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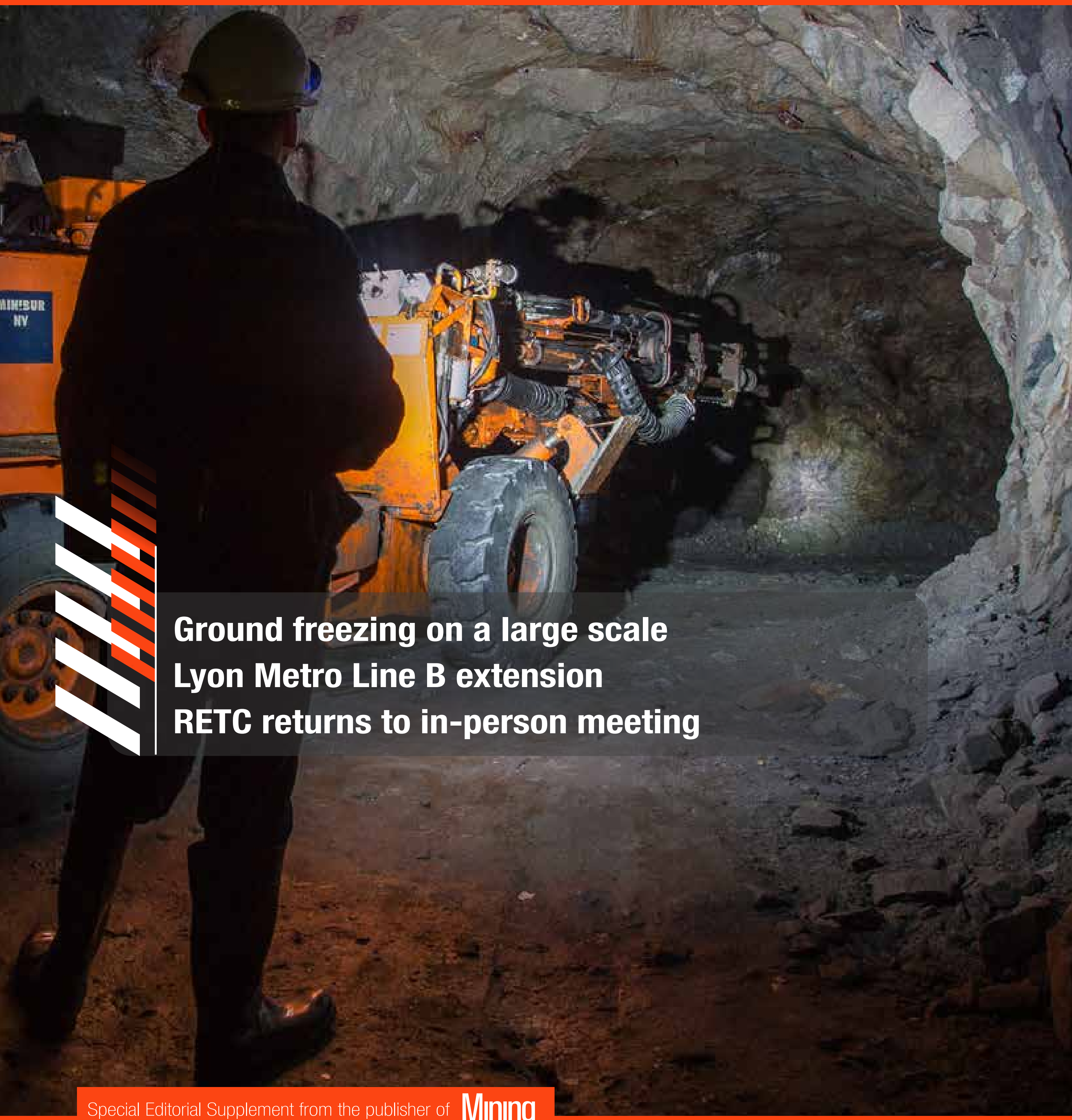

Ground freezing on a large scale

Lyon Metro Line B extension

RETC returns to in-person meeting

Special Editorial Supplement from the publisher of Mining engineering


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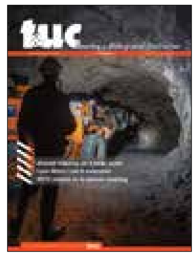

In This Issue

Ground freezing technique to provide temporary earth support and ground water control, originated in the mining industry in the late 1800s. On page 39 J. Sopko and F.A. Auld provide an in-depth look at the history and advantages of ground freezing to sink shafts.

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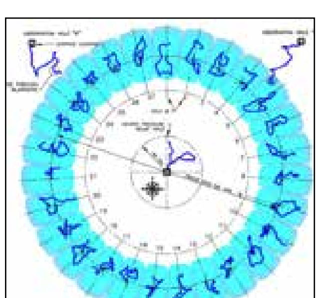

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Special editorial section from the publisher of Mining Engineering

Mining engineering

Into the breach ... New leadership for the UCA

It seems somehow fitting personally that the technical theme of this issue of *T&UC* is shafts. Shafts are often the entry point into our great tunneling and underground excavation projects: the start, the point of ingress, the beginning of ambitious works underground.

This coincides with the beginning of my two-year tenure whereby I have the honor of representing our association, the UCA of SME, as chair. Perhaps there's a serendipitous analogy there somewhere; "into the breach," as they say.

It's my pleasure to welcome Erika Moonin, of Moonin Associates, to the position of vice-chair. I am delighted to have her support in this role over the next two years and wish her the very best as she embarks on her six-year journey as a UCA Officer.

I also celebrate the accomplishments of Bob Goodfellow, of Aldea Services, as he concludes his term as chair and transitions to past-chair. Bob has done a spectacular job over the last two years under what can only be defined as very challenging circumstances. The association has moved impressively forward and he has left "big shoes to fill." I'll count on the inspiration he has given me as a sustaining force.

Mike Roach, of Traylor Brothers, now leaves the officer roll, concluding his term as past-chair. He has also been inspirational to me and has served with great energy and distinction over his six-year span. While the current term concludes, I am sure that we will continue to benefit from Mike's presence and experience in the UCA.

I welcome also the new members of the executive committee (UCA ExCo), Douglas Gabriel, Moussa Wone and John Huh who began on July 1. And I recognize and thank Pamela Moran and Edward Dowey whose terms ended at that time. Your service to the industry is greatly appreciated.

Our UCA has grown in leaps and bounds over the last decade. Perhaps some of this growth has been readily apparent, perhaps some not. Accordingly, when taking stock of where we are currently, it occurred to the officers that it may be helpful to map the organization in a way that showed, on a single page, a summary of the responsibilities and undertakings with which we are involved. I hope that you will share my conviction that we are active in a lot of ways that are beneficial to our membership and the industry. We also chose to align positions under each of the volunteer officers, such that there is structure but, more importantly, to assign to each of us the clear responsibility of supporting and nurturing the efforts of each of the volunteer initiatives (see UCA executive committee organizational chart on page 49).

It's my sincere hope that you will also note that there are a number of open opportunities to get involved and participate in UCA, if you are not already and if you have the drive and energy to do so. The UCA staff is working on a volunteer portal for the UCA website, whereby you, the membership, will have the opportunity to see on a current basis what opportunities are available, and with whom to get in contact to get started. We are a volunteer organization and it is a strength of the UCA that our members, from all walks of the industry, get the opportunity to have voice and actions in where we go in the future.

Speaking of the future, a hallmark of any good organization is not just being able to point to where it is but also where it wants to go and how it plans to get there. Serendipitously (again), the UCA ExCo has recently put the finishing touches on the UCA Strategic Plan update, whereby we

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EDITORIAL STAFF

Editor
William Gleason
gleason@smenet.org

Production Graphic Artist
Ted Robertson
robertson@smenet.org

BUSINESS STAFF

Media Manager
Advertising
Gary Garvey
garvey@smenet.org

Phone +1-800-763-3132 or +1-303-973-4200
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US Senate passes $1 trillion infrastructure bill

On Aug. 10, the U.S. Senate passed a $1.2 trillion infrastructure bill aimed at repairing and enhancing the nation's infrastructure including transportation and water tunnels along with roads, bridges and the electric grid.

The bipartisan bill advanced out of the Senate with a 60-30 vote with 19 Republicans voting yes. The bill still needs to be approved by the U.S. House of Representatives where it faces a less certain future before it can be sent to President Joe Biden.

Following the Aug. 10 vote, Senate Democrats pushed ahead with a $3.5 trillion budget reconciliation.

The bill — called the Infrastructure Investment and Jobs Act — features $550 billion in new federal spending over five years. It invests $110 billion in roads, bridges and major projects, $66 billion in passenger and freight rail, $65 billion to rebuild the electric grid, $65 billion to expand broadband internet access, $39 billion to modernize and expand transit systems and $7.5 billion to build a national network of charging infrastructure for electric vehicles. Among other priorities, the bill also includes $55 billion for water infrastructure, $15 billion of which will be directed toward replacing lead pipes.

NJ.com reported that New York and New Jersey are among the states that could see the largest benefits from the bill.

The legislation provided several possible funding sources for the federal share of the long-awaited $11.6 billion Gateway Tunnel under the Hudson River. The long-sought-after project would build a new tunnel to carry Amtrak and New Jersey Transit trains to and from New York's Penn Station, allowing the existing tubes to be closed to repair damage caused by Hurricane Sandy.

"The biggest obstacle has been funding," said Transportation Secretary Pete Buttigieg during a visit to New Jersey. "This is our chance to do something very big about that biggest obstacle."

That funding could come from $16 billion set aside for major projects deemed to provide substantial economic benefits, $30 billion earmarked for Amtrak's Northeast Corridor, and $8 billion for capital improvement grants.

New York City's transit system will be one of the biggest beneficiaries

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Tunnel boring machine lowered at Clearwater Project in Los Angeles

The ambitious $630-million Clearwater project in Los Angeles, CA to replace two aging underground wastewater pipes launched on June 21 as the tunnel boring machine (TBM) was lowered to begin boring the 11-km (7-mile) project.

The *San Gabriel Valley Tribune* reported that the details have been continually refined since planning began in 2006. The Clearwater Project was approved in 2012 by the Los Angeles County Sanitation Districts and was described by engineers involved in the work as sophisticated, intricate and precise.

The boring of the project will begin in July or August and will take about four years to complete. Factoring in a two-year project at the end to build a smaller shaft at Royal Palms Beach in San Pedro that will connect to the existing outfalls to the ocean, the entire project won't be finished until 2027, according to current projections.

The aim of the project is to replace two aging wastewater pipes — installed in 1937 and 1958 — with one 5.4 m (18-ft) wide pipe sufficient for much larger water flow.

The new tunnel will be between 15 and 140 m (50 and 460 ft) below the surface, depending on the overlying topography. At the beach, the tunnel will be 9 m (30 ft) below the surface.

"It will take three and a half to four years of tunneling from Carson to Royal Palms Beach," said Clearwater spokesman Glenn Acosta. "Just before that, the work on the beach will start to build a smaller shaft" to connect to the existing outfalls. Three of the four existing ocean outfalls are in good working order. The work at the beach, planned for 2024-25, should take about two years with the beach and parking remaining open, Acosta said.

The need for the project was first documented as planning began. Currently, 73 of Los Angeles County's 88 cities rely on the existing antiquated pipelines to take more than 260 million gallons of treated

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Northeast Corridor Commission releases $117 billion plan

The United States' Northeast Corridor (NEC) Commission released the US$117 billion Connect NEC 2035 (C35) 15-year plan on July 14.

The NEC, primarily owned by Amtrak, runs from Boston via Providence, New Haven, New York City, Philadelphia, Wilmington and Baltimore to Washington, DC.

"C35 represents the most ambitious reinvestment program in the NEC's history and a new way of planning: a multi-agency, multi-year, shared action plan guided by a long-term vision," NEC said in its executive summary. "The state governments of the Northeast, the federal government, eight commuter rail agencies, and Amtrak have come together through the NEC Commission as never before to develop a detailed and efficient sequencing of infrastructure investments over 15 years. If funded, this program will achieve significant progress on improving service and eliminating the state-of-good-repair (SOGR) backlog, while keeping this critical system running safely and reliably, and supporting our economy."

The "new way" is described as "a multi-agency, multi-year, shared action plan guided by a long-term vision." The northeast state governments, United States federal government, eight commuter rail agencies and Amtrak collaborated through the NEC Commission "to develop a detailed and efficient sequencing of infrastructure investments covering 150 projects and capital renewal efforts along the corridor.

"Improving the NEC rail system is a vital multi-state effort," said deputy federal railroad administrator and NEC Commission co-chair Amit Bose. "C35 is a sequenced plan and a mobilizing force that not only puts people back at work renewing the NEC, but also supports new travel patterns as our economy returns to full strength."

The NEC Commission is governed by a board comprising one member from each of the NEC states – Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware and Maryland – and the District of Columbia; four members from

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Undersea tunnel planned to release treated water from Fukushima nuclear power plant

Tokyo Electric Power Company Holdings Inc. (TEPCO) announced that it plans to build a 1-km (0.6-mile) undersea tunnel that will release treated radioactive water from the crippled Fukushima Daiichi nuclear power plant out to sea.

The undersea tunnel will be constructed by hollowing out bedrock on the seabed near the No. 5 reactor at the Fukushima plant.

It will stretch 1 km (0.6 mile) east from the plant out to sea, releasing the water into an area of the ocean where no fishing rights are in place, according to the sources.

KYODO News reported that the level of the radioactive substance tritium that remains in the treated water will be diluted to below regulatory standards, however, the plan has faced opposition from fishermen.

TEPCO plans to dilute the treated water with a large amount of seawater to reduce its tritium concentration to less than 1,500 becquerels per liter. As the seawater within the nuclear plant's port area contains radioactive materials, the water will be taken from outside the port.

The Japanese government said the same day it will buy marine products as an emergency step to support fishermen if the planned discharge of treated water from the Fukushima plant into the sea hurts their sales. The government decided in April to start discharging the water from around spring of 2023.

TEPCO plans to apply to the Nuclear Regulation Authority for a review of the tunnel construction plan and begin preparatory work in the near future. It is seeking to start full-scale construction in early 2022, with the discharge of treated water to begin around spring 2023 in line with government policy.

The operator has also considered directly releasing water from within the plant site to reduce construction work, but the diffusion of tritium remained a key concern. It said it will increase the sampling locations and frequency of tritium concentration measurements in the surrounding area.

More than 907 kt (1 million st) of treated water has accumulated at the complex since a massive earthquake and tsunami triggered a triple meltdown at the Fukushima plant in March 2011.

Water pumped into the ruined reactors at the Fukushima plant to cool the melted fuel, mixed with rain and groundwater, which has also been contaminated, is being treated using an advanced liquid processing system.

The process removes most radioactive materials, including strontium and cesium, but leaves behind tritium, which is said to pose little health risks in low concentrations. ■

Key decisions for Hudson Tunnel Project reached in May

The planned $11.6 billion Hudson Tunnel Project reached two key milestones on May 28 when the Federal Railroad Administration (FRA) along with NJ Transit and the Port Authority of New York and New Jersey issued the Final Environmental Impact Statement (EIS)/Final Section 4(f) Evaluation for the Hudson Tunnel Project.

The Hudson Tunnel Project proposes to rehabilitate the existing tunnel under the Hudson River that carries Amtrak and NJ Transit Northeast Corridor passenger trains between New Jersey and New York, and construct a new tunnel and associated railroad infrastructure to carry passenger rail trains while the existing tunnel is being rehabilitated.

The final EIS and Record of Decision for the Hudson Tunnel Project from the FRA and TTA are key steps for the project that is a crucial economic link in the U.S. Northeast.

“This is a big step for the Northeast, and for the entire country, as these tunnels connect so many people, jobs and businesses,” U.S. Transportation Secretary Pete Buttigieg said in a statement.

Approximately 450 trains every weekday use the Hudson Tunnel and, before COVID-19, approximately 200,000 daily passenger trips took place, *Reuters* reported.

The Hudson Tunnel Project is one component of the Gateway Program, a major project to overhaul much of the aging rail infrastructure in the New York City area.

U.S. passenger railroad Amtrak in April asked Congress for $16 billion for Gateway, including $6.7 billion over five years for the Hudson Tunnel project. The project would result in four modern tubes connecting New Jersey to New York Penn Station in Manhattan.

The 111-year-old New York City-area rail tunnel was damaged in 2012 when Superstorm Sandy flooded parts of the city.

The department noted no federal funding has been dedicated for the Hudson Tunnel project to date. Completion of these two

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Bart Silicon Valley Phase II names joint venture finalists

Three joint ventures have been shortlisted for the Santa Clara Valley Transportation Authority's (VTA) estimated US$2 billion tunnel and trackwork contract for the Bay Area Rapid Transit (BART) Silicon Valley Phase II (BSVII) extension project.

VTA reported the project has advanced to the final step in the application process for the Federal Transit Administration's Expedited Project Delivery Pilot Funding Program (EPD), and selected three joint ventures to submit proposals.

VTA has applied for $1.735 billion in federal funds through the EPD Program which will complete the funding plan to build the Phase II Project.

"Advancing to the next step in the evaluation process reaffirms that VTA has successfully demonstrated the merits and management of the project and has met all the requirements to be considered for funding through the program," said VTA board chair Glenn Hendricks.

The application included information about the project's local funding sources, inclusion in local and regional plans, environmental clearance, documentation of estimated capital and operating costs, engineering and design documents, ridership projections, project benefit information related to mobility, congestion relief, environmental and economic development; the project's public-private partnership agreement and critical third-party agreements.

In December 2020 the Phase II Project issued a Request for Qualifications from the contracting community for the tunnel and trackwork contract, one of the four contract packages for the project. The VTA evaluated the robust submittals which included information on past tunnel and rail projects, proposed management teams, project approach, and safety plans and records. Interviews were also conducted with the prospective teams. In response to the evaluation the following teams have been selected to the short-list are:

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Tunnel boring machine launched at New Zealand's largest infrastructure project

The tunnel boring machine (TBM) that will excavate a 1.6 km (1 mile) tunnel as part of the largest infrastructure project in New Zealand was launched on May 10.

The German-designed Chinese-built machine, named Dame Whina Cooper, was launched at the City Rail Link's (CRL) project's Mt Eden site. The CRL is a $4.4 billion project in Auckland.

"Completing Auckland's City Rail Link has taken an exciting step forward today with the official launch of the machine at the project's Mt Eden site," CRL announced.

The machine will be operated by the Link Alliance: New Zealand and international design and construction companies building stations, tunnels and rail systems.

NewsTalkZB reported that the first 50 m (164 ft) of tunnel at Mt. Eden has already been mined to give room for the front sections of the enormous 130-m (427-ft) long machine.

That will excavate 1.6 km (1 mile) under the Central Motorway Junction and Karangahape Rd into central Auckland to connect with the CRL tunnels already built from the Britomart Station.

The TBM is expected to complete her first tunnel near the end of the year, then be trucked back to Mt Eden in sections and prepared for its second tunnel drive next year.

Transport minister Michael Wood described the launch event as an "exciting milestone" for New Zealand's largest transport infrastructure project, "one that is helping our economic recovery and supporting jobs. Building infrastructure like the City Rail Link is part of our COVID-19 economic plan. This project is providing real jobs and opportunities for thousands of Aucklanders. It'll give us a step-change in our public transport and cultivate a diverse and highly-skilled workforce."

Mayor Phil Goff said: "The City

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Hudson Tunnel: Project includes new rail tunnel

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steps is a prerequisite for either agency to direct future federal funding to advance this project through pre-construction activities such as engineering, final design development, property acquisition and construction.

The Hudson Tunnel project includes building a new rail tunnel under the Hudson River and rehabilitating the existing tunnel, known as the North River Tunnel, once the new tunnel is complete.

When rehabilitation is complete, both tunnels would provide redundant capacity and increased operational flexibility for both Amtrak and NJ Transit.

President Joe Biden has proposed a $2.3 trillion jobs and infrastructure spending that includes $39 billion for modernizing the northeast rail corridor.

In total, Amtrak is seeking $31 billion from Congress over five years to overhaul the Northeast Corridor, the Boston to Washington, DC, corridor that is the busiest passenger rail route in the country. ■

Clearwater: Aging water tunnels will be replaced

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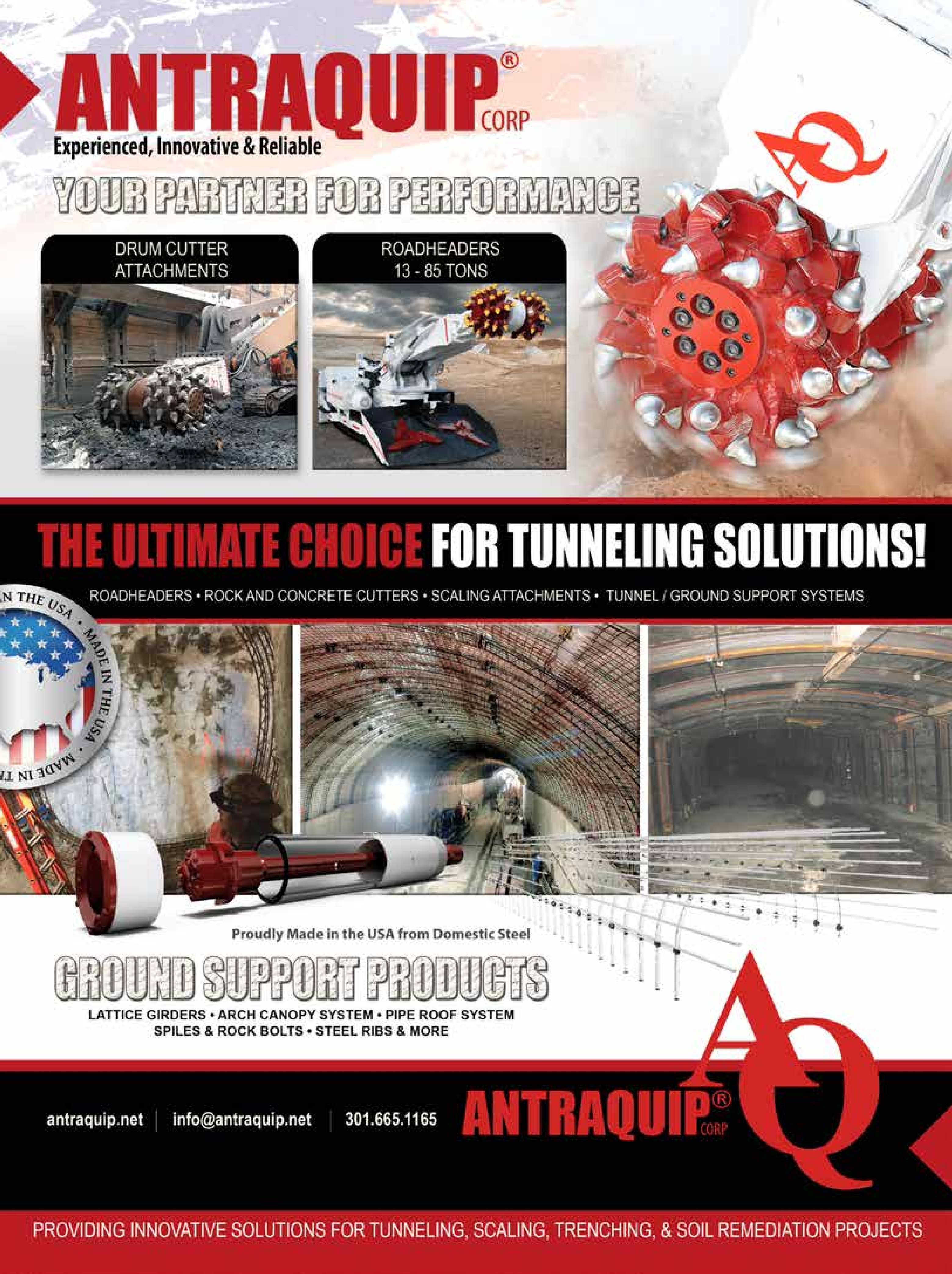
wastewater from the plant to the ocean.

The sanitation department, Acosta said, has been "the largest provider of recycled water in the U.S. Since 1962 more than a trillion gallons of water" have been recycled with 11 wastewater treatment plants across the county.

Recycling of water has become a pressing issue. But the water transported through the pipes being replaced — due to the many industrial sites that are its source in the southern region — is too salty to be recycled or used, he said. To remove all the salt and other impurities from that particular water requires an advanced water purification system that is still in the design phase. ■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Chairman's column: UCA tradition carries on

(continued from page 3)

affirmed a Mission, Vision and vivid description of a future state, and the goals and objectives that will enable us to get there. I invite you to review the details of the strategic plan later in this issue (see page 45). The ExCo welcomes any questions or feedback you may have. We encourage you to volunteer for one of the many opportunities and hope that you would choose to be a part of that collective journey.

I look forward to meeting as many of you in person as possible as things (hopefully) continue to open up and the opportunities for face-to-face interaction increase.

The next conference is The Cutting Edge, in Dallas, TX on Nov. 15-17, and we hope that circumstances and lessening restrictions allow you to attend.

Tunnel on!

Mike Rispin,
UCA Chair

New Zealand: TBM launched in Auckland

(continued from page 14)

Rail Link will transform rail travel in Tmaki Makaurau. It will carry up to 54,000 people an hour, moving the equivalent capacity of three Auckland Harbour Bridges or 16 extra traffic lanes into and through the city at peak times."

"The official start of tunneling represents an important milestone on Auckland's journey toward providing a world-class, 21st-century transport network."

Mining tradition had a significant role at the event. One tradition involved breaking a bottle of champagne on the machine to mark its official launch. Father Christopher Denham of the Catholic St Patrick and St Joseph's Cathedral blessed the machine and the teams who will operate her in acknowledgment to St Barbara, the patron saint of miners and others working underground.

The other significant wahine acknowledged was Maori rights champion, Kahurangi Dame Whina Cooper. ■

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Northeast Corridor: Plan will connect many cities

(continued from page 8)

Amtrak; and five members from the U.S. Department of Transportation. The commission also includes non-voting representatives from freight railroads, states with connecting corridors and commuter rail operators.

The NEC Commission said it "supports a strong federal-state funding partnership to fund C35. The total investment needed to implement C35 more than the 15-year period is estimated to be US$117 billion in 2020 dollars, and the funding gap is approximately $100 billion, to be shared between the federal government and states. To maximize the detailed sequencing laid out in C35 and provide the certainty needed to make long-term investments in workforce development and equipment procurement, multi-year funding needs to be predictable and should fund the plan, rather than individual projects."

"The corridor supports more than 800,000 daily passenger trips between the greater Washington, DC and Boston regions," said NJ Transit president and CEO and NEC Commission co-chair, Kevin Corbett. "It is imperative that together we seize this once-in-a-generation opportunity to replace aging assets, add rail capacity, improve performance, and enhance the customer experience along the entire corridor through the advancement of the vital and ambitious C35 plan."

C35 is the first phase of the long-term vision for the corridor established in the Federal Railroad Administration's (FRA) 2017 NEC Future plan, making significant improvements to NEC rail service for both existing and new riders, on both commuter rail systems and Amtrak. C35, the NEC Commission notes, would result in "a renewed NEC with the following benefits for a thriving Northeast region":

- Travel time savings valued at nearly $140 million annually for inter-city and commuter rail passengers corridor-wide.
- Reducing Washington, DC – New York City by 26 minutes for Acela passengers, and by 28 minutes for New York City – Boston services.
- Reducing New Haven, CT – New York City travel times by 25 minutes
- a 33 percent increase in daily Amtrak NEC service and twice as many services on several commuter railways.
- New one-seat ride services in New Jersey, New York and Connecticut on NJ Transit, the Long Island Rail Road and Metro-North into Penn Station, New York
- Nearly 1.7 million new jobs and $90 billion in earnings over 15 years throughout the United States.
- New and enhanced connections between affordable housing and high-wage job centers.
- New off-peak and reverse-peak services for underserved markets.
- Providing long-term viability for existing services.
- 60 million new rail trips annually.
- Investments in infrastructure to build a more resilient railway.
- Innovation districts and a catalyst for ongoing development initiatives in places such as Newark, Delaware, Philadelphia, Providence and Boston.
- Reliable, frequent access to support that will sustain transit-oriented development. ■


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Boring of Deep Rock Tunnel in Indiana completed in July with TBM breakthrough

The boring of the 8 km (5 mile) Deep Rock Tunnel in Fort Wayne, IN concluded in July as the tunnel boring machine (TBM) named MamaJo broke through.

The *Associated Press* reported tunneling for the combined sewer overflow (CSO) tunnel began in February 2019.

The tunnel connects with 14 neighborhoods, storing and transporting sewage during heavy rain and reducing overflows into local rivers.

MamaJo's tunnel has been the largest part of the project's scope, Deputy Director of City Utilities Matthew Wirtz said. The 14-year construction endeavor has been decades in the making. The tunnel is slated to be fully operational by the end of 2023.

Once completed, the Deep Rock Tunnel will be able to handle 3.2 million liters (850 million gal) of combined sewage traveling through it each day, city officials said.

The increased sewer capacity is expected to result in cleaner rivers and protect about 45,000 residents and 15,000 properties from basement backups and street flooding. The $188 million investment is expected to serve the city for more than 100 years.

Fort Wayne Mayor Tom Henry said too much untreated sewage making its way into our rivers in days gone by.

"We all knew that was totally unacceptable, not only from a health perspective but environmentally as well. So we began to look at various initiatives, ultimately the deep rock tunnel was the option that we chose. It's a very huge project, we knew it was going to take a while, but it was the right thing to do," Henry said.

MamaJo's name comes from the first two letters of each of Fort Wayne's rivers: "Ma" from the St. Marys and the Maumee and "Jo" from the St. Joseph River.

The deep rock tunnel is the largest construction project in the city's history. The $188-million investment is supposed to have a life expectancy of more than 100 years. ■

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Check us out on our website: millercontracting.us

BART: Finalists named for $2 billion project

(continued on page 12)

- The BART Silicon Valley Phase II Tunnel Partners (B2TP), a Joint Venture between Acciona Construction Corp USA (Acciona), FCC Construcción S.A. (FCC) and The Lane Construction Corporation (Lane), supported by Hatch Associate Consultants Inc. (Hatch) and COWI.
- Bay Valley Connect, a joint venture (JV) between Civil & Building North America (BouyguesTP's subsidiary in the U.S.), VINCI Construction and Barnard Construction, supported by Parsons
- Kiewit/Shea/Traylor Joint Venture, a JV between Kiewit Infrastructure West Co, J.F. Shea Construction and Traylor Brothers, supported by Kiewit Engineering Group and ARUP.

The successful team from the next phase of the Progressive Design Build Tunnel and Trackwork contract package will advance design and ultimately construct the 8-km (5-mile), 13-m (43-ft) diameter internal diameter tunnel, underground tunnel to station adit connections, ventilation and emergency egress facilities and three underground station support-of-excavation substructures. The other three contract packages which will be delivered via design-build include the contract for the build out of three underground with above ground entrances and ticketing, the systems contract and the above ground station and rail yard.

The 10-km (6-mile), BART Phase II Extension Project will extend southwest from the recently opened Berryessa/North San José Station with three more underground stations in San Jose and one above-grade station in Santa Clara adjacent to the existing Santa Clara Caltrain Station. Five miles of the alignment will be underground, with a single bore tunnel containing side-by-side and stacked tracks and platforms. Construction is planned to begin in 2022, with substantial construction completed by 2028, followed by system testing and then passenger service in 2030. The $225 million underground storage tunnel is part of the larger $570 million King County Ship Canal Water Quality Project.

Lane Construction, contractor on the tunnel portion of the project, launched the TBM on April 19 and plans to have the overflow tunnel ready by 2025. When completed, the tunnel can, on average, prevent 75 million gallons of polluted stormwater and sewage from entering the neighboring waterways. The tunnel will capture and temporarily hold more than 29.6 million gallons during heavy rains.

Engineering News Record reported the storage tunnel is part of the larger Ship Canal project from Seattle Public Utilities and the King County wastewater treatment division. Along the tunnel path, five vertical shafts in Ballard, East Ballard, Fremont, Queen Anne and Wallingford can collect stormwater and sewage flows from each basin and send them 64 to 128 m (40 to 80 ft) below ground to the tunnel. To bring flows from Queen Anne into the storage tunnel, an additional 12-m (8-ft) diameter conveyance tunnel underneath the Ship Canal connects the vertical shafts in Queen Anne and Fremont. ■

Infrastructure: Gateway Project part of plan

(continued from page 4)

of the $1 trillion infrastructure bill worked out in the Senate this week, Sen. Chuck Schumer, the majority leader, said.

New York's Metropolitan Transportation Authority, which operates New York's subway, bus and commuter-rail networks, stands to receive at least $10.7 billion in federal funding through the bill, Schumer said.

Funding for public transit would also go toward advancing several other major projects in the New York metropolitan area, Schumer said, including the Gateway plan to build rail tunnels under the Hudson River, completion of the Second Avenue subway in Manhattan and rehabilitation of the rail tunnels under the East River.

New York will also be a focal point of much of Amtrak's plan to modernize the Northeast Corridor, which connects Washington to Boston. The bill includes $58 billion for rail projects, most of which would go to Amtrak.

Amtrak owns the corridor as well as Pennsylvania Station in Manhattan and the crumbling, 110-year-old tunnels under the Hudson that are the only way for trains to travel between New York City and New Jersey. The $30 billion Gateway plan includes the rehabilitation of the old two-track tunnel and construction of another one, as well as extensive improvements on both sides of the Hudson.

The domestic mining industry is also expected to benefit from the passage from the bill as infrastructure will require an increased amount of raw materials including critical minerals needed for the upgrading of the nation's electric grid. Industrial minerals will also be in high demand for the construction of roads and bridges. ■

Tunnel boring machines complete triple tunnel drives in Mumbai

In spring 2021, the second of two 6.65-m (21.8-ft) diameter Robbins Crossover XRE tunnel boring machines (TBMs) made its third and final breakthrough for India's Mumbai Metro Line 3. The first machine made its final breakthrough for the project in late April. The tunnel drives were a triumph for joint venture contractor Larsen & Toubro and the Shanghai Tunnel Engineering Company (L&T – STEC), as the crew and equipment overcame unpredictable terrain, high-pressure water ingress, and government-imposed lockdown orders during the COVID-19 pandemic.

The two custom-built machines were selected to bore parallel 2.9-km (1.8-mile) tunnels between the Cuffe Parade station and CST stations, breaking through into several station sites along the way. "It is the first time in India that dual mode, crossover type TBMs equipped with a horizontal screw conveyor and high torque/

The two custom-built Robbins machines were selected to bore parallel 2.9 km (1.8 mile) tunnels between the Cuffe Parade station and CST stations.

high speed (two-speed) cutterhead drives were used. Overall, the performance of the crossover TBMs was found satisfactory and we are in the process of shifting these TBMs for the L&T Chennai Metro project," said Palwinder Singh, head – Tunnel Construction for the L&T – STEC JV.

In another first for India, the crossover TBMs employed a unique technique in a 554-m (1,820-ft) long section from Hutatma Chowk to CST stations. They were used in the benching of the NATM Platform tunnel through basalt rock (removal of the bottom section of rock remaining in the station after conventionally removing the top section). "This requires fine control of the operational parameters of the TBM because only 25 percent of the cutterhead is excavating the rock mass, while the remaining 75 percent of the cutterhead has no contact with rock or soil. In addition, the TBM was relaunched without using a reaction frame, instead taking reaction from half segments erected during the benching of the NATM Platform Tunnel. These innovative concepts were accomplished for the first time in India at Mumbai Metro Line-3, Package 1, and I therefore have many reasons to feel proud of the completion of tunneling," said Singh.

L&T – STEC made impressive progress throughout tunneling despite the many exacting circumstances surrounding the scope of work. Above ground, the joint venture not only had to navigate the restrictions of working within an urban environment, such as limited work hours and the slow removal of muck due to minimal space and traffic, but also faced concern for major structures such as the Mittal Towers and the historic Bhikha Behram Well located along the tunneling route. The crossover TBMs excavated with only 15 to 20 m (49 to 65 ft) of cover separating them from these important structures, which had to be instrumented to monitor vibrations, movements and potential settlement.

Underground, L&T – STEC faced a complex geological mix of fresh grayish basalt, soft volcanic tuffs, shale, and breccias—consolidated rocks of angular fragments of disintegrated volcanic rock. One of the biggest concerns, however, came from the tunnels' proximity to the coastline of the Arabian Sea. During one point, TBM 1 was only 25 m (82 ft) from the coastline, with the invert level of the tunnel running approximately 22 m (72 ft) below mean sea level. As anticipated with circumstances such as these, the TBMs faced a significant amount of groundwater with up to 300 L/min during their excavation.

Despite these obstacles, the TBMs were still able to maintain impressive rates. TBM 2 even completed one push in a swift 14 minutes. "In fact, the boring rate of the Crossover TBMs was never an issue for us. It was only limited by the rate of muck removal and we could have finished the tunnels much faster," said Singh.

L&T engineers were highly involved in the specifications and designs of the machines and worked closely with Robbins to prepare for the challenges the project presented. While L&T had extensive tunneling experience, tunneling with a Crossover machine was entirely new to them. To remedy this, Robbins provided a team of key personnel to train L&T in all aspects of the machines' design and operation. "Working with Robbins field service was more than satisfactory. Even during the Covid-19 pandemic times, Robbins field service was available 24 hours a day, 7 days a week. What else can one expect?" said Singh. ■

Each milestone reached on this

Tunneling and underground construction professionals meet in person at RETC

by William Gleason, Editor

For the first time in more than a year professionals in the tunneling and underground construction industry were able to gather for an in-person technical conference and exhibit when the Rapid Excavation and Tunneling Conference (RETC) kicked off in Las Vegas, NV June 13-16.

For three days, more than 800 industry professionals shook hands, bumped elbows, attended technical sessions, walked two exhibit halls and discussed the hot topics in the tunneling and underground construction industry at Caesars Palace.

“I think it’s absolutely outstanding that we are back together,” said Mike Rispin, the chairman of the UCA, a division of SME. “As well as the industry varied the circumstances and worked with the curves with virtual meetings it is still important to be able to get back to face-to-face content. It is really important for everyone as

More than 800 people attended the RETC Conference in Las Vegas, NV June 13-16, the first in-person meeting in more than an year for the UCA.

individuals to move their businesses forward."

The technical conference from June 13-16 included 21 sessions with 106 papers covering a number of topics including contract practices, design, difficult ground, hard rock tunnel boring machines and tunnels, ground support, international projects, large span tunnels and caverns, future projects, new and innovative technologies, pressurized face tunneling, SEM applications and projects, geotechnical considerations, microtunneling and trenchless tunneling, project planning and risk management and tunnel rehabilitation.

Of course, there were some modifications because of the COVID-19 protocols including socially distanced seating in conference rooms and other events as SME - which organized the conference - adhered to all local, state and federal regulations.

"The quality of the communication is so much higher than the virtual conference," said Rispin. "The virtual conferences satisfied part, the informational interchange, but the networking aspect was really missing, so we are back."

This year the exhibit hall was split into two halls to allow for more social distancing. In the two halls 107 companies displayed the best technology in the industry.

While the conference marks a return to some level of normalcy for the industry, Rispin said it also marks the start of a bright future for the industry.

"The industry is very strong," said Rispin. "The compounded annual growth rate for the industry is forecast to be 7 to 9

Robert Goodfellow, L, passed the UCA Chair duties to Mike Rispin at RETC.

percent for the next eight to 10 years and I think it will actually be higher for much longer. The biggest issue we are going to have is the workforce issues to sustain it. The need, the demand and the funding will be there both domestically and internationally and we have to have the people to sustain it and get the expertise in. The whole deal with the scholarships is really exciting. I spoke with many of them and I think it is a bright future for all of us."

Likewise, Robert Goodfellow, former chair of UCA said the future looks strong for the industry. "New projects have been held back in many cases where city and agency funding streams have been uncertain. Others have proceeded without delay. We now see additional delay in some cases where agencies wait for the potential federal stimulus funding that appears to be forthcoming," said Goodfellow. "Stimulus funding has the potential to flood the market with new work at all stages of planning, design and construction. This stimulus will happen not just in the United States but all over the world. This global need to stimulate economies could easily overwhelm the underground construction industry but at least it provides us with a projection of growing industry backlog for years to come."

On June 15, the UCA hosted its annual breakfast where Rispin assumed the chair position from Bob Goodfellow who was given a T-shirt honoring him as the COVID Chair. Mike Roach, Ted Dowey and Pamela Moran also rotated off the executive committee while Erika Moonin, John Huh, Gabriel Douglas and Moussa Wone joined the UCA Executive Committee.

In a continuing effort to attract students to the industry UCA Young Member Attendance Scholarship were awarded to 30 students, and six students were awarded RETC Attendance Scholarships.

Maksymillian Jasiak, University of Illinois at Urbana-Champaign and Carolina Navia Vasquez, Colorado School of Mines, received the RETC Executive Scholarship. ■

ITA Week begins Sept. 20

The International Tunnelling and Underground Space Association (ITA) has organized the first ever Tunnelling Week from Sept. 20 to 24, 2021.

The five-day conference will feature a number of technical sessions on project around the world.

Each day will include two live sessions, two hours each and a 30-minute panel discussion. The presentations will be afterwards available on demand.

The presentations will come from all over the world, Europe, Asia, North and South America, Asutralasia and also from ITA Working Groups and Committees.

Each session includes live or prerecorded presentations as well as a live debate with the panelists. Participants are able to access an exhibition hall, a viewing room with different videos of projects, ITA library with many publications and a chat to exchange with other participants. The event is available free of charge after registration. ■

Underground Construction Association
A Division of SME

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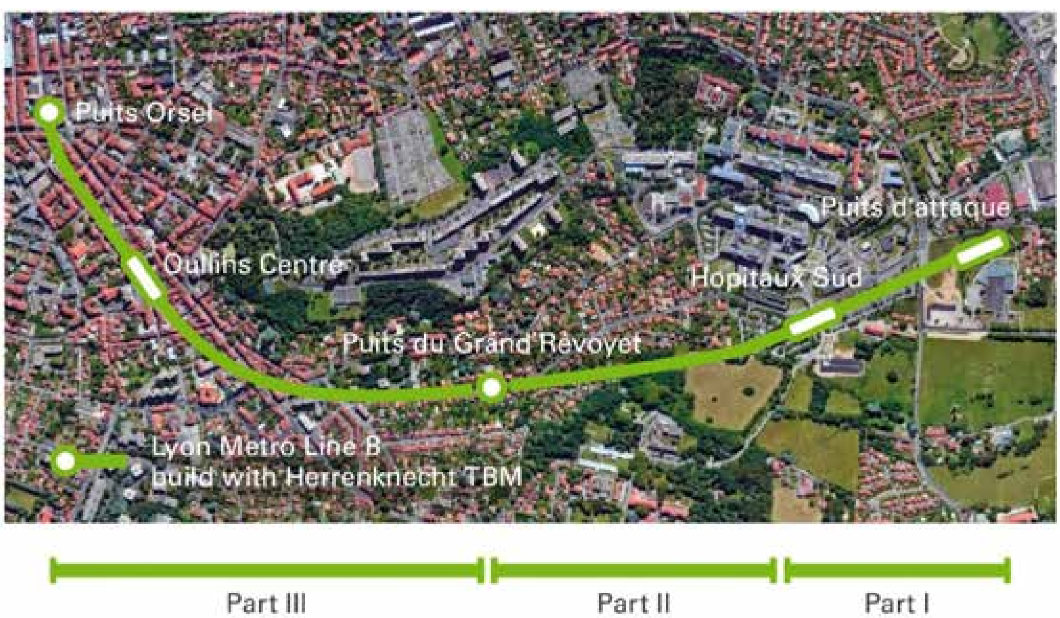
Lyon Metro Line B extension:
A variable density TBM for an underground mission in a remarkably diverse geology

The metro of the eastern French city of Lyon the third largest city in France, after Paris and Lille has a share of around 50 percent of passenger movements, and it is by far the most important means of public transport in the city.

Part of the metro system in greater Lyon is the Metro Line B Extension that is currently under construction. The project is located west of the Rhone Valley and extends to Hôpitaux Sud. It comprises a bored tunnel section of 2.4 km (1.5 miles), a new metro station in Oullins Centre and the start shaft at Saint-Genis-Laval. This new metro section is not one of the basic and ordinary metro extension projects with favorable geological conditions and simple machine solutions. The subsurface conditions along the 2.4-km (1.5-mile) long bored tunnel section are anything but ordinary and demand a solution of applied tailored machine technology. The project sets a benchmark for the use of variable density tunnel boring machine (TBM) technology in view of the forecast geological conditions along the tunnel route. They comprise sections of average highly permeable and extremely highly abrasive alluvial deposits of mainly coarse-grained soils that will be excavated mainly above the water table, as well as areas of crystalline substratum (fresh granite) with UCS of up to 164 MPa. This article will concentrate on this special area of application with sophisticated mechanized tunneling technology. This applied technology is not only scoring with high levels of safety and quality, it also helps to master tunnel construction in built-up area without impacting the aboveground environment during the construction phase.

FIG. 1

Plan view of tunnel site.



Karin Bäppler

Karin Bäppler is head of geotechnics & consulting traffic tunnelling, Herrenknecht Tunneling Systems USA, email bappler.karin@herrenknecht.de

Subsurface conditions and tunnel design

TBM tunnel operations started in 2020 beneath the built-up area. The tunnel will connect the Metro Line B to two new stations at Oullins Centre and at Saint-Genis-Laval/ Hôpitaux Sud with a total length of 2.4 km (1.5 miles). The tunnel is segmentally lined and designed with an inner diameter of 8.55 m (27.8 ft). The predicted ground conditions along the tunnel corridor comprise a variation of mostly highly permeable alluvial deposits and a section of fresh granite. The tunnel runs mainly above the groundwater table with ground cover in the range of 9 to 24 m (30 to 79 ft).

The tunnel route can be divided into three sections with regard to the conditions on surface:

1. Km 1+800 to km 2+411 "Arrière-gare": No densely built-up area, almost rural.
2. Km 1+100 to km 1+800 "Saint Genies": Built-up area with one- and two-story buildings.
3. Km 0+012 to km 1+100 "Oullins": Densely built-up with particularly sensitive old buildings.

The overall geology at tunnel level is predicted to be of high heterogeneity alluvial deposits and with diverse mechanical properties including a section of crystalline substratum that is composed of granite with UCS of up to 164 MPa. The majority of the soft soils are highly permeable with fines content of less than 15 percent except the portions that are composed of silty lenses. The geological report also indicates the possibility of occurrence of erratic blocks mainly through the alignment between Saint Genies and Arrière-gare. Both soil and rock sections are classified as extremely abrasive. Therefore, one of the key construction considerations was that the design and operation of the TBM must accommodate variable excavation conditions for face stability, muck handling and discharge.

The design of the tunnel lining is based on the predicted geological conditions and water pressure along the alignment. It consists of six precast concrete segments plus a key segment having an inner diameter of 8.55 m (27.8 ft). The segments have a thickness of 400 mm (15.8 in.). The annular gap between the outside of the segmental lining and the excavated surface of the ground is backfilled as the TBM advances to provide the bedding of the lining and to prevent subsidence. The backfill material is injected through six grout lines (DN 65 mm or 2.5 in.) incorporated in the tailskin at the rear of the shield structure. Tunneling started at the start shaft Pahls in the district Saint-Genis-Laval toward the reception shaft Orsel in Oullins.

TBM layout and project-specific design features

The contract for the construction of the Lyon Metro Line B Extension was awarded to the joint venture (JV) of Implenia and Demathieu Bard. According to the predicted geological conditions and exceptionally diverse geology the JV decided to use a variable density TBM for the 2.4-km (1.5-mile) long bored tunnel section. The machine has a diameter of 9.68 m (31.8 ft) and is designed to operate at 4

FIG. 2

Variable Density TBM Lyon, slurry mode or HDSM operation for optimum adaptability in diverse geology.

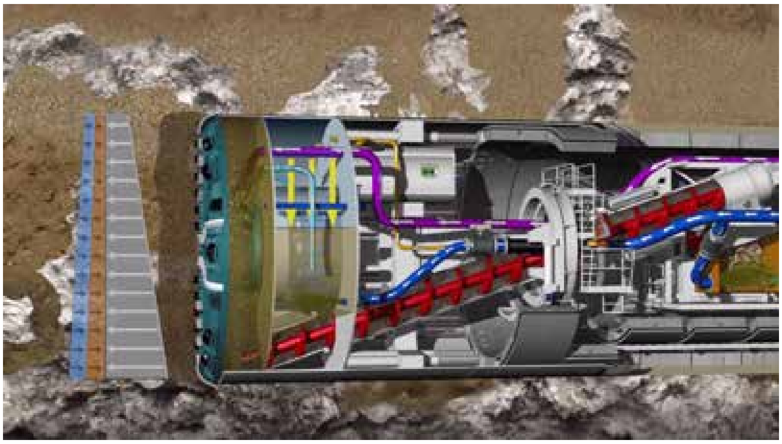
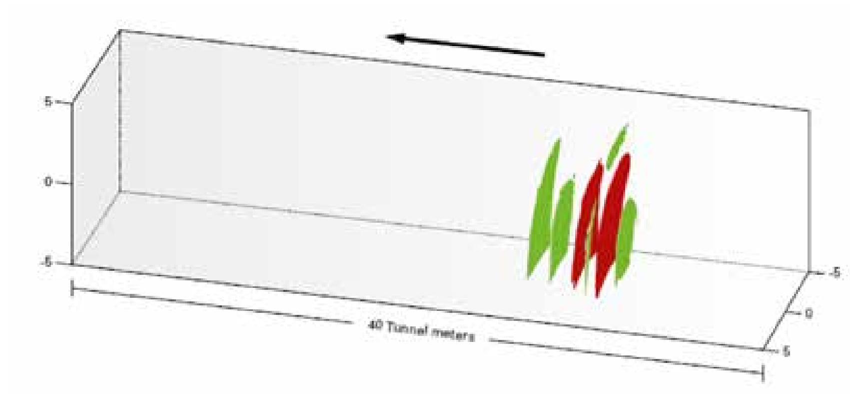


FIG. 3

SSP-E result: 3-D visualization of the reflectors in the ground ahead of the TBM.



bars. The variable density TBM in use for this project is the basic version of this machine type and consists only of one muck transportation system in the tunnel. It is designed with a slurry circuit and always functions in the corresponding closed operating mode. Thereby the excavation chamber is filled with material and the tunnel face pressure is controlled. This guarantees the ground stability during excavation. The special characteristic of the variable density technology is that the individual advantages of both systems, EPB and slurry, are combined in one machine. It is possible to change between operation modes from earth pressure supported tunnel face to a slurry supported face with full control of the face pressure. The transition between the operating modes can be achieved without the need for chamber interventions and without any need of mechanical modification in the excavation chamber or in the gantry area. The machine for Lyon can also be operated using a high-density material in the excavation chamber that would be too dense for classical slurry operation but that would be too fluid for a classical EPB operation. In both, EPB and slurry operating modes the muck is extracted from the pressurized excavation chamber by a screw conveyor. The excavated muck is then transported via a closed, pressurized slurry circuit in the slurry mode or HDSM operation to a slurry treatment plant on surface. At the discharge end of the screw conveyor the excavated material passes into a slurrifier box where the excavated muck is liquefied. A jaw crusher installed in the box processes the material to a size suitable for hydraulic mucking through the slurry circuit.

The predicted diverse highly abrasive geological conditions demanded an adapted cutterhead design. The cutterhead has a bore diameter of 9.75 m (32 ft) and is designed with a nominal torque of 15,000 kNm. Wear protection is provided by grillbars, protection wedges and hardox plates in the face and gauge area. The wear detection system has four hydraulic structural wear detectors for the face area. The cutterhead tooling consists of 482-mm (19-in.) disc cutters (4x double discs and 49x single discs) and soft ground tools (130x).

One of the specific design features of the TBM is the disc cutter rotation monitoring (DCRM) system that is fitted to 15 x of the disc cutters. The DCRM system is used to optimize the maintenance intervals of the disc cutters on the cutterhead. This is particularly of interest in highly abrasive geology. One main benefit is that an operator does not have to enter the pressurized chamber for regular disc cutter inspections but only when needed. In the past, the TBM advance had to be stopped for disc cutter inspections. The DRCM system monitors the rotation and temperatures of the disc cutters that are equipped with the DCRM units during tunneling. Thus, stoppages for disc cutter inspection can be reduced to a minimum. This independent monitoring system is used for immediate detection of blocked disc cutters with the following further benefits:

- Service and maintenance work can be minimized by failure detection and track identification in real time, e.g. with the occurrence of abruptly blocked disc cutters or gradual bearing damage.
- Avoidance of disc cutter overload through the possibility to adjust cutterhead rotation speed and thrust force in case of detection of unstable or blocky tunnel face conditions.
- Optimization of disc cutter lifetime and decrease of downtime periods and thus achieving an efficient tunneling process.
- Load impact of all instrumented disc cutters is visualized continuously and displayed in simple traffic light colours on a radar-like circular guided image.

Another specific design feature of the machine is the possibility of making the invisible visible with a sonic soft ground probing system. This seismic system is called SSP-E. The measurement hardware is mounted within the shield and can be maintained in free air conditions. It is composed of two sources installed within the shield at about 5 and 7 o'clock positions, three receiver cylinders that are pushed horizontally through the excavation chamber and the stationary cutterhead into the tunnel face and two receiver cylinders that are installed radially in the shield. During each ring building phase, a signal is sent from the transmitter positioned in the shield into the ground. This signal or swipe induces seismic waves. The travel paths of the seismic waves in direction of TBM advance are the ones used by the SSP-E. The signal energy is propagated at the relevant wave speed of the specific geology and is reflected by any contrast in seismic impedance such as boulders, cavities or abrupt changes of geological conditions. The reflected signals are picked up by the receivers and evaluated. On the

FIG. 4

Transport of the cutterhead center including truck via barge across the river Rhone.

FIG. 5

TBM launch with umbilical lines and first back-up assembled in the shaft.

basis of the detected density contrasts it is possible to obtain a three-dimensional visualization of the ground up to 40 m (131 ft) ahead of the tunnel face within the tunnel alignment and making obstacles visible. The advantage of this system is, that it is largely integrated in the boring process, enabling continuous, ring-by-ring preliminary exploration parallel to tunneling. The measured data are processed and evaluated nearly in real time.

Site experience to date

In July 2018 Sytral (Syndicat mixte des transports pour le Rhône et l'agglomération Lyonnaise) awarded the contract to build the Metro Line B extension in Lyon to the JV Implenia and Demathieu Bard. The 9.68-m (32-ft) diameter variable density TBM that is excavating the 2.4-km (1.5-mile) long tunnel section toward Oullins was designed and manufactured by Herrenknecht in Germany. The machine was accepted in the TBMs manufacturer's headquarters beginning of August 2019 and was then directly transported to the jobsite in Lyon by trucks. The cutterhead arrived on site end of August 2019. Because of its size and weight of about 117 tons, a barge was used only to transfer the cutterhead center, loaded on a truck, to transport it from one side of the river Rhone to the other to the Edouard Herriot port in Lyon and then further on the road to the launch shaft in Saint-Genis-Laval.

The TBM started tunneling on November 29, 2019 toward the Station Hôpitaux Sud via Gare d'Oullins and will end its operation at the Orsel shaft. The 9.68 m (32 ft) diameter TBM started out of a short shaft (37 x 20 m) with the first back-up assembled in the shaft and the gantries two and three assembled on surface using umbilical lines. The machine will be disassembled in the reception shaft Orsel with the shield being left in the ground.

Mid of May 2020, at the time of writing this publication, the shutdown of the jobsite due to the Covid-19 virus was slowly deactivated. Till then, the machine operated only a few hundred meters so that TBM operation experiences cannot be shared within the framework of this publication.

Before TBM operations could begin the contractors needed to find an appropriate slurry or high-density suspension to cope with the predicted difficult ground conditions and coarse soil structures along the tunnel route.

There was already experience of this demand for an appropriate high-density suspension from previous projects where this Variable Density TBM technology was applied, in particular with the first use of this technology for a metro project in Malaysia where the subsurface conditions included karstic characteristics.

Coarse to very coarse soil structures of high permeability, such as prevalent in Lyon, demand a suspension that avoids the risk of suspension loss into the ground and can improve face support behavior. The contractor did several suspension tests and developed a support medium made of technical mud of confidential composition, with a density close to 1 t/m^3 that can block grain sizes of less than 0.5 m. They developed several technical muds or support medium according to the needs such as for example for hyperbaric intervention, mining operation or emergency situations. These different mixtures are stored on surface and are sent to the TBM with a dedicated pump and pipe at max. 100 m^3/h.

Conclusion

The project Metro Line B extension in Lyon is part of an intelligent underground solution that will enhance the mobility and living standards of people in Greater Lyon. It will support sustainable urban development. The project is with focus on its remarkably singular diverse subsurface conditions one of the few challenging projects to be realized in built-up area. It will set a benchmark when successfully finished related to TBM works in difficult grounds characterized by a significant variation in ground conditions of compact rock and highly permeable and abrasive soils. ■

References

Dr. Karin Bäppler, Michael Straesser. Certainty and reliability in mechanized tunnelling, RETC 2015, New Orleans, June 2015

Dr. Karin Bäppler, Frédéric Battistoni, Werner Burger, Variable Density TBM-combining two soft ground TBM technologies, AFTES, Congrès International, Paris, 13-15 November 2017

Dr. Karin Bäppler, Michael Straesser, Forrestfield Airport Link-Project Challenges and TBM solution, RETC 2019, Chicago, June 2019

Ground freezing on a large scale

Artificial ground freezing for shafts and tunnels related to subway, water and sewer projects have been the focus of many articles and conference topics in recent years. Few readers are aware however, that this technique to provide temporary earth support and ground water control originated in the mining industry in the late 1800s. The first documented project was a coal mine in Wales. Another unknown fact is the magnitude of ground freezing projects on mining projects. This article reviews past mine projects throughout the world where ground freezing was essential for successful shaft sinking and surface drift construction. It mentions other innovative mine projects where again, it was necessary to adopt ground freezing to enable the projects to be undertaken and three of these are discussed in more detail. Projects of the magnitude in mining works require specialized design and analysis techniques that are reviewed. The construction methods and quality assurance programs are emphasized. The projects discussed show how innovative methods set records for projects on a very large scale.

Although patented by H. Poetsch in Germany in 1883, artificial ground freezing (AGF) was first adopted for mine shaft construction in South Wales in 1862 providing temporary ground support and ground water ingress control during sinking. Since then, the process has been applied globally in the mining field for deep shaft and surface drift construction. Many innovative projects have only been successful with the adoption of AGF; exemplifying the importance and substantial value of AGF in the mining world over many years.

Mine shafts

UK coal mine shafts. The German freezing system was introduced into England about the year 1900 and successfully employed in several shaft sinkings (Neelands 1926). An English company, known as the Shaft Freezing Company with headquarters at Selby, Yorkshire, was formed to exploit the process. In 1912, Shaft Freezing Company was contracted to bore the freezing holes and carry out the freezing, sinking and lining of two 6.7-m (22-ft) ID shafts to be sunk to 500 m (1,640 ft) depth

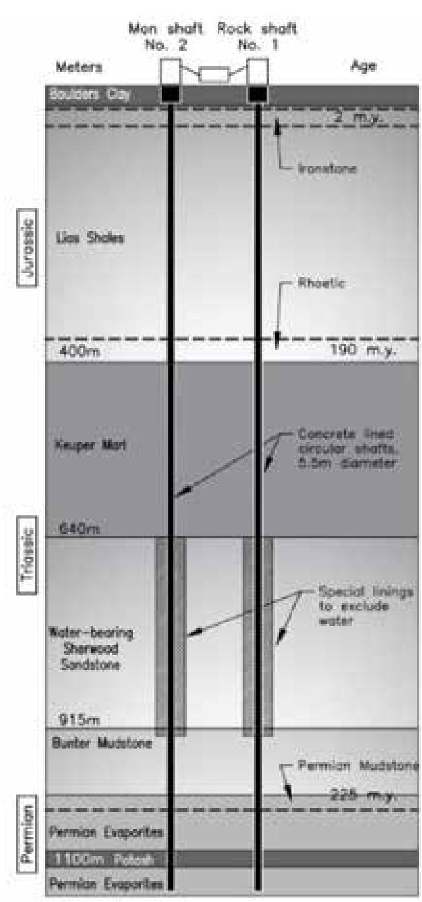
TABLE 1

Shafts constructed in the UK between 1947 and 1960.

	Location	Freezing depth
1947-1949	Calverton No. Shaft	1 shaft x 125 m
1952-1955	Bevercotes Nos. 1 and 2 shafts	2 shafts at 248 m and 250 m
1952-1955	Lea Hall Nos. 1 and 2 shafts	2 shafts at 218 m and 222 m
1954-1957	Cotgrave	2 shafts at 268 m each
1956-1957	Hawthorn Shaft Co. Durham	UG freeze, 1 shaft, 76 m to 137 m
1956-1959	Wearmouth 'D' Shaft, Co. Durham	1 shaft x 108 m
1958-1960	Kellingley No. 1 and No. 2 shafts	2 shafts at 195 m each

FIG. 1

Boulby Potash Mine. Sratigraphic section (Williams and Auld 2002)

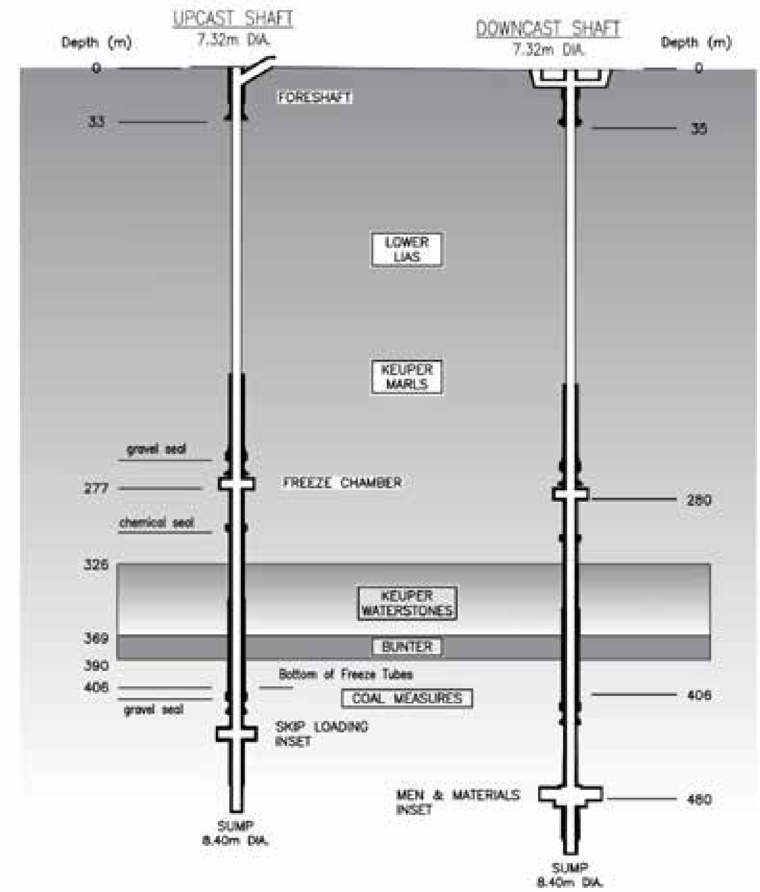


J. Sopko and F. A. Auld

J. Sopko, member UCA of SME, and F. A. Auld, are director ground freezing, Keller-North America and consultant, Golder/WSP, email jasopko@keller-na.com.

FIG. 2

Asfordby Mine. General geological section through the shafts (Harvey and Martin, 1988).



at Thorne Colliery, South Yorkshire. The freeze holes were drilled, cased and the inner inlet tubes installed, but activities ended due to World War I. The German operatives, unsuccessful in returning to Germany, were interned. New mine projects at the time were also halted for the term of the war to concentrate the producing pits and war munition factories. After the Armistice, in November 1918, the freezing process was abandoned due to difficulties reinstating the contract with the German company. The work was completed using the cementation process for ground stability and water ingress control.

Table 1 lists the deep mine shafts constructed in the UK between 1947 and 1960 (Wild and Forrest, 1981). The location and freezing depths are shown with the maximum freeze depth indicated as 268 m (880 ft).

During 1968-1974 two 5.486-m (18-ft) ID shafts were sunk to 1,150 m (3,770 ft) at Boulby, North Yorkshire, for the Cleveland Potash mine (Cleasby et al 1975). Presently they are the deepest shafts in the UK.

Two methods were used to overcome the high-pressure saline water in the Sherwood Sandstone. The grouting and tubbng method was adopted for the No. 2 shaft and the freezing and steel lining method was used in the No. 1 shaft (Fig. 2). For the freezing method, the drilling of the freeze holes from the surface to a depth of 1,000 m (3,280 ft) and the deflection of these holes into positions later to be intersected by an underground freeze chamber at 590 m (1,935 ft) was successfully achieved.

Between 1977 and 1986, six shafts were sunk by Cementation Mining Ltd. for the Selby Coalfield Project in North Yorkshire, UK. These were at Wistow, Riccall and North Selby. Thyssen Mining (GB) Ltd sunk the other four at Stillingfleet and Whitemoor.

In the No. 1 shaft at Wistow, the freeze depth was 273 m (895 ft) to provide ground water ingress control through the Bunter Sandstone and Lower Magnesian Limestone plus ground stability control through the Basal Sands. In all the other cases, the freeze depths ranged from 148 m (485 ft) at the Wistow No. 2 shaft site to the deepest at 305 m (1,000 ft) in the case of Whitemoor to provide ground water ingress control through the Bunter Sandstone.

Canadian Potash Mine shafts. Of the 21 shafts sunk for the Saskatchewan potash industry since the 1950s, five early ones had major water inflow problems, and one had to be abandoned during the sinking process. To address the problem, ground freezing was adopted for the construction of subsequent shafts. Table 2 lists a number of these shafts.

The greatest obstacle shaft sinkers faced was a succession of water-bearing formations, as many as 10 in some areas, all the way from the glacial till near the surface to the Dawson Bay dolomites just above the salts of the Prairie Evaporite Formation. Of these water-bearing formations, the one to prove the most difficult was the Blairmore (Fig. 3). It ranges in thickness from 60 m (197 ft) to 150 m (492 ft) and occurs at a depth from 375 m (1,230 ft) to 440 m (1,444 ft) in the Esterhazy area and from 520 m (1,706 ft) to 640 m (2,100 ft) west of Saskatoon. It consists of unconsolidated water-bearing sand, clay, shale and silt under pressures of up to 6.5 MPa.

Prior to 1963, the established freeze hole drilling technique was either a modified percussion method developed early in Europe or the standard rotary method with whipstocks. Both had severe limitations, even at shallow depths. A new technique could greatly improve the drilling efficiency, especially since depths in excess of 610 m (2,000 ft) were expected in the potash fields in Western Canada. In 1963 Precision Drilling Co. Ltd, together with Eastman Oil Well Survey Co. of Canada, undertook the drilling of a hole at Esterhazy, Saskatchewan, for International Minerals Corp. to test the feasibility of turbo-drilling in conjunction with rotary drilling for deep freeze hole application (Adamson and Storey, 1969). The overriding criterion in the test hole specification was the limited tolerance specified for deviation. A target of 305 mm (1 ft) radius over the entire length of the hole was chosen as the deviation limit for the exercise. The test hole was completed to a depth of 467.3 m (1,533 ft) within the target area, except for two short sections falling outside the 305 mm (1 ft) radius limit. Surveying of the hole was carried out at 9.1 m (30 ft) intervals with the Eastman single-shot magnetic equipment.

German coal mine shafts. The importance of ground freezing for shaft sinking in the West German coal mining industry is demonstrated by the 10 shafts constructed between 1980 and 1990 (Fig. 5). German ground conditions consist of unstable sands, silts and clays down to depths of around 600 m (1,969 ft) in some cases. They require a specially designed "sliding" lining system as temporary ground support to accommodate freeze wall deformation before the permanent lining can be installed upwards from the bottom (Fig. 4). The concrete blocks with chipboards (squeeze packs) allow the large freeze wall deformations to be carried while the inner lining is constructed.

Chinese coal mine shafts. Zhang et al. 2012, report that more than 600 shafts have been sunk in China using ground freezing for temporary support. The thickest sinking through alluvium was 587 m (1,926 ft) with a freezing depth of 800 m (2,625 ft).

Mine surface drifts

Selby Gascoigne Wood mine surface drift. The drift was driven through Basal Sands, known to be weakly cemented, and when water is allowed to flow through them, the sands also flow. To provide the necessary ground support and ground water ingress prevention, a single line of vertical freeze holes was drilled and kicked off alternatively to form a tent of frozen ground over the drift (Fig 6). At the time, the method adopted was believed to be the first of its kind in the world.

Innovative mine projects

Apart from the shaft sinking and surface drift construction projects, several innovative mine projects have been considered or successfully completed only with the help of artificial ground freezing:

1. Underground Oil Platform, Alaska - Anaconda Minerals 1984. The concept was to recover heavy oil from the shallow deposits on the North Slope of Alaska by using artificial ground freezing to enhance the 609.6 m (2,000 ft) of permafrost. Shafts could then be sunk to a depth of 1,219 m (4,000 ft) to enable the oil to be extracted by drilling from an underground mine environment.

FIG. 3

Cominco Vanscoy No. 1 shaft section (Kelland and Black 1969).

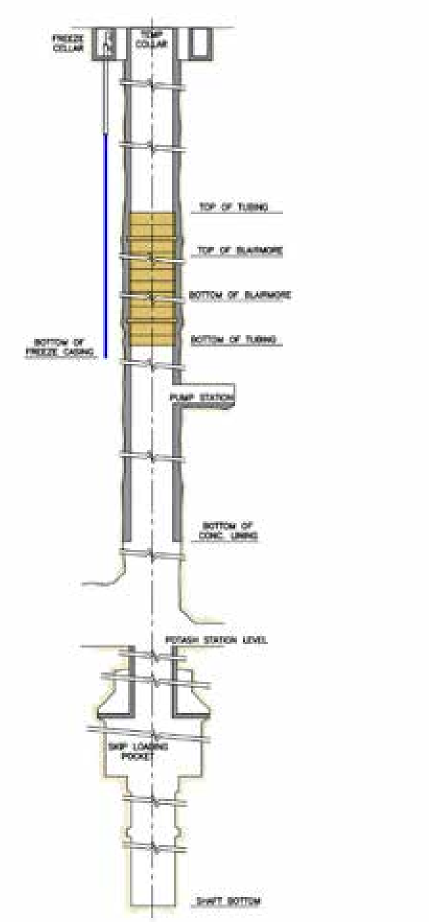


FIG. 4

German coal mine shafts constructed between 1980 and 1990 (Klein 1989).

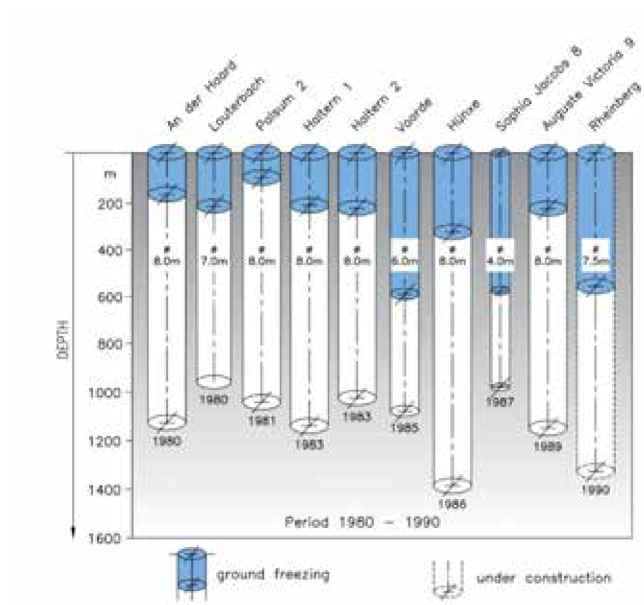


TABLE 2

Saskatchewan potash shafts.

Project	Client	Contractor	Internal diameter	Depth m (ft)	Freeze depth m (ft)	Date
Esterhazy (Yarbo) K1 and K2	International Minerals Corp.	Cementation Co. (Canada)	No.1 shaft 5.486 (18)	1,029.6 (3,378)	No. 2 shaft 467.9 (1,535)	1957-1962
Vanscoy No. 1 Production) and No. 2 (Service) shafts	Cominco Ltd	Cementation Co. (Canada)	No. 1 shaft 5.639 (18.5)	1143.6 (3,752)	684.3 (2,245)	1963-1967
Cory No. 1 and No.2 shafts	Duval Corp.	Cementation Co. (Canada)		1,012 (3,320)	592.5 (1,944)	1963-1967
Patience Lake No. 1 and No. 2 shafts	Potash Corp. of Saskatchewan (PCS)		16 (4.877)		27 FT's to 609.6 (2000); 16 FT's to 914.4 (3000)	1963-1967
Allan No.1 and No. 2 shafts	Potash Corp. of Saskatchewan			1,036		1968
Lanigan (Alwinsal) No. 1 Production and No. 2 Service shafts	Potash Corp. of Saskatchewan	Associated Mining Construction	No. 1 shaft 5.5 (18) No. 2 shaft 4.32 (14)	1,010 (3,314)		1967 -1969 (No. 1);1973-1979 (No. 2)
Scissors Creek (Rocanville West expansion project)	Potash Corp. of Saskatchewan (PCS)	Associated Mining Construction	6 (19.685)	1,123 (3,684)		2009
Esterhazy K3 shaft	Mosaic Company			1,021.1 (3,350)		2009-2012
Jansen No.1 and No.2 shafts	BHP Billiton	DMC	6.5 (21.325)	975	720 (2362)	2016-2020

The project did not go ahead because of the drop in oil price at the time and it became uneconomical to proceed.

2. Aquarius Gold Mine – Timmins, Ontario, Canada.
3. Underground heating of oil shale, Colorado Basin, Shell MIT Project.
4. Ground stability and water ingress prevention for open cast mining of Oil Shale – Fort Hills, Alberta, Canada. In 2015 Suncor/TOTAL/Teck were in the process of developing an open pit mine at Fort Hills for the extraction of oil sands. To prevent the ingress of ground water into the excavation, a cut-off barrier was being considered using ground freezing. This was a large-scale project involving many kilometres of freeze wall.
5. Cameco Cigar Lake Uranium Mine, northern Saskatchewan, Canada – frozen ore body. Ground freezing from the surfacer has been used to stabilize the ore body at depth to facilitate retrieval of the ore by drilling from underground tunnels.
6. Crown pillar excavation project, Quebec, Canada – Noranda.

Three of these projects are described in more detail in the following sections.

Aquarius Gold Mine – Timmins, Ontario. While many large-scale AGF projects have been conceived, the first field implementation (but not completed) was the Aquarius Gold Mine in 1996. The Aquarius property was originally owned by Asarco and started as an underground mine in the 1970s. High ground water inflows required Asarco to abandon the mine and it was sold to Echo Bay Mines. In 1996, Echo Bay proceeded with plans to mine the gold from a large open pit with a conventional approach using high-capacity dewatering wells around the 4-km (2.5-mile) perimeter. Hydrogeological studies indicated that this massive dewatering program had the potential for depleting the water in several small lakes at a provincial park adjacent to the project, as well as several residential wells.

A frozen earth barrier was proposed and installed around the 4-km (2.5-mile) perimeter. The ground freezing system had 2,335 individual 8.9-cm (3.5-in.) diameter freeze pipes into the underlying bedrock. The spacing between pipes varied depending on the depth to the underlying bedrock to compensate for deviation during drilling. In some locations, the bedrock was as shallow as 42 m (140 ft) but could be as deep as 153 m (505 ft) at locations on the east side of the project. Pipes at the shallower depths were spaced approximately 2 m (6.5 ft) apart, while deeper ones were spaced at 1 m (3.2 ft). Since the pipes deviation during drilling increased with depth, the shallower pipes would have less deviation and could be placed further apart at the ground surface.

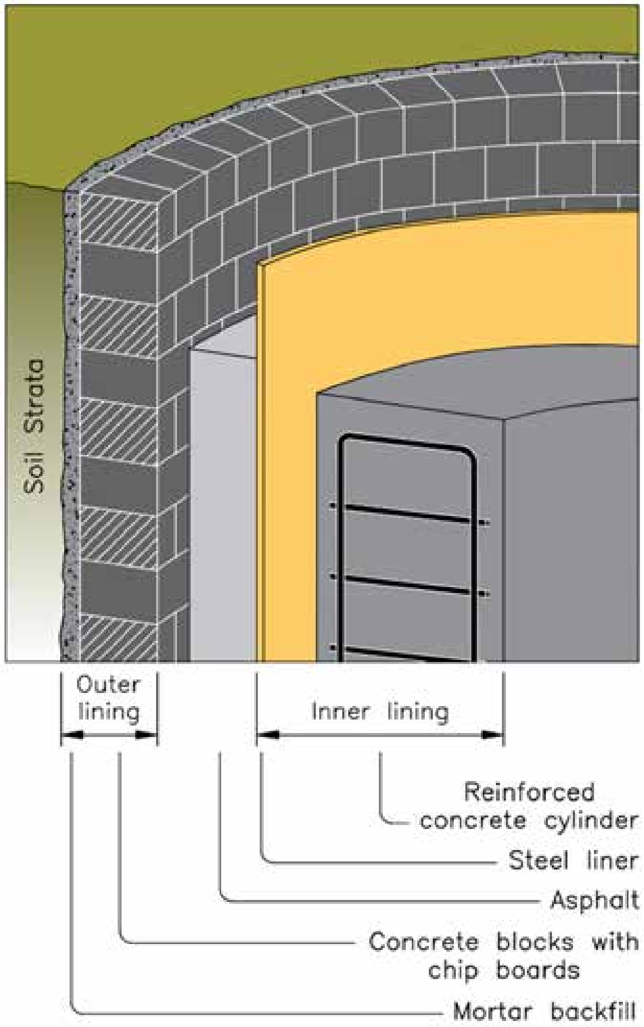
The refrigeration system was based on two permanent buildings at the north and south ends of the frozen barrier. Each building had five 900-hp compressors for a combined capacity of 4.5 kt (5,000 st) of refrigeration. The large compressors used ammonia as the primary refrigeration gas that cooled the circulating calcium chloride brine. The circulating coolant system was a major engineering challenge. Each freeze pipe required a minimum of 20 gpm of the refrigerated calcium chloride brine. To ensure a balanced flow, it was necessary to have a supply, return and reverse return (balancing) distribution manifold.

As the installation of the ground freezing system was nearing completion, gold prices fell to below $300/oz (U.S.). The freezing system was completed and tested and put into a standby mode. For four consecutive years the system was started up and tested. During that time, the gold price remained too low to justify the expense of operating the ground freezing system and mining the ore. It was eventually abandoned. While never fully operational, the Aquarius ground freezing system provided sufficient data to confirm that ground freezing systems could be installed on large scale projects.

Underground heating of oil shale - Shell MIT project. The Mahogany Isolation Project (MIT) was a pilot test conducted near Meeker, CO to evaluate the effectiveness of a frozen soil barrier used with high temperature heating of oil shale. Shell's process used in situ heating of the oil shale that converts the kerogen to shale oil. Heating probes were installed into boreholes and warmed to approximately 662 °F (350 °C). This heating would result in the conversion of the shale to oil. After this conversion, the oil would be pumped to the surface. In the early stages of the testing, it was observed

FIG. 5

German "sliding" lining system through unstable frozen ground (Stoss and Braun 1983)



that the ground water present within sand seams in the shale would cool the probes preventing them from reaching the required temperature. Additionally, toxic by-products and gases would form requiring the isolation of the process from the ground water.

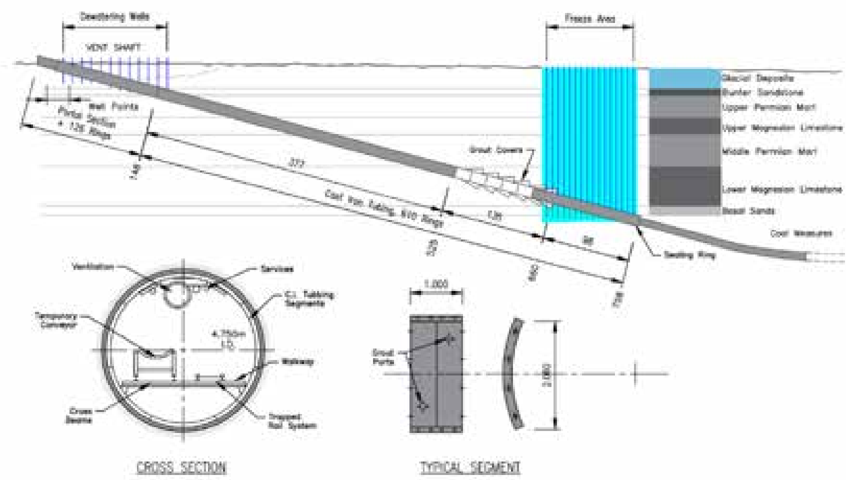
The concept of creating a frozen earth barrier around multiple probes was considered as a method to both prevent the inflow of ground water and isolate the toxic by-products until remediated. A pilot test was conducted to evaluate the effectiveness of a frozen earth barrier. The initial pilot test is shown in the drawings.

There were 18 freeze pipes, two temperature-monitoring pipes and seven ground water instrumentation borings, drilled to depths of approximately 381 m (1,250 ft). Two heating wells and one oil extraction well were installed in the interior of the frozen cell. Freezing was completed using a total of 400 t (450 st) of refrigeration.

The remoteness of the site added considerable logistical issues for a ground freezing operation. Diesel

FIG. 6

Ground freezing for Selby Gascoigne Wood Mine Surface Drift (Forrest and Black 1979)



powered generators were used to provide the 1,500 kW power required. The mobile refrigeration plants had water-cooled condensers requiring water to be delivered to the site daily.

The freezing process was longer than originally anticipated due to a geothermal gradient that had not been previously discovered.

Crown Pillar Excavation project – Noranda. The Quemont Mine in Rouyn-Noranda, Quebec, was completed and closed several decades ago. A crown pillar remained in place and was known to contain approximately 11,000 m^3 of zinc. The deposit was located 24 to 37 m (78 to 121 ft) below water-bearing unconsolidated mine tailings and very soft clay. Mining from the surface had been considered for several years; however, excavation support was the limiting factor, both technically and economically.

After evaluating several open-cut options with very narrow slopes and potential dewatering, the concept of creating one large excavation was considered. The concept called for a large frozen earth wall to provide temporary earth support and ground water control.

The final design had a 61-m (200-ft) diameter circular excavation to a depth of 30 m (98 ft). Laboratory tests indicated that the clay material had a very high-water content and was susceptible to creep deformation when frozen. To compensate for the long-term creep potential, a 10-m (33-ft) thick frozen earth wall was designed. Additionally, the excavation time was limited to 120 days.

The freezing operation started in September and was specifically coordinated so that excavation would begin in early January when temperatures were known to be well below freezing.

Excavation proceeded from January through March. As the ambient air temperatures started warming, sloughing of the south wall was observed in an area that was exposed to direct sunlight. Large concrete blankets were hung form the surface to protect the face of the frozen earth wall. While they helped somewhat, ambient temperatures continued to increase as mining operations continued. During the early part of April, a severe thunderstorm occurred, and lightning damaged the transformer for the refrigeration plants. It was decided to begin backfilling and terminate the project with a minimal quantity of ore left in the excavation.

Summary

The review of previous mine shaft and surface drift construction on a worldwide basis has demonstrated how important the use of ground freezing has been in enabling the projects to be attempted and completed successfully. Innovation has also been a critical element in many mining projects, as demonstrated by the projects which have been reviewed. Without the use of ground freezing, none of the work described could have been achieved. ■

References

Adamson, J. N. and Storey, J. H. 1969. Paper 19. Turbo-drilling as applied to potash developments in the Saskatchewan field. Ninth Commonwealth Mining and Metallurgical Congress. Mining and Petroleum Geology Section. Institution of Mining and Metallurgy. London. pp. 1-14.

Cleasby, J. V., Pearse, G. E., Grieves, M. and Thorburn, G. 1975. Shaft-sinking at Boulby mine, Cleveland Potash Ltd. Transactions/Section A (Mining Industry), Vol. 84, January, Institution of Mining and Metallurgy. pp. A7-A28.

Forrest, W. and Black, J. C. 1979. Hydrogeological analysis, ground treatment and special construction techniques at Selby:Gascoigne Wood surface drift mine. Tunnelling '79 Symposium, 12-16 March. Institution of Mining and Metallurgy. London. pp. 3-10.

Harvey, S. J. and Martin, C. J. 1988. Construction of the Asfordby Mine shafts through the Bunter Sandstone by use of ground freezing. *The Mining Engineer*. August. pp. 51-58.

Kelland, J. D. and Black, J. C. 1969. Cominco's Saskatchewan potash shafts. Ninth Commonwealth Mining and Metallurgical Congress. Mining and Petroleum Geology Section. Institution of Mining and Metallurgy. London. pp. 1-20.

Klein, J. 1989. Shaft sinking by ground freezing in the coal-mining industry in the Federal Republic of Germany. Shaft Engineering Conference. 5-7 June. Institution of Mining and Metallurgy.

Harrogate, England. pp 269-280 Neelands, A. R. 1926. The Thorne Colliery pit sinkings. pp. 1-43 Stoss, K. and Braun, B. 1983. Sinking a freeze shaft with installation of a water-tight, flexible lining. RETC Proceedings, Volume 1. pp. 513-532.

Tunnicliffe, J. F. and Keeble, S. 1981. Shaft sinking at Selby. *The Mining Engineer*. August. pp. 69-79.

Wild, W. M. and Forrest, W. 1981. The application of the freezing process to ten shafts and two drifts at the Selby Project. *The Mining Engineer.* June. pp. 895-904.

Williams, A. and Auld, F. A. 2002. Boulby mine shaft lining design – second restoration. Trans. Instn Min. Metall. (Sect. A: Min. technol.), 111, January – April. The Institution of Mining and Metallurgy. pp. A13-A27.

Zhang, Y., Liu, Z. and Duan, B. 2012. Achievements of China's coal mine construction in recent years. 3rd International Conference on Shaft Design and Construction. April. London. *Tunnels and Tunnelling International*. pp. 127-130

UCA unveils new five-year strategic plan

by William Gleason, Editor

In 2020, SME unveiled a five-year strategic plan to guide the Society. In 2021, UCA, a Division of SME unveiled its own plan that aligns with SME's strategic plan, but is specific to the UCA Division.

Robert Goodfellow, who chaired the Division from 2019-2021, led the process of creating the new UCA Strategic Plan.

"We had not updated our UCA strategic plan for several years and SME had just completed its own strategic planning process in 2020. For these reasons, we made an assessment that it would be timely and beneficial for us to update and produce a new plan for UCA," Goodfellow explained. "With Bill Edgerton and Dave Rogstad (as members of the SME Board of Directors) integrally involved in the SME process, the UCA interests were well represented in the overall SME Strategic Plan, so it made even more sense to produce a plan that not only considered our own objectives but also a plan that brought us in line with the overall direction of SME."

Central to the UCA strategic plan is the core purpose of UCA "to promote the responsible development and use of underground space." This core purpose is supported by a vision of "building a better world through underground construction as a superior, long-term solution."

Goodfellow explained that the plan has three major goals complete with objectives and strategies of how UCA intends to achieve these goals within the five-year strategic planning horizon. These goals are:

- Industry education – where UCA is recognized as the preferred forum for exchanging information for the advancement of the industry.
- Stakeholder awareness – where external stakeholders understand the value and support the use of underground space.
- Association growth – where UCA is valued by members and is experiencing growth.

"The plan lays out a series of actions that will focus on workforce development and education, membership engagement in the numerous opportunities for betterment of the industry and our association, and creating great guideline documents to inform and educate owners and industry members alike," said Goodfellow.

Mike Rispin became Chair of the UCA during the Rapid Excavation and Tunneling Conference in June and will hold the position for a two-year term in which many of the objectives of the strategic plan will be implemented.

"The plan is our guiding light and a blueprint for where we want to go, as an association, and how we want to get there," Rispin said. " As such, everything we do will flow from the

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UCA 2021 Strategic Plan

Core purpose

To promote the responsible development and use of underground space.

Safety	Ethics
Stewardship	Innovation
Excellence	Collaboration
Inclusion	

Vision statement

Building a better world through underground construction as a superior, long-term solution.

Vivid description of a desired future

Through active engagement in UCA, the underground construction and tunneling community works together to solve common challenges and to create solutions for building a better world. The industry is viewed as safe, environmentally sustainable, socially responsible, efficient, and necessary for worldwide economic growth. The association leads in developing the standards and guidelines contributing to the success of the industry. UCA promotes innovation and the highest ethical standards of its members. Through UCA, designers, suppliers, developers, contractors, and owners work together to achieve their common goals.

The industry turns to UCA for resources to assist with the recruitment and growth of its future and diverse workforce. Technology is being used effectively by the industry and UCA to attract the next generation of workers and to transform practice.

Industry Education

Goal: UCA is recognized as the preferred forum for exchanging information for the advancement of the industry.

Objectives:

1. Enhance relationships between industry stakeholders.
2. Increase opportunities to exchange information between parties delivering tunneling projects.
3. Promote more efficient methods to construct underground spaces.

Strategies:

- Build events and networking opportunities that connect project owners, contractors, engineers and suppliers in efficient and desirable ways.
  - o Evaluate educational offerings and formats.
  - o Host workshops with industry stakeholders to determine direction of industry in the future (one, five and 10 years and 20 years) and use information to anticipate needs of industry and sweet spot for UCA.
- Define the body of knowledge needed to be a successful underground construction professional.
  - o Identify career paths and the experience and skills needed to advance from entry- level to senior-level positions.
  - o Develop a content strategy to support the body of knowledge needed to be a successful underground construction professional.
  - o Offer relevant content and professional development opportunities based on the body of knowledge.

Stakeholder Awareness

Goal: External stakeholders understand the value and support the use of underground space.

Objectives:

1. Increase the positive perception of underground space as a viable solution.
2. Progress the legislative outreach program.
3. Enhance awards program to increase visibility.

Strategies:

- Develop a communications and outreach strategy targeted to community leaders, government officials and other external stakeholders outlining the benefits of underground construction solutions.
- Develop a toolkit and training to help members educate local stakeholders.
- Enhance relationship with ASCE and partner/sponsor the annual legislative fly-in.
- Expand the Awards Program judiciously, showcase the stories of award winners and share widely both inside and outside the industry.

Association Growth

Goal: UCA is valued by members and is experiencing growth.

Objectives:

1. Consistently enhance and communicate member value.
2. Grow individual, student and corporate memberships.
3. Increase member diversity.
4. Strategically partner with peer groups to expand opportunities for members.
5. Enhance financial sustainability.

Strategies:

- Conduct segmented member research and solicit feedback frequently for ways to continuously enhance the member value.
- Promote and support special interest groups within the organization.
- Build a robust volunteer offering that provides meaningful engagement opportunities and encourages diversity.
- Provide leadership training to all volunteers.
- Develop relationships with industry stakeholder groups for collaboration and cross-promotion of UCA activities.
  - o Implement and leverage Association Liaison Committee.
- Systematically reach out to SME Mining Student Chapters to proliferate knowledge of the Underground Construction industry.

UCA strategic plan to guide the next five years

(continued from page 28)

plan; for example, programs (existing and new), sub-objectives for each of these, relationships and external communications. We're even retooling the executive committee agenda so that all but basic items are grouped according to strategic objective."

As chair of the UCA, Rispin will keep close tabs on the progress of the plan.

"My quarterly columns in *T&UC* are going to periodically report on achievements toward the objectives in order to keep them relevant for our membership at-large. We will report on them at conferences such as the North American Tunneling (NAT) conference. We also intend to reference them as program activities unfold: Awards, scholarships, Women in Tunneling, Young Members, the Owners' Focus, etc. These initiatives are also tied directly to the strategic plan," said Rispin.

Erika Moonin, vice chair of the UCA, will help guide the plan for the next four years.

"The strategic plan is a great way to enhance communications with our current and future members about what the UCA is doing to advance the industry and the services we provide," said Moonin.

"Our initiatives provide an opportunity to increase member engagement of those members wanting to get more involved – as little or as much as they want – they will be able to see all the initiatives and offer to get involved with the ones that they are most passionate about. The plan includes the goals and initiatives which all feed into enhancing and advancing the tunneling and underground industry as a whole – and that is what it's all about."

"Our process also involved candid feedback and input from senior industry figures, as well as the entire executive committee working many multi-hour sessions over a period of a few months," Goodfellow said of the process to create the plan. "It was important for us to set a path of consensus across the industry simply because the primary purpose of the UCA is to represent the entire underground industry. We are very happy that our process has produced a plan that opens up the association to any and all members that want to get involved and sets us on a clear path to be more responsive to the needs of industry." ■

DFI Educational Trust Awards Women In Deep Foundations professional development grants

DFI Educational Trust has awarded five Women in Deep Foundations (WiDF) Professional Development Grants of $1,750 each. The recipients are invited to attend DFI's 46th Annual Conference in Las Vegas, NV, Oct 12-15. The grant includes complimentary conference registration and covers related expenses for attending the conference.

The recipients are:

- Sangeen A. Desai, deputy manager-business manager, Keller Ground Engineering, India.
- Lauren Dziagwa, P.E., geotechnical project engineer, American Geotechnical and Environmental Services (AGES).
- Min Liew, graduate research assistant, The Pennsylvania State University.
- Abigail Stein, P.E., geotechnical engineer, GEI Consultants.
- Gaby Vasquez, staff geotechnical engineer, D&S Engineering Labs.

The grants are being presented during the Annual Conference at the WiDF 6th annual networking event on Oct. 12. To register for the reception or to sponsor the event, visit www.dfi.org/Annual2021.

The WiDF Committee is comprised of women and men who are

(continued on page 48)


Desai


Dziagwa


Liew


Stein


Vasquez

Moles announces newest members

The Moles, a fraternal organization composed of individuals engaged in the construction of tunnels and major heavy construction projects announced that Women in Tunneling board and founding member Lizan Gilbert has been inducted into the organization. The Moles promotes the industry and supports their members through outreach programs and networking opportunities. Gary Almeraris, president of the Moles stated "The Moles, are extremely pleased about the increased number of women who have joined our ranks in recent years. These women, who have established themselves as movers and shakers in the underground construction industry, have aided The Moles organization efforts in fostering engineering students, many of whom are women, to become the future leaders of the heavy construction industry."

Congratulations again to all of these talented women who, with their contributions to the industry, are "Deconstructing Tunnel Vision." ■

DFI: Micropile committee appointment

(continued from page 28)

advocates for retaining women in the deep foundations industry. The goal of the committee is to foster greater success and interest of professional women in the industry by promoting networking events, endorsing outreach and building mentoring relationships.

DFI announced **Helen Robinson**, P.E., PMP, D.GE, senior project manager and branch manager at GEI Consultants, as the new co-chair of its Micropile Committee, joining Pete Speier, P.E., of Williams Form Engineering, who represents ADSC: The International Association of Foundation Drilling for this joint committee. Robinson succeeds Steve Davidow, P.E., S.E., P. Eng., of Quanta Subsurface.

Robinson earned B.S. and M.S. degrees in civil engineering from Penn State University and has more than 18 years of experience providing design, analysis and construction management services for geotechnical and geostructural projects. She specializes in the design of micropiles, tiebacks, soil nails, drilled shafts, retaining walls, braced excavation support, and grouting and ground improvement methods. Robinson was the inaugural chair of the DFI Women in Deep Foundations Committee and currently serves as secretary and trustee for the DFI Educational Trust. She was named Engineer of the Year by the Society for Professional Engineers and was recognized as an ENR National Top 20 Under 40 in 2019. She has served on the joint micropile committee for many years as a member, and additionally has contributed her expertise to many International Society for Micropiles (ISM) workshops, specifically serving as technical program chair for its 2019 workshop in Queensland, Australia.

Helen Robinson

The DFI Micropile Committee is involved in the support, understanding and application of micropile foundation technology. The committee operates jointly with the ADSC Micropile Committee visiting the state of practice regularly through seminars and global workshops. The committee has an international arm, the International Society for Micropiles (ISM), to further technology transfer across the globe. ■

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UCA executive committee organizational chart

Vice Chair

- Mentoring
- Owners Forum - Moussa Wone
- Scholarships
- SME Fellows Committee
- Association Liaisons
  - ACEC - Ashley Heckman
  - AEG - Paul Headland & Nick Sokol
  - APTA - Matt Preedy
  - ARMA - Carlos Jaramillo
  - ASA - Grover Vargas
  - ASCE
    - UEC and GeoInstitute - Lizan Gilbert
    - Legislative Fly-In - Erika Moonin
    - Partners in Education Conference - Lonnie Jacobs
  - AWWA - Amanda Kerr
  - Beavers - Matt Pope
  - CMAA - Heather Marsh & Matt Preedy
  - DBIA - Heather Marsh & Matt Preedy
  - DFI - Mike Roach
  - DRBF - Mike Vitale
  - Moles - Paul Schmall
  - NACWA - Jim Rush
  - NASTT - Everett Litton
  - TRB - Henry Russell
  - WEF - Joe Clare

Chair

- EXCO
- ITA
- SME
- Strategic Plan
- EXCO Liaison
  - SME Committees
    - SME MINEEXCHANGE - Jamal Rostami
    - Info Publishing - Open
    - Journal Oversight - Open
    - Gov't & Public Affairs - Open
    - Research - Open
    - Robert E. Murray Innovation Award - Open
- Workforce Sustainability
  - Women in Tunneling - Elisa Comis
  - Young Members - Vojtech E. Gall, Jr.
  - Down for That - Paul Schmall
    - Teach the Professors - Mike Mooney
  - Inclusion & Diversity - Elisa Comis
- Conferences
  - Cutting Edge - Elisa Comis
  - George Fox - Bob Palermo
  - NAT - Matt Preedy
  - RETC (Liaison only) - Open

Past Chair

- Nominating
- Awards - Lonnie Jacobs
- Top 20 Projects - Grover Vargas
- Technical Publications
  - T&UC Editorials - Colin Lawrence
  - Webinars - Mark Johnson
- US Working Groups
  - 2 Research - William Hansmire
  - 3 Contract Practices in Underground Construction - Bill Edgerton
  - 5 Health & Safety - Robert Labbe
  - 6 Maintenance & Repair of Underground Structures - Henry Russell
  - 9 Seismic Effects - Conrad Felice
  - 11 Immersed & Floating Tunnels - Christian Ingerslev
  - 12 Sprayed Concrete Use - Grover Vargas
  - 14 Mechanization of Excavation - Brian Fulcher
  - 15 Underground & Environment - Kamran Bakhsh
  - 17 Long Tunnels at Great Depth - Brad Grothen
  - 19 Conventional Tunnels - Nasri Munfah
  - 20 Urban Problems- Underground Solutions - Sanja Zlatanic
  - 21 Life Cycle Asset Management - Jim Brady
  - 22 Information Modelling in Tunneling - Vojtech E. Gall, Jr.
  - 23 Design & Construction of Shafts- Verya Nasri

T&UC Tunnel Demand Forecast

COMPILED BY JONATHAN KLUG, DAVID R. KLUG & ASSOCIATES

TUNNEL NAME	OWNER	LOCATION	STATE	TUNNEL USE	LENGTH (FEET)	WIDTH (FEET)	BID YEAR	STATUS
Gateway Tunnel	Amtrak	Newark	NJ	Subway	14,600	24.5	2022	Awaiting funding
2nd Ave. Phase 2	NYC-MTA	New York	NY	Subway	16,000	20	2023	Under design
2nd Ave. Phase 3-4	NYC-MTA	New York	NY	Subway	89,600	20	2024-29	Under study
Kensico-Eastview Connection Tunnel	NYC-DEP	New York	NY	Water	10,500	27	2024	Under study
Flushing Bay CSO	NYC_DEP	New York	NY	CSO	13,200	20	2026	Under study
Cross Harbor Freight Tunnel	NYC Reg. Develop. Authority	New York	NY	Rail	25,000	30	2022	Under study
Metro Tunnel Program - Northern	Boston MRWA	Boston	MA	Water	23,760	10	2027	Under study
Metro Tunnel Program - Southern	Boston MRWA	Boston	MA	CSO	50,160	10	2028	Under study
Silver Line Extension	Boston Transit Authority	Boston	MA	Subway	8,400	22	2024	Under design
Narragansett Bay CSO Phase III - Conveyance Tunnel	Narragansett Bay Commission	Providence	RI	CSO	8,800	10	2024	Under design
Amtrak B&P Tunnel	Amtrak	Baltimore	MD	Rail	40,000	32	2023	Awaiting funding
Ellicott City North Tunnel	Howard County	Ellicott City	MD	CSO	5,800	15	2022	Under design
Potomac River CSO Tunnel	DC Water and Sewer Authority	Washington	DC	CSO	24,000	18	2022	Under design
Superconducting Maglev Project - Northeast Corridor	TNEM/BWRR	Washington	DC	Rail	146,520	43	2023	Under design
Alum Creek Relief Tunnel Phase 1 Phase 2	City of Columbus	Columbus	OH	Sewer	30,000 21,000	18 14	2022 2023	Under design Under design
Shoreline Storage Tunnel	NEORSD	Cleveland	OH	CSO	14,250	21	2021	McNally-Kiewit low bid
Shoreline Consolidation Tunnel	NEORSD	Cleveland	OH	CSO	11,700	9.5	2021	Under design
Southerly Storage Tunnel	NEORSD	Cleveland	OH	CSO	18,000	23	2024	Under design
Big Creek Storage	NEORSD	Cleveland	OH	CSO	22.450	18	2026	Under design
Enbridge Line 5 Tunnel	Enbridge	Traverse City	MI	Oil	23,760	12	2020	delayed
Minneapolis Central City Parallel Tunnel	City of Minneapolis	Minneapolis	MN	CSO	4,200	10-19	2021	Final planning
ALCOSAN CSO Ohio River Allegheny River Monongahela River	Allegheny Co. Sanitary Authority	Pittsburgh	PA	CSO	10,000 41,700 53,900	14 14 14	2023 2027 2030	Under design Under design Under design

To have your major tunnel project added to the Tunnel Demand Forecast, or to update information on a listed project, please contact Jonathan Klug at jklug@drklug.com.

TUNNEL NAME	OWNER	LOCATION	STATE	TUNNEL USE	LENGTH (FEET)	WIDTH (FEET)	BID YEAR	STATUS
I-70 Floyd Hill Highway Tunnel	Colorado Dept. of Transportation	Denver	CO	Highway	15,840	60 x 25	2022	Under design
Stormwater Control Program	Harris Co. Flood Control District	Houston	TX	CSO	52,800	25-40	2021	Under design
Project Connect Subway Program	City of Austin	Austin	TX	Subway	8,500	20	2023	Under design
Section 19 Long Tunnel Crossing	City of Dallas	Dallas	TX	CSO	12,310	10	2021	Bid date Sept.
D2 Subway - 2nd Light Rail Alignment	Dallas Area Rapid Transit	Dallas	TX	Highway	3,000	22	2020	Under design
Mill Creek Trunk Improvements	City of Nashville	Nashville	TN	CSO	13,800	10	2023	Under design
West Seattle to Ballard Extension	Sound Transit	Seattle	WA	Transit	10,500	18	2024	Under design
LA Metro Speulvada Pass Corridor	Los Angeles MTA	Los Angeles	CA	High/Trans.	55,500	60	2024	LOI received
Folsom Area Storm Water Improvement	SFPUC	San Francisco	CA	CSO	4,000	12	2022	Under design
BART Silicon Valley Phase 2 Tunnel	Santa Clara Valley Transit Authority	San Jose	CA	Subway	26,400	56	2021	Under design
California Waterfix 1 California Waterfix 2	Delta Conveyance Design and Const.	Sacramento	CA	Water	39,905 403,400	28 40	2020 2020	Delayed Delayed
Yonge St. Extension	Toronto Transit	Toronto	ON	Subway	15,000	18	2022	Under design
Massey Tunnel	City of Toronto	Toronto	ON	CSO	20,000	18	2022	Under design
Inner Harbour West	City of Toronto	Toronto	ON	CSO	18,400	19	2022	Under design
Scarborough Rapid Transit Extension	Toronto Transit Commission	Toronto	ON	Subway	25,000	18	2018	Strabag low bidder
Elington Crosstown West Extension	Toronto Transit Commission	Toronto	ON	Subway	40,000	18	2020	West End Contractors low bid
Ontario Line North Extension	Toronto Transit Commission	Toronto	ON	Subway	29,500	20	2022	Under design
Ontario Line South Extension	Toronto Transit Commission	Toronto	ON	Subway	29,500	20	2021	Shortlist announced
Blue Line Extension	Societe de transport de Montreal	Montreal	QC	Subway	19,000	20	2021	Under design
Green Line LRT	City of Calgary	Calgary	AB	Transit	26,250	20	2021	RFQ submitted
Nose Hill Project	City of Calgary	Calgary	AB	CSO	10,800	10	2020	Under design
Annacis Water Supply	City of Vancouver	Vancouver	BC	Water	7,500	15	2021	RFQ requested
Millennium Line Broadway Extenstion	Metro Vancouver	Vancouver	BC	Subway	18,700	18	2020	Acciona/Ghella JV awarded
Eagle Mt. Pipeline	Fortic BC Woodfibre	Vancouver	BC	Oil	29,500	13	2021	Awaiting final award
Stanley Park Water Supply Tunnel	City of Vancouver	Vancouver	BC	Water	5,000	15	2021	Under design

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Advertising Information T&UC

Hooper Jones
CENTRAL, NW U.S.
+1.847.486.1021
Cell: +1.847.903.1853
hooperhja@aol.com

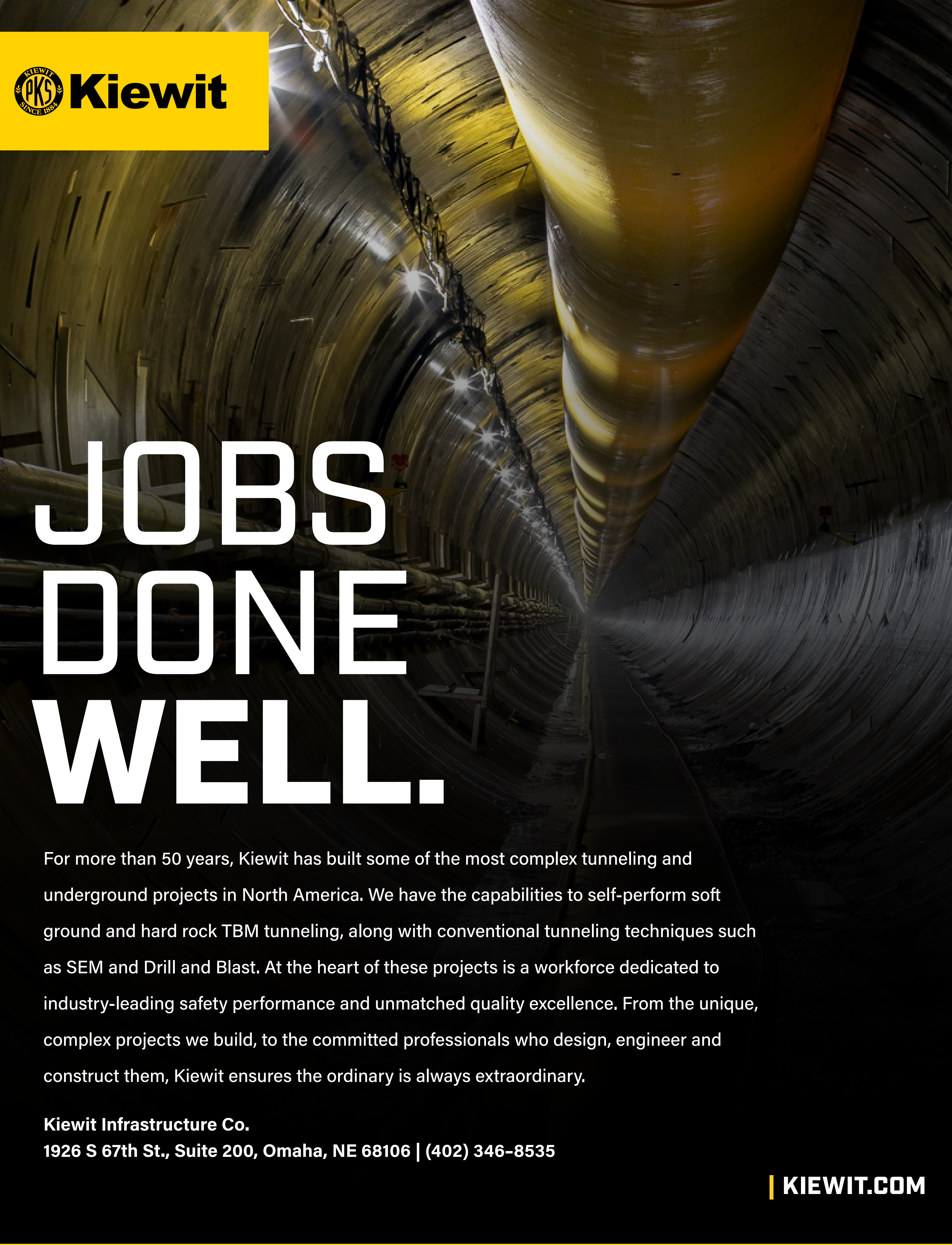
Laura Lemos
EAST, SOUTH, WEST U.S.
Cell: +1.973.668.2449
Main: +1.973.822.9274
laura@boja.com

Darren Dunay
CANADA
+1.201.781.6133
Cell: +1.201.873.0891
sme@dunayassociates.com

Eberhard G. Heuser
EUROPE
+49 1520.9269629
Fax: +49 202 2838126
egh@heusermedia.com

Patrick Connolly
UNITED KINGDOM
+44 1702.477341
Fax: +44 1702.177559
patco44uk@aol.com

Gary Garvey
INTERNATIONAL SALES
+1.303.948.4243
Fax: +1.303.973.3845
garvey@smenet.org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1926 S 67th St., Suite 200, Omaha, NE 68106 | (402) 346-8535
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