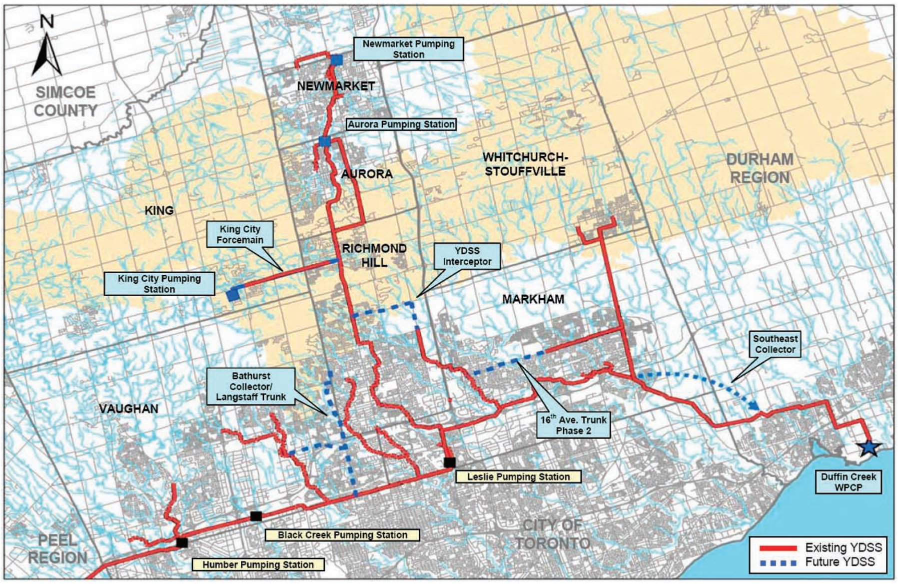
Earth pressure balance tunneling in Canada

In 2006, McNally International Inc., in a joint venture partnership with Aecon Constructors, was the successful bidder on two York Region Tunnel Projects: the Bathurst Collector/Langstaff Trunk Sewers and the York Durham Sewer System (YDSS) Interceptor Sewer 19th Avenue, both in the Toronto area.

These projects comprised a total of 13 km (8 miles) of 2.74 m (9 ft) finished diameter tunnels and are both part of the YDSS.

Both contracts required the use of earth pressure balance (EPB) tunnel boring machines (TBM) with a precast concrete segmental liner.

Overview of the York Durham Sewer System.



Project overviews

The Bathurst Collector & Langstaff Trunk Sewer was a design/build project that included construction of 8,625 m (28,300 ft) of 2,744 mm (108 in.) internal diameter tunnel and six access shafts. The tunnels range from 9 to 30 m (30 to 98 ft) in depth. They were being constructed through till, sand silt and clay deposits with water heads up to 1.5 bar.

There were three tunnel drives on the project.

The Bathurst Collector portion of the project included two 2,500 m (8,200 ft) tunnel drives north and south from a main mining shaft, which is located at the mid-point. Langstaff included construction of a 3,525-m (11,565-ft) tunnel drive from the west to intersect the Bathurst tunnel.

The YDSS/19th Avenue project was a conventional bid project managed by Earth Tech on behalf of York Region. The project involved construction of 3,600 m (11,810 ft) of tunnel on 19th Avenue and 500 m (1,640 ft) on Leslie Street. The tunnels range in depth from 9 to 18 m (30 to 60 ft) and were constructed through boulder rich glacial tills and sand and water heads up to 1.5 bar.

The tunnel alignment crossed through the Oak Ridges Moraine Aquifer (a significant feature for Ontario), as well as highly sensitive environmental features.

The two tunnel drives were completed from one mining shaft located at 19th Avenue and Leslie Street and, due to schedule restraints, involved concurrent mining of two TBMs from the same shaft.

Laura McNally and Steve Skelhorn

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Environmental considerations

To obtain approval for these projects, York Region compiled a broad database of baseline information, completed extensive environmental studies and undertook significant agency, stakeholder and public consultation. Although the mandate for both projects was to minimize dewatering through the use of EPB TBMs and sealed shaft techniques, York Region applied for and was granted a permit to take water (PTTW) on both projects. The full extent of the PTTW can only be accessed on a contingency basis and only by adhering to all conditions of the PTTW. The contracts stipulate that dewatering was only to be used as a last resort after all other feasible options had been exhausted.

For both contracts, ground water seepage into each shaft and the tunnel during construction were limited and monitored. Bathurst and Langstaff tunnels are located within a developed area in the city of Vaughan. Seepage and process discharge water can, therefore, be directed to local sanitary sewers.

The 19th Avenue project is located in Richmond Hill, a mainly rural and undeveloped area that includes sensitive aquatic habitat and spawning grounds for endangered fish species. Stringent environmental controls were put in place including continuous monitoring of quality and quantity with restrictions based on allowable discharge to receiving streams.

Lovat TBMs selected for tunnel excavations.

By combining the two projects, it was possible to schedule the work using three new machines. The first TBM was used exclusively for Bathurst. The second was for 19th Avenue and the third TBM was to construct the short Leslie tunnel on the 19th Avenue project before moving to the Langstaff tunnel.

All three TBMs are identical full face EPB machines. The TBMs are 3.25 m (10.6 ft) in diameter. They incorporated mixed face cutterheads with the facility to dress the head with ripper teeth over the full face, scraper teeth on the outer two-thirds of the arms and disc cutters at any of the ripper locations. The face is protected with wear plates and incorporates grizzly bars to limit cobble and boulder ingress to 225 mm (8.8 in.). The head incorporates five ground conditioning injection ports, four on the face and one on the outer wrap. For the Langstaff and 19th Avenue tunnels, the TBM were set up with an initial dressing of rippers and discs. The Bathurst machine was dressed with rippers only.

The cutter head design incorporates an outboard triple roller bearing with the screw conveyor located through the bearing, below spring line. The option of using a smaller bearing to locate the screw at the bottom of the head was considered. It was not selected, though, because it would increase the risk of screw damage due to cobbles and prevent the inclusion of a head access door.

The main drive is electrohydraulic with power provided from two 250-Hp electrical motors driving six hydraulic motors on the head. Hydraulic motors were selected over electrical VFD drives because of space limitations.

EPB control is maintained with a single, variable-speed screw conveyor with horizontal discharge. An adjustable aperture exit gate allows for controlled discharge to the secondary conveyor.

Precast concrete segmental tunnel lining

The tunnels use precast reinforced concrete segmental liners. The segments are manufactured in Ottawa by Boucher Precast and the joint venture team. North American Segment Co. with Chris Smith of CRS Consultants was retained by the joint venture to provide management and quality assurance during setup of the plant and casting. The joint venture procured 18 sets of molds from CBE, in France, as well as all components and accessories required for the segment manufacturing.

The segment design was carried out by Halcrow Group Ltd. in the United Kingdom. The segments are designed as steel reinforced concrete with bolted radial joints and dowels to the circumferential joints.

The option of fiber-reinforced concrete was considered. However, specific ground loadings along the alignment negated this possibility.

Ring selection was reviewed in detail by the project team, with the main focus on selecting an arrangement that provides ease of ring construction and optimizes build options in curves. A universal ring was selected as a starting point and constructability of the ring was analyzed and modified for the projects. The main concern was the potential difficulty with placement of a relatively large key segment, generally 45°, in a universal ring. This problem was expected to be greater with a smaller diameter ring. To address this concern, it was decided to reduce the key to 22.5° and increase the size of the counter key to 67.5°. The final ring consists of four 67.5° rhomboid plates, one 67.5 counter key and one 22.5° key.

Environmental controls on the 19th Avenue project.

Lovat's EPB TBM "Motoclara" during commissioning.

TBM installation at the C7 Shaft for Bathurst South Drive.

For alignment control, the segments are tapered with a maximum length of 1.22 m (4 ft), a minimum of 1.2 m (3.93 ft) and a nominal length of 1.21 m (3.96 ft). There are numerous curves along the tunnel alignments, with the tightest curve having a radius of 260 m (853 ft).

With a universal ring and small key combination, the ring cannot be rotated about the vertical axis. Consequently, the counter key must be placed at any location to maintain alignment. To minimize the occurrence of building the ring with the key below axis, left and right rings are used. The left and right rings have opposite maximum and minimum lengths at the axis when built with key in the same position.

TBM guidance systems

ZED tunnel guidance systems were procured by the joint venture. These systems include Leica 1103 automated thoedolites with built-in lasers, radio modems and surface linked computers to allow remote monitoring and data logging.

Alignment control for both projects is critical, as sealed shaft designs limit the target for TBM entry eyes. The size of the mining shaft at Bathurst (6.7 m or 22 ft diameter) is constrained by existing utilities and property limits, reducing survey base line accuracy.

To improve the survey accuracy, a gyroscope is used.

Shaft sinking

Both contracts included restrictions on ground water seepage into shafts. Several of the shafts are located in areas where the geology consists of stable clays and tills with minimal ground water. In these locations, liner plate or soldier pile and lagging structures were suitable. These included the main mining shafts on Bathurst and 19th Avenue, the two Bathurst TBM recovery shafts, the Leslie Street recovery shaft, and an intermediate shaft on 19th Avenue.

The liner plate shafts on 19th Avenue, were constructed with gasketed plates and combined with neat cement grout to limit water ingress.

In areas of unstable ground, slurry wall and secant pile shaft design options were selected. Two slurry wall shafts were designed and constructed by Petrifond on the 19th Avenue project. The shafts are octagonal in shape, with dimensions of 7.6 m (25 ft) diameter, 18 m (59 ft) deep and 10.6 m (35 ft) diameter and 15 m (49 ft) deep. The shaft designs do not use a keyway to secure the base plug to the slurry wall, but rely on friction between the concrete wall and the plug. To ensure a proper bond between the plug and shaft wall, divers were required to clean down the slurry walls prior to placing the plugs. Both shafts required excavation underwater with tremmie base plugs up to 3.6 m (11.8 ft) thick.

On completion of the slurry walls, jet grout blocks were formed at the tunnel entry/exit. The blocks are approximately 6- x 6- x 9-m- (19- x 19- x 29-ft-) long.

The jet grouting was carried out after the slurry wall shafts were excavated. This gave the advantage of using the completed shafts as settlement tanks during the jet grout operations. This limited the risk of contamination of the surrounding creeks.

Three secant pile shafts were constructed by Deep Foundations on the Bathurst/Langstaff project.

These include a 34- x 5- x 12-m- (111- x 16- x 39-ft-) deep mining shaft on Langstaff; a 5-m- (16-ft-) diameter 24-m- (79-ft-) deep intermediate shaft on Langstaff and a 9-m- (29-ft-) diameter, 22-m- (72-ft-) deep shaft for recovery of the Langstaff TBM and interconnection structure between the Bathurst & Langstaff tunnels. The shafts consist of interlocking piles 1.067 m (3.5 ft) diameter. For TBM entry and exit at the intermediate shafts, the base of the shaft was backfilled with low

Precast concrete segments.

strength concrete to 1 m (3 ft) above the top of tunnel. The TBM was to mine through the shafts, with segments remaining in place. This approach removed the need to undertake ground treatment for the tunnel eyes in advance of mining.

Upon tunnel completion, a portion of the concrete will be removed to build manhole base structures above the tunnel and segments will be cored out to provide access.

TBM launch

To accelerate the launch of the TBMs, starter tunnels approximately 45-m- (148-ft-) long were constructed. On 19th Avenue, the schedule demanded that both tunnels (west and south) be driven concurrently from the same launch shaft. To accommodate the launch of both TBMs, two starter tunnels were constructed from the main shaft. The starter tunnels on both projects were constructed in stable ground. Therefore, it was possible to excavate these tunnels by hand using steel liner plate as temporary support.

The starter tunnels allowed for the assembly of the TBM underground prior to launch and provided clearance for a switch. Logistics during the driving of the two tunnels at 19 th Avenue, gave little time for shaft bottom crews to change out the trains. However, with a relatively short drive to the south, this did not present too many problems.

The Langstaff TBM launch was completed from the 34-m- (111-ft-) long secant pile shaft without construction of a starter tunnel. The shaft length provided sufficient space for critical gantry sections to be placed in the shaft during startup and other sections lowered in place as the TBM advanced.

EPB parameters

Although the launches for all tunnels were in stable ground, it was necessary to operate the TBMs in full EPB mode following the launch to allow for potential pockets of unstable ground.

EPB pressures were reviewed based on a minimum of full piezometric pressure plus 10 kPa (0.1 bar) and a maximum of full piezometric pressure plus 100 kPa (1 bar). A target pressure of 30 kPa (0.3 bar) above minimum was selected.

At the onset, it was decided to adjust the target pressures so that they were suitable throughout areas of primarily stable ground. Previous experiences have highlighted difficulties in monitoring actual face pressures within clays and dense tills. This is considered to be the result of a pressure drop within the mined soil matrix between the face and the EPB cells mounted inside the TBM head. To allow for this, an adjustment factor was used to lower EPB targets for mining through these more plastic materials.

The EPB calculations were based on the following criteria:

CBE molds set up at the casting plant.

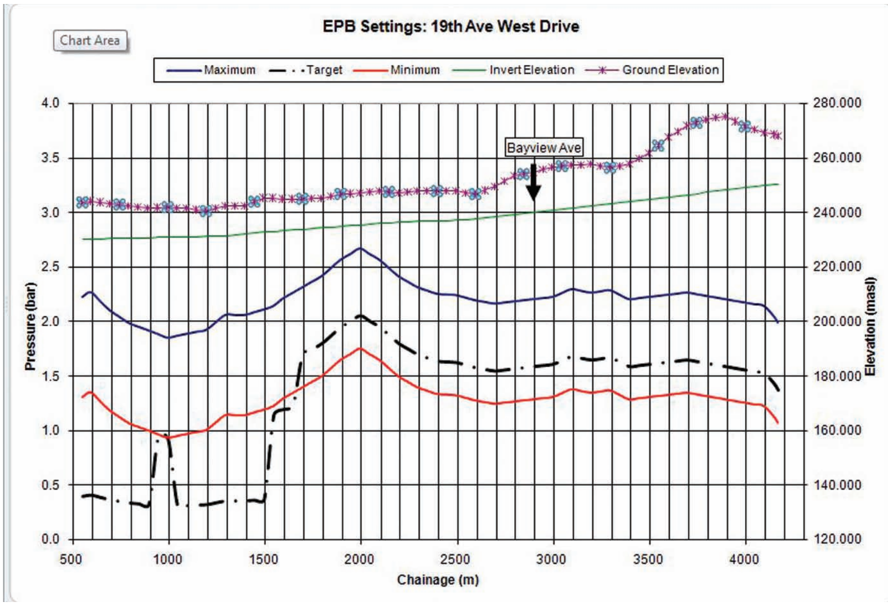
- Full ground water pressure estimated on the basis of worst-case GBR interpreted piezometric level.
- TBM forward chamber full of unmodified, saturated soil at depth to pressure sensor.

The following assumptions were made for the initial EPB settings based on ground conditions:

- Full face of clay or till — pressure drop through the head assumed to be 75 percent. Minimum EPB pressure to be maintained at 25 percent of the target pressure.
- Mixed face (30 percent till or more) — pressure drop through the head assumed to be 25 percent. Minimum EPB pressure to be maintained at 75 percent of the target pressure.
- Full face of sand or silt — pressure drop assumed to be zero. Target pressure to be maintained at all times.

Completed slurry wall shaft on the 19th Avenue tunnel drive.

Calculated EPB targets for the 19th Avenue tunnel drive.



Ground conditioning

The variations of the stratigraphy required a range of conditioning agents, from foams to polymers.

With all three TBMs identical, the systems needed to be versatile. The following outlines the basic requirements identified during the planning stage for each of the tunnels.

19th Avenue tunnel — Till for the first 1,000 m (3,280 ft) was followed by well-graded sand with some silt. Foam requirements were the same as the Bathurst tunnel for the first 1,000 m (3,280 ft), switching to polymer for the sand and silt with foam injection required at a low rate thereafter.

Foam rates for the sand and silt were estimated to be around 10 percent of that required in the clays and till.

Polymer injection was estimated at around 15 L/min (1.3 gpm) of a five practice by volume dilute polymer mix.

Bathurst tunnels — This is mostly clay and till with some silt, sand and gravel; with water heads of up to 1 bar. Foam ground conditioning required for clay and till ground with 60 percent foam injection ratio. This required a system capable of 600 L/min (158 gpm). Using an expansion ratio of 1:3, this required water pumps capable of supplying 150 L/min (40 gpm). Polymer requirements were the same as for the 19th Avenue tunnel.

Langstaff tunnel — This is mixed ground throughout consisting of clay, till, sand, silt and gravel. It is variable for the entire drive requiring foam rates of up to 60 percent combined with polymer injection. The system needed to be capable on switching between full foam and full polymer.

Ground conditioning system

The Lovat ground conditioning system was incorporated into the TBM. This was based on a system initially designed by a consortium of McNally Construction, Lovat and Morrison Mud for the Sheppard Subway tunnel project in Toronto.

The system consists of five independent pumps, four of which are connected to a universal manifold supplying a dilute foam/water solution. The fifth pump is connected directly to a polymer holding tank mounted on the TBM. The four foam pumps are connected through individual air diffusers to independent ports on the TBM head (five ports were provided. However, due to limitations within the swivel on this relatively small TBM, only four of these ports are used concurrently). The polymer pump is directly connected through a quick release and can be fitted to the TBM plenum or to any of the face ports. Ports were also added to the screw conveyor to allow the injection of pure polymer into the screw, if required. A separate pump was required for this operation.

Progress to date

As the time of writing (October 2008), the Bathurst & 19th Avenue tunnels were completed, and after a unexpected setback on Langstaff, tunneling is progressing well with approximately 1,000 rings remaining on the drive.

The first TBM was launched in late January 2007 at Bathurst Street. The machine progressed well through the till. However, the sticky clay proved more problematic, with difficulty passing through the TBM. Additional

Langstaff C5 mining shaft.

ground conditioning did alleviate the issues to some degree and different types of foaming agents will be tried on the second drive. Breakthrough of the second drive was achieved in August 2008 and completion of the final manhole structures was expected in early November 2008.

The second TBM was launched at 19th Avenue in early March 2007. The machine completed the first section of tunnel through the till by July 2007.

Progress through this zone was good with relatively few problems. While progress was good, problems were encountered with the ground. Initially, maintaining a plug within the screw was difficult.

This issue was resolved by increasing the earth pressures and increasing injection of dilute polymer ahead of the TBM. A secondary problem was also encountered with leaks through the tail brushes.

The finished 19th Avenue tunnel.

Additional tail grease injection was not successful in these zones and it was necessary to install a temporary bulkhead and inject polyurethane grout as the TBM advanced to keep the tail can dry. This TBM completed 1,850 rings out of the 2,950 drive by November 2007, arriving at an intermediate shaft. To maximize the schedule, it was decided to move the mining up to this intermediate shaft. This would free the completed tunnel section and associated shafts for finishing work. Additionally, it would substantially reduce the haulage time reuired for the remainder of the drive. Due to the alignment requirements, the TBM was removed and rotated to allow mining of the remaining 1,100 rings to continue. Mining recommenced in January 2008 and the tunnel breakthrough was achieved on May 2, 2008. The third TBM was launched at 19th Avenue in April 2007 for the Leslie tunnel. The ground consisted of competent till material and did not present any difficulty for tunneling. The drive included a very tight, 260-m (853-ft) radius curve at TBM launch. This proved problematic at first due to ring orientation selection, combined with the steering of the TBM. The short drive (500 m or 1,640 ft) was completed by July and the TBM was relocated to Langstaff.

Substantial completion of the 19th Avenue tunnel project was achived in August, 2008. Mining at Langstaff commenced in August 2007.

The TBM progressed through the most challenging ground conditions on the projects – very fine sand and silt with water pressure of 1.5 bar. Problems were experienced with tail seal leaks in this material. On May 2, 2008, a breach of the tail seals occurred at ring 1,450, approximating 150 m (490 ft)west of the intermediate shaft. This resulted in an inflow of material, which the crew was not able to control. The tunnel was safely evacuated and secured. No one was injured. Approximately 1,000 m^3 (35,310 cu ft) of material entered the tunnel over a 48-hour period, causing a large sinkhole on the surface. Crews responded quickly to secure the tunnel and surface. Damage to local infrastructure occurred, including a watermain and a portion of Langstaff Road.

Work is ongoing to further investigate the cause of the incident and recover the tunnel. Work commenced on a recovery shaft in late June, including installation of an educator dewatering system and a secant pile wall shaft, 30-m-long x 5-m-wide (100-ft x 16-ft). To date 75 percent of the secant piles have been completed and work is expected to commence on shaft excavation in early December.

In order to minimize impacts on the project schedule, another TBM has been launch from the C2 shaft at east end of the tunnel drive (Bathurst Street, south of Highway 407). The TBM was launch in August 2008, and, as of time of writing, was 450 rings into the drive. The TBM will be removed at the recovery shaft and the two sections of tunnel will be connected at the shaft. Overall completion of the tunnel is expected in spring 2009.

Summary

The two projects, three TBMs and five tunnels are providing some interesting and unique challenges.

Having three identical machines should, in theory, make everything much easier, as procedures, systems and operating parameters should be similar for all tunnels. However, these jobs are highlighting the fact that changes in ground can radically alter the operation of the TBMs. To date, it has clearly been demonstrated that there is not one set formula for driving these tunnels. As the projects proceed, the knowledge gained from having three TBMs mining concurrently will be invaluable. ■

Battery Park trunk sewer emergency tunnel project

On Aug. 31, 2006, Tropical Storm Ernesto hit the city of Richmond, VA. The Battery Park area was hit particularly hard, as flooding forced an evacuation of the area. A large sinkhole collapsed a sewer line in the Battery Park area, blocking the pipe and causing more serious flooding.

This article describes the fast track design, bidding and construction of an emergency tunnel to bypass the collapsed sewer. Innovative value engineering, tunneling and shaft-sinking methods and final lining design all contributed to the success of this project.

The storm inundated Richmond, VA with up to 305 mm (12 in.) of rain that, in some areas, caused widespread flooding and damage. One of the hardest hit areas of Richmond was Battery Park. A major trunk sewer in the Battery Park area collapsed and caused local combined sewer and stormwater flooding.

The collapsed sewer was a 2.4-m x 76-mm (8-ft- x 3-in.-) wide by 2.7-m- x 152-mm- (9-ft- x 6 in.-) high arch sewer that was constructed in the 1920s and later filled over with municipal solid waste and a soil fill cap to current elevations. A sinkhole was created in the area of collapse approximately 18 m (60 ft) deep and 31 m (100 ft) in diameter. This caused the existing arch sewer to become blocked. As a result of this blockage, contaminated floodwaters reached depths in low-lying areas in excess of 8 m (25 ft).

Mark Rybak and Todd Brown

Mark Rybak and Todd Brown are project manager and project engineer , respectively with Bradshaw Construction Corp., Ellicott City, MD, e-mail tunnel@bradshawcorp.com.

As a temporary measure to relieve flooding, the city of Richmond contracted to have a battery of 13 bypass pumps, each with the capabilities to pump 41.6 ML/d (11 million gal/day), set up and manned 24 hours a day, seven days a week until a permanent fix was completed.

Battery Park after Tropical Storm Ernesto.

From August 2006 through February 2007, the city of Richmond and Greeley and Hansen Engineers designed a new tunnel that would connect a new junction structure. It would be built at the Bacon's Quarter sewer. A new diversion structure to be constructed in the valley south of The Terrace and Overbrook Road that would completely bypass the existing sewer built below the landfill. The tunnel alignment was designed to avoid the existing municipal solid waste materials to the maximum extent possible.

In February 2007, the Battery Park emergency trunk sewer tunnel project went out for bid. Bradshaw Construction Corp. (Bradshaw) was the sole bidder for the $25.5-million dollar project.

The original project as bid consisted of the following main components:

- The Bacon's Quarter Structure is a large steel-reinforced, cast-in-place concrete structure at the downstream end of the project that ties the new bypass tunnel into a large existing box culvert called Bacon's Quarter.
- The optional south shaft is a 9-m- (30-ft-) diameter New Austrian Tunneling Method (NATM) shaft 28-m- (60-ft-) deep that was excavated through municipal solid waste and Miocene clay.
- The tunnel consists of 1,021 linear m (3,350 linear ft) of 3.65-m- (144-in.-) diameter digger shield excavated tunnel in Miocene clay with a primary lining of oak lagging spanning 1.5 x 5 m (5 x 16 ft) circular steel ribs. The final liner is 2.8 m (110 in.) inside diameter fiberglass-reinforced polymer pipe backfilled with low-strength grout.

- The School Street shaft is a 9-m- (30-ft-) diameter NATM shaft that is 28-m- (60-ft-) deep. It is excavated through municipal solid waste and Miocene clay. This shaft served as the main work shaft for the tunnel drive and pipe installation. It is located at the approximate midpoint of the tunnel. The final lining consists of a cast-in-place, steel-reinforced circular concrete lining 305 m (12 in.) in thickness.
- The 1.8-m (72-in.) drop shaft is a 3.6-m- (12-ft-) diameter liner plate shaft that is 12-m- (40-ft-) deep. It intersects an existing 1.8-m (72-in.) reinforced concrete pipe (RCP) sewer.
- The new north 1.8-m (72-in.) sewer is 63 linear m (208 linear ft) of 1.8-m (72-in.) RCP-lined tunnel connecting the 1.8-m (72-in.) drop shaft to the north shaft, where it would drop into the mainline tunnel pipe.
- The North shaft is a 9-m- (30-ft-) diameter NATM shaft is 28-m- (60-ft-) deep. It is excavated through municipal solid waste and Miocene clay.
- The new north diversion structure is a large, steel-reinforced, cast-in-place concrete structure located at the upstream end of the tunnel. It diverts flow from an existing brick arch sewer (the one that collapsed), an existing 1.4-m (54-in.) RCP sewer and the new 1.5-m (60-in.) RCP sewer.
- A 1.5-m (60-in.) opencut RCP consists of 91 linear m (300 linear ft) 1.5 m (60 in.) diameter RCP in opencut trench.
- A 1.2-m (48-in.) opencut RCP consists of 262 linear m (860 linear ft) of 1.2-m (48-in.) diameter RCP in opencut trench.
- A 1.2-m (48-in.) pipe in 1.7-m (66-in.) steel casing consists of 168 linear m (550 linear ft) of 1.7-m (66-in.) direct jack steel casing with a 1.2-m- (48-in.-) diameter RCP carrier pipe backfill grouted in place.
- A 305-mm (12-in.) opencut RCP consists of 91 linear m (300 linear ft) of 305-mm- (12-in.-) diameter RCP in opencut trench.
- Manholes range in size from 1.2 m (48 in.) to 2.4 m (96 in.) diameter.

Design modifications

All parties involved were aware that there was limited time to develop a complete design for this emergency project and that design changes to major components of the project were likely. Upon award of the contract, the city of Richmond, Greeley and Hansen Engineers, and Bradshaw entered into discussions to determine which components of the project could be redesigned to improve constructability and lower cost.

The following is a summary of those changes:

- 168 linear m (550 linear ft) of 1.2-m (48-in.) RCP in direct-jacked, 1.7-m (66-in.) steel casing jacked in two different directions from one shaft and 152 linear m (500 linear ft) of 1.2-m (48-in.) RCP in opencut trench was redesigned into 320 linear m (1,050 linear ft) of direct-jacked, 1.2-m (48-in.) RCP from one shaft. This eliminated the need for opencut pipe in an area where there where numerous existing utilities within the tunnel alignment. This design change improved constructability and lowered the cost, resulting in a substantial credit to the owner.
- 79 linear m (260 linear ft) of opencut 1.5-m (60-in.) RCP through historic Battery Park was redesigned into 79 linear m (260 linear ft) of direct-jacked pipe, eliminating the need to dismantle, remove and replace valuable historic items. This design change improved constructability and, even though it was more costly than opencut methods, was more appealing to the owner due to the less disruptive nature of the trench-

Applying shotcrete at the School Steet shaft.

An Akkerman 3.6-m (144-in.) digger shield is put in place.

School Street Shaft at full depth.

less method in a historically sensitive area.

- The north diversion structure was originally designed as a massive cast-in-place, steel-reinforced concrete structure 11 m (35 ft) below existing grade. The vertical alignment of the tunnel was redesigned so that the north end of the tunnel, where it ties into the north diversion structure, was raised approximately 5 m (17 ft). This allowed for a much shallower excavation for the structure and tie-ins. The structure itself was redesigned into a prefabricated fiberglass-reinforced polymer pipe manifold, a very creative and unique solution. This design change improved constructability and lowered the cost, resulting in a credit to the owner.
- The 1.8-m (72-in.) drop shaft was eliminated. The 1.8-m (72-in.) connection to the mainline pipe was redesigned as a tunneled connection from the north shaft. And the finished north shaft structure and drop was redesigned as a prefabricated fiberglass reinforced polymer pipe system constructed within the 9-m- (30-ft-) diameter 18-m- (60-ft-) deep NATM north shaft. These design changes improved constructability and lowered the cost, resulting in a credit to the owner.
- The School Street shaft structure was redesigned from a finished steel-reinforced 304-mm- (12-in.-) thick concrete lining to a prefabricated fiberglass-reinforced polymer pipe system. This design change improved constructability and lowered the cost, resulting in a credit to the owner.
- The optional south shaft was eliminated.

Notice to proceed was issued on April 16, 2007 and mobilization of the project commenced immediately. The excavation and primary support of the School Street shaft began within a week of receiving the notice to proceed.

The School Street shaft supports were designed by Jenny Engineering. It served as the main work shaft for the tunnel drive and pipe installation. The shaft was a 9-m- (30-ft-) inside diameter NATM shaft 21 m (70 ft) deep. The primary support consisted of a steel lattice girder and mesh reinforced 24.6 MPa (4,000 psi) shotcrete lining up to 381 mm (15 in.) thick. Using day and night shifts, the excavation and support of the shaft took approximately six weeks to accomplish and was completed on June 6. The majority of the excavation and mucking was done with a mini-excavator. The trim work around the sides of the shaft was done with clay spades.

Tunnel drive

Ninety-five percent of the tunnel alignment was designed to bypass the landfill. The last 31 m (100 ft) of tunnel, at the downstream end, intersected the landfill.

Municipal solid waste (MSW) was expected to be encountered. Keeping that in mind and after careful review of the GBR, Bradshaw chose a tunnel boring machine (TBM) built by Akkerman Inc. It was a 3.6-m (144-in.) digger shield outfitted with a PPS guidance system to excavate the tunnel. The general belief was that if large objects were encountered in the MSW, they could be

Holing out through municipal solid waste.

North shaft at the bottom of the eye.

handled through the forward doors of the shield.

Muck haulage was accomplished by electric locomotives pulling five CY muck cars running on 609-mm (24-in.) gauge, 13.6-kg (30-lb) rail.

The south drive was launched on June 7, 2007 and took approximately four weeks to complete. The last 31 linear m (100 linear ft) of the south drive encountered MSW within the tunnel heading and easily handled it.

The TBM was re-launched for the north drive on July 25, 2007 and took approximately five weeks to complete.

The tunnel drive was relatively uneventful. The TBM was recovered in Battery Park on Sept. 5, 2007. At that point, the completed tunnel excavation and temporary initial lining was available to provide the city of Richmond emergency flood relief, approximately six weeks ahead of schedule.

2.8-m (110-in.) fiberglass-reinforced polymer pipe final lining

The final lining of the tunnel is 2.8-m- (110-in.-) inside diameter fiberglass-reinforced polymer pipe (FRPP) manufactured by Future Pipe Industries. The pipe installation in the south tunnel section began immediately after the completion of the north tunnel drive. The last joint of pipe was installed on Sept. 24, 2007 for the south drive. The total pipe installation took approximately eight weeks and the FRPP for two tunnel drives was connected on Oct. 29, 2007.

As the pipe was installed, partial bulkheads were built every 152 to 182 m (500 to 600 ft), allowing workers to begin backfill grouting while still installing pipe. The 1.37-MPa (200 psi) cement, flyash, water slurry was produced in a mobile batch plant, supplied and operated by Son-Haul Inc. and conveyed to the tunnel annulus through down holes located every 46 m (150 ft). The grouting operation was completed on Nov. 6, 2007, approximately one week after the last piece of pipe was installed.

Bacon's Quarter structure

The Bacon's Quarter Structure was a steel-reinforced, cast-in-place concrete structure located at the downstream end of the tunnel. It connected the new tunnel pipe to an existing large box culvert sewer.

The new structure was built around the existing culvert during active flow conditions. It completely supported the existing walls and roof of it during the entirety of the construction process and incorporated them into the permanent junction chamber. Bradshaw subcontracted the construction of the structure to Corman Construction. Work on the structure began in June 2007 and was completed in October 2007.

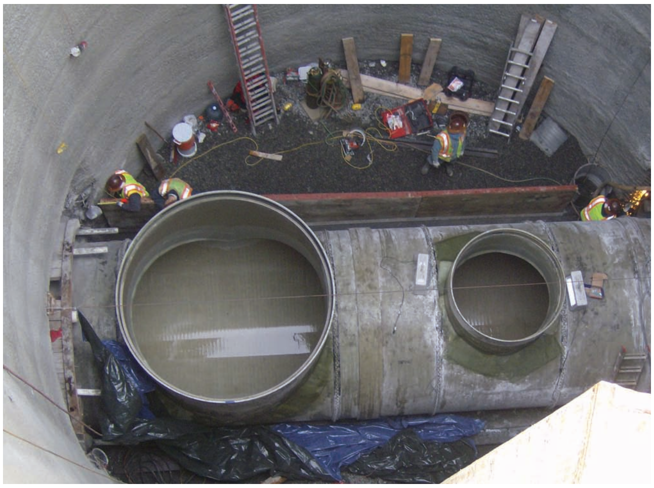
North 1.8-m (72-in.) connection shaft

The north 1.8-m (72-in.) connection shaft support system was also designed by Jenny Engineering. This shaft was located to intercept an existing 1.8-m (72-in.) RCP sewer.

It was offset from the mainline tunnel by approximately 12 linear m (40 linear ft). The shaft was a 9-m- (30-ft-) inside diameter NATM shaft, 18-m- (60-ft-) deep. The primary support consisted of a steel lattice girder and mesh-reinforced 24.6-MPa (4,000-psi) shotcrete lining 382 mm (15 in.) thick. The excavation and support of the shaft took approximately eight weeks to accomplish.

The 2.6-m (102-in.) tunnel connection to the mainline 3.6-m (144-in.) tunnel.

School Street shaft, post lamination.



The existing 1.8 m (72 in.) sewer was at a depth of 11 m (35 ft). As the shaft excavation reached the existing sewer, a support system was installed to temporarily support the sewer during construction of the shaft and connection.

This consisted of a steel beam installed above the pipe, either end penetrating the shotcrete lining through designed support pockets. 19 mm (0.75 in.) steel cables on 1-m (3-ft) centers were wrapped around the existing sewer, connected to the steel beam with shackles and tensioned with turnbuckles.

Like the School Street shaft, the majority of the excavation and mucking was done with a mini-excavator. The trim work around the sides of the shaft was done with clay spades.

1.8-m (72-in.) connection

The north 1.8-m (72-in.) connection shaft was designed to connect at a 45° angle to the mainline tunnel by a 12-m- (40-ft-) long hand-mined 2.6-m- (102-in.-) diameter steel liner plate tunnel.

The excavation began soon after the tunnel drive had passed the point of connection and took approximately three weeks to complete. The excavation was accomplished with a mini-excavator and clay spades, 1.8 m (72 in.). Fiberglass-reinforced polymer pipe was installed in the hand-mined tunnel, tied into the 2.8-m- (110-in.-) mainline tunnel pipe and backfill grouted.

The connection between the 1.8-m (72-in.) and 2.8-m- (110-in.-) FRPP was completed on Oct. 11, 2007.

1.2-m (48-in.) direct-jack RCP

What was originally 152 linear m (500 linear ft) of jacked pipe was value-engineered into 320 linear m (1,050 linear ft), avoiding 152 linear m (500 linear ft) of opencut trench down the middle of a residential street packed with existing utilities. The jacking shaft consisted of 5-x 7.3-m (16- x 24-ft) boxes supporting a 7.6-m- (25-ft-) deep excavation.

An Akkerman WC 480C TBM was used to excavate the tunnel with a SP-400 jacking system to jack the pipe behind. Two intermediate jacking stations were installed during the drive. But they were not needed, as no excessive pressures were encountered. Average production was 12 linear m (40 linear ft) per shift. The retrieval shaft consisted of stacked trench boxes.

1.5-m (60-in.) direct-jack RCP

The Battery Park 1.5-m (60-in.) RCP opencut connection pipe to the north diversion structure was redesigned to jacked pipe to avoid historic elements of the park. The run was 81-linear m- (265-linear ft-) long. The jacking shaft was constructed with 5- x 7.3-m (16- x 24-ft) trench boxes, similar to the shaft used for the 1.2-m- (48-in.-) pipe jacking operation, aligned perpendicular to the jacking shaft for the 1.2-m- (48-in.-) drive. An Akkerman WC 600C TBM was used to excavate the tunnel with the same SP-400 jacking system to jack the 1.5 m (60 in.) RCP behind. The average production rate was 18 linear m (60 linear ft) per shift. The retrieval shaft consisted of stacked trench boxes.

North division structure

The north diversion structure was redesigned from a massive concrete structure to a prefabricated fiberglass pipe manifold. The manifold will tie in the existing 1.7- x 2-m (5.6- x 6.9-ft) concrete arch sewer and an existing 1.4-m (54-in.) RCP sewer to the new 2.5-m (100-in.) FRPP using a 2.1- x 2.1-m (7- x 7-ft) reinforced-concrete box culvert and the new 1.5-m (60-in.) FRPP system to transition the two existing sewers, respectively. The new 1.5-m (60-in.) RCP and 1.2-m (48-in.) RCP connect to the surface laterals and catch basins in the neighborhood on the east side of the project.

The shaft excavation for this structure consisted of steel sheeting with a wale and strut internal bracing system. Demolition of the existing sewers and installation of the diversion manifold was completed in mid-December 2007.

The remaining work on this project included completing the north diversion structure, the North 1.8-m (72-in.) connection shaft, the School Street shaft and connections and small diameter opencut RCP, manholes and tie-ins. All work was completed by mid-January 2008.

The total duration of this project was nine months. The owner, design engineer and contractor worked together as a team designing and building this project in record time. The project had three milestone dates that had to be met with incentives if you beat the date and liquidate damages if you exceeded the date. Bradshaw earned two of three incentives and ultimately completed the project ahead of schedule.

This has been a challenging project and thanks to the innovative, hard working and talented employees of Bradshaw working closely with an involved owner and innovative engineer, this was an exceptionally successful project. ■

FEATURE ARTICLE

Excavating New York's East Side Access project

One of New York City's largest subway projects is under way 43 m (140 ft) beneath the surface of downtown Manhattan. The East Side Access project, more than 30 years in the making, was halted after a partial excavation in the 1970s due to a lack of funding. The project, once dubbed the "Tunnel to Nowhere," has been revitalized into a groundbreaking subway line that includes unique tunnel boring machines (TBM), construction methods and muck removal systems.

Rock support during the Robbins Main Beam machine's first tunnel drive consisted of rock bolts and steel ribs.

Project overview

The East Side Access project involves construction of a new 6.7-km (4.2-mile) subway line needed to relieve heavy traffic congestion between the boroughs of Queens and Manhattan. The line will serve approximately 160,000 commuters daily between Grand Central and Sunnyside rail stations.

Manhattan and Queens will be connected under the East River by the 63rd Street tunnel, a submersed double-decker tube. The submersed tube consists of reinforced concrete sections barged in place on the riverbed. The tube contains operational subway lines on the top deck, while the bottom deck (the "Tunnel to Nowhere") will become operational when the East Side Access project is completed in 2013.

The project, awarded to the Dragados/Judlau joint venture (JV), is located in a range of geology from soft ground to hard rock. Twin 2.6-km- (1.6-mile-) long Manhattan approach tunnels, located in hard rock consisting of schist, gneiss and granite from 15,000 to 40,000 psi UCS, will run from the Manhattan side of the submersed tube up to Grand Central Station.

Both Manhattan approach tunnels are located directly under major structures in New York City including the Park Avenue and Metro North rail lines. As they approach Grand Central Station, the tunnels split to form four tunnels. At the tunnel terminus, two underground chambers with upper and lower levels will provide access underneath Grand Central Station for commuters to travel on the new rail lines.

Contracts for the Manhattan approach tunnels (eastbound and westbound) were awarded in 2006. A 6.7-m (22-ft) rebuilt Robbins double shield TBM, supplied by SELI, was launched in September 2007 to bore the eastbound tunnel, while a 6.7-m (22-ft) high performance Robbins main beam TBM began boring the main westbound tunnel later in the year. The westbound tunnel contract, awarded to Robbins by the Dragados/ Judlau JV, included supply of a TBM, backup system and spare parts. Robbins was also awarded the supply of the complete muck haulage system that includes the continuous conveyor system. In addition, Dragados/Judlau awarded Robbins the disc cutter contract to supply both TBMs with new and rebuilt disc cutters.

Design for multiple tunnel headings

Both TBMs are boring multiple headings underneath Grand Central Station, including the parallel 2.6-km- (1.6-mile-) main tunnels plus 3.2 km (2 miles) of auxiliary

Desiree Willis

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The 6.7 m (22 ft) diameter Robbins Main Beam Machine broke through its first heading on September 29th.

tunnels. The boring sequence, consisting of three separate headings, requires a design that allows for swift retraction and relaunching of the TBM. Launched in December 2007, the Robbins main beam machine excavated the 2.6 km (1.6 mile) main tunnel to Grand Central Station. It was then retracted through the newly bored tunnel to a large crossover cavern.

In December 2008, the machine will be relaunched at a "Y" shaped intersection to bore another 610-m (2,000-ft) tunnel at a slightly higher elevation. After the second heading, the machine will then be retracted the full 610 m (2,000 ft), leaving all tracks and tunnel support structures in place before embarking on the third and final heading.

The main beam machine was designed using a segmented, bolt-on cutterhead for swift disassembly. For full retraction, first the outer components of the cutterhead are removed. The shielded front section of the TBM, designed as an "umbrella," is then retracted using hydraulic extensions. The extensions allow the bottom, side and roof supports to move radially inward, reducing the machine diameter from 6.7 m (22 ft) when fully extended to 6.1 m (20 ft) with removal of the shield assemblies.

The machine uses specially designed transport dollies, supplied by Robbins, to operate with this machine. They which allow the TBM to be walked backward through the tunnel without major disassembly. To deal with sloping floors at a 3-percent grade, there is a braking system supplied on the transport dollies and rails can be installed at precise elevations along the backup.

TBM assembly and transport

Due to the dense urban area, no surface access was available at the starting face in Manhattan. All components for the main beam TBM instead were taken in at the Queens pit and transported through the submersed tube under the East River for about 2.6 km (1.6 miles) to an underground assembly chamber on the Manhattan side. This transport process posed some unique challenges, as the submersed tube had a square cross section of 4.5-m- wide x 4.5-m-high (15- x 15-ft) — much smaller than the TBM diameter of 6.7 m (22 ft). Further limitations, including a live subway tunnel only 1.5 m (5 ft) above the crown of the westbound tunnel, restricted the underground assembly chamber size to 23-m-long x 7-m-wide (75-ft x 23-ft).

During assembly, main beam TBM outer components, including the outer segments of the cutterhead and hydraulic supports, were transported to the assembly chamber ahead of the machine. The "core" of the TBM, including the square-shaped inner ring of the cutterhead, the main beam, gripper assembly and drive units, was then assembled at the bottom of the shaft and walked forward using the transport dollies. The dollies allowed the partially assembled TBM to move forward as backup decks were added.

Conveyor systems in urban settings

The innovative conveyor design involves nine separate belt conveyors. They handle muck simultaneously from two tunnels and crossing major structures including highways and rail lines.

The system consists of two extensible fabric belt

The innovative Robbins Conveyor System consists of every commonly recognized version of belt conveyor.

conveyors 914-mm- (36-in-) wide traveling behind the main beam and double shield TBMs. These conveyors dump by a crown-mounted cross conveyor onto a single 1,860-m (6,100-ft), fixed-length conveyor mounted inside the submersed tube.

From the tunnel, muck is transported up the 23-m- (75-ft-) deep Queens shaft using a fixed-length, steel cable vertical conveyor. Once the muck has reached the top of the shaft, it is transferred to the rail yard using three overland conveyors and a radial stacker. The second overland conveyor, 37 m (120 ft) in length, crosses Northern Boulevard, a major thoroughfare in Manhattan. This conveyor was designed as an enclosed box truss to eliminate debris from reaching the roadway. It sits approximately 6 m (20 ft) above Northern Boulevard and under pre-existing rail lines. From this second overland conveyor, muck discharges onto a final overland conveyor and then to a radial stacker in the Sunnyside Rail Yard, more than 366 m (1,200 ft) away from the opencut.

New York City's East Side Access project will provide a new subway line between Manhattan and Queens underneath the East River.

Excavating the headings

Before launch of the Robbins main beam TBM, additional tunnel support was added in the form of a counter frame in the adjacent tunnel, providing support to the 1.5-m- (5-ft-) wide pillar of rock separating the two tunnels.

The slim pillar required several modifications to the westbound machine during the first half of the drive. "Crews had to reduce the gripper and thrust pressure by 45 to 50 percent, to ensure that the force reacted against the tunnel walls was within safe limits," said King Daniels, field service manager for Robbins. The machine also encountered some fractured ground with seams early in its drive, requiring up to eight steel ribs per day in addition to rock bolts.

The double shield TBM completed its initial heading on July 2, 2008, averaging 10 m/d (32 ft/day). The machine has since been retracted into a large crossover cavern while a roadheader excavates the launch chamber for its second heading.

The first heading for the main beam machine was completed on Sept. 29, 2008, with the machine averaging about 11 m/d (37 ft/day). As of October 2008, retraction of the main beam TBM into the larger cross-over cavern was under way. Crews first removed rails to clean the tunnel invert and then replaced the rails before retraction began. "The retraction process has gone very well. Our best result was about 76 m (250 ft) of retraction in one eight-hour shift," said Kerry Clark, Robbins field service superintendent. The machine is fully assembled and using the gripper system to reverse out of the tunnels. The 'umbrella' action of the machine will not be used until the machine reaches its second heading, when it will be retracted the full 1.9 km (1.2 miles), past concrete formwork that will restrict the tunnel diameter.

The Robbins continuous conveyor system is also operating smoothly at the site. Since going online in January to receive muck from both tunnel headings, the conveyor system has been operating at an average of 89 percent system availability. The efficiency of the system is in part due to the VFD conveyor drives and PLC controls, which regulate belt tension, torque and overall speed.

Both TBMs will be launched to bore on their second headings by January 2009. The East Side Access project is one of several MTA projects under way in New York City and is scheduled to be operational by 2013. ■

NEW TECHNOLOGY

Sandvik offers new DTi-series tunneling jumbos equipped with i-Sure software

The new DTi-series Sandvik tunneling jumbo is the culmination of 50 years of experience, research and development in drilling, said Jorma Kalliomäki, market and offering manager tunneling and underground civil engineering at Sandvik.

"This has been one of the most comprehensive projects we have ever accomplished. There was a global team for assessing the customer needs when we started and our key customers have played a central role in the development work. We have received very good feedback already; one of the operators at Lemminkäinen – the company runs one of the first units – told us that this is the best tunneling jumbo of all times"

The intelligence features in the DTi jumbos include data collection of production and process information such as round data, cumulative production data and drilling parameters logging that help production logistics planning, scheduled maintenance and productivity improvement.

The DTi series jumbos are designed for automatic use. With the automatic mode, the jumbo works as per the designed drill plan and drilling sequence. For added flexibility in special rock conditions, there are also a range of practical features allowing the operator to fine tune the process online. Lock-to-Target helps the operator to rapidly find the correct hole position. QuickStep allows the operator to affect the operation steps and Dynamic Correct continuously redirects drilling when the booms are moving, keeping the hole bottom as planned. The operator can also adjust drilling power level, feed and rotation speed online when appropriate.

Adding to the accuracy of the DTi series is the boom control. It is based on proven and widely tested deflection compensation but improved further with new features: Roll-over joint and boom location compensation model.

The DTi series advanced accuracy features also include a new type of front centralizers for drill steel guidance in the collaring phase. In addition, the drill bit remains inside the front guide in the collaring. This allows the bit to get as close to the rock as possible.

The new Sandvik DTi tunneling jumbo.

The DTi jumbos use an advanced tunnel planning software, Sandvik iSure that offers a new and efficient way of working with blasting and drilling pattern simultaneously. The major benefit of the new software lies on the use of the level of hole ends — where the excavation is at its most demanding and where more energy is needed to break and loosen rock — for calculating the hole spacing and burden The iSure ensures optimized blasting as per plan and supplies better pull-out, decreased need for scaling, increased rock loadability and smoother collaring in the following round.

The iSure also produces a perfect review of the drilling process as it offers a possibility to report round, user, service as well as overall performance. The reports offer a numeric and a graphical display of the results. Moreover, the iSure generates visual three-dimensional and diagram presentations of several essential parameters of drilling, offering an MWD tool for excavation process development and rock monitoring development.

The Sandvik i-series jumbos, as well as the iSure tunnel plan software, offer the possibility to define separate drilling parameters for different kind of holes. This feature allows low power and longer collaring phase for contour holes where accuracy plays a key role and high power for field holes to cut down the round time without sacrificing the profile quality.

Another feature to increase accuracy is the possibility for advanced factory calibration meant for customer use in job site conditions.

The modern, FOPS-certified safety cabin with 20 percent larger-than-before window surface gives a feeling of space and provides top visibility in all drilling applications, also when the cabin is not elevated. Adding to the visibility is an operator seat placed as close to the windshield as possible, and high power xenon lights for drilling and tramming. Ergonomically designed workstation with armrest integrated controls, efficient air filtration and optimized flow, and excellent noise (75 dB (A)) and vibration suppression. ■

UCA of SME forms Education and Training Committee

At its Aug. 5, 2008 meeting, the UCA Executive Committee approved the establishment of the permanent Education and Training Committee. The mission of this committee is to increase the quality of education and training available to engineers and construction supervisors. The committee will enhance the training of tunnel engineers and constructors to improve the efficiency and effectiveness of the industry.

A number of possibilities for training initiatives were discussed. These included the creation of an institute or academy operated by SME volunteers and a certificate program. The first goal is to recognize a basic level of competence and understanding in tunnel engineering and construction. Another goal of the committee is to encourage continuing education, so that practitioners can stay current with the changes in the underground industry. However, no initiatives were approved at the August meeting.

The Education and Training Committee seeks industry volunteers to participate in committee functions and be a part of the development of all initiatives. Participation on this committee does not require a permanent commitment of time, but it does require creativity and an interest in advancing the professionalism of the industry. If you are interested in serving on the Education and Training Committee, please advise any of the following persons by e-mail before Dec. 31, 2008.

- William Edgerton, edgerton@jacobssf.com.
- Brenda Bohlke, bmbohlke@hotmail.com.
- Mary O'Shea, oshea@smenet.org.

Immediately following the Jan. 28, 2009 UCA Executive Committee meeting, those selected to be a committee member will be notified of the time, date and other logistics for the first organizational meeting. ■

BYLAWS

UCA of SME proposes updated bylaws

The Executive Committee of the Underground Construction Association (UCA) division has recently reviewed the division's bylaws and has made some changes to improve clarity and consistency. In particular, it has added conference program committees for the North American Tunneling Conference and the Fox Conference, along with a Program Oversight Committee with representatives from the Executive Committee. In addition, the changes clarify the standing committees and task forces. The revised bylaws are on the UCA Web site, www.uca.smenet.org, for member review and comment. These changes and any additional comments will be addressed at the January 2009 meeting of the UCA Executive Committee. Please send comments to: ucachair@smenet.org with a copy to oshea@smenet.org.

Article I — Name and Objective

Section 1. The organization will be called the Underground Construction Association of the Society for Mining, Metallurgy, and Exploration – (UCA of SME), hereafter referred to as the Division.

Section 2. The purpose of the Division shall be the multidisciplinary exploration of all professional concerns, which promote the wise and effective development and use of underground space, including the development of general public awareness of the potential of this important resource.

The goals of the Division shall be the following:

1. To act as an advocate and proponent for the development and use of underground space and related facilities;

2. To act as an advocate and proponent for all firms and individuals, collectively, who represent any and all aspects of the wise and effective development and use of underground space and related facilities;

3. To provide a communications link, a forum, and educational services for members, related organizations and the general public;

4. To be a repository of information related to the development and use of underground space and related facilities.

The Division shall encourage education, scientific investigation, and research on technical, environmental, legal, economic, social and political issues associated with the development and use of the underground space and related facilities, and shall gather, correlate and disseminate information that improves our ability to characterize, design, construct, use and maintain underground space and related facilities.

The Division shall promote professional competency and good practices in all professions involved in all aspects of the development and use of underground space and related facilities.

Article II — Membership

Section 1. Membership in the Division is open to all with a professional interest in the underground industry. Members of the

Division must be members of SME, and elect the UCA option on the membership form.

Participation by all persons with a professional interest in the development or use of underground space and related facilities shall be encouraged, including individuals and organizations engaged in underground construction, mining, geotechnical services, equipment manufacturing, civil engineering, geology, geography, architecture, law, economics, conservation, planning, sociology, or any other profession or activity involved in the development or use of underground space and related facilities.

Section 2. Members of the Division shall be classified as individual professional members, registered members, and student members. Members in all classes have all the rights and privileges of membership except as noted below.

A. An "individual professional member" shall be a person.

B. A "registered member" shall be a person meeting certain education and experience requirements defined by SME and who is willing to abide by the SME Code of Ethics in their professional activities.

C. A "student member" shall be a person who is a full-time graduate or undergraduate student in good standing.

Section 3. Sponsors shall be classified as either corporate or sustaining sponsors. In addition to the ability to name individual professional members, sponsors shall be given other rights and privileges as determined by the Executive Committee.

A. A "corporate sponsor" shall be a firm, corporation, society, agency of government, or other organization. Corporate sponsors shall be entitled to designate two individual professional members with all the rights and privileges thereof.

B. A "sustaining sponsor" shall be a firm, corporation, society, agency of government, or other organization electing to give greater support to Division activities through the payment of larger dues. A sustaining sponsor shall be entitled to designate five individual professional members with all the rights and privileges thereof.

Section 4. Admission to and continuation of membership shall be contingent upon (1) membership in SME and (2) a professional interest in the development or use of underground space and related facilities.

Section 5. Each professional or registered member shall be entitled to one vote on each matter submitted to a membership vote.

Section 6. Each member shall receive a subscription to the Division's official journal in addition to all other benefits received as a member of SME.

Article III — Finances

Section 1. The Division may solicit voluntary contributions subject to approval of SME, and it may accept contributions.

Section 2. The disbursement of funds received by the Division shall be authorized by the Executive Committee of the Division, and recommended to the SME Board of Directors for final approval.

Section 3. Upon the dissolution of the Division, all funds remaining after payment of its debts and obligations shall be turned over and paid to an organization exempted under section 501(c)(3) of the Internal Revenue Code of 1954. This section of the Bylaws is not amendable during the existence of the Division.

Article IV — Officers and Directors

Section 1. Division Officers and Directors.

The Officers of the Division shall be the Chair, the Vice Chair; Secretary/Treasurer ex-officio non-voting (the SME Executive Director will serve as the Secretary/Treasurer); and the immediate Past Chair. The Division Officers should be rotated to represent, to the maximum extent possible, the diversity of fields of interest of the Division membership as qualified candidates become available. In addition to the Officers, there shall be not more than sixteen (16) and not less than twelve (12) Directors of the Division at any time. A balance of Directors should be sought to represent four (4) general categories of membership interest; namely owners, suppliers, contractors, and engineers. The Officers and Directors together shall operate and be known as the "Executive Committee" of the Division and may be individually referred to as an "Executive Committee Member." Student Members are not eligible to serve on the Executive Committee until which time they become a Professional or Registered Member.

Section 2. Nomination and Election of Executive Committee Members.

A. Officers. The Nominating Committee shall propose and submit to the Chair of the Division, on or before April 15 of the year that the term for the Vice Chair of the Division will expire, one or more nominees to serve as the Vice Chair for the following term of service. The Chair shall submit the nominee(s) to the Executive Committee for discussion and election of the new Vice Chair. At the Annual Meeting, the previous Vice Chair automatically becomes the new Chair, the previous Chair automatically becomes the new Past Chair, and the previous Past Chair is excused from service as an Officer of the Division.

B. Directors. The Nominating Committee shall propose and submit to the Chair of the Division, on or before April 15 of the year that the term for a Director of the Division will expire, one or more nominees to serve as Director for the subsequent term of service. The Chair shall submit the nominees to the Executive Committee for discussion and election of the new Director(s).

C. The Secretary/Treasurer shall arrange for the names of newly elected Officers and Directors, along with biographies, to be published in *Tunneling & Underground Construction*.

Section 3. Terms of Service. Each Officer shall serve for a term of two years, with their term of service beginning on July 1 of every odd year. Each Director shall serve for a term of four (4) years or, if elected to fill a vacated position, until the completion of an unexpired term. No Director will be allowed to serve more than two (2) full consecutive terms in addition to the completion of an unexpired term, if so appointed.

Section 4. Resignation, Removal, and Replacement of Executive Committee Members. In the event of the resignation, disability or other indisposition of any Officer or Director of the Division, or neglect in the performance of their duties, the Executive Committee shall declare their position vacant. Any Executive Committee Member who shall have unexcused absences from two consecutive meetings of the Executive Committee shall be deemed to have vacated their position on the Executive Committee and the vacancy shall be filled as provided herein. The Executive Committee shall have the authority by an affirmative vote of a majority of the Executive Committee to excuse an Executive Committee Member from attendance. The SME Board of Directors may also remove an Officer of the Division for cause. Removal of an Officer or Director of the Division shall not be accomplished in violation of the SME bylaws.

Article V – Committees

Section 1. General Provisions.

A. The affairs of the Division will be accomplished through the organization and efforts of the Executive Committee and other standing committees and task forces. The Executive Committee shall have general supervision over the activities of all other committees and task forces.

B. The standing committees identified in this Article of the Bylaws shall be established by the Executive Committee and the Executive Committee may establish other committees as needed. The Executive Committee shall authorize and appoint the chair for these standing committees and all other authorized committees and task forces and assign them such duties and authorities as it deems necessary to carry on the work of the Division. The chair of each committee or task force may appoint additional committee and task force members, in consultation with the Executive Committee.

C. Task forces may be established to represent a discipline or specialty of underground construction issues of current interest for the purpose of meeting a need for technical education or programming consistent with the goals of the Division. The Executive Committee Chair shall appoint task forces and their chairs as needed, in consultation with the Executive Committee. Task forces shall be established and authorized to function for not longer than one year, unless specifically authorized otherwise by the Executive Committee.

D. Committee chairs and members, other than the Executive Committee, generally should not serve for a term exceeding one-year and the term of service usually should end on June 30 of each year. However, the term of service for committee chairs and members, other than for the Executive Committee, may be renewed at the discretion of the Executive Committee Chair.

E. Resignation, Removal, and Replacement of Committee Chairs and Members. Any Officer or committee chair who has the authority to appoint a committee chair or committee member also has the authority to remove that person from their position for failure to perform the duties in an adequate manner, provided such action is not in conflict with SME bylaws. Should a vacancy occur for this reason or because a member is indisposed or resigns from a committee position, the same authority and process originally employed to fill the position may be used to a secure a replacement to serve out the term of the position.

Section 2. Executive Committee. The Executive Committee shall consist of the Officers and Directors defined in Article IV. The Chair shall manage the affairs of the Division between meetings of the Executive Committee. The Chair shall perform the usual duties of the office, including presiding at meetings of the Executive Committee, and shall serve as an ex-facto member of all committees. The Vice Chair shall discharge the duties of the Chair when the Chair is absent. The Executive Committee shall meet on call of the Chair or any three of its members. A quorum shall be constituted with a majority of Executive Committee Members present, one of whom must be the Chair or Vice Chair.

Section 3. Program Oversight Committee. The Program Oversight Committee is responsible for oversight of the biennial North American Tunneling (NAT) Conference, Fox Conference and other programs as identified and approved by the Executive Committee for the current year. The Program Oversight Committee Chair will be the Executive Committee Chair. The Program Oversight Committee members shall consist of the Executive Committee Vice Chair and such other members as

BYLAWS

the UCA Chair may appoint.

Section 4. Program Planning Committees. Program Planning Committees are responsible for the execution of the biennial NAT Conference, Fox Conference and other programs as identified and approved by the Executive Committee for the following year. Program Planning Committees shall consist of at least one Executive Committee Member nominated at the beginning of the programming cycle by the Program Oversight Committee. Recurring programs, such as annual or biennial conferences, may develop Program Planning Committee guidelines to facilitate efficient continuous execution of the program. These guidelines require approval by the Program Oversight Committee.

Section 5. Nominating Committee. The Nominating Committee shall be chaired by the Past Chair of the Executive Committee or, if the current Past Chair is not available, a previous Past Chair of the Executive Committee. The Nominating Committee members will include the current Chair and Vice Chair of the Executive Committee and up to three other Division members who have previously served but are not currently serving on the Executive Committee.

ARTICLE VI — Duties of Officers and Other Representatives

Section 1. The duties of the Chair are as follows:

A. Preside at the annual business meeting of the Division, which will take place at the time of NAT or Rapid Excavation and Tunneling Conference;

B. Preside at the annual Division functions;

C. Call other meetings as required to transact the business of the Division;

D. Coordinate the programs for the meeting of the Division;

E. Transact all business of the Division not specifically delegated to other Officers by these Bylaws;

F. Keep SME Headquarters advised of actions taken;

G. Arrange the program for the annual social function and meeting of the Division held at the conclusion of his/her term as Chair:

- Speaker (if one is desired).
- Identifies guests (other Divisional, Society, and Institute Officers).

H. Install incoming officers at the end of the Annual Business Meeting; and

I. Keep the Vice Chair apprised of goals and activities so that the Vice Chair can function effectively in the event the Vice Chair has to act for the Chair.

Section 2. The Vice Chair shall act for the Chair if the Chair is unable to function or attend any meetings. The Vice Chair shall assist the Chair as directed.

Section 3. The Program Oversight Committee Chair shall represent the Division on the SME Program Committee.

Section 4. The Program Planning Committee Chairs shall represent the Division on the SME Program Coordination Committee.

ARTICLE VII — Amendments

These Bylaws may be amended by affirmative action by letter ballot of a majority of the UCA Executive Committee whose properly executed ballots are received on or before the day previously announced for canvass of the vote and by consent of UCA of SME.

Proposals to amend these Bylaws shall be made by the UCA Division Executive Committee. They shall be considered by the Executive Committee and announced to the UCA members in *Tunneling & Underground Construction* for 60 days, together with any comments made by the Executive Committee thereon. Following the required 60 day announcement period, the Executive Committee shall provide a proper vehicle for a vote of the Executive Committee Members on such proposals in an expedient manner. If favored by a majority, the amendments shall thereupon be submitted to the SME Board of Directors for final approval. ■

CHAIRMAN'S COLUMN

Volunteer for a UCA committee

(Continued from page 4)

under construction in Austria. The Fox conference is held every year the day before the Mole Annual Banquet, making it convenient for attendees to take in both events in a short two-day visit to New York.

The UCA will have a technical session on underground ventilation at the SME Annual Meeting in Denver, CO Feb. 22-29. The session is being organized by Richard Potter of Arup.

The UCA of SME is also organizing a short course on shaft design and construction in Atlanta, GA Sept. 10 and 11, 2009. This two-day workshop will include a half-day field trip.

Be looking for notices, brochures and e-mail alerts concerning this course. ■

PERSONAL NEWS

DAVID YANKOVICH P.E. (SME) has joined Parsons Brinckerhoff as the principal project manager of the Joint Water Pollution Control Plant Tunnel and Ocean Outfall project for the sanitation districts of Los Angeles County. Yankovich has 28 years of experience in civil and structural engineering, especially in the design and management of water and transportation infrastructure. ■

Weda pumps available from Atlas Copco

At the MinExpo 2008 convention in Las Vegas, NV in September, Atlas Copco announced the launch of the Weda range of pumps.

There are now 16 models of submersible drainage and one sludge pump to choose from. The motors range from 1 to 85 hp in three-phase or single-phase power options. The 51- to 254-mm (2- to 10-in.) discharges can pump up to 82 m (270 ft) and 19,000 L/min (50,000 gpm).

Weda pumps include the seal system that is straightforward and can be replaced in 30 minutes.

The Weda pump is easily transportable and simple to install because of its compact design. The high chrome steel impeller and rubber-lined wear parts add to its longevity.

Weda pumps.

www.dynapac.com

TBM guidance system

The acs TBM guidance system for Tacs gmbh acts as an interface between the areas of expertise in mechanical tunneling. By integrating methods, insights and practical experience of surveying, civil engineering and machine technology, multidisciplinary synergy effects are released.

It used to be the surveyors' task to determine the position of the tunnel boring machine (TBM). The operator of the TBM tried to navigate the TBM close to the designed tunnel axis at the end of each advance as exact as possible. The ring builder tried to build the ring inside the TBM tail as exact as possible.

By providing clear graphical and numerical displays, the relationship between determination of position, initiation of navigation steps and building rings without squeeze tensions becomes apparent to the user. Some of the damages that occured at the final tunnel in the past can, therefore, be avoided.

www.tacsgmbh.de

Solutions for fracturing when blasting is not an option

When blasting is not an option, the non-explosive demolition agent Da-mite rock splitting mortar can be used to break concrete or rock quickly and quietly.

Rock splitting mortar can be used on boulders or reinforced concrete to split and fracture the material, speeding its removal.

Mass rock can be drilled with holes up to 76-mm (3-in.) in diameter cutting drilling costs and speeding excavation. This makeDa-mite flexible in its use.

Da-mite is useful for rock that is in a compressive condition in a pit or trench can be fractured and excavated. It can also eliminate vibration from blasting, fly rock, permitting, seismic and explosives monitoring and minimize vibration from large breakers.

Da-mite starts with the typical demolition process of drilling holes in the rock or concrete. From there, Da-mite rock splitting mortar is mixed with a fixed quantity of water and poured into the predrilled holes. Da-mite will set and eventually expand with a force of more than 18,000 psi, overcoming the tensile strength the rock or concrete.

www.daighcompany.com

Akkerman introduces Jetting and Lubrication Pump

Akkerman Inc. has introduced the combination Jetting and Lubrication Pump for its guided boring machine (GBM) system.

The new Jetting and Lubrication Pump arrangement allows customers to maintain optimum production rates in variable soil conditions in one compact, easily-transported unit.

The Jetting and Lubrication Pump features independent hydrostatic flow controls for premium user control in a variety of soil conditions during each step in the three-step GBM process. The pumps are made with either a 3,000 rpm, 22 kW (30 hp) diesel engine or the equivalent ac electric power source. The large 1,230 L (325-gal) tanks provide appropriate production capacity to meet powered cutter head (PCH) and cutter head with integral swivel requirements. The tanks can be easily serviced at the open/close valve on the tank outlet. Highly transportable, contractors will find the Jetting and Lubrication Pump platform easy to move on site and travels well on a flat bed trailer. ■

www.akkerman.com

• Denotes new listing.

Industry Events

January 2009

• **20-22, Underground Construction Technology Conference and Exhibition,** Henry B. Gonzalez Convention Center, San Antonio, TX. Contact: Karen Francis, P.O. Box 941669, Houston, TX 77094-8669, phone 281-558-6930, ext. 222, fax 281-558-7029, e-mail kfrancis@uctonline.com. Web site www.uctonline.com.

February 2009

• **9-12, Microtunneling/Pilot Tube,** Colorado School of Mines, Golden, CO. Contact: Office of Special Programs and Continuing Education Colorado School of Mines Golden, CO 80401. phone: 303-273-3321, fax: 303-273-3314, e-mail: space@mines.edu, Web site www.mines.edu/outreach/cont_ed/microtun.html.

8-11, 35th Annual Conference on Explosives and Blasting Techniques, Hyatt Regency, Denver CO. Contact: International Society of Explosives Engineers, 30325 Bainbridge Road, Cleveland, OH 44139, phone 440-349-4400, fax 440-349-3788, e-mail isee@isee.org, Web site www.isee.org

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

May 2009

23-28, 35th Annual ITA-AITES World Tunnel Congress, Budapest Congress and World Trade Center, Budapest, Hungary. Contact: phone 36-1-214-7701, fax 36-1-201-2680, e-mail secretariat@wtc2009.org, Web site www. wtc2009.org/00entry.htm.

June 2009

14-17, RETC 2009, Las Vegas, NV. Contact: Meetings Dept., SME, 8307 Shaffer Parkway, Littleton, CO 80127, phone 800-763-3132 or 303-973-9550, fax 303-979-3461, e-mail sme@smenet.org, Web site www.smenet.org.

22-25, 5th Symposium on Strait Crossings, Trondheim, Norway. Contact: Strait Crossings 2009, NTNU VIDERE, Pavilion A, Dragvoll, NO-7491 Trondheim, Norway, Attn: Astrid Bye/Jorunn Sommervold, phone 47-73-59-52-54 or 47-73-55-04-41, fax 47-73-59-51-50, e-mail sc09@adm.ntnu.no, Web site www. straitcrossings.com. ■

September 2009

9-11, EURO:TUN 2009, Ruhr University, Bochum, Germany. Contact: Institute for Structural Mechanics - Ruhr-University Bochum, phone 49-234-32-29069, fax 49-234-32-14149, e-mail felix.nagel@rub.de, Web site www. eurotun.rub.de. ■

UCA of SME

Eighth Annual George A. Fox Conference

Large Rock Cavern and Soft Ground Mechanical Excavation

January 27, 2009

Graduate Center, City University of New York

New York, NY

FOR ADDITIONAL INFORMATION CONTACT: Meetings Dept., SME 800-763-3132, 303-973-9550, fax 303-979-4361, e-mail sme@smenet.org

TUNNELING & UNDERGROUND CONSTRUCTION INDEX TO VOLUME 2
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* Denotes feature article or technical paper

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